Universitat Autònoma de Barcelona

SOCIAL NORMS AS STRATEGY OF REGULATION OF REPRODUCTION AMONG HUNTING-FISHING-GATHERING SOCIETIES
An experimental approach using a multi-agent based simulation system

Juana Maria Olives Pons

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Dissertation

zur Erlangung des

Doktorgrades der Philosophie (Dr. phil.)

vorgelegt

der Philosophischen Fakultät I

Sozialwissenschaften und historische Kulturwissenschaften

der Martin-Luther-Universität

Halle-Wittenberg

und

Facultat de Lletres i Filosofia

Departament de Prehistòria de la

Universitat Autònoma de Barcelona

von Frau Juana Maria Olives Pons

geb. am 04.04.1991 in Maó

Doctoral thesis

_____

Departament de Prehistòria de la Universitat Autònoma de Barcelona

Prähistorische Archäologie und Archäologie des Mittelalters und der Neuzeit von Martin-Luther Universität Halle-Wittenberg

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AN EXPERIMENTAL APPROACH USING A MULTI-AGENT BASED SIMULATION SYSTEM

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2019

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Zusammenfassung

Im Paläolithikum existierten in Europa und Asien mehrere Arten der Gattung Homo, vom *Homo ergaster* im Altpaläolithikum bis hin zur heute noch existierenden Art des modernen Menschen *Homo sapiens sapiens*. Die archäologische Forschung hat viele Aspekte der geographischen und chronologischen Verbreitung der Urmenschen sowie ihrer Transformation und Resilienz beleuchtet – unter anderem ihre anthropologische Morphologie, ihre Umwelt, Nahrung und Technologie. Diese Studien sind überwiegend durch einen biologisch- und umweltdeterministischen Rahmen geprägt, und Ansätze und Hypothesen basieren beispielsweise auf Malthusianischen, Darwinistischen oder Boserupschen Theorien. Die nur begrenzt vorhandenen archäologischen Materialen stellen eine weitere Einschränkung der Stichproben- und Forschungsmöglichkeiten dar, sodass Forschungsfragen im Hinblick auf soziale Strukturen und die soziale Organisation der prähistorischen Menschen nur eingeschränkt beantwortet werden können.

In der vorliegenden Doktorarbeit stelle ich einen alternativen Ansatz zur Erforschung der sozialen Organisation paläolithischer (insbesondere mittel- und jungpaläolithischer) Bevölkerungen vor. Ich stelle die Hypothese auf, dass Gesellschaften, deren Produktionsweise auf der Nutzung natürlicher Ressourcen basiert, ihre Reproduktion mittels sozialer Normen regulieren, um mit der Begrenztheit natürlicher Ressourcen umzugehen. Aus marxistischer Perspektive ist Arbeit die grundlegende soziale Aktivität jeder Gesellschaft, und sie bestimmt die sozialen Beziehungen zwischen den Menschen. Der historischen Demographie entsprechend wurde argumentiert, dass Jäger-, Fischer- und Sammlergesellschaften eine „natürliche“ Fruchtbarkeit aufweisen – d.h. im Unterschied zur kontrollierten Fruchtbarkeit verwenden sie keine Maßnahmen zur intentionalen Geburtenkontrolle oder Begrenzung der Anzahl der Kinder. In Jäger-, Fischer- und Sammlergesellschaften gibt es einen engen Zusammenhang zwischen Arbeit und sozialen Beziehungen. Die Entwicklung und das Fortbestehen einer von Jagd, Fischerei und Sammeln lebenden Bevölkerung hängen vom (un)bilanzierten Verhältnis zwischen Fruchtbarkeitsrate und Sterberate ab. In der Forschung wurde dieses Gleichgewicht gemeinhin als Ergebnis der Wechselbeziehung zwischen der Bevölkerungszahl und der Verfügbarkeit von Ressourcen erklärt. Gemäß dieser Sichtweise führt Bevölkerungswachstum zum zunehmenden Druck auf Ressourcen, was zu einer katastrophalen Steigerung der Sterberate aufgrund der

zunehmenden Ressourcenknappheit führt. Nachdem durch Bevölkerungsrückgang der Druck zum Ausgangsniveau zurückkehrt, sinkt die Sterberate und die Bevölkerung wächst solange, bis der Schwellenwert wieder erreicht wird. Einigen archäologischen Studien zufolge sei dieses demographische Profil im Paläolithikum konstant geblieben (was die niedrige Bevölkerungsdichte oder etwa die mangelnde technische Innovation erklären soll). Allerdings unterstützen Befunde zur genetischen Variation des Menschen im Paläolithikum diese These nicht. Merkmal eines solchen demographischen Profils wäre ein regelmäßig wiederkehrender drastischer Bevölkerungsrückgang, der deutliche Spuren in der genetischen Vielfalt hinterlässt. Die DNA- Ergebnisse von Bevölkerungsgruppen aus dieser Zeit geben jedoch keine Hinweise auf häufige derartige genetische Flaschenhälse.

Ich vertrete die These, dass demographische Stabilität nur schwer durch kontextabhängige und spezifische externe Ereignisse, die lediglich Auswirkungen auf Sterblichkeitsmuster haben, zu erreichen ist. Stattdessen argumentiere ich, dass sich eine flexible Regulierung durch kollektive soziale Entscheidungen auf die Fruchtbarkeitsrate und somit auch auf das Bevölkerungswachstum auswirkt. Um die niedrige und stabile Bevölkerungsdichte im Paläolithikum zu erklären, bedarf es einer analytischen Perspektive, in der die soziale Organisation von Bevölkerungsgruppen sowie die soziale Regulierung der Reproduktion berücksichtigt werden.

Ich gehe von der Annahme aus, dass prähistorische und gegenwärtige Jäger-, Fischer- und Sammlergemeinschaften einer sehr ähnlichen Produktionsweise nachgehen; somit können gegenwärtige Bevölkerungsgruppen als Bezugspunkt benutzt werden, um Einsichten in paläolithische, und insbesondere jungpaläolithische Gesellschaften zu gewinnen. Wenn man aber die Forschungsliteratur in diesen zwei Bereichen vergleicht, wird deutlich, dass sie von jeweils unterschiedlichen Prämissen ausgeht: Die archäologischen demographischen Studien setzen eine Bevölkerung mit natürlicher Fruchtbarkeit voraus, in der sowohl Fruchtbarkeits- als auch Sterblichkeitsraten hoch sind. In den Studien gegenwärtiger Gesellschaften wird eine Varianz von Sterblichkeitsraten, aber auch von Fruchtbarkeitsraten nachgewiesen. Deswegen ist es wichtig zu erkennen, dass es keine universelle Fruchtbarkeitsrate gibt, vielmehr organisiert jede menschliche Gesellschaft – inklusive Jäger-, Fischer- und Sammlergruppen – ihre Reproduktion auf jeweils spezifische Weise. Darüber hinaus sind in den ethnographischen Studien gegenwärtiger Jäger-, Fischer- und Sammlergruppen zwei weitverbreitete Muster zu erkennen:

erstens wird die Arbeitsteilung weitgehend durch das Geschlecht bestimmt, und zweitens sind die sozialen Verhältnisse zwischen Männern und Frauen asymmetrisch. Das heißt, die Organisation der Arbeit in diesen Gruppen weist nicht nur auf eine spezifische Produktionsweise hin, sondern auch auf eine spezifische soziale Organisation der Gruppenmitglieder und ihrer sozialen Beziehungen zueinander.

Die Erforschung dieser Frage umfasst drei Phasen. Eine erste Phase widmet sich der Frage, ob eine sozial organisierte Reproduktion, die auf einem Set von Normen basiert, die reproduktive Beziehungen regeln, das demographische Wachstum wirksam reguliert. Ein zweiter Schritt erfordert die Untersuchung der ethnoarchäologischen Kontexte, es gilt dabei Ausgrabungstechniken zu verfeinern und die Indizien für die Regulierung der Produktion und Reproduktion besser zu erkennen. Eine dritte Phase würde hauptsächlich auf die Untersuchung archäologischer Fundstätten des Paläolithikums fokussieren. In dieser Arbeit beschäftige ich mich vorwiegend mit der ersten Phase.

Obwohl die Forschungsfragen und der akademische Beitrag dieser Arbeit in der Archäologie angesiedelt sind, benutze ich hier Daten und Materialen aus ethnohistorischen Quellen und ethnographischen Studien. Ethnographische und demographische Daten über gegenwärtige Jäger-, Fischer-, und Sammlergruppen wurden häufig herangezogen, um die Demographie prähistorischer Bevölkerungen zu erklären. Diese Daten sind aber jeweils auf Feldstudien beschränkt, die zu einem bestimmten Zeitpunkt und in einem bestimmten historischen Kontext stattfanden (Zugang zur Bildung und zur medizinischen Versorgung kann beispielsweise die Organisation der Reproduktion schnell ändern), und folglich stellen sie eine begrenzte und statische Aufnahme eines de facto größeren, dynamischen demographischen Profils dar. Somit ist es unmöglich, alle Faktoren und ihre Wechselwirkungen aus den Daten abzuleiten. Ich verfolge daher einen anderen Ansatz. In dieser Methodologie werden qualitative und quantitative Daten aus unterschiedlichen Quellenarten – ethnohistorischen und ethnographischen Studien, medizinischen Erhebungen, demographischen Statistiken – zusammengebracht und in eine Multi-Agenten-Simulation eingegeben. Zunächst durchsuchte ich die ethnohistorische Literatur über ausgestorbene und noch existierende Jäger-, Fischer- und Sammlergesellschaften nach Informationen über soziale Verhaltensformen und Normen. Die besondere Relevanz der ethnohistorischen Quellen besteht in ihrer diachronen Dimension, durch die der historische Kontext der ethnologischen Daten ersichtlich wird, was wiederum eine umfassendere Analyse

der sozioökonomischen Organisation(en) sowie ihrer Resilienz und zeitlichen Transformation ermöglicht. Angesichts der vorhandenen Variabilität der demographischen Parameter wäre die Berücksichtigung einer einzigen Jäger-, Fischer- und Sammlergesellschaft unzureichend, um mögliche demographische Profile auszuwerten. Aus diesem Grund benutze ich als Bezugspunkte für meinen Vergleich vier bedeutende und umfangreiche Studien über gegenwärtige Jäger-, Fischer- und Sammlergruppen (die Agta, Aché, !Kung und Hadza). In einem interdisziplinären Ansatz dient ein Multi-Agenten-Simulationsprogramm als Experimentierfeld, um demographische Prozessen zu modellieren. Dadurch wird getestet, wie sich soziale Normen auf das Bevölkerungswachstum auswirken. Die gewonnen statistischen Ergebnisse sollen Diskussionen über die sozioökonomische Organisation der Jäger-, Fischer- und Sammlergesellschaften des Mittel- und Jungpaläolithikums anregen.

Die Dissertation gliedert sich in eine Einführung, acht Diskussionskapitel und die Schlussbemerkungen. Die Arbeit wird am Ende durch einen Appendix mit Anlagen ergänzt.

Kapitel 1: Demographie und Paläodemographie. Ich gebe eine Übersicht des historischen Verständnisses von Bevölkerungsgruppen und Reproduktion von der Antike (China und Griechenland) bis zur Gegenwart. Die Theorien von Malthus, Darwin und Boserup haben die Sozialwissenschaften nachhaltig beeinflusst; Ergebnis davon sind konsolidierte Theorien über die Wechselwirkung zwischen der Bevölkerungszahl und der Ressourcenverfügbarkeit. Diese Theorien haben ebenso bedeutend auf die theoretischen und methodologischen Ansätze in der Archäologie – und somit auch auf die Erforschung paläolithischer Gesellschaften – eingewirkt. Als Beispiel dieses theoretischen Bias erläutere ich kurz die Forschung über die Entwicklung der *Hominina*, der unterschiedlichen Arten der Urmenschen, in Europa und Asien im Paläolithikum. Es wird deutlich, dass in den Studien nur die Dimensionen der Umwelt, der Biologie und der Produktion (d.h. Subsistenzstrategien, technologische Innovationen und Anpassung an der Umwelt) berücksichtigt werden. Allgemein gesprochen werden die paläolithischen Bevölkerungsgruppen (d.h. ihr Fortbestehen oder Verschwinden) überwiegend im Hinblick auf ihre Fähigkeiten (Technologie) und Anpassung (Biologie) analysiert. Wie ich betone, ist es allerdings wichtig, diese Analysen durch eine weitere Dimension – nämlich, die soziale Organisation von Menschen (Reproduktion) – zu ergänzen. Einzelne archäologische Studien haben bereits versucht, Bevölkerungsanalyse (Demographie) in die paläolithische Archäologie zu integrieren. Das Kapitel schließt mit einer Diskussion der Ansätze und Methodologien dieser

paläodemographischen Studien sowie der Unstimmigkeiten und Widersprüche, die bei einem Vergleich ihrer Ergebnisse mit den Ergebnissen ethnographischer und demographischer Studien gegenwärtiger Jäger-, Fischer- und Sammlergruppen zum Vorschein kommen.

Kapitel 2: Theorie mittlerer Reichweite. Zur Erläuterung der demographischen Dynamiken befasse ich mich in diesem Kapitel mit den vorhandenen demographischen Daten über gegenwärtige Jäger-, Fischer- und Sammlergruppen sowie mit dem allgemeinen Bild der Demographie präindustrieller Gruppen. Das demographische Profil beider Typen von Gesellschaften ist durch hohe Fruchtbarkeits- und Sterberaten gekennzeichnet und wird als „natürliche“ Fruchtbarkeit bezeichnet. In diesem Zusammenhang werden die rein biologischen Faktoren, die zur Reproduktion menschlicher Bevölkerungen beitragen diskutiert. Die Widersprüche, die beim Vergleich paläodemographischer und demographischer Studien sichtbar werden stammen aus der Annahme daß ausschließlich natürliche Faktoren zur Begrenzung des Bevölkerungswachstums in der Vergangenheit beigetragen hätten. Nachdem die biologischen Variablen identifiziert werden, wird jedoch das Vorhandensein von sozialen Normen oder spezifischen sozialen Verhaltensmustern erkennbar. Hier stelle ich einen alternativen theoretischen Rahmen vor, in dem folgende Elemente berücksichtigt werden: der grundlegende Konflikt zwischen Bevölkerungswachstum und Reproduktion von natürlichen Ressourcen; die sozioökonomischen Verbindungen zwischen Arbeit und Arbeitskräften (Produktion und Menschen); die zwei Dimensionen Jäger-, Fischer- und Sammler-Gesellschaften (Produktion und Reproduktion); und die Nichtübereinstimmung der paläodemographischen und demographischen Profile von prähistorischen und gegenwärtigen Jäger-, Fischer- und Sammlergruppen. Ich berücksichtige hierbei einen analytischen Ansatz, demzufolge führen die Organisation der Arbeit und die Regulierung der Reproduktion zur Legitimierung von sozialer Ungleichheit entlang der Geschlechterdimension. Diese strategische Arbeitsteilung relativiert nicht nur den Wert des Produkts, sondern auch den Wert, der den produzierenden Menschen zugeschrieben wird. Zuletzt werden soziale Normen im Kontext dieser Arbeit definiert – als soziale Konstrukte, die das menschliche Verhalten, die sozialen Beziehungen und die Reproduktionsbeziehungen im Laufe des Lebens eines Menschen je nach Alter und Geschlecht organisieren.

Kapitel 3: Methodologie. In diesem Kapitel werden die Vorteile eines interdisziplinären methodologischen Ansatzes vorgestellt. Ethnohistorische Quellen bieten Information über die sozioökonomische Organisation moderner Jäger-, Fischer- und Sammlergruppen, zudem werden

neuere ethnographische Arbeiten sowie medizinische und biologische Studien berücksichtigt. Darüber hinaus werden auch verfügbare demographische statistische Daten über vorindustrielle Gesellschaften mit angeblich natürlicher Fruchtbarkeit genutzt, um einen quantitativen Rahmen für die allgemeinen Bevölkerungsdynamiken zu erstellen. Dazu gehören die Bevölkerungsstruktur, die vorhandenen Wachstumsraten, Fruchtbarkeitsraten, Sterblichkeitsraten, Häufigkeit spontaner Fehlgeburten, Dauer der sekundären Amenorrhoe usw. Diese heterogenen Daten wurden dann in das für dieses Projekt verwendete Multi-Agenten-Simulationsprogramm eingegeben. Gewählt wurde ein von Adrià Vila erstelltes Programm, das bereits für das Modellieren von demographischen Entwicklungen in Jäger-, Fischer- und Sammlergesellschaften verwendet wurde. Nach der Eingabe der reproduktionsbedingten (biologischen und sozialen) Variablen werden unterschiedliche demographische Szenarien simuliert. Die biologischen und sozialen Variablen können im Programm auf die Befunde der unterschiedlichen von mir verwendeten Quellen und Studien abgestimmt werden. Die wichtigsten Merkmale und Funktionen des sehr komplexen Programms werden im Kapitel erläutert.

Kapitel 4: Komparative Analyse: die Bevölkerungen des südlichen Afrika. Dieses Kapitel widmet sich den Risiken der Verwendung von Daten über gegenwärtige Jäger-, Fischer- und Sammlergruppen, um prähistorische und ausgestorbene Jäger-, Fischer- und Sammlergruppen zu verstehen. Obwohl die demographischen und ethnographischen Studien gewisse Schranken aufweisen, argumentiere ich für die Relevanz ihrer demographischen Parameter und ihrer Daten zur sozioökonomischen Organisation. Um den Bezugsrahmen zu verbessern, wird eine vergleichende Analyse vorgenommen. In dieser Arbeit werden die wichtigsten demographischen Studien über gegenwärtige Jäger-, Fischer- und Sammlergruppen sowie ethnoarchäologische und historiographische Studien über die Bevölkerungen Terra del Fuego im südlichen Südamerika (die als „generalisierte“ Jäger-, Fischer- und Sammler gelten) und über die Küsten-Salish im nordamerikanischen Nordwesten (die als „komplexe“ Jäger-, Fischer- und Sammler gelten) berücksichtigt. Meine eigene Forschung wird anhand der ethnohistorischen Quellen über die Bevölkerungen des südlichen Afrikas (Khoisan) durchgeführt. In der prähistorischen Archäologie wurden die Khoisangruppe Dobe !kung häufig als Paradebeispiel einer Jäger- und Sammlergesellschaft angeführt, aber diese Übertragung der ethnographischen Daten auf den prähistorischen Kontext in der Form von Extrapolationen und Analogien ist auf breite Kritik gestoßen. Die in dieser Dissertation vorgestellte Methodologie will diese Probleme vermeiden,

und das Potenzial ethnohistorischer und ethnographischer Studien – das heißt, ihrer Daten und Befunde zur Demographie und sozioökonomischen Organisation – nutzbar machen. Indem allgemeine Muster in den unterschiedlichen untersuchten Gruppen identifiziert werden, wird es möglich, die Hauptvariablen abzuleiten, die für die Regulierung der Reproduktion relevant sind.

Kapitel 5: Ethnoarchäologie und Ethnohistorie: die Bevölkerungen des südlichen Afrika. Damit zwei unabhängige Informationsquellen gegeben sind, soll die Forschung idealerweise sowohl ethnohistorische als auch ethnoarchäologische Daten beinhalten. Das Erstellen einer umfassenden Datenbank mit den Befunden beider Forschungsgebiete wäre jedoch ein umfangreiches Unternehmen, das den Rahmen dieser Arbeit sprengen würde. Ich fokussiere daher auf ethnoarchäologische Studien, die im südlichen Afrika durchgeführt wurden. Die Mehrheit der in der Dissertation verwendeten Materialen sind ethnohistorische Quellen. Insgesamt handelt es sich um über fünfzig ethnohistorische Quellen und zeitgenössische demographisch-ethnographische Studien zu Bevölkerungsgruppen im südlichen Afrika (Khoisan) aus einer Zeitspanne von fast 400 Jahren (17. bis 21. Jahrhundert). Da Art und Beschaffenheit der ethnohistorischen Quellen sehr unterschiedlich sind, werden ihre Zuverlässigkeit und Potenziale erörtert und ein analytischer Ansatz für den Umgang mit den Ähnlichkeiten, Unterschieden und Widersprüchen dargelegt.

Kapitel 6: Materialen. In diesem Kapitel werden die quantitativen und qualitativen Befunde aus den ethnohistorischen Berichten und ethnographischen Studien neueren Datums über die Bevölkerungsgruppen des südlichen Afrikas (Khoisan) dargelegt. Ich erläutere die Daten in Bezug auf die Forschungsfragen dieser Arbeit, das heißt, ihre Relevanz für das soziale Verhalten um die Teilnahme an Reproduktion in einer Bevölkerung mit angeblich natürlicher Fruchtbarkeit. Ohne mich streng an die traditionelle *ethnische* Aufteilung der Khoisan zu halten, erstelle ich eine Liste der wichtigsten sozialen Normen zweier Arten von Gruppen, die in Hinsicht auf ihre Lebensweise unterschiedlich sind: überwiegend Jagen und Sammeln oder überwiegend Hirtennomadismus (den San bzw. den Khoi entsprechend). Die Lebensphasen jedes einzelnen Menschen werden sozial reguliert u.a. in Hinblick auf die Teilnahme an Reproduktion, und diese Normen haben Folgen für die langfristige demographische Entwicklung der Gruppe (Bevölkerungswachstum). Die gebündelten Kategorien der sozialen Normen lassen sich wie folgt beschreiben: Übergangsriten, Erstheiratsalter, Eheform, Geburtsintervalle. Die Beschreibungen in den unterschiedlichen ethnohistorischen Quellen sind manchmal beinahe identisch, manchmal

aber auch widersprüchlich, z.B. wenn es in einer Quelle heißt, die Bevölkerungsgruppe praktiziere Polygamie, und in einer anderen, sie praktiziere ausschließlich Monogamie. Innerhalb jeder Bevölkerungsgruppe (Khoi und San) strukturiere ich die sozialen Normen über den Lebensverlauf der Männer und Frauen und vergleiche die unterschiedlichen Ausprägungen und Entwicklungen gleicher oder sehr ähnlicher sozialer Normen. Widersprüche werden dabei nicht ausgeklammert: So ist es möglich, dass bestimmte soziale Praktiken von den jeweiligen Verfasserinnen oder Verfassern nicht richtig beobachtet oder falsch interpretiert wurden. Es ist aber ebenfalls möglich, dass die unterschiedlichen Formen dieser sozialen Praktiken vielmehr auf chronologische oder geographische Varianz hinweisen.

Kapitel 7: Demographische Simulationsexperimente. In diesem Kapitel werden die Einzelheiten der experimentellen Simulationen erklärt. Ich stelle die einzelnen Schritte in der Nachbildung einer fiktiven Gemeinschaft (oder fiktiven Bevölkerungsgruppe) vor. Gewählt wurde eine für Jäger-, Fischer- und Sammlergruppen typische pyramidenförmige Altersstruktur. Die unterschiedlichen sozialen und biologischen Variablen, die für jeden Agenten (jedes Individuum) im Simulationsprogramm spezifiziert werden, werden erklärt. Im zweiten Teil des Kapitels verschiebt sich der Fokus auf die Vorgehensweise bei der Gestaltung und Strukturierung der Simulationen. Die qualitativen und quantitativen Daten geben nämlich unterschiedliche und manchmal widersprüchliche Auskünfte über das sozioökonomische Verhalten. Es ist schwierig, festzustellen, welche Berichte den eigentlichen Verhältnissen am nächsten kommen. Zudem ist es auch möglich, dass zeitliche und räumliche Unterschiede existierten. Darüber hinaus schildern die ethnohistorischen Berichte und ethnographischen Studien nur einen Bruchteil des sozioökonomischen Verhaltens und geben somit ein unvollständiges Bild wieder – etwa hat die Verfasserin oder der Verfasser manche sozialen Praktiken nicht beobachtet oder der Fokus der Beobachtungen bzw. der Studie hat manche sozialen Praktiken nicht berücksichtigt. Aus diesem Grund ist die Information sehr ungleichmäßig verteilt: je nach Verfasser(in), temporalem oder räumlichen Kontext. Um den Effekt dieser Ungleichmäßigkeit möglichst zu reduzieren, kalkuliere ich die unterschiedlich starken Ausprägungen dieser Normen mit ein: als Minimalform und als Maximalform, z.B. ein einjähriger Geburtsintervall oder ein frühes Erstheiratsalter bzw. ein fünfjähriger Geburtsintervall oder ein spätes Erstheiratsalter. In den Simulationsläufen werden beide Ausdrucksformen jeweils auf ihre Auswirkungen hin getestet und analysiert: in der Simulationsreihe ist das gesamte Spektrum der Möglichkeiten enthalten, von Modellen ganz ohne

soziale Normen bis hin zur restriktivsten und umfangreichsten Kombination der sozialen Normen.

Kapitel 8: Ergebnisse der experimentellen Simulationen. In diesem Kapitel diskutiere ich die Ergebnisse der experimentellen Simulationen. Die Ergebnisse unterstützen meine Ausgangshypothese: soziale Normen haben eine Wirkung auf die Reproduktion (natürliche Fruchtbarkeit) und somit auch auf das demographische Wachstum einer Jäger-, Fischer- und Sammlergesellschaft. Die Ergebnisse lassen drei allgemeine Muster erkennen. Das erste Muster kommt in den Simulationsmodellen vor, in denen nur biologische Parameter (z.B. Alter der sexuellen Reife, Lebenserwartung) einkalkuliert wurden. Das Ergebnis ist ein rapides Bevölkerungswachstum über einen Zeitraum von 150 Jahren. Dieses Muster ist bei einer auf Sammeln und Wildbeute basierten Produktionsweise nicht nachhaltig, darüber hinaus entspricht es weder den archäologischen noch den ethnologischen Daten. Das zweite Muster ist in den Simulationsmodellen mit der Minimalform aller sozialen Normen zu beobachten: hier ist das Bevölkerungswachstum langsamer als in der ersten Simulationsgruppe, aber nach 150 Jahren dennoch nennenswert. Es wird deutlich, dass auch eine geringe Regulierung der Reproduktion langfristige Wirkungen hat. Das dritte Muster ist charakteristisch für die Modelle, in denen die Maximalform aller sozialen Normen einkalkuliert wird und ergibt eine mehr oder weniger stabile Bevölkerungszahl über einen Zeitraum von mehr als 450 Jahren. Im Allgemeinen entstehen aus der Regulierung der Reproduktion zwei Möglichkeiten: entweder wird die Bevölkerung durch übermäßiges Wachstum kritisch gefährdet, oder soziale Normen können die Bevölkerungszahl so regulieren, dass sie langfristig bestehen kann, ohne die Tragfähigkeit der natürlichen Umwelt zu übersteigen.

In der vorliegenden Dissertation wird gezeigt, dass der interdisziplinäre Ansatz einen präziseren Rahmen bildet, um die soziale Organisation prähistorischer Jäger-, Fischer- und Sammlergesellschaften zu untersuchen. Durch die unterschiedlichen Perspektiven der jeweiligen Disziplinen wird es möglich, allen Aspekten des untersuchten Phänomens nachzuspüren. Die Wechselwirkungen zwischen den verschiedenen Faktoren müssen identifiziert und verstanden werden, bevor ihre Bedeutung und ihre Auswirkungen ausgewertet werden können. Auf diese Weise leisten die Ergebnisse des Dissertationsprojekts einen wichtigen Beitrag zur Weiterentwicklung der Forschung über paläolithische Gesellschaften. Der neue Blick auf ihre demographischen Dynamiken ändert unser Verständnis der sozioökonomischen Organisation

dieser Gesellschaften auf radikale Weise, denn er führt zur Erkenntnis, dass prähistorische Menschen ihre Reproduktion durch soziale Normen reguliert haben. Dies wiederum könnte geschlechtsspezifische soziale Ungleichheiten beleuchten: die Organisation der Arbeit zusammen mit der Regulierung der Reproduktion können eine Legitimierung der Arbeitsteilung nach Geschlecht hervorrufen. Zur Erforschung dieser Fragen muss noch viel Arbeit geleistet werden, als erstes müssen im Zusammenhang mit den archäologischen Befunden die Ausgrabungstechniken weiterentwickelt werden, die dann zur Untersuchung paläolithischer Fundstätten verwendet werden können. Parallel dazu sollte das Verständnis über das Entstehen und die Transformation sozialer Ungleichheiten ausgeweitet werden.

Resum

En el Paleolític, Europa i Àsia varen ser habitades per diferents espècies humanes, començant des de l'*Homo ergaster* en el Paleolític Inferior, fins als nostres dies amb la forma *Homo sapiens sapiens.* Els estudis arqueològics han donat a conèixer el seu abast geogràfic i cronològic, així com altres aspectes relacionats amb processos de transformació o de continuïtat –per exemple, la morfologia antropològica, l'entorn ambiental, la dieta, tecnologia, entre altres. Aquests estudis s'han emmarcat principalment en propostes de caràcter biològic o ambiental, conduint a aproximacions d'estudi i hipòtesis basades, per exemple, en les teories Malthusiana, Darwiniana o Boserupiana. Simultàniament, les característiques del material arqueològic limiten el mostreig i les possibilitats de recerca, el que conseqüentment comporta que els estudis hagin d'afrontar diverses dificultats per poder analitzar estructures socials o l'organització social de comunitats prehistòriques.

En la present tesi doctoral, plantejo una proposta alternativa que té per objectiu desenvolupar i seguir una nova línea de recerca sobre l'organització social de les poblacions paleolítiques –especialment en el Paleolític Mitjà, Paleolític Superior i Mesolític. La tesi que segueixo estableix que aquelles societats que tenen un mode de producció basat en l'explotació dels recursos naturals organitzen socialment la seva reproducció, per tal d'adequar-se a la capacitat de càrrega dels recursos naturals. Des d'una perspectiva Marxista, el treball representa al mateix temps la relació social bàsica en qualsevol societat, el que inherentment conté el caràcter de les relacions entre els individus. En el cas dels caçadors-pescadors-recol·lectors, s'esdevé una correspondència entre el treball i les relacions socials. Tal i com ha establert la demografia històrica, s'ha sugerit que les societats caçadores-pescadores-recol·lectores presenten (suposadament) una fecunditat natural, en contraposició amb la fecunditat controlada –i.e. aquestes no comptem amb mètodes eficients pel control de fecunditat. Simplificadament, el desenvolupament i continuïtat d'una població caçadora-pescadora-recol·lectora es recolza en la (des-)equilibrada interrelació entre la taxa de fecunditat i la taxa de mortalitat. Tradicionalment, aquest equilibri s'ha explicat en funció de la relació entre persones i recursos. Aquesta proposta exposa que un increment de la pressió demogràfica sobre els recursos naturals, condueix a un context de catàstrofe en el que la taxa de mortalitat s'incrementa degut a la mancança de recursos. Un cop els nivells de pressió demogràfica retornen als inicials, la taxa de mortalitat disminueix i la població inicia una nova

fase de creixement fins a arribar al següent sostre de l'equilibri. Diversos estudis arqueològics semblen coincidir que aquest perfil demogràfic hauria estat una constant durant el Paleolític (el que explicaria la baixa densitat demogràfica, o la manca d'innovació tecnològica). Tècnicament, aquest perfil demogràfic estaria caracteritzat per freqüents reduccions del volum de la població, el que hauria deixat una emprempta en la diversitat genètica en les poblacions antigues. En aquest respecte, els estudis d'ADN antic no corroboren aquesta possibilitat, degut a què els resultats de les seves anàl·lisis no indiquen que els episodis de coll d'ampolla fossin freqüents.

Des del meu punt de vista, considero que és difícil aconseguir estabilitat demogràfica únicament a través de fenòmens circumstancials, específics i externs, que afecten exclusivament els patrons de mortalitat. Alternativament, considero que mecanismes de regulació flexibles, conformats a partir de les decisions socials i col·lectives que afecten a la fecunditat, tenen un impacte molt important en el desenvolupament demogràfic. La densitat demogràfica baixa i estable que s'observa en el Paleolític requereix d'una perspectiva d'anàlisis diferent, que tingui en compte l'organització social de la població i la regulació social de la reproducció.

Parteixo de l'assumpció que els grups caçadors-pescadors-recol·lectors prehistòrics i moderns comparteixen un mode de producció similar en lo tècnic i en els factors externs (dependència de la capacitat de reproducción dels recursos) i que, per tant, els grups grups caçadors-pescadors-recol·lectors moderns poden servir com a referències per l'estudi de les societats Paleolítiques – especialment les del Paleolític Superior, la capacitat tecnològica extractiva de les quals no és gaire diferent. No obstant, de la comparació dels estudis demogràfics dels caçadors-pescadors-recol·lectors moderns amb els estudis paleodemogràfics en sorgeix una contradicció. D'una banda, els estudis paleodemogràfics emmarquen les seves hipòtesis dintre de la tipologia de societat que segueix una fecunditat natural, teòricament caracteritzada per una elevada fecunditat i elevada mortalitat. De l'altra banda, els estudis demogràfics de grups moderns no només exposen l'existència de taxes de mortalitat variables, sinó que també hi ha variabilitat en les taxes de fecunditat. En aquest sentit, és imprescindible reconèixer que una taxa de fecunditat universal no existeix, tot el contrari, totes les societats humanes han organitzat la reproducció de manera diferent. Addicionalment, dels estudis etnogràfics sobre societats caçadores-pescadores-recol·lectores modernes se n'extrauen dos patrons comuns: d'una banda, la divisió i organització del treball basada essencialment en l'edat i el sexe i, de l'altra banda, la constatació d'una asimetria social entre homes i dones. D'aquesta manera, l'organització del treball en aquests

grups no només assenyala un mode de producció específic, sinó també l'organització social específica de la seva gent i de les seves relacions socials.

Principalment, hi ha tres fases de recerca en l'agenda. En la primera fase, cal primer verificar la principal pregunta de recerca, respecte a si l'organització social de la reproducció constituïda entorn a un conjunt de normes socials que regulen les relacions socials de reproducció té efectivament un efecte notable sobre el creixement demogràfic. Una segona fase consisteix en l'estudi de contextos etnoarqueològics, per tal de refinar les metodologies d'excavació i de millorar el coneixement que permeti la identificació de marcadors relacionats amb la regulació de la producció i de la reproducció. Finalment, la tercera fase portaria l'atenció cap a l'estudi de contextos arqueològics del Paleo-mesolític, sobre els quals aplicar els coneixements acumulats. En la present tesi doctoral, centro la meva atenció a la primera fase de l'agenda.

La tesi té per objectiu trobar respostes que contribueixin al camp de l'arqueologia, no obstant els materials i dades amb les que treballo provenen de fonts etnohistòriques i estudis etnogràfics. Les dades etnogràfiques i demogràfiques sobre poblacions caçadores-pescadores-recol·lectores modernes han estat sovint utilitzades per explicar la demografia de les prehistòriques. No obstant, aquestes dades estan limitades pel seu propi temps, el que porta a una imatge reduïda i estàtica del perfil demogràfic, quan en realitat aquest és dinàmic, el que no permet una extracció encertada de la correlació de tots els factors involucrats. Des d'una perspectiva diferent, la metodologia que segueixo combina les dades qualitatives i quantitatives extretes de les fonts etnohistòriques, de diferents estudis etnogràfics, mèdics, i d'estadístiques demogràfiques, juntament amb un programa de simulació multi agent. Primerament, he buscat i identificat informació relacionada amb el comportament social i les normes socials en les fonts etnohistòriques de grups caçadors-pescadors-recol·lectors extingits o que encara perviuen. La importància d'accedir a fonts etnohistòriques recau en el potencial de la dimensió diacrònica. La dimensió diacrònica exposa el context històric en el qual s'enquadren les dades etnològiques, permetent una anàlisis completa de les organitzacions socioeconòmiques, juntament amb les seves transformacions o continuïtats al llarg del temps. Donada l'existència de variabilitat en els paràmetres demogràfics identificats, no seria suficient treballar una única societat caçadora-pescadora-recol·lectora, sobretot si es pretén contrastar correctament els possibles perfils demogràfics. En aquest sentit, tinc en compte els quatre estudis principals de demografia de societats caçadores-recol·lectores modernes (Agta, Aché, !kung, i Hadza). En aquesta perspectiva

interdisciplinària, el sistema de simulació multi agent (un programa computacional) proporciona el terreny per a l'experimentació, donat que amb aquest és possible simular processos demogràfics, en els quals puc posar a prova i avaluar els efectes que les normes socials tenen sobre el creixement demogràfic. Els resultats estadístics obtinguts poden reobrir la discussió entorn a l'organització socioeconòmica per la reproducció de les societats caçadores-pescadores-recol·lectores Paleo-mesolítiques.

L'estructura de la tesi s'organitza en 8 capítols, precedits per la introducció i seguits per les conclusions. Al final de la tesi s'hi troben diversos annexos, el propòsit dels quals és complementar el contingut dels capítols en els quals es referencien.

Capítol 1. Demografia i Paleodemografia. En aquest capítol presento un recull del caràcter que s'ha donat a les entitats de població i reproducció al llarg de la història, des de l'antiga Xina o Grècia, fins al present més recent. Argumento com la exposició perllongada dels estudis socials a teories com la Malthusiana, Darwiniana o Boserupiana ha demarcat i consolidat les interpretacions respecte a la interrelació entre recursos naturals i poblacions. Aquestes mateixes teories també han influenciat notòriament les propostes teòriques i metodològiques en el camp de l'arqueologia i, per tant, a l'estudi de les societats Paleolítiques. En aquest sentit, resumeixo breument en aquest capítol el desenvolupament de les espècies hominina antigues durant el Paleolític a Europa i Àsia, posant èmfasi a l'esbiaixi dels estudis en els que només estan presents les dimensions de l'entorn ecològic, la biologia o la producció –i.e. estratègies de subsistència, innovació tecnològica, adaptació ambiental. En termes generals, aquesta aproximació ha condicionat l'anàlisi de les poblacions Paleolítiques en termes demogràfics (continuïtat o extinció), de capacitat (tecnologia) i d'adaptabilitat (biologia). Complementàriament, remarco la importància de incloure la dimensió de l'organització social de les poblacions (reproducció). En el camp de l'arqueologia del Paleolític, diversos estudis han intentat incorporar a les poblacions (la demografia) en l'equació . Per tancar el capítol, resumeixo quines han estat les perspectives i metodologies d'estudi d'aquest treballs, indicant les discrepàncies o contradiccions que sorgeixen quan es comparen amb els resultats dels estudis etnogràfics i demogràfics de grups caçadors-pescadors-recol·lectors moderns.

Capítol 2. Teoria de Rang Mitjà. Considerant el tema de les dinàmiques poblacionals, en aquest capítol introdueixo les dades demogràfiques disponibles dels estudis duts a termes sobre les

comunitats caçadores-pescadores-recol·lectores contemporànies, comptant juntament amb referències generals de les dades disponibles de poblacions pre-industrials que també segueixen teòricament una fecunditat natural. Aquesta informació és posada en relació amb el debat entorn a les variables exclusivament biològiques que formen part de la reproducció de poblacions humanes. Les contradiccions que sorgeixen en comparar els grups prehistòrics amb els moderns són resultat de l'assumpció que el creixement demogràfic de les poblacions prehistòriques estava limitat únicament per causes naturals. Un cop identificats i delimitats els factors biològics, apareix la presència de normes socials o de determinats comportaments social. La meva proposta té en consideració la contradicció inherent (entre creixement demogràfic i reproducció dels recursos naturals), la interrelació socioeconòmica entre treball i força de treball (producció i persones), les dues dimensions de la població caçadora-pescadora-recol·lectora (producció i reproducció), i la contradicció entre els perfils paleodemogràfics i demogràfics (prehistòrics i contemporanis). Finalment, en el capítol introdueixo la definició de norma social en el context d'aquesta tesi –entesa com un constructe social que organitza el comportament humà, les relacions socials i reproductives al llarg del curs de les vides de les persones, en funció del sexe i l'edat.

Capítol 3. Metodologia. En aquest capítol presento el potencial que pot tenir una metodologia interdisciplinària. Les fonts etnohistòriques proporcionen informació diversa sobre l'organització socioeconòmica dels grups caçadors-pescadors-recol·lectors moderns, al mateix temps que els estudis etnogràfics recents completen la base de dades, juntament amb estudis mèdics i biològics. De igual rellevància són les dades estadístiques sobre els patrons de demografia en societats pre-industrials (les que segueixen presumptament també una fecunditat natural), per tal de comptar amb un marc de referència quantitatiu pel que fa a dinàmiques poblacionals: estructura poblacional, índexs de creixement, taxes de fecunditat, taxes de mortalitat, incidència d'avortament espontani, esperança de vida, durada de l'amenorrea secundària, etc. Totes aquestes dades heterogènies recollides s'incorporen en un sistema de simulació multi agent, un programa computacional desenvolupat per Adrià Vila, derivat del projecte de recerca «Analisis etnoarqueólogico de la reproducción en sociedades cazadoras-recolectoras» HAR2011-24356 de la Dirección General de Enseñanza Superior e Investigación Científica. Aquest programa genera un entorn complex en el qual introdueixo les variables relacionades amb la reproducció (biològiques i socials) amb la possibilitat de simular contextos demogràfics. L'estructura del

programa de simulació fa possible ajustar les variables socials i biològiques en funció de les troballes en les diferents fonts i estudis que he utilitzat. El programa de simulació és un instrument molt complex com per detallar-lo en aquesta tesi, no obstant descriuré les principals característiques i funcions.

Capítol 4. Estudi comparatiu: les poblacions del sud d'Àfrica. Aquest capítol es centra principalment en dirigir el debat entorn al risc d'utilitzar grups de caçadors-pescadors-recol·lectors moderns i contemporanis amb el propòsit d'estudiar grups de caçadors-pescadors-recol·lectors prehistòrics i/o extingits. Tot i les limitacions dels estudis demogràfics i etnogràfics, argumento que els paràmetres demogràfics i les dades respecte a l'organització socioeconòmica són rellevants i, per tant, no poden ser ignorats. Un estudi comparatiu ofereix un millor marc de referència, per la qual cosa tinc en consideració als quatre estudis principals de demografia de grups caçadors-pescadors-recol·lectors contemporanis, juntament amb els estudis etnoarqueològics i historiogràfics de les poblacions de Tierra del Fuego al sud de Sud-Amèrica (classificats com caçadors-pescadors-recol·lectors simples) i els Salish de la costa nord-oest de Nord-Amèrica (classificats com a caçadors-pescadors-recol·lectors complexos). Personalment, la meva recerca ha consistit en estudiar les fonts etnohistòriqes de les poblacions del sud de Sud-Àfrica (Khoisan). Molt sovint els estudis arqueològics enfocats a la prehistòria han fet ús d'un dels grups dels Khoisan (Dobe !kung) com a paradigma d'una societat caçadora i recol·lectora; malauradament aquest ús de les dades etnogràfiques a través d'extrapolacions i analogies ha estat durament criticat. De manera diferent, la metodologia proposada en aquesta tesi fa possible treballar amb dades etnhistòriques i etnogràfiques, fent ús del seu potencial pel que fa a dades demogràfiques i sobre l'organització socioeconòmica. Amb els patrons que s'identifiquen transversalment és possible extreure les principals variables involucrades en la regulació de la reproducció.

Capítol 5. Etnoarqueologia i Etnohistòria : les poblacions del sud d'Àfrica. Preferiblement, per tal de comptar amb dues fonts de informació independents, la recerca hauria de contenir ambdues, dades les etnoarqueològiques i les etnohistòriques. Malauradament, una base de dades comformada per les troballes en ambdós camps requereix d'un treball extensiu que sobrepassa el marc de la recerca doctoral. No obstant, considero important assenyalar alguns dels estudis arqueològics i etnoarqueològics que s'han dut a terme en contextos al sud d'Àfrica, els seus temes de recerca i les principals troballes. En qualsevol cas, les fonts etnohistòriques representen

el nucli dels materials que utilitzo en la tesi. En total, estudio més de cinquanta fonts etnohistòriques, i estudis etnogràfics i demogràfics contemporanis diferents, sobre les poblacions del sud d'Àfrica (Khoisan), abastant una cronologia de quasi 400 anys entre els segles XVII i XXI. Considerant la naturalesa diversa i el caràcter de les fonts etnohistòriques, discuteixo quines són la seva fiabilitat i possibilitats, juntament amb una proposta analítica de les similituds, diferències i discrepàncies dels continguts de les fonts i els treballs etnogràfics.

Capítol 6. Materials. El contingut del capítol és l'exposició de la informació qualitativa i quantitativa que he recollit de les fonts etnohistòriques i dels estudis etnogràfics de les poblacions del sud d'Àfrica. Considerant les preguntes de recerca de la tesi, la informació recollida està relacionada amb el comportament social entorn a l'exposició a la fecunditat en una població que aparentment segueix una fecunditat natural. Tot i que no tinc intenció de seguir la tradicional divisió ètnica dels Khoisan (Bosquimans i Hottentots), en aquest capítol organitzo les principals normes socials en dos grups diferents, basant-me en el mode de producció predominant (principalment caçadors-pescadors-recol·lectors versus principalment pastors, San i Khoi respectivament). En el transcurs de la vida d'una persona, cada fase de la vida està regulada socialment d'una manera que afecta l'exposició a la fecundació, el que en el fons repercuteix en el creixement demogràfic a llarg termini. He distribuit les normes socials en diverses categories que he definit com: rituals de pas, edat en el primer matrimoni o unió, tipus de matrimonis o unions, i intervals entre els naixements. Les fonts etnohistòriques a vegades presenten descripcions pràcticament idèntiques, i a vegades presenten descripcions contradictòries, e.g. la població practica la poligàmia versus la població practica exclusivament la monogàmia. En cada grup de poblacions (San, Khoi), estructuro les normes socials en el transcurs de la vida de homes i dones, comparant les diferents expressions i extensions de cada noma o de normes molts semblants. En cap cas descarto aquelles que es presenten discrepants respecte a les altres; és possible que l'autor observés erròniament certa pràctica social, però també és possible que les diferents expressions de les pràctiques socials estan en realitat insinuant la variabilitat cronològica o geogràfica de la mateixa.

Capítol 7. Exercicis experimentals: simulant la demografia. En aquest capítol explico la mecànica dels exercicis experimentals. Per una banda, explico els passos seguits per tal de crear una comunitat artificial (una població artificial), caracteritzada per una distribució piramidal dels indivídus segons el sexe i l'edat, típica de les societats caçadores-pescadores-recol·lectores.

També explico la distribució de les diferents variables socials i biològiques que defineix cada agent (individu) en el programa. La segona part del capítol consisteix en explicar el procediment seguit per organitzar i estructurar els exercicis de simulacions. És a dir, les dades qualitatives i quantitatives presenten descripcions diferents i a vegades contradictòries pel que fa al comportament socioeconòmic. De l'altra banda, resulta complicat determinar quina font és absolutament més correcte, però de l'altra banda, també és possible que les diferències siguin indicis de la variabilitat a través del temps i espai. Adicionalment, les fonts etnohistòriques i els estudis etnogràfics contenen només part del total de la informació del comportament socioeconòmic –ja sigui perquè l'autor no va observar certes pràctiques o bé perquè no era el centre de les observacions o interès d'estudi. Conseqüentment, la informació està heterogèniament distribuïda d'autor a autor, de període a període, i geogràficament. Per tal de minimitzar l'impacte d'questa distribució desigual, he orgnitzat les diferents expressions de la mateixa norma en dues categories: l' expressió mínima de la norma (e.g. un any de interval entre naixements, o el primer matrimoni té lloc a una edat primerenca), i l'expressió màxima de la mateixa (e.g. cinc anys d'espaiament entre naixements, o el primer matrimoni té lloc a una edat tardana). En els exercicis experimentals poso a prova els efectes d'ambdues expressions: els conjunts de simulacions van des de simulacions que no contenen cap norma social, fins a experiments amb paquets de normes molt restrictius.

Capítol 8. Resultats. Aquí discuteixo els resultats obtinguts en l'agenda de simulacions abans descrita. Els resultats de les simulacions verifiquen la hipòtesi de la tesi: les normes socials sí tenen un efecte notable sobre la reproducció (fecunditat natural) i, per tant, en el creixement demogràfic d'una societat caçadora-pescadora-recol·lectora. Els resultats mostren tres majors tendències. La primera tendència sorgeix dels exercicis de simulació en els quals només tinc en compte els paràmetres biològics (e.g. edat de maduració sexual, l'esperança de vida), sota els quals la població experimenta un ràpid creixement demogràfica en un període de 150 anys –naturalment, aquesta tendència no és sostenible en el context d'un mode de producció caçador-pescador-recol·lector, alhora que els contextos arqueològics i etnogràfics tampoc ho corroboren. La segona tendència s'observa en els exercicis en els quals he inclós l'expressió mínima de cada norma; en aquest cas la població presenta un creixement demogràfic lleugerament més lent comparat amb el conjunt anterior, tot i que el creixement és encara excessivament elevat en un període de només 150 anys. No obstant, fins aquí es pot confirmar que sense cap dubte la més

petita regulació sobre la reproducció comporta un impacte a llarg termini. La tercera tendència resulta dels exercicis en els que incorporo les expressions màximes de cada norma, en aquest cas la població presenta una major o menor estabilitat demogràfica durant un període superior als 450 anys. Per tant, es donen principalment dues situacions en la regulació de la reproducció en les quals, la població sobrepassa els límits de la capacitat de càrrega de l'entorn (excés de creixement), o bé troba un punt d'equilibri que possibilita la coninuïtat de la població a llarg termini. Aquest equilibri s'ha aconseguit únicament a través de normes socials, el que situa a la població en una línia preventiva de xocar amb la limitada reproducció dels recursos naturals.

Per concloure, aquesta tesi ha aconseguit resultats importants que incentiven continuar amb la recerca sobre l'organització social i les estructures socials en societats caçadores-pescadores-recol·lectores prehistòriques i contemporànies. És important incorporar la dimensió social en la recerca per tal de comprendre plenament, fins on és possible, la interrelació dels diferents factors que prenen part en el desenvolupament d'una població, per exemple, com s'organitzen els grups internament i respecte a grups veïns, com influeix en altres aspectes com moviments migratoris, violència, gestió de recursos, o la desigualtat social i econòmica. Finalment, afegir que aquesta tesi ha demostrat que una perspectiva interdisciplinària proporciona un millor marc de treball en el qual desenvolupar i refinar l'agenda de recerca. La mesura en la que cada disciplina pot contribuir fa possible seguir cada segment del fenomen investigat. En aquest sentit, és indispensable que l'investigador identifiqui correctament el caràcter i la interrelació dels diferents factors que en formen part, per tal d'avaluar la seva extensió, el seu paper i el seu impacte en el fenomen.

Summary

During the Palaeolithic, several and different ancient human species inhabited Europe and Asia, starting with the *Homo ergaster* in the Lower Palaeolithic until our present-day form *Homo sapiens sapiens*. Archaeological studies have contributed to the understanding of their geographical and chronological range, together with aspects on transformation and resilience –in relation to their anthropological morphology, their environment, diet spectrum, technology, among many others. A mostly biological and environmental deterministic framework predominated among these studies, leading to approaches and hypothesis based on, for example, Malthusian, Darwinian or Boserupian theories. Additionally, the characteristics of the archaeological materials constrain the sampling and research possibilities and, consequently, the research questions related to social structures or social organization remain difficult to access.

I present here an alternative proposal whose aim is to develop or open an alternative approach towards the research of the social organization of Palaeolithic populations – particularly in the Middle and Upper Palaeolithic. The hypothesis I present proposes that societies, whose mode of production is based on the exploitation of natural resources, socially regulate their reproduction in order to cope with the limits of the natural resources. From a Marxist perspective, labour is the basic social activity within any society, and inherently establishes the character of the social relations between the individuals. In the case of HFGS, there is a correspondence between labour and social relationships. In historical demography it has been argued that HFGS present a natural fertility; that is, in contrast to a society with controlled fertility, they do not make use of deliberate methods of birth control or attempt to limit the number of children. Behind the development and continuation of a hunting-fishing-gathering population lays the (un-)balanced interrelation between fertility rate and mortality rate. Traditionally, this balance has been explained in accordance to the interrelation between people and resources. This view states that an increasing population pressure on natural resources, leads to a catastrophic context of increasing population mortality due to the scarcity of resources. After the levels of pressure return to the initials due to population decrease, the mortality rate decreases and the population starts growing again until the next threshold is reached. Some archaeological studies suggest that this particular demographic profile would have been a constant during the Palaeolithic (explaining the low demographic density, or the lack of technological innovation). However, studies of genetic

variation in Palaeolithic humans do not support such a thesis: this demographic profile would be characterized by frequent drastic reductions of the population size, which would leave a mark on the genetic diversity, and the DNA findings on ancient populations do not point to frequent bottleneck episodes.

I consider that demographic stability is difficult to achieve through circumstantial and specific external events that affect mortality patterns only. Instead, I consider that flexible means of regulation sustained through the social collective choices affect fertility and have an important impact on the development of the population. The low and stable demographic density during the Palaeolithic requires a different perspective of analysis that takes into account the social organization of the populations, and the social regulation of their reproduction.

I assume that prehistoric and contemporaneous hunter-fisher-gatherers share a very similar mode of production and, hence, contemporaneous populations may be taken into account as a reference to conduct research on Palaeolithic societies – especially the Upper Palaeolithic. However, a discrepancy emerges when comparing demographic studies on Palaeolithic and contemporary hunter-fisher-gatherers. The archaeological studies frame their hypotheses within a natural fertility type of population, theoretically characterized by high fertility and high mortality rates. By contrast, the studies of contemporary hunter-fisher-gatherers attest variability not only of mortality rates, but also of fertility rates. Therefore, it is important to acknowledge that a universal fertility rate does not exist; on the contrary, every human society, including HFGS, has organized reproduction differently. In addition to this, the existing ethnographic studies on contemporary hunter-fisher-gatherers show that these groups present two common patterns: on the one hand, labour division is mostly based on sex, and on the other hand, there is an asymmetric social condition between men and women. This is, the organization of labour among these groups is not only pointing to a specific mode of production but also to a specific social organization of their people and their social relations.

There are three main stages in this research agenda. On a first stage, the main research question is formulated around the verification of whether a socially organized reproduction, constituted by a set of norms that manage the social reproductive relationships, does effectively regulate demographic growth. A second stage requires the study of ethnoarchaeological contexts, refining the excavation methodologies and learning to identify markers related to the regulation of

production and reproduction. Expectantly, a third stage would be mainly focused on the study of Palaeolithic archaeological sites. In the current thesis, I focus my attention and efforts on the first stage.

While the thesis is seeking answers and expects to contribute in the field of archaeology, the data and materials I work with are collected from ethnohistorical sources and ethnographic studies. Ethnographic and demographic data from contemporary hunter-fisher-gatherers have been often used to explain the demography of prehistoric populations, however each of these demographic studies are limited to the fieldwork conducted during a specific period and within a particular historical context (the access to education and health care can easily transform the organization of the reproduction) – which leads to a small and static picture of an actually larger and dynamic demographic profile, making it not possible the extraction of the interrelation of all factors. In a different approach, the methodology I follow combines the qualitative and quantitative data from ethnohistorical sources, ethnographic studies, medical studies, demographic statistics together in a multi-agent based simulation program. Firstly, in the ethnohistorical sources of extinct and/or existing contemporary HFGS, I searched and identified information on the social behaviour and social norms. The relevance of accessing ethnohistorical sources lays on the importance of the diachronic dimension. The diachronic dimension reveals the historical context of the ethnological data, allowing a complete analysis of the socioeconomic organization(s), with their resilience and transformation across time. Given the existing variability of the demographic parameters, taking into account one single case of a HFGS would not be sufficient to correctly assess the plausible demographic profiles, because of this I take as a reference for comparison the four major existing demographic studies on contemporary hunter-fisher-gatherers (Agta, Aché, !Kung, and Hadza). In this interdisciplinary approach, the multi-agent based system, a computer simulation program, offers an experimental ground in which it is possible to simulate demographic processes, in which I directly test and assess the effect social norms have on demographic growth. The statistical results obtained are expected to open the discussion about the socioeconomic organization of the Middle and Upper Palaeolithic hunter-fisher-gatherers.

The structure of the thesis is organized in 8 chapters, preceded by the introduction, and followed by the conclusions. At the end of the thesis there are several annexes, whose purpose is to complement the content of the chapters in which they are referred to.

Chapter 1. Demography and Palaeodemography. I compile an overview of the understanding of population and reproduction across history, as early as in the ancient China or Greece, until our most recent days. I discuss the long-term exposure of social studies to the Malthusian, Darwinian and Boserupian theories, leading to consolidated interpretations of the interrelation between human population and natural resources. These same theories have strongly influenced the theoretical and methodological approach in the field of archaeology and, hence, to the study of Palaeolithic societies. In a manner to exemplify this, I introduce a short summary of the development of the ancient Hominina during the Palaeolithic in Europe and Asia, emphasizing the biased analysis in which only the dimensions of environment, biology and production are taken into account – i.e. subsistence strategies, technological innovation, environmental adaptability. Broadly speaking, this approach has conditioned the analysis of Palaeolithic populations (continuity or disappearance) in terms of capability (technology) and adaptability (biology). Complementarily, I point out to the importance of including the dimension of the social organization of people (reproduction). Several archaeological studies have already attempted to incorporate the analysis of populations (demography) into the field of Palaeolithic archaeology. Closing the chapter, I discuss the approach and methodology of these palaeodemographic studies, indicating the discrepancies or contradictions that emerge when comparing their results to those of the ethnographic and demographic studies of contemporary hunter-fisher-gatherers.

Chapter 2. Middle Range Theory. Considering the topic around demographic dynamics, in this chapter I introduce the existing demographic data on contemporary hunter-fisher-gatherer groups, together with the general picture of demography among pre-industrial groups. Both of these types of population are characterized by high fertility and mortality rates and have been assumed to follow a natural fertility. This is put into relation with a discussion on the exclusively biological variables involved in the reproduction of human populations. The contradictions found when comparing palaeodemographic and demographic studies root from the assumption that only natural causes limited population growth in the past. After clearly distinguishing the biological variables, the existence of social norms or of a specific social behaviour arises. I introduce an alternative theoretical framework that takes into account the inherent antagonism (population growth and natural resources reproduction), the socioeconomic interrelation between labour and workforce (production and people), the two dimensions of a human foraging population

(production and reproduction), and the paradox in the palaeodemographic and demographic profiles (prehistoric and contemporary hunter-fisher-gatherers). I take into account the analytical perspective which proposes that the organization of labour and the regulation of reproduction bring together a legitimization of a social inequality based on gender –the strategic division of labour relativizes not only the value of the product obtained but consequently also the value assigned to the people producing it. Finally, in this chapter I also include the definition of social norm(s) in the context of this thesis –understood as the social construct that organizes the human behaviour, the social relations and reproductive relations along the life course of people, depending on sex and age.

Chapter 3. Methodology. In this chapter I present the potential of an interdisciplinary methodological approach. I use ethnohistorical sources to collect information on socioeconomic organization of modern hunter-fisher-gatherers, while at the same time I take into account recent ethnographic studies, as well as medical and biological studies. In addition to these, I consider the available demographic statistical data on pre-industrial societies, who presumably follow a natural fertility, in order to establish a quantitative frame of general population dynamics: population structure, existing growth rates, fertility rates, mortality rates, incidence of spontaneous abortion, life expectancy, duration of secondary amenorrhea, etc. All these heterogeneous data collected are then incorporated into a multi-agent based simulation system. I used a computer program created by Adrià Vila, which was developed to model social behaviour and demographic change in small-scale societies. This program generates a complex environment in which I can insert all variables related to reproduction (biological and social) and simulate demographic contexts. The structure of the simulation program makes it possible to adjust the biological and social variables in accordance to the findings from the different sources and studies I access. While the system of this program is very complex, I explain in this chapter its main features and functions.

Chapter 4. Comparative study: the populations in southern Africa. The focus of this chapter is mainly to bring the discussion around the risk of using modern and contemporary HFGS with the purpose to study prehistoric and extinct hunter-fisher-gatherers. Despite the limitations of the demographic and ethnographic studies, I argue that the demographic parameters and data on socioeconomic organization are relevant and, therefore, cannot be ignored. A comparative analysis provides a better frame for reference, for this I take into account the major demographic

studies on contemporary hunter-fisher-gatherers, together with the ethnoarchaeological and historiographic studies conducted on the populations of Tierra del Fuego in southern South-America (classified as simple hunter-fisher-gatherers), and the North West Coast Salish in North America (classified as complex hunter-fisher-gatherers). I personally conduct my research with the ethnohistorical sources of the populations in southern Africa (Khoisan). Prehistoric archaeological research has very often used one of the Khoisan groups, (Dobe !kung) as the paradigm of hunters and gatherers, but the use of the ethnographic data in this manner (via extrapolations and analogies) has been widely criticised. This thesis proposes a different methodology that avoids these problems and makes it possible to work with ethnohistorical and ethnographic information and to apply their potentially valuable data on demographics and/or socioeconomic organization. Looking into the patterns identified across the different groups under study, it is possible to extract the main variables involved in the regulation of reproduction.

Chapter 5. Ethnoarchaeology and Ethnohistory: the populations in southern Africa. Ideally, in order to ensure that two independent sources of information are consulted, the research should contain both ethnohistorical and ethnoarchaeological data. However, a proper database that compiles the findings in both fields requires extensive work, which greatly exceeds the working frame of the doctoral research. Therefore, I find it relevant to mention some ethnoarchaeological studies conducted in southern African archaeological contexts, highlighting the focus of their research and their findings. Ethnohistorical sources represent the bulk of the materials I use in my thesis. In total, I access more than fifty different ethnohistorical sources and contemporary demographic-ethnographic studies of the southern African populations (Khoisan), spanning a chronology of almost 400 years between the 17th and 21th centuries. Considering the diverse nature and character of the ethnohistorical sources, I discuss their reliability and possibilities, together with the analytical approach towards the similitudes, differences and discrepancies they present.

Chapter 6. Materials. The content of this chapter is the exposition of the quantitative and qualitative information I gather from the ethnohistorical accounts and recent ethnographic studies of the southern African populations (Khoisan). Considering the research questions of the thesis, the information is connected to the social behaviour around participation in reproduction in a presumably natural fertility population. Even though it is not intended to follow the traditional *ethnic* division of the Khoisan, in this chapter I list the main social norms in two separate groups

of populations, according to the predominant mode of subsistence of each population (mostly hunter-gatherers or mostly herders, San and Khoi respectively). In the life course of a person, every stage in life is socially regulated in a manner that it affects the exposure to conception, which actually affects the demographic growth in the long term. The clustered categories of the social norms are defined as: rites of passage, age at first marriage, type of marriage, and childbirth intervals. The ethnohistorical sources sometimes present practically identical descriptions, and sometimes present contradictory descriptions, e.g. the population practiced polygamy versus the population practiced exclusively monogamy. Within each group of population (the Khoi and the San), I structure the social norms along the life course of men and women, comparing the different expressions or extensions of the same or very similar social norms. In any case, I do not discard the discrepancies, it is indeed possible that the author(s) observed or understood erroneously certain social practices, however, it is also possible that the different expressions of these social practices are actually pointing to chronological or geographical variability.

Chapter 7. Experimental exercise: simulating demography. In this chapter I explain the mechanics of the experimental exercises. On the one hand, I introduce the steps followed to create the artificial community (an artificial population), with a typical pyramidal distribution of a HFGS. I also explain the distribution of the different social and biological variables that will define every agent (every individual) in the program. The second part of the chapter is centred on the procedure followed to organize and structure the simulation exercises. That is, the qualitative and quantitative information show different and sometimes contradictory descriptions of the socioeconomic behaviour. On the one hand, it is difficult to determine which of the accounts is absolutely accurate, but on the other hand, it is also possible that variability existed across time and place. Furthermore, the ethnohistorical accounts and ethnographic studies contain only part of the information of the entire picture of the socioeconomic behaviour –either the author did not observe certain social practices or the focus of the observation or study did not take into account certain social practices. Consequently, the information is heterogeneously distributed from author to author, from period to period, and geographically. In order to minimize the impact of this unequal distribution, I take into account the different expressions of each social norm, and cluster them in two groups: the minimum expression of the norms (e.g. one year of child-birth intervals, or early age at first marriage) and the maximum expression of the same (e.g. five years of child-

birth intervals, or late age at first marriage). In the experimental exercises, I test and analyse the effect of both expressions: the set of experiments test the variability ranging from experiments without social norms, up to experiments with the most restrictive and complete set of social norms.

Chapter 8. Results. In this chapter, I present a discussion of the results obtained following the agenda of simulation experiments described before. The results of the simulations supports the hypothesis of this thesis: social norms do have an effect on reproduction (natural fertility) and, hence, on the demographic growth among a HFGS. The results obtained point to mainly three patterns. The first pattern results from the experimental exercises in which I only take into account biological parameters (e.g. sexual maturation age, life expectancy) under which the population experiences a rapid demographic growth within a period of 150 years – this is clearly not sustainable in a context of a foraging mode of production, and, furthermore, neither the archaeological nor the ethnographic data support this demographic development. The second pattern results from the exercises in which I add the minimum expression of every social norm; in this case the population presents a slower demographic growth compared to the previous set of experiments, but there is still a notable demographic increase after only 150 years. Therefore, at a first stage of the analysis, there is no doubt that the smallest regulation of reproduction has a long-term impact. The third pattern results from the exercises in which I incorporate the maximum expression of every social norm; in this case the population is more or less demographically stable for a period of over 450 years. In short, from my results I conclude that there are two main possibilities that arise from the regulation of reproduction: the population may be critically compromised due to an excessive growth; alternatively, social norms may manage to regulate a population in the long term and, therefore, prevent it from clashing with the carrying capacity of the natural environment.

This thesis has shown that an interdisciplinary approach provides a more accurate frame within which to develop and refine the analysis and research of the social organization of prehistoric HFGS. The perspective each discipline can contribute with makes it possible to track every segment of the phenomenon under study. The character of the interrelation of the different factors involved must be identified and understood in order to assess their extension and, hence, their impact and role in the phenomenon under study. In this way, the results obtained in this thesis are an important contribution to previously difficult-to-access research questions regarding

Palaeolithic societies. The revised view of their demographic dynamics means that our understanding of the socioeconomic organization of these societies changes radically, for it leads to the recognition that prehistoric populations must have regulated their reproduction through social norms. This, in turn, can shed light on the on-going debate regarding the constitution of gender social inequalities: The organization of labour together with the regulation of reproduction create interdependence between the sexes and can legitimize a social inequality based on gender. In the research agenda there are many points to further continue with, the first of which demands working with ethnoarchaeological contexts in order to refine the excavation methods, to later study Palaeolithic archaeological contexts. The comprehension of the rise and transformation of social inequality(ies) is necessarily a parallel point to this research agenda.

Acknowledgements

I would like to express my gratitude to Prof. Chris Hann and Prof. François Bertemes, who gave me the opportunity to work on my doctoral research within the International Research School of the Max Planck Institute for Social Anthropology, within the interdisciplinary research group of ANARCHIE (Anthropology, Archaeology, and History of Eurasia). In the academic environment of the Max Planck Institute for Social Anthropology, I engaged in a plurality and enriching discussions with researchers from different backgrounds. I am particularly thankful for the advices and fruitful discussion I exchanged with Prof. Christoph Brumann, Dr. Lale Yalçin-Heckmann, Prof. Goerg Fertig and Dr. habil. Mikołaj Szołtysek, as well as many other colleagues at the Institute, Dr. Sascha Roth, Brenda Black, Jutta Turner, Annabell Körner, Sabina Cveček, Dr. Brian Campbell, Dr. Elena Soler, Dr. Sophie Nakueira, Hoài Trần, Elena Revert, and outside the Institute, Dr. Jordi Sarangeli, Ivo Verheijen, Wolfgang Mertens.

I want to specially thank Prof. Jordi Estévez Escalera and Prof.Assumpció Vila Mitjà, who both first developped the theory of hunter-fisher-gatherers principal contradiction and the idea to use Agent Based Simulation System to explore the reproduction of those societies, introducing me to unconventional methods for archaeological research during my master, and from whom I learned and developed my research carrier in a cross-disciplinarily fashion. I appreciate the task both my supervisors developed, Prof. Jordi Estévez and Prof. François Bertemes patiently followed my work, encouraged and supported my research. It is indispensable to acknowledge the efforts of Adrià Vila Moreno, who invested his time in developing the multi-agent based simulation program I use in this doctoral thesis

Since I started this journey, I have always counted with the great support and advice from many colleagues and friends, Ángela Álbeniz, David Lara, Andrea Roche, David Aliaga, Patricia Santacruz, Roger Alcántara, Susanne Höhm, and Monika Höhm.

And last but not least, nothing of this would have ever been possible without the immeasurable support and encouragement I received from my parents, who both became a model of dedication, patience and perseverance.

Introduction

The current doctoral thesis is focused on the study of prehistoric hunting, fishing and gathering societies (from now on, HFGS), aiming to contribute in the study and knowledge of the socioeconomic organization of these societies. It would be impossible to summarize in a few lines the state of the art of the research of the Palaeo- Mesolithic HFGS, but there is no doubt that archaeology and social anthropology have constantly been involved in this research, although these fields have been influenced by different perspectives resulting from the scholars' particular historical context. On the present day, bio- and geochemical analysis have gained an important role in the field of archaeology, achieving impressive results and enriching the existing knowledge –including diet spectrum, mobility patterns, identification of diseases, filiation, etc. The input from these methods has transformed many research questions in prehistoric archaeology. It is possible now to find plausible evidence on topics that appeared to be invisible to the common archaeological analysis. However, this approach may be misleading in the understanding of the social and economic organization of past societies, because the results are constrained by the material analysed and by the correlation of the different values observed and the lack of adjusted questions. Ethnoarchaeology was once largely used in archaeological studies, in order to study prehistoric contexts, by taking into account examples of living contemporary societies. Prehistoric hunter-fisher-gatherers were not an exception, but the main subject in Ethnoarchaeology. Thus, anthropological studies of contemporary HFGS have been taken into account as models to support the study and interpretation of prehistoric HFGS –analogy and uniformitarisms were the common practice of such approach. Critical reviews argued that contemporary HFGS cannot be a model, because: they have their own history, they have never been isolated but on the contrary involved in a larger socioeconomic network, they have been affected with different diseases imported by colonialists, and they convulsed in pre- and post-contact violent episodes. It is argued that several pre- and post-colonial political and administrative regulations have pushed these societies into remote (and unfit) areas or being displaced into reservations. In some of the cases, these societies were incorporated into different programs to stimulate the adoption of agriculture as a mode of production, or were given access to health care and education.

Regarding the study of prehistoric HFGS, it appears that there is a rather discouraging situation. The viability of the methods and the reliability of the results convey the impression that there are a limited number of topics to research, questioning the possibilities to study the socioeconomic organization of Palaeolithic HFGS.

Despite of this, several questions arise when comparing the knowledge about what are HFGS generated by prehistorians and the knowledge generated by social anthropologist. Following the HRAF (Human Relation Area Files[1]), HFGS of recent times are defined as fully or semi-nomadic, living in small communities with low demographic densities, and lack of any hierarchical structure –with a rather strong antithesis to food-producers. In a few words, contemporary HFGS are small nomadic egalitarian societies. The lifestyle of these people seems to be determined by their subsistence and mode of production, characterised by the reliance on the carrying capacity of the environment and the exploitation strategy they select. Their characteristic high mobility would restrict the impact of overexploitation of the natural resources in a certain area, implying that the social organization would adapt to this condition –explaining the egalitarianism and the low demographic density. In principle, these values are easily exportable to the prehistoric contexts, where they seem to find agreement in the archaeological record. Consequently, prehistoric HFGS have been also considered to be high mobile, small in population size, egalitarian, without any concept of individual property or territorial borders. To some extent, this concurrence may have found consensus, deliberately or not, in the existing theories which have constantly framed archaeological and anthropological research –most of them stressing on the environmental, technological and biological constraints, but very few dealing with the social relationships between men and women and social reproduction (i.e. Cohen 2016; Estévez, *et al.,* 1998; Vila & Estévez, 2010b). In this manner, these societies fitted into the concepts of primitive communism or affluent society. A deeper discussion of this general framework has to consider the exceptions to this definition, for example, the complex societies of the Pacific Northwest Coast (for an extensive discussion, Vila & Estévez, 2010) and the perspective of some scholars specially involved in the study of these last societies (i.e. Hayden, 2008).

[1] http://hraf.yale.edu/ehc/summaries/hunter-gatherers Last access, 11th December 2018

Despite the development of potential research methodologies along with new theories –or revisiting the existing theories- sometimes the ambivalence among the different studies does not satisfy the reader.

The "strange case" of the disappearance of Homo neanderthalensis

The inability to obtain satisfying explanations may be exemplified with the case regarding the disappearance of *Homo neanderthalensis*, which became the trigger of this doctoral thesis. According to the research conducted in the last years, *Homo neanderthalensis*, who developed its own technology, mode of subsistence and successfully survived and perpetuated in Eurasia for *circa* 150.000 years, was suddenly wiped-out. Countless of studies have addressed the questions of why and how did *Homo neanderthalensis* end. The chronological context of its disappearance was coincident with climatic fluctuations and environmental transformations. The different correlated evidences pointed to a demographic contraction favoured by the sudden inadaptability of this species to the changing environment, in front of which its biological and technological apparatus was unable to assure the survival (i.e. Bradtmöller *et al.*, 2012; Mellars, 2002). On a first stage of the research, scholars concluded that the main cause was related to an increase of mortality rate. On a second stage, the scholars found that the disappearance of *Homo neanderthalensis* was coincident with the expansive wave of the Anatomically Modern Humans migrating to Eurasia. Initially, the hypotheses established that when the first Anatomically Modern Humans arrived to Eurasia, *Homo neanderthalensis* had already and completely disappeared –according to this, the Anatomically Modern Human occupied regions uninhabited and free of other *hominine.* However, these hypotheses were soon confronted by others that pointed to a different and more likely context, in which these two *hominina* actually met and crossed their ways. The interpretations regarding the character of the encounter diverge from violent to pacific, lacking of convincing and unambiguous archaeological record to support either interpretation (Banks *et al.*, 2006; Defleur *et al.*, 1999; Hortolà & Martínez-Navarro, 2013; Roper, 1969; Underdown, 2008; Walker, 2001; Wolff & Greenwood, 2010).

Approximately ten years ago, palaeogeneticists successfully recovered samples of ancient DNA from bones corresponding to *Homo neanderthalensis*, which were preserved in good conditions, optimizing promising analysis of palaeo-DNA. In the first attempts, only mitochondrial DNA (mtDNA) was possible to recover –the mtDNA is transmitted only through female lineages.

Considering only the results of mtDNA, any hypothesis formulated about the interbreeding of the two species was fully rejected. The results showed that the ancient mtDNA belonging to *Homo neanderthalensis* was different from that of present-day populations. The turn of the validation of the hypothesis took place after a successful extraction of a sample of ancient DNA, which also contained the patrilineal genetic information. The results indicated that *Homo neanderthalensis* DNA contributes between 1-4% in the genome of present-day non-African populations. These results validated the hypothesis that late *Homo neanderthalensis* and Anatomically Modern Human crossed pathways in Eurasia and successfully interbred (Green *et al.,* 2009; 2010; Krings *et al.,* 1997). The character of the interbreeding remains unknown, and any explanation would be a mere conjecture. There are still too many open questions: it is of particular interest how did the interbreeding take place –most of the remarkable skeleton characters of the Anatomically Modern Human prevailed over the form of *Homo neanderthalensis*. Clearly both populations were biologically compatible so that their offspring would be fecund –the risk of interbreeding two different species is that the embryo born is infertile. The palaeogenetic studies conclude that these two *hominina* have common ancestor back to 700.000 years, and their forms split and diverged about 370.000 years ago. Comparatively, traditional textbooks on palaeontology introduce both populations as belonging to different species, but from a biological point of view it may be possible that they did not change to the extreme of being incompatible and different species.

Framed within this debate, different approaches had developed, aiming to obtain an approximate idea of the peopling during the Palaeolithic. Using different methodologies several studies have tried to contribute to the understanding of the palaeodemographic picture, some examples include the quantification of archaeological sites diachronically, the assessment of technological development, and the frequency of radiocarbon dates across time (Ashton & Lewis, 2002; Bocquet-Appel & Demars, 2000; Bocquet-Appel *et al.,* 2005; Excoffier & Schneider, 1999; Goodale *et al.,* 2008; Hosfield, 2005; Riede, 2009; Shennan, 2001; Surovell & Brantingham, 2007). The main problem these approaches face is that they clearly rely on the excavated material, which is mainly exposed to two different biased elements: archaeological sampling and natural preservation. Hence, an increase of archaeological sites may be indicative of demographic growth, but it may also answer to a change of mobility –the same problem of representativeness applies to the quantification and frequency of radiocarbon dates. Assessing the technological development as a proxy to demographic change roots in the actualistic concept that complexity is

associated to larger groups, while ignoring the possibility that social and political structures can also constrain technological and symbolic development. Archaeological research may have found in biochemical studies an independent source for contrasting its results. The recovery of well-preserved bone remains, optimizing palaeogenetic analysis, encouraged further research in this field –making it possible to identify common ancestors, but also to detect demographic transformations. Different papers on palaeogenetics do not describe the Palaeolithic populations to be constantly subjected to drastic demographic declines. Simultaneously, these studies have adventured saying that Palaeolithic population would not have exceed the 10.000 individuals – this is in accordance to the variation in the genetic flow. Comparatively, other mathematical models announce an estimate global population of about 350.000 individuals (Hawks, 2008).

Alternatively, other methodologies have used ethnology and primatology, from which they collect different life-history variables (e.g. sexual maturation age, life expectancy) in order to extrapolate a model to apply in the Palaeolithic case. This approach may seem a viable option; however, the calculations are dependent on fixed mathematic equations that are always at risk of leading to erroneous measurements.

In the overall, the archaeological materials and the methodologies at hand are facing several difficulties, at different stages of the research, which do not facilitate finding a plausible model that can contribute in the understanding of prehistoric HFGS. Nevertheless, this field of research shall not be left aside, but rather alternative approaches shall be found.

Labour, subsistence and social organization

The question regarding the mode of subsistence among HFGS, regardless of their chronological context, is not as elusive as that about the mode of reproduction and social organization. Prehistoric and contemporary HFGS do share some features, one of them is a mode of subsistence that relies on natural resources with none or little control over the reproduction of these. Considering all known contemporary cases, studied in the field of social anthropology, there seems to be a pattern generally observed in the mode of production, consisting on a gender based division of labour that supports their subsistence. In this manner, women are generally in charge of gathering vegetable foodstuffs and hunting little animals, while the men are exclusively in charge of hunting big and small game. This division does not correspond to a universal environmental nor to a biological order, is it socially structured. From this, I understand that

production is socially organized in a manner that it assures the sustainability of the community, its continuity in the long term and at the same time entails a mutual dependence between both sexes –one first plausible archaeological evidence of this could be the Palaeolithic art, an item indisputably linked to ideology. It would not be entirely misleading if the existence of a gender division of labour were to be also attributed to *Homo neanderthalensis* and early Anatomically Modern Humans –if not even earlier. This line of approach has been developed since 1979 (i.e. Estévez *et al.*, 1998; Estévez & Vila, 2013; Vila & Estévez, 2010; Vila & Ruiz, 2001) and still until now (i.e. Vila, 2017), and by this time of the research I joined for my master degree (Olives, 2014; Olives & Estévez 2016).

Following this Marxist theoretical frame, any human society is constituted historically from the workforce and around labour[2]. There is no doubt that the basic social activity in any society is labour, without which the continuation of the society is put at risk. Intrinsically, labour carries the social relations of the individuals within the community. Considering their mode of production, in the case of the hunter-fisher-gatherers there is a correspondence between the labour force and the social relations. A discussion on this topic has been extensively developed by other scholars, even from a historical materialism point of view (cf. Bate, 1986; Montané, 1982; Sanoja & Vargas, 1995. For discussion see Estévez *et al.*, 1998).

Although the discussion around the social organization of labour within HFGS is undoubtedly important, it is not the focus of the topic of my doctoral thesis. My focus is placed to analyse the intentional regulation of reproduction exercised among hunter-fisher-gatherers. There is no doubt that if mortality is located on one side of the population's balance, on the opposite side lays the reproduction –both parameters tightly involved in the development of any population. Natural resources follow a natural reconstitution of their carrying capacity, over which the prehistoric HFGS had little control. As a consequence, at some point of their history, these populations developed certain social mechanisms that controlled their demographic growth, in a manner that the sustainability and survival of the population was not at risk of falling into a subsistence and demographic crisis.

[2] It is crucial to notice here that "labour" may not be assimilated to the modern concept of activity that can be converted and changed as merchandise. Labour is here understood as the time and the efforts invested by people, in order to survive and reproduce the society. Thus, labour force has to be considered the sum of social efforts that people develop in the interests of the society to continue.

The driving causes of shaping prehistoric HFGS have been often excessively framed under biological, technological and environmental factors. The environment has often been considered to be the main factor for economic change (adaptation) of predator societies (Palaeolithic and contemporary). Demographic studies have categorised HFGS as belonging to the category of societies in which fertility and mortality rates follow a natural course –these populations do not intentionally control birth (natural fertility), and mortality is reduced to natural causes of death and starvation (related to inadaptability). These assumptions lead many scholars to conclude that hunter-fisher-gatherers are characterized by high mortality and high fertility rates along their history and, consequently, they present a demographic growth rate of zero.

Therefore, if it is indeed the case, it is expected to find very similar fertility and mortality rates across the different contemporary HFGS –including also pre-industrial societies for a broader comparison. Additionally, it is also expected to find a constant demographic decrease following the global decrease of the hunted species –the latter attributed to natural changes in environment. Contrarily, it is attested the existence of variability across the different contemporary HFGS populations. It is undeniable that the variation of population rates is partially caused by their own historical experience, for example, in a post-epidemic context, or due to conservative reproduction strategies, which can also explain a negative growth rate. However, despite of these circumstantial factors, the variation observed is actually the result of the populations' specific socioeconomic organization. In this manner, fully established social mechanisms shaped fertility rates differently, which determines the population structure and the demographic profiles.

Gender social inequality in the general framework of hunter fisher gatherers

The ethnographic studies point to another commonly shared feature among HFGS: the existence of a social inequality between men and women. This inequality is visible in different aspects of the community's life, for example, the already mentioned strategy of labour division. Several existing and identified social mechanisms in charge to regulate demographic growth are also (and simultaneously) structuring the inequality between men and women. The manner in which labour is divided (hunting activities, gathering activities) is at the same time distributing the value of the productive contribution of the participating individuals, and by extension their social value within the community (cf. Estévez *et al.*, 2007; Vila & Estévez, 2010). This perspective is taken in order to develop the central research questions that stimulated this doctoral thesis:

I. Is it possible to consider that Palaeolithic HFGS developed social mechanisms to control their demographic growth?
II. If it is the case, is it possible to consider the emergence of gender social inequality as a consequence of the regulating strategies to balance production and reproduction among HFGS?

The archaeological record seems elusive to reach the answer for these two questions. Alternatively, it may be possible to bring new insights through an interdisciplinary approach. The assumed zero demographic growth rate must first be reconsidered, naturally taking into account the existing demographic studies on contemporary HFGS, their post-contact or post-epidemics history, the implications of having access to education and modern health care, and the possibility that they were pushed to reserves or unfit environments. Within this approach, it is insightful to also consider the ethnohistorical sources at hand, in order to incorporate a larger view about the development of the societies chronologically and geographically. The incorporation of ethnohistorical sources offers the possibility to follow synchronically and diachronically the societies, tracking the transformations across time –from early encounters until the very present. The social and ideological background of the early observers and their early descriptions have significantly conditioned the stage and historical moment contained in the ethnologic observations. Despite of this, these sources should not be fully disqualified as they still contain relevant information about the socioeconomic organization, including aspects related to the organization of reproduction.

It cannot be ignored that certain variables involved in the reproduction of humans are strictly of biological character. In order to cover the extension of the biological factors, I take into account the existing literature and studies from the fields of biology and medicine. In addition to these, I likewise require a general demographic frame, in order to count with statistically representative demographic parameters, as well as further information on population structure of a typical hunting-fishing-gathering population. In this respect, I take into account additional literature and modern demographic studies to properly frame every factor actively involved in the development of populations.

Altogether, different types of qualitative and quantitative data, belonging to different fields of research (ethnography, ethnohistory, sociology, human biology, and demography) are

incorporated in the methodological approach in which I intent to test the hypothesis and to answer the research questions. The last tool in the methodological approach consists of a multi-agent based simulation system. Ethnographic analogies, as well as equation systems and differential calculus have been commonly used to project a reconstruction of the social organization of prehistoric hunter-fisher-gatherers, or to obtain demographic estimations on population dynamics and density. The first method has been largely criticised because it extrapolates actualistic data and forces it to fit into the prehistoric contexts; the second method usually consists of a mathematical based approach that seems sufficient to analyse macro dynamics, but it fails to study small-scale societies –where the individual and random factors cannot be represented. In a different way, all different data I collected are incorporated into a customized multi-agent-based system, developed by Adrià Vila. In the program, general demographic statistics frame the simulation context, and biological factors are correlated to other variables of social character (for example, age at marriage). Unfortunately, other variables are difficult to measure, as it is the case of nutrition –it is clear that nutrition plays an important role in the development and maintenance of the organisms fit for reproduction. The solution applied for those variables, which do not count with an exact measurement is to include them into the simulation program in the form of combined probabilities. The interactions between all variables, those of precise measurement and those established in probabilistic terms, turns the possible biases into negligible. The frame for reproduction in the simulation program is set in a manner that includes biological variables that favours an optimum reproductive capacity, similar to the case of the Hutterites[3]. The population of Hutterites, one of the most recalled examples in demographic studies, serves as a reference of a population that does not deliberately control the number of births per woman.

The main purpose of this doctoral thesis is to demonstrate that the population of hunter-fisher-gatherers can effectively be regulated and stabilized with social mechanisms. This is assessed by incorporating social norms in to the simulations, while excluding variable determined by technology or environment. The results of the simulations are expected to support the following hypothesis: *prehistoric hunter-fisher-gatherers intentionally regulated their population growth in*

[3] The Hutterites is an Anabaptist religious sect, living in the United States and Canada in small colonies. They present a high homogeneity in the socioeconomic structures, education and other social aspects (Eaton & Mayer, 1953).

order to maintain a fit balance with the exploited natural resources. This regulation will entail the development of certain forms of social organization, which will in any case establish an unequal condition between men and women.

On this first stage of this methodological proposal, considering the extensive period of the Palaeolithic (geographically and chronologically) and the scope of knowledge achieved about the different prehistoric *Homo*, it is not possible to extrapolate the biological data to all prehistoric *Homo* species. For instance, several studies seem to point out that *Homo neanderthalensis* and Anatomically Modern Humans had different life courses, not only regarding the attainment of sexual maturity but also regarding life expectancy. For this reason, the object of study in this doctoral thesis is the Anatomically Modern Human, whose biological parameters would not differ greatly from present-day humankind. Chronologically speaking, the Anatomically Modern Human species first appeared in the southern African archaeological context *circa* 190.000 years ago, spreading to the Eurasian continent about 100.000 years later. It may be arguable that the features of life course within the same species underwent to some type of biological transformation. Because of this possibility, the chronological frame referred in this doctoral thesis is the Upper Palaeolithic. Nonetheless, it is not discarded the possibility that the hypothesis here established may also be applied to other *Homo* species. For instance, perhaps the *Homo neanderthalensis* also developed mechanisms to regulate their demography, which could explain their wide and lasting presence in Europe and part of Asia –only disrupted by the arrival of the first Anatomically Modern Humans.

The core of the doctoral thesis is found in the quantitative and qualitative data gathered from the ethnohistorical sources and ethnographic studies. From these written accounts, I locate and identify social mechanism or social norms. Relying solely on the observations and analyses of the social anthropologist about different contemporary HFGS would only bring a narrative, insufficient to support and validate the hypothesis. Aside from this, contemporary HFGS are a product of their own history and their present condition, consequently they cannot be extrapolated directly into prehistory. The multi-agent based simulation system becomes a bridge that connects the data with the hypothesis and research questions. Therefore, the methodology I follow combines different materials for one same purpose. I do not rely exclusively on the ethnographic and ethnohistorical narratives, but I can actually recreate demographic processes with the simulation program, including social and biological variables. From the results of the

simulations I can analyse the emerging demographic patterns. As referred previously, the ethnohistorical sources complete the context regarding the social norms, bringing forward a diachronic perspective and making it possible to track back in the past of the contemporary hunter-fisher-gatherers –when possible. For instance, there are several ethnohistorical sources dating back to the 18th century about the Yaghan and Selk'nam in Isla Grande de Tierra del Fuego (in the southern cone of South America). There is also a large corpus of documentation starting in the 15th century about the widely discussed hunters from southern Africa. These populations are especially significant because they have been used by many scholars, who conceptualized them as "the paradigm" from which to develop analogies to extrapolate to prehistoric HFGS. While the groups already mentioned are documented through a long time, other HFGS had been barely captured in the early literature, as it is the case of the hunters from Borneo. Nevertheless, a cross-cultural comparison is of great importance for the methodological approach proposed, so that it is assured that the social norms are not an accidental exception belonging to a particular group, but indeed a general pattern observed among different groups. This opens a wide perspective and spectrum of variability to be considered in the interpretation of prehistoric HFGS.

The experimental exercises will attempt to combine the social norms regularly observed among HFGS with a reproductively optimizing population –following the example of the Hutterites. According to the study by J. W. Eaton and A. J. Mayer (1953), the Hutterites did not practice any intentional birth control, which favoured a maximum total fertility rate. In this manner, the Hutterites possibly represent a viable example of a population reproducing itself close to the theoretical maximum level of human natural fertility. Expectantly, the results should present lower fertility rates and lower annual growth rates, in comparison to the actual Hutterites in the 1950s. If the results clearly show such transformation, it may be secure to affirm that social norms and social behaviour indeed have an important impact on demographic growth, legitimizing and supporting the hypothesis.

Another plausible attempt for this doctoral thesis is to experiment and assess the transformations given under different conditions, taking advantage on the readiness of the different materials and the multi-agent based simulation system. Existing studies, following the theory of the stable population (for a discussion see Coale, 1972), consider that a population without migration and subject to constant age-specific birth and death rates over a considerable past period will assume

a particular stable age distribution and a constant growth rate, either positive, negative, or zero. Disruptions to the population from a temporary change in birth or death rates will disturb this stability, but the population will eventually return to its particular stable age distribution and constant growth rate. This is, for example, after a case of high mortality resulting of extensive violence, or after the burst of a disease that takes the population into an endangered situation where its continuity becomes uncertain. It may be interesting to test to what extent is the population capable of recovering by increasing their reproduction capacity after changing different social norms and their social behaviour.

The structure of the thesis

The doctoral thesis is structured in eight chapters: (1) Demography and Palaeodemography; (2) Middle Range Theory; (3) Methodology; (4) Comparative study: the populations in southern Africa; (5) Ethnoarchaeology and Ethnohistory: the populations in southern Africa; (6) Materials; (7) Simulation and Modelling; (8) Results, and Conclusions. I would like to briefly introduce the inner structure of these chapters and their content, in order to offer a preliminary overview of the content of the doctoral thesis. The interdisciplinary approach forces a division of the different topics under discussion within the different chapters.

The first chapter

The chapter of «Demography and Palaeodemography» opens the discussion around the character of human population and how it is incorporated into the field of prehistoric archaeology. It is structured in three subchapters: "The social nature of population", "Hunter-fisher-gathers in Eurasia", and "Palaeodemographic studies of hunter-fisher-gatherers". In the subchapter about the social nature of population I aim to expose, according to my own understanding, the knowledge accumulated from the contribution of different scientists who followed different perspectives of analysis, and the manner in which these contributions did influence the field of research in social sciences. This overview about the long lasting theories is intended to frame the revisionism that will follow in chapter number 2.

In the second subchapter, I summarise the state of the art of the research of HFGS in Eurasia during the Palaeolithic, connecting with the discussion of the previous subchapter. My research does not count with direct archaeological materials, but I expect to provide new insights in the study of prehistoric archaeology. Understandably, it is not possible to include extensive details, for which reason the focus of this subchapter is to highlight the mainstream approach in the study of past societies, pointing to the main events in the development of the different *Homo* species, including issues and new research questions. The purpose of this subchapter is to exemplify how the general focus of the research is on its majority a consequence of the character of the archaeological record and the predominant paradigms. Confronting the established biological and ecological deterministic narratives, I present my theoretical framework, acknowledging that among foraging societies labour is socially organized and, by extension, reproduction may be also socially organized.

The third subchapter contains a literature review of the existing palaeodemographic studies from Palaeolithic hunter-fisher-gatherers. The aim of this subchapter is to introduce the existing studies, their different methodologies and results. I remark how these works are indeed a good example of the different possibilities the archaeological material offers. Interestingly, the comparison between palaeodemographic studies on prehistoric hunter-fisher-gatherers and modern demographic studies on contemporary hunter-fisher-gatherers shows that both fields do not agree entirely on the profile of a typical foraging society, but they rather point to very different conclusions. The aim of this subchapter is to emphasize the importance of finding alternative perspectives, theoretical frames and methodological approaches, in order to obtain reliable and convincing explanations.

The second chapter

In the chapter «Middle Range Theory», I indicate the gaps from every field involved and the importance to establish a connection between different kinds of sources under a common theoretical frame. The chapter is subdivided in four parts: "Contemporary hunter-fisher-gatherers: demographic studies", "Social regulation of the human reproduction", "An inherent contradiction", and "What is a social norm?". The chapter itself refers briefly to the category of hunter-fisher-gatherers in the field of research, which constrains the potential of modern data to advance in the research of prehistoric societies.

In the first subchapter I put special attention on the available demographic measurements of contemporary hunting-fishing-gathering populations. Considering the observations concluded in the first chapter, it is striking to attest that demographic studies on contemporary hunter-fisher-gatherers do not present a unique demographic profile. The existing demographic and ethnographic studies show that these populations do not resemble one to another in terms of fertility and mortality rates, and by extension, in their annual demographic growth. These differences or variability could be explained to be the result of post-contact or post-epidemics episodes. I argue that these differences exhibit the differences of their social norms and social behaviour. At the same time, this attested variability disagrees with the demographic profile drawn in the palaeodemographic studies, which conclude that Palaeolithic HFGS presented low demographic densities mainly because of the environmental constraints. From this comparison

there is a contradiction arising, which is actually proving the need of revisiting the demographic patterns of prehistoric and modern HFGS.

The problematic of studying prehistoric hunter-fisher-gatherers is that very often biological or environmental factors prevail. The second subchapter tries to discuss and compile from a variety of biological and medical sources specific information about human reproduction, in order to obtain an approximate inventory and measurements of factors of strictly biological nature (e.g. fecundity). Simultaneously, I identify the non-biologically determined variables that are equally involved in reproduction (e.g. weaning). Combining the information on both sides of reproduction, biological and social, I come to define the different stages in the life course of men and women, together with the categories within which I will place the different social norms and social behaviour conditioning and responsible of reproduction as a whole.

Rejecting a deterministic approach based on neo-Darwinian, Malthusian or Boserupian theories, in the third subchapter I alternatively propose to follow a different perspective (Bate *et al.*, 2014; Estévez, 2005; 2009). This perspective argues that there is a dialectic interrelation of factors in charge of the global causation of change. Clearly, and taking into account the mode of production of foraging societies, the two essential components of the society (production and the reproduction) enter in an endless contradiction. Therefore, this type of society cannot be studied while excluding one of the components (reproduction) and overemphasizing the role of the other (production). In order to analyse reproduction, I will adopt a different perspective as opposed to the traditionally and mostly adopted cultural materialism and adaptive environmental driven perspectives. Thus, I will explore the relevance of social internal factors involved in reproduction, leaving the environmental variables as independent and stable. Therefore, in the current thesis, I do not consider environmental variability instead I centre the research on social variables and social norms to test the relevance of their impact in population's growing indexes.

In the last subchapter I present the definition and understanding of the concept of social norms or social behaviour in the way it is incorporated in this doctoral thesis. The definition presented is put in relation with the research aim and research questions. From my perspective, the category of social norm or social behaviour contains the observed social practices among foraging groups which clearly have an impact on their reproduction behaviour –in contraposition to the category of arbitrary or accidental process, as well as in opposition to biologically determined phenomena.

In synthesis, chapter 1 and chapter 2 have the aim to introduce the context of the research question (Upper Palaeolithic), the character of the object studied (hunting-fishing-gathering societies), the phenomenon under discussion (the lack of uncontrolled demographic growth *versus* the evidence of long term demographic stability), and the main hypothesis (reproduction is socially regulated among HFGS). The chapters that follow contain a detailed description of the methodology, the materials, and the results of the experimental exercises.

The third chapter

The third chapter, under the title of «Methodology» is structured around three subchapters, "The hypothesis of a controlled fertility", "Archaeology, History and Ethnography: combining disciplines", and "Multi-agent based simulation system". The main purpose of this chapter is to present the methodological approach followed, in which three disciplines are combined in order to aim common research questions.

In the subchapter regarding the character of controlled fertility, I mention the already referred difficulties in archaeology to access to certain research questions related to the social organization of Palaeolithic HFGS. This research problem shall be approached via an alternative theoretical and methodological proposal consisting of an interdisciplinary frame which may make it possible to test the plausible hypothesis. In this manner, in this subchapter I recapitulate the interconnectedness between the two universals observed from the ethnographic studies (labour division based on gender, and social asymmetry between men and women) and the strictly biological parameters involved in human reproduction. The procedure to test this hypothesis relies on the contribution of the combination of archaeological studies, ethnographic studies, demographic studies, and ethnohistorical sources.

The risk of ambiguous or insufficiently convincing arguments has led many topics to fall under constant revision. In the second subchapter I basically present the background of the research in archaeology in which ethnographic studies served as a base for re-conceptualizing and re-analysing. On a first stage, ethnoarchaeological studies took off, bringing forward studies of material culture aiming to access to the socioeconomic behaviour behind the object. The resulting tendency consisted on the consideration that every case of study is particular and henceforth cannot be taken as representative or comparably. I present here my perspective on this matter, in which I base my assumptions on the possibility that a set of universal principles is possible to be

applied on a wide diversity of human societies. In this manner, I try to reconcile archaeology and ethnography, by ultimately including also ethnohistorical sources and a multi-agent based simulation system.

In the third subchapter I put attention on the multi-agent simulation program used (ARESOCARE), developed entirely by Adrià Vila following our discussions, specific questions and demands. I present a description of this program and its main functions, together with the modelling possibilities from the results obtained. At the beginning of the 1960s, studies including simulation and computer modelling opened a field of experimentation in archaeology (cf. Miguel Quesada *et al.*, 2014). The computer simulation makes it possible to achieve a better understanding of *societies*¸ because it obliges the scientists to identify the factors involved, and to measure their exact character. It is important to retain that in the current doctoral thesis, it is not intended to reproduce the demographic history of a particular HFGS, but to test the effect of actual social norms on an artificial and theoretical hunting-fishing-gathering type of population. I integrate into the simulation program all the information I gathered from the ethnographic studies, demographic studies, biological and medical studies and ethnohistorical sources. This information is principally related to the socioeconomic human behaviour among foraging societies, and reproduction parameters. ARESOCARE offers a "handmade" and supple platform adapted to my specific aims and with which I can test the effect of social norms on a socio-biological environment typical of foraging societies.

The fourth chapter

In the fourth chapter, «Comparative study: the populations in southern Africa», serving myself from the Ethnographic Atlas by George O. Murdock (electronic database, Murdock, 1962-1980), I indicate the main difficulties in the selection of an extinct or contemporary HFGS for the purpose to study prehistoric foraging societies. In this chapter, I present the problematic of using contemporary HFGS as a reference. Existing studies, which based their analyses on ethnohistorical sources and ethnoarchaeological materials, have concluded that within the category of HFGS exists a range of variability that needs further exploration. I structure this chapter around four subchapters: "The Ethnographic Atlas by George P. Murdock", "Simple and complex hunter-fisher-gatherers", "The selection of the Khoisan peoples: advantages and disadvantages", and "History of the inhabitants of southern Africa".

In the first subchapter, I discuss the issue regarding the selection of an extinct or contemporary HFGS, which may be used with the methodological approach presented in this thesis. The Ethnographic Atlas by George P. Murdock may serve as a starting and referencing point for a first delimitation of the possible selection for a paradigm of HFGS. My criteria of selection are based on the principle of the mode of production. I understand that in a foraging society the social relations are strongly interrelated to the relations of production established (mainly, hunting, fishing, gathering) –in contrast with food-producing societies (mainly, agriculture, stock breeding, industry). I assume that these social relations are likewise strongly interrelated to the reproductive relations.

In the second subchapter, I give an overview of the existing studies in which the methodological approach included ethnohistorical sources and ethnoarchaeological materials corresponding, to some extent, to the same populations across time. Comparatively, some of these studies seem to point out to a variability of the socioeconomic structures, ranging from simple (Fuegians in Tierra el Fuego, south of South America) to complex hunter-fisher-gatherers (Coast Salish in north West Coast of North America). Within this existing frame, I select the southern African populations named Khoisan (including both, the pastoralists Khoi and the hunters San, in the analytical frame).

The Khoisan, together with the Fuegians, Australians, Artic, and Pacific Northwest Coast native peoples, has been considered to be paradigms for HFGS. In the third subchapter, I discuss the main arguments behind the selection of the Khoisan as a case of study to test the hypothesis presented in this doctoral thesis: one the one hand, I indicate the advantages and disadvantages of the selection of the Khoisan and, on the other hand, I underline the potential of the ethnohistorical sources available corresponding to these populations. It is important to highlight that from the ethnohistorical sources it is possible to extract information on the socioeconomic organization(s) of the populations across time, synchronically and diachronically. Whether similar or different, from the information gathered several patterns regarding the social and economic behaviour emerge. These patterns or recurrences may show resilience and/or transformations across time and space, for which reason every variant is taken into account.

Finally, in the last subchapter, I present a summarised history of the populations that inhabited southern Africa, according to the historical accounts starting in the 15th century. I take into

account the work of different historians and anthropologists (Elphick, 1977; Szalay, 1995; Wilmsen, 1992) who have studied the relationship between the different populations who practiced different modes of subsistence. The existing studies point to the different social, economic and political events that placed an important impact on the demographic development of the populations, from civilising programs to commando expeditions –the demographic studies conducted in the 1960s present a particular picture of a particular moment and place corresponding to a population as result of its own past.

The fifth chapter

Following up to the content of the previous chapter, in the fifth chapter «Ethnoarchaeology and Ethnohistory: the populations in southern Africa», I incorporate additional information of the past of the southern African populations according to archaeological and ethnoarchaeological studies, included in the subchapter "Ethnoarchaeological research: state of the art". Ideally, the current thesis should include direct ethnoarchaeological research, in order to count with two independent sources of information (ethnoarchaeological and ethnohistorical), however the combination of both tasks greatly exceeds the frame of a doctoral research. Thus I focus my attention solely to the ethnohistorical sources, which become the centre of the content of the second and third subchapters, "Ethnohistorical sources: their reliability and validity", "Exploring the ethnohistorical sources".

In the first subchapter, although I do not conduct research directly on ethnoarchaeological contexts, I consider it relevant to highlight the main archaeological findings and ethnoarchaeological studies that have been developed or are still on-going. On the one hand, I briefly introduce the recent prehistoric past of southern Africa, with special attention to the arrival of domestication (cattle and agriculture). On the other hand, I list the main ethnoarchaeological studies, which integrate a scientific scope including settlement layout, diet spectrum, and funerary practices, among others.

The core of the thesis is supported by the materials I gathered from several ethnohistorical sources. Naturally, the use of ancient written sources, which were produced under different historical environments, puts into question their reliability. In the second subchapter I refer to the existing works in which they propose analytical methods to treat historical ethnological accounts (Orquera & Piana, 1995; Schapera, 1965; Szalay & Laade, 1983; Vila & Estévez, 2010; 1999). I

organize the ethnohistorical sources according to their chronology and geographical region, together with simplified profiles of the authors behind them. I assume that the different authors tried to leave a description as close as possible to the reality they observed and understood. From source to source, there may be information that appears to respond to very similar patterns (e.g. early age at marriage), but this does not prevent different descriptions and discrepancies to likewise occur. The manner in which I will proceed with the materials is further explained in chapters 7 and 8.

Finally, in the third subchapter I give an overview of the ethnohistorical sources selected. Clearly, it has not been possible to study each of the existing written accounts, but I have selected those, which contain in clearer manner information on the social organization of the peoples, and especially information related to reproduction and demographics. In the great majority of the cases, I accessed the original source or, alternatively, a translation of the original. Only a couple of the ethnohistorical accounts are actually relying on previous sources, whereas the rest correspond to written accounts resulting from the direct observation of their same author.

Recapitulating, the chapters 3, 4 and 5 combined present the methodological and analytical approach towards the subjects (hunting-fishing-gathering society) and objects under study (ethnohistorical sources). I argue that the potential of the data available on the ethnohistorical accounts have an important input in the research of the social organization of people in a foraging society, including the social regulation of reproduction. I have likewise described the main functions of the simulation programme, so that in the remaining chapters to follow I introduce the specific quantitative and qualitative data I gathered about the social organization of peoples around reproduction, the agenda of experimental exercises organized for this data and, finally, a discussion on the results.

The sixth chapter

In the chapter of «Materials» I present the qualitative and quantitative materials I collected from the different ethnohistorical sources, and recent anthropological studies. I established a selective search of ethnohistorical sources in which I expected to find information on the social and economic organization of peoples within their corresponding camp or group, and especially information related to the organization of reproduction. In this manner, this chapter is divided in four subchapters, “The patterns of the life course of men and women”, “Social norms among the

Khoisan: the pastoralists", "Social norms among the Khoisan: the foragers", and "Patterns in the social norms".

In the first subchapter I present the recurrent stages of the life course of men and women (infancy, adolescence, adulthood), and how it may be also structured in different social phases in which the exposure to conception changes (single, married, widowed). The exposure to conception depends on the social and reproductive relations between men and women, in correspondence to their specific socioeconomic organization. For the current thesis, I structure these social phases as follows: rites of passage, age at marriage, types of marriages, and childbirth spacing. The two subchapters following basically contain the specific social norms and social behaviour related to the reproduction relations. Although I do not intend to follow the commonly used division between "Hottentot" (Khoi) and "Bushmen" (San), I do structure the different social norms and behaviour in two groups based on the main mode of production of the groups as described and referred in the ethnohistorical accounts (mostly hunting and gathering versus mostly pastoralism).

In the last subchapter, I discuss the main conflictive point, which is the uneven distribution of information across time and space. On the one hand, I do not find a homogenous account of every information in the different periods (e.g. in the early reports the information is generally scarce, whereas in recent reports the descriptions are more systematic). Sometimes I come across similar descriptions (e.g. lactation is prolonged over 3 years, or the child is weaned when he/she is able to walk), and sometimes I find contradictory descriptions (e.g. men and women marry at an early age versus men and women marry at a later age). I do not think that there is a source, which is entirely correct and true, and a source that it is entirely wrong and false. I conclude the chapter announcing the agenda established to simulate this heterogeneous data.

The seventh chapter

After describing type of information available and its distribution across time and place, in chapter 7, «Simulation and Modelling», I explain the procedure selected to simulate the information at hand. The main functions of the simulation program have been detailed in chapter 3, while in this chapter I put my attention on the data that will be incorporated into the input files for the simulations, mainly the artificial population and the social norms –the biological variables

(e.g. mortality probability, life expectancy, incidence of spontaneous abortion, etc.) are based on existing published materials, but these will not be discussed here.

In this manner, the chapter is organized in five subchapters: "Creating a population", "Artificial community I", "Artificial community II", "Defining the agents: biological and social variables", and "Incorporating the social norms into the system".

Very briefly, the first three subchapters are concerned on the preparation of the artificial population that will serve for the experimental exercises with the simulation program. On the one hand, there are extensive demographic studies (Howell, 2000; Lee, 1979) about one particular foraging group (Dobe !kung). Although these studies base their calculations on a particular group in a particular moment in history, they contain potential information about the population structure, which is relevant for the preparation of the artificial community. The procedure that leads to the final artificial population is described in the two first subchapters. On the other hand, there are several population censuses from the 19th century that include the *ethnic* category of "Hottentots" (Khoi). In the third subchapter I argue the character of the information contained in theses censuses, and the main limitations to possibly export them for a second artificial community. Due to the absence of a systematic analysis of the demography of the Khoi, I will use the same artificial community elaborated in the previous subchapter for both foragers and pastoralists –the social norms and socioeconomic organization will be adapted to each group in accordance to the descriptions provided in chapter number 6.

In the fourth subchapter, I describe which are the social and biological variables that will be unique to every agent of the entire artificial community. Every agent counts with a very detailed profile that makes him or her unique along the entire simulation. At the same time, the social and biological characteristics of every agent will serve to develop their life course in accordance to the social organization generated, and depending on the general biological parameters (e.g. life expectancy or specific on age mortality probability). In all cases, and depending on different circumstances, the social and biological variables of every agent will readjust themselves along the simulation. These variables are in charge to place every agent in his or her possibilities in the simulation (e.g., from the pool of single (unmarried) agents, some will be more likely to be selected as partners than others; from the agent already married, some are more likely to divorce,

or to marry a second wife, etc.). The entire engine of the simulation program is interconnected from all sides, in which every parameter and variable have a very specific function.

Finally, the remaining input file to prepare is that which contains the specific social norms to test. I previously mentioned the uneven distribution of information and the heterogeneity of the descriptions when available. I have organized the social norms and data available on socioeconomic behaviour in two categories for each the foraging population and pastoralist population: minimum restriction and maximum restriction. I consider the different descriptions to be part of one same package in which one norm shows different degrees of applicability. Said differently, I take the minimum expression of a social norm (early age at marriage) and its correspondent maximum expression (late age at marriage), organizing every social norm depending on its degree of restrictiveness. My hypothesis requires verification by testing whether social norms have a long-term impact on demographic growth. The simulation agenda includes three main parts: the first part does not include social norms in order to simulate the demographic development without restrictions; the second part corresponds to the foragers (including one set of minimum and one set of maximum restrictions); and the third to the pastoralists (including one set of minimum and one set of maximum restrictions. The results of the simulations and the discussion are included in the chapter number 8, «Results».

The eighth chapter

The chapter «Results» contains basically the ultimate results of the entire efforts put in this doctoral thesis. The subchapters are organized depending on the environments simulated: “Simulations without social norms”, “Simulating hunter-fisher-gatherers”, “Simulating pastoralists”, and “Results and implications”.

The first subchapter basically shows the results obtained in those environments simulated in which I did not include any social norm, but only biological variables related to life expectancy, sexual maturation age, and age at first marriage. The purpose of these simulations is to count with a frame for comparison for the simulations following in which social norms will be included. The results of the simulations contained in this subchapter show the variability when modifying the fecundity potential (higher or lower for both men and women), the mortality probability (higher or lower mortality, together with longer or shorter life expectancy for both men and women), and the inclusion of simple conditions for the fulfilment of a marriage. In any of the cases, the

demographic growth obtained surpasses any existing example of pre-industrial demographic growth, while at the same time it is not attested in the archaeological context. Therefore, these simulations do not find corroboration and, consequently, they are presenting a theoretical example of the demographic growth a human population can achieve without any control.

In the second and third subchapters, I test the effect of the lesser and the most restrictive social norms have in the foraging and pastoralist populations separately. The different rules are organized around the different stages of the life course of men and women: the organization of people into the category of single and eligible for marriage, the organization of marriage and types of marriages, the organization of the condition of widowed or divorced people, the organization of the length child birth intervals, among others.

On the one hand, the results of the simulations with the minimum restriction show that the less restrictive norms affect the demographic growth in the long-term, although it still surpasses any documented demographic growth described in the ethnographies or observed in the Palaeolithic archaeological contexts. On the other hand, the most restrictive norms bring forward a surprisingly stable population growth. Although the expression of the social norms included in the most restrictive environments do not belong to a synchronic nor geographic range, the results show that it is possible to achieve a more or less long-term demographic stability only with social norms. Therefore, it is very plausible that Palaeolithic hunter-fisher-gatherers also developed certain social mechanisms that regulated their demographic growth.

1.- Demography and Palaeodemography

The understanding of the character and nature of (human) population and (human) reproduction has changed across time. However, both terms, especially that of population, have been exposed to consolidated theories such as those of Malthus or Darwin. This has left a print on the study human societies, including the HFGS. The interrelation established between the demographic pressure and the natural resources (carrying capacity of the environment) became inherent among foraging societies who have little or no control on the reproduction of the natural resources. Alternatively, in the current thesis I argue that there is a scale of variables that comes into play in the development of a foraging society. This scale is compound of a dominant cause, a determinant cause, and a trigger. The dominant cause may be defined as a long term constant; the determinant cause may be defined as a new constant introduced in the context that leads the chain of events towards a particular direction; and the trigger, which often responds to a sudden change relatively short in term or to a small scale change, affects the chain of events.

The problematic lays on the fact that there are not evidences that confirm that the regulation of the demographic pressure in the Palaeolithic responds to the increase of mortality. I consider it relevant to present an overview of the transformations of the concept of population until our present day, in order to locate the main variables (biology, technology, and environment) attributed in the definition of the prehistoric populations that inhabited Europe and Asia. From this definition the elaboration of the category of natural fertility found its subject. This is, historical demography analysed the transformation of fertility in the human populations and established the classification between industrialized and non-industrialized populations in terms of demography, the former stated to have a controlled fertility while the latter followed a natural fertility.

The purpose of this chapter is to contrast the formulated theories on population, with a general overview of the state of the art in the archaeology and palaeodemographic studies of the prehistoric hunting-fishing-gathering populations. These fields find corroboration one on the other, concluding that Palaeolithic populations are characterized by a small demographic density and the lack of demographic expansion, fitting into the profile of natural fertility –consisting of high fertility and high mortality rates.

The social nature of population

There is not the slightest doubt that population and resources are closely related. An excess of population has a significant impact on the carrying capacity, worsening the standard of living and, as a consequence, social tensions rise up and health conditions decrease. In ancient times, there was the concern about population pressure, and how measures to maintain an optimum level of population were necessary[4]. In the Middle Age, within the frame of ethics and morality, the general conviction was that population growth was preferable –practices such as divorce, infanticide, abortion were prohibited[5]. In the seventeenth and eighteenth centuries, growth was considered the optimum measure, in connection to the interest of economic growth, early colonialism, and the dawn of capitalism and demand for labour force. In modern times, some first *scientific* demographic studies were likewise developed[6] (Sinha & Zacharia, 1984).

It is worth mentioning the awareness of the close relation existing between population and resources. All these tentative *demographic* thoughts focused their attention to their own particular chronological and geographical contexts. Under the title *An Essay on the Principle of population as it affects the Future Improvement of the Society with remarks on the Speculations of Mr. Godwin, M. Condorcet and other writers*, Thomas Robert Malthus left the first statement on foraging populations, as follows:

> «In the rudest state of mankind, in which hunting is the principal occupation and the only mode of acquiring food, the means of subsistence being scattered over a

[4] Confucious (551-479BC, in the ancient China) pointed to territorial migration, restrictions on marriage, and punitive tax to regulate population density. Plato (428/427-348/347BC, in Classical Greece) estimated the optimum population for a city state. Aristotle (348-322 BC, in Classical Greece) pointed to the need of a balance between population and resources. Plato and Aristotle also coincide on the importance of controlling the population size by means of banning physically handicapped people to marry, practicing infanticide and abortion, and with colonizing and migratory movements. They also remarked that an increase of population is achieved via immigration, rewards, and disapproval of unmarried people. On the contrary, the Roman –in a context of an expanding empire – encouraged demographic growth (Sinha & Zacharia, 1984).

[5] Ibn Khaldun (1342-1406) and Givanni Botero (1544-1617)(Sinha & Zacharia, 1984).

[6] Johan Graunt (1620-1644), William Patty (1623-1687), Edmund Halley (1656-1742), Richard Price (1723-1791), Johan Peter Süßmilch (1707-1767) carried out quantitative studies including some life course observations (e.g. urbanization, unemployment, and national income, among others) (Sinha & Zacharia, 1984).

> large extent of territory, the comparative population must necessarily be thin (Malthus, [1798] 1999:23) ».

Malthus's efforts were focused on responding Godwin and Condorcet's portrays of a society characterized by progress. In their specific context, in which the future path of the society was under discussion, Malthus initiated his work based on two physiological assumptions: on the one hand, human being needs food, and, on the other hand, human reproduction will always take a fundamental part. From his perspective, population grows geometrically, whereas subsistence means arithmetically. Following this interrelation, Malthus emphasized that foraging populations have a strong dependency on resources:

> «May we not then fairly infer from this short review… their population [the foragers] is thin from the scarcity of food; that it would immediately increase if food was in greater plenty… misery is the check that represses the superior power of population, and keeps its effects equal to the means of subsistence (Malthus, [1798] 1999:24-25) ».

A deeper analysis of Malthus's work it is not possible in the present dissertation, nevertheless, the two fragments above mentioned illustrate the presumed interrelation between population and resources, but also the relevance of the mode of production. Hence, foragers are expected to be demographically small in size, because their growth is inevitably regulated by the availability of natural resources, which at the same time is conditioned by their own mode of production – hunting and gathering. Scarcity and precariousness would have been thus a universal feature of "the rude state of mankind".

Malthus's work did not go unperceived by scientists in the nineteenth century, among whom Charles Darwin and Alfred Russel Wallace may be mentioned. In his autobiography –edited by his son Francis Darwin- Darwin acknowledges the influence of the Malthus's text:

> «…I happened to read for amusement Malthus on *Population*, and being well prepared to appreciate the struggle for existence which everywhere goes on… it at once struck me that under these circumstances favourable variations would tend to be preserved, and unfavourable ones to be destroyed. The result of this would be

> the formation of the new species. Here, then, I had at last got theory by which to work (Darwin, 1887: 83) ».

In other words, by the second half of the nineteenth century, it was widely accepted that human history always contained a contradictory relation between population and resources, or said with different words, between human reproduction and production. In such context, a process of selection of species occurs, leading to an evolutionary course[7].

In 1865, John Lubbock, who was interested in archaeology and evolutionary theory, contributed with a definition of prehistoric periods according to the technology and resources exploited:

> «We must now pass on to still earlier times and ruder races of men; to a period which, for obvious reasons, is called by archaeologists Stone Age. The Stone Age, however, falls naturally, as has been already stated, into two great divisions: First, that of the Drift, which I have proposed to call the Palaeolithic Period. Secondly, the later Stone Age, for which I have suggested the term Neolithic, and in which the stone implements are mores skilfully made, more varied in form, and often polished (Lubbock, [1865] 1913:73) ».

In the same vein, Christian Jürgensen Thomsen established a relative chronology for archaeological artifacts for an antiquarian exhibition. Thomsen's established an evolutionary coherence, according to the complexity of the artifacts, i.e. stone, bronze and iron artifacts –thus, defining three eras as Stone Age, Bronze Age, and Iron Age, respectively. These observations incorporated technology and technological development as conditioning factors in human history, as well as the (apparent) linear and progressive tendency. Automatically, all these factors would be lined in parallel to social development. In 1877, Lewis Henry Morgan (1997) defined three stages of the history of man, by taking into account the mode of production practiced: savagery, barbarism, and civilization. Friedrich Engels was strongly influenced by Morgan's work when he developed his theory on the origin of the family in 1884 (Engels, [1884] 1986). Engel's theory presents an inseparable the relation between the mode of production and the family system –and,

[7] In 1830, fossil remains were found in Engis (Belgium), and in 1848 in Forbes (Gibraltar), but none of them received enough attention for further discussion. In 1886, the fossil findings in Neanderthal in the Düssel Valley (near Düsseldorf), which clearly presented differentiated anthropological characteristics, started the debate on human origins with the empirical evidence of extinct human ancestors (Arsuaga & Martínez, 2011).

by extension, to the human reproduction. Thus, in a primitive stage, restrictions did not exist, meaning that every woman belonged equally to every man and every man to every woman[8]. On this point, Engels highlights the importance of Johann Jakob Bachofen's work in the search of a stage of promiscuity, which he concluded impossible to located –on a later stage it is possible to trace a form named as group marriage. Still from an evolutionary perspective, Engels includes different group marriages according to Morgan's classification of the developed family structure after the promiscuous intercourse stage: at first, groups marriage were separated according to generations (parents and children are excluded from sexual intercourse with one another), secondly, brothers and sisters from the same mother are excluded, and thirdly, the pairing family would displace group marriages by introducing monogamy (polygamy and occasional infidelity would be punished only on women). Marriage by capture, marriage by purchase (in a context with absence of women), and penance (chastity of women) are also considered to have an effect on family structures and, therefore, reproduction itself. Monogamous marriage represents the last stage of family structure that bridges between barbarism and civilization, expressed with the purpose to produce children with undisputed paternity as they will become part of the property of the father, and ultimately become his heirs –note the progression of family complexity towards monogamous marriage with a strong relation to development, including technological development, mode of production, and property. Such aprioristic formulation is a result of its specific context under the transformations of industrialization.

Differently, Ester Boserup's work on agricultural populations takes a different trajectory, contrasting the environmental deterministic theory. Boserup pointed out the importance of the change on technology and its effect on environment, and the demographic change and its effect on technology and environment (Boserup, 1976). Boserup considers that the population is the one determining the resources production –specifically that of agrarian populations. Following her perspective, when a hunting-gathering population increases, it increases the consumption of vegetal resources, and from the intensification of exploitation, technological change occurs towards cultivation, «…the women, who were gathering vegetable food while the men hunted,

[8] This particular view recalls me to the work of Power and others (2013), in which they debated the synchrony and asynchrony of reproduction and mating system among primate females. The main statement of this study is that where females do not follow seasonal reproduction constraints, fertility is desynchronized, enabling single males to monopolize mating –in connection, at the same time, to fitness optimization.

become cultivators of crops (Boserup, 1996:513)». On this occasion, the emphasis is placed on the interrelation between population and technology.

It is mostly assumed that Palaeolithic HFGS are to be considered self-reproductive economies or simple subsistence economies. The knowledge accumulated by the foraging groups implied the awareness of the carrying capacity of the environment, developing a high mobile strategy based on constant migrations. In the 1980s, evolutionary theories took again a central place in the archaeological research, emphasizing the important role of archaeology to re-develop theoretical studies (cf. Bate *et al.,* 2014):

> «If evolutionary theory is to be extended to the explanation of cultural phenomena, archaeology as a discipline will have to play a major role in its development. To a very real extent, the application of evolutionary concepts to sociocultural phenomena may depend upon the development of archaeological theory in this mould and not the reverse (Dunnell, 1980:37-38) ».

The concept of adaptation appeared in connection to culture, considering cultural adaptation as a response to the specific environment, and cultural evolution as a model developed from the empirical variability, whereas the causality of the processes is external to themselves. Neo-Darwinism or modern synthesis states that the organisms are subjected to evolutionary processes, such as natural selection, genetic drift, founder effect, and genetic flow. In this sense, societies are considered organisms. In the field of archaeology, the analysis of artefacts, for instance, is framed by a hierarchical scheme within the evolutionary theory. On the other hand, it is also attempted to explain speciation by identifying stasis processes. An alternative to the classic Darwinism, Evo-Devo (also known as Evolutionary developmental biology) compares the development of processes of different organisms in order to determine their ancestral relations – small mutations on very specific genes contribute to greater changing processes, with no need of natural selection. This is, indeed, an interesting turn, because the internal processes of the organisms are in charge to explain macro-scale transformations. Following on this perspective, Autopoiesis theory remarks that the coherent interrelation between the organism and the environment does not imply that a change in the environment determines a specific change on the organism, but the organism itself will have a specific response. Changes result from the

interaction between organism and environment, and are triggered by a disruptive agent while being determined by the structure of the specific disruption (Bate *et al.*, 2014).

In Prehistoric research, a great quantity of studies conducted place environmental, technological and biological constraints in the core of their approach. However, as it has been stated above, a universal response to environmental, technological and biological transformations is not possible to identify. Instead, the approach shall consider the specific response given to a specific context. Different time scales and a hierarchy of causes and conditions may be considered for the explanations of social dynamics (Estévez, 2005; 2009). Among those causalities, the organizational strategies for subsistence production and the strategies assuring the reproduction and continuity may play different roles and have different hierarchical situations.

Hunter-Fisher-Gatherers in Eurasia

Archaeological studies have put special attention to climate, environmental, technological, and bioanthropological factors when analysing prehistoric societies. A distinction between ancient *hominine* was established according to the specific anatomic features in combination with technological artifacts. This specific approach has strongly shaped the reconstruction of human evolution. In a resumed and simple schema: the first accepted *Homo genus*, the *Homo habilis* found in the Lower Palaeolithic (2,5 million years ago) in East Arica, has been associated to Oldowan lithic technology (Leakey *et al.*, 1964). The next step in the evolution of human ancestors leads to *Homo ergaster*[9] (around 1,8 million years), who featured Acheulean artifacts (Broom & Robinson, 1949). In the last western corner of the Eurasian continent the paradigmatic archaeological site of Atapuerca-Trinchera contains remains of *Homo antecessor* (at least 780.000 years ago), who also used Oldowan type artifacts (Bermúdez de Castro *et al.*, 1997). At

[9] *Homo ergaster* is the first from our ancestors that initiated a migrating process out of Africa reaching eastern Europe and western Asia about 1,7 million years ago (Ferring *et al.*, 2011). The archaeological site of Atapuerca (Spain) contains anthropological evidence from 1 million years ago (Falguères *et al.*, 1999). At Mojokerto (Java, Indonesia) *Homo erectus* is dated to 1,81 million years ago, and 1,6-1,7 million years at the archaeological site of Sangiran (also in Java, Indonesia) (Dennell & Roebroeks, 2005). The oldest certain occupation of the continental Asia is dated to 1,15 million year in southern China at Gongwangling (Antón, 2003).

this same archaeological place, in Atapuerca-Sima de los Huesos site, more than two dozen individuals are dated back to 430.000 years ago, they have been concluded to be related to a direct predecessor of *Homo neanderthalensis* from western Eurasia (Arsuaga *et al.*, 2014; Meyer *et al.*, 2016). In south- and eastern Africa, the earliest fossils corresponding to the Anatomically Modern Human are 195.000 years old (Brown *et al.*, 2012; Day, 1969; McDougall *et al.*, 2008). These first humans, with this modern-shape skeleton, reached Near East at least 100.000 years ago[10] (Grün & Stringer, 1991; McDermott *et al.*, 1993; Valladas *et al.*, 1987) along with Aurignacian type tools[11]. Some scholars identify a greater diversity of *Homo* species that inhabited Eurasia later on, from *Homo neanderthalensis*[12] (Harvati *et al.*, 2004; Tattersall & Schwartz, 1999) with Mousterian technology, the Denisovan *hominin*[13] in southern Siberia (Brown, 2010; Reich *et al.*, 2010), less than 20.000 years ago the *Homo floresiensis* in Indonesia (Brown *et al.*, 2004; Jungers & Baab, 2009), and the Anatomically Modern Humans are to be found in Balkan region around 50.000 years ago (Hoffecker, 2009; Hublin, 2012), introducing the Aurignacian technology into Europe.

The great focus of the research was placed on migratory movements, where the earliest remain of a specific human type is to be found, adaptation responses to environmental and climatic change, and a large contribution to the study of technology and diet transformations. The possibilities offered by biochemical analysis expanded the quality of the studies and the impact of the results. The research was accumulating a great deal of information about *production*, the mode of

[10] In the last years, archaeological research on the transformations of Palaeolithic populations in Asia has been intensified. Some researchers consider that local hominids evolved continuously, with little influence from external populations, but statements are only supported by artifacts found, as Qiu explains (2016).

[11] Fossil remains identified as Early Modern Human have been documented in Morocco, with an estimated date of about 315.000 years old (Callaway, 2017; Hublin *et al.*, 2017; Richter *et al.*, 2017).

[12] The earliest dates for the form *Homo neanderthalensis* has been posted to be at least 400.000 years ago in Europe (Stringer & Hublin, 1999) and 150.000 in western Asia (Grün & Stringer, 2000). This human form has been the focus of many debates, including the issue of its disappearance correlated, with the end of the Middle Palaeolithic and beginning of the Upper Palaeolithic technologies (Banks *et al.*, 2006; Bradtmöller *et al.*, 2012; Defleur *et al.*, 1999; Finlayson *et al.*, 2006; Hortolà & Martínez-Navarro, 2013; Mellars, 1998; Pinhasi *et al.*, 2011; Roper, 1969; Strauss, 1991; Underdown, 2008;Walker, 2001; Wolff & Greenwood, 2010;).

[13] The only remains from the Denisovan *hominin* is a distal manual phalanx of a juvenile individual, excavated at Denisova Cave, which contain levels dated to 28.000 years old. The levels associated to the specific phalanx have been dated between 50.000 and 30.000 years (Brown, 2010; Reich *et al.*, 2010).

subsistence according to the archaeological empirical data related to environment (resources) and technology (means of production). In the attempt of estimating population dynamics, the studies proved to be biased, inevitably falling into Malthusian explanations. The lack of attention to the *reproduction*, which ironically is the first factor involved in demography, may be due to the limitations of the archaeological material, but mostly, to the preconceived and actualistic perspectives regarding reproduction among foraging societies. The technical capability to develop more or less complex hunting strategies was discussed, but the capability for adopting reproductive strategies was not.

In the 1960s, a first definition of *natural fertility* and *controlled fertility* was introduced by L. Henry:

> «…in the absence of deliberate birth control… Control can be said to exist when the behaviour of the couple is bound to the number of children already born and is modified when this number reaches the maximum which the couple does not want to exceed (Henry, 1961)».

Following such assumptions, foraging societies were considered to fall within the range of those societies who do not practice any fertility control method. This was simultaneously supported by the idea that societies with high mortality require high fertility[14]. These arguments would find confirmation with the observation of low demographic density among most extant hunter-fisher-gatherer populations.

It is known that any human society is constituted historically from the workforce and around the labour (Marx, [1867] 1967). Labour is the basic social activity that allows the continuity of a group, with the main objective to obtain products. This sociality contains social strategies that assure the continuation of a specific society, as it includes not only the mechanisms of production, but also the relations and processes for the subsistence and survival of that specific group.

[14] Traditionally, three stages of demographic transition have been identified. A first stage, low population growth resulted from high fertility and high mortality rates. A second stage kept a high fertility rate, but mortality rate decreased, which lead to a rapid population growth. And finally, the third stage returns to a very low population growth, by decreasing fertility rate as well (Davis, 1945; Notestein, 1945).

The hunting-fishing-gathering mode of production is characterised by a correspondence between the workforce and the social relation forms. The labour division is simple, there is a technical division, or domestic (sex and age), and there may also be domestic units exploiting different resources (Estévez *et al.,* 1998). The knowledge of prehistoric societies is often conditioned by the preconceived and non-proved assumptions, which are present since particularistic reactions to evolutionism. This knowledge is filled with the idea of a strong dependence to environment, and with the conviction that politics or inequality are excluded, assuming these societies live on a utopian primitive communism –with collective property of means of production and workforce:

> «In early communal societies in which primitive communism prevailed, and even in the ancient communal towns, it was this communal society itself with its conditions which appeared as the basis of production, and its reproduction appeared as its ultimate purpose (Marx, [1894] 1967: 557)».

No doubt, Marx developed his concepts within the context of capitalist societies. Nevertheless, the resources availability and profitability, and their location and exploitation are likewise important for the former as capital, commodities and markets are to latter societies[15] (Winterhalder, 2001). Therefore, it is relevant to take into consideration the role of work force and relations of production to better understand the socioeconomic structure of HFGS. Following Bate (1986), according to a materialistic view of history, social relations are defined by the property relations on production and, by extension, define the production mode. Modes of production are differentiated one from another depending on the effective capacity of the agents to dispose of the elements of the production process. On this regard, hunter-fisher-gatherers can dispose of two elements: the workforce and the means of production. Property on natural resources would be performed when workforce is applied. Semi-elaborated or elaborated tools destined to production, which involve other production processes as objects, become part of

[15] In comparison to pastoralists, with whom mobility is shared, foragers lack of domesticated fauna. This is analysed as a constrain with implications for material accumulation, forms of property, and resources distribution. On the other extreme, agricultural economies usually can intensify their production, domesticating animals, improving plough efficacy, selecting better-adapted crops, controlling pests, etc., in order to overcome catastrophes. While the actualistic logic defines technology as leading the subsistence strategy, several early indicators of diet change in the east of the Mediterranean precedes the technological transformation, as the latter is a response of already existing challenges (Stiner, 2001)

property. The society invests and organizes the capacity to obtain the natural resources from the natural disposal and availability. This does not exclude the plausible existence of the perception of territoriality –according to Bate (1986), the possession of territory precedes land property developed in tribal society.

Therefore, in order to better understand the whole context, when studying the mode of production, the reproduction cannot be ignored. Human reproduction, which includes several interrelated stages (sexual relations, conception and pregnancy, birth, child raising) does not have a universal form or mechanism as if they were strictly biological processes, but it is managed socially. There are stimulus, regulations, pressures, which can be applied by physical force or ideological coercion, from the very simple to the most sophisticated (Brightman, 1996; Mathieu, 1985; Narotzky, 1995).

While a strong emphasis was placed on the impact of mortality, very little attention was paid to fertility. The field of demography provides the tools to approach this data. However, depending on the interest placed on the demographic analysis, economists, geographers and social scientists have applied demography according to their own particular approach and objectives. Clearly, most of the studies have focused on a quantitative compilation of data from the population under study, which most of the time is referenced according to administrative borders, rather than social and cultural, offering little opportunities to actually infer on the interrelation between the socioeconomic structures and the quantitative results obtained. Carr-Saunders (1922) made the first contribution in the study of fertility rates of non-industrial societies, and also the factors involved. He concluded that the fertility levels of societies, whose economy was based on hunting, gathering, or agriculture with rudimentary tools, and whose social organization gave a relatively high importance to mutual cooperation, were generally quite low. At the same time, a correspondence was visible between the population pressure, the resources, and technology in use. Additionally, Carr-Saunders identified involuntary and voluntary factors (e.g. prolonged lactation versus abortion and prolonged sexual abstinence), which had an effect to increase or decrease the population size. However, in the last years, some of these factors went under revision and were lastly disproved –as is the case of prolonged lactation to cause amenorrhea (this and related issues will be detailed in chapter 2).

Palaeodemographic studies of hunter-fisher-gatherers

> «…[T]he relative importance of demography, selection, and changing environments to human genetic variation during the past million years remain unclear (Hawks, 2008:26)».

Hawks summarizes the contradiction between the data available from genetic studies and the results obtained with mathematical models. The former conclude that Pleistocene populations may have not exceeded 10.000 individuals as a consequence of inbreeding, bottlenecks and selection factors. The latter suggest a global census of 350.000 for the same time period (Hawks, 2008). Palaeogenetic studies trace the genetic variation and frequencies, however, such information is not self-explanatory of long-term demographic profiles.

The demographic increase attested after the Last Maximum Glacial is impossible to miss (Bar-Yosef, 2002; Churchill, 1993; Hoffecker, 2005; Stiner, 2001; Stiner & Munro, 2002; Stiner & Kuhn, 2006; Straus, 1991). The main explanations point to technological improvements and change of the dietary spectrum. Whether the population growth is the trigger or the consequence of these changes still remains unclear. On this regard, it is considered that before this shift, the dietary selection and mobility were in charge to manage the local resources scarcity. Comparing the Middle and Upper Palaeolithic in Eurasia, the population growth may be a plausible explanation to the transformations on diet spectrum, for instance, with a focus on smaller ungulate prey or marine resources (Hu *et al.,* 2009; Richards *et al.,* 2005; Richards *et al.,* 2001; Stiner *et al.,* 2008; Stiner & Kuhn, 2006), but it does not explain the persistence of some type of resources similar to older chronologies. Contrarily, further archaeological excavations have proved that in the Middle Palaeolithic, marine and small prey were also occasionally collected (Bar-Yosef, 2004; Burke, 2000; Gaudzinski, 2004; Stewart, 2004; Stringer *et al.,* 2008).

Additionally, demographic density has also been linked to "modern human behaviour", hence symbolic and technologic complexity[16]. To some degree, such statements seem to find confirmation when comparing archaeological evidence of modern human behaviour in Eurasia

[16] The demographic transition from Mesolithic to Neolithic has been explained as a transformation on the base of fertility rate, e.g. reducing the age at weaning (Bocquet-Appel, 2002).

with that of sub-Saharan Africa (where it emerged 45.000 years earlier) in combination to the estimated population size according to genetic studies (Powell *et al.*, 2009).

Although the difficulties to accurately estimate the demographic parameters of prehistoric hunter-fisher-gatherers (population size, structure, density, the connectedness of groups), these variables are important for a better understanding of the archaeological record and, by extension, of the processes of material culture transformations (Riede, 2009).

Several studies have attempted to establish a reconstruction of Palaeolithic population density, following different perspectives and methods, with the objective to identify episodes of demographic expansion or contraction –with special attention to the transition between Middle and Upper Palaeolithic in Eurasia. Several studies have attempted to understand the population transformations, based on the quantification of settlements (Bocquet-Appel *et al.*, 2005), quantification of radiocarbon dates and their distribution (Bocquet-Appel & Demars, 2000; Goodale *et al.*, 2008; Riede, 2009; Surovell & Brantingham, 2007), quantification of artifacts (Ashton & Lewis, 2002; Hosfield, 2005), the analysis of technological innovation (Shennan, 2001), and palaeogenetic measurements (Excoffier & Schneider, 1999). Each of these studies, with their specific archaeological sample, at the end just achieved a partial reconstruction, if not a biased. Absolute quantifications in archaeology are not reliable[17], for example a restrictive control on a population can limit the technological innovation. Even more, simple technology combined with accurate exploitation strategies can easily satisfy the goals for subsistence, perhaps better than accurate technology without proper exploitation strategies. Additionally, taphonomic processes become another condition of random and biased effect for sampling and analysing. In parallel, some premises of these studies are connected to the biological and ecological capacities and limitations, which continuously condition the demographic dynamic.

Palaeolithic populations' dynamics are dependent on the carrying capacity of the environment (Estévez *et al.*, 1998) and, therefore, a dynamic equilibrium between population reproduction and

[17] The quantification of settlements within a chronological frame does not indicate the specific demographic density. An increase of spatial human activities could indicate an increase on demographic density, or alternatively an increase on mobility patterns. At the same time, the analysis of population structure according to human fossil remains is also limited. On the one hand, the absolute amount of individuals from the Palaeolithic in Eurasia is scarce and is not representative and, on the other hand, the sample decreases when considering only those fossils whose age can be determined (Trinkaus, 1995; 2011).

the natural replacement of foraged resources from the environment is required for assuring the continuity of the population. Following this premise, some studies also consider the carrying capacity of the environment by measuring the demographic density per square kilometre, assessing the minimum and maximum sustainability for the corresponding environment (Bocquet-Appel *et al.,* 2005; Hassan, 1981).

On the overall, while some studies agree that Palaeolithic populations were characterized by low demographic densities (Briggs *et al.,* 2009; Fabre *et al.,* 2009; Hublin & Roebroeks, 2009; Krings *et al.,* 2000; Lalueza-Fox *et al.,* 2005), others studies emphasize the importance of the impact environmental constraints may have on population growth (Kuznets, 1973; Shennan, 2001; Simon, 1997; Powell *et al.,* 2009).

2.- Middle Range Theory

Exposing a plausible hypothesis to explain an observed phenomenon is the first step to follow in a scientific process. In the current doctoral thesis the phenomenon under observation is the fact that Palaeolithic societies present low demographic density in the long term. The existing explanations are not sufficiently convincing, while at the same time they present ambiguities and sometimes come into contradiction with other palaeodemographic studies. The hypothesis needs to be confronted with archaeological and palaeoanthropological data, but sometimes the validation of a hypothesis cannot solely rely on direct archaeological evidence, but actually on simulating the necessary consequences of the premises. Experimental archaeology, ethnoarchaeological or ethnohistorical procedures have become important tools to expose a critical warning on simplified analogies or extrapolations that have been traditionally used to categorize the prehistoric record of HFGS.

Henceforth, this chapter will confront the demographic data available from contemporary societies labelled as hunter-fisher-gatherers with data from the palaeodemographic studies. Interestingly, contemporary HFGS present variability in their demographic parameters that does not seem to fully fit into the category of natural fertility. This is, it is critical to acknowledge that there are biological but also social variables that come into play in the shaping of reproduction among foraging societies.

In this chapter, I outline the major existing demographic studies on contemporary HFGS in order to illustrate the attested fertility rates, which do not respond exclusively to natural factors. On the other side, it may be likewise relevant to introduce the state of the art regarding the strictly biological factors interfering in the fecundity of men and women, as well as other topics still under discussions (e.g. lactational amenorrhea). On the overall, the only confirmed thesis is that there is an inherent contradiction between population and natural resources among foraging societies. In other words, an uncontrolled demographic growth puts into a critical position the carrying capacity of the natural resources and by extension the survival of the group. In this intricate structure, the social regulation of reproduction turns to be an effective mechanism that controls demographic growth. In this chapter, I introduce the definition or understanding of social regulation or social norms in the context of the current thesis.

Contemporary hunter-fisher-gatherers: demographic studies

The question here refers to what kind of actualistic and historical information do we count with, that can be used as an initial point to develop a middle range theory regarding the reproductive issues of hunting-fishing-gathering societies.

In historical demographic studies, the data available are different depending on the purpose of the study and the actual material at hand. In the same manner, in combination to ethnographic research, there are countless of studies on contemporary hunter-fisher-gatherers that have combined different disciplines, perspectives, and methods. However, at this point, the critical discussion raises again to "who are the contemporary hunter-fisher-gatherers?". In the last years, transformations in health care, subsistence strategy and settlement organization had a strong impact over pre-industrial populations. Anthropological surveys have attempted to collect census data of "the last hunter-fisher-gatherers", in order to obtain reliable age and sex structure, as well as mortality and fertility profiles (Chamberlain, 2009). A few cases may be here summarized, in order to exemplify the possibilities of demographic studies on living societies, some of the most relevant cases exemplify the task of gathering empirical demographic data among small-scale societies. From these studies, the attention is placed on the observations and calculations of mortality and fertility rates –other demographic parameters will be further discussed later.

The existing works at hand correspond to those by Nancy Howell among the !Kung in the 1970s (Howell, 1979; 2000), by Kim Hill and A. Magdalena Hurtado among the Ache of eastern Paraguay in the 1990s (Hill & Hurtado, 1995), by Nicholas G. Blurton Jones, Lars S. Smith, James F. O'Connell, Kristen Hawkes and C. L. Kamuzora among the Hadza in the 1980s (Blurton Jones *et al.*, 1992), and the work by Tom and Janet Headland among the Agta in the 1960s, 1970s and 1980s (Headland, 1989). Simultaneously, some of these studies additionally offer several statistical tables, including population structure according to sex and age, or the natural mortality distribution, also according to age and sex. The statistical data from these particular studies is not sufficient to fully frame the demographic parameters, therefore other demographic studies (i.e. Carr-Saunders, 1922; Lorimer, 1954; Nag, 1962) and medical studies are also taken into account. A few examples of these ethno-demographic studies shall be briefly commented in order to provide an overview of the context of the research and data.

Between 1967 and 1969, Howell conducted her research on a small San population located in the Dobe Area, between Botswana and Southwest Africa (Howell, 2000). Howell's data are the result of surveys obtained interviewing 850 people, with special attention to 165 adult women, in addition to the data collected by R. Lee in 1963-1964 and 1973 (Lee, 1979). It was presumed that the Dobe area enjoyed a special isolation in comparison to other regions where the San lived in (mutual) dependency with European farmers and cattlemen or with Bantu farmers and cattlemen, or settled at governmentally or privately organized stations, where hunting and gathering activities were being lost. The commonly labelled Bushman, among whom the Ju/'hoansi have been targeted with great interest due to the erroneous thought that they were long-term (as far as to the Prehistoric time) living inhabitants of the Kalahari. The calculations on mortality rate indicate low mortality among young adults –with an estimated life expectancy over 50 years of age. On the other side, the results indicate low fertility rates (only 4,69 children per woman over her lifetime), which Howel (2000) associates with a cease of childbearing (mostly due to sterility). Likewise striking is Howell's observation that older women report higher number of children born, leading to an apparent declining trend of fertility while approaching to the younger women. Usually, according to Howell, older women report fewer children than they had as they "forget" to count children who died.

The Ache, a small group who inhabited eastern Paraguay, is considered to present distinct linguistic and cultural material compared to other indigenous Paraguayans. Demographic data from the period between 1890 and 1993 were collected by Hill and Hurtado (1995). According to this particular study, the Ache practiced a hunting and gathering mode of subsistence (in authors' words: ancient economic regime), and did not trade nor intermarry with other Guarani Indian groups. It is known that shortly after the contact in the 1970s, the population decreased nearly one-third as a consequence of contact-related respiratory diseases. Horticulture took part in the small-scale subsistence, as well wage labour among young men. The results from the study show that the Ache seem to present a very different picture in comparison to the !Kung San; while the first are characterized by high fertility and high mortality rates, the latter show low rates on both parameters. Other differentiated features were also identified, such as biased juvenile sex ratio, among others. As a consequence of this variation, besides that neither of these two foraging groups could be considered as the only representative of a foraging society, dependent and independent variables involved in the demographic dynamic needed further examination.

The Philippines was first occupied 25.000 years ago, being the Agta their probable descendant. With the arrival of the Europeans, the records indicate a great decline of population in the Negrito groups. In 1962, Tom and Janet Headland began studying the Casiguran Agta population of the Philippine Islands (1989). In contrast to the Ache, the Agta practiced trade with nearby farmers, for whom they may also work as seasonal labourers. Later in the 1980s, they confirmed that in a region north of Casiguran, women were also found to hunt wild pig and deer with bow and arrow. From their observations, a general declining tendency was detected, between 1936 (Vanoverbergh's census) and 1984 (Headland's censuses in 1977 and 1984) the population had decreased 40% (from 1000 to 609 people). The numbers show a total fertility rate of 7, while keeping at the same time a high mortality rate, with a life expectancy around the age of 20,7 for males and 22 for females. As noticed by Headland, the Agta are the only population with high death rate, but also negative growth rate –in contraposition to the Yanomama, who had a total fertility rate of 8,2 and at the same time a positive growth rate. The main conclusion reached, on regard to the decline of the Casiguran Agta, is that they represent a population which has some kind of maladaptive state with its ecological context.

As a last example, the Hadza, a population of East Africa considered to also be an example of hunter-gatherers, has been studied in 1985 by Blurton Jones and others (1992). There are historic records of neighbouring pastoral and agricultural groups, but the stations were the main agent in charge to encourage the Hadza to abandon the hunting and gathering, in order to take part in farms. Regarding the data of interest here, the authors had the opportunity to compare their results to the data collected by Dyson in 1967. On the whole, they do not see important changes since 1967 in respect to fertility and mortality rates. With a fertility rate to 6,15 and a life expectancy between 31 and 32 years, the population presents a steady growth rate of 1,3-1,4%. Within the research context of the Kalahari *hunter-gatherers*, they conclude that the ecological and biological factors are commanding the demographic shape, explaining the higher fertility and demographic density among the Hadza in comparison to the !Kung from Howell (2000).

These four examples of systematic demographic study show that different mortality and fertility rate are possible, even though the population structure from all populations might not strongly differ (Fig.1).

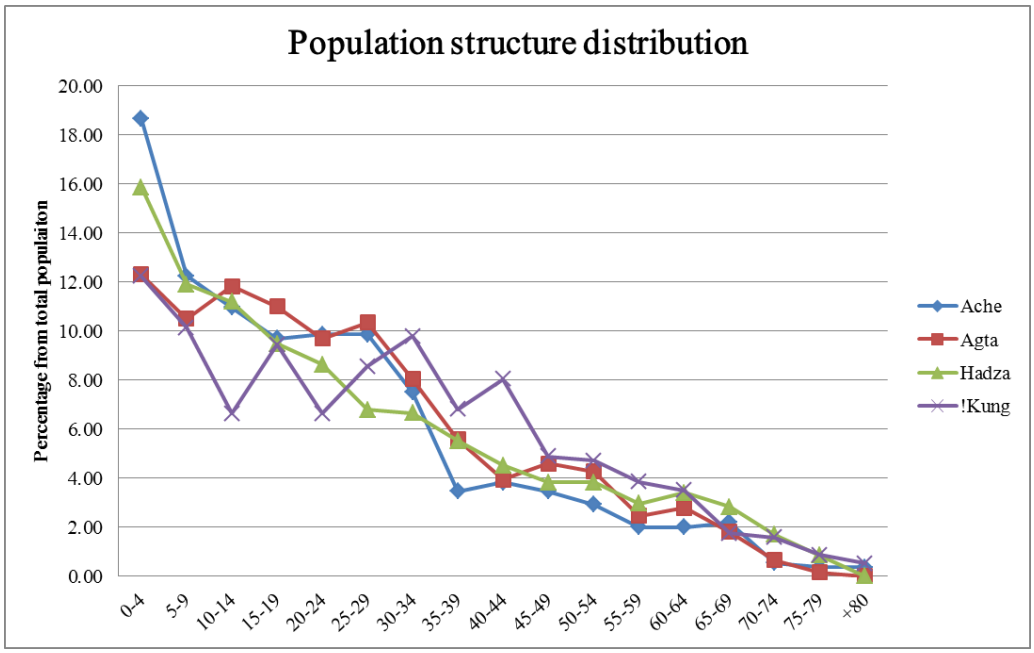

Figure 1. Distribution of the population structure of four foraging groups, following the data available in Chamberlain (2009), based on the demographic data published by Hill and Hurtado (1995), Headland (1989), Blurton and others (1992), and Howell (1979**).**

Biological and social regulation of the human reproduction

Ethnographic research on HFGS presents a different picture compared to that summarized in chapter 1. Instead of a unique demographic pattern based on Malthusian or Boserupian theories, ethnographic groups show variability in the mortality and fertility rates (Chamberlain, 2009). At the same time, there are many historical contexts that evidence a great demographic recovery capability after a contraction event –e.g. after a natural catastrophe, the spread of diseases, or an armed conflict. A contradiction appears to exist between what is archaeologically interpreted and ethnographically attested. This contradiction sets the question of whether archaeology is using proper methodologies and analogies to study the demographic features of prehistoric groups.

Most of the explanations on the ethnographic societies are based on an assumed "natural" process of human reproduction. Their demography is mostly regulated according to their subsistence strategy and technological equipment, in the same manner a technological development theoretically brings a population increase –discussed in chapter 1. A direct correlation between

subsistence strategy and the carrying capacity of the environment is established in order to explain demographic tendencies. The environment limited the survival of the group to a demographic density level in which the natural resources[18] would not be overexploited or, alternatively, some decisions had to be taken for the sake of the survival of the group (e.g. spacing births, practice of infanticide, among others) (Birdsell, 1968; Brightman, 1996; Kelly, 1995; Hassan, 1981; Surovell, 2000; Sussman & Hall, 1972).

Other authors consider that there has always existed a population growth pressure due to the human fecundity capacity, which would have stimulated the immediate technological developments (Hayden *et al.,* 1981), or the appearance of agriculture and herding (Cohen, 1977). In addition, the existence of specific food prohibitions could have affected the nutritive health of women, and by extension their fecundity, which along with other sexual prohibitions can reduce fertility (Ellison, 2008; Spielmann, 1989).

It is crucial to review the ethnographic and biological data on reproduction in order to evaluate the presuppositions, analogies and explanations that have considered human reproduction an independent variable in the trails of prehistoric HFGS.

Naturally, the character of the sources is diverse, and brings forward different type of information that is in fact closely interrelated. In any case, it is indispensable to first understand that reproduction is primarily conditioned by the exposure to conception, which is for its part conditioned by the relations between sexes, which are socially regulated in any existing human society. Secondly, there are several variables that come into play on a specific level among female individuals (age at menarche, conception, pregnancy, childbirth, breastfeeding, and the pre-menopausal stage) and among male individuals (fecundity, sterility, and age-correlated biological changes). Clearly the extension of the knowledge on these variables is dependent on the existing publications. While some of these variables count with a clear and unquestionable

[18] Without entering into detail, it may be here remarked the existing issue on the basic misconception of "natural resources". This is, resources are not "natural" but only recognized as "exploitable" depending on the technology, accumulated experience, and many other social and ideological factors. Several instances show and exemplify how in some cases Europeans did starve, where and while a hunting-fishing-gathering population flourished without problems. Therefore, provisionally, the assumption here is that resources are limited because the work effort is not devoted to their reproduction, but instead depend on their natural rhythm of reproduction.

description, some are still the focus of different debates. I list below the main biological variables at play in reproduction and the associated empirical data.

Pubertal development in females occurs in connection to breast development (thelarche), pubic hair growth (andrenarche), and finally the first menstruation period (menarche) –an abnormal delay in puberty may be marked by the lack of thelarche by the age of 13,5, of andrenarche by the age of 14, or the menarche at the age of 16. On average, the puberty development is found at the age of 12,8 (Corenblum & Boyd, 2017)[19].

A primary amenorrhea (when the onset of menarche is lacking) exists and it is estimated to be between 3-4% (Practice Committee of American Society for Reproductive Medicine, 2008). It seems to respond to the levels of gonadotropin[20], and to the presence or absence of sexual characteristics. Biologists have also identified what they termed as secondary amenorrhea. For example, after giving birth, the period following has been classified as secondary amenorrhea, during which the woman is apparently less fecund.

This phenomenon has been commonly associated to lactation. The clear understanding of this particular biological event is still under discussion. Some scholars consider that there is a period of variable length in which the mother is less fecund after giving birth. The postpartum amenorrhea has been constantly used to justify and explain the low total fertility rate among societies that do not use modern contraceptive methods, implying that prolonging breastfeeding women are postponing the birth of the next child under natural circumstances.

On the opposite direction, other studies stress on the plausible evidence that women start ovulating even while still breastfeeding, which means that the risk for another pregnancy increases. Lactation seems to supress the resume of the ovarian activity, delaying therefore the resumption of the menses in postpartum women, although, as before mentioned, there is no

[19] Pearl (1939, quoted in Nag, 1962) observed the earliest age at menarche around 13,17, and latest at the age of 16. Mils and Ogle (1936, quoted in Nag, 1962) observed that menarche starts up to two years later in tropical regions. Key and others (1950, quoted in Nag, 1962) found that urban and upper-class girls started menstruating earlier than rural or lower-class girls, which they associated to differentiated nutrition.

[20] Gonadotropin are the central hormones to the endocrine system that regulate the normal growth, the sexual development, and the reproductive function. Gonadotropin deficiency can lead to infertility (Corenblum & Boyd, 2017).

consensus between researches. Statistical studies (Jackson & Glasier, 2011; Speroff & Mishell, 2008; Tietze & Lincoln, 1987; Practice Committee of American Society for Reproductive Medicine, 2008) conclude that ovulation may not start until 6 weeks postpartum –earlier ovulation was also identified[21]. The difficulty to measure such variables is always present, nevertheless from a sample of Danish women, it was concluded that lactation longer than 9 months does not prolong postpartum amenorrhea[22]. In another study, different methods are tested to measure the start of ovulation and the onset of the first menses among non-lactating women. It is found that the majority start ovulating after 4 weeks postpartum, however about 70% of the cases ovulate before the first menses is resumed. This is, the first menses postpartum cannot be considered as observable indicator of the start of ovulation among non-lactating women (Speroff & Mishell, 2008). Among lactating women, it is found that the increase in prolactin (active protein in the production of milk among mammals) during suckling is directly correlated with the intensity and duration of suckling episodes, however such increase gradually declines as the interval after childbirth increases. The initiation of supplementary feeding is also associated to the decrease of nursing, to the decline of prolactin and the increase in estrogen secretion (in charge to regulate the reproductive system), and ovulation. The statistics indicate that among lactating women, 70% remain amenorrheic for 6 months, and only 37% for one year (Speroff & Mishell, 2008).

In this same study (Speroff & Mishell, 2008), it is indicated that not a single society under a natural fertility regime has ever achieved a fertility rate at the maximum level possible. This statement is based on several studies conducted between the 1970s and 1990s among different female population groups from different regions around the world. These studies measured the impact of breastfeeding on the fecundity of women. They conclude that fertility rate can be reduced up to 30%, the majority of the women may remain anovulatory up to 6 months, while very few actually resume ovulation earlier than 6 months postpartum. In any case, the probability

[21] The mean day of first ovulation postpartum ranged between 45 and 94 days, from all cases between 20% and 71% of first menses were preceded by ovulation, and between 0% and 60% of these ovulations were potentially fertile (Jackson & Glasier, 2011).

[22] Menstruation was resumed before weaning in 57% of the women (from a sample size of 361 women), and the remaining 43% terminated breastfeeding before the first postpartum menstruation. Among the latter, in 79% of the cases, the menstruation started after 4 weeks from weaning, and 93% from all women after 8 weeks (Vestermakr *et al.*, 1994).

of ovulation increases a 17% by the 12th week postpartum, and a 36% by the 18th week postpartum –actually, in these same studies, a few cases of women conceived while still fully nursing. Nevertheless, Speroff and Mishell (2008) agree that the *contraceptive* protection of breastfeeding lasts until 10 weeks, afterwards and in combination to the initiation of supplementary feeding, the chances of ovulation increase. Even though the different cases seem to confirm the positive effect of lactation on ovulation, it is not certain whether those studies did not observe other (social) patterns related to conception. Additionally, others have pointed an unclear correlation between lactation and amenorrhea, as menstruation may return while still nursing (possibly preceded by ovulation by 2 weeks) or amenorrhea may continue even after cessation of breastfeeding (Tietze & Lincoln, 1987). Another point, which Tietze & Lincoln (1987) remark is that, whether lactating or not, women present one or more anovulatory cycles after postpartum amenorrhea. On the overall, considering both postpartum amenorrhea and the additional two weeks before the first ovulation and menses, non-lactating women experience, on average, about 4 months of *secondary sterility*; in the case of lactating women, such estimation is less precise (Tietze & Lincoln, 1987). Perhaps, the safest conclusion to reach is to simplify the facts in that, not only the duration of lactation is variable, but also the secondary amenorrhea among different women.

Studies have pointed to the decrease of bone mineral density due to pregnancy and the consequent period of amenorrhea (Holmberg *et al.*, 2000), that would be a very interesting point to follow in archaeology. Unfortunately the studies cannot yet confirm whether this bone loss is permanent[23].

In connection to the menarche, it has been stated that pregnancies occurring at an early age have a higher probability to end in miscarriage and stillbirth (Kuczynski, 1949; Montgau, 1946). In the same manner, a woman who had miscarriage or stillbirth has also higher probability to present

[23] At the moment, it is assumed that those women who resume the menses early may have smaller bone loss and better recovery after weaning, compared to women with longer amenorrhea. In principle, the demand of milk production for larger amounts of calcium may cause the maternal bone loss (Holmberg *et al.*, 2000).

her reproductive organs damaged at later age, being secondary sterility one possible consequence –and especially among young mothers[24].

On the other side of the reproductive capacity of women lays the menopause. Due to irregular ovulation cycles prior to the actual cessation of menstruation, it is rather complicated to determine the true menopause age (Pearl, 1939, quoted in Nag, 1962). The groups Pearl analyses ranged from 43,96 to 49,40, with an overall mean of 46,38 years of age –the deviation observed has been associated mostly to biological factors. Additionally, Nag (1962) mentions the discussion around the possibility that a certain number of menstrual cycles are allotted to each woman, implying, therefore, that menopause is delayed among women with frequent pregnancies –but empirical data is lacking to possibly confirm it. Nevertheless, there is no doubt at all that the age at menopause does not increase with the increase of life expectancy. With certainty, what can be stated is that a woman's reproductive span is less than the period between menarche and menopause.

Fertility is not only constrained by the biology of women, but also by that of men. However, the reproductive life of man is less precise compared to the women (e.g. women experience menarche, periods of amenorrhea and menopause). In principle, the appearance of spermatozoa in the testes of men is a necessary condition for attaining complete reproductive capacity among men, but it cannot be reduced to only one variable. As with menarche, the emission of seminal fluid is not directly translated as fecund, as it could proceed to the actual production of spermatozoa. In the same manner, there is no such a thing as menopause among men, but the end of their reproductive capacity comes slower –the percentage of active cells in seminal fluid decreases after 40 years of age, however, motile spermatozoa is still found among men ranging 60 to 82 years old (Leathen, 1958, quoted in Nag, 1962), while Farris suggests that men terminate

[24] Pregnancies at an early age also come in association with high maternal and/or child mortality (Mehra & Agrawal, 2004). Child marriage, low socioeconomic status, poor access to health care, and husbands who had multiple sex partners are common risks for cervical cancer. Pregnancy challenge girls, as it supresses the immune system and, therefore, they remain at an increased risk of acquiring diseases. On the other hand, the problem of young girls delivering children is that they are at a significant higher risk of debilitating illness and even death (including eclampsia, postpartum haemorrhage, HIV infection, malaria, and obstructed labour), in comparison to older women. Between 35% and 55% of young girls with early pregnancy experience higher risk than older women, for delivering preterm or low birth-weight children (Kamal & Hassan, 2015; Nour, 2006; Raj, 2010).

their reproductive capacity at the age of 60 (Farris, 1950, quoted in Nag, 1962). Additionally, some studies point out that closely spaced ejaculation reduce the sperm count, and by extension the percentage of sperm motility (mobility) (Wilcox *et al.*, 1995; Johnson *et al.*, 2012), which may be associated to coitus frequency[25]. The results on this matter do not appear to be enough conclusive by the authors. Hotchkiss indicates that the count of spermatozoa in an ejaculation returns to its original value after an *abstinence* of 72 hours (1944, quoted in Nag, 1962). Another biological factor involved in the probability of conception is the persistence of spermatozoa after sexual intercourse (Davies & Wilson, 1974; Wilcox *et al.*, 1995). The studies concluded that motile sperm is detected in the female reproductive tract 3 days after intercourse, and occasionally up to 6 days.

The chance of conception is strongly conditioned by the timing of sexual intercourse and ovulation. The results of a study show that the probability of conception increases significantly between the previous five days to the end of ovulation –independently to the frequency or age of sperm (Wilcox *et al.*, 1995). The model this study brought forward indicates that daily intercourse has the highest probability for conception, this is 0,33 per cycle, while lower frequency of intercourse reduces to 0,15 the chance of conception per ovulatory cycle. However, as mentioned earlier, frequent intercourse may decrease the quality of sperm. Nutrition may also play an important role on the reproductive fitness of men and women. Malnutrition, including deficiency of vitamins and caloric intake, increases the probability of miscarriage and stillbirths, as well as has a negative impact on spermatogenesis.

On the overall, conception is the main event clearly constrained by biological factors. But sexual relations, pregnancy, childbirth and nursing do not follow universal laws. These are actually events socially regulated (Brightman, 1996; Mathieu, 1985; Narotzky, 1995). Different scholars (Bongaarts, 1978; Davis & Blake, 1956; Nag, 1962) have established a classification of the factors affecting fertility, depending on whether they have an impact on the exposure to intercourse (e.g. age of entry into a sexual union, sexual abstinence), on the exposure to conception (e.g. temporal abstinence, coitus frequency), and on gestation and parturition (e.g.

[25] Other authors have pointed that excessive frequency of sexual intercourse leads to male impotency (Kuczyknsi, 1948; Rommer, 1952, quoted in Nag, 1962).

voluntary and involuntary foetal mortality, infanticide), as well as other factors such as type of marriage, proportion of married people, sterility, nutrition, reproduction span, among others.

In the early 1920s, the first study of fertility trends among pre-industrials societies (Carr-Saunders, 1922) turned a work of reference for the studies following, as it also considered all different factors involved[26]. In the same manner, Nag (1962) extended the sample with 61 additional non-industrial societies. In the whole set, similar patterns were recurrent. On the one hand, different fertility and mortality rates were attested. On the other hand, while high fertility rates were expected among the natural fertility groups, these presented instead low fertility rates. Comparatively, the results from the demographic study among the Hutterites (Eaton & Mayer, 1953) show that they had a fertility ratio (number of children under 5 years of age per 100 women of ages comprised between 15 and 49) greater than any other human population[27]. Among these *presumably* natural fertility populations, two poles emerge. Among the majority of these populations, several social practices are observed to take an important part on the fertility outcome, such as age at marriage among women, the interval allowed between consecutive childbirths, abortion or infanticide, temporal sexual abstinence, *contraceptive methods* believed to be effective (e.g. expelling the semen after the coitus by turning over or urinating), marriage structures (e.g. monogamy, polygamy, re-marriage), among others. These social practices together contribute towards a lower fertility rate in a population defined to be following a natural fertility. On the opposite side, the Hutterites do not practice any sort of birth control, hence favouring and optimizing their reproduction capacity. Consequently, the particular case of the Hutterites has been commonly taken as an example of a society framed within a natural fertility context

[26] Carr-Saunders noticed different practices, including prolonged lactation, initiation ceremonies, temporary or permanent celibacy, the age at marriage (with special attention to women), abortion, infanticide and warfare between the different groups he analysed (Eskimos, Fuegians, central Australian, the Indians from the Pacific Coat, Andaman Islanders, among others).

[27] The fertility ratio among the Hutterites was of 93,3, while in Algeria it was 63,1 (1948); in Jamaica,49,5 (1949); Israel, 45,8 (1948); or the United States, 42,3 (1950). A cross-cultural comparison of the age specific fertility rate between the Hutterite population and other populations in the late 1940s (Jamaica, Japan, and the Netherlands) shows that the Hutterite females have a record fertility in all age group, except girls between the ages 15 to 19. The relatively low fertility of young Hutterite girls reflects their custom of marrying only after adult baptism, and the median age at marriage was of 23,5 (Eaton & Meyer, 1953).

Davis and Blake (1956) indicated that intercourse, conception, and gestation and parturition are the necessary steps in human reproduction. By considering these categories, it is then possible for them to identify three groups of strictly non-biological factors shaping the fertility outcome. These are factors affecting exposure to intercourse (including age of entry into sexual unions, permanent sexual abstinence, amount of time spent between unions, due to divorce or widowhood), factors affecting the exposure to conception (including temporal abstinence, whether voluntary or not, and coitus frequency), and factors affecting the gestation and parturition (these are voluntary or involuntary foetal mortality, through spontaneous or induced abortion, or through infanticide). Davis and Blake's categorization coincide with those factors defined by Nag (1962): probability of coitus, sexual abstinence, age at marriage, marriage systems, separation, reproduction span, sterility, diseases, nutrition, and infantile mortality. In the case of Bongaarts's perspective (1978), the factors may be listed as exposure factors (e.g. proportion of people married), deliberated marital fertility control (e.g. contraception or induced abortion), and natural marital fertility factors (lactational amenorrhea, frequency of intercourse, sterility, spontaneous abortion, reproduction span).

As a conclusion, although reproduction seems a biologically derived process, it is important to acknowledge that the social organization has a significant influence on it. This social organization not only controls the sexual intercourse of females, its frequency, or the age of the sexual partners, but also the duration of breastfeeding, and the nutrition (morbidity) of women. In short, there is the possibility to influence the demographic rates with the appropriate strategies (may they be termed reproduction strategies). By controlling women's sexual relations, it is possible to regulate the fertility outcome of a population. As a last resource, demographic rates can clearly be socially controlled murdering individuals, including here induced abortion, infanticide (especially female infanticide), euthanasia or war. Without question, any of these practices are completely socially driven strategies, and common in the ethnographic record (cf. Divale, 1972; 1974; Divale *et al.*, 1976; Ember, 1978; Ember & Ember, 1972).

Finally, it is essential to consider that reproduction (the production of socially fit individuals) does not only involve biological processes, but also a complete social working process, structured through norms, which begins with the sexual maturity recognition, marriage, gestation, childbirth, lactation, weaning and childcare, and education (Vila, 2017).

An inherent contradiction: the paradox and the search for an integrated explanation

Natural mortality, with its particular distribution depending on sex and age, is not sufficient to regulate demographic growth. The main starting point of this doctoral thesis is that, at some stage of the early history of humankind, reproduction ceased to be a strictly biological process and began to be socially controlled. As it has been already announced, by controlling specially women's sexuality and fertility, it is possible to transform the total fertility rate in a population –a few examples have been very briefly introduce a few lines above.

An integrated explanation of the mode of production and reproductive strategies provide us the clue to a definition of what would be a HFGS.

According to Estévez and others (1998), these societies have little control on the reproduction of the resources, which may lead to a delicate situation with the human population growing rate, which endangers the equilibrium of resources exploitation and environmental recovery. As it has been mentioned before, the hunting-fishing-gathering mode of production is characterised by a correspondence between the workforce and the forms of social relations. The point in which the human reproduction overcomes the resources reproduction, thus putting into danger the immediate survival of the human group, indicates the materialisation of the mentioned contradiction between production and reproduction among foragers.

In this study, three levels of causality interrelated are considered: a dominant causal actor, a determinant, and a triggering effect (Estévez, 2005; 2009). This particular perspective argues that changes result from the interrelation between the organism (the society) and the environment, triggered by a disruptive agent, simultaneously being determined by the structure and the particular state of its internal contradictions. There is a specific response depending on the combination of these different levels of conditions. Following this perspective, the long-term relationship between population parameters, resources reproduction and availability with the existing technologies is the dominant causal actor. The triggering effect consists of little disturbances –environmental or social- that come into play at a specific moment, leading to a change that may affect or activate the contradiction on a different scale.

Population growth is not only connected to the development of technology and productive strategies, but it is the result of the people's own organization of reproduction strategies –this is, the social relations between men and women, in order to re-produce the workforce (Vila & Estévez, 2010). In the same manner the dawn of technology and strategies for production are observed along the prehistory, the organization of labour is also observable. In the same manner the strategies for production are studied, it is also important to study when and how reproduction can also be understood as being socially organized.

Therefore, it is absolutely important to state that the relationship and mutual causalities between these two contradictory elements need to be explored, and to establish an approach that connects production and reproduction to understand hunter-fisher-gatherer's demographic patterns and the social organization behind.

There are two universals found in the ethnographic literature about contemporary HFGS, which must be correlated with the announced inherent contradiction between production and reproduction. These two universals are: the sexual division of labour and a clear dissymmetry between men and women (Argelés & Vila, 1993; Estévez *et al.*, 1998; Vila; 2004; 2015; Vila & Estévez, 2010). Unfortunately, both of these have received little attention because they have often been naturalized. The sexual division of labour has been attributed to biological specific features of both sexes: women would mainly be in charge of a more continued and time-consuming daily gathering of foodstuffs activity (vegetables, collecting molluscs, or hunting small animals), while men would mainly be in charge of a more punctuated and less-continued hunting of big game activity (Biesele, 1993; Dahlberg, 1981). This division is neither homogeneous or universal in its details, nor correspons it to a universal environmental or biological condition. In parallel, the social dissymmetry based on sexes has been often denied or reduced to a natural character. Although the universality of both characteristics, the variability of forms they take among the different HFGS as well as the great ideological investment developed to justify them demonstrates that they are no restricted to biological causes[28].

Assuming the social character of these two universals, they both tie together with the announced internal contradiction, in which the required balance between production and reproduction is

[28] For instance, there is no ideological need nor investment to justify why humans need to breath, eat, drink, sleep, among other biological constraints.

mainly maintained through the control of reproduction (especially women's) and the maintenance of a restrictive production. In a few words, as a last resort the practice of infanticide clearly affects the demographic growth of a population. In the majority of the ethnographically documented HFGS in which infanticide is attested, there is a clear preference to sacrifice female newborns. Considering this, it is necessary to count with a well-structured believe that legitimates it. The manner in which labour is divided (organized) is at the same time distributing the subjective value of the productive contribution of the individuals participating in the production. For example, if hunting is considered of greater value for the community, the hunters will sustain a higher social value. Devaluating the value of collecting vegetables or of small hunting, the gatherers will sustain a lower social value among the groups.

Therefore, labour represents the means through which social relations and social behaviour are easily controlled. The difference in production activities according to sex makes it possible to set an interdependence (between the two sexes that assure reproduction) and at the same time to relativize the value of the product obtained and, by extension, the value assigned to the people producing it. The organization of labour together with the regulation of reproduction brings together a legitimization of a social inequality based on gender. Connecting all points until now presented in the last pages, the gender-based division of labour, and the inequality and discrimination against women could be seen as historical consequences of the strategies in charge to manage reproduction through norms in order to control demographic growth (Estévez *et al.*, 1998).

What is a social norm?

The definition of social norms would need an entire chapter, considering that there are several points of discussion that have been the focus of attention from different perspectives – philosophy, anthropology, sociology, psychology, economy, and also among legal scholars. A blurry line between the different types of norms, such as moral, legal or social, constrains the analysis of the interrelation between people's normative belief and their behaviour.

The emergence of norms, their implementation and function, their transformation or persistence, are just a few of the mostly discussed topics. Despite the interest of these issues, I will not enter into this subject, because it will digress from the framed objectives of the current doctoral thesis. Some indices could be corollary referred in the archaeological record to assert when and how did this organization of the hunting-fisher-gathering mode of production arise, for instance: the evidence of developed production strategies enough to endanger the reproduction of the targeted resources (i.e. a substantial diminution of the main prey, an efficient hunting technology such as bows and arrows), the evidence of ideological construction of sex-identities (i.e. in the parietal and mobile art), or the evidence of sexual division of labour and/or prestige directly on skeletons and associated items[29].

Nevertheless, such aspects may be considered for future research. I will mainly point out to some issues concerning directly to the case and aim of the doctoral thesis: discussion and evaluation of the influence of a shared and sanctioned behaviour in social reproduction (often maintained through mythological justifications and distributed punishment). This behaviour is followed in order to obtain social recognition and prestige (Pedraza Marín, 2016; 2017).

Among the recent literature, the term of norms is placed in a specific social setting, in which individuals behave usually in a certain way, and when individuals do not behave in this manner they are punished (Axelrod, 2006). In this line, it is assumed that punishment is in charge to balance the permissibility and normative of the social behaviour within a group. A certain action may be taken as a norm, depending on how often it is punished for not taking this action. Behind this particular concept, several hypothesis seem to fit in a way or another to understand the decision of social behaviour: the more effective individuals are more likely to survive (and therefore to reproduce), by trial and error individuals learn which strategies are more effective, or by observing individuals taken as a model the strategies of those who seem to perform better (Axelrod, 2006). Axelrod explains that dominance or reputation represent the two main mechanisms through which specific social behaviour is established as a *norm*. Alternatively, social sciences have also attempted to establish social norms as rational (efficient means to

[29] Hypothetically, some of these exemplifying indicators could exist in an archaeological context, such as the case of the Last Glacial Maximum, about 25.000 years ago –in some parts of western and central Europe. Unfortunately, the archaeological record is yet to be explored in this direction. Additionally, it is not easy to reconcile macro social dimension events of long-term durability with short-term individual and particular information

achieve individual or social well-being) or that conforming to norms is rational (in the sense of utility maximization). As Bicchieri expresses it (1990), social norms are a group of expectations, where the conformity to social norms is a conditional choice based on expectations about other people's behaviour. Bicchieri also considers the approval and disapproval as sanctions that lead a specific action to become a norm. The emergence of a norm may be considered an example of a spontaneous order, a coordinated action occurs despite the inexistence of a clear established central authority. And yet, behind this process a rationality of decisions is expected, following the preferences or beliefs of the individuals. In a different study, Bicchieri (2002) argues that fifty years of experiments on social dilemma have shown that cooperation rates range from 40% to 60%, and everyday experience has shown people contributing voluntarily to public goods, charities, refraining from wasting resources, etc. Allowing the subjects to discuss the dilemma shows a dramatic increase of cooperation rates. Bicchieri's main arguments explain that communication stimulates the formation of social norms –alternatively to the common concept of group identity enhancement.

The main difficulty when analysing the social norms of an existing group is precisely the root of the arranged system containing the obligations and sanctions. As a starting point, it is clear that social norms are not individual and isolated arbitrary acts of behaviour. For the current study, norms, or more precisely social norms, are understood as shared prescriptions or proscriptions for people's behaviour. Basically, norms are expected to define the boundaries of what people are allowed to do, and what are not. There must necessarily exist a mechanism through which social norms are reinforced in order to assure their compliance. That is, the norms exercise a regulation of people's behaviour, which does not necessarily require a mutually shared approval. In any case, the main effect of norms is a (expected) homogeneous behaviour.

In the documentation analysed, social (and economic) norms are identified as those actions repeatedly observed, as well as their general compliance. In the early ethnohistorical sources, the social norms are usually implicitly referenced. For instance, in the case of the age at first marriage for girls, it is constantly described the importance for the girls to have initiated their menstruation –implying that a marriage with a prepubescent girls would not be approved. Another example relates to the geographic boundary organization. A clear division of the lands, as it is understood in our Western society did not exist, nevertheless the southern African populations do express a structuration of the different territories, and the resources contained

within them. For example, the waterholes were a source of water shared by a people of a family (or families). Naturally, this does not mean that the waterhole is out of range for any other wandering group(s), but instead these will *require* the sanction of the *owners* (group with preference over the source of water) to have access. In the same line, in many occasions it is mentioned how the San are excellent tracers, that they even recognize whose footprints they see on the ground, and how they have a great knowledge of the immediate land. The method of hunting is characterized by a party of hunters equipped with bows and arrows. The man who shoots the prey is the hunter who takes it and shares it. Usually, after the prey is shot by an (poisoned) arrow, it will flee away; the chase of the animal could last days, but the hunter will stalk it until it collapses from exhaustion. In this long chase, the animal could have *crossed* a boundary between *lands of peoples,* but the people inhabiting the territory where the animal has collapsed recognise that the prey belongs to its hunter, even if he comes from a different place.

There are many types of social norms which are of interesting value, however, the focus on the current study is to identify norms and social practices which have an important impact on the human reproduction behaviour, and do not answer to biological universals, but rather to individuals' socioeconomic constructs. A practice such as induced abortion cannot be simplified to arbitrary or one-self's (the to-be-mother's)decision, as this would entail demographic instability in the long term. There are different sanctions and prohibitions that regulate in the long term the demographic pattern of the groups. The social behaviour and social practices are shared for the entire community, understanding community as the immediate individuals sharing a unit of resources and social obligations, which at the same time is coincident with another community with whom extensive relations are maintained (sharing self-recognized identities, resources or marriageable candidates exchange and common social practices). This extensive structuration is not a result of arbitrary or accidental processes, but instead, it is a deliberate organization, which includes the means and mechanisms for its transmission and continuation. Even though such practices may not be rationally future oriented, they do have such projection due to transmission and continued exercising.

The recurrence in the documentation or the exceptional mention of a specific behaviour may be considered differently. Here, the chronology encompassed in the documentation allows for a more or less verification of whether a particular behaviour observed is an erroneous perception by an author or indeed a generalized action. Unfortunately, as it will later be introduced, the

distribution of information for the purpose of the study is uneven. Nevertheless, the quantitative and qualitative potential of the data is of great interest, aiming to observe and identify patterns which may allow an approximation to the life history of the peoples.

Altogether, the manner in which the information collected from the social norms, social behaviour and social practices can enlighten significantly the understanding of the reproduction in a HFGS, contributes incredibly in the archaeological research of ancient *hominina*. While some parameters may be possibly inferred, for instance the sexual maturation age, life expectancy or the weaning age (Austin *et al.,* 2013[30]; Froehle & Churchill, 2009; Kaplan *et al.,* 2000; Macchiarelli *et al.,* 2006; Purvis & Harvey, 1995; Ramírez Rozzi & Bermúdez de Castro, 2004), other parameters still depend on the existing demographic, ethnographic and medical studies, in order to bring models of reproduction and social organization (The Practice Committee of the American Society for Reproductive Medicine, 2004; Blurton *et al.,* 2002; Gurven & Kaplan, 2007; Jackson & Glasier, 2011; Speroff & Mishell, 2008; Tietze & Lincoln, 1987; Vestermark *et al.*, 1994, are only some of them), to later incorporate in archaeology as sources and resources for further work in modelling and testing hypothesis. This demonstrates that it is not impossible to stress further the archaeological evidence to obtain a significant record.

[30] The study by Austin and others (2013) concludes from their analysis that a tooth belonging to a *Homo neanderthalensis* individual from the Middle Palaeolithic, who died at the age of 8, was presumably weaned at the age of 1,2.

3.- Methodology

The hypothesis in the current thesis considers that in the Palaeolithic HFGS developed certain systems of regulation of their reproduction in order to sustain a stable balance with the reproduction of natural resources. The regulation of reproduction would be achieved with flexible means through the social collective choices of the members of the population, which in the long term will shape the fertility and the development of the demographic growth –in contraposition to a hypothesis based on the increase of mortality rates.

Although the archaeological record offers little answer, the hypothesis requires verification in order to later possibly apply to any archaeological context. In this manner, the current thesis follows an interdisciplinary approach, in which not only archaeology and demography are relevant, but also ethnology and history. The limitation of the contemporary ethnographic and demographic studies is that they respond to the specific period of observation and study, which in the majority of the cases may be the result of interrupted periods of fieldwork. Despite, the potential of their results, these correspond only to the interviewed group of people, in a specific place, at a specific time. In other words, the resulting picture appears to be static and lacking of transformations. Human societies are inherently dynamic, therefore it is indispensable to properly analyse all interconnected variables within the scale of time, and their effect in the long term.

The methodology proposed in this thesis combines ethnohistorical sources and a multi agent based simulation system. The ethnohistorical sources provide the characterization of the social organization of HFGS in the diachronic and synchronic dimensions. The multi agent based simulation system, consisting of a computational program that simulates demographic processes, provides the experimental ground in which it is possible to test the data collected from the ethnohistorical sources, and expectedly verify the pertinence of the hypothesis exposed in this doctoral thesis.

The hypothesis of a controlled fertility

As already discussed, the current usual archaeological record does not give direct answers to questions relative to the social organisation. Thus, for instance, it is not known how actually was the sexual division of labour or if structural dissymmetry between sexes did exist in the oldest Prehistory. No hypothesis has been yet verified about the origin of this division and dissymmetry, neither about the causes of their continuity or change. These questions are essential if, for example, it is intended an objective analysis of the present state, or a diagnosis and prospective of future possibilities of the social relationships.

After a systematic and objective analysis of the written and graphic sources about small-scale societies, whose subsistence system based on self-reproducing resources is presumably similar to that of the first fully human societies[31], two universals are stated: the sexual division of the labour activities, and the structural asymmetry between women and men. The hypothesis of the current doctoral thesis establishes that these two main universals are the consequence of a need to balance both elements of the internal contradiction in this type of society: the social management of production, and the control of human reproduction.

Even if small-scale societies are predominantly self-regulated and lack of central institutions, they still contain strict norms which regulate the social behaviour in production and reproduction. Thus, a comprehensive aim in the research about the development of these societies must consider several objectives:

- It is important to study the mechanisms of self-organisation and distributed social control (such as reputation and prestige), which are generators and maintainers of social norms in human societies.
- It is relevant to study the mechanisms that make a specific set of rules arise, become dominant, and maintained by the majority of members of the society. The existence of shared norms is the kernel that constitutes the society and, therefore, they must be internalised. This is especially important due to the fact that social norms can emerge in a

[31] Under the term of "fully" human only hominin of our species are included, by considering only those who would had had biological features of labour force similar to the present-day humans.

decentralised interaction between members of a collective –in opposition to social norms imposed by an authority.

- Lastly, it is necessary to refine the hypotheses about the mechanisms of assumption, transmission and maintenance of norms that allow inequality in HFGS, in order to detect which indicators (the materiality) will enable the researchers to demonstrate the existence of such norms in human social relations based on the archaeological record.

Obviously these objectives are far from being solved in one single thesis. On account of this, the critical aim of the current thesis is ***to verify how and why does a normative system effectively control the human reproduction in a small scale society*.**

Under the generalized idea that defines foraging societies as egalitarian, anthropological and ethnological social studies seem to have missed a deeper analysis of their social organization. On the same line, and given the empirical record at hand, archaeological studies also face several limitations because archaeology has renounced to discuss the possibilities to obtain a relevant archaeological record and, therefore, have worked based on simple analogies. While economic activities seem clearly represented at the archaeological sites, the social organization is mostly deduced from analogies based on ethnographic and anthropologic data. They seemed to find confirmation on each other, as factors such as nomadism, lack of technological specialization or low demographic densities have been automatically associated to simple and *egalitarian* social structures, excluding elements such as hierarchy or structural violence.

Thus, it may be illustrative to review the human biological potential of reproduction on a hypothetical level. From the existing published materials, it is known that the human species has a great reproductive capacity. If measured, each woman is able to bear a minimum of 12 children in her total reproductive life span (since the offset of menstruation until menopause, which includes at least 30 reproductive years). Excluding 9 months of gestation and an average of 6 months post-partum *sterility*, a natural fertility rate is without doubt high. However, such figures do not seem to find corroboration in the archaeological data, neither in demographic studies of contemporary foraging groups. It has been assumed that high mortality is the natural regulating force in front of an excess of population. However, it remains unclear how this *natural regulating force* is indeed effectively assuring and supporting the survival of a group in the long term –for instance, the *Homo neanderthalensis* inhabited Eurasia for more than 150.000 years, and the Australian aboriginal people had been isolated in a subcontinent for more than 50.000 years.

Rather than a Malthusian model, it is necessary to rethink the different factors involved in human natural fertility to understand the general pattern observed in demographic studies. Any society needs to generate a certain balance (between labour force and resources produced) in order to continue and perpetuate itself. When such stasis is lost, the society is exposed to destabilization. An uncontrolled demographic regime may also follow a catastrophic end due to the lack of resources.

Another source for this elemental approach is the information derived from primatology. In biological studies based on zoology, life-history variables are analysed in order to find their interrelationships. In this manner, age of sexual maturity, age at last reproduction, the probability of survival among juvenile and adult individuals and, lastly, the fertility, they all together take part in the observed population growth –observed empirically, and measured statistically (Charnov, 1991; Oli & Dobson, 2003). Similarly, the maternal investment in gestation and breastfeeding is also taken into account to assess the cost of reproduction directly on the living (female) individuals (Millar, 1977; Lee, 1987; Lee *et al.*, 1991). Yet a strong ecological perspective frames these studies, because of the strong correlation found between mortality rate and life-history variables. One example of these correlations is the age of sexual maturity: mammals with high mortality rate tend to mature early and give birth to small offspring in large litters after a short gestation. In short, the conclusions state that the demographic balance also results of age-specific costs and benefits of reproduction and parental investment (Promislow & Harvey, 1990).

However, the life-history of modern humans (late sexual maturity, relatively short gestation, long fertile and post-fertile life span) differs greatly from that of other primates and cannot be used as a paradigm. On the contrary, it is possible to point them as potential causes of evolutionary divergence between humans and other primates.

Beyond the approaches until now developed, this doctoral thesis aims to assess the factors involved on the so called *natural fertility* societies (cf. Henry, 1961), contributing to the understanding of a conscious regulation of reproduction –the very first objective of the current doctoral thesis.

I elaborated the current study mainly with and from ethnohistorical materials. The compiled ethnohistorical data and the discussion around it will occupy largely the chapter number 6.

Significant results to support the hypothesis stressed here need of experimental testing in order to assess the weight of the different variables I have called to be relevant. Clearly, the possibility for experimentation lies beyond reach for ethnology (even for compared ethnology) and for ethnographic sources. On account of this limitation, all materials collected, including human biology, ethnographic and ethnohistorical data, are combined in an experimental exercise with the support of a multi-agent based simulation system (named as ARESOCARE). This combined method makes it possible to obtain quantitative data based on qualitative and quantitative data.

The normative system used in the simulation platform is both the kernel and the main research subject of the simulation. The purpose of the simulations is to answer questions such as:

- How does the normative system determine the viability of a society?
- Which norms are essential for its sustainability in a given environment?
- Could other normative systems have the same effect on a society?
- How much does the normative system contribute to the sustainability of a society?

The possibility to use and adjust the social norms in a multi-agent based system helps to understand how human societies respond. In this approach, the normative system establishes what an agent should and should not do, but at the same time, an agent is to some extent free to follow or not the norms according to its personal goals and character. The behaviour of an agent is determined by its current goals, its internal state, a set of social norms that regulate the context, and its willingness to follow those norms. While the goals and the internal state are specific of each agent, the norms that regulate the behaviour are common and assumed to be known for all the agents in the simulation (Vila *et al.*, 2013).

In the present case, the "willingness" of the agents is reduced and simplified. The agents react passively to the norms that are imposed mechanically, while at the same time depending on the function of their characteristics and capabilities –some of these characteristics are inherited partially from the parents, and some change depending on what do the agents experience. Simultaneously, the agents are exposed to several random effects along their life course or in their relationships with other agents. In parallel, the natural environment is a variable excluded from the simulation. The reason behind this is that the simulation experiments solely test the effect of the social norms on reproduction. Nevertheless, it would not be difficult to introduce environmental stress or more "intelligence" in the agents in further simulations, but the purpose

of this thesis is not to assess the dawn of diverging behaviour or the reaction of a population under environmental stress.

Archaeology, History, and Ethnography: combining disciplines

In the process of understanding an object or a phenomenon, the human mind resorts to existing known structures. Analogy has been not only a source of information, but also a method to establish differentiated or similar contexts. It is difficult to imagine the dawn of prehistoric archaeology without appealing to ethnographic analogy. From the very beginning of the discipline of archaeology, archaeologists have taken into account contemporary and still living pre-industrial societies. In the 19th century, there was an optimistic and simplistic use of extrapolations, but the particularism of Cultural History, dominant in the first half of the 20th century, put the recourse to ethnographic analogy into apparent crisis.

Moving away from a research whose objectives are mere descriptions and extensive catalogues, archaeology aims to contribute in the understanding of human societies in the remote past. Starting in the late 1960s, Processual archaeology resorted again to analogies, through the development of a new approach: the building of middle-range theory. Ethnoarchaeology, an interdisciplinary approach, found its way into the studies conducted during the 1970s and 1980s. This research started from a processual and cultural-materialist approach with a clearly economic emphasis. This idea soon expanded from the English speaking scholars to other countries (i.e. Estévez & Vila, 1995; Vila *et al.*, 2006).

An increasing interest for mental and ideational characters of human societies also started from structuralism. Following this, a society's *cultural* values are also reflected in its materiality, for instance in the settlement, dwelling architecture, or bodily decoration.

Other scholars would point out that material does not only show economic and adaptive patterns, but it is actually mirroring the social behaviour. In Hodder's words, «It has been suggested as a result of the ethnoarchaeological studies that material culture is meaningfully constituted. Material culture patterning transforms structurally rather than reflects behaviourally social relations (Hodder, 1982:218)». By understanding the entire context of the materials, including the

production, it was expected to understand the underlying social and economic spheres. At the same time, it was criticised that analogical analysis does not provide answers, but only plausible connections, in opposition to causality explanations (Hodder, 1986). This is, material culture has not only a functionalist purpose, but also contains the behavioural and ideological context.

The contextual archaeology brought new studies, including valuable data about the underlying social and economic categories in the production of pots, or in the organisation of a settlement. This approach allowed the incorporation of additional sources of information, achieving general principles of the material culture in the social practice and enlarging the field of Ethnoarchaeology (i.e. Vila *et al.,* 2006; Lugli *et al.,* 2013; Biagetti & Lugli, 2016).

As stated by Hodder (1986), it is not correct to establish such simple functional links (plausible causality), because historical contextual and structuring principles have their specific impact. This is, analogical analysis indicates a plausible connection, rather than a certain causality. Analogies offer similar contexts, from which it is possible to collect the relationship between subjects and objects, but in any of the cases it implies a universal law for human behaviour. Hodder further claims that this relationship «…must be studied as a unique combination of general principles of meaning and symbolism, negotiated and manipulated in specific ways (Hodder, 1982:218)».

As a problematic counterpart, in a post-processual discourse, the extreme particularism lead material culture to only show specific forms of itself, which at the same time was tied to the subjective intentions from the past actors and from the present scholars. As a consequence, the analogical method lost its applicability and usefulness. At the end, ethnographic sources were considered to contribute only with a wider theoretical framework, while not being accepted for specific archaeological explanations (Van Reybrouck, 2000).

As a counterbalance to this particularism, from a Marxist point of view, it is considered that a set of universal principles is possible to be applied on the wide diversity of human societies. From a (neo-)Marxist perspective, material culture is a product of actual social realities (relations) among pre-industrial societies, within their specific mode of production (Argelès *et al.,* 1995). The material culture not only reflects socio-economic structures, but simultaneously constitutes a channel with which ideological and power mechanisms find legitimation and access to the manipulation of social reality (Van Reybrouck, 2000).

Pointing to the potential of the existing sources at hand, Tilley (1991) stressed on the advantages of ethnographic and ethnohistorical literature, as heuristic devices for hermeneutic understanding. That is, the ethnographic study of material culture can also contribute in the field of archaeology, by including its specific content of information on material culture. In other words, interdisciplinariety (prehistoric archaeologists, social anthropologists, modern and contemporary historians and sociologists) was again observed as an advantageous approach to offer the best result on the study of prehistoric societies (Barceló *et al.,* 2006).

However, one of the main criticisms against such approach is precisely the many differences which can be listed between Pleistocene and contemporary HFGS. Environmental and climatological conditions have been stated as one of the first. Other critique points underline that the contemporary societies are not prehistoric fossils. They have actually accumulated experience along the last millennia. The present-day world is also inhabited by industrialized societies, and also in the recent past most foraging groups had close contact with agriculturalists and pastoralists groups or merchants (Wilmsen, 1992; Woodburn, 1988). Therefore, scholars ask for caution when using ethnographic accounts to study prehistoric populations. Nevertheless, the identification and analysis of the different variables of the socio-economic structures among contemporary foragers still provides a basis for the study of prehistoric foragers. I may emphasize, the proposed and followed method is not seeking particularism, but instead it is aiming to cross-cut groups with differentiated histories, finding patterns.

Several studies rooted and found their way to establish general theories or concepts, such as subsistence variation, technology variation, or land use, with a strong basis on ecological constraints –e.g. Optimal Foraging Theory, the broad spectrum revolution. In the case of the prehistoric record, a strong correlation has been established between resources exploitation and technological development –and by extension, the socio-economic complexity behind. However, the strong dependency on taphonimc processes and preservation of the materials hinders the interpretations. Such was the case of the palaeodiet among *Homo neanderthalensis*, continuously challenged (Bocherens *et al.,* 2005; Hardy *et al.,* 2012; Henry *et al.,* 2011; Lev *et al.,* 2005; Richards *et al.,* 2000; Richards & Trinkaus, 2009).

The apparent limitations archaeology faces due to the kind of material directly available makes it necessary to re-discover new perspectives and methodologies to discuss human behaviour.

Therefore, it is necessary to re-conceptualize the approach, avoiding plausible explanations from particularisms, always considering the conflict, which arises from the archaeological contexts.

Considering all mentioned, the current doctoral thesis tries to reconcile archaeology and ethnography, including at the same time ethnohistory. Ethnoarchaeological research does not only take into account the direct observations made by the archaeologist in the field on still living societies, but it also has the possibility to incorporate in the analysis the existing records made by prior observers (De la Cruz *et al.*, 2010; Estévez & Vila, 1996; Vila, 2011).

Following this methodological proposal, it is possible to incorporate a temporal dimension and a dynamic perspective into the framework, which are not present at the punctual observation of *living ethnoarchaeology*. Additionally, when relying solely on the punctual observation, the research is at risk of bias due to the subjectivism and the particular situation of the observed context. Conversely, the inherent subjectivity of the historical observers can be evaluated and reduced through a critical analysis, by taking into account the subjective, contextual and historical situation of the observers in the past, which is offered by the researcher's own historical perspective.

It is not intended to fall again into particular analogies or extrapolations, but rather to identify general patterns, which could be also applied for the prehistoric context. There is no doubt that contemporary hunting-fishing-gathering groups show social inequality between men and women. As already stated, this inequality cannot be explained only under exclusively biological determinants, but it actually arises from the socio-economic organization. This is, the mode of production of HFGS dictates the social relations of all individuals. By analysing this interrelation, it is possible to visualize the social inequality as a social construct. This fact is observed among most of the ethnographically documented hunter-fisher-gatherers. Furthermore, while populations in prehistory seem to have had low demographic densities with barely any demographic growth, contemporary foragers present differentiated demographic patterns, of both fertility and mortality. Considering this comparison, it is clear that it is necessary to find alternative explanations, assuming that the demographic dynamics among Palaeolithic foragers may have followed to some extent that of the contemporary. Such demographic patterns are not possible to visualize (yet) on the archaeological contexts. Despite this, different studies have attempted to establish approximated demographic densities or to assess plausible contraction or expansion of

the populations. These studies contribute to comprehend the changes in the population, but they do not shed light about long-term processes.

It is important to identify all variables involved in hunter-fisher-gatherers' demography. On the one hand, there are the biological –practically universal- constraints (briefly explained in chapter 2), and on the other hand, there are the social constructs in charge to shape the biological reproduction. Several studies have developed systematic demographic analyses of HFGS (Blurton Jones *et al.*, 1992; Hill & Hurtado, 1995; Headland, 1989; Howell, 2000; 2010). Sceptical archaeologists and social anthropologists consider that such studies only offer a particular view of a particular group in a particular context. As a consequence, their models cannot be extrapolated on prehistoric groups. Nevertheless, the data they contain actually offer many possibilities for an alternative analysis.

The alternative analysis shall include the existing literature on the biological facet of human reproduction, the large collection of ethnohistorical sources, the ethnographic studies on contemporary HFGS, and the different studies with quantitative basis for demographic analysis. The current focus of this doctoral thesis uses universal biological and social variables (such as fertility, libido, health, morbidity, boldness, rules respect, prestige, reproductive unit, etc.) that play a role in reproduction, aiming to obtain demographic patterns viable to apply to prehistoric societies. This interdisciplinary approach is completed with the experimental exercises with the multi-agent-based simulation system. By establishing the different scenarios observed, it is aimed to assess the impact of the social organization of reproduction on a population with presumed a *"natural fertility"*.

Multi-Agent based Simulation System

Several of the pioneering attempts to model behaviour of human organisation and of social systems have been applied within the field of archaeology. In recent years, there has been a realization that the archaeological data require a different approach in order to explain the changes within a well-formulated methodology. Some have sought simply to use the data of prehistory to create a narrative very similar to the products of the historians of later periods, that

is the traditional historiographical approach. When seeking insights into processes of long-term change, it is not sufficient to only examine one aspect of the human cultural system. Mode widely-ranging models, holistic models, are needed if the behaviour of the system as a whole is to be taken into consideration (Renfrew, 1987). One issue difficult to solve in the existing approaches is that none of the models creates a system that is able to alter its own structure. Considering these problems, such models cannot arrive at true changes in structure such as one might describe by the term morphogenesis. In the same manner, they fail to incorporate all sides of human behaviour.

The possibility to achieve an accurate understanding of *societies* obliges the scientist to identify all factors and constraints involved, as well as measure the exact character of these. Studies including simulation and data modelling opened a field of experimentation in archaeology. The first simulation models for investigation in theoretical archaeology appeared in the early 1960s and the burst of applications appeared in the middle and late 1970s. In the 1980s, the simulation models would follow more controlled and clearer guidelines, with a better focused understanding of the tasks of this method (Bell, 1987). Early simulation models in archaeology were imitative, they were adopted from other fields and used to explore problems similar to those of the other fields. Later on, theoretical archaeologists formulated their own models for problems situated within an archaeological framework. Computer simulation found its way with a similar trajectory within ethnographic studies. Computer modelling allows the kind of analysis ethnographers say they would like to do but which is limited by the linguistic descriptions, said differently, a holistic analysis that looks at phenomena within the context of larger cultural and historical dynamics. The model can show the implications of a specific set of rules or relationships within a system, or contribute in the understanding of the dynamic relationships that result in a particular outcome (Small *et al.*, 1997).

Archaeology, which has an exceptional set of data, is a discipline dedicated to the history of peoples in space and time, and the transmission of their traits from one generation to the next, with special interest on how these processes transform over the long-term. Modelling is especially useful for historical sciences such as archaeology and palaeoanthropology, because the deep past can rarely be assessed by direct experiments. It can generate null hypotheses concerning the most important variables in any given process. Studies within this methodological frame have opened greater possibilities to social sciences, particularly in the recognition that

certain emergent patterns appear similarly across different phenomena. Models borrowed from other disciplines have been applied in archaeology, such as optimal foraging theory from ecology, linear programming to diet choice among foragers, or game theory to choices made by Jamaican fishermen. The models often do not fully take into account the implications of the cultural aspect of human social systems. Instead, economic models are typically based on the assumptions of rationality, the equal access to all information when economic decisions are being made, assumption of a fixed function, and do not consider where the utilities themselves come from. It is problematic for anthropological studies to assume of a fixed structure within which decisions making take place (Pollak & Watkins, 1993).

Interdisciplinariety is vital for building more powerful and robust quantitative models of cultural behaviour, structure, and evolution (Riede & Bentley, 2008). However, researchers approaching historical and prehistoric problems from other disciplines are advised that archaeologists have already made significant headway in this direction. Suitable experiments with a simulation program offer opportunities for studying the distribution of a variety of indices under different conditions, as well as changes in relationships from sample to sample (Ridley & Sheps, 1966).

Nevertheless, only to mention a few, uncountable studies ventured the possibilities of computer simulation and modelling, including human dispersals and settlement patterns from an ecological perspective (Banks *et al.,* 2006; Garfinkel *et al.,* 2010; Grove, 2008; Hazelwood & Steele, 2004; Kennett & Winterhalder, 2008; Kohler *et al.,* 1996; Steele *et al.,* 1998; Steele, 2009; Wainwright, 2008), language distribution (Nichols, 1997), subsistence behaviour (Arroyo, 2009; Belovsky, 1987; Bousquet *et al.,* 2001; Burger *et al.,* 2005; Cordain *et al.,* 2000; Mithen, 1987; Read, 2002; Stiner *et al.*, 2008), kinship (Aureli *et al.*, 2008; Berninghaus *et* al., 2008; Bird & Bird, 1997; Burtsev, 2005; Gurven, 2006; Kaplan *et al.,* 2005; Korobitsin & Frolova, 2003; Kuznar & Frederick, 2003; Ochoa & González, 2009; Read, 1987; Turchin & Gavrilets, 2009) the emergence of hierarchical structures (Gardner, 1991; Henrich *et al.,* 2005; Kennett *et al.,* 2009; Read, 2002; 1987; Villatoro *et al.,* 2012), assessing technological development (Bousman, 1998; Hamilton & Buchanan, 2009; MacDonald, 2007), and, of course, demographic dynamics and reproduction traits (Anderies, 1996; Cabana *et al.*, 2008; Howell & Lehotay, 1978; McArthur *et al.*, 1976; Ridley & Sheps, 1966).

Models play an important role in any mature science because they force us to make explicit the assumptions about how a phenomenon works, and allow us to explore the way in which different variables influence a complex biological system (Dunbar, 2002).

Nevertheless, the difficulties of coordinating an interdisciplinary project (working with computational scientists) and the predominant ecological-cultural and adaptationist perspective of Processual Archaeology have restricted the development of this kind of experimentation. Agent-based virtual experimentation systems have mainly focused on the relation of agents within an ecologic-environmental board from which population forage resources (or information), and from such exchanges social structures originate. There are many other works focused in this issue where its application in archaeology is discussed (cf. Barceló, 2009a; 2009b; 2010; del Castillo Bernal, 2012). The advantage of simulation against ethnographic or ethnohistorical accounts is that the experiments can be reproduced indefinitely and their results can be checked. The relevance of each variable and its specific influence in the interactions can also be tested. In this way, it is possible to formalize the hypotheses literally described.

The multi-agent based simulation program ARESOCARE[32] was developed in the frame of two research projects, in which ethnographic and biological data related to reproduction and its norms were used. The project aims to assess, via modelling with an agent-based simulation system, the impact of social norms on the biological reproduction of societies, whose production strategy is not addressed to the reproduction of resources, but to achieve balance between their own reproduction and that of resources they forage (Estévez *et al.*, 1998). This is a computerized system composed of multiple interacting agents and their "social" environment, and it is used for the purpose of the research focus of the current thesis.

Generally, demographic studies use equation systems and differential calculus in their analyses and estimations. This exercise is designed and led to control macro social dynamics and assemblages. The study of small-scale populations has also been object of these macro-

[32] Analysis of reproduction in Hunter-Gatherer societies (Análisis de la Reproducción en Sociedades Cazadoras-Recolectoras, ARESOCARE) was developed. Today, the system does not consist of a prefabricated standard program, but is a system based in Java language programmed by Adrià Vila Moreno –previously developed through a project PIF (Proyecto Intramural de Frontera) led by J.Sabater and A.Vila of the Spanish Research Council-CSIC, and later as a Spanish Ministry of Economy and Competitiveness research project (HAR2011-24356) led by J.Estévez.

demographic analyses. However, this approach may over-estimate or under-estimate the different variables involved in the entire demographic process. This is, in small-scale societies it is highly probable that the variability at the level of individuals, or random elements out of reach for measuring, have a relevant function. Because of this, it is preferred to adjust to another perspective with an agent-based system in which dynamics are not established by equations, but by the interactions of the agents, incorporating also random components and other rules according to simple algorithms. This system appears to be more appropriate for the study of small groups –like societies with a hunting-fishing-gathering subsistence.

Reconsidering which factors are primarily involved in the demographic pattern of a hunting-fishing-gathering society, in the current thesis it is attempted to assess the impact of the social norms. Genetic and/or environmental factors have usually been overemphasized when explaining the development of societies whose mode of production was not based on the production of food products. The evident precarious balance between the inevitable population growth and the limited natural resources, forces a different reading of the interrelated factors. I may insist, this is not an attempt to realise a rigorous and strictly demographic study, but instead the combination of a sociological approach with a demographic analysis is expected to highlight some important aspects of (prehistoric) HFGS. It is very likely that a change of a demographic variable is closely related to a change in social organization, which in the long term can lead to different demographic patterns –the range of this variability is found from side to side between demographic expansions and demographic contractions. Thus, a social based driven organization of a *Homo* society can have an effective control of population growth, achieving a viable balance with the natural resources. An important amount of demographic, biologic and ethnographic data (Ariel Fuentes, 2010; Corenblum & Boyd, 2017; Holmberg *et al.*, 2000; Johnson *et al.*, 2012; Kuczynski, 1949; Montagu, 1946; Wilcox *et al.*, 1995), as well as other studies with the purpose to analyse them (Chamberlain, 2009; Eaton & Mayer, 1953; Hill & Hurtado, 1995; Jackson & Glasier, 2011; Nonaka *et al.*, 1994; Pearl, 1939, quoted in Nag, 1962; Speroff & Mishell, 2008; Tietze & Lincoln, 1987; Weiss & Wobst, 1973; Wobst, 1974; 1976; Practice Committee of American Society for Reproductive Medicine, 2008) have been gathered from in order to develop the entire environment for the simulation.

In order to support this perspective, the simulation system ARESOCARE becomes an important tool. This system consists of an engine, which uses four modules containing the data in *xml* language (Fig. 2).

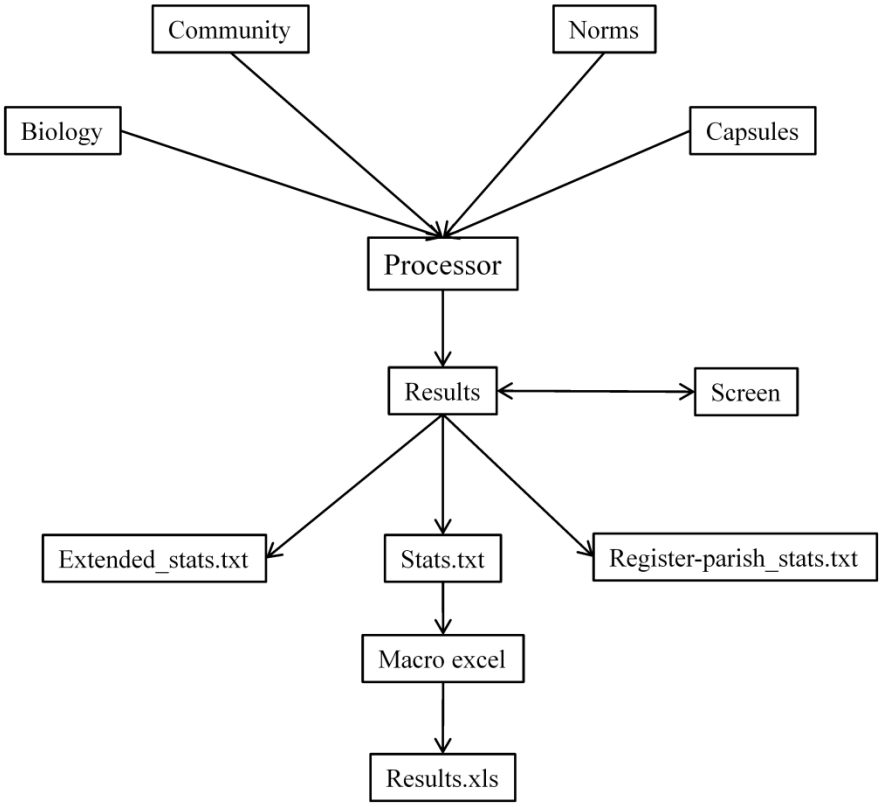

Figure 2. Structure of the simulation engine ARESOCARE, including four modules (Community, Biology, Capsules, and Norms) and the three output files (Extended stats, Stats, Register-parish stats).

In the experimental exercises, the simulation program generates three outcome files, within which extensive resumes of the simulation and resulting artificial community are included. These resumes include all information from the entire simulation: births, deaths, marriages, divorces, residence reallocation, and which agents were involved in these events. It is then possible to trace the *life* of the agents during the simulation. I can analyse these data statistically following all events since the start of the simulation until its conclusion, which gives me many analytical possibilities to measure the corresponding demography (growth rate, mortality rate, fertility rate, etc.). The input data is partially defined in probabilistic terms, which means that the same artificial community within the same environment can go under slightly different demographic

processes. Because of this, it is very important to repeat the same simulation several times to collect significant results that represent the existing variability within the same biological and social conditions.

In the following, sections the different parts will be described: the initial Community, the Biology, the Capsules, and the Norms. The program contains at this very moment over 9000 sentences, as it can be noticed too long to be treated here in detail and falling out of the aim of this doctoral thesis. For further details, the multi-agent based simulation program will be presented as an independent master thesis for Informatics Engineering in the Open University of Catalonia by Adrià Vila (2019). Nevertheless, the main functions and the interrelation between the different input and output files will be briefly explained.

An artificial community

The initial community of the simulation is contained in the module *community*. This file could be automatically developed every time the system starts, but it has been decided to develop it manually so that it is possible to better control it. The file contains the initial agents, *the people*, with all their individual characteristics. The agents are organized in a way that families and social environments are delimited. Every agent is different one to another, as several traits compound the individuality of each of them. Each initial agent is defined by at least 8 variables: name, age, sex, libido, health, fecundity, morbidity and reputation. Some of these variables will be further inherited from the *progenitor* agents, while at the same time some of them may undergo to changes during the simulation. While age and sex are defined within the biological limits, according to different biological, demographic and ethnographic literature, the other variables connected to biological and social behaviour are established following a distribution of probabilities, also based from data of existing studies. Very briefly, these variables will be described below:

1. The variable group is defined arbitrarily.
2. The variable family is also arbitrary and each new family created receives the letters of the original family, adding two consecutive numbers to each new generation.

3. The variable *name* is basically in charge to differentiate the agents and allow an easy identification. For the first individuals the male individuals have names starting with "M", while female individuals start with "F", followed by a letter representing the family name, followed by a number to assure single identity for each agent. The naming of the agents generated during the simulation begins also with M or F according to their sex and with a consecutive number, and the names of the progenitors between brackets. For example, an initial agent may be named as "MB001" and "FH001", while a generated agent would be "F050(MB001+FH001)".
4. The variable *age* refers to the specific age. It establishes the current age of each agent. In order to be as accurate as possible, the age structure established for the initial community is based on the age structure of hunting-fishing-gathering populations (in accordance to modern demographic studies on present day HFGS, e.g. Weiss & Wobst, 1973; Howell, 2010).
5. The variable *sex* establishes the sex of each agent (F potentially can have children, M cannot). To the previously mentioned age structure, the sex ratio of 49,5% of women to men is also extracted from the existing literature. This relation is also established in the system for each generation of agents generated during the simulation.
6. The variables of *libido*, *health*, *fecundity*, *morbidity* and *reputation* are of numeric value. The distribution of the value of these variables was in accordance to previous tests and experiments. The numeric value consists of a natural number ranging from 0 to 10000, following a normal curve distribution around the mean value of 5000, distributing these scores randomly among the original individuals.

   The values attributed to the descendent agents are generated during the simulation: different formulas are applied, combining an inheritance factor, taking into account the values of the progenitor-agents, and a random factor. For example, an agent may inherit 70% of its *health* from the progenitor-agents, while the remaining 30% is weighted randomly by the system. This will be further detailed in chapter 7.

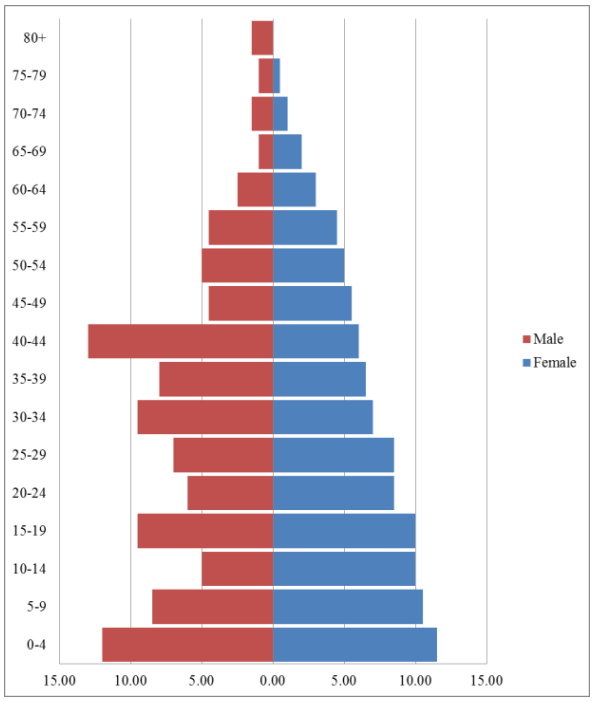

Figure 3. General demographic structure of pre-industrial societies. The vertical axis indicates the age cohorts. Measured in percentages

7. Simultaneously, each agent is attributed with additional variables (current reputation, current libido, current health, etc.). These receive the effect of the different events (biological or social) during the simulation. They are the current active condition of the agent regarding each specific variable. For example, the fecundity of a woman will change in accordance to her current health, but also depending on her age.

8. Other variables are the "X" and "Y" chromosomes, indicated with capital and lower case letter respectively. The incorporation of a patrilineal and matrilineal biological lineage, makes it possible to trace the development of families, by combining the nominal family name and the biological family ascendance[33].

[33] Very interestingly, this can be compared to the case of the assimilation of the Neanderthal population into the first anatomically modern humans. Palaeogeneticists have found that among any present day population the mitochondrial DNA from the *Homo neanderthalensis* is absent, however, when analysing the genome, it has been confirmed that some present-day populations do have in their DNA traces of this extinct species. Therefore, it is indeed relevant to incorporate such markers into the simulation system, previously used to study another issue in a different paper (Olives & Estévez, 2016).

The system has been programmed to assign social and biological conditions to the agents depending on their social and biological situation. The biological categories are: newborn (at the age of 0), infant (ages comprised between 1-13 for females, 1 -14 for males), adolescent (ages comprised between 13 -17 for females, and 14 - 18 for males), and adult (starting at the age of 17 for females, and 18 for males). The social categories are: newborn (at the age of 0), child (starting at the age of 3), boy or girl (this depends on the social norms of the simulated society, this is, when the segregation between both sexes is socially recognized), single, pending status, paired or married, family head, polygamous, widowed or divorced (according to the social norms, always possible to redefine). This follows a conventional understanding of the individuals growth at their own individual sphere (e.g. sexual maturity), and at the community sphere (socioeconomic dependency to the household of the family or to the own household).

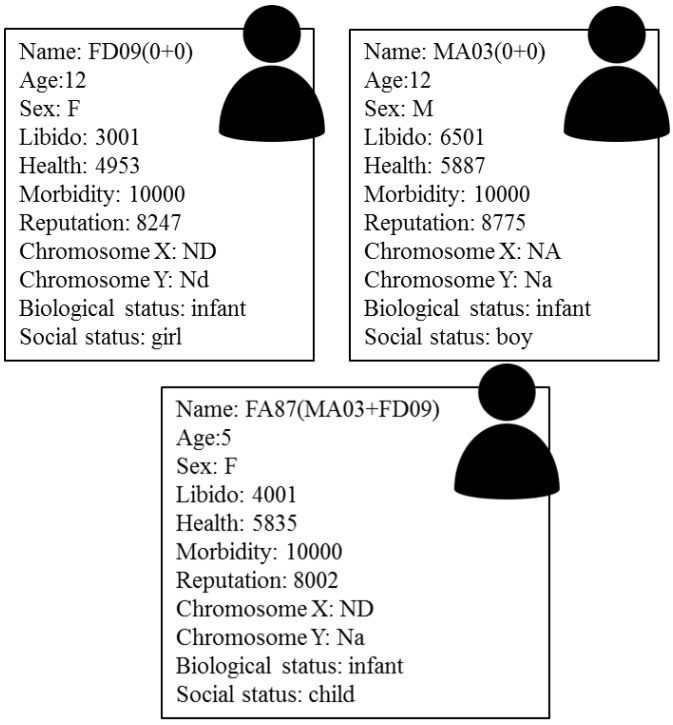

Figure 4. Examples of the profiles of the agents prepared for the simulations. The 12 years old male agent belongs to the nominal family A, while the 12 years old female agent belongs to the nominal family D. Because these are the profiles of two agents from the initial community, the letters of the chromosome lineages are coincident with that of the nominal family. In the hypothetical case these two individuals, once they reach adulthood, marry and start a new household, their offspring-agents will adopt the parents' name FA87(MA03+FD09),while the chromosomes will depend on that of the father-agent (Na) and mother-agent (ND).

In chapter 7, the mechanism within which all these variables come into play will be explained in detail.

Aside from the particular characters of the agents, it is likewise important to structure the population size in the artificial community. Some studies (Weiss & Wobst, 1973; Wobst, 1974; 1976) have attempted to measure the population size, which can consistently provide groups members with suitable and eligible mate candidates upon reaching maturity. Factors such as exogamy, age restrictions, and prevention of remarriage after widowhood tend to decrease the number of eligible mates. In a similar manner intervenes sex ratio, though with some differences between monogamous and polygamous groups. According to Wobst (1974) the size of the population has to be large enough to include all expected sizes of the Pleistocene plausible scenarios, which he places between 1.200 to 200 people, divided in 61 smaller groups, compounded of about 25 members. Other ethnographers have recorded also a minimum size of 25 members among contemporary foragers: the !Kung Bushmen and the Birhor have a mean of 25 members, the Iglulingmiut 35, and the Copper Eskimos 15, while the Hadzapi range from 20 to 60 members, Semang from 20 to 30, Andaman Islanders from 30 to 50, Athapaskans from 20 to 75, and eastern subarctic hunters from 25 to 50 (Wobst, 1974:170). Wobst continues explaining that it is more profitable to split the local group in order to maximize the amount of production and to minimize transport costs and walking distances. Given Pleistocene population densities, and Palaeolithic exploitative technologies and means of transport, this point must have been below his estimations. He argues that the exploitative technology of hunters and gatherers does not require year-round maintenance of large cooperative groups in a given place; but a minimum band group provides sufficient manpower reservoir for most task-specific groups in a hunting and gathering society. The collective lifetime experience of the members should provide the individual with a sufficient range of choice to cope with daily crisis situations and with sufficient input from daily observations to insure hunting and gathering success. There have to be enough members to effectively carry out the daily activities required for the group's survival, to decrease the impact of individual failure through mutual food sharing and cooperation, and to exploit the environment more efficiently through a division of labour by age and sex. This size, 25 members, is sufficient to guarantee the survival of minimum bands over many generations (Wobst, 1974).

In addition, not only a size is needed to construct the artificial community, but a sex and age specific distribution of population is also very important. Without question, it is not possible in any case to take as a reference the population structure of an industrialized population. In general, developed countries present a contracted population pyramid, which consists of low infant mortality and long life expectancy, with slight differences from male to female individuals.

By contrast, preindustrial societies (in the current case, HFGS) present an expanding pyramid with short life expectancy, while the bias between male and females may be higher. While slight general trends in life expectancy are observed in this general scheme of cultural evolution, some notions about the demographic effects of cultural changes are clearly unjustified. For example, the agricultural revolution cannot be viewed as being a great demographic change with regard to the individuals. Although denser, more predictable food supply allowed more individuals to live, it did not dramatically change their life expectancies. Longevity did not jump significantly until industrialization (Weiss & Wobst, 1973:50). And also a purely demographic standpoint, Coale (1957) has shown that, for a given population, changes in the fertility schedule have a greater effect on the age distribution than changes in the mortality schedule (cf. Cavalli-Sforza & Bodmer, 1971;Weiss & Wobst, 1973)

Consequently, already existing demographic studies on pre-industrial societies (some of them have already been referenced above) offer a reliable source of information. The detailed description and information on the artificial community used in this thesis is detailed in chapter 7.

From additional statistical studies, it is possible also to include measures of the natural sterility within a population. Only 3% of the married Hutterite women had never borne a child by the time they reached the age of 50. It has been suggested that this is an unusually low rate of permanent sterility and that higher sterility can be expected in poorly nourished populations. Demographic surveys in a number of poor developing countries do not support that view. For example, in Bangladesh 2.1% of women, 2% in Pakistan, and 2.6% in Nepal, have never given birth (Bongaarts, 1980; Eaton & Mayer, 1953; Frisch, 1978; Tietze & Lincoln, 1987; World Fertility Survey, Frist reports: Bangladesh Fertility Survey (1975-1978), Nepal Fertility Survey 1976, Pakistan Fertility Survey, 1975).

Most of the animal populations present a growth rate close to zero, even though biologically they are indeed capable to increase demographically (Weiss & Wobst, 1973). As it has been exposed,

in general human populations would follow the same pattern, but differently to other animals they are neither subjects of depredation nor necessarily to intra-specific male competition. However, with the simulation program and the artificial community it is attempted to demonstrate that human populations do not exist under uncontrolled cyclical demographic expansions followed by catastrophes, but instead there is a conscious stable equilibrium in charge of the population fate. The biological conditions are those already exposed along this and the previous chapter (sex ratio at birth, natural sterility, life expectancy, and mortality probability). But most important, the social factors are the main behavioural mechanisms to shape human vital processes in his and her pre-reproductive, reproductive, and post-reproductive phase. In chapter 6, this information is deeply examined.

The biology

The module containing the biological parameters is in charge to define the community within certain biological limits. It contains variables which will come into play on the life history of the agents in the simulation. For the development of this module, literature from biology, medicine, and especially from demography and ethnography are taken into account. Some parameters are difficult to establish because the raw material at hand is biased or incomplete. This variability has been already introduced in chapter 2. The variables of life course are settled with probabilistic schemes, following the data available in biological and demographic studies. Unfortunately, other variables of biological base are not possible to settle based on real data because these are not available. Nevertheless, the data can still be of great use in the system. For this, the values are smoothed, recalculating the polynomial curve using the automatic calculation of excel –this is a convenient smoothing procedure in a similar manner of the Schiller or Gompertz models of curves[34] (Gompertz, 1825; Winsor, 1932; see also, Finch & Pike, 1996; Tjørve & Tjørve, 2017; Zullinger *et al.*, 1984).

[34] In 1825, Benjamin Gompertz published a paper in the *Philosophical Transactions of the Royal Society*, "On the Nature of the Function Expressive of the Law of Human Mortality". His curve became a model that gives a good approximation for adult-related mortality rates in the mammals and birds examined, because of the close fit of the

For the purpose of constructing a probability of mortality, several demographic and ethnographic studies are additionally taken into account. Furthermore, mortality may be related not only to aging, but also to the "probability of accidental mortality", within which different causes of death related to hunting and interpersonal violence are included. Another example is the risk of mortality during birth delivery, which for the current case it is set at 0,1%, following the plausible indices from literature (Hill *et al.,* 2007; Hogan-Marttila *et al.,* 2010; Ronsmans & Graham, 2006).

In the same manner, the system requires a defined frame where it is established the probability of conception. Equally to the definition of the mortality probability, several events are connected in the definition of the probability of an effective conception. These are the biological capability of the agents (fecundity and infertility), the exposure to sexual intercourse (coitus frequency), the viability of the female to develop the foetus (current health and current morbidity, but also probability of miscarriage), and later on the survival of the newborn (infantile natural mortality rate or incidence of infanticide). In this manner, the probability for conception is calculated and distributed according to the age of the agents (the general tendency is that the older the agents are, the less likely it is for a positive conception to occur). On the other side, in the case of a positive conception, the module of biology contains the probability for miscarriage, established depending on the age of the male (in this case, it duplicates if the male is older than 50 years of age), and at the same time depending on the age of the female (set to 10000 in the scale from 0 to 10000, if she is younger than 10 or older than 55, that is before the average age of menarche and menopause). Following the existing literature, a primary infertility rate is also established to a 3% of the entire population.

Therefore, the interrelation between the different sets of probabilities or rates are defined in the module of biology. The other two modules (capsules and socials norms) contain the remaining mechanisms, which complete the different biological and social events.

observed to the reported in that population. More recently, however, it has been used by various authors as a growth curve, both for biological and for economic phenomena (Winsor, 1932).

Capsules

This module named capsules contains *necessary consequences* of biological and also some social actions. These consequences have a biological and social impact on the agents. There are basically four items:

1. If the different biological and social factors are met, a positive pregnancy will be activated. This event will have different effects on the mother-to-be agent, for example, an increase of her current reputation.
2. If the different biological factors are met and the set of probabilities favour a successful pregnancy, a child delivery will be activated. This will have an important effect on the mother-agent, for example to her current libido and her current fecundity. In other words, the system will apply different pre-established formulas that will lead the agent to initiate a breastfeeding period (which can have a length of 1 step (1 year), 2 steps (2 years), etc.). During this period, it is highly unlikely that the female agent may become pregnant soon. This same capsule can also affect other of her variables (health, reputation, libido, etc.) or that of the partner.
3. If the different biological factors are met, after a successful child delivery, the newborn may inherit all variables to define its identity within the community. This identity is measured partly taking the values of the parents, and partly following a random estimation[35].
4. If the different biological and social factors are met, in case of miscarriage or induced abortion, a capsule associated to this event will affect the health of the mother-agent.

This module is very flexible, in the sense that it is possible to incorporate additional consequences or effects in accordance to what is of interest to observe and analyse.

[35] Unfortunately, biologists seem not to be able to define nor to measure the exact biological inheritance from progenitor to progeny. For example, in the case of the variable of fecundity: if a newborn agent were to inherit an equal share from its parents' fecundity values (50% of the father and 50% of the mother), in the long run of the entire simulation, a natural selection of individuals with high natural fecundity will take place. It can safely be affirmed that this is not the case in the real world. For this reason, a random element is added to the predefined formulas, which may help to avoid such deviations.

Norms

This module contains all norms which, whether they are respected or not, have different implications to the community and the agent. The norms may be grouped in 6 categories:

1. The very first norm, which is activated once the program starts running. Following this norm, the system fills the remaining variables of the agents (current health, current libido, etc.).
2. Other norms are present at every step of the simulation, for example, the increase of the *current morbidity* of each agent, or the increase of *current reputation* when considering reputation to be associated to age and experience.
3. Several norms define the transition of the agents in the different social and biological categories. Observe that the function of the norms is also the prevention of erroneous events. For example, a norm establishes that a *child* becomes a *boy* as long as age (for instance, defined at the age of 15) and sex (male) are fulfilled. Following this example, a male younger than 15 years of age cannot become a boy, or a female at the age of 15 cannot become a boy.
4. It contains also the norms establishing the organization of the social environment and of the structuration of families. The entire community may be organized in at least two environments, where each environment contains several families. Unions can be arranged within environments (but between different families) or between environments. Likewise, the mechanism for the change or formation of new families is also included, defining then the post-marital residence (if the husband or the wife shall move into the camp of his/her spouse, or alternatively, if a new independent family shall be generated).
5. It contains a complex set of norms, which establishes the marriage system, whether monogamous or polygamous, and the divorce.
6. And finally, there are additional norms, which have an important impact on the *life* of the agents. Here it is included the relation of mechanisms which lead to infanticide or murder and rapping.

Each norm is strictly structured so that no errors may occur. In its structure there are four sub-modules to necessarily fulfil, starting with the limitations contained in every precondition, and the preconditions contained in every social norms (Fig. 5).

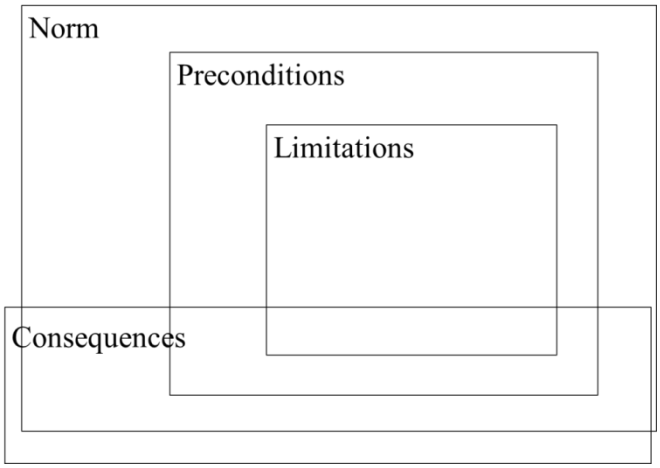

Figure 5. Overview of the relation between norms, preconditions, limitations and consequences.

Before any norm itself can be triggered and activate the consequences, the corresponding limitations requested in the corresponding preconditions must be fulfilled. A precondition may contain one or more limitations, from which all of them or a certain combination of them must be fulfilled. The proper fulfilment of the limitations and preconditions activates the norm, whether it leads to a success or to a failure. For example, a marriageable male agent searches for a female agent to marry (within a monogamous context): the system will first check if the limitations invoked by the preconditions are fulfilled. If they are, one (or various) consequent events will follow. Alternatively, if the preconditions are not fulfilled, different consequent events will follow. Following this example, the preconditions to activate a marriage involve both agents affected and, therefore, there is a set of preconditions to be fulfilled by the male agent, and another set of preconditions to fulfil by the potential female candidate agent[36].

Depending on the characteristics of the entire environment and on the profile of the agents involved in this particular case, a successful activation of the norm leads to a particular set of

[36] The case described here is meant to illustrate in broad terms the mechanism the system of simulation follows when using the data incorporated in the module of norms.

consequences which affect both male and female agents, and to some extent their environment (Fig.6). If the necessary limitations are not given, only part of the preconditions will be validated, and the norm will lead to a failure containing a different set of consequences, which can affect the male and female agents, and to some extent their environment (Fig.7).

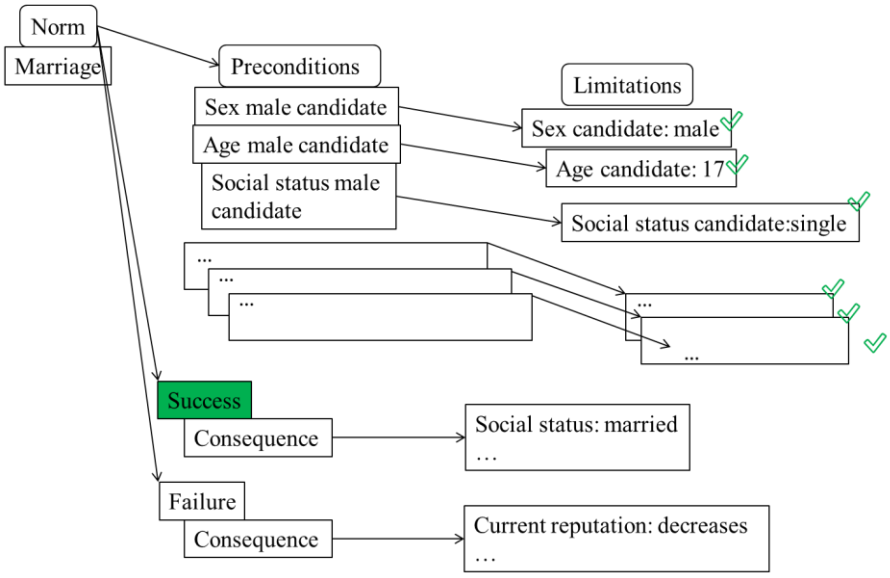

Figure 6. Overview of the structure of a norm in a context of success.

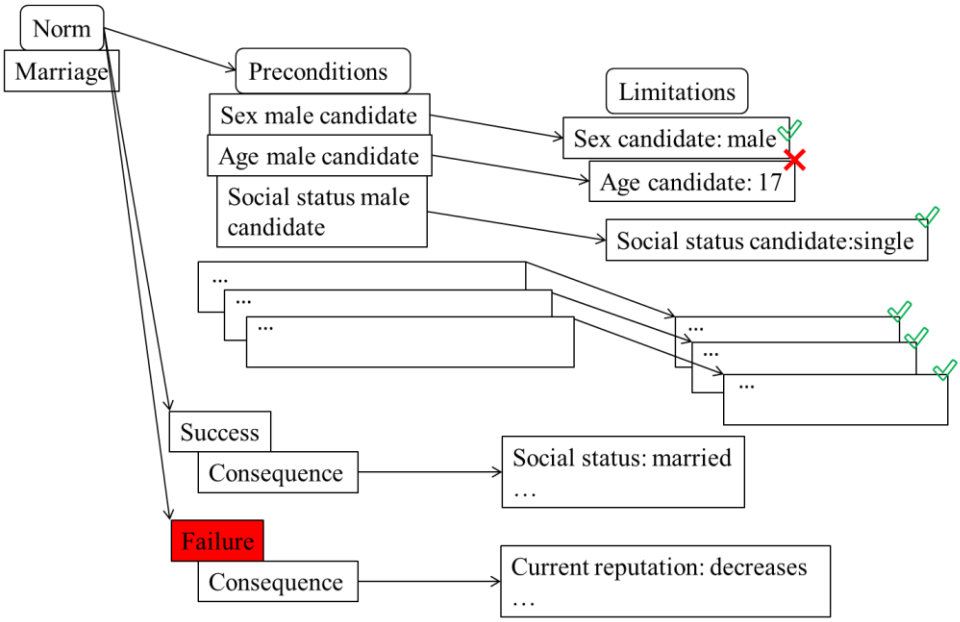

Figure 7. Overview of the structure of a norm in a context of failure.

The *limitations* use variables, which can be literal, quantitative, defined as intervals, or formulas. A few examples of a literal variable are the biological or social status: boy, girl, single, divorced. A few examples of quantitative variables are: age or current biological conditions (current health, current morbidity). The limitations containing intervals specify an interval for validation, quantities lower or higher than the interval indicated do not allow validation (e.g. current reputation shall be between the values 5500-7500).

In short, the simulation system is built in a manner that it contains different parts, which contain very specific data, which are linked together within the entire net of the system. The purpose of the system is to simulate an environment of reproduction. Depending on the characteristics of the norms (their preconditions and limitations) and the consequences established, the development of the reproduction will show different results. There is no doubt that in an environment with non-restrictive norms, where the norms contain preconditions which barely have restrictive limitations, the probabilities for the norm to be validated are very high. This would clearly lead to an expansive demographic growth. On the other side, the more complex preconditions and limitations are, the more restrictive the norms are. In this case, it is clear that the growth rate of the population must be lower as a result of the restrictions.

For the purpose of the assessment of the hypothesis in this doctoral thesis, I do not intend to verify the impact of different biological events (different mortality rates, or different fecundity rates). I put my attention on the *social norms*, which I collected from the ethnohistorical sources and ethnography, aiming to assess the effect of certain social practices on a population. The characteristics of the modules offer flexibility to the experiments in a way that it is possible to modify the raw data (adding or changing norms, readjusting capsules) to obtain results from the different contexts intended to review.

«[T]he extent to which the error in fitting a model is acceptable is exactly the extent to which the error in suing the model is acceptable (Weiss & Wobst, 1973: 77)», there is no model which fits perfectly to the real world where the research question is contained. It is important to assess whether the results meet good enough an answer, which scientifically explains the phenomenon under observation, leaving no space for ambiguity or doubt. As it will be discussed later, most of the credibility of the program relies on the reliability of the data and materials used, which, in the

first place, abounds in mistakes, as well as assumptions and approximations. Too many things remain unknown, either because the researcher lacks of material or of the method for analysis. Research on Palaeolithic contexts cannot proceed to a systemic level without general models, which have test implications for the archaeological records (Wobst, 1974). On the one hand, from present-day available archaeological material, it is difficult to induce on Pleistocene societies, on the other hand, derive a model from only contemporary HFGS groups is neither a possibility, due to the many distortions they present in comparison to Pleistocene groups. Given these conditions, testing a hypothesis with an experimental exercise of simulation offers an alternative approach.

4.- Comparative study: the populations in southern Africa

In a comparative analysis, the first issue that arises is the basic definition of the category Hunter-Fisher-Gatherers. The question is when and where shall this category be applied in the oldest prehistory, considering that it is not improbable that in the past there may have existed ways of life that have no paragon in the modern world. Or conversely, the societies that we consider to be extant hunter-gatherers were not fossilized since Prehistory, but they actually had their own extensive history of accumulated experiences, and lastly became the surviving remains after experiencing catastrophic changes –e.g. contact with expansive and/or colonizing societies. In fact, this is one of the main points of the criticism towards ethnoarchaeology conceived only as living archaeology.

Nevertheless, taking as a reference the well-known Ethnographic Atlas by G. O. Murdock (electronic database, Murdock, 1962-1980), I list the existing possible contemporary HFGS that may serve as a reference for the current study. My perspective establishes that some of the documented contemporary HFGS still presented a mode of production mostly based on hunting and gathering wild resources –whereas livestock and agriculture may insignificantly contribute into the mode of subsistence. Behind this assumption lies that fact that in a foraging society there is a correspondence between labour division and social relations. In this manner, I expect that contemporary groups with a mostly hunting-fishing-gathering mode of production could present a very similar social organization of their people and, therefore, they may serve as a reference from which to collect information on social organization, social behaviour and, complementarily, social norms in order to construct a reliable base for generating hypothesis and explanations in the study of prehistoric HFGS.

I personally conduct my research on the group of hunters in southern Africa, commonly known as Bushmen or San. This population, specially the Dobe !Kung, has been commonly used for analogies in archaeological studies. In this chapter, I weight the advantages and disadvantages of using this case in order to fulfil the agenda of my research. My proposal is somewhat different, I do not intent to extrapolate the data, but to collect the main patterns of social organization and expressions of socials norms, which will serve for the experimental exercises of simulations.

The Ethnographic Atlas by George P. Murdock

Earlier, the difficulties to agree on what defines contemporary HFGS and prehistoric HFGS have been briefly discussed, as well the reasons to avoid extrapolations. Indeed, nowadays there is not any contemporary group that has not modified to some extent their mode of production, by incorporating agriculture and/or livestock, or by incorporating themselves into a larger network of market with other populations. This situation basically puts into conflict the validity of the use of contemporary foraging societies with the purpose of re-analysing prehistoric societies. However, the alternative methodology followed in the current thesis offers the possibility to identify general and shared patterns. Considering this, the axiom of the selection is that a hunting-gathering-fishing society has a mode of production based on hunting, gathering and fishing natural resources, with very little control of the reproduction of these. This particular organization entails a very specific social organization of labour –therefore, following the hypothesis presented in the current doctoral thesis, it will also entail a specific social organization of the population.

Between 1926 and 1980, twenty-nine successive instalments granted access to a huge ethnographic database, the result of which was an ethnographic atlas. The Ethnographic Atlas consists of a database with 1167 societies coded by Murdock, published in successive instalments in the journal *Ethnology* [37].

The Ethnographic Atlas allows a cross-cultural[38] comparison including several variables: the economic subsistence (gathering, fishing, hunting, animal husbandry, agriculture), the kinship structures (organization of marriage, post-marital residence, kin terms), settlement pattern (dwelling, size, local hierarchy, class or caste stratification), customs and traditions (games, beliefs), labour organization and division, or mobile property management, among others.

This Atlas may be taken into account as a starting point to prospect the viable groups for a first analysis. It is important to keep in mind that it is not intended to identify a group to extrapolate

[37] The database can be accessed at http://lucy.ukc.ac.uk/cgi-bin/uncgi/Ethnoatlas/atlas.vopts. (Last access: 2nd May, 2017)

[38] Naturally, the Ethnographic Atlas includes not only hunting and gathering societies, but also food producers who practice stock-breeding and/or agriculture.

into prehistoric chronologies, neither to identify a group which shall fit in the prehistoric frame, it is neither expected the prehistoric evidence to fit into the contemporary contexts. In its place, it is expected to find a broader frame within which it shall be possible find patterns.

According to the database of the Ethnographic Atlas (electronic database, Murdock, 1962-1980), from a total of 186 groups worldwide, gathering represents at least 50% of the total economic activity among 8 groups, hunting among 12 groups, and fishing among 19 groups. Among all these groups, food production, including live-stock and/or agriculture have a contribution below 10% of the total economic activity, except among the mostly fishers, in which case food production has a higher presence –about 35% of the economic activity.

Following the explanation provided at the *e*-Human Relations Area Files (e-HRAF)[39], and after numerous anthropological studies among such pre-food producers, it is considered that hunter-gatherers are small, egalitarian (fully or semi) nomadic communities, with low demographic densities, who have not specialized political officials, economically specialized according to age and gender, under a gendered division of labour. The contrast of the description is in opposition to food producers, who would consequently be characterized as sedentary and larger communities with considerable demographic densities, with a structured hierarchy and differentiated wealth distribution, in combination to a specialization of labour division.

As introduced earlier, a relevant point in the hypothesis of this thesis is the fact that the organization of labour among prehistoric societies implied the foundation of the social relations as inseparable of such organization[40]. Only those groups whose subsistence is mostly based on hunting, gathering and fishing are considered. In figures 8 to 10, the distribution of the different groups is displayed[41].

[39] http://hraf.yale.edu/ehc/summaries/hunter-gatherers (Last access: 2nd May, 2017)

[40] Though of great interest, unfortunately it is not possible to enter into detail in the discussion held by some academics, who state that Marx was exclusively concerned with capitalism -which on the other hand is not true- and that, consequently, Marxism applied to foragers would not differ to the positions from evolutionary or structuralist theories.

[41] Groups who are mostly gatherers: the Hadza and the Kung (Africa), the Tiwi and the Aranda (Australia, insular Pacific), the Paiute, the Yokuts and the Chiricahua (North-America), and the Botocudo (South America). Groups who are mostly hunters: the Mbuti (Africa), the Yukaghir (East Asia), the Micmac, the Slave, the Montagnais, the Gros Ventre and the Comanche (North America), the Siriono, the Lengua, the Aweikoma, the Abipon and the

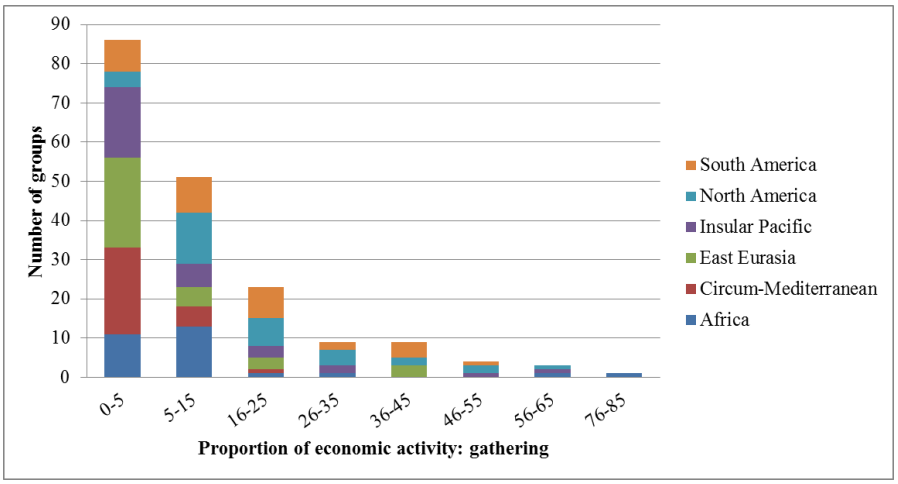

Figure 8. Distribution of groups depending on the proportion of gathering activities, following the Ethnographic Atlas database.

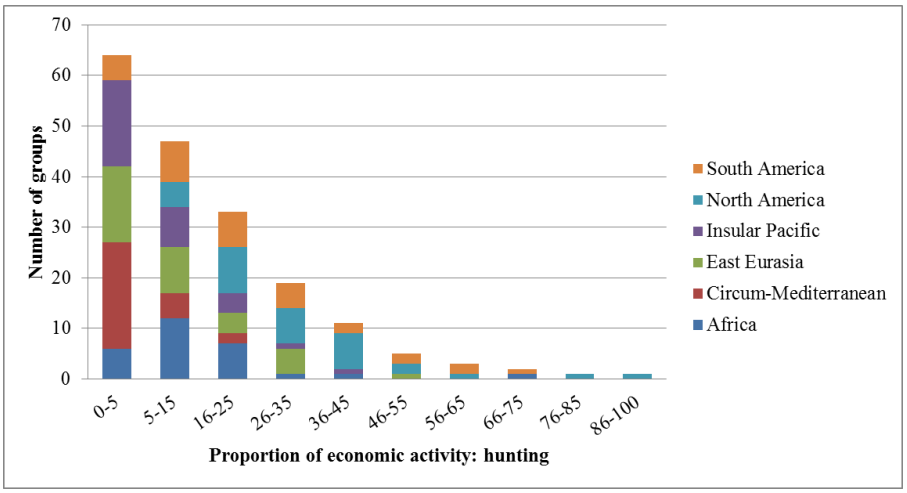

Figure 9. Distribution of groups depending on the proportion of hunting activities, following the Ethnographic Atlas database.

Based on the different sources and literature containing ethnographic and historical data of all these groups, the quantified results on their mode of subsistence leaves a rather complex picture, giving little options for the archaeologists to assess the possibilities of establishing a frame for reference. The question here is which cases offer a reliable source of information to project a model, which may be accepted for research in prehistoric societies.

Tehuelche (South America. Groups who are mostly fishers: Gilyak (East Asia), the Tikopia, the Trukese, the Marshallese, the Mbau, the Badjau, and the Manus (Insular Pacific), the Ingalik, the Klamath, the Yurok, the Eyak, the Kaska, the Twana, the Bellacoola, the Haida, the Copper Eskimo and the Aleut (North America), the Callinago and Yaghan (South America).

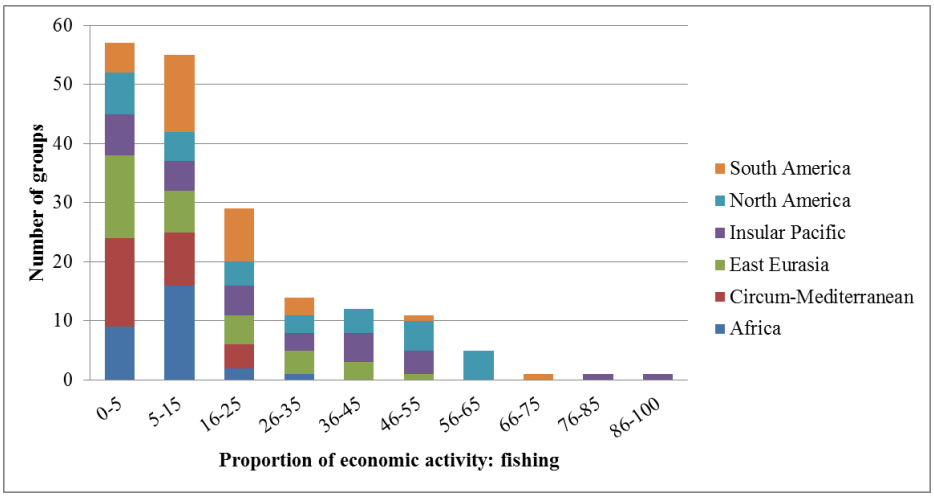

Figure 10. Distribution of groups depending on the proportion of fishing activities, following the Ethnographic Atlas database.

The historical context and the development of the groups themselves turn the selection of potential *samples* complicated. Simultaneously, the information necessary to collect for the purpose in the current study cuts down the list of candidates, due to the absence of information of my interest or to the language the documents are is written in. Finally, the chronological range of the reported information adds more specificities, questioning then whether ethnographic analogy is a dead-end street.

Simple and complex hunter-fisher-gatherers

In the aim to identify patterns and to frame the category of HFGS, it is worth to observe among the existing studies what lays at each side of the frame. Several studies (cf. Ames & Maschner, 1999; Estévez et *al.*, 1998; Estévez & Vila, 2013; Grier, 2001; 2010; Moss, 1993; Suttles, 1968; Vila & Estévez, 2010) have identified the inhabitants of Tierra del Fuego (southernmost tip of South America) as simple HFGS, and those of the Pacific North West Coast (from North America) as complex HFGS. This can substantively contribute in the analysis of the impact of social norms and social behaviour on the total fertility rate among populations with *natural fertility*.

From an ethnoarchaeological methodological approach, written sources from the early encounters with the Europeans place within reach qualitative material about the inhabitants from Tierra del

Fuego and the Pacific North West Coast. Under the title *La vida material y social de los Yámana*, Piana and Orquera (1995; 1999) present extensively all data available on the inhabitants of Tierra del Fuego (southernmost tip of South America)[42]. On the other hand, the studies by Estévez and Vila (2010; 2013) discuss the written sources available on the Coast Salish[43]. This methodology, which takes into account the early accounts and the archaeological contexts, brings forward a plausible reconstruction of the socio-economic organization, and the different transformations. The written accounts are of particular interest, because they contain information of the populations' *reproductive* and population organization (e.g. age at marriage, types of marriages, puberty rituals or ceremonies, etc.), adding the last piece into the structure. As already introduced in chapter 2, a scale of factors is considered, in which a dominant cause (long term variable), a determinant cause (new constant) and a triggering event (sudden change) are interrelated generating the different equilibriums and transformations (Estévez, 2005; 2009) –e.g. environment resources, volcanic eruption, and social norms.

The inhabitants from Tierra del Fuego would have lived outside of the influence of agriculture until late 19th century, time when the missionary established there. On the other side, the Coast Salish, who made salmon their economic foundation, had a stratified social organization, including slavery. Indeed it was long debated how the Coast Salish *did not fit* within the frame of what HFGS were meant to be, until it was finally accepted the possibility of complex HFGS – also discussed in the early research on Upper Palaeolithic[44].

The archaeological studies point to an interesting and first parallel development between Tierra del Fuego and the North West Coast, until a particular moment in which their development diverged. The general trajectory indicates that at the beginning both regions neither intensified shellfish exploitation nor were they specialized on any particular resource. Particularly in the archaeological context of the Pacific North West Coast, the archaeologists have identified hiatuses and changes, concluding that these are indicators of the attempts of stabilizing

[42] The data date to mid-19th and early 20th centuries. It was written by the hand of different authors, such as Bridges (1866), Bove (1883), Martial (1888), Gusinde (1937), Hyades (1891), and Lothrop (1928) (Vila & Estévez, 2010).

[43] For instance, Barnett (1955), Duff (1952), or Suttles (1951) (Vila & Estévez, 2010).

[44] For instance, the period of the Upper Palaeolithic in Europe, or in other archaeological sites, such as Poverty Point (EEUU), where the construction of monumental architecture by hunter-gatherers is read as a manifestation of social and political inequality (Kidder & Fritz, 1993; Ortmann & Kidder, 2012).

mechanisms in a dynamic development (Vila & Estévez, 2010). In both regions the populations had to interact with the environment, but in the 4th millennium, the regions followed different behavioural paths. The fuegians kept the same economic strategies until the arrival of the first Europeans. In the Pacific North West Coast, the populations intensified the exploitation and storage of salmon and other marine species, presenting simultaneously larger dwellings, greater social complexity, concluding with war-like structures and weapons (indicatives signs of conflict). Thus, these studies opened a possibility to understand the historical development of both extremes of what may be considered HFGS.

It is of great interest to contrast these two examples with other extant or contemporary HFGS. Despite the different transformations the contemporary HFGS have undergone (which makes it clear that it is impossible to obtain a picture of them in their *actual* pre-contact social and economic status), it is nevertheless of great interest to take into account the existing ethnohistorical materials. The ethnohistorical sources may be discussed to be unreliable, however, when contextualized these incorporate the dimensions of chronology and geography into the categories of social norms and social behaviour. Lastly, counting with the frame of simple and complex HFGS (exemplified by the cases of the inhabitants of Tierra del Fuego and the Pacific North West Coast), one plausible attempt is to assess where other cases fit.

The selection of the Khoisan peoples: advantages and disadvantages

In order to continue in the search for the understanding of hunting-fishing-gathering population dynamics, I select the case of the southern African populations, commonly known by the term of Khoisan (or Hottentots and Bushmen).

The term of Khoisan refers to a complex and heterogeneous population which inhabited southern Africa. The first written sources that contain any reference to the inhabitants of this region seem to indicate the existence of mainly two different groups, according to the social and economic differences between them. The context of the European colonialism towards new worlds placed a new interpretation of the stages of humankind. From the perspective of the Europeans, the native inhabitants of southern Africa had a *primitive* and *savage* lifestyle. Relying on historical documentation puts the methodology precisely into a critical position. The texts are extremely

biased, from a political view (primitivism), from a religious understanding (heathenism), as well as from the economic and social ethic or moral values (lack of decency, of advanced tools and dwellings). At the same time, the quality of the already limited accuracy of the texts is likewise affected by the actual purpose of the travels and expeditions, the length of the period of observation, the degree of interaction with the populations, region explored, and the specific chronology of the travels and expeditions (especially when different European forces tried to establish an administrative and ideological control of southern African lands within the broader colonial network). Despite the inaccuracy of the reports, these have left narratives that may not be taken literally but only as a reference that shows certain aspects of the mode of production and of the social behaviour. The manner in which peoples clothed or what sort of edibles did they consume are not relevant for the current thesis. However, for example, there are several sources stating that a woman is rarely seen with more than 4 to 5 children. In a hypothetical case of a woman giving birth to a child every two years, the average number of children per woman would definitely be greater. This example illustrates the manner in which general observations can indicate a general and recurrent pattern of social behaviour (e.g. fertility control).

The choice of the Khoisan as a subject of study based on the ethnohistorical sources was taken after considering their long exposure in archaeology, field in which the paradigm of prehistoric HFGS further developed after their example. With a critical perspective, it may be insightful to consider this heterogeneous group for the topic under research and goals in this doctoral thesis.

On regard to the ethnohistorical sources, the Khoisan represents a potential sample considering that there is an extensive literature since the late 15th century until the present day. Even though it is not possible to review and access every documentation, report, diary and chronicle[45], the quantity is significantly improving the possibility for comparison diachronically and synchronically. Additionally, there has been a large research trajectory about southern Africa, in

[45] The existing collection of ethnohistorical sources is extensive which simultaneously entails a problem of delimitation. On the one hand, my first delimitation is based on the presence of the information related to my research questions and, therefore, related social norms and social behaviour. Because of this, reports focused on the environmental aspects are mostly excluded from the bibliographic ethnohistorical list. On the other hand, as a second delimitation, the libraries, archives and collections in different museums from different countries in Europe contain a great part of the collection, but some written accounts were not accessible due to their geographical location or difficulties to obtain a partial copy.

different disciplines such as anthropology and history. In other words, an extensive scientific literature is available also on regard to different topics as can be settlement, mode of subsistence, kinship, or trade. These studies act as a supporting pillar, so that it is not necessary to start from the scratch in every topic. Naturally, the studies present their own perspectives and offer specific material, although some other aspects may have not received attention before.

Several anthropologists mention the difficulties for male scientists to have access to women in the studied population, when some particular events or social practices were exclusively for women. Therefore, until a female anthropologist entered to the field, the study included only a part of the population under study[46].

Equally important, in the 1960s and 1970s a systematic demographic research was conducted by R. Lee and later also by N. Howell. They particularly surveyed the inhabitants of the Dobe area, the so called !kung. Despite they considered the inhabitants of the Dobe area to have lived isolated (according to the information the same !kung delivered them), they produced some qualitative and quantitative data of interest. From the qualitative data, it is worth to keep their difficulties to estimate the age of the inhabitants. The !kung themselves do not count their age in years, while at the same time people age (the physical appearance) differently to the European standards, estimated to be older than they look[47]. From the quantitative data, it is necessary to retain that the demographic studies show low fertility rates, which surprises the demographers, considering the !kung to be a group who does not use contraceptive methods and, hence, expected to follow a natural fertility. A second relevant information to take into account is that women had on average 4,69 children within their entire reproductive span. In short, the material

[46] Interestingly, in the ethnohistorical sources it is possible to find information about *women's space*, which shall be collected through questioning rather than observing. The risk on relaying simply on answers may invalidate the description as, on the one hand, the interviewed decides how much information to share and, on the other hand, a lot of information may be under or overrepresented between translations. In the case of the Dobe !kung the bias of the only-male ethnographers is compensated by the fact that one of the main source is the fieldwork of a women, N. Howell.

[47] In the written sources it is practically absent the mention of doubt, but the writer would rather just leave their stronger impression. On regard to age, they seem to be confident in stating the age of young people, however, more unreasonable are the ages given to some adults –exceeding even the average life expectancy in developed industrial society.

available from these existing surveys offer a frame for comparison to which I will come back in chapter 8.

In the current study, it is expected to identify demographic patterns and analyse them within their own context, which may also be used for comparison with other studies in the future.

This comparative possibility may allow to re-locate the southern African populations within the discussion (the Kalahari Debate), as whether these may be taken as a reference to use for archaeological research. Many studies conducted, among anthropologists and archaeologists have taken for granted the validity of the !kung to represent the genuine hunter-gatherer[48]. Furthermore, these demographic studies have been incorporated in comparative tables of general studies (cf. Bocquet-Appel & Masset, 1982; Chamberlain, 2009).

Finally, the ethnohistorical sources present themselves as abundant, available in different languages, which increases the possibilities to come across the qualitative information of interest[49]. On the contrary, as it will be later further discussed, the sources present a large variability of names for the different *peoples*. The term *Bosjesman* (Bushman) appears for the first time in a colonial document from the 17th century (Szalay, 1995); the concepts Hottentot (*Khoikhoi*, pastoralists) or Bushman Hottentot (prescribing the term to a group of people who lost their cattle) are constant. The term Bushman returns by the 19th century, as a result of an intended search of the *primitive people*, which leads the discussion of the disadvantages on using these peoples as a reference.

From a scientific perspective, the Khoisan has been the subject of a long-going discussion among the scholars. The roots of the discussion are based on the early contacts between the European and the populations in southern Africa. The first European travellers established a dividing line between populations with cattle and populations without cattle, who at the same time differentiated one another in other aspects, such as dwellings. At the same time, it seems that the

[48] In these studies (e.g. Howell, 2010) it is still found the belief that the Dobe area is a remote and isolated region, although (adult) people were able to speak one of the Bantu languages.

[49] Indeed true, from the sources available, those from the 15th and 16th centuries barely left any detail on social behaviour, as the Europeans focused their attention to aspects such as clothing or technological objects –as well as landscape features and flora and fauna organisms in it.

inhabitants used different terminologies in order to name one or other people –the same differentiated terminology is present among other neighbouring groups, such as the Bantu.

In the research field on non-food (re-)producer societies, there have been many scientists who have tried to find and analyse these populations. Under this premise, those groups living in (apparently) isolation were put into the centre of attention, expecting them to provide to the science with a reference for ancient HFGS. The truth was that contemporary HFGS confined to deserts or jungles, had their own particular historical trajectory which lead them to their own present. This situation placed the discussion between traditionalists and revisionists. The former argued on the perception of a hunting and gathering culture, and the latter the perception of an underclass group within a larger social system (Barnard, 2004).

It is not intended to enter into the depth of this discussion, but the main points of conflict may be highlighted. In several occasions, the importance of the mode of subsistence has been remarked, in tight correlation to social organization. The manner traditionalists see a foraging mode of subsistence points to it as a result of an adaptation, while the revisionists remind of the presence of other modes of production in the region (e.g. agriculture). Wilmsen (1992) states that the Bushmen, who are universally considered to be the longest-term living residents of the Kalahari, "are permitted antiquity while denied history". The main critique refers to the lack of integration of these groups into the larger southern African political and economic structures. As a consequence, revisionism rejects the possibility of the Kalahari hunters to serve as an example to use by archaeologists.

An additional difficulty about the case of the Khoisan is that the extensive existing literature carries different labels and names for the different peoples, sometimes used similarly, other occasions being less clear[50]. To some extent, the observations lead to the definition of peoples living in the bushes (Bosjesman), the peoples who had cattle (Hottentot), and settled peoples who worked the land (Bantu). According to the ethnohistorical documentation, the peoples called Hottentot by the Europeans named themselves as Khoikhoi. On its part, the Bushmen were mainly called San by the Khoikhoi, and Basarwa by the Bantu.

[50] This is far from being an issue exclusively of the southern African peoples. Researchers among the hunters of Borneo have found themselves in the same situation, due to the fact that in Borneo farming groups also coined different names for their nomadic neighbours (Sellato & Sercombe, 2008)

In 1685, a colonial document includes for the first time the term *Bosjesman*. Simultaneously several other terms appear, apparently all of them referring to a group of people who hunt and gather, without cattle. Some authors (cf. Parkington, 1977; 1984) have suggested that the term Soaqua shall refer the aboriginal hunter-gatherer social formation in southern Africa, while Bushman shall refer to the pastoralists and hunter-gatherers who were disrupted by the arrival of the Dutch. In the mid-17th century, there are references to indigenous peoples near Olifants River, named Soaqua, Namaqua and Chariguairqua. Parkington says that, although several spellings occur in the sources (Souqua, Soaqua, Sonqua, or Somqua[51]), there seems to be no doubt that the explorers are making reference to the same people. Additionally, closely connected, this people is described as tiny people grouped in bands, and living in huts made of branches, whose state of poverty compels them to maintain themselves by robbing and stealing from other Hottentots. The picture differs after reviewing some reports by the end of the same century, where colonists identified the Sonqua as employees of the Hottentot, whom they serve (a kraal of Hottentots) – changing then the version of robbers who steal indiscriminately, to robbers who do not steal the kraal they are *employed*. This is one of the key elements of the revisionists, the interconnected relationship between different actors within a large socio-economic system. In the 18th century, the term is used to specifically designate people dispossessed of cattle, fleeing slaves, and also people who used to be called Sonqua earlier in time, becoming at the same time a synonym for livestock thief (Parkington, 1977).

The settlement arrangement may be used in favour of identifying groups themselves organized independently of another, expecting to detect small unit of peoples sharing a mode of subsistence on a small scale. Already in the 17th century, it seems clear that Bushman and Hottentot organize their settlements differently: the former appears to be thinly and continuously spread over the regions, while the latter are more aggregated. This also applies to the frequency in which during their journeys the European travellers came across a party of hunters, which only included adult men. On the contrary, it was highly difficult to meet an entire settled group, including women and children. There are numerous instances of Europeans who found a Bushman settlement and the dwellers fled immediately upon their sight. On the same line, the typology and material for their

[51] Wikar, when speaking of the San peoples or Bushmen, employs a variety of terms: Chaboup, Tkaboek, Tkaboeb and Sam (Mossop, [1779] 1935).

huts differed. However, such settling and migrating patterns may be also emphasizing the existence of two different *classes*.

«When you go hunting for the goal, you may continue to search until the evidence is such that it isn't obvious that you haven't found it (Wilmsen, 1992:36) ». Ethnographies have constructed their culture alienating them from their own history. They were never isolated, but indeed entwined with pastoralists (more often than with agriculturalists). It is hard to say where is the line which defines whether contemporary HFGS establish the parameters of such societies, or prehistoric HFGS do and, hence, whether the past or the present take the lead in the discussion.

The main conflict in this debate is that if the definition of *genuine* HFGS were to be taken (no domesticated animals, no contact with food-producers, no metals, etc.), the list of contemporary examples will contain none. Wilmsen (1992) considers incorrect to accept the possibility of using ethnohistorical data only because the technological and subsistence strategies between Palaeolithic and contemporary foragers are the same. He continues explaining that, by paying attention to the associated asymmetrical relations, in which some groups exercise control on these relations for their own advantage at the expense of other groups, the essential elements of class structure are visible. In the case of the southern African populations, he points to the relations established between the Bushmen and the Hottentot.

Despite this critical advise, the !Kung have been long and constantly used by scholars in social anthropology, archaeology, palaeodemography and palaeogenetics as a solid reference of HFGS, ignoring the historical context. May it be again stressed, the selection of the Khoisan in this doctoral thesis is not meant to extrapolate their example or to use them as an analogy. I intend to bring forward a critical and reviewed possibility of the potential the ethnohistorical and ethnographic information available about these populations.

It is clear that the Bushman cannot be taken as *the* reference for HFGS, whether contemporary or prehistoric. However, as mentioned, it is necessary to develop a frame for the study of social structures among HFGS. It is true that it is becoming more generalized the concept of inequality among the HFGS type of society, while until recently inequality was expected to emerge with the raise of differentiated distribution of wealth, property or inheritance –in broad terms. Therefore, a comparative approach that takes into account the data available on different non-food producers, such as the Yaghan, Selk'nam, Coast Salish, and Bushman (or San), with a special focus on their

demographic parameters, can contribute to the general picture of population dynamic among different the HFGS and lastly, contribute with a frame for comparative analysis. Ideally, this approach requires ethnoarchaeological research in the same manner it has been done in Tierra del Fuego and the North West Coast, but in the current study I use only ethnohistorical sources with the purpose of collecting qualitative and quantitative information about the social norms and socio-economic behaviour of the Khoisan.

History of the inhabitants of southern Africa

Countless of works have been published regarding the history of southern Africa before and after the arrival of the first Europeans (Bhebe, 1989; Boahen, 1985; Denoon, 1999; Elphick, 1977; 1989; Mashingaidze, 1989; Phillipson, 2005; Stow, 1905; Szalay, 1995; Theal, 1916; 1922; Wilmsen, 1992). It is no possible to point to every detail of the history, nevertheless it may be insightful to have an overview of the main events. In Table 1, I include a list of some relevant events.

The Portuguese were the first Europeans to engage in contact with the inhabitants of the southern African lands, as described in «…tawny-coloured. Their food is confined to the flesh of seals, whales, and gazelles, and the roots of herbs. They are dressed in skins, and wear sheaths over their virile members. They are armed with poles of olive wood to which a horn to a browned in the fire, is attached. Their numerous dogs resemble those of Portugal, and bark like them (quoted in Barnard, 2007:11) ». The text is part of the notes left by the Portuguese fleet that landed in 1487, near Saint Helena Bay. Even though this encounter continued rather peacefully, the conflict soon burst. Fernão Veloso (a seaman) asked for permission to follow the inhabitants to their settlement. Unfortunately, the only description left from this early intercourse is its violent turn. The sources describe that the inhabitants chased Fernão Veloso along the coast while he was trying to reach the boat back to the ship[52](Velho, 2014). It will be necessary to wait to the arrival of the Dutch to find the next reports.

[52] «Als wir ihn ins Boot aufnehmen wollten, begannen sie ihre Assegais zu werfen, wobei der Kommandant und drei oder vier Leute verwundet wurden (Velho, 2014:19)».

The Dutch were the first to systematize a colonial settlement at the Cape of Good Hope, as it was a convenient position for the trading route between Holland and the East Indies. The episode of the *Nieuw-Haarlem*, the ship that wrecked at Table Bay in 1648, gave a first-hand experience to the Dutch about the conditions of the land and a non-violent encounter with the indigenous. Starting 1655, small parties were set further north, and under the commandment of Simon van der Stel, large scale exploration teams penetrated the interior. In the following century, Peter Kolb developed his legacy under the title of *The present state of the Cape of Good Hope: Or, particular account of the several nations of the Hottentots: their religion. Government, laws, customs, ceremonies, and opinions: their art of wars, professions, language, genius &c., together with a short account of the Dutch settlement at Cape*. His exploration in southern Africa attested the hunting and gathering strategies of a population, coinciding with the previous accounts. However, he also points out to the existence of exchanging activities with the European (honey in exchange for knives, brandy, or tobacco, for example) (Kolb, 1738). The different accounts introduce several names to designate to the inhabitants –i.e. the Khoikhoi called San the people the Europeans termed as Bushman or Bushman Hottentot, while the Bantu called them Basarwa. The San foragers and San raising cattle are also present in the different accounts. At the end of the 18th century, the European forces at Cape Town changed, and the British government initiated their dominance. H. Lichtenstein left a written account on the distinction between San and Khoikhoi he himself recognised: «Dass aber ordentliche Jagden auf sie angestellt werden, wie neuere Schriftsteller behauptet haben, ist unwahr; ersonnen ferner die Angabe, dass die Nation aus zusammengelaufenen flüchtigen Sclaven und Hottentotten bestehe. Die Buschmänner sind und waren von jeher eine eigne Nation, die ihre eigne Sprache und Sitte hatte, wenn man anders die niedrigste Stufe von Ausbildung… (Lichtenstein, [1811]1967:185)»[53].

As noted by some of the early travellers, groups of San (or Bushman Hottentot) combined the possession of cattle with hunting and foods gathering[54]. In Ngamiland, since 1847, the Bantu

[53] «Equally untrue is the assertion that the nation of the Bosjemans is composed of fugitive slaves and Hottentots. They are, and ever have been, a distinct people, having their own peculiar language, and their own peculiar customs, if the terms language and customs can be applied to people upon the very lowest step in the order of civilization… (translation by Barnard, 2007:15)» .

[54] «That evening, 9th September [1779], party of Bushmen Hottentot came from the Zandveldskraal or Samgomomkoa. They have cattle, but only a few, and yet they do not steal, but because they support themselves by

began dispossessing the San, creating a *dispossessed serf class* within the Bantu hierarchical system –part of the San decided, instead, to retreat into the sandveld (Wilmsen, 1992). The Europeans would find in this situation the San they will encounter in the early 19th century. The intensification of trading networks between the Europeans and the producers in southern Africa may had an effect reorienting the focus the natives had in their economy. Wilmsen (1992) insists that the picture of the San as landless and in scattered communities is a product of the chain of events or a larger socio-economic system. Their remoteness or peripheral politic and economic position is in reality dispossessed foraging people, who were entirely dependent on their kin at cattle-posts, in order to obtain further products, such as tobacco, coffee, tea, pots, etc.

It may be added, that several policies were additionally developed in other to assist the native in their incorporation to "civilization", trying to find at the same time a solution to conclude the violence between the San and the Europeans. Despite the San were employed in farms, in other occasions the relations ended violently (Szalay, 1995). Since early 18th century, a commando system was introduced, in which a body of volunteers formed under a military commander. The purpose of the commandos was to recover any stolen head of cattle and sheep, and also to punish the perpetrators. On the other side, in the late 18th century a great number of San were incorporated into the colony, or joined a mission station[55], where livestock breeding and agriculture were part of the tasks to learn. Numbers indicate that between 1823 and 1824, about 1.071 San children were employed at the service of the farmers in Graff-Reinet district – simultaneously with other 862 adults (Szalay, 1995)[56]. Szalay (1995) indicates that the San incorporated into the colony soon received the legal status of the Hottentots, being shortly after also called Hottentots.

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shooting game and by what they find in the veld, they are called Chaboup or Bushmen by the Namacquoas (Mossop, 1935:29-31)»

[55] Some of the mission stations were Zak River (from 1802 to 1806), Thornberg (1814-1818), Hephzibah (1816-1818), Philippolis (1823-1826), and Caledon River (1828-1834). The difficulty to assess the impact the mission stations is mostly due to their short period active. The San had no other choice at a moment or another to employ themselves back to the farms.

[56] The colonists had preference for San children, because were highly dependent and mouldable. Usually, a couple of sheep or goats would make the price of purchase, even though the parents still expected the children to be returned back after a certain period of time. Governour Somerset signed the prohibition for trading San children, in 1817.

From these interrelations, some estimated numbers may shed some light to consider the degree and impact of the socioeconomic disturbances on the demographic profiles. Szalay (1995) explains that about 3.000 to 4.000 San were killed by commandos, and between 9.000 to 12.000 would have been incorporated into the colony (under violent or peaceful terms). Other publications across history include their own estimations according to their own observations, from the Bushmen they met with or studied (Campbell, 1823[57]; Gusinde, 1953[58]; Müller, 1912[59]; Passarge, 1907[60]; Seiner, 1909[61]; Seydel, 1910[62]; Trenk, 1910[63]; Wilhelm, 1954[64]). Aside the specific politic and economic development, it may not be forgotten that wars and epidemic outbreaks likewise participated shaping the demography of different southern African populations. From this intricate state, the anthropological and demographical studies from the 1960s and posterior developed their analysis of a *hunting-gathering* populaiton, which became *the* reference of *the foraging society*, also in the field of archaeology.

[57] «Makuhn, den Häuptling der am Malalarihn wohnenden Buschmänner, geschickt hatten, um diesen, falls er noch am Leben sey…In seiner Jugend waren die Buschmänner in dieser Gegend wie zahlreicher als gegenwärtig, da sie durch Kriege mit den Matschappih's und Coranna's sehr zusammengeschmolzen sind... Noch vor einigen Jahren zählte sein Kraal etwa 100 Einwohner, die aber durch Morde und Krankheit zu einem kleinen Häuschen herabgekommen sind. Indeß befinden sich noch außerhalb seines Kraals an drei Orten kleine Abtheilungen, welche seine Obergewalt anerkennen (Campbell, 1823:167-168)».

[58] «My investigations revealed that there are 10.000 !kun. of these, 7000 individuals are living south of the Okawango-River; the remaining 3000 inhabit a southern area of the Portuguese colony of Angola (Gusinde, 1953:26)».

[59] «Passarge estimates the number of Bushmen living in the Kaukau veld at about 300 (Guenther/Müller, [1912] 2005: 206)».

[60] « Vielleicht könnte man sagen, daß sie gesamte Buschmannrasse heutzutage höchstens 5000 bis 10.000 Köpfe stark sein mag. Ihre Zahl ist aber dauernd im Rückgang begriffen (Passarge, 1907: 10)».

[61] «Die Eingeborenen gliedern sich in Bantu, Betschuanen und Buschmänner: Bantu: 259 Dörfer, 22.000 Köpfe Betschuanen: 3 Dörfer, 220 Köpfe Buschmänner: 10 Dörfer, 1800 Köpfe (Seiner, 1909: 100)».

[62] «Their numbers [ǀGeinin's and ǂGanin] were estimated by the expedition mentioned above at 400; however, in actual fact there are probably no more than 100 people (Guenther/Seydel, [1910] 2005 :230)».

[63] «I don't think that there are more than between 900 to 1000 Bushmen in Namib between the Orange Swakop rivers, and in the mountains that border the Namib (Guenther/Trenk, [1910] 2005: 246)».

[64] «An exact estimate of all the !Kung Bushmen is impossible given that the people are forever moving around. Their probable number is between 3000 to 4000 people. All in all, the population is likely on the decline (Guenther/Wilhelm, [1954] 2005:109)».

Table 1. Chronological table with the main historical events, according to the ethnohistorical sources and existing studies.

Date	Location	Description of event
circa 5.000 BC	Central Africa	Bantu dispersal started in present-day border between Nigeria and Cameroon (Beleza *et al.*, 2005; Bousman, 1998; Diamond & Bellwood, 2003; Gignoux *et al.*, 2011; Henshilwood, 1996; Mitchell, 2002).
circa 2.000 BP	Northern Botswana	Archaeological evidence indicates agriculturalist settlements (Bousman, 1998; Diamond & Bellwood, 2003; Gignoux *et al.*, 2011; Henshilwood, 1996;Mitchell, 2002).
circa 2.000 BP	Bambata Cave, Spoegrivier, Blombos, Geduld, etc.	Migratory waves of populations introduce in southern Africa the first domesticated stock (Bousman, 1998; Diamond & Bellwood, 2003; Gignoux *et al.*, 2011; Henshilwood, 1996).
1487	Saint Helena Bay	The Portuguese see natives at the coast (Barnard, 2007).
1498	Cape of Good Hope	A party of a Portuguese fleet has a conflict with a group of natives with cattle (Kolb, 1738).
1500-1600	Cape of Good Hope	Occasionally, the Portuguese and the Dutch go ashore (Kolb, 1738).
1602	Netherlands	Foundation of Vereenigde Oost-Indische Compagnie (Percival, 1804).
1620s	Cape of Good Hope	Settlers establish near Cape, under the incentive of the Dutch administration to cultivate the land, receiving concessions and grants (Percival, 1804).
1620s	Cape of Good Hope and surroundings	Cape Town, Stellenbosch, Swellingdam and Graff Reinet form four districts, with attached villages and small courts of justice (Percival, 1804).
1632	Table Bay	Twenty-three men from a Dutch ship have a violent episode with natives who had cattle (Theal, 1922).
1648	Table Bay	Report from the wrecked ship Nieuw-Haarlem, stating the advantages of the land for a permanent settlement (Leibbrandt, 1897).
1652	Table Bay	Jan van Riebeeck arrives (in1661, assumes the Dutch colonial administration at the Cape). New arrangements to work the land are established, for the settler's own profit, but also to supply the Dutch garrison (Waterhouse, 1979; Kolb, 1738).

Date	Location	Description of event
1655	Towards the interior of Cape	Jan Wintervogel (freebooting soldier) meets with "a certain tribe, very low in stature, and very lean, entirely savage, without any huts, cattle or anything in the world, clad in little skins" (van der Post & Taylor, 1984).
1657	Cape Peninsula	Jan van Riebeeck writes about Kobonas (also called Choboquas, Cobonas), from the Bantu, who live in permanent dwellings made of wood, clay and other material, and whose subsistence is based also on cattle (Schapera & Farrington, 1933).
1659	Near Cape Peninsula	First Khoikhoi-Dutch war. The natives (Khoikhoi, also called Hottentot) see themselves deprived of grazing grounds for their cattle as the Dutch are taking lands to cultivate (Smith & Pheiffer, 1993).
1660	North-eastern from Cape	Expedition lead by Jan Danckert, towards the Monomotapa empire, meeting on the way different Hottentot groups (under the names of Cochoqua, Chainouqua, and Hancumqua) (Theal, 1922).
1660s	Cape of Good Hope	Some first peace pacts are established between the Dutch and the Khoikhoi (Hottentot). The natives bring cattle as token of friendship, while asking the Dutch not to plough up more land than it was already under cultivation (Schapera & Farrington, 1933).
1661	East north-east of the Cape	Expedition lead by Cruythoff, another by van Meerhoff, and another by Pieter Everaerts set off towards east (Schapera & Farrington, 1933).
1662	Dutch fort at Cape of Good Hope	A group of Sonquas (term usually referring to people with no cattle) bring skins to the Cape, they exchange for tobacco and other things (Schapera & Farrington, 1933).
1668	Bakkeley Plaats, western of Cape	A conflict between Dutch and Namaqua, due to the stealing of cattle from them and from other Khoikhoi (Hottentots) (Schapera & Farrington, 1933).
1668	As far as Gourits River, western of Cape	Expedition lead by Cruse, who met with Attaquas (Schapera & Farrington, 1933).
1672	Western Cape	The Dutch purchase land from the Goringhaiqua (the whole district of the Cape, including Table Hout and Saldanha Bays). Later also the land known as Hottentoos Holland (Schapera & Farrington, 1933).

Date	Location	Description of event
1682	Doornbosch (today called Groen) River	After the Namaquas brought copper ore to the Cape in 1681, an expedition lead by Ensign Olof Bergh is set off in search of the Copper Mountains. And again by Hendrick van Rede in 1685 (Waterhouse, 1979).
1685	Lands in the north of the Cape Colony	The Dutch negotiate peace terms with the Amacquas (Khoikhoi), also asking these to stop waging war among themselves, while the Commander of the colony (at this time, Simon van der Stel) granted assistance and aid (Waterhouse, 1979).
1686	Coffee Bay (eastern Cape)	The crew of the Stavenisse leaves account of the favourable reception and treatment by the natives [probably Bantu] of the region (Schapera & Farrington, 1933).
1701	Cape Town	The Dutch Council at Cape Town decides to send a commando of 40 people to capture the Khoikhoi (Hottentot) who had stolen and wounded a farmer, and bring them to Cape Town (Leibbrandt, 1896).
1713	Cape Colony	Small pox epidemic, during which nine out of ten Khoikhoi were stated to die. During the same year, livestock spread and a drought stoke the lands (Smith & Pheiffer, 1993; Smith, 1989; Theal, 1922).
1715	Cape Colony	A commando system is established, compounded of Dutch settlers volunteers, under a military commander, sent to retrieve the stolen cattle and kill the suspects (van der Post & Taylor, 1984).
1752	Eastern Cape Colony	Ensign August Frederik Beutler meets a group of Khoikhoi who states that the San had stolen their cattle, forcing them to subsist from the wild resources (Elphick, 1977).
1770-1830	Further inland in the north of the Cape Colony	The colonial borders expand towards the interior. The resistance applied by the natives intensifies by the last quarter of the 18th century. Prisoners are distributed among the colonists to serve them for a fixed term of years (Szalay, 1995).
1774	Northern border of the Cape Colony	Veldkommandant Godlieb Rudolph Opperman leads an attack against San (Bushmen) along the northern border from Pikeberger eastwards to the Sneeuwberg. The commando kills 503 San and takes prisoner 241 (Szalay, 1995).

Date	Location	Description of event
1775	Swellendam	In his journey, Anders Sparrman finds a farm possessed by slaves. One of the slaves of about 50 years of age was bought in for a bailiff by a farmer. Further in the journey, Sparrman will find other similar cases of labour or slavery (Sparrman, 1789a; 1789b).
1775	Near the borders of theCape Colony	Adriaan van Jaarlsveld decides to trick the San, by first offering them (when they crossed ways) a piece of the game they hunted and gain their trust. In the next occasion, instead of an offer, they would attack the San intending to kill them (van der Post & Taylor, 1984).
1786-1795	Graff-Reinet (eastern Cape)	In Graff-Reinet district, 2504 San are killed by commandos, and 669 taken prisoners. The number of European causalities is reported to be 276. Between 1798-1824, 184 are reported killed, and 302 carried off to the colony (Szalay, 1995).
1788	Cape Colony	The London Missionary Society turned its attention to South Africa (van der Post & Taylor, 1984).
1789	Cape Colony and colonial borders	The Governor Macartney declares to stop war against the San and, instead, initiate peaceful relations (Szalay, 1995).
1795	Cape Colony	England assumes the Colony in South Africa (Thurner, 1983).
1799	North-western colonial boundary	Sheep and cattle are distributed among San. In the north-west, later in the 1820s, two farmers supply the San with about 200 sheep (Szalay, 1995).
1799	Zak Rivier	The London Missionary Society founds a mission station, with the objective to civilize the San, learning agriculture and livestock-breeding, building houses and dams. The station is closed in 1806 (Szalay, 1995).
1801	Orange River	At the expansion of the Boers to Transorangia, the San are largely absorbed by Tswana, Griqua and Kora (Szalay, 1995).
1807	-	Slavery is abolished (Szalay, 1995).
1812	Cape Colony	The military engages on the eastern border against the Xhosa (Bantu), particularly after 1817 (Szalay, 1995).

Date	Location	Description of event
1814	Beyond the colony borders	The London Missionary Society founds the Thornberg mission station. In 1816 they found Hephzibah mission station. By 1816, the colonial government abolishes the mission stations, and continues the negotiations with the San through violence (Szalay, 1995; Van der Post & Taylor, 1984).
1817	Cape Colony	Governor Somerset abolishes the purchase and trading of San children. Similar to that for Hottentot from 1812 (Szalay, 1995).
1820s	Graff-Reinet, Orange River, Sneeuwberg	Several sources describe the San working at cattle-post and farms (Szalay, 1995).
1823-1824	Graff-Reinet	A survey indicates that 1.071 San children are under the protection in the service of the colonists. In the same survey, it is found that there are 862 adults San in the service of the Cradock district (Szalay, 1995).
1824	Orange River	The colony border is pushed to the Orange River. By 1834 it was said that 1.500 Boers were on the other side of the Orange River. The expansion of the northwest border is not accomplished until 1842 (Szalay, 1995).
1824	Natal	A group of English traders establish a settlement in Natal, and establish contact with the Zulu King (van der Post & Taylor, 1984).
1827	Cape Colony	Stockenstrom (lieutenant governor of British Kaffraria) suggests to survey a proper land or the settlement of the San, whose country was compromised by the extended colonial boundary lines. The proposal is rejected and not applied (Szalay, 1995).
1828	Caledon River	The London Missionary Society founds the Caledon River mission station, which remains active until 1834, when the government closes the missions by means of a decree (Szalay, 1995).
1830	Cape Colony	The data available suggests that some 3.000 to 4.000 San are killed by commandos until 1830. Most of the San are probably incorporate to the colony, numbering about 9.000 to 12.000, from a population ranging 1.2000 to 16.000 (Szalay, 1995).

Date	Location	Description of event
1837	Natal	Several thousand Dutch colonists (Boers) set up their own republic in the Natal. In 1842 the British occupied Natal and oblige the Boers to submit to them (van der Post & Taylor, 1984).
1848	Lower Range of Drakensberg	A new military post is established on the Bushman's river, where an African police force is in charge of the protection of the subjects of the colony, from the robberies of the Bushmen inhabiting the region (van der Post & Taylor, 1984).
Mid-1850	Natal	The Durban Volunteer Guard and the Natal Cabineers are two units which take action against the San. They are created after a substantial increase of colonists arrived to Natal, increasing their numbers. The San are systematically eliminated with guns (van der Post & Taylor, 1984).
1868-1869	South Orange River	The San join forces with the Kora (northern neighbours), against the colonial expansion. The conflict turns into two wars, called Boer War. The second Boer war takes place between 1878-1879 (Szalay, 1995).
1871-1884	Robben Island	Wilhelm Heinrich Immanuel Bleek and Lucy Lloyd study the San prisoners in Robben Island (Thurner, 1983).
1884	Present day Namibia	The extensive country becomes German South West Africa, a colony until 1915(Thurner, 1983).
Late 20th and beginning of 21th centuries	German South West Africa, Kalahari, Rietfontein, Grootfontein, etc.	Several exploration journeys aiming for a study of the territory and peoples are planned: E. Holub (1873), A. J. M. Orpen (1873), H. Schinz (1884), H. T. Wagenman (1886), S. Passarge (1896), L. Gentz (1903), L. Schultze (1903), H.Werner (1906), H. Vedder (1907), H. Kaufmann (1908), Dr. Hannemann (1909), O.P. Trenk (1910), J. H. Wilhelm (1914), S. S. Dornan (1919,1917, 1921,1925,1928), etc. (Thurner, 1983).
1950-1961	Kalahari	The Marshall family initiates their expedition under the sponsorship of the Peabody Museum (Thurner, 1983).
1961	Kalahari	The Game Reserve of Central Kalahari is established. Since 1990s, the Botswana government has tried to relocate the Bushmen from the Reserve, claiming they were a drain on financial resources (Wilmsen, 1992).

5.- Ethnoarchaeology and Ethnohistory: the populations in southern Africa

In chapter 3, I discussed the importance to reconcile archaeology and ethnography. The aim of accessing both archaeological and ethnographic data is to obtain a solid comparison of the information and the corresponding corroboration.

Ideally, the research agenda should contain both ethnohistorical and ethnoarchaeological data on the same population under study. For instance, the different descriptions found across the ethnohistorical sources, about settlement layout (including dwellings), the different tools (especially those made of perishable materials), the diet spectrum (food gathering and food production), funerary practices, mobility patterns, etc., they have left a specific material print which can be studied with archaeology. The possibility to combine the archaeological evidence with the narrative descriptions left by the people who travelled in the same regions makes it possible to analyse one phenomenon from two different and independent sources of information. I focused my efforts in to locate several ethnohistorical sources and ethnographic studies. Unfortunately I could not conduct research with direct and associated ethnoarchaeological contexts –both tasks entail exhaustive studies that cannot be simultaneously developed within a single thesis.

Nevertheless, I find it insightful to introduce in this chapter an overview of the existing ethnoarchaeological studies conducted until the present day. Naturally, there are several topics still under discussion, I may refer the reader to consider different publications for further details.

The main content of this chapter is related to the ethnohistorical sources I studied. I discuss here the discussed reliability of ethnohistorical sources, considering their nature and character, and which steps are followed in order to estimate the validity of the information they contain. I insist that the ethnohistorical accounts have potential as a source of information, with special attention to the dimension of time. In the ethnohistorical sources I can follow the resilience and transformations of the social organization of the peoples in southern Africa. I also present here the list of all the sources I accessed and a few details about the authors, their chronology and their main geographical range.

Ethnoarchaeological research: state of the art

A. J. H. Goodwin may represent the beginning of a professionalized archaeological work in South Africa. Working on a local perspective, in the mid-1920s Goodwin presented his classification of the archaeological materials into three periods he called Early Stone Age, Middle Stone Age and Late Stone Age (Barnard, 2007). In the period known as Late Stone Age (*circa* 50.000-12.000 years ago), the inhabitants in southern Africa practiced a foraging mode of subsistence. The archaeological studies point to archaeological assemblages similar to the European Mesolithic, associated to the Anatomically Modern Humans (Deacon, 1984). These assemblages include art and items of personal adornment, specialized hunting and fishing equipment, greater variety of scrappers for skin-working, specialized gathering tools, formal burial of the dead, miniaturization of stones tools associated to hafting, and many other stone tools. These elements appear to be common at most sites only in the last 10.000 years.

It does not seem there are significant differences in the range of fauna hunted between the Middle Stone Age and the Late Stone Age. The researchers have detected a shift between the Late Stone Age and the Early Holocene, which has been associated to differences of fauna availability, and in the relative frequency of gregarious and non-gregarious species (which has been associated to changes in preference and hunting methods) (Deacon, 1984). The archaeological account of the practice of fishing and shellfish collecting seems to be sparse between 90.000 and 12.000 years ago. Only exceptional cases have laid clear evidence of consumption of marine resources, such is the case of rock-shelter of Sehonghong (Lesotho), which contains an important sample of marine resources dating back to 26.000 years (Plug & Mitchell, 2008).

On regard to plant food gathering, the unlikeliness that these organic remains have been preserved to our days undermines the possibility to document it. Alternatively, the documentation of tools associated to this economic activity is still indicative of its practice (e.g. bored stone stick weights, or ostrich eggshell water containers, tortoiseshell bowls and scoops, later also pottery and stone bowls). Exceptionally, several archaeological sites (Matopos in Zimbabwe, Zebrarivier in Namibia, and Bushman Rock shelter, Heuningeskrans and Kruger Cave in the Transvaal) contained different seeds assemblages, dating between 12.000 and 8.000 years BP (Deacon, 1984). On the overall, it is clear that the mode of production relied exclusively on wild resources.

Between the first and second century AD, bones of domestic animals appear in archaeological contexts in Namibia and Western Cape, resulting of the expansion of several communities towards southern Africa (Cameron, 2019; Deacon, 1984; Klein & Cruz-Uribe, 1989; Mitchell, 2002; Sadr, 2007; 2008; Smith & Jacobson, 1995). The appearance of the pottery seems to be contemporaneous. However, pottery remains have also been found in archaeological contexts associated to a more hunting and gathering subsistence. In any case, herding appears to be rapidly adopted across southern Africa –although, there is still an on-going debate regarding the transformations the foraging communities followed. One possibility is that foragers incorporated herding into their subsistence; a second possibility is that herding populations replaced local populations. There is the additional question regarding what entails to change the mode of subsistence. This question argues that the social structures of the foraging communities would have not allowed the adoption of non-foraging subsistence practices and, therefore, the transformation would have only been possible with changes in their own social structures (cf. Smith, 1998).

The Bantu (farmers) initiated their expansion from West Central Africa 5.000 years ago (Grollemund *et al.,* 2015). These farming communities reached South Africa by 350AD (Vansina, 1994), archaeologically attested with the Iron Age *package*: metallurgy, agriculture, livestock, pottery, and semi-permanent settlements. Upon their arrival, these groups met other inhabitants that practiced hunting and herding economies (Sadr, 2008). Finally, in this context of populations migrating and of a plurality of subsistence strategies in a large geographical range, towards the end of the first millennium AD some sites were incorporated in the trans-Indian Ocean trading network, in which the farming communities exchanged ivory and other commodities for imported goods, such as glass beads (cf. Huffman, 2014).

Traditionally, in the archaeological studies, the distinction between the different inhabitants in southern Africa (farmers, pastoralists and foragers) was done according to the cultural material recovered at the archaeological site. In this manner, sites that had been occupied by pastoralists would have fewer retouched stone tools, many potsherds, and abundant seals and sheep remains. Sites that had been occupied by foragers would have many stone tools, fewer potsherds and abundant remains of wild game (Smith *et al.,* 1991). This perspective has been widely criticized (Schrire, 1992) and comes into opposition with the revisionist anthropological position (Wilmsen, 1992). Particularly, Schrire (1992) argues that the list with the presumably specific characters of

one or another group does not hold consistently (e.g. the extent and reasonable neat distinction between sites and the variability of the archaeological features, the extent the archaeological context actually responds to chronology or site typology rather than cultural differences). In general terms, one of the main discussions from archaeology turns around the continuity or discontinuity of socioeconomic structures, and the assimilation or replacement of populations.

Ethnoarchaeological studies were first starting to be applied in the southern African archaeological contexts with a strong emphasis on spatial distribution, but later on also including questions regarding economic activities, technology, and gender roles[65]. This broadening of topics is exemplified with the numerous studies on pre-colonial archaeological. The plurality of topics includes discussions on taphonomy (Yellen, 1991), settlement layout (Parkington & Mill, 1991; Webley, 1986), food production and diet spectrum (Badenhorst, 2018; Jerardino *et al.*,1992; Mitchell, 2002; Sealy & van der Merwe,1985; 1988; Sealy & Pfeiffer, 2000), material culture (Goodwin, 1956; Rudner, 1979), population's mobility (Sealy *et al.*, 1995), funerary practices (Hall & Binneman, 1987), trading activities and/or the interrelations between groups (Goodwin, 1956; Kinahan, 2014; Parkington *et al.*, 1986; Saitowitz & Sampson, 1992; Thorp, 1996; Wilmsen, 1992), as well as excavation of European colonial sites (Abrahams, 1993; Cox *et al.*, 2001; Schrire, 1988).

Unfortunately, as previously mentioned, it is not possible to enter into a detailed discussion. However, and considering the leading questions of the current doctoral thesis, it is relevant to mention one particular study focused on diet change. Clayton and others (2006) studied 37 samples of bone and dentin from 35 juvenile individuals from Matjes River Rock Shelter (southern Cape), one of the largest collections of hunter-fisher-gatherer remains dating from the mid-Holocene. Both nitrogen and carbon stable isotopes were analysed, leading to interesting conclusions: the individuals presented higher nitrogen values until the age of 1.5 years (which they associate to breastfeeding), lower values appear between the ages of 2 to 4 years (which they associate to breastfeeding with supplementary food), and finally, individuals older than 4 years present decreasing nitrogen values until reaching those of adults (expected after weaning). Therefore, the study by Clayton and others (2006) study is suggesting that the inhabitants of

[65] For a more exhaustive overview of the ethnoarchaeological study in southern Africa, I suggest the publications by MacEachern (1996) and Phillipson (2005).

Matjes River Rock Shelter, who followed a mode of subsistence based on hunting and gathering, had a prolonged breastfeeding or a late weaning age –although it corresponds to a one sample, it is nevertheless important to retain.

Ethnohistorical sources: their reliability and validity

The question is whether the analysis pursued in the current doctoral thesis would have been also possible relying exclusively on present-day ethnographic and anthropological studies. Scientific studies would indeed point to more reliable and analytical data. However, the study of humankind compels the inclusion of chronology. Time is a constant dimension in the development of the human societies in terms of synchronism and diachronism. The variable of time becomes a limitation to the social anthropologist. Participant observation may be one of the main methods to collect data and this method is clearly constrained by the amount of time and frequency the anthropologist stays in the field. The amount of opportunities the anthropologist can to return to the field will depend on his or her own historical context, as well as that of the field destination, and to his or her personal condition to continue conducting research. Comparatively, the chronological frame in archaeology usually spans along several generations of the society under study. Naturally, the anthropologist can resort to the historical documentation when possible, in order to learn the past of the society. However, the historical documentation will again be constrained by additional factors such as type of documentation, part of the society represented, or if the documents are still preserved.

The approach in the current thesis requires a broader chronological frame, a limitation most of the social sciences face. Anthropological and demographic studies of contemporary HFGS are limited by the time of the researcher. This narrowness in the scale of time provides as a result a description of a particular society on a particular time. As a consequence, this leads to the assumption that small-scale societies are trapped in a resilient socioeconomic organization, ignoring or underestimating the actual existing dynamism and transformations. A diachronic frame, accessible through an ethnohistorical review, brings forwards the dimensions through which the socioeconomic organization has gone through. Combining in this frame the historical dimension, the ethnohistorical documentation can shed some additional information. Accessing

the past of the present-day societies is indispensable, so that it is possible to understand their historical development. In this manner, depending on the character and content of the ethnohistorical sources, it is possible to include additional information on the manner in which a present-day society was socially organized in the past.

Voyageurs and explorers are the main authors and responsible of the ethnohistorical documentation. Their journeys and expeditions followed different purposes, they decided subjectively which information was relevant to report, and how to formulate it. Nevertheless, I assume that, despite the limitations in their observations or their ideological setting, the observers attempted to report what they observed as much accurately as they could. The methodological approach to ethnohistorical sources has been already developed by other scholars (Orquera & Piana, 1995; 1999; Schapera, 1965; Vila & Estévez, 2010). This offers to possibility to count with existing works and to take into account their ethnohistorical analysis. From these studies, it is already noted the different advantages and disadvantages:

I. First of all, the ethnohistorical materials are inevitably the result of the observations by an external observer. Not only the subjective perception and understanding of the event conditions the character of the written account, but also the fact that the event under observation may have been altered during the observation. Arguably, this limitation may also be present to some extent in the present-day anthropological studies.

II. In the past, the external observers placed a subjective bias over the observations. As a consequence, the descriptions that have arrived to the present may be emphasizing certain aspects, which erroneously define the aspect as *habitual*. The recurrence or reuse of a description can reinforce this *habituality*. Therefore, it is important to identify who and when said what and in which manner.

III. The presence of the description of an aspect in a particular report at a specific time does not validate it to be exportable to previous chronologies –especially when absent in previous reports. The extension of change to which one particular aspect has undergone may go unperceived by the observer. In this manner, if a recent historical event (e.g. post-epidemics, process of sedentarization) is ignored or unknown, the understanding of the current observation is inevitably biased. A diachronic search through the ethnohistorical documentation may allow reducing the impact of this particular bias. When possible, it is

important to find the first report containing the description of certain aspect, note who wrote it, when, and in which manner.

IV. There may be a few compilation works, by authors who had accessed older reports, whether they acknowledge or not the original source. Notwithstanding the content given in these works, it is crucial to find the original source. When possible, the access to independent sources makes it possible to compare their content –through comparison it is possible to thereafter assess the similarities, the discrepancies, and the contradictions.

V. In the case of original sources, even if the observer spoke and understood the language, the information he transmitted (in the text) may be altered from its original sense, because of his personal understanding and the manner in which he decided to describe it –in some other cases, the *informants* spoke and understood one of the European languages. It is clearly preferably to find these types of reports, than reports written by someone who needed intermediaries or by someone who never interacted directly with the population of interest –offering little options to contrast the information.

VI. In every case it is assumed that the writer had the intention to describe something he observed, in the best way possible. Regardless of the ideological and historical bias, the different travellers and explorers left accounts of particular events. To some extent, when comparing diachronically and synchronically, it may be possible to assess the reliability character of certain information.

Discrepancies or contradictions can easily arise when comparing different written accounts. Szalay and Laade (1983) comment on the different plausible explanations of the inconsistence of the information:

I. The sources compared that present contradictory information are gathered in different chronologies. It is possible that the sources belonging to different times are pointing to what would plausibly be a transformation.

II. Alternatively, the ideological background of the observer may establish certain information in a way that becomes contradictory with another author's statement.

III. It is also possible that the contradictory information contained in contemporaneous sources is actually pointing to regional differences. Additionally, there are also authors who point to contradictory or divergent information within their own text. In this case, some authors do not explain or argue it, while others do clarify that they respond to regional differences.

IV. Finally, the discrepancies may result from the length and duration of the contact or interaction between the writer and the inhabitants. It can also be related to information lost in translation among those cases in which there were intermediaries.

All factors mentioned put into question the reliability of the ethnohistorical sources. Orquera and Piana (1995; 1999) stressed that it is not only important identify the everyday and dominant picture, but that it is also indispensable to detect the flexibility and variability. Szalay and Laade (1983) stressed on the importance to read the original source of information, while taking into consideration the chronology, geography, and group under observation. It is of great relevance to distinguish between those sources that are the result of direct information, from those, which are dependant from primary sources –it may be the case that a secondary source becomes the primary source, when the original is no longer preserved.

In order to obtain an organized layout of the different ethnohistorical sources I used, I detail several characteristics (see Table 2, and the map in Fig. 11).

I. The chronology of the source. On the one hand, the publication or the date the document was issued may be sufficient. However, it may be possible that a report is based on events that took place several years before. I take into account the date of the actual journey, expedition or encounter, rather than the publication date, in order to have a more realistic chronological view of the events.

II. The geography of the source. The relevance to identify the geographical range included within the source brings the possibility to compare different ethnohistorical sources with recent scientific studies conducted in more or less the same region. The sources I have accessed include journeys, expeditions and fieldworks spreading in regions from present-day South Africa, Lesotho, Namibia and Botswana. Flexible forms of socioeconomic organization or behaviour existed synchronically and diachronically, in the same and in different geographical areas.

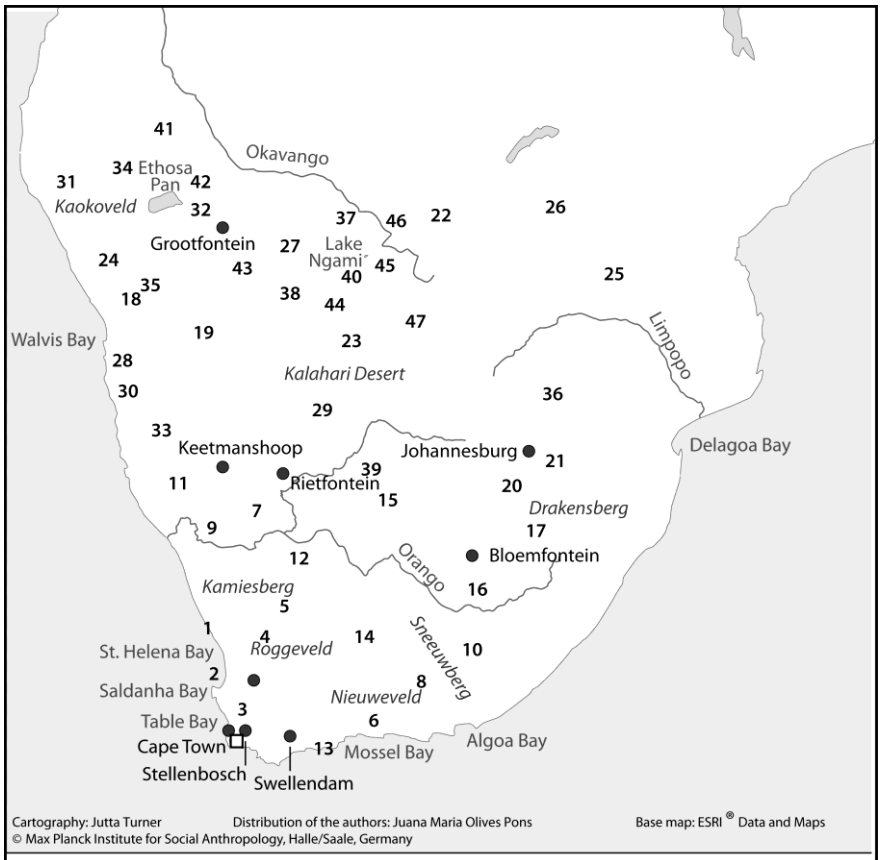
III. The authorship. Considering the colonial history of the period, it is relevant to learn if the person who led the journey/expedition or was present during the same is also responsible of the written account –primary source. To the extent possible, taking into account the particular background of the person may be insightful to understand the purpose of traveling in southern Africa.

Responding to the purpose of the current thesis, the gathering and selection of ethnohistorical sources –and their inclusion in this thesis- depend on their narrative content. Those written accounts which had a strong focus in the description of landscape, flora and fauna species are not taken into consideration. The focus of my interest is in the narrative content related to the social and economic behaviour of peoples, with special emphasis in the organization of reproduction. As it may be observed in the Table 3 in the chapter 6, in the early reports there is barely any reference to the socioeconomic behaviour of peoples, but the interest is placed in their physical appearance (anatomically), as well as their cultural material.

Exploring the ethnohistorical sources

Large and voluminous accounts bear witness of the lands and peoples, firstly under the characteristics of a diary, later as extensive books, while simultaneously other documentation is also produced (e.g. private letters, précis of the colonial administration). The volume of ethnohistorical sources is exceedingly large, which makes it a difficult task to reach every single of them[66]. The priority given in the selection of sources has been dependant on whether the written reports contain any description on the social organization and behaviour around the reproductive relations among the different inhabitants from southern Africa –particularly of the Khoisan.

[66] Despite I do not include the entire collection of ethnohistorical, historical and anthropological accounts, I consider that other contemporaneous texts may not differ greatly from those I do incorporate in the current doctoral thesis.



Distribution of the authors according to the main location of their expedition or fieldwork.
The years indicated between brackets refer to the period of observation.
The years marked with * indicate the year of publication.

1	Vasco Da Gama (1497)	25	Samuel Shaw Dornan (1899-1923)
2	Jan Wintervogel (1655)	26	Franz Josef Seiner (1905-1906)
3	Olaf Bergh (1682-1683)	27	Heinrich Werner (1905)
4	Simon van der Stel (1685-1686)	28	Oberleut P. Trenk (1909)
5	Isaq Schrijver (1689)	29	Hans Kaufmann (1908)
6	Peter Kolb (1705-1713)	30	Ernst Seydel (1909)
7	Jacobus Coetsé Jansz (1760)	31	Captain Müller (1911)
8	Anders Sparrman (1775-1776)	32	Berengar von Zastrow (1910-1919)
9	Hendrik Jacob Wikar (1779)	33	A. Winifred Hoernlé (1912-1913)
10	Francois Le Vaillant (1780-1785)	34	J. H. Wilhelm (1914-1919)
11	Willem van Reenen (1791-1792)	35	L. Fourie (1916)
12	Sir John Barrow (1797-1798)	36	Drothea F. Bleek (1921-1922)
13	Dirk Gysbert van Reenen (1803)	37	Viktor Lebzelter (1926-1928)
14	Hinrich Lichtenstein (1803-1806)	38	Oscar T. Crosby (1927)
15	John Campbell (1820)	39	J. A. Engelbrecht (1926))
16	Rev. Thomas Arbousset (1836)	40	Frank Brownlee (1937)
17	George W. Stow (1843)	41	R. P. Ch. Estermann (1946*)
18	James Chapman (1860-1863)	42	Martin Gusinde (1950-1957)
19	Thomas Baines (1861-1862)	43	Lorna Marshall (1951-1961)
20	Gustav Theodor Fritsch (1863-1866)	44	Richard Borshay Lee (1963-1973)
21	Johannes Theophilus Hahn (1870*)	45	Nancy Howell (1967-1969)
22	Hans Schinz (1885-1886)	46	Megan Biesele et ali. (1970-1972)
23	Siegfried Passarge (1897-1898)	47	Carlos Valiente-Noailles (1973-1990)
24	Heinrich Vedder & Alfred Unterkötter (1899)		

□ Cornelius de Houtman (1595), Johan Antoniszoon Van Riebeeck (1652-1662), Johann Schreyer (1669-1677), Olfert Dapper (1659-1663), Johann Christian Hoffmann (1671-1672), William Ten Rhyne (1673), Johannes Gulielmus de Grevenbroek (1684-1694), Robert Percival (1796,1801), Franz Ewald Theodor Bachman (1883), Isaac Schapera (1930*)

Figure 11. Approximate distribution of the travelers, explorers and scientists, according to the main geographical area of their journey or fieldwork

The ethnohistorical sources consist of different kind of documentation, dating back to 1487, until the most recent scientific studies. There is a rather safe continuity from source to source covering the entire chronology of four centuries. The purpose of the expedition or travel, the duration of the interrelations between inhabitants and Europeans, the information missed in translation, the bias among the travellers, and the group the Europeans met with, can possibly explain the reports written that arrived to our present. The first impression from the early reports is the exhaustive and detailed descriptions the explorers and travellers wrote down in their notebooks and diaries, about all vegetal and animal organisms they encountered, about the landscape features and, lastly, about the peoples.

At the end of this chapter, I include a table (Table 2) with the list of the names of the explorers, travellers and scientists whose account and reports I studied. Considering the main aim of the current doctoral thesis, it has not been possible to develop a detailed analysis of each author of the written accounts I studied (57 to be precise), this would require an entire thesis by itself –I suggest the reader to consider the publications by Thurner (1983), who provides a detailed biography of some writers of the 18th century, and by Barnard (2007), who provides an overview of some of the writers across all centuries.

In order to understand the table, I may indicate a few comments on its structure. The information in the cell of "background" contains information, which can be illustrative about the purpose of the expedition or journey. In the column of "period of observation" I give the approximate period during which the traveller, explorer or scientist conducted their journeys. In some cases I can be as precise as it is indicated in the written account (including day, month and year), in other occasions I only found a vague idea of the period during which the person lived in the Colony, without specifying in their text when did the journey exactly take place (in this case, I indicate the year or possible range of years). Those cases in which the chronology is given between square brackets are cases in which the author reports information without specifying any particular period, but they rather inform of general descriptions usually resulting of prolonged periods of observation and sometimes in combination with the compilation of former reports. The cell of "year of publication" refers to both the original year of publication and the edition I accessed –if both dates are available. I accessed several early reports with the publications from anthropologists and historians who provide a translation from early texts, which were, for example, originally in Latin (e.g. Schapera & Farrington, 1933) or Dutch (e.g. Mossop, 1931;

1935). When possible I accessed an original copy (e.g. Le Vaillant, 1790) or a contemporaneous copy (e.g. Barrow, 1801). This information is made available under the column of "source". Finally, in the "geography", I include a few landforms expressed in the accounts, and corresponding to landforms observed during the journey. In some cases, the precision of this geo-reference information is not accurate, in which case I simplify it to regional names or the cell is simply left blank. In combination with Table 2, in the map (Fig. 11) I present an approximate distribution of every source I studied. I have mentioned the impossibility to detail the geographical routes of every journey in this thesis. Nevertheless, I find it sufficiently illustrative to place the sources according to the approximate geographical range contained in their texts.

In the beginning, the trips circumnavigated the Cape of Good Hope, because the main interest was to reach the East Indies. Hence, there is a hiatus after the Portuguese that lasts until the arrival of the Dutch, encouraged by the account from two merchants from the wrecked ship Nieuw-Harlem at Table Bay in 1648[67]. In this moment, a systematic exploration of the interior land followed. In which the majority of the journeys responded to exploratory projects, in order to learn the extension of the lands beyond Cape, their inhabitants and the natural resources. The majority of the writers participated personally in the explorations –only the case of Dapper seems to be dubious, it appears that he received most of his information from George Frederick Wreede.

[67] «The soil is very food in the valley, and during the dry season the water can be used for irrigation as required. Everything would grow there as well as in any other part of the world, especially pumpkin, water melon, cabbage, carrot, radish, turnip, onion, garlic, and all kinds of vegetables, as those who were wrecked in the Harlem can testify. It is also beyond doubt that all kind of fruits will thrive there, as orange, lime, apple, citron, shaddock, pear, pilum, cherry, gooseberry, and currant, which could be kept on board for long time. […] From the cattle, butter cheese and milt could also be obtained for refreshment. […] Pigs could also be reared there, and fattened on cabbages, carrots and turnips, and if once in abundance each ship might take on board one or two sows which have littered or are near the time of doing do, which if fed on board one or two months would be no small refreshment. […] Everything could be procured there in sufficient quantity. There is fish in abundance, which if dried might be distributed among the ships. Further, there are elands and steenbucks in numbers, whose skins would in course of time also bring in something. All kinds of birds are there by thousands, all which may be caught or shot, and with which the garrison may be fed, an ox being killed now and then. Annually a large quantity of train oil might be boiled for at certain seasons Table Bay is full of whales, whilst the Robben and other islands are always swarming with seals, so that a boiler can be kept continually going…(Leibbrandt, 1897:1-17)».

Peter Kolb may represent the first extensive account, and he also refers to previous texts. Kolb not only read the existing texts, but he also compared the information he found with his own experience, giving his personal opinion on the coincidences and discrepancies. Especially since the 18th century, the profile of the explorers is rather diverse, most of them have some sort of background in natural sciences, were at the service of the London Missionary Society, or at the service of the colonial administration. The geographical range explored expanded towards western and eastern Cape, in the proximities of the Orange River. Naturally, the expansion of the colonial administration entailed the reaction of the inhabitants, especially conflictive among the called Bushman (appreciation already present in the Dutch colonial administration[68]), transforming the relations and, hence, the perception. In the following century, the profile of the writers and the characteristics of their journeys remain more or less the same, incorporating a few ethnologists. The work of Stow may be comparable to the case of Kolb. Even though Stow's text was published posthumously, he did his own research about southern African societies, and he likewise included his own observation and knowledge on the matter. In any of the cases, Passarge is considered to be the first anthropologist to systematically study the hunters.

With the distribution of the African lands among the European nations after the Berlin Conference (1884-1885), the Germans initiated their colonial presence in South West Africa (present-day Namibia). In this context, the higher presence of German writers is noticeable in the early 20th century. Aside from ethnologists and priests, also German soldiers from the *Schutztruppe* (German colonial troops) left account of their observations while stationed in South West Africa. Interestingly, the amount of publications decreases between the decades 1920s to 1940s. Barnard (2007) points out that there are fewer ethnographic works related to the hunting and gathering groups during this period. However, as Barnard summarises (2007), in 1921

[68] From the journals of the Governors of the Dutch colony in Cape Town (compiled by Leibbrandt, keeper of the Archives of the Cape of Good Hope) several instances regarding conflictive relations are found: in March 1701, «Letter received from the Landdrost that the Ubiqua Hottentots [group without cattle] had crossed the Red sand and gone to Riebeeks Kasteel, stealing 40 cattle belonging to Gerrit Cloete. They stat their intention to be, first to impoverish the freeman and afterwards attack the Company's post. He wishes to receive immediate orders as the Heemraden meet to-morrow (Leibbrandt, 1896:35)». In April 1703 «Sergeant Louw returned, having been sent some time ago by the Governor, with a commando at the request of the Hottentot Captain Coopman, to recover some cattle stolen by the Ubiqua nation [group without cattle]. He had partly succeeded. Some of the robbers were shot and two taken prisoners. The cattle were restored to Coopman (Leibbrandt, 1896:60)».

Radcliffe-Brown, who had been Malinowski and Rivers's student, took his first chair at the University of Cape Town, where he introduced anthropology; and Winfried Hoernlé, who studied in Cambridge, introduced anthropology at the University of Johannesburg. At the Afrikaans-speaking universities, anthropology was mostly influenced from German-language diffusionism and America cultural anthropology. In 1930, Schapera published his doctoral thesis (which was mostly based on existing ethnohistorical accounts), and Dorothea Bleek continued publishing Wilhelm Bleek and Lucy Lloyd's notes, as well as her own fieldwork. Additionally, there are several publications that included translations into English from early accounts that were only available in Latin or Dutch. Therefore, the field was not ignored, but developed in different directions.

Finally, in the 1950s, straightforward anthropological projects restart the study of the *hunters and gatherers*, in this case by the hand of American anthropologists[69]. Among these, the focus was placed on the inhabitants at that moment living in north-east Namibia and north-west Kalahari.

[69]The discussion regarding the Kalahari Debate has been presented in a previous chapter.

Table 2. List of the authors of the ethnohistorical sources and ethnographic studies, ordered chronologically.

Author	Background	Period observation	Year publication	Source	Geography
Abul Hassan Ali ibn Husain Ali al-Masudi	Arabic historian	10th century	1965	[in Hirschberg]	
Vasco Da Gama	Explorer to complete the sea route to India	1497	2014	Da Gama [von Velho]	St. Helena; Durban; Delagoa Bay (Circumnavigation)
Balthasar Springer	Representative of the Augsburg trading house	15th June 1506	1965	[in Hirschberg]	
Cornelius de Houtman	Merchant	1595	1965	[in Hirschberg]	Passed the Cape without landing in 1583; Table Bay in November 1598
Johan Antoniszoon Van Riebeeck	Commander of the Dutch colony at the Cape of Good Hope	1652-1662	1897	Van Riebeeck [in Leibbrandt]	Cape Town
Jan Wintervogel	Served the Dutch East India Company	1655	1965	[in Hirschberg]	Saldanha Bay
Johann Schreyer	Served the Dutch East India Company	1669-1677	1931 [1681]	Johann Schreyer	Cape Town
Olfert Dapper	Registered as a medical student at the University in Utrecht	1659-1663 [George Frederick Wreede]	1933[1670]	Olfert Dapper [in Schapera & Farrington]	[Cape Town]
Johann Christian Hoffmann	Served the Dutch East India Company	1671-1672	1931 [1680]	Johann Christian Hoffmann	Cape Town
William Ten Rhyne	Doctor and botanist at the service of the Dutch East India Company	October-November 1673	1933 [1686]	Ten Rhyne [in Schapera & Farrington]	Cape Town
Olaf Bergh	Served the Dutch East India Company	October-December 1682; August-October 1683	1931 [1683]	Olaf Bergh [in Mossop]	Bergh River; (along) Olifants River; Doorn Bosch River

Johannes Gulielmus de Grevenbroek	Secretary in the Council of Policy at the Cape of Good Hope	1684-1694	1933 [1695]	Johannes Grevenbroek [in Schapera & Farrington]	Cape Town
Simon van der Stel	Last Commander and first Governor of the Cape of Good Hope	August 1685- January 1686	1979 [1692]	van der Stel [in Gilbert Waterhouse]	Olifants River; Groote Doorn Bosch River; Kamiesberg
Isaq Schrijver	Officer of the Dutch East Company	January-September 1689	1931[1689]	Isaq Schrijver [in Mossop]	Kamiesberg
Peter Kolb	Studied philosophy, mathematics, physics, logic, oriental languages and theology.	1705-1713	1738	Peter Kolb	Cape Town; Stellenbosch; Caledon
Jacobus Coetsé Jansz	Burger who obtained permission to betake himself inland for the purpose of shooting elephants	July-November 1760	1935 [1760]	Jacobus Coetsé Jansz [in Mossop]	Orange River
Anders Sparrman	Swedish physician who after completing the studies visited Cape of Good Hope as a naturalist	July 1775-april 1776	1789	Anders Sparrman	Central Karoo; Sneeuwberg; Swellendam; Plettenberg; Sundays River; Great Fish River
Hendrik Jacob Wikar	Swedish at the service of the Dutch East India Company	April-June 1779	1935 [1779]	Hendrik Jacob Wikar [in Mossop]	Along the Orange River
Francois Le Vaillant	French naturalist, zoological collector and ornithologist	1780-1785	1790	Francois Le Vaillant	Swellendam; Mossel Bay; across Outeniqua Mountains; Langkloof; Sundays River; Great Fish River
Willem van Reenen	At his own expenses, journeyed across the Orange River towards Damaraland	September 1791-June 1792	1935 [1791]	Willem van Reenen [in Mossop]	Cape; (across) Orange River; Damaraland

Robert Percival	English traveller and writer, he joined the army as captain in the 18th Regiment of Infantry.	1796; 1801	1804	Robert Percival	Cape Town (max. 80km)
Sir John Barrow	Lord Macartney (Governor of Cape of Good Hope in 1797) chose Barrow as one of his private secretaries	1797-1798	1801	Sir John Barrow	Graaff-Reinet; Algoa Bay; Keiskamma River; junction of the Orange and Seekoei Rivers; Sneuwberg; Hartebeest River; Kamiesberg; (eastwards) Roggeveld
Dirk Gysbert van Reenen	Prominent burger and winemaker who held the wine and meat contracts for the East India Company	April-August 1803	1937[1803]	Dirk Gysbert van Reenen [in Blommaert]	Gamtoos River; Orange River
Hinrich Lichtenstein	German physician and naturalist.	1803-1806	1967 [1811]	Hinrich Lichtenstein [in Wahrhold Drascher]	Cape Town; Hartbeestfontein; Swellendam; (area) Mossel Bay; Algoa Bay; Fish River; Sneuwberg; Stellenbosch; Roggeveld; (along) Orange River; Rietfontein
John Campbell	Served the London Missionary Society	January-September 1820	1823	John Campbell	Namaqualand; Orange river; Bushmanland; Lattakuh
Rev. Thomas Arbousset (F. Daumas)	French protestant pioneer missionary in Lesotho	March-May 1836	1842	T. Arbousset & F. Daumas	(along) Caledon River; Namahadi River; Orange River; Tugela River; Mont-aux-Sources
George W. Stow	Geologist and ethnologist.	[Arrived to Eastern Cape in 1843]	1905	George W. Stow	Cuylerville (Eastern Cape); Bloemfontein (from where he writes)
James Chapman	Explorer, naturalist, trader and hunter, who worked as merchant in Durban	1860-1863	1868	James Chapman	Damaraland; Walvis Bay; (near) Windhoek; Otjimbengwe; Cape Town
Thomas Baines	Son of master mariner, his first expedition was a hunting trip	March 1861-August 1862	1864	Thomas Baines	(near) Otjimbingwe; Olifants River; Lake Ngami; Victoria Falls

Gustav Theodor Fritsch	German anatomist, anthropologist and traveller.	1863-1866	1868	Gustav Theodor Fritsch	Cape Town; (present) Free State; (present) Lesotho; (present) KwaZulu; (present) Botswana
Johannes Theophilus Hahn	Trader and Nama linguist. He grew up at the mission station Ebenhaeser and Bethanien in southern Namibia, with Nama as his second language	[Grew up]	1870	Johannes Theophilus Hahn	(grew up) southern Namibia; Keetmanshoop; Rehoboth; Stellenbosch; Johannesburg
Franz Ewald Theodor Bachman	German medical practitioner and naturalist.	[Arrived to Cape 1883]	1899	Franz Ewald Theodor Bachman	Western Cape
Hans Schinz	Swiss botanist	April 1885-November 1886	1891	Hans Schinz	Keetmanshoop; Stampriet; Rehoboth; Windhoek; Otjimbingwe; Karibib; Omaruru; Outjo; (western) Ovamboland; Grootfontein; Lake Ngami; Walvis Bay
Karl Barthel	Teaching position in Leipzig		1893	From existing sources	
Siegfried Passarge	German geographer and ethnographer, studied physics, chemistry and geology.	1897-1898	1907	Siegfried Passarge	Kalahari; Kaokoland
Heinrich Vedder & Alfred Unterkötter	German missionary, linguist, ethnologist and historian	[Arrived 1899]	1937	Heinrich Vedder & Alfred Unterkötter	Namibia (German South West Africa)
Samuel Shaw Dornan	Presbyterian missionary	1899-1923	1925	Samuel Shaw Dornan	Basutoland (Lesotho); Southern Rhodesia (now Zimbabwe)
Franz Josef Seiner	Austrian journalist and traveller	August 1905 - June 1906	1909	Franz Josef Seiner	Okavango-Zambezi (area)
Heinrich Werner	Medical doctor of the colonial troop for German South West Africa	1905	1906	Heinrich Werner	Omuramba ua omatoko
Oberleut P. Trenk	Officer of the colonial troops in German South	1909	1910	Oberleut P. Trenk [in Guenther]	District Maltahöhe (Namib)

	West Africa				
Hans Kaufmann	Lieutenant of the colonial force for German South West Africa	August-September 1908	1910	Hans Kaufmann	South West Africa; Middle Kalahari
Ernst Seydel	Commander of the Maltahöhe Schutztrupper contingent	1909	1910	Ernst Seydel [in Guenther]	Namib Desert
Captain Müller	Captain, embarked on an official voyage of exploration inland	1911	1912	Captain Müller [in Guenther]	Kaukauland
Berengar von Zastrow	Bezirksamtmann of Grootfontein	Bezirksamtmann of Grootfontein 1910-1919	1914	Berengar von Zastrow	Grootfontein; Etosha-Pan; Kaukauland
A. Winifred Hoernlé	Social anthropologist	1912-1913	1925	A. Winifred Hoernlé	Southwest Africa
J.H. Wilhelm	Operated a farm at Outjituo. Extensive hunting and exploratory	1914-1919	1954	J.H. Wilhelm [in Guenther]	South West Africa; Outjituo; Hukwe veld (western Caprivi); Kaukauland; Okavango
L. Fourie	Medical officer	1916	1926	L. Fourie	South West Africa; Damaraland/Ovamboland
Dorothea F. Bleek	Ethnographer and linguist	1921-1922	1928	Dorothea F. Bleek	Sandfonteni
Viktor Lebzelter	Anthropologist and Curator Natural History Museum of Vienna	1926-1928	1934	Viktor Lebzelter	South West Africa
Oscar T. Crosby	United States assistant secretary of the treasury, explorer, author	1927	1931	Oscar T. Crosby	From Windhoek to Kunene River, and between Kaokoveld mountains and the Kalahari desert
Isaac Schapera	Social Anthropologist		1965 [1930]	From existing sources	

J. A. Engelbrecht	Linguistic (Bantu language)	1920s	1936	J. A. Engelbrecht	Orange Free State, Bultfontein, Hoopstad, Hertzogville, Bloemhof, Kimberley, Boshof, Windsorton, Barkly West, along Vaal River
Frank Brownlee	Colonial administrator	1937	1943	Frank Brownlee	North-western Kalahari
R. P. Ch. Estermann	Ethnographer	24 years of fieldwork	1946/1949	R. P. Ch. Estermann	Meridional Angola
Martin Gusinde	Austrian priest and ethnologist	June 1950 - September 1957	1953	Martin Gusinde	Okavangoswamps; Etosha-Pan
Lorna Marshall	Sent to South West Africa to conduct ethnographic study	1951; 1952-1953; 1955; 1959; 1961	1959; 1960	Lorna Marshall	Namibia
Richard Borshay Lee	Social Anthropologist	1963-1973	1979	Richard Borshay Lee	Botswana; Namibia
Megan Biesele [*et al.*]	Social Anthropologist	1970-1972	1986	Megan Biesele [*et al.]*	North-east corner of South-West Africa, from Grootfontein in the west to Okavango and Lake Ngami in the north and east
Nancy Howell	Sociologist and Demographer	1967-69	[1979] 2000; 2010	Nancy Howell	Namibia
Carlos Valiente-Noailles	Argentinian lawyer	1973-1990	1993	Carlos Valiente-Noailles	South-eastern Central Kalahari; Botswana (Reserve Game)

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6.- Materials

The content of this chapter is basically the exposition of the quantitative and qualitative information I gathered from the ethnohistorical accounts and recent ethnographic studies of the southern African populations (Khoisan).

On the first place, I define the stages in the life course of a man and a woman from birth until death. I associate these stages to different parts of the social organization of the relations established between people, to the particular social behaviour established in accordance to age and sex. These categories facilitate the distribution of the different social norms I collected from the ethnohistorical sources and ethnographic studies. Although my intention is not to follow the established division between Khoi (pastoralists) and San (hunters), I do find important to respect the distribution of the social norms and social behaviour in accordance to the original sources, when these refer to groups who are mostly hunters and to groups who are mostly pastoralists.

Following the division of the stages in the life course and population groups, I present in a more or less detailed manner the different socials norms I have found. These social norms are clustered into four groups: rites of passage, age at first marriage, type of marriage, and childbirth intervals. The amount of data gathered is large and it does not fit entirely and in the chapter. However, there are several annexes prepared that complete the information in the chapter presented. Naturally, from the ethnohistorical sources and ethnographic studies there is not a single and unique description of the social behaviour or the social organization of the relations between men and women. The information gathered sometimes presents similarities, sometimes differences, and occasionally strong contradictions. I cannot discern with absolute accuracy which source is completely true I assume the authors of all the sources I studied attempted to leave an account as best as they could describe it. I also assume that the social organization of people was dynamic, and that the variability may respond to regional differences, or even chronological differences. I explain in this chapter how I approach to the data and how will it be used for the experimental exercises.

The patterns of the life course of men and women

Even though the purpose of the current study is to contribute to the archaeological research of Palaeolithic societies, the materials and data here presented are taken from ethnohistory and ethnography. Present-day HFGS have their own extensive and specific history, meaning that they have undergone to different transformations which have altered their demography and their socioeconomic organization. It is attempted to collect from early reports information on groups whose mode of subsistence is mostly based on wild resources. These early reports consist of diaries, exploration reports, minutes from the government council, volumes, and letters written by the European colonists and travellers –later in time also by the scientist. This documentation encompasses a chronology extending from the 15th century to our present-day. As already discussed previously, by taking this approach it is not implied to expect to find descriptions of one solely and *genuine* hunting and gathering society. Instead, within a comparative analysis (synchronic and diachronic), and in a cross-cultural comparison (other existing compilations of other HFGS), it is possible to assess and study the demographic development of these types of societies in the long run. The disadvantage of present-day studies is that these attest only the object or subject observed by the scientist. However, the potential of qualitative information available in a range of almost 500 years opens the possibility to review transformations and resiliencies, challenging the identification of patterns.

While existing literature has been published including several pre-industrial groups (Carr-Saunders, 1922; Lorimer, 1954; Nag, 1962), some include data collected from early historical reports (following the line proposed by authors working previously with other examples, Orquera & Piana 1995; 1999; Schapera, 1965; Vila & Estévez, 2010). The approach of the current study tries to find itself within the last group of literature. Locating and reviewing most of the existing historical documentation, starting with the first contacts between colonialists and the inhabitants of the lands in southern Africa until our present-day. It is aimed to identify and collect an extensive list of *social norms*.

It has been already discussed the underlying problematic regarding the inhabitants of southern Africa. Until the end 18th-19th centuries, the sources do not seem to suggest a clear and sharp *ethnic* division between pastoralists (Khoikhoi) and foragers (San). The division based on cattle ownership will explicitly appear in the 18th century and it will be a constant in the following

written accounts, extended also to their livelihoods. I decided to respect the original designation given by the different authors when attributing the descriptions to one or another group, from the two main populations, "people with cattle" and "people without cattle and relying on wild resources". The different categories I select are mostly connected to the social structuration of reproduction. The different stages in the life course of a man or a woman, and their role in the engine of reproduction are shown in Fig. 11. The life course of an individual is biologically characterised by the condition of aging from childhood into adulthood. Especially in the case of the woman, when she is not sterile, her reproductive capacity has a limited duration –starting with the menarche and ending with the menopause. Therefore, it is important to identify all variables involved in the social and reproductive relations.

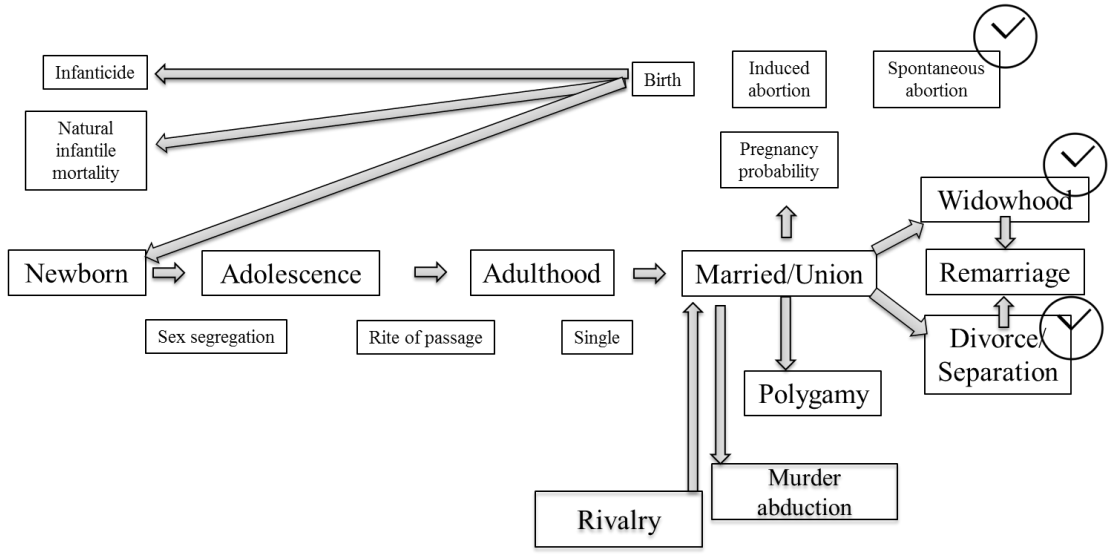


Figure 12. Simplification of the life course of men and women, highlighting the biological (e.g. adulthood) and social stages (e.g. rite of passage).

In this manner, I structure the social norms in the following categories:

I. Rites of passage: these indicate the transition of girls or boys into single and marriageable individuals.

II. Age at marriage: clearly, it is not possible that within the same group all women and men marry at the exact same age, but the age at first marriage may be found within a small range. In this manner, it is important to take into account the minimum and the maximum observed age at first marriage.

III. Marriage: independently of the age at marriage, the type of marriage has an important role. The *availability* of women and how many is a man entitled to marry may affect the total fertility rate. In a polygamous system, even if every man does not marry exactly the same number of wives, there is a rather mixed situation in which some men may marry easily a second, third or fourth wife, and some men do not, or remain monogamous. Finally, it is important to incorporate any information regarding the possibilities of separation and remarriage. Both, separation and remarriage are considered in the manner that exposure of women to conception decreases while separated –and the exposure increases again after remarrying. The social context may also include social restrictions that do not allow sexual intercourse outside of the union.

IV. Finally, besides the assessment of the increase or decrease of the exposure to conception, it is likewise important to take into account social norms affecting the length of the period between conceptions. This is identified under practices associated to birth-spacing and deliberated fertility control. In the first category I include the length of the interval between births and the weaning age. In the second category I include infanticide and induced abortion.

These norms are distributed depending on what section of a population is affected, that is according to sex and age, but also to the specific social conditions –for instance, pregnant woman, widower, married or single. I provide in the annexes 9 to 20 the distribution of the information gathered from the ethnohistorical sources and ethnographic studies on every stage of life course from the two main populations under study in this thesis.

Table 3 presents a condensed summary of the materials gathered from the ethnohistorical sources and ethnographic studies[70]. As it may be seen, the sources in the 15th and 16th centuries do not contain clear and specific reference to any particular form of social behaviour. In the early times, the authors mostly left witness of the trips they accomplished, describing the landscapes, the living ecosystem, the character of the encounter with the natives, and a few features they learned about them. At the end of the 17th century, the quality of information of interest increases, with

[70] The table presents mainly the data corresponding to the pastoralists (Khoikhoi) and foragers (San). I did not collect systematically data corresponding to the Bantu (farmers), but I include a couple of sources that described them, in order to count with a few examples about these populations. In all cases, the chronological position of the author corresponds to that coetaneous to the observations, except for Isaac Schapera, who mostly conducted archiving work.

more specific descriptions, such as types of marriages or puberty ceremonies are at least mentioned. At the beginning the authors refer to the natives according to the names they are told or have heard of, as well as the common terms of Hottentot or Bushmen, later used.

Unfortunately, the distribution of qualitative information is not regular throughout the periods, receiving particular aspects of social behaviour more or less attention by one author or another – in annex 1 two tables are displayed, containing a short description of the different accounts related to the different social practices or social behaviours. Additionally, annexes 1, 2, 3, 4, 5, 6, and 7 contain the exact quotations. Equally unfortunate is that the time of observation is different between the authors. Some authors experienced sporadic encounters on their journeys inland, others spent intermittently several months, even years, among the populations. The time allotted for observation and understanding may have left a strong print on the text. Additionally, the database is based on the positive mentions in the text. On its part, the absence of other information may be due to its inexistence, or to the lack of observation. Clearly, the more recent the sources are, the more precise or detailed the information is given, and more topics are added.

Table 3. Data gathered ordered chronologically and typologically.

Chronology	Author/Observer	Puberty		Age at marriage				Postmarital Residence		Mono-gamy	Polygamy			Divorce	Remar-riage	Inter-birth		Wean age		Sexual abstinence			Infanticide					Abortion	
		F	M	<16 F	>16 F	<18 M	>18 M	Uxor-locality	Viri-locality		Rare	Usual	Excep-tional			≤1 year	> 1 year	≤1 year	>1 year	Preg-nancy/ Postpartum	Menstrua-tion	Extra-, pre-marital	Short birth interval	Twins	Mal-formed birth	Death of mother	Not practi-ced	Practiced	Not practi-ced
10th c.	Abul Hassan Ali ibn Husain Ali al-Masudi																												
15th c.	V. Da Gama																												
16th c.	B. Springer																												
	C. Houtman																												
17th Century	J. van Riebeeck																												
	W. Wintervogel																												
	J. Schreyer																												
	D. O. Dapper																												
	J. C. Hoffmann																												
	W. Ten Rhyne																												
	O. Bergh																												
	J. G. Grevenbroek																												
	S. Van der Stel																												
	I. Schrijver																												
18th Century	P. Kolb																												
	J. Coetsé Jansz																												
	A. Sparrman																												
	H. J. Wikar																												
	F. Le Vaillant																												
	W. van Reenen																												
	R. Percival																												
	J. Barrow																												
19th Century	D. G. van Reenen																												
	H. Lichtenstein																												
	J. Campbell																												
	T. Arbousset; F. Daumas																												
	G.W. Stow																												
	J. Chapman																												
	T. Baines																												
	G. T. Fritsch																												
	T. Hahn																												
	F. Bachman																												
	H. Schinz																												
	K. Barthel																												
	S. Passarge																												
	H. Vedder; A. Unterkötter																												
	S. S. Dornan																												
20th Century	F. Seiner																												
	H. Werner																												
	P. Trenk																												
	H. Kaufmann																												
	E. Seydel																												
	(Captain) Müller																												
	B. Zastrow																												
	A. W. Hoemlé																												
	J. H. Wilhelm																												
	L. Fourie																												
	Dorothea F. Bleek																												
	V. Lebzelter																												
	Oscar T. Crosby																												
	I. Schapera																												
	J. A. Engelbrecht																												
	F. Brownlee																												
	R. P. Ch. Estermann																												
	M. Gusinde																												
	L. Marshall																												
	R. B. Lee																												
	Biesele et ali.																												
	N. Howell																												
	C. Valiente-Noailles																												

Khoikhoi
Bantu
San

Social Norms among Khoisan: the pastoralists

The attribution of the social norm to the pastoralists follows in accordance to the specific designation in the ethnohistorical source (e.g. Griqua, Namaqua, Hessequa, Hottentot, Khoe, etc.). Additionally, any contextual information regarding their mode of subsistence was likewise taken into account. The accounts mainly give witness of populations inhabiting in the proximity of the Dutch and later English Colony. The majority of the Hottentots became part of the colonial population and was assimilated in other *ethnic* categories, such as "Mixed and Other Coloured" or "Coloured"[71] –for further details on the social norms and the quotations, I refer the reader to see annexes in 1 to 7.

Rites of passage

The rites of passage may be indicative of the transition from childhood into womanhood and manhood, and a stage in the life course that is understood as *marriageable*. The information regarding rites of passage or the end of puberty may be indicative of a plausible minimum age for marriage.

In this manner, among the herding groups, in the 17th century Schreyer ([1681] 1931) and Grevenbroek (Schapera & Farrington, [1695] 1933) mention the practice of a ceremony among boys, sometimes involving body mutilation (circumcision and castration of one testicle). Schreyer seems to imply that after the ceremony the man shall start finding a wife, but Grevebroek does not sufficiently clarify it. Unfortunately, I could not find or identify any ceremony associated to the transition of girls into womanhood (either the travellers did not have the opportunity to witness it, did not consider asking about it, or basically they did not have access due to their condition as male and strangers).

[71] Several censuses were conducted between 1865 and 2001 in South Africa. The censuses of 1865, 1875, 1891, and 1904 kept the term of Hottentot in their classification –a classification based on race. The following censuses, combined different peoples under the terms of Mixed and Other Coloured (Christopher, 2002).

The 18th century contains richer references for both girls and boys. Kolb (1738) does not specify the age to the ceremony, but Wikar (Mossop, [1779] 1935) and Le Vaillant (1790) do clearly connect the event they describe to the onset of menarche, which is also found in the 19th century in the description by Schinz (1891). In the case of boys, in the 18th century, Kolb (1738) says that it is necessary to go through castration before a man is allowed to marry. However, Sparrman (1789a) could not observe himself the practice of circumcision or castration, even though he was told that it was a common practice among boys at the age of 10 years. Wikar (Mossop, [1779] 1935) refers for the first time to the practice of the big hunt as necessary step prior to the attainment of manhood. By the turn to the 19th century, both Stow (1905) and Schinz (1897) assure that circumcision and castration are not practiced. Considering that these groups had domestic animals, only Schreyer ([1681]1931) mentions the sacrifice of cattle for the purpose of these ceremonies in the case of boys, and Schinz (1891) in the case of girls.

Despite the variability and the contradictions, it can certainly be said that among pastoralists existed a concept of transition into manhood and womanhood, with all the socioeconomic consequences attached to it.

Age at marriage

In the accounts of the 17th century, I could not find any reference regarding the age at marriage among girls, and the accounts of the two next centuries are not more precise. Sparrmann (1789a) indicates one particular case of a girl who at the age of 16-17 was not married yet. Only Schreyer ([1681]1931) seems to imply that a man shall marry after the rite of passage. In his description, he estimates the age of the participants in the ceremony to be between 18 and 20, estimation that agrees with Kolb's account (1738). On the overall, the little information about the age at marriage is imprecise. But, taking into account the transition from puberty into adulthood may sufficiently evidence that the first marriage took place at an early age –the majority of the writers do mention that a man initiates the search for a wife *once he becomes a man*. However, the minimum or average age of entrance to marriage among women is actually more important, because it is from women's fertility rate that it is possible to calculate the total fertility rate of a population.

Marriage

Across time, the different accounts point to heterogeneous pictures of the most common type of marriage practiced. This diversity could be the result of erroneous observations, but geographical variance may also take part in it.

Monogamy is only stated by Dapper (Schapera & Farrington, [1670] 1933) and Le Vaillant (1790). In his text, Dapper refers to one particular chief who was married exclusively to one wife, while at the same time he compares it with another chief who was married to many wives. Le Vaillant's statement is somehow coincident with Sparrman's (1789a), in the manner that polygamy is observed to rarely occur, also described by Lichtenstein ([1811] 1967). A different description of polygamy is associated to a specific social status the man holds: Ten Rhyne (Schapera & Farrington, [1686] 1933), Kolb (1738), and Wikar (Mossop, [1779] 1935) coincide in that polygamy is exclusive to wealthy (in cattle) men. The bride prices would have consisted of 2 to 3 oxen (Kolb, 1738), 2 milk cows specifically for the mother-in-law, and cattle (not quantified) for the father-in-law Wikar (Mossop, [1779] 1935). In addition to that, others explain that in the celebration of marriage they sacrificed several animals (sheep or oxen) in different numbers (Mossop/Wikar, [1779] 1935; Schapera & Farrington/Dapper, [1670] 1933; Schapera & Farrington/Grevenbroek, [1695] 1933). This bride price also coincides with that given by Schreyer ([1681] 1931), who states that polygamous marriages are common, with an average of 2 to 3 wives. Grevenbroek (Schapera & Farrington, [1695] 1933) also describes polygamy to be usual, but he does not specify the exact number of women a man would marry. Wikar (Mossop, [1779] 1935) also connects polygamy as a result of warfare, in which case the victorious would capture cattle and women. Finally, in the 19th century, Chapman (1868) still describes the pastoralists to be mostly polygamous, while Schinz (1891) and Hoernlé (1925) indicate that the practice is dying out.

In the same manner, the age at marriage is relevant to indicate one plausible starting point to the exposure to conception, the duration of the marriage is also relevant. The eventuality of a separation to happen, and the time between the separation and the next marriage become both factors that exclude women from the reproduction engine. In this manner, Ten Rhyne (Schapera & Farrington, [1686] 1933) and Grevenbroek (Schapera & Farrington, 1933 [1695]) indicate that

it is more common for a husband to divorce his wife, while Kolb (1738) and Le Vaillant (1790) indicates that a separation usually results from mutual agreement. These four accounts do not make it sufficiently clear which are the circumstances around a separation –Grevenbroek does mention that a man would divorce his wife is she is bad beyond reformation. It is widely known the submissive position to which women are put in many societies, that it would not be entirely wrong to assume it was the also case among these groups.

The possibility to marry again after widowhood or after separation is attested by different travellers. Dapper (Schapera & Farrington, [1670] 1933), Hoffmann ([1680] 1931) and Ten Rhyne (Schapera & Farrington, [1686] 1933) explain that a woman who shows a specific amputation on one or more fingers is indicative that she is widow or that she remarried. Kolb (1738) is the only one to explain that a woman cannot remarry as long as her first husband is still living –requirement that does not apply in the case of separated men. Wikar (Mossop, [1779] 1935) and Le Vaillant (1790) describe that it is possible to marry again, but they do not make precise the circumstances around. Solely Wikar mentions the common practice of levirate. In the 19th century, there is not a single account where I could find a reference regarding divorce or remarriage, with the exception of Baines (1864), who leaves a short reference on the case of one widow.

Child birth intervals

The entrance and duration of marriage are not the only variables to play in the reproduction engine. The period in-between every pregnancy and every child born also shape the reproductive potential capacity of women. In this manner, I tried to identify the different references to the number of children the observers see in each family, or the number of children for every woman. Some of the travellers express the difference of age between siblings, or point to the length (months or years) between every birth. Alternatively, the traveller may point to the duration of breastfeeding or the observed age at which the child when is weaned.

The type of information is not only scarce, but also different from writer to writer. Schreyer ([1681] 1931) comments that he observed around 4 children in every family. This statement is

conflictive, because he also explains polygamy to be common, and consequently it is unclear whether he describes around "4 children for every woman" or "4 children for every family including more than one wife". Bachman (1899) and Schinz (1891) make it clear that breastfeeding lasts from 2 to 4 years, even though the next child may be born when the previous is still being nursed. Nevertheless, I assume that the prolongation of breastfeeding is a significant evidence of intentional long birth-spacing. Only Kolb (1738) explains that children are weaned at the 6th month after birth, which would imply that children follow one to another close in birth, –which however is contradictory with the previous accounts referred.

The length of the period in-between pregnancies or children born may be also correlated to the periods of intentional sexual abstinence. Dapper (Schapera & Farrington, [1670] 1933) and Grevenbroek (Schapera & Farrington, [1695] 1933) explain that pre-marital intercourse is looked upon as wrong, which emphasizes my assumption that children are only legitimate if born within marriage[72]. Kolb (1738) coincides in these terms, mentioning that a boy who has not gone through the rite of passage cannot have sexual intercourse with a woman. In the account by Le Vaillant (1790), pubescent girls cannot have sexual intercourse with men. Kolb (1738) gives further information on celibacy, he explains that a husband would abstain from having sexual intercourse with his wife when she is menstruating, and probably after she gave birth. It seems then that pre-marital relations are condemned, but Sparrman (1789b) explains that it is not a scandal for a man and woman, who are not married, to partake into sexual relations.

Finally, another measure of intentional fertility regulation is infanticide or induced abortion. Such practices may understandably be more difficult for the early explorers to recognise, observe, or obtain any information. It is nevertheless surprising that male strangers collected some information regarding woman's affairs, with more or less bias –especially when considering that even the men belonging to the group were not allowed to take part in certain female events, such as menstruation rites, birth delivery, etc. Several of the travellers explain that intentional infanticide was common in the case of twins (Kolb, 1738; Le Vaillant, 1790; Schapera & Farrington/Grevenbroek, [1695] 1933; Schapera & Farrington/Ten Rhyne, [1686] 1933; Schreyer, [1681] 1931) or in the case the mother died shortly after giving birth (Le Vaillant, 1790; Schapera & Farrington/Grevenbroek, [1695] 1933; Schreyer, [1681] 1931;

[72] In case a woman became pregnant before marriage, it was expected the father of the child to marry the woman.

Sparrman, 1789a). Contradictorily, Le Vaillant also explains that infanticide is not a generalized practice, and he further adds that people would not be pleased when asked about such practice.

Social Norms among Khoisan: the foragers

Specially starting in the 18th-19th centuries, I found the first accounts in which there was a sharp distinction between pastoralists and foragers. The growing interest to study the hunters has left accounts that comprise regions from present-day Namibia, south of Botswana and the Kalahari. The information available on aspects related to the social behaviour around reproduction is larger, but this does not save from the discrepancies and contradictions between the different authors –for further details on the social norms and the quotations, I refer the reader to see annexes in 1 to 7.

Rites of passage

I found several descriptions of ceremonies or particular events in the proximities of puberty for both girls and boys. Baines (1864) indicates that there is a ceremony takes place when the girls are 12 to 14 years old, in which they are instructed to what will be their responsibilities in adulthood. Even though he does not mention it is directly related to the onset of menarche, the age does seem to imply it is, as described later by Passarge (1907). The observation that menarche marks a process of transition remains unchanged in the 20th century (Fourie, 1926; Guenther/Kaufmann, [1910] 2005; Guenther/Wilhelm, [1954] 2005; Gusinde, 1966; Lebzelter, 1934; Marshall, 1959; Valiente-Noailles, 1993). In the case of boys, Arbousset and Daumas (1842) and Baines (1864) briefly refer to the practice of circumcision, the former particularly mentions that this practice is more common among those groups who live closer to the Caffres and Bantu settlements. On the other side Passarge (1907) explains that there is a ceremony in which a boy enters manhood, which coincides with the concept of instruction delivered by Kaufmann (Guenther, [1910] 2005) and Wilhelm (Guenther, [1954] 2005). Lebzelter (1934), Gusinde (1966) and Valiente-Noailles (1993) described the boys' rite simply as a ceremony that

takes place around puberty. Only Werner (1906) explains that circumcision is not practiced, but it is unclear if he is implying that there is not any ceremony related to both the transition into womanhood and manhood. Howell (2010) differently indicates that the transition into manhood is mostly defined after the boy hunts his first big game.

In the same manner as seen among the pastoralists, there is a clear transformation of the socioeconomic position of the individuals when they are incorporated among the adults. Simultaneously, the timing of the rite or ceremony is taken as an additional reference that indicates a plausible minimum age at the first of marriage.

Age at marriage

The majority of the accounts agree that girls marry at an early age, between 12 and 16 (Arbousset & Daumas, 1842; Guenther/Kaufmann, [1910] 2005; Guenther/Wilhelm, [1954] 2005; Lebzelter, 1934; Lee, 1993; Valiente-Noailles, 1933). Others express it in terms of "a girl shall marry after the puberty ceremony" (Baines, 1864; Guenther/Trenk, [1910] 2005; Marshall, 1959; Passarge, 1907). In comparison to these, some travellers have seen pre-pubescent girls already married (Lebzelter, 1934; Marshall, 1959). Lee (1993) notes that by 1960s and 1970s the age at marriage is delayed to 15-18, coinciding with Howell's observations (2010).

Howell's demographic study on the inhabitant of the Dobe area follows a very systematic analysis. She argues about the difficulties to estimate the age of the people according to their physical appearance, and because of that she follows relative methods to estimate people's age. Howell describes them as «small and slightly built people, characteristically, with the type of facial features called pedomorphic (childlike). They live healthy outdoor life, free of the aging effects of obesity and the stress and strains of modern society, so that they might appear to us to be much younger than they actually are (Howell, 2010: 23) ». In contrast, she refers Silberbauer's statement, officer of the Bechuanaland Government, who suggested that because of the hardships of their life and their diet, the drying effects of the sun and wind, the foragers look older than they really are.

The same issue to estimate the age applies to the boys. Arbousset and Daumas (1842) insist that they marry early, between 13 and 15, and Passarge (1907) indicates that they are fit for marriage after the ceremony into manhood. The descriptions of the 20th century point to an age at first marriage between 12 and 18 (Guenther/Kaufmann, [1910] 2005; Guenther/Wilhelm, [1954] 2005); Lebzelter, 1934; Marshall, 1959; Seydel, 1910; Valiente-Noailles, 1933). Trenk (Guenther, [1910] 2005) explains they marry after the onset of puberty –therefore, at an early age. Only Lee (1993) and Howell (2010) establish a later age at marriage, between 18 and 30 years old.

It may be possible that the extreme differences between the estimated age at marriage (very early, very late) respond to a transformation attested diachronically. However, the pending question on the reliability of the estimated age according to the physical appearance does not validate better one or other.

Marriage

On this matter, there appears to be a great diversity of conditions, which may respond to distance in chronology, but perhaps also to geographical variation. The impact of the relationship with other groups (farmers, pastoralists or colonialists) may be responsible to some extent of the transformation of the marriage system. For example, Stow (1905) explains that "some" groups are monogamous, and "other" groups can be polygamous –having as many wives as they can. This is the same case obtained from the accounts by Lee (1993) and Kaufmann (Guenther, [1910] 2005). Others authors point out monogamy to be an established rule (Guenther/Trenk, [1910] 2005; Guenther/Wilhelm, [1954] 2005; Gusinde, 1966; Lebzelter, 1934).

Arbousset and Daumas (1842), Gusinde (1966), Lee (1993) and Valiente-Noailles (1993) describe polygamy to rarely happen. Expressed differently, Wilehlm (Guenther, [1954] 2005) explains that polygamy may be the result of a sororate union which, he adds, seldom happens. Lebzelter (1934) specifies that a man must first obtain the approval of his first wife to be allowed to marry a second wife. Finally, Howell (2010) comments that polygamous marriage is not preferred.

In contrast, there are many accounts that describe polygamous marriages to be usual and widely spread. This polygamy consisted of a man marrying on average 2 wives (Barrow, 1801; Fourie, 1926; Lebzelter, 1934; Marshall, 1959), Campbell (1823) counts up to 4 or 5 wives, Passarge (1907) between 3 and 4, Kaufmann (Guenther, [1910] 2005) indicates they usually marry 2, but he has also seen husbands with 5 wives. Other accounts also establish polygamy to be usual, but they do not specify the number of wives (Chapman, 1868; Lee, 1993; Stow, 1905; Vadder and Unterköter, 1937).

Seydel (1910) is the only case that mentions polyandry and, therefore, it is difficult to assess the reliability of his observation on this matter.

On a different side, Stow (1905) and Dornan (1925) additionally explain that polygamy may be only possible to middle-aged men or to strong men –hence, it may be possible that certain social factors condition the feasibility. Completely different is the conclusion by Lee (1993), who explains that the few polygamists he met were all healers, this is, men who had a very specific and maybe even hierarchical role within the group.

In addition to the type of marriage, several travellers and scientists observe the practice of separation and remarriage under different circumstances and applied to different situations. Three completely different and short descriptions are given in the 19th regarding divorce: Lichteinstein ([1811]1967) explains that husband and wife have the choice to divorce and join another band, Stow (1905) specifies that the husband has the choice to divorce, and Vedder and Unterkötter (1937) comment on one particular interview with a man who said that a husband should not divorce his wife. During the 20th century, it is mentioned that quarrels or adultery can be the reasons causing the divorce (Guenther/Trenk, [1910] 2005; Guenther/Wilhelm, [1954] 2005; Howell, 2000; Seydel, 1910). Lee (1993) explains that divorce is possible, and Kaufmann (Guenther, [1910] 2005) adds that it rarely happens. Lebzelter (1934) explains that divorce is only possible before the first child is born, while Marshall (1959) refers it to be the result of mutual consent. Valiente-Noailles (1993) explains the divorce is the consequence of the failure of a man and woman fulfilling their duties as husband and wife. Fourie (1926) vaguely mentions that divorce results from different circumstances. Gusinde (1966) incorporates a chronological perspective explaining that previously it was not possible, in comparison to the time he did

observed it. Therefore, it appears that the end of a marriage is highly possible, but it is not clear whether it was from mutual consent or decided only by the husbands.

In the same statement by Lichtenstein ([1811] 1967), it seems it was not complicated to join another band after leaving the previous, which would include the plausible event of a remarriage. Differently are the circumstances of remarriage described by Arbousset and Daumas (1842) and Vedder and Unterköter (1937), both accounts mention that it mostly consists of a post-widowhood event. In the 20th century additional details around remarriage appear, for example, remarriage is easier and less complicated after separation (Guenther/Trenk, [1910] 2005), however Kaufmann (Guenther, [1910] 2005) indicates that divorced woman a remain unmarried for certain length of time. This delay of remarriage is also referred in other accounts Wilhelm (Guenther, [1954] 2005) says that only widows and widowers have to wait some time before marrying again. Howell (2000) and Marshall (1959) coincide in that only widows remarry slower than divorced or widowers. Furthermore, in several cases the practice of remarriage is connected to the practice of levirate (Lebzelter, 1934) and sororate (Lebzelter, 1934; Lee, 1993).

Child birth intervals

The information available regarding birth spacing or age at weaning is diverse, but in any case converging to similar results. On the one hand, Campbell (1823) describes a family with 8 children, the details about whether they belonged to the same mother and, if so, how old was the mother are missing. A priori, it would seem that the interval between births is low. Dornan (1925) explains that there are 3 to 4 children per family, indicating long birth spacing. Stow (1905) describes one particular family within which two different situations are given. The family Stow describes consists of three siblings, one is 12, the other is 11 years old, and the last one is 18 months old. The two older brothers give an example in which birth spacing was 1 year or less, while the new-born is at least 9 years apart from the older siblings. Clearly, it is unknown whether this long inter-birth spacing was intentioned, or whether the mother had miscarriages in between, or if the father was absent for some time (e.g. working at a cattle post).

In the 20th century, only Valiente-Noailles (1993) refers to the possibility that children may be born every year to the same mother. On the other side, the majority of the accounts seem to agree that the interval between children born is greater than 1 year: born 2 years apart (Guenther/Wilhelm, [1954] 2005), at least 3 years (Vedder & Unterköter, 1937; Howell, 2010), between 2 and 3 years (Guenther/Kaufmann, [1910] 2005), 4 years (Lee, 1979), sometimes even 5 years (Marshall, 1960).

The majority of accounts seem to also agree that breastfeeding was prolonged. Passarge (1907) describes it to last "until the child is grown", similarly to Fourie (1926) who expresses it in terms of "until the child is able to walk" –both cases are implying at least 2 years breastfeeding. Others are more clear, and explain that children are nursed until the age of 2 (Lebzelter, 1934), the age of 3 (Guenther/Kaufmann, [1910] 2005; Guenther/Wilhelm, [1954] 2005), between 2 and 3 years of age (Lee, 1979; Valiente-Noailles, 1993). Marshall (1960) and Howell (2010) describe longer breastfeeding, between 4 and 5 years.

Sexual abstinence is an aspect complicated to document or to understand, which may explain the lack of information in the accounts –and when it is referred, it is vaguely described. Wilhelm (Guenther, [1954] 2005) and Lebzelter (1934) both indicate that after pregnancy a man should abstain from sexual intercourse with his wife, for one year or "until the child can sit". Premarital sexual intercourse is looked upon as wrong but it is often indulged as described by Dornan (1925). Kaufmann (Guenther, [1910] 2005) explains that premarital sexual intercourse hardly occurs, to what Trenk (Guenther, [1910] 2005) adds that it is a consequence of marriage at an early age. Under the observations by Lebzelter (1934), premarital sexual intercourse is strongly prohibited, whereas Marshall (1960) and Lee (1993) explain that the concept of virginity is meaningless.

As a last point to review, the practice of infanticide seems to be very limited. If practiced, the main reasons behind seem to be a short birth interval between children (Guenther/Kaufmann, [1910] 2005; Passarge, 1907; Vedder & Unterköter, 1937), the birth of twins (Dornan, 1925; Guenther/Kaufmann, [1910] 2005; Guenther/Wilhelm, [1954] 2005; Lebzelter, 1934), the child is ill-shaped (Dornan, 1925; Schinz, 1891; Stow, 1905), or the mother died shortly after giving birth (Guenther/Wilhelm, [1954] 2005; Passarge, 1907). In the case of short birth interval, Wilhlem (Guenther, [1954] 2005) adds that infanticide is practiced in case there is lack of food;

and in the case of ill-shaped children, he explains that he has rarely seen crippled people – perhaps pointing to some plausible selection of fit children when they are born. Howell (2010) explains how Bantu women took the child of a Bushman woman who was about to smother it because it had six toes. Very differently, Vedder and Unterköter (1937) explain that polygamous marriages may save the child's live because the other wife can take care of it in case its own mother could not –partially coincident with Howell's (2010) account. In absolute opposition, both Trenk (Guenther, [1910] 2005) and Fourie (1926) indicate that child murder is not practiced; whereas Lebzelter (1934) points to regional variation.

Regarding the practice of abortion, it appears it has been hardly identified and the observers fail to ask about it. Passarge (1907) explains that the people seem to know some sort of abortive drugs –the question to add to this is what their actual effects are. However, his statement comes into complete contradiction with those by Fourie (1926), Lebzelter (1934) and Valiente-Noailles (1993), who say clearly that abortion does not exist.

Patterns of the social norms

In short, the qualitative (and when possible quantitative) information required for the current thesis is very fragmentary. There appears to be a general and homogeneous description of the different, in my understanding, significant social norms involved in reproduction, but sometimes the information contains discrepancies which may be due to different reasons: the accurate perception of the observer (age estimation of the peoples), the understanding of the event (monogamous or polygamous marriages), and also the possibility to obtain the information when asking the people.

A grosso modo, there seems to be a general tendency regarding the organization of reproduction regardless of the group. Unfortunately, there is little information in the early reports about the age at marriage among pastoralists, but it appears that diachronically the age at first marriage increases. Consequently, the shift from a first marriage shortly after the onset of menarche (at a maximum of 16 years of age) to a late marriage at 18 could respond to a transformation of the norms and not necessarily to the inexperienced eye of the observer in estimating the age. The

observation stating that in the 20th century men would marry between 22 and 30 years of age may respond to a transformation of their subsistence –labour at cattle posts, farms, etc.

Regarding the character of the marriage, whether monogamous or polygamous, across both groups and diachronically, there appears to be the same type of picture. On the one hand, polygamy seems to be a common practice, with an average of two wives per husband, while at the same time some cases are associated to specific circumstances (wealth, levirate). The synchronism between monogamous groups and polygamous groups may be due to geographical variation or biased observations. Surprisingly, polygamous marriage could be compounded to up to 4 or 5 wives, especially noted by the 19th and 20th centuries.

Divorce and remarriage are scarcely represented and referred in the written sources. In any case, both are possible, even though they may respond to different circumstances. The common aspect on this matter is that sometimes a divorced or widowed woman may have more difficulties to remarry, because additional restrictive norms apply only to women.

The length of the interval period between births is likewise similar. On average, there are 2 years between births, and breastfeeding is prolonged between 2 to 3 years. The shortest period noticed would be of one year, while the longest is at least 4 years. Lastly, infanticide seems to be limited among pastoralists and mostly referred in circumstances involving the birth of twins or the death of the mother shortly after giving birth. Differently, among the foragers infanticide includes additional circumstances in which it may be applied. Diachronically, it seems that by the turn to the 19th and especially to the 20th, the practice of infanticide decreases.

Altogether, these different social norms and their different intensities within the variability will be applied in the simulation exercises, in order to assess the different plausible outcomes and their actual effect on the control of demographic growth. Under the concept of different intensities, I refer to the two main extremes of each norm. In the simulation program the same biological population will be subjected to the *minimum* and *maximum* restrictive expression of every social norm–this will be further discussed in the following chapter 7.

7.- Simulation and modelling

In a step previous to the experimental exercises it is important to first prepare the necessary data to be included into the simulation environments. In this chapter I refer to the procedure followed in order to develop an artificial community that will serve for the simulations. I create a population over which the social norms will be applied. This population cannot be taken from any existing case of a human population. It is highly important that the population structure follows the general pattern observed among many of the HFGS societies. Considering that there are a few ethnographic and demographic studies, I decided to take the Dobe !kung, as a reference in order to organize the distribution of the people according to age and sex. Furthermore, from the same existing studies I count with information on household size, and finally the number of households forming the different camps.

Unfortunately, in the case of the pastoralists I do not count with studies which are as precise as those on the Dobe !kung. In the late 19th century, several censuses were conducted in the colony of South Africa, in which the category of "Hottentot" (former pastoralists) is also included. From these censuses I attempt to extract the main information on the composition of the population of former pastoralists (age distribution and sex ratio). However, there is not information regarding the household composition nor to the distribution of the households in camps. Furthermore, there is clearly a different pattern of the population structure when comparing the data of the former pastoralist in the urban and in the rural settlements. In the end, the migration and incorporation of this population into the colony responds to a particular labour market and, therefore, the social organization undergoes to some transformations.

Finally, I decided to use the same artificial community resulting from the demographic profile of the Dobe !kung for the simulation of the environments of the pastoralists. In a manner, this will facilitate the comparison of the demographic development of both groups, in accordance to their specific social organization of the relations of men and women and, by extension, of reproduction.

Creating a population

In the ethnohistorical accounts, the manner in which the size of the population is described varies. Regarding the mostly hunter-gatherers, Barrow (1810) mentions he observed a *horde* of about 150 people, distributed in 5 to 20 huts, and another numbering about 500. Kaufmann (Guenther, [1910] 2005) explains that in the dry season the composition of a kraal included 2 to 3 families, while in the abundance there can be up to 30 families. Other authors give a vague idea of the amount of people within regions or veld: 300 in Kaukauveld according to Müller (Guenther, [1912] 2005), 400 in the district Maltahöhe in the Namib as by Seydel (1910), and several thousand according to Dapper (Schapera & Farrington, [1689] 1933). Passarge (1907) established a quantification separating several groups, which they all numbered between 100 and 500.

Regarding the mostly pastoralists, Dapper (Schapera & Farrington, [1689] 1933) gives the following numbers for different groups: the Gouringhaiquas had about 1000 men "capable of bearing arms", there were between 15 to 16 kraals inhabited by Kochoquas, numbering some 450 huts (from 30 to 50 huts per kraal), and the Chainouquas numbered 400 in total. Sparrman (1789a) witnessed groups ranging between 20 and 40 people, Kolb (1738) counts between 100 and 500 near the Cape Colony, distributed in 10 to 12 families per kraal, and one family per hut; Seiner (1909) also refers to the size in a few hundreds.

This information present in the ethnohistorical accounts, far from being irrelevant, does not serve me for the purpose of simulating demography. I do not require the exact number of peoples in southern Africa, but I actually require precise information on the age and sex composition, which unfortunately is not present in the ethnohistorical sources. Only in the ethnographic studies from the 1960s and 1970s I find the first demographic data systematically collected about one particular group (the Dobe !kung). From these ethnographic and demographic studies it is possible to develop the artificial community that I will incorporate in the simulation program. Unfortunately, in the case of the pastoralists, there is barely any detailed information that can be used to develop their specific virtual community. The pastoralists, labelled as Hottentot appear in the censuses of the colony of South Africa, starting in the 1865 until 1904 –in the censuses following, they are included within the category of "Mixed & Other Coloured" which also

integrated other segments of population such as the Fingo (Bantu). Due to this, it is decided to use the same artificial community (the one based on the Dobe !kung data) for all experimental exercises, and only the norms will be adapted accordingly to the group they are referred to.

Artificial community I

Nancy Howell conducted a detailed and extensive demographic study of the Dobe !Kung (2000), following up Richard B. Lee's research in the 1960s (1979). They both had different methodologies to study the demographic profile of the population. Naturally, this data refers to a particular group inhabiting a particular region at a particular historical moment. The purpose here is not to extrapolate this population structure, but use it as a starting point for the elaboration of the artificial community –assuming the population structure of the Dobe Kung! falls within the range of a typical pyramidal structure of a hunting-fishing-gathering society[73].

The demographic data of the population of the Dobe !kung varied between 1964 and 1973, especially because the researchers accumulated a better knowledge of the inhabitants and implemented the quantitative methods in their studies. In any case, one of the main issues in these studies concerns the accurate estimation of the age of the people, for which Howell (2000) decided to apply the procedure Frederick G. G. Rose developed in the 1960s, consisting of a systematic use of the knowledge of the relative age of the individuals from which to elaborate a reliable age ranking. In this manner, Howell interviewed the inhabitants of Dobe (particularly, 244 female residents) and obtained a sequence of 841 cards ranked from the youngest to the oldest person, whose plausible birthday was placed on a timeline. The resulting distribution is as shown in Fig.13, in which only the residents are displayed, presenting then a typical pyramidal shape. Howell clarifies that the distribution of men is more irregular compared to the women's distribution, partly because Howell starts estimating the age from adult female residents in 1968

[73] Previously in chapter 3, I discussed Weiss and Wobst's work in the 1970s, where they analysed all available data regarding population size in the ethnographies, in order to conclude what would be the minimum size of a group to guarantee its survival over several generations in the Pleistocene: 25 members per group, which he further explains may compound a larger network of 61 groups.

(n=244), which the method artificially spaced out over the age groups, and partly because men more often migrate into and out of the area.

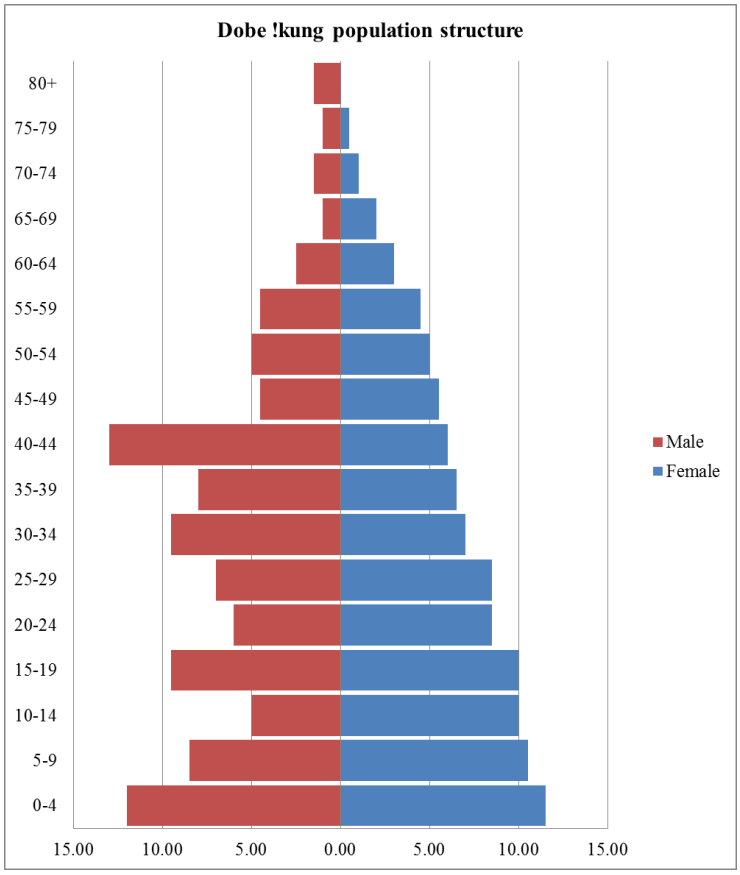


Figure 13. Population distribution within sex categories, according to following Howell's data (2000).

Howell (2000) does not provide the percentages of the distribution of age for men and women within the total population, but within sexes. Consequently, from her study there is not a clear statement in which she indicates which is the specific sex ratio and hence the specific age-sex composition of the population. It is know she is studying the reproductive life history of 244 women, but the number of girls under the age of 13-14 is not mentioned –the numbering of men is less present. Lee (1979) does offer a closer view to the age and sex composition, from a population whose size was counted in 1964 (n=379), 1968 (n=457) and 1973 (n=457). Lee distributes women and men in three age categories: young (between 0 and 14 years old), adult (between 15-59) and old (above 60).

Considering Howell's data corresponds to the population in 1968, I decided to use Lee's estimation of the population in 1968 as well (Fig. 14).

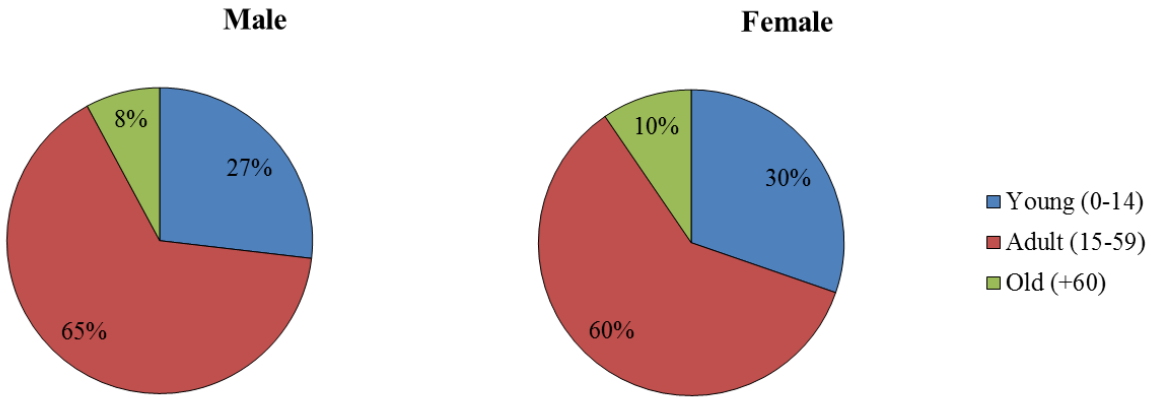


Figure 14. Distribution of the population within sex in 1968, according to age following Lee (1979)

According to Lee (1979), in 1968, from a total population of 457, 216 were male and 241 were female. I take into account this sex ratio and the age-sex composition from Lee's census in order to also re-distribute Howell's population composition according to sex, and further developing the artificial community. I take into account the distribution of people according to the three age categories and sex ratio from Lee, but using Howell's data (2000). The result presents a slightly different distribution of ages within sex categories (Fig. 15), but they are very close and, therefore, can be taken as reliable.

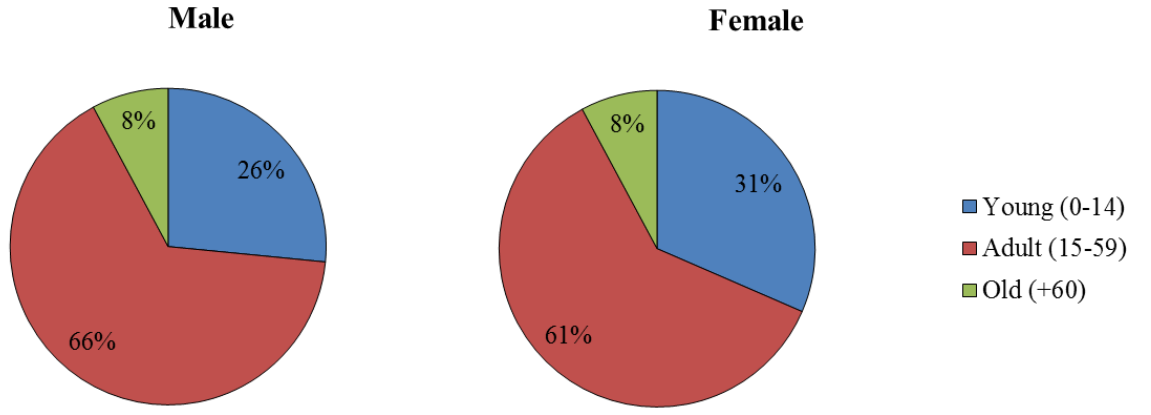


Figure 15. Distribution of the population within sex in 1968, according to age following Howell's data (2000).

The next step consisted in to spread these age clusters into age-cohort categories, and later into specific age, in order to generate an artificial community whose agents (individuals) have a specific sex and age. Lee's (1979) data are calculated from a population with the size of 457, while Howell's (2000) measured a population of 574. Despite the difference of the population samples they worked with (probably resulting from their fieldwork methodology and focus), the percentages of the distributions are still relevant and can be used to organize the artificial community. Lee's (1979) data indicates a total sex ratio of 47,26% male and 52,74% female. Taking into account these percentages, Howell's population, which has a size of 574, would then present 271 males and 303 females. Recovering the percentage distribution within the three age categories, the total population is distributed as shown in Table 4.

Table 4. Distribution (absolute numbers) of Howell's population (2000), following the sex ratio and the 3-age categories from Lee's (1979)

Age category	Absolute number		Sex ratio	
	Male	Female	Male	Female
Young	72	95	43.11	56.89
Adult	178	184	49.17	50.83
Old	21	24	46.67	53.33

On the overall, the resulting outcome seems to be respecting Howell's own age distribution (Howell, 2000) and the sex ratio calculated by Lee (1979). Because Howell's does provide specific age distribution within sex, it is then possible to spread the absolute number from the 3-age categories into the different cohorts (Fig. 16).

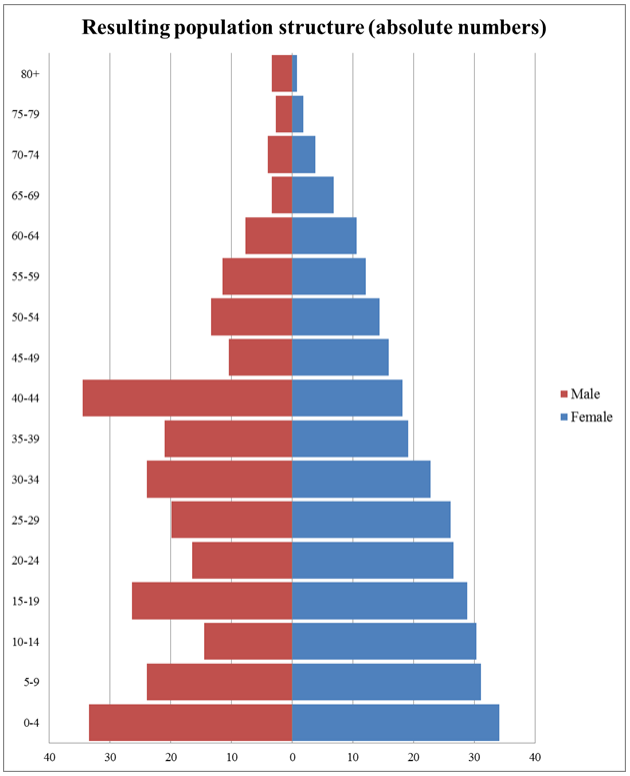


Figure 16. Population distribution within sex, in age cohorts following Howell's demographic data (2000), and partly based on Lee's demographic statistics (1979**).**

The multi-agent based program is composed of multiple and interacting agents. In the current case study, the agents equal to individuals of the entire population. In consequence, it is important not only to turn the percentage scales into numerical distributions, but also to distribute the individuals into household groups and camps or villages. Howell's analysis considers the distribution of the people according to age, household and finally village. During her fieldwork, she identified 34 villages that contained a total of 227 households, in which a total of 574 people lived in. She distributed the people according to their age (by cohort) and size of household (Howell, 2000:44-45). The results showed that the composition of a village was normally of 4 households and at least 10 inhabitants. The average composition consisted of 20 members per village, distributed between 6 to 8 households.

Howell (2000) explains that several households lived in close relation to Bantu families, which I decided to exclude from the preparation of the artificial community –in total, 19 households, containing 45 people were excluded. After filtering, the sample had a size of 529 individuals (249 men and 280 women) (Fig. 17), distributed in 22 villages, and 208 households.

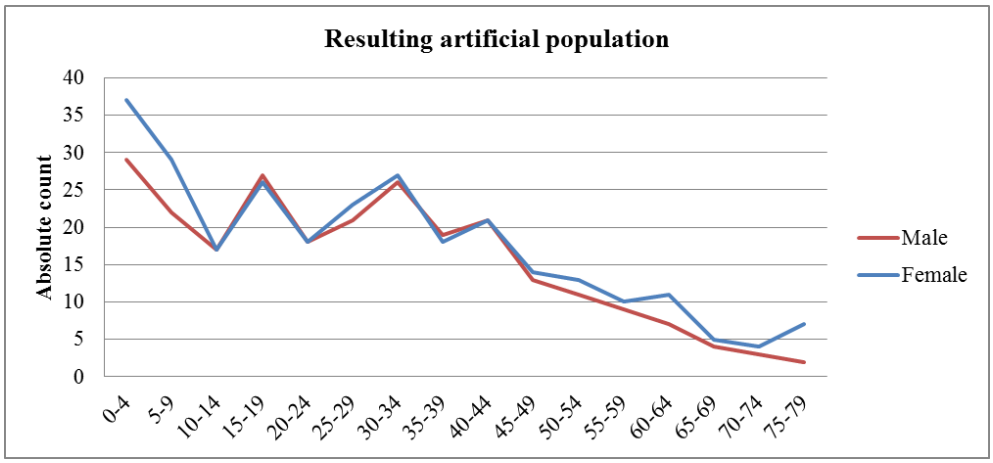


Figure 17. Population structure, respecting the sex ratio following Lee (1979) and the age structure following Howell (2000). In total, 529 people, 249 men and 280 women.

The simulation program requires a specific age attributed to every agent, because of this the age-cohort distribution had to be spread into specific ages from 0 to 80 –in all cases, respecting the distribution specified for every cohort and the sex ratio. Unfortunately, Howell does not provide the specific age of the population, but she does include a table in which she organizes the population according to two variables: age-cohort and the number of members in the household. From these, I do know the exact age-cohort in the households of one member only, as well as in the two single cases of households of 7 and 9 members. However, for the remaining population and household composition, this information is clustered in larger groups, see for example Fig. 18.

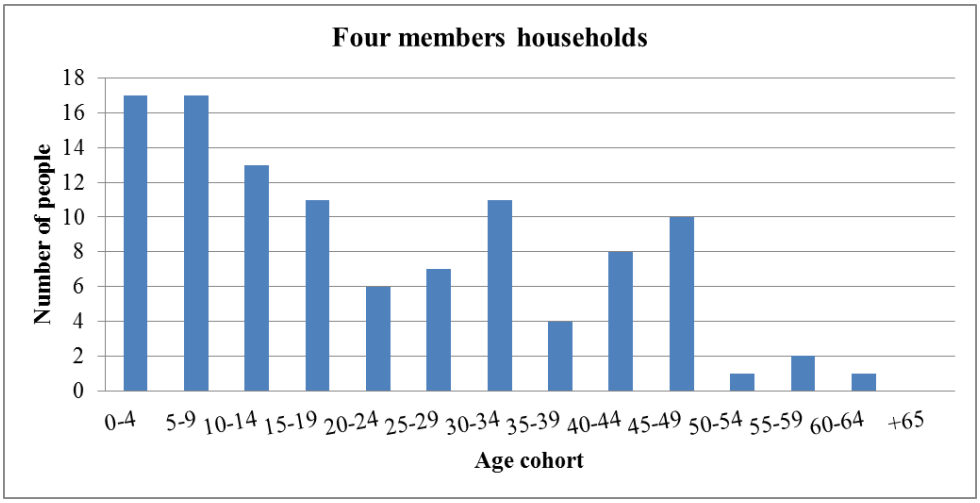


Figure 18. Number of people in every age-cohort who are members of households of 4 members, following Howell (2000).

In this particular case, there are 27 households composed by 4 members each, whose age-cohort distribution is as shown in Fig.18. The missing information is the exact belongingness of each member. This issue repeats for the households compound by 2, 3, 4, 5, 6 and 8 members. As a plausible solution, I distributed the individuals following a random probability for the individuals in every cohort to be of a specific age and household –respecting the data available on sex ratio, age cohort and household compositions. Finally, from the total resulting population composition, I excluded those households, that lived in close association with the Bantu[74]. After this, the percentages slightly changed (Table 5 and Fig. 19), but these have an insignificant impact on the demographic structure and, therefore, the resulting population distribution by sex and specific age is reliable and may be used for the simulations.

Table 5. Distribution of the population according to the 3-age categories and within sex; including the percentage of every age category within sex, and the sex ratio in every age category

Age category	Absolute number		Percentage within sex		Sex ratio	
	Male	Female	Male	Female	Male	Female
Young	68	83	27.31	29.64	45.03	54.97
Adult	165	170	66.27	60.71	49.25	50.75
Old	16	27	6.43	9.64	37.21	62.79

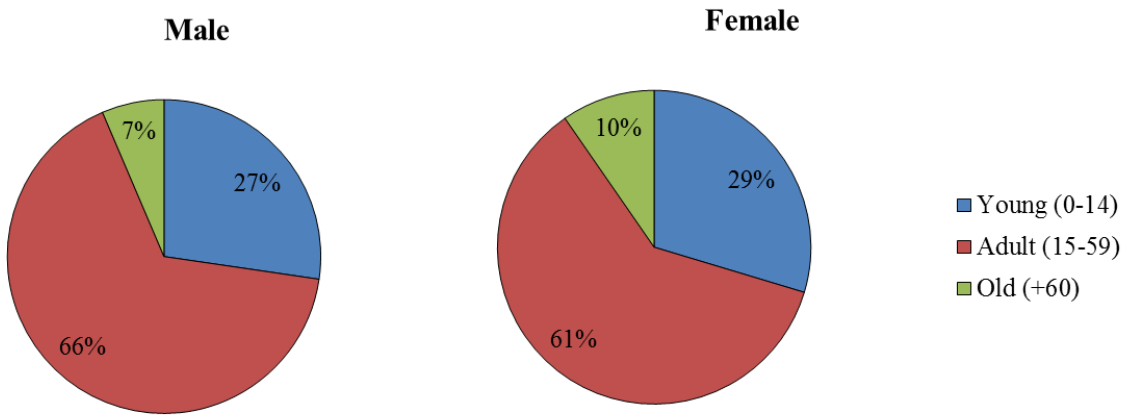


Figure 19. Proportion of people in every age category, after reorganizing the population with a size of 529, from which 249 are male and 280 are female.

[74] Eight households of 1 member, five households of 2 members, one household of 3 members, two households of 4 members, two households of 5 members and one household of 6 members.

Artificial community II

In the case of the pastoralists, as mentioned previously, I do not count with a demographic study, but mainly on population censuses from the late 19th and early 20th centuries. The accuracy of these censuses is very arguable. The methods used for the collection of the profiles of the population are unclear. It appears to be obvious that the categorization of people depended mostly on religion and ethnicity. In the censuses of 1865, 1875, 1891 and 1904 the former pastoralists are classified in a category labelled as "Hottentot/Kaffir". Later in 1911, 1921, 1936 and 1946, both these would be merged into a larger category of "Mixed & Other Coloured", and since 1951 into the category of "Coloured" (Christopher, 2002; Sáenz *et al.,* 2015). Independently of the degree of accuracy of these censuses, in some censuses the individuals ageing between 0 and 14 are all merged into the category of "under age 15", while at the same time there are many other individuals whose age could not be estimated and therefore were simply put into the category of "unspecified". Finally, life expectancy of the people is pulled to rather unrealistic values, several individuals are older than 110 years of age, independently of their group category.

In the census that include separated tables for rural and urban areas, the population of formerly pastoralists integrated in the rural and in the urban areas show different demographic characteristics, resulting from the character of the inclusion into the rural and into the urban areas (Results of census of the Colony of Cape of Good Hope in 1877 and 1891). I shall mention below a few of these demographic characteristics.

Following the census from 1891, one of the two lasts censuses in which the former pastoralists or Hottentots remain as an independent demographic category, the population distribution in the rural and urban areas present differentiated demographic structures, see Fig. 20 and Fig. 21.

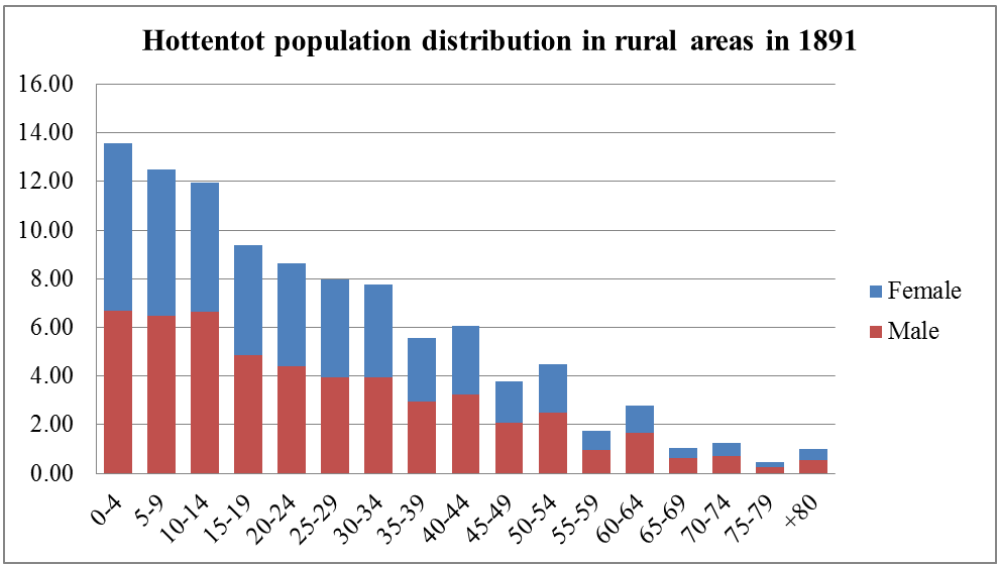


Figure 20. Population distribution in rural areas, according to age and sex, following the census from the Cape of Good Hope Colony in 1891.

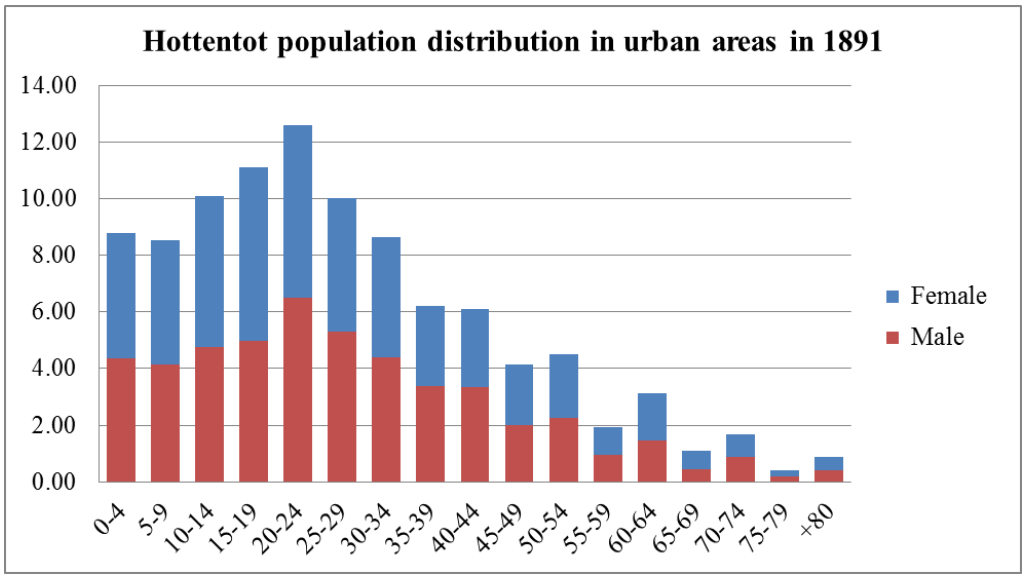


Figure 21. Population distribution in urban areas, according to age and sex, following the census from the Cape of Good Hope Colony in 1891.

Hoping that the error deviation in the censuses is small, in the Fig. 21, the decrease in the cohorts younger than 15 years of age may point to lower fertility rates in urban areas, while at the same time the increase of the cohorts between ages 20 and 34 may respond to the labour market available in the colony, although quantitatively there were more Hottentot living in the rural areas (n= 42089) than in the urban areas (n= 8299). The sex ratio shows that there are more

female than male in the urban areas, 49,80 % and 50,20% respectively, while in the rural areas male represent the 52,54% and the female the 47,46%.

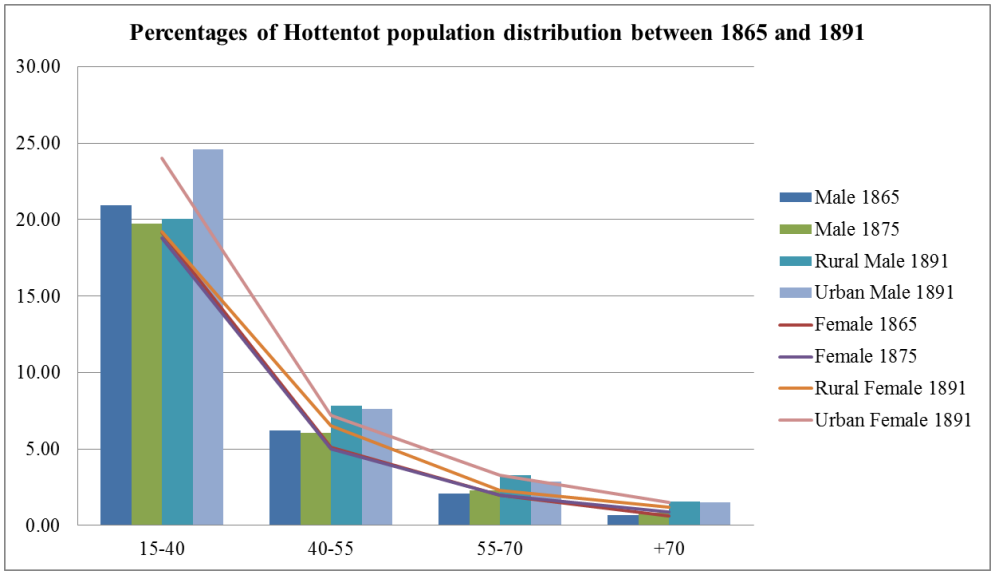


Figure 22. Hottentot population distribution in 4-age categories, comprised between the ages of 15 and above 70, according to the censuses in 1865, 1875 and 1891.

The figure above (Fig. 22) follows the aggrupation in the census of 1875 in which a comparison to the data from the census in 1865 is included, giving 4 age categories: between 15-40, 40-55, 55-70 and above 70. The number of individuals under the age of 15, whether male or female, remained below the 25% of the entire population in the censuses of 1865 and 1875, and below 15% in the census from 1891. Aside from this, it is noticeable the increase of adult females in the tables of the census from 1891, as compared to the two previous censuses. Finally, the number of individuals listed in the category of "unspecified" decreases significantly from 2284 in 1875 to only 31 in 1891.

Recovering Lee's (1979) three age categories, the populations for former pastoralists in the colony present the following distribution within sex (Figs. 23, 24, and 25).

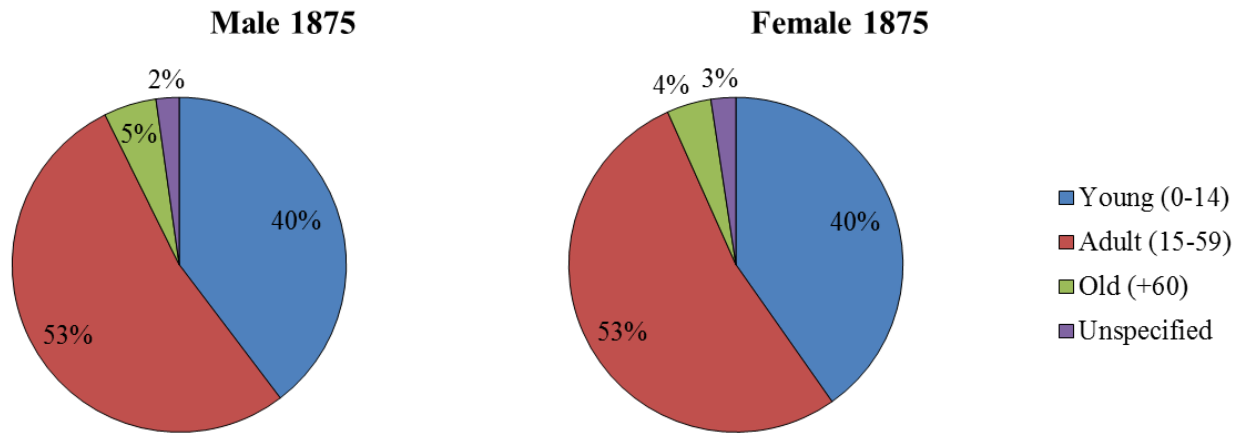


Figure 23. Distribution of the Hottentots in 1875, using the 3- age categories and, following the census from the Cape of Good Hope Colony in 1875.

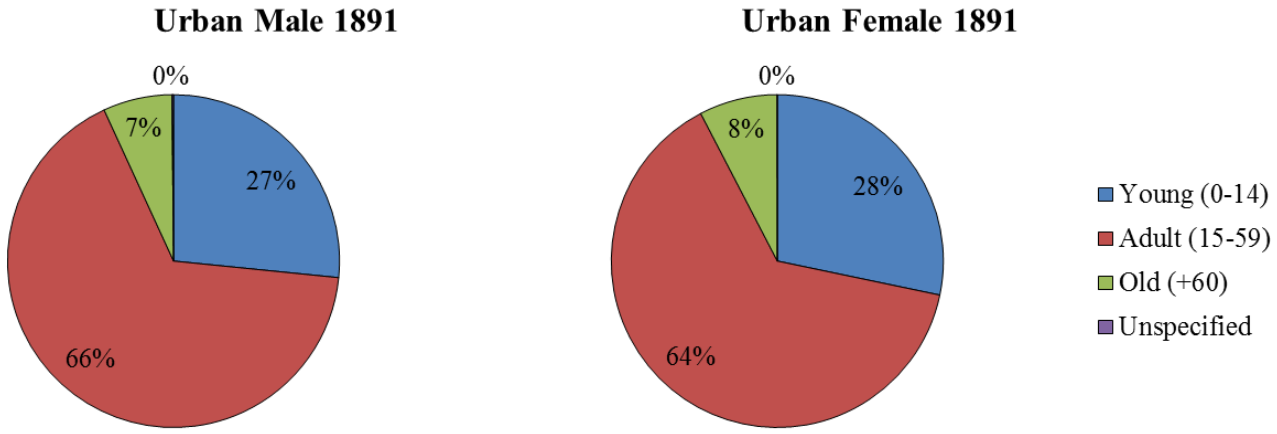


Figure 24. Distribution of the Hottentots in the urban areas in 1891, using the 3- age categories and, following the census from the Cape of Good Hope Colony in 1891.

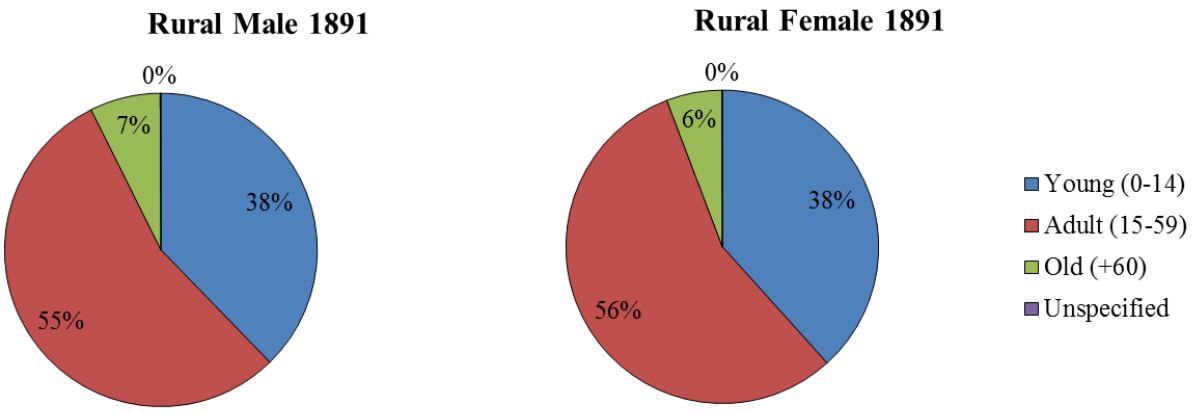


Figure 25. Distribution of the Hottentots in the rural areas in 1891, using the 3- age categories and, following the census from the Cape of Good Hope Colony in 1891.

Interestingly enough, and referring to the census of 1891, the population of former pastoralists present a higher proportion of young individuals in the rural areas than in the urban areas –also compared to the demography of the Dobe !kung. It appears that the census data from 1891 are somehow representative of a population of former pastoralists. On the one hand, this same population present different patterns in rural and urban areas, which may respond to a different organization of reproduction –together with other variables, such as mortality rate and migration patterns. Unfortunately, I cannot research into detail in all these necessary demographic features and also it is unlikely to find information on the level of, for example, household composition, in the same manner as with the Dobe !Kung (Howell, 2000; Lee, 1979). Nevertheless, the age composition within sex from the census in the urban settlements from 1891 shows a very close relation of ages as compared to the Dobe !Kung. Considering this, I have decided that it is safe to use the same artificial community created based on the demographic data from Lee (1979) and Howell (2000). Only the social norms and social behaviour will differ accordingly to the qualitative and quantitative information gathered from the ethnohistorical sources. Counting with a common and same starting population, it will be possible to further discuss the different developments observed in the simulations depending on the set of norms. In addition, and expectedly, to some extent the result for the pastoralists, in what refers to population structure, may turn similar to the population structures observed in the censuses of 1875 and/or 1891.

Defining the agents: biological and social variables

Once the population structure is completed, the next step in refining all sides of the artificial community consists in further developing the agents on a micro level. In the program, every agent is equivalent to one individual, and every agent interacts accordingly to the biological and social environment of the simulation. For this reason, not only age, sex and household composition are important, but also additional individual characteristics which are grouped within several customizable variables. Some of these variables are distributed according to existing established data (e.g. sex and age), and some are distributed randomly or following specific formulas (e.g. fecundity, reputation). This content has been briefly introduced in chapter 2, here I further develop the description of the variables used in my simulations.

The variable of sex is defined under the capital letter of "M" if male, and "F" if female, regardless of the age. Some social and biological variables are dependent on the sex and age of the agent, this is, for example, a female agent at the age of 13 has the social status of "girl" and the biological status of "adolescent", while a male agent at the age of 31 has a social status of "single" and a biological status of "adult". These social and biological statuses will vary along the simulation depending on the natural ageing process (newborn, child, adolescent, adult) and their development in the social relations (infant, boy, girl, single, married, polygamous, divorced, widowed).

There are other variables that complete the profile of every agent, which have been labelled as follows:

- Fecundity
- Current fecundity
- Health
- Current health
- Libido
- Current libido
- Reputation
- Current reputation
- Morbidity
- Current morbidity
- Rules-respect
- Current rules-respect
- Boldness
- Current boldness

These variables represent more or less the biological (fecundity, health, libido and morbidity) and social (reputation, rules-respect and boldness) behaviour of agents. There is not a precise and established measurement of any of these. It is know that a woman at the age of 25 has higher probabilities to conceive than a woman at the age of 45, however, in numerical values there is not particular measurement. However, these variables are important because, together with the list of social norms, they frame the possibilities in which every agent may behave and interact depending on its own profile and the others' profile. In this manner, and fitting into the simulation program language, in the initial artificial community, several variables including reputation, health, libido, and fecundity are randomly attributed to the agents with numerical values between 500 and 10000, following a normal curve distribution around the median value of 5000, regardless of the age and sex (Fig. 26). Other variables including, morbidity, rules-respect and boldness receive a random value between 500 and 10000 at the start of the simulation. All these variables will remain invariable along the life course of the simulation, but their respective "current" will vary along the simulation according to pre-established rules and events.

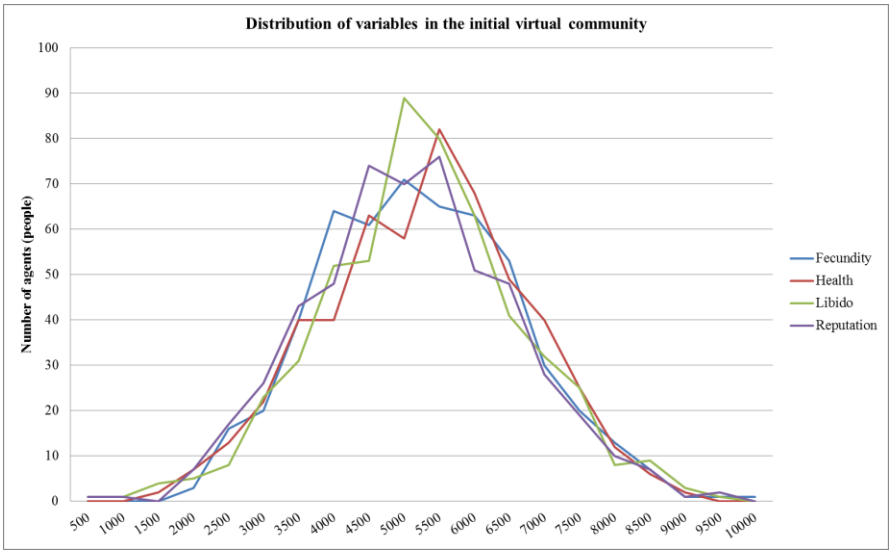


Figure 26. Distribution of the four social and biological variables among all agents (individuals) in the initial artificial community.

These variables defined as "current" are the social and biological variables that will vary along the simulation depending on the natural process of aging and other social developments the agents (individual) undergo during the simulation, and in accordance to the formulas predefined:

- Current morbidity results from $age * 120$ at every step of the program (in a manner, it equals to aging). The more current morbidity the agent has, the higher are the probabilities for the agent to be eliminated from the simulation (deceased). Other events may also increase the current morbidity e.g. giving birth).
- Current reputation results from $\frac{age*reputation}{80}$ when initiating the simulation, afterwards it increases by 55 for male, and 50 for female agents. The more current reputation the agent has, the more advantages has towards social events (e.g. finding a suitable candidate for marriage).
- Current rules-respect equals to rules-respect, and it varies increasing or decreasing along the simulations depending on the social events (e.g. after a successful marriage it increases, after a failure of an attempt for marriage it decreases).
- Current boldness results from $\frac{boldness*age}{75}$, and it varies along the simulation depending on the life course of the agent (e.g. increases in the adolescence, it decreases after a successful marriage).
- Current health equals to the health given at initialising the simulation and it varies along the simulation depending on the norms (e.g. it decreases after giving birth).
- Current libido results from $\frac{libido+random}{2}$ and it varies depending on the life course of the agent (e.g. after a successful marriage it decreases, by a failed attempt for marriage it increases).
- Current fecundity results from a ratio between age and the inherited fecundity following the charts and tables elaborated by medical studies on reproduction.

Finally, the individuals are given *genetic* code, mainly a Y and X chromosome each. For the initial population it is not relevant to be accurate when distributing these variables. The development of villages and the families within them contained may lead to the enlargement of some family lines or to the disappearance of others. While the village or family names are not traceable once they disappear, it is still possible to trace the genealogy through the two chromosomes.

Below, in Fig. 27, I include an example of a household with two members, as it incorporated into the program.

```
<family>
        <name_family>AA</name_family>
        <person>    <name>FAA1(000)</name>
                    <age>9</edat>
                    <libido>4180</libido>
                    <health>8591</health>
                    <fecundity>5626</fecundity>
                    <morbidity>100000</morbidity>
                    <reputation>5361</reputation>
                    <sex>F</sex>
                    <chromosomeX>NB</chromosomeX>
                    <chromosomeY>Nb</chromosomeY>
                    <bio_status>infant</bio_status>
                    <social_status>girl</social_status>
        </person>
        <person>    <name>FAA2(000)</name>
                    <age>30</edat>
                    <libido>2816</libido>
                    <health>6900</health>
                    <fecundity>7354</fecundity>
                    <morbidity>100000</morbidity>
                    <reputation>7082</reputation>
                    <sex>F</sex>
                    <chromosomeX>NB</chromosomeX>
                    <chromosomeY>Nb</chromosomeY>
                    <bio_status>adult</bio_status>
                    <social_status>single</social_status>
        </person>
</family>
```

Figure 27. An example of a household of two members (a girl and an adult) in the format in which the data are incorporate into the simulation program (java language).

During the simulations, the agents born (children) will inherit the values for the variables of reputation, fertility, health, libido, rules-respect and boldness according to the values their parents have and following predefined formulas. Naturally, it is difficult to know the exact measure of the social and biological variables and how are these transmitted across generations. For this reason, the formulas establish that the parents' *inheritance* represents 70%, and the remaining 30% is randomly attributed by the simulation program.

On the overall, the simulation system counts with a clear definition of the agent in all its facets that will manage its correct incorporation into the simulation experiments. Many variables vary according to probabilistic schemes and, therefore, the same artificial community within the same experimental case may develop differently, because the agents may be submitted to different circumstances and random events that lead to different chains of events depending on their characters. Because of this, every experimental case is repeated 30 times, allowing the possibility to review the variability within it. The majority of the experimental exercises are simulated across 150 steps (equivalent to 150 years), or 450 steps when possible. Clearly, it is not possible to create *the correct* HFGS. However, the results obtained have a consistent and reliable structure, which in any case will undergo to some transformations in the course of the simulation.

Incorporating the social norms into the system

In the simulation program, two input files labelled as "biology" and "capsules" contain the biological and social parameters that will define the environment in which the agents will *live*, and within which they will act, together with the file of "norms". The internal way in which the simulation program works is too complex and would be the subject of a detailed technical explanation by Adrià Vila, who developed entirely the simulation program, in his master thesis. In this subchapter I may refer exclusively to the structuration of the file of norms, for which I am responsible[75].

I have shown the existence of variability and, in different occasions, the existence of contradictory information of the social norms and socioeconomic behaviour. I am in no position to determine which source is more reliable than another. I assume the different authors tried to leave a written account of what they indeed observed, without intentionally manipulating it. Naturally the historical context and the particular background of the person may have shaped the accounts differently, but it is likely possible that the social behaviour changed across time or place. As a consequence, the approach selected to proceed with the simulation exercises is to pull the two polarities of the social behaviour and social norms. I organized all social norms in two groups, depending on the extension and expression the same norm, from the smallest or inexistent (minimum) to the greatest (maximum) restrictive degree in which they are described.

Following this procedure, I present four tables (Annexes 21 to 24), two for each group of peoples (mostly hunter-fisher-gatherers, and mostly pastoralists), and two within each group, one contain the minimum expressions of the social norms, and the other containing the maximum expressions of the same norms when available (Tables 6 and 7). In any case, all the levels indicated in the tables are established in accordance to the materials extracted from the

[75] The simulation program contains a system that interacts with data written in java language. Every biological and social data has been written and re-written in this manner. In order to fulfil the agenda, Adrià Vila has been in charge to build the system, while Prof. Jordi Estévez and myself have translated the data I collected into norms in Java assimilable language. I used the input files and the simulation system to simulate every case in this thesis introduced, to later on analyse and understand the different demographic processes.

ethnohistorical accounts and more recent ethnographic studies. I would address the reader to the annexes 1 to 7 for the specific quotations and source of every social norms and social behaviour.

In a very simplified manner, the organization of the norms is as below presented. In some cases the sources are not clear enough to confirm, for instance, whether their descriptions of a rite of passage can directly be (co-)related to the age allowed for marriage. In any case, I take into account every description in every possibility in order to test what effect may be the behind.

Table 6. Configuration of the minimum and maximum restriction of each main social norm and social behaviour among the pastoralists, between the 17th and 20th centuries

Pastoralists	Minimum	17th	18th	19th	20th	Maximum	17th	18th	19th	20th
Age at marriage	Girls: puberty					Girls: age 18-20				
	Boys: puberty					Boys: age 18-20				
Marriage	Monogamous					Polygamous: up to 6 wives				
	Restricted polygamy					Polygamy: "spoils" of war				
	Polygamy is rare									
Divorce and Remarriage	Divorce: unlikely					Divorce: under several circumstances				
	Remarriage: unlikely					Remarriage: levirate, sororate,complicated				
Child spacing	Short birth intervals					Long birth intervals				
Infanticide	Uncommon					Under several circumstances				

The structure of the simulation program is mostly organized around probabilities, and every agent has a specific profile which depending on its development in the environment can lead to different life histories. This probabilistic feature also means that within the exact same social and biological environment, the chain of events and the development of every agent within the simulation can vary. Because of this, as I have previously announced, I will simulate every set of experiments developed for simulation 30 times, and from the 30 tests I will attempt to analyse the main tendency, while also considering the outliers blow and above the average obtained.

Table 7. Configuration of the minimum and maximum restriction of each main social norm and social behaviour among the foragers, between the 19th and 20th centuries

Foragers	Minimum	19th	20th	Maximum	19th	20th
Age at marriage	Girls: (pre-)puberty			Girls: age 15-18		
	Boys: puberty			Boys: 22-30		
Marriage	Monogamy			Polygamous: up to 5 wives		
	Restricted polygamy			As many wives as they can support		
	Polygamy is rare					
Divorce and remarriage	Divorce: unlikely			Divorce: under several circumstances		
	Remarriage: unlikely			Remarriage: levirate, sororate, complicated		
Child spacing	Short birth intervals			Long birth intervals		
Infanticide	Rarely happens			Under several circumstances		

8.- Results of the simulations experiments

In the simulation exercises I am not mirroring to the exactitude a society, neither are the biological and social parameters included in the simulation program perfectly configured in the attempt to develop a virtual environment as close as to a real one. There are countless of factors that come into play in the demographic development of a human population that may escape to our measurements. At the same time, the descriptions of the social norms in the ethnographic accounts show variance, for which reason these norms and their different expressions may lead to different population growths. For this reason, the relevance and contribution of the current study are particularly the assessment of the effect certain identified social norms and socioeconomic practices have within the socioeconomic settings of a foraging and pastoralist societies, together with the emerging demographic growth fluctuations.

In this chapter, I show and analyse the different simulation environments generated for each group (foragers, pastoralists), within which I apply the different social norms listed in chapter 6. After the simulation program concludes every simulation exercise, I obtain 3 different output files (txt. files, see chapter 3 for further details), which I can treat with excel. The information contained in these three files is extremely large and detailed, which allows me to develop many and different analyses. However, such a detailed microanalysis is not possible in the current thesis as it steps outside the scope of the research driving force. For this, I focus my attention to the data that are relevant to the discussion on the effective regulation of population growth through social norms, including: the population size at the end of the simulation, fertility rate, mean demographic growth, and other additional data (e.g. age distribution, percentage of unmarried people, percentage of widows, etc.).

In order to correctly assess the effect of social norms, I organized the simulations in three units: 1) simulations without social norms, 2) simulations with less restrictive norms (one subunit about foragers, another about pastoralists), and 3) simulations with the most restrictive norms (one subunit about foragers, another about pastoralists). At the end of this chapter, I compile the major observations from across the different units and populations.

The artificial population inserted at the beginning in every simulation of the second (less restrictive norms) and third (most restrictive norms) units corresponds to the one elaborated as explained in chapter 7. However, in the first unit (without social norms) I use a different and simpler artificial population, which has a size of 300 people, distributed in 48 families and10 villages. In any case and regardless of the structure of the social norms prepared in every unit, all sets of experiments are subjected to the same biological predefined contexts:

- Mortality probabilities registered in foraging societies (mortality probabilities and life expectancies for both male and female).
- Fecundity potential (biological fecundity for both male and female).
- Probability of spontaneous abortion (in the current study, associated to pregnancies among very young girls or elder women and men)
- And a 3% of primary sterility on the entire population.

Therefore, the differences in the results obtained will respond exclusively to the interrelation of the social norms and capsules (for further details, see chapter 3) with the above listed biological factors. Due to the different sets of probabilities predefined, not only the development of the events but also the development of the life course of the agents may vary within the same experimental environment. For this reason, every set, with its unique structuration of the social norms, has been simulated 30 times (repeated 30 times), in order to objectively assess the range of variability within it.

Simulations: without social norms

The purpose of the sets of experiments contained in this unit is to mainly check the results obtained under different *biological* circumstances. The simulation exercise will set up the basic biological coordinates that will be used as a framework for the further units of simulations in which I test the social norms –thus the unit here presented does not include any social norm. The different sets of experiments simulated have been readjusted based on 6 variables (Table 8).

While sexual maturation age and life expectancy are easily extracted from ethnographic and medical studies, birth spacing has been summited to a reduction of female fecundity and libido for a period of at least 3 years in all cases. Although we are aware that this reduction is highly dependent on other social factors, for example diet and the organization of sexual intercourse after birth, in relation to prepare the simulations, I take into account the often-recalled myth of the universal reduction of fecundity due to lactation. The variables of fecundity and mortality are distributed as shown in the charts (Fig.28).

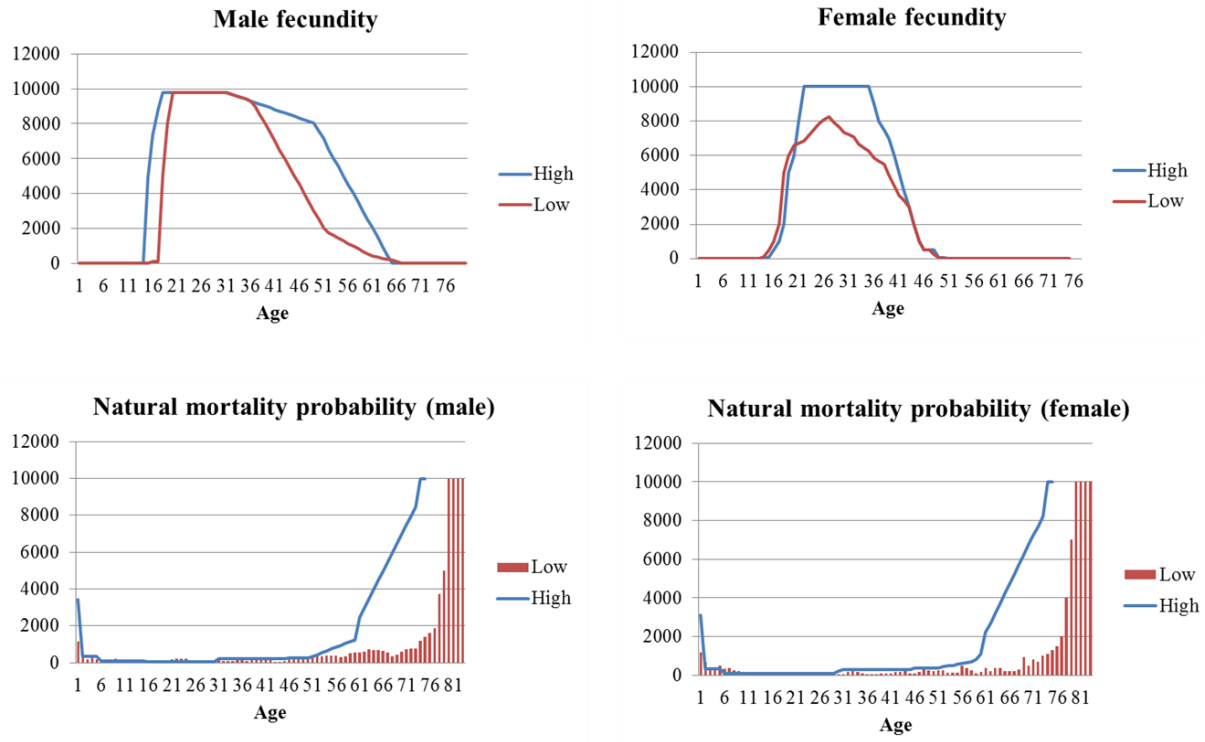


Figure 28. Distribution of each fecundity potential and mortality probability used in the simulations.

These variables follow units of measurement that the simulation program can interpret (from 0 to 10000). By paying attention to the line of age in the charts, it is simple to follow the fecundity and life expectancy course in both sexes.

Table 8. Variables integrated in the simulations of the unit without social norms. The text marked in red simply emphasizes the adjustments within every set.

Simulation set	Life expectancy (M)	Life expectancy (F)	Fecundity (M)	Fecundity (F)	Female age at first marriage	Type of marriage	Priority male candidate	Priority female candidate
No norms I-a	short	short	low	high	>15	Monogamous	current boldness +current health	current health
No norms I-b	short	short	high	low	>15	Monogamous	current boldness +current health	current health
No norms I-c	long	long	low	high	>15	Monogamous	Sex (M)	current health
No norms I-d	long	long	high	low	>15	Monogamous	Sex (M)	current health
No norms II-a	short	short	low	high	>15	Monogamous	current boldness +current health	current health -current morbidity
No norms II-b	short	short	high	low	>15	Monogamous	current boldness +current health	current health +current libido
No norms II-c	short	short	low	low	>15	Monogamous	current boldness +current health	current health -current morbidity
No norms II-d	long	long	high	low	>15	Monogamous	Sex (M)	current health -current morbidity
No norms III-a	short	short	high	low	>15	Monogamous	current boldness +current health +current libido	current health +current libido
No norms III-b	short	short	high	low	>8	Monogamous Prolonged widowhood (F)	current boldness +current health +current libido	current health -current morbidity
No norms III-c	short	short	high	low	>8	Monogamous and exogamous Prolonged widowhood (F)	current boldness +current health +current libido	current health -current morbidity

In the case of fecundity, the lowest the values the less likely the agent to be potentially fecund; in the case of mortality, the higher the values the more likely is the agent to perish. In the case of the female fecundity, it is set to start at the onset of the age 13-14, with two possible developments: the first shows a pick in the mid-twenties with a slow decrease until menopause, while the other presents a stable and high fecundity potential starting in the early twenties until the late thirties. In the case of the male fecundity, it is set to also start early in age, after which it either shows a slow decrease at the mid-thirties, or a rather fast decrease at the late forties.

In the case of the probability of natural mortality and length of life expectancy, for both male and female, the settings basically establish two different possibilities. The first shows lower probability of mortality at a specific age, while at the same time has a longer life expectancy, for both male and female. The second shows a higher probability of mortality at a specific age, while at the same time has a shorter life expectancy. These values are taken from the data of the highest mortality registered for HFGS societies, the Agta (from Headland, 1989) and a less high mortality group, the Aché (from Hill and Hurtado, 1995).

Even if social norms are meant to be absent in the sets of simulations here prepared, it is still important to establish a norm of marriage as a guideline for the simulation program to create new families. The function of variables such as "current boldness" or "current health" (see chapter 7 for further details) is basically to organize the agents within a behavioural frame. These types of variables respond to predefined formulas, after which they may progressively increase /decrease[76], and in other cases they depend on established formulas that also count with a random fluctuation[77]. These same variables may be used to organize the formation of marriages in accordance to predefined and customizable formulas. The program is configured to first organize the eligible candidates for marriage in two lists (male candidates and female candidates), ordered according to the character of the *priority*.

[76] For instance, "current health" progressively decreases along the life course of the agents, and "current morbidity" increases. Both these variables are related to the natural process of aging.

[77] For instance, the value of the variable fecundity of a newborn results from combining the father and mother's fecundity with a weight of 70%, and the remaining 30% responds to a random increase or decrease calculated by the simulation system.

In the experimental sets of this current unit, the priority for men is defined after the formulas $current\_boldness + current\_health$, or alternatively $current\ boldness + current\ health + current\ libido$ –therefore *braver* and *healthier* are the first to select a woman. A third possibility is based exclusively on the variable of sex, in this case they are ordered randomly. In the case of women, the priority is defined after the formulas $current\_health + current\_libido$, c$urrent_health - current_morbidity$, or simply according to the variable of *current health* – therefore the *healthier* and *better looking* women are the first to be selected by men

In this unit, I asked the simulation program to run 150 steps for every test of every environment here presented. As a result, every test shows a time span of 150 years[78]. Already referred previously, every environment is simulated 30 times under the exact same social and biological circumstances, which generates a sample size of 30 tests per environment.

In Fig. 29, I present the results obtained from the 11 environments simulated under exclusively and variable biological factors (fecundity and mortality), excluding any social norm –except for the priorities of marriage. The numbers in the chart refer to the absolute number of individuals at the end of the simulation (the population size after 150 years). I do not intend to go into details in this set of simulations, but I want to point to the different patterns observed according to the 6 variables tested:

- The variability in the results depends mostly, as anticipated, on the different fecundity (higher, lower) or life expectancy (shorter, longer) applied. Although it may not be a great change, the difference is noticeable when looking at the case No norms II-c, in which low fecundity for men and female, together with a short life expectancy and high mortality probability lead to the smallest demographic increase compared to the other cases.

[78] The simulation program, after all input files are introduced requests for the extension the simulation should run, in the form of steps. Every step requested to the simulation system is equivalent to years. Therefore, 150 steps run by the system represent 150 years, which the population has existed.

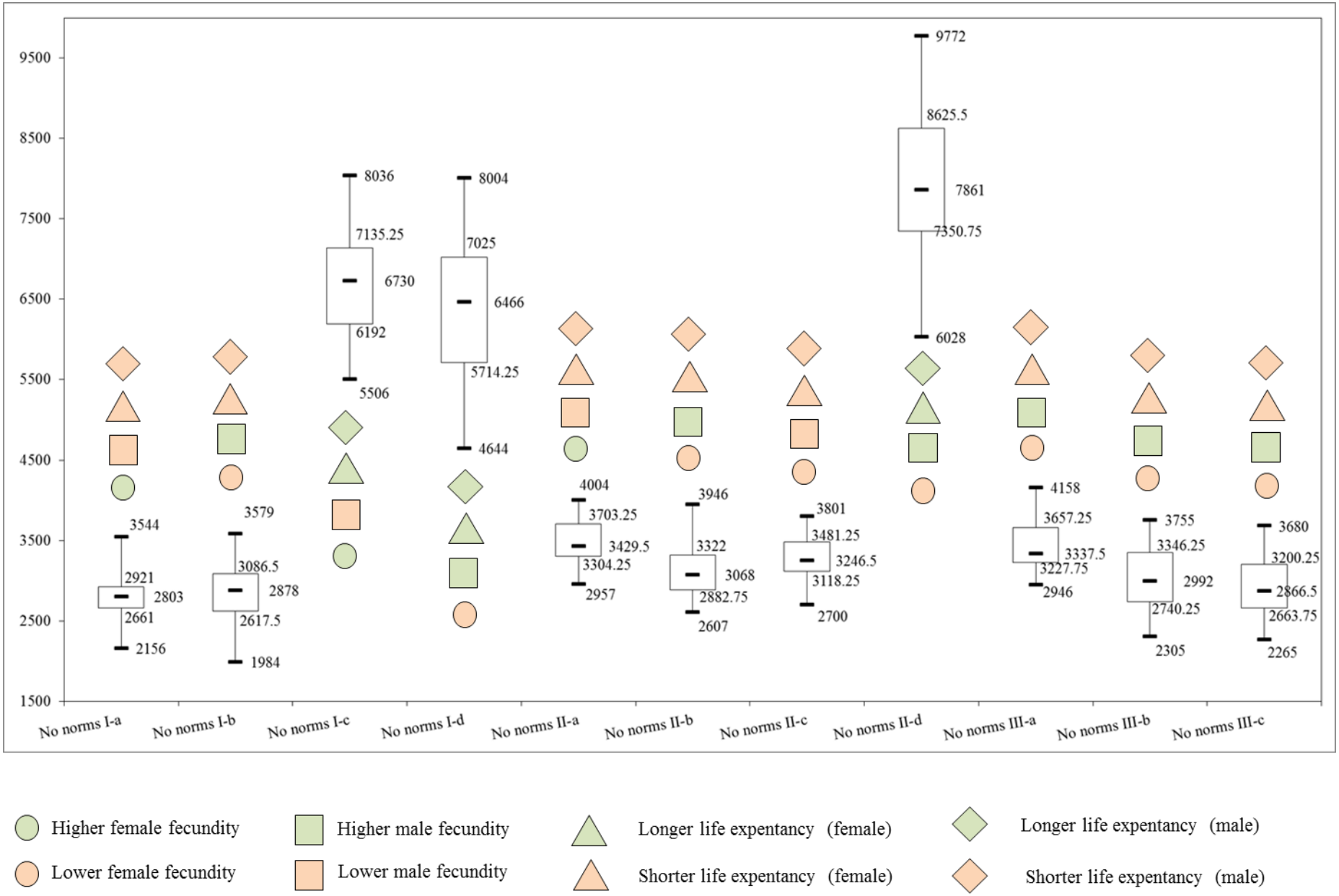


Figure 29. Total results of the unit of simulations without social norms.

- The sets No norms I-c, No norms I-d and No norms II-d show the highest demographic growth because they contain a lower probability of mortality, and simultaneously the priority lists the male based exclusively on their sex, in which case any man is fit for marriage. The results attested in these three sets practically triple the population size of the case No norms II-c.

- The experiments show a null effect dependant on the priority established for the selection of a female candidate for marriage.

- The difference between the test with the maximum and the test minimum population size within every environment, as well as the size range within the 50% of the tests concentrated around the median, is larger in No norms I-d, No norms I-c and No norms II-d, due to the fact that these sets of experiments present fewer impediments in the formation marriages and, simultaneously, life expectancy is higher and mortality probability is lower. These sets of experiments are in a manner more relaxed, which generates larger variability within the same simulation context.

The results from No norms III obtained point to the following observations:

- No norms III-a shows a greater demographic growth as compared to No norms I-b, while both having the same biological environment. The explanation lays on the organization of the candidates listed for marriage. It appears that the formulas predefined for No norms III-a facilitates the formation of marriages and, hence, the proportion of women married and exposed to conception is higher.

- Although the sets of experiments of No norms III-b and III-c allow an earlier age at first marriage among women, they present similar population sizes as observed in the previous cases (with the exception of No norms I-c, I-d and II-c). The main difference is that these two sets include an additional condition which forces widows to remain unmarried longer (Fig.30). Finally, population size is slightly smaller in No norms III-b due to the incorporation of the norm of exogamy (the man must look for a marriageable candidate in a different family).

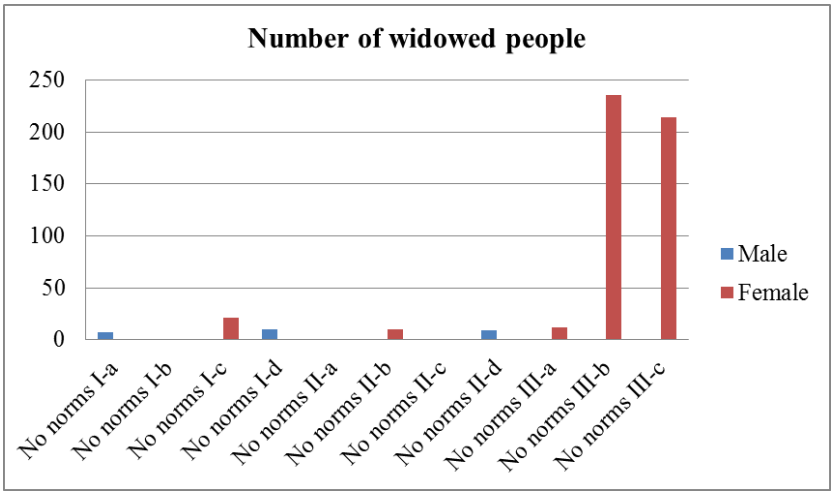
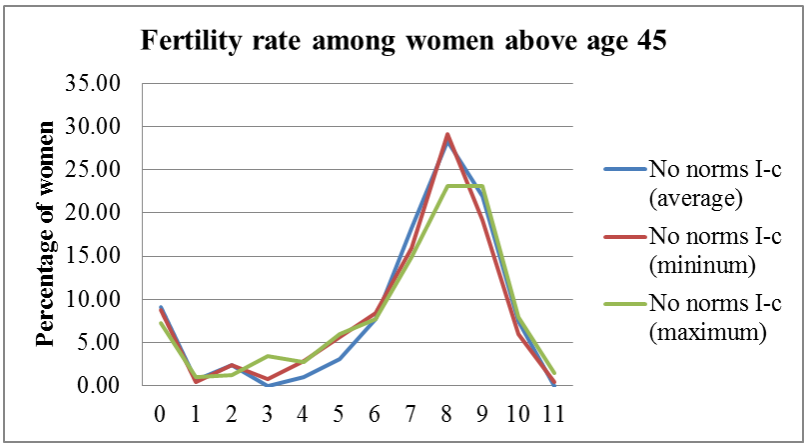


Figure 30. Absolute number if widows and widowers in the resulting population at the end of the simulation, in all 11 sets of simulations.

I find relevant to compare a few parameters from No norms I-c (environment characterised by low mortality probability combined with high female fecundity) and no norms III-c (environment characterised by high mortality probability, low female fecundity, together with early age at marriage for girls and exogamy):



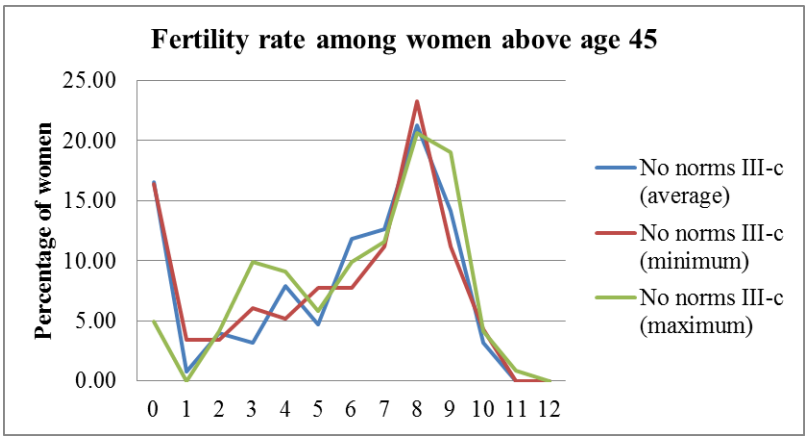


Figure 31. Fertility rates of the experimental sets No norms I-c and No norms III-c. From the total of 30 repeated tests, the maximum, minimum and one average example are displayed.

- Fertility rate[79]: in both cases, a great part of women gave birth to about 8 to 9 children, almost 30% in No norms I-c, and almost 25% in No norms III-c (Fig. 31).

- Surprisingly, up to 15% of women remain childless in the set No norms III-c. This may result from primary sterility, however, and comparatively, it is more likely due to the fact that the system does not prevent very young girls (8 years old) marry very old men (above 50 years of age). The predefined formula ordering the female candidates for marriage prioritizes those with better health and lesser morbidity, which negatively affects older women and widows (Fig. 30).

- On the overall, there is indeed a different demographic growth experienced by these two sets (Fig. 32; annual demographic growth chart in Fig.87 of Annex 26)[80].

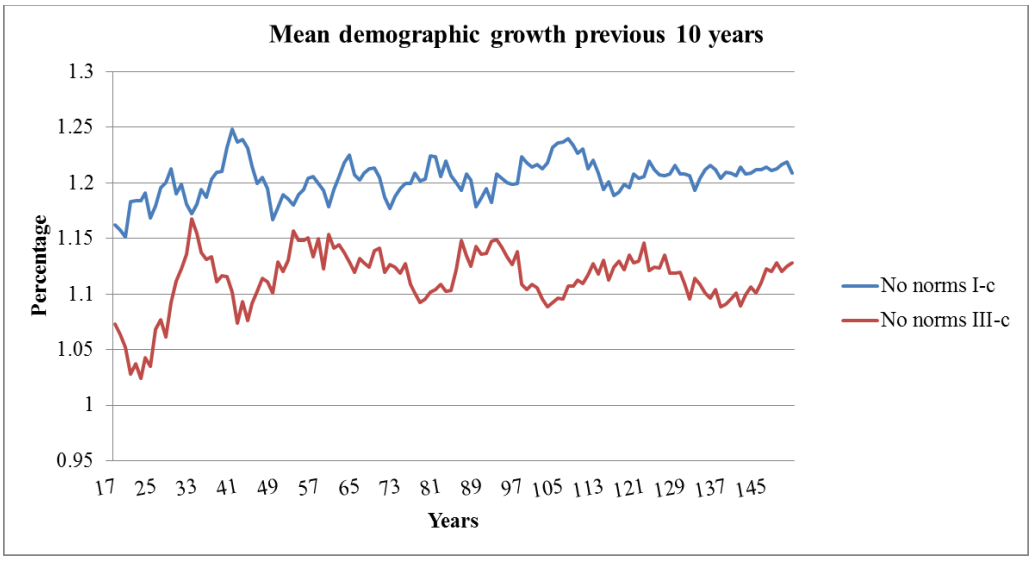


Figure 32. Mean demographic growth of No norms I-c and III-c, taken from one average test out of the 30 from each environment.

[79] Although the rate does not take into account which percentage of the children born survive past infancy, the experimental exercises in this current doctoral thesis present the same infantile mortality probability.

[80] The charts display the period between the years-steps 17 and 150. The first 7 steps (or years) are not taken into account because the initial artificial community is still strongly being transforming due to the exposure to the social and biological values of the initial community. As it may be appreciated in the chart, starting in the step 30 approximately, the development of the population becomes more regular.

To conclude, the different biological variables have been tested to point out the plausible variability in the fertility rate outcome in the absence of social norms. The principal observation in this unit is that without any other conditions aside from fecundity or mortality, demographic growth can be very pronounced. And most important, there is not any ethnographic case or prehistoric context that corroborates it. Even if a catastrophe were to have a remarkable impact on the populations, these would soon recover and overgrow as seen in the simulations within a short period of time.

Simulating hunter-fisher-gatherers

After testing the biological parameters in the previous subchapter, in the current subchapter I present the results of the simulations with the less and most restrictive social norms among foragers. The sets of experiments following in this subchapter and in the next (pastoralists) are subjected to high mortality probability, short life expectancy, together with low fecundity potential for both men and women. In the case of the less restrictive environments, fecundity is reduced for 3 years after-birth (conditioning the length of birth intervals), whereas in the most restrictive environments fecundity is reduced for 5 years. Finally, in every case I use the artificial community generated in chapter 7, consisting of 529 individuals, 208 families and 22 villages.

The content of this subchapter is subdivided into three sections. In the first section I discuss the results obtained from the simulations prepared aiming to isolate the effect of every social norm in its minimum expression. After assessing and controlling every social norm, they are all combined in one complete "minimum control" environment, where the less restrictive norms are included[81], whose results are discussed in the second section of this chapter. The third section includes the complete set of "maximum control" and, therefore, the most restrictive norms.

[81] In the annex 21 to 24 the organization of the social norms into the categories of minimum versus maximum are presented.

Simulations: preparation and individual assessment of social norms

The simulation system is very complex and it would be extremely difficult to isolate the effect every social norm has on the demographic development. For this reason, 13 different environments are generated, in which I progressively incorporate several social norms: marriage conditions, divorce, prolonged widowhood for widows, polygamy, and exogamy. In addition to this, other parameters and conditions are likewise structured in different ways in order to assess the flexibility the norms have. All the environments I present in this section have been subjected to 150 steps and, therefore, the resulting population corresponds to that after a period of 150 years. The characteristics of the norm and environments are detailed in several tables (Tables 9, 10, 11, and 12).

Low control norms

The sets of norms under the name of "low control" contain environments of simulations in which only the norm of marriage is adjusted (Table 9). There are 5 different sets of "low control", whose purpose is to assess the plausible variability resulting from different conditions acting over the regulation of marriage. Therefore, the successful formation of a new marriage depends on several variables differently formulated. In Fig. 33 I show the results of every case, indicating the population size after concluding the simulation.

It is clear that, the size of the populations resulting after 150 steps exceeds demographically any existing pre-industrial society. However, it is interesting to observe that by adding more conditions to the norm of marriage, or increasing the number of attempts a man can try to find a wife within the same year, the population growth remarkably transforms –especially for case Low control IV.

Table 9. Characteristics of the environments in "Low control". The cells marked in colour indicate the main differences from case to case.

Variables		Low control I	Low control II	Low control III	Low control IV	Low control V
Marriage	Male social status	Single, widower	Single, widower	Single, widower	Single, widower	Single, widower
	Female social status	Single, widow	Single, widow	Single, widow	Single, widow	Single, widow
	Male age at marriage	13#80 (gradual[82])	13#80 (gradual)	13#80 (gradual)	13#80 (gradual)	13#80 (gradual)
	Female age at marriage	8#75 (gradual)	8#75 (gradual)	8#75 (gradual)	8#75 (gradual)	8#75 (gradual)
	Priority male candidates	Current boldness+ current health+ current libido	Current boldness+ current health+ current libido	Current boldness+ current health+ current libido	Current boldness+ current health+ current libido	Current boldness+ current health+ current libido
	Priority female candidates	Current health - current morbidity	Current health - current morbidity	Current health - current morbidity	Current health - current morbidity	Current health - current morbidity
	Female candidate conditions	None	None	None	None	None
	Conditions for marriage acceptation	Exogamy	Exogamy, fulfil 1 out of 2 conditions	Exogamy, fulfil 1 out of 2 conditions	Exogamy, fulfil 2 out of 3 conditions	Exogamy, fulfil 2 out of 3 conditions
	Marriage attempts per step	1	1	3	1	**3**

[82] In order to prevent the automatic and instant entrance into marriage after turning 13 and 8 years old, boys and girls respectively, several predefined formulas including variables such as “current health” or “current boldness” place the individuals into the list of single candidates.

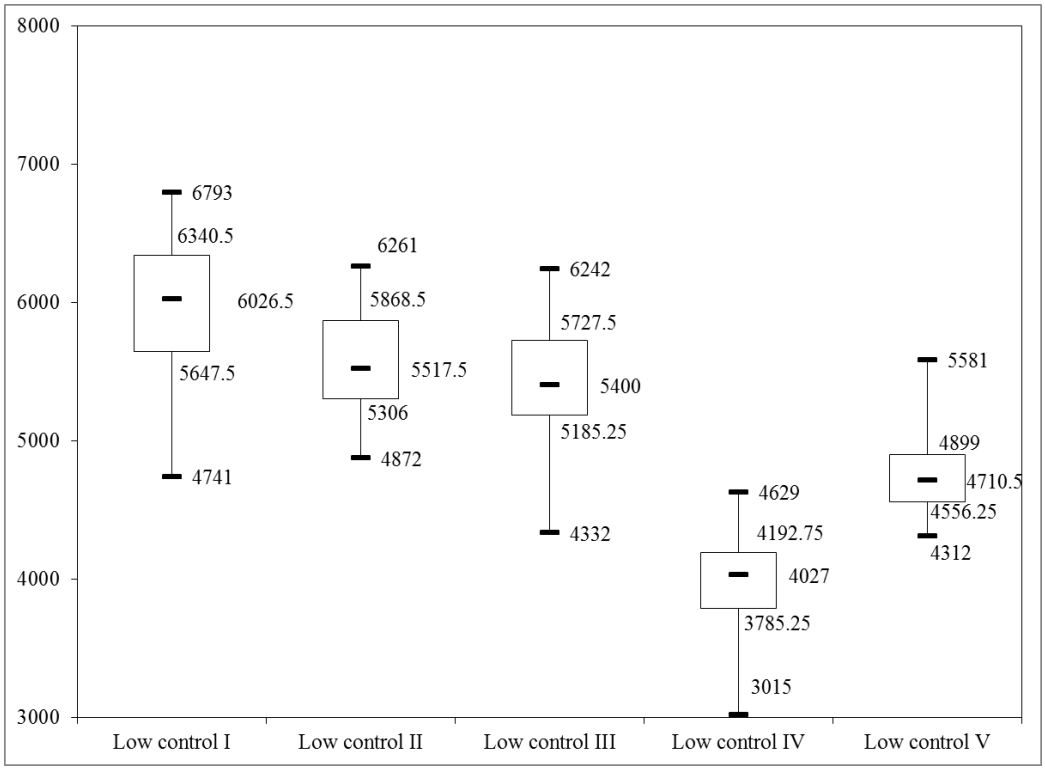


Figure 33. Total results of the unit of simulations of Low control.

The following 5 figures (Figs. 34-38) visually display the mechanics of the norm of marriage within every environment of Low control. The two candidates for marriage must fulfil several conditions that make them eligible for marriage, and depending on the case further conditions may also take part, or in case of failure bring a certain consequence.

- Low control I:

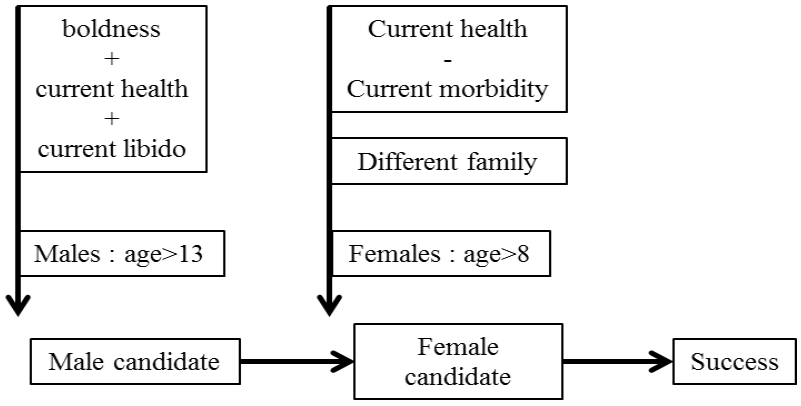


Figure 34. Organization of the norm of marriage in Low control I.

- Low control II:

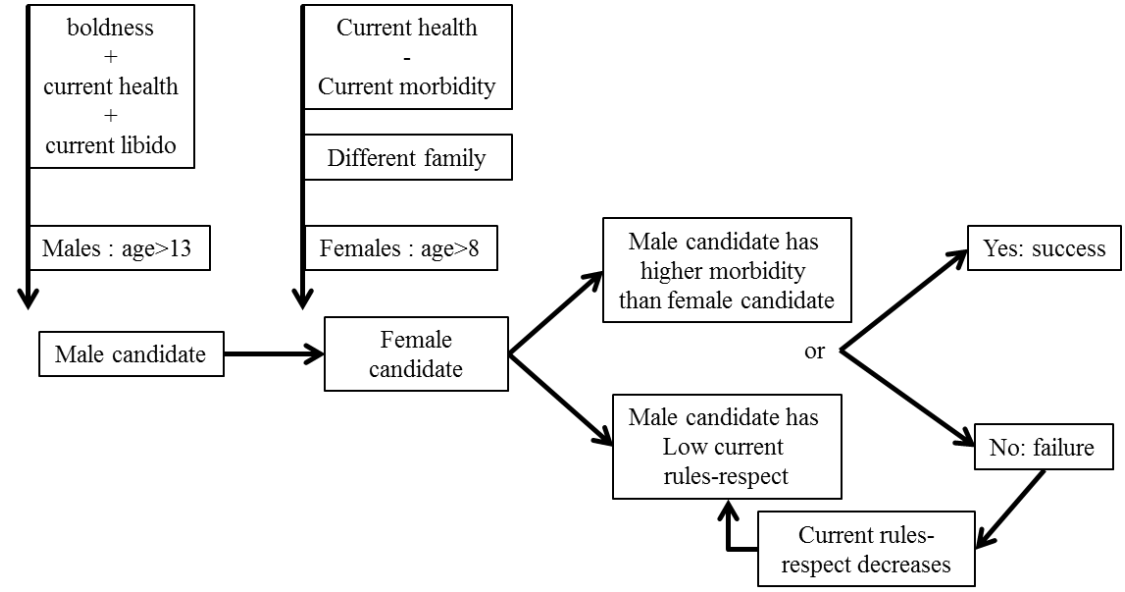


Figure 35. Organization of the norm of marriage in Low control II, with a consequence in case of failed attempt.

Low control IV is clearly the less favourable environment for the formation of marriages, whereas Low control I is the more relaxed.

- Low control III:

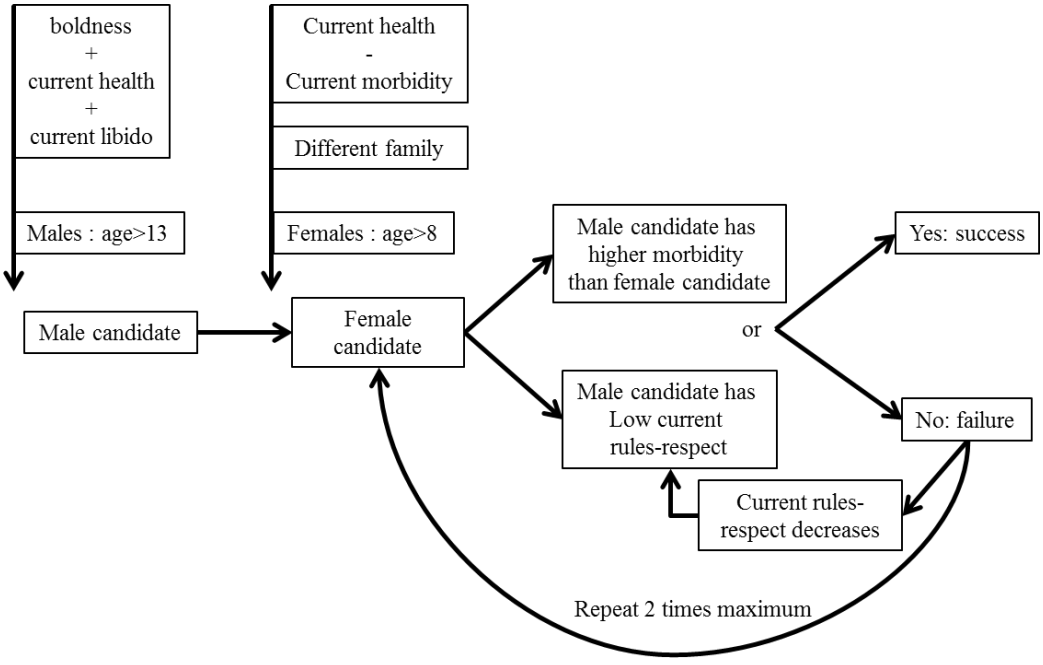


Figure 36. Organization of the norm of marriage in Low control III, counting with 3 attempts per step.

- Low control IV:

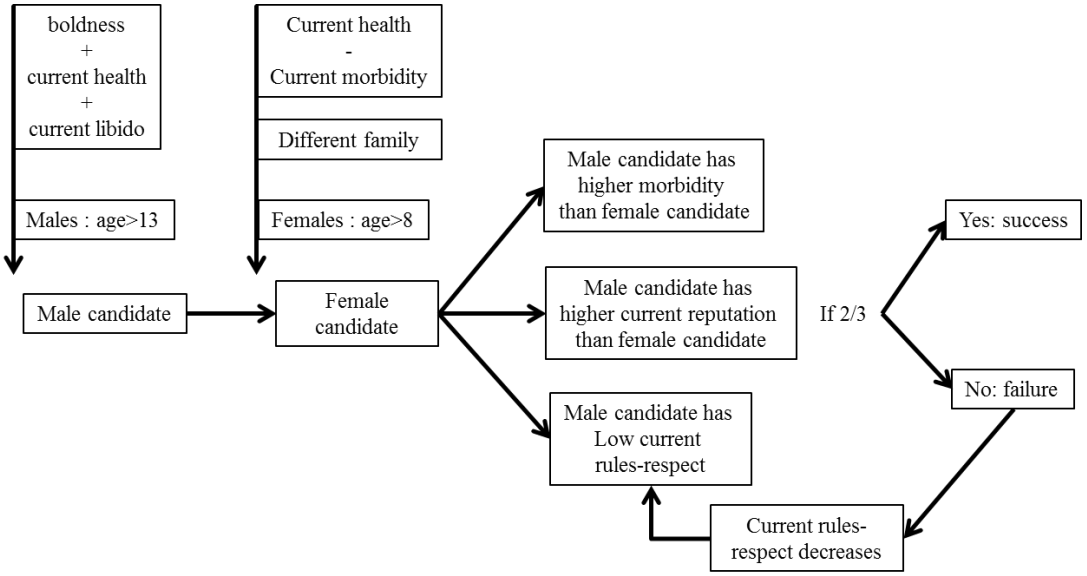


Figure 37. Organization of the norm of marriage in Low control IV, with more conditions required.

- Low control V:

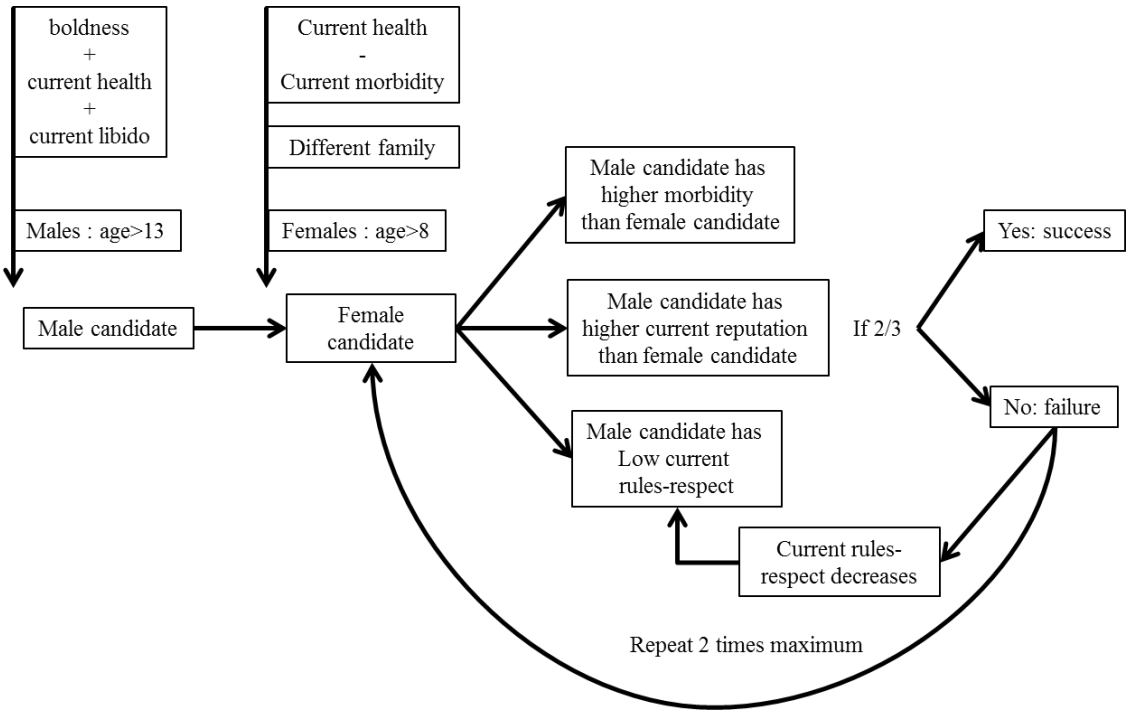


Figure 38. Organization of the norm of marriage in Low control V.

In general terms, and regardless of the restrictions to the norm of marriage, all 5 environments present the same fertility rates: the great part of women above the age of 45 had around 8 to 9 children (Fig.39).

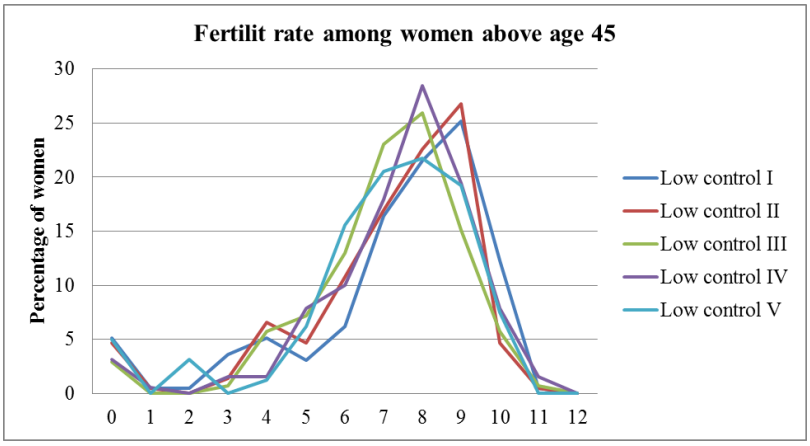


Figure 39. Fertility rates in Low control, represented with one average test from the sample of 30 within every environment.

Although the mortality probability is the highest, the life expectancy the shortest and the fecundity potential the lowest, in general the population growing rate is sometimes larger than some environments shown in the simulations without social norms. Despite the smaller size of the initial population in the simulations without social norms, the plausible answer behind this may lay on the proportion of women within the social category of "single" (Figs. 40 and 41):

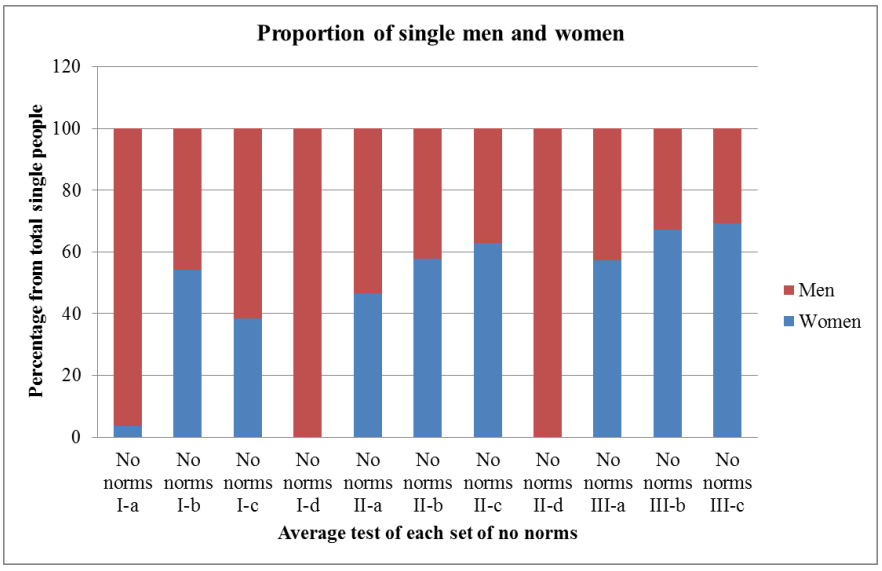


Figure 40. Proportion of unmarried men and women in the different environments without social norms. See also Tables 17 to 19 of Annex 25.

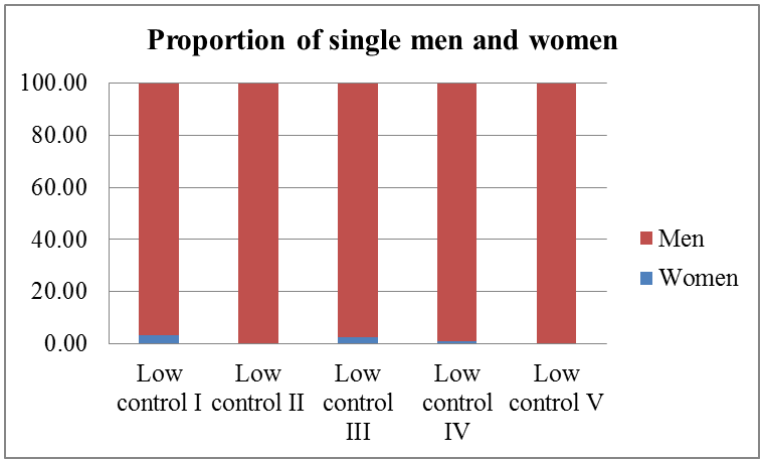


Figure 41. Proportion of unmarried men and women in the different environments of Low control. See also Table 20 of Annex 25.

It appears that, in comparison to the environments simulated without norms, in the 5 environments of Low control the proportion of unmarried women is insignificant. The organization of marriage within any of the Low control environments positively places every marriageable woman into a monogamous marriage. The fertility rate results from the active role of all the women in reproduction. In Low control IV it is more difficult for men to marry given the required conditions, which in turn delays marriage and leading to a slower dimorphic growth.

Divorce

In this part I analyse the effect of including the possibility for divorcing, together with a prolonged widowhood for women (i.e. slower reincorporation of widows into a new marriage). The social norm of divorce is configured in three different manners (Fig. 42, and Table 10):

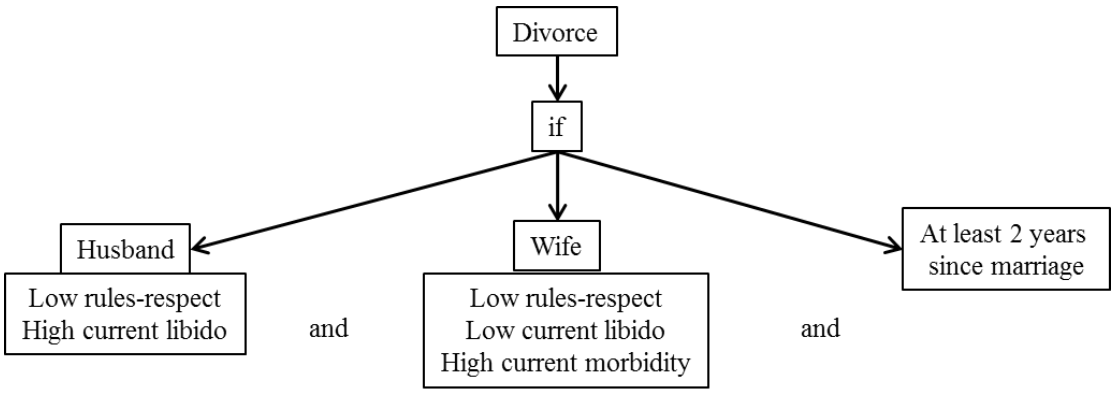


Figure 42. General schema of the norm of divorce, following environment Divorce I

Table 10. Characteristics of the environments in "Divorce". The cells highlighted indicate the differences from case to case.

Variables		Divorce I	Divorce II	Divorce III
Marriage	Male social status	Single, widower, divorced	Single, widower, divorced	Single, widower, divorced
	Female social status	Single, widow, divorced	Single, widow, divorced	Single, widow, divorced
	Male age at marriage	13#80 (gradual)	13#80 (gradual)	13#80 (gradual)
	Female age at marriage	8#75 (gradual)	8#75 (gradual)	8#75 (gradual)
	Priority male candidates	Current boldness+ current health+ current libido	Current boldness+ current health+ current libido	Current boldness+ current health+ current libido
	Priority female candidates	Current health - current morbidity	Current health - current morbidity	Current health - current morbidity
	Female candidate conditions	Widows: high current boldness	Widows: high current boldness	Widows: high current boldness, **age 18#35**
	Conditions for marriage acceptation	Exogamy, fulfil 1 out of 1 condition	Exogamy, fulfil 1 out of 1 condition	Exogamy, fulfil 1 out of 1 condition
	Marriage attempts per step	1	3	1
Divorce	Husband conditions	Low current rules-respect, high current libido	Low current rules-respect, high current libido	Low current rules-respect, high current libido
	Wife conditions	Low rules-respect, low current libido, high current morbidity	Low rules-respect, low current libido, high current morbidity	Low rules-respect, low current libido, high current morbidity
	Term	At least 2 years after marriage	At least 2 years after marriage	At least 3 years after marriage
	Other conditions	None	None	None
	Husband conditions	None	None	None

The results show that the dissolution of marriage and the prolonged widowhood have a striking effect, leading to significant smaller population sizes after 150 steps –practically half the size of the case Low control I (Fig. 43).

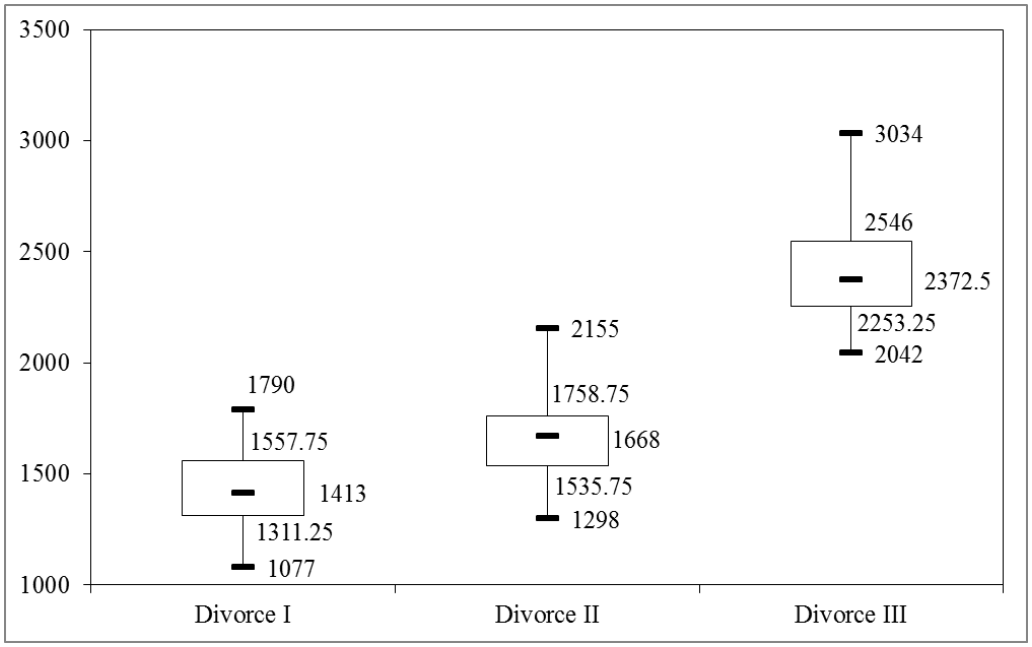


Figure 43. Results corresponding to the 30 repeated tests of the three different Divorce environments.

Divorce I presents about 20% of women who had around 8 children, and at the same time a very similar percentage of women that remained childless, explaining perhaps the lower demographic growth and smaller population size (Fig. 44). Divorce II has higher proportion of unmarried women, but this does not change that around 20% of the women had about 8 children. The main difference between Divorce I and II is that in the latter men have up to 3 attempts to marry within the same step, meaning that there are greater possibilities for the norm of marriage to be fulfilled –this explains the slightly higher population resulting in Divorce II compared to Divorce I.

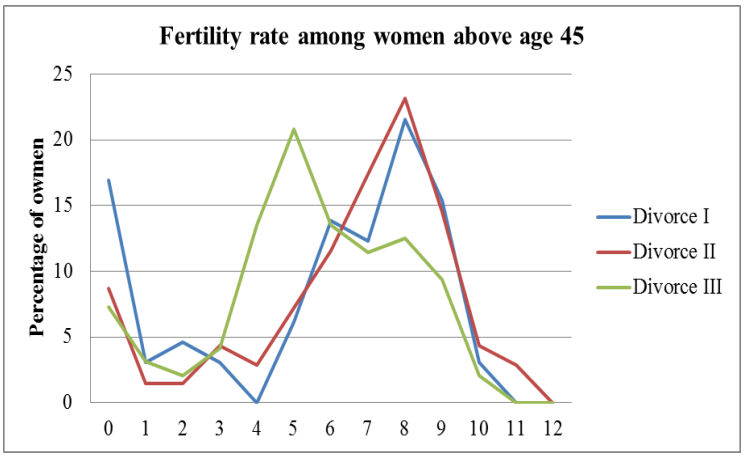


Figure 44. Fertility rates in Divorce, represented with one average test from the sample of 30 within every environment.

In Divorce III, it is more unlikely for marriages to dissolve, because the norm establishes a term of at least 3 years after marriage –there is a delayed probability for divorcing, which comparatively entails a lesser effect on restricting demographic growth. The proportion of unmarried women decreases as compared to Divorce II, as well as the distribution of women in the fertility rate, where almost 21% of women would have around 5 children and barely some 12,5% would manage to have 8. This remarkable difference may be due to the prolonged widowhood for widows, as they become less eligible for marriage and, consequently, bear fewer children (Fig. 45).

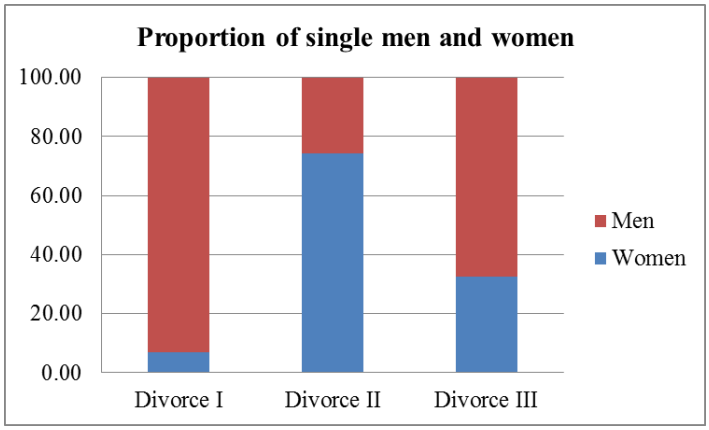


Figure 45. Proportion of unmarried men and women in the different environments of Divorce. See also Table 21 of Annex 25.

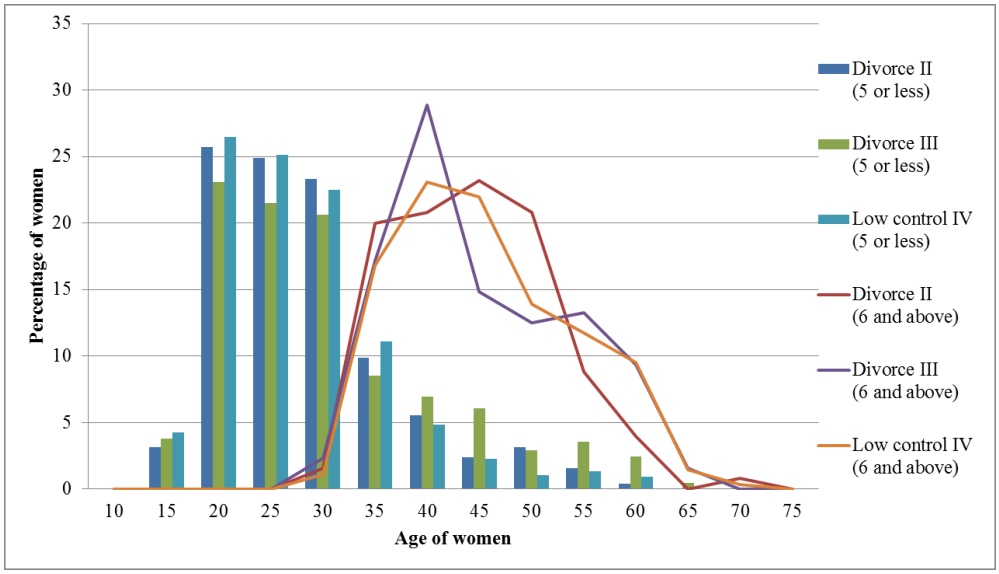


Figure 46. Age distribution of women who had 5 or less children, and 6 or more children.

Taking as a reference the Low control IV, in which fertility rate is high and the proportion of unmarried women is insignificant, there is a clear differentiated pattern on the distribution of women who had 5 or less children, and 6 or more children –I cut at the number of 5 and 6 by taking into account the fertility rates observed in Divorce III (Fig. 46). Obviously, those women who had 1 to 3 children would be mostly represented by younger women who just initiated their reproduction. However, the shift after the age of 45 clearly shows a higher percentage of women with less than 5 children in Divorce II and III as compared to Low control IV. The proportion of women who had 6 or more children is clearly distributed among older women who completed their reproductive cycle.

The resulting population size shows that the more frequent the divorce is (Divorce I and II) the less time are the women exposed to conception. In Divorce III, where divorce is less likely, the population size is considerably higher as compared to the other two environments. This is also supported by the demographic growth observed along the entire simulation (Fig.47; annual demographic growth chart in Fig. 88 of Annex 26).

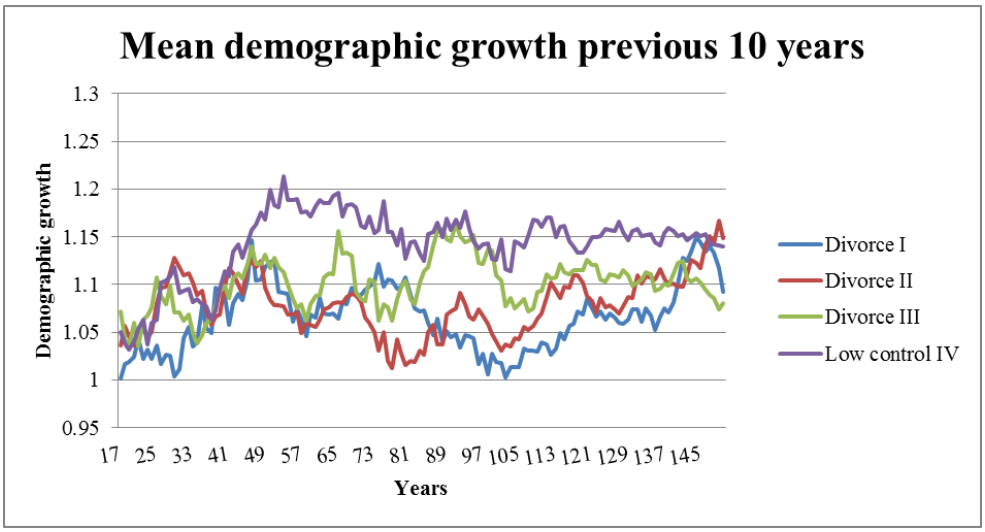


Figure 47. Mean demographic growth calculated on periods of ten years, represented by one average test out of the sample of 30 from each case.

Widowhood and widows

The configuration of a social norm that generates prolonged widowhood to widows has been already tested in No norms III-b, III-c, and in the three Divorce cases. But this particular social norm deserves its own environment to test individually. The characteristics of the environment are as shown in Table 11, and the results in Fig. 48 (see also Table 22 of Annex 25).

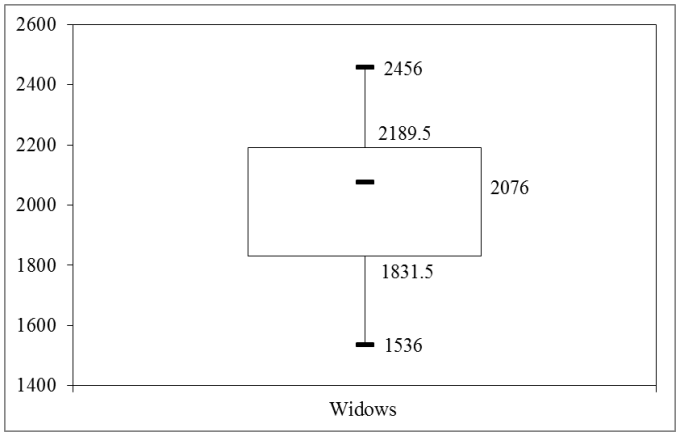


Figure 48. Total results corresponding to 30 tests of the environment "Widows".

Table 11. Characteristics of the environment of "Widows".

Variables		Widows
Marriage	Male social status	Single, widower
	Female social status	Single, widow
	Male age at marriage	13#80 (gradual)
	Female age at marriage	8#75 (gradual)
	Priority male candidates	Current boldness+ current health+ current libido
	Priority female candidates	Current health- current morbidity
	Female candidate conditions	Widows: high current boldness
	Conditions for marriage acceptation	Exogamy, fulfil 1 out of 1 conditions
	Marriage attempts per step	1

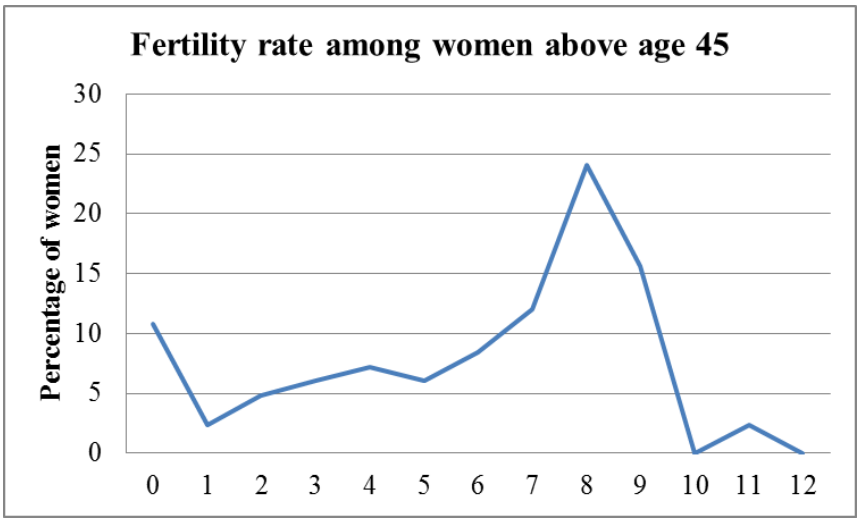


Figure 49. Fertility rates in "Widows", represented with one average test from the sample of 30.

In the environment of Widows, the demographic growth is located in-between the Low control IV (lowest demographic growth from the environments of Low control) and Divorce I (the lowest among the environments of Divorce) (Fig. 50; annual demographic growth chart in Fig.89 of Annex 26). The population experiences a slower development due to the preference for younger female candidates, meanwhile widows become less suitable to be candidates for marriage. In general terms, there is an interruption of the female potential reproduction, or even possible that in some case they cease their reproduction.

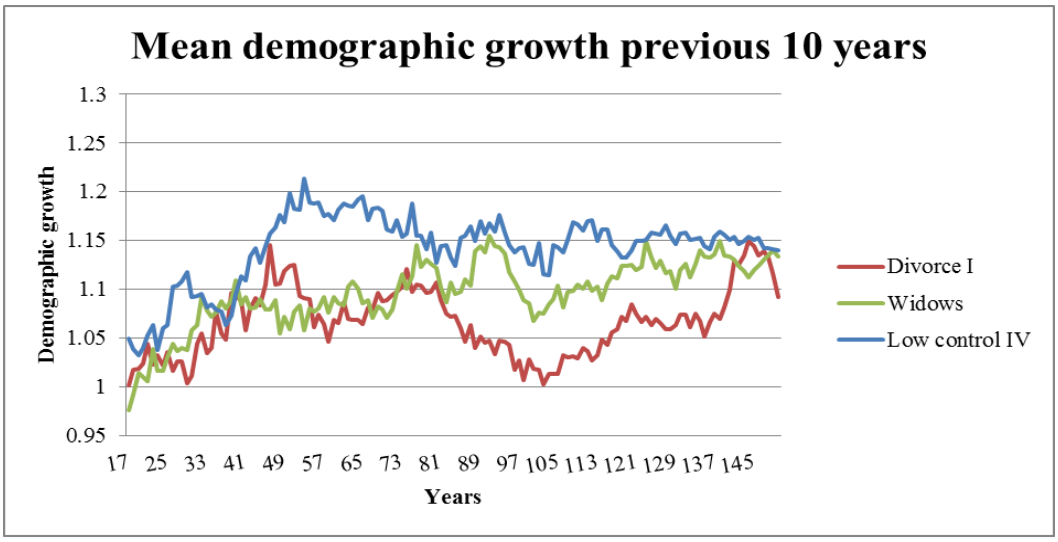


Figure 50. Demographic growth calculated on periods of ten years, exemplified with one average test out of the sample of 30 in each environment.

Polygamy

One last environment examines the effects of the practice of non-widely spread polygamous marriages (Fig.51). The marriage system remains to be mostly monogamous, nevertheless, when the circumstances are given, a married man shall marry a second wife. There are four polygamous environments prepared (Table 12). The results are displayed in Fig. 52.

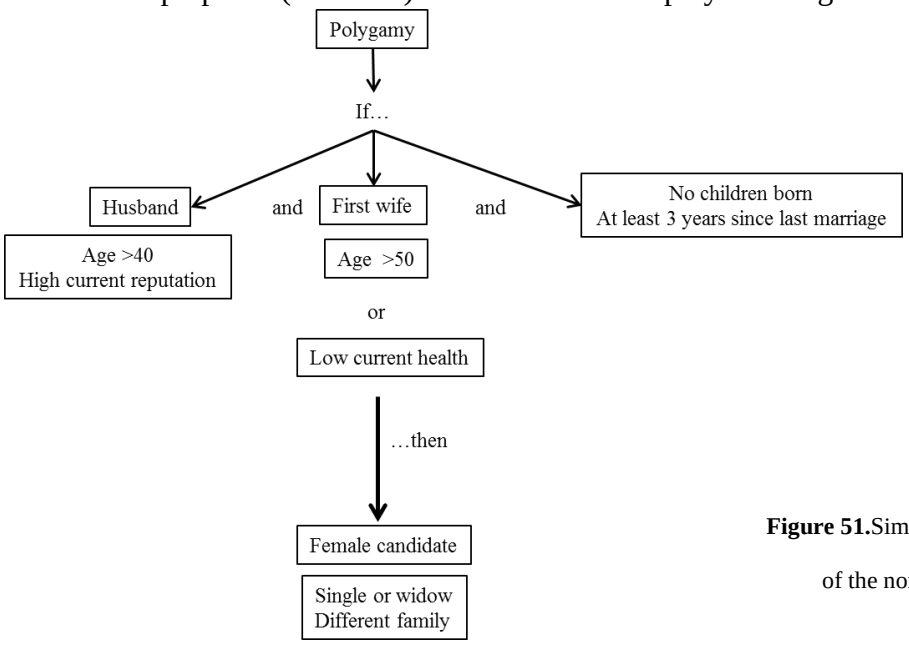


Figure 51. Simplified structure of the norm of polygamy

Table 12. Characteristics of the environments in "Polygamy". The cells highlighted indicate the main differences from case to case

Variables		Polygamy I	Polygamy II	Polygamy III	Polygamy IV
Marriage	Male social status	Single, widower, divorced, married	Single, widower, divorced, married	Single, widower, divorced, married	Single, widower, divorced, married
	Female social status	Single, widow, divorced	Single, widow, divorced	Single, widow, divorced	Single, widow, divorced
	Male age at marriage	13#80 (gradual)	13#80 (gradual)	13#80 (gradual)	13#80 (gradual)
	Female age at marriage	8#75 (gradual)	8#75 (gradual)	8#75 (gradual)	8#75 (gradual)
	Priority male candidates	Current boldness+ current health+ current libido	Current boldness+ current health+ current libido	Current boldness+ current health+ current libido	Current boldness+ current health+ current libido
	Priority female candidates	Current health- current morbidity	Current health- current morbidity	Current health- current morbidity	Current health- current morbidity
	Female candidate conditions	Widows: high current boldness	Widows: high current boldness, age 18#35	Widows: high current boldness, age 18#35	Widows: high current boldness, age 18#35
	Conditions for marriage acceptation	Exogamy, fulfil 1 out of 2 conditions	Exogamy, fulfil 1 out of 1 condition	Exogamy, fulfil 1 out of 1 condition	Exogamy, fulfil 1 out of 1 condition
	Marriage attempts per step	1	1	1	1
Divorce	Husband conditions	Low current rules-respect, high current libido	Low current rules-respect, high current libido	-	-
	Wife conditions	Low rules-respect, low current libido, high current morbidity	Low rules-respect, low current libido, high current morbidity	-	-

Variables		Polygamy I	Polygamy II	Polygamy III	Polygamy IV
	Term	At least 2 years after marriage	At least 3 years after marriage	-	-
	Other conditions	None	None	-	-
Polygamy	Husband conditions	Age 40#50, high current reputation	Age 40#60, high current reputation	Age 40#60, high current reputation	Age 40#60, high current reputation
	Wife conditions	Age +50 or current health low. No children	Age +40 or current health low. No children	Age +40 or current morbidity high. No children	Age +40 or current morbidity high. No children
	Single female candidate	Single, widow (1 restriction), exogamy	Single, widow (1 restriction), exogamy	Single, widow (1 restriction), exogamy	Single, widow (2 restrictions), exogamy
	Term	At least 3 years after marriage	At least 3 years after marriage	At least 3 years after marriage	At least 3 years after marriage
	Other conditions	Maximum 2 wives	Maximum 2 wives	Maximum 2 wives	Maximum 2 wives
	Marriage attempts per step	1	1	1	1
	If successful	Husband current libido-100	Husband current libido-100	$\frac{Husband\ libido}{2}$	$\frac{Husband\ libido}{2}$

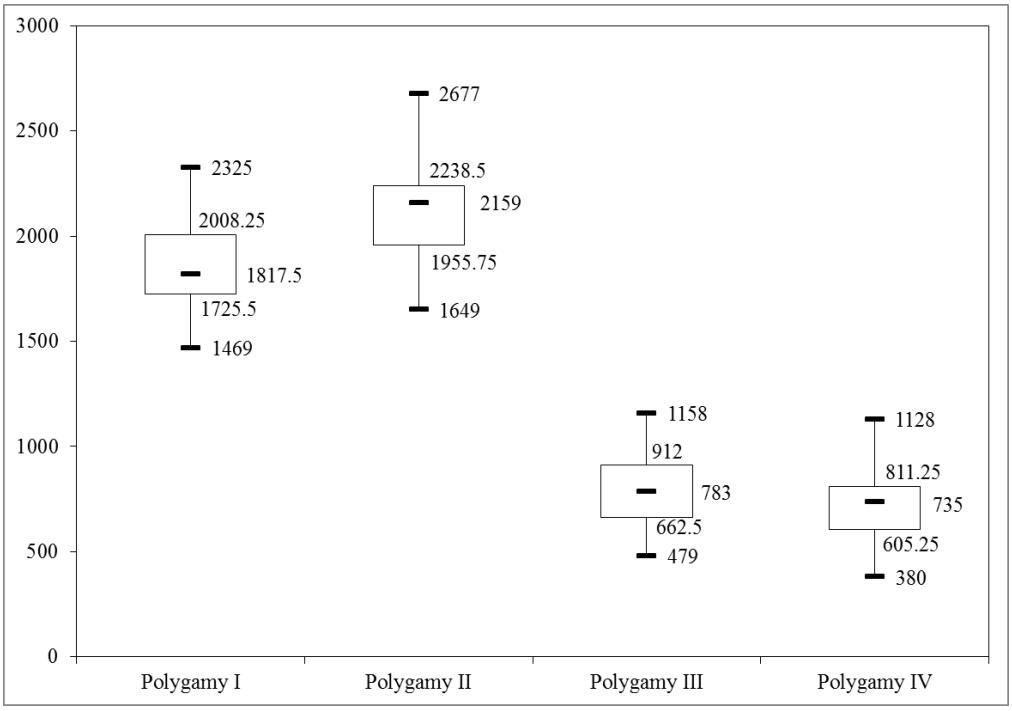


Figure 52. Total results corresponding to 30 tests of every polygamous environment.

On regard to the fertility rates, there is a drastic redistribution of women 45 years old or older (Fig.53):

- Polygamy I shows two peaks of 14% of women who had up to 5 or 8 children, whereas up to 20% had 6 or 7. Polygamy II presents the same pattern observed in the previous environments, although the percentage of women concentrated around 6 children is smaller. On first sight, it appears that the norm of polygamy compensates the demographic decrease pushed by the social norms of divorce and prolonged widowhood.

- Polygamy III includes one additional restriction for widows to enter into a polygamous marriage; and Polygamy IV includes two additional restrictions while at the same time the coitus frequency within polygamous marriages is limited. These conditions clearly transform the fertility rate, especially in the latter case where 20% of the women (probably widows) had an average of 4 children.

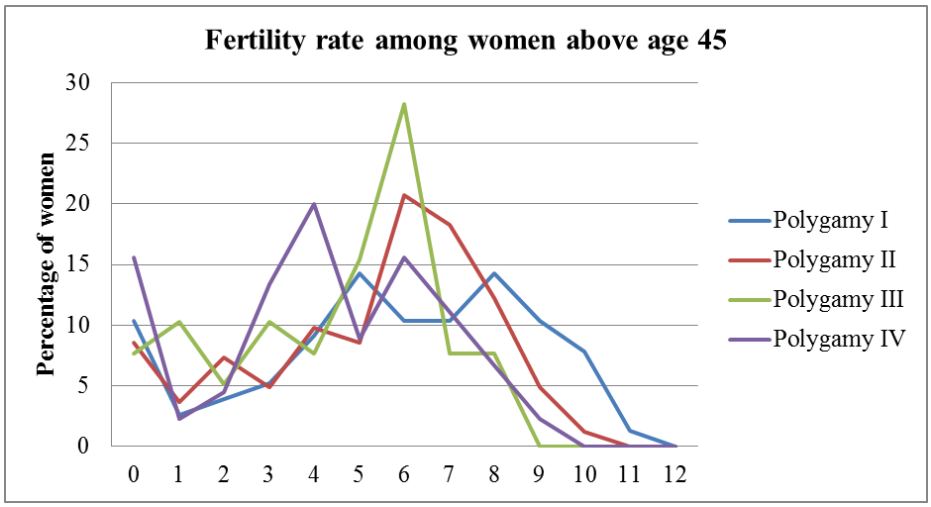


Figure 53. Fertility rates of the different environment of Polygamy, represented by one average test out of a sample size of 30 tests in each case.

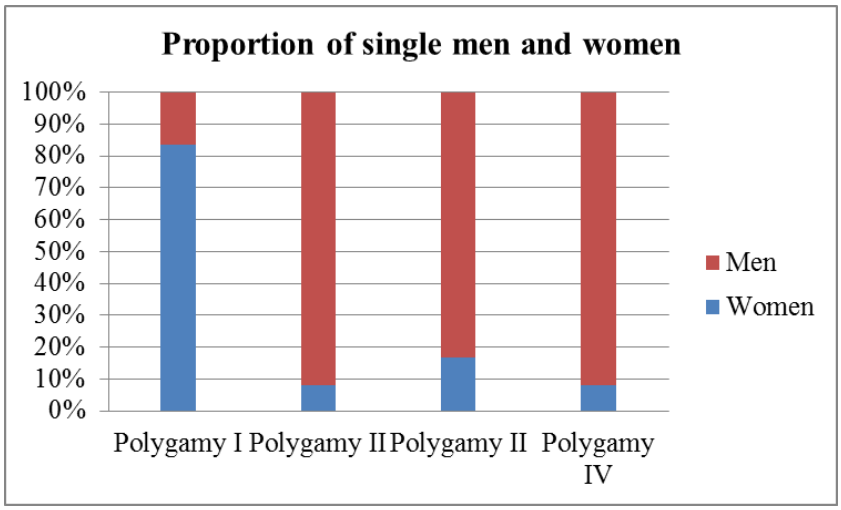


Figure 54. Proportion of single men and women in the different environments of Polygamy, represented by one average test out of a sample size of 30 tests in each case. See also Table 23 of Annex 25.

In Polygamous I it is easier for widows to remarry as compared to polygamous II, III, IV, which may explain the higher proportion of unmarried women (single or divorced) (Fig. 54). In the exact same environment allowing only monogamous marriages (Minimum control-monogamous), there are more widows who are still at a reproductive age (between 18 and 45), as compared to the other sets of polygamous environments where less widows are counted – especially Polygamy I (Fig. 55).

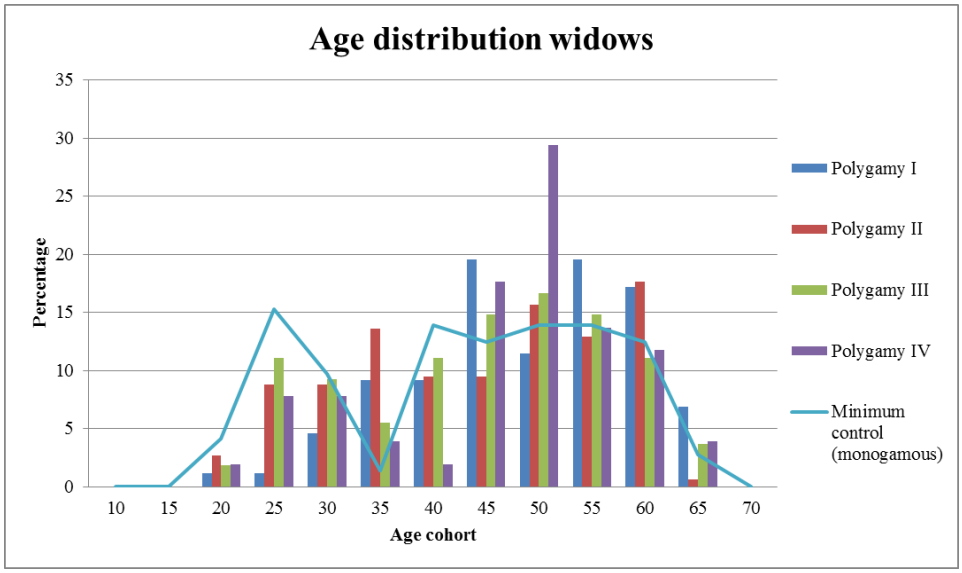


Figure 55. Comparison percentage widows from sets of polygamy and one monogamous case.

On the overall, the highest and lowest demographic growths observed among the norms of polygamy present a lower demographic growth compared to the previous environments analysed (Fig.56; annual demographic growth chart in Fig.90 of Annex 26).

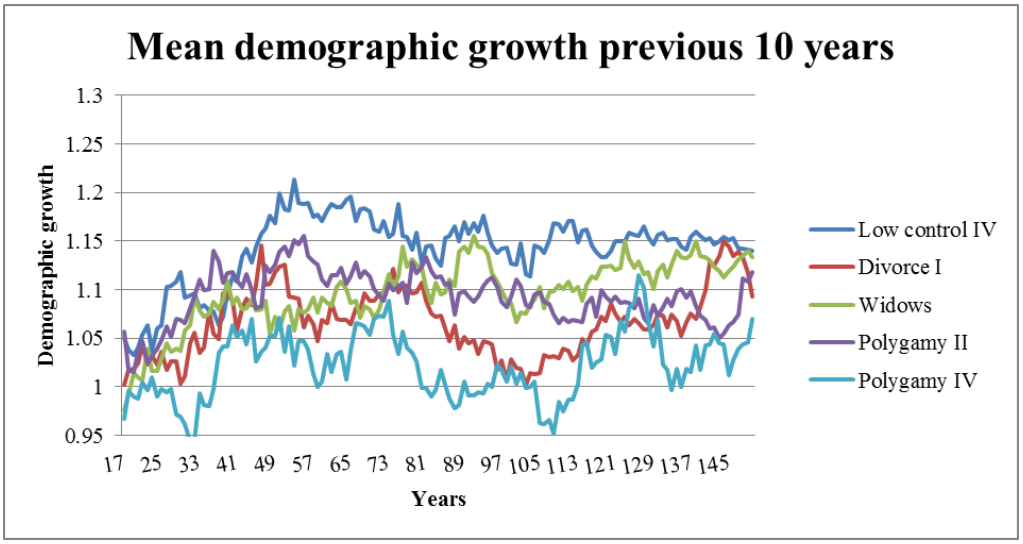


Figure 56. Mean demographic growth calculated on periods of ten years, represented by one average test out of a sample size of 30 tests in each case.

The ultimate observation to point out on this last section is that the proportion of women being reproductively active (within marriage) can alter significantly the long-term demographic development.

Simulations: less restrictive social norms

After analysing individually every social norm, in this section I present the results of the simulations in which I applied a complete package of the less restrictive social norms stated in the context of a foraging society inspired on the ethnographic accounts for the southern African hunters (Annex 23). The biological environment remains the same as seen in the previous section, as well as the age at marriage.

Minimum control

I prepared two environments in which I incorporate a complete package of the less restrictive social norms, as shown in Table 13. The main difference between the two environments is the length of the intervals between births. In all the previous simulations the length consisted of three years. On this occasion, I also test a length of 5 years. Looking at the population size resulting there is an unquestionable difference in the results caused only by the readjustment of the intervals in-between births (Fig. 57).

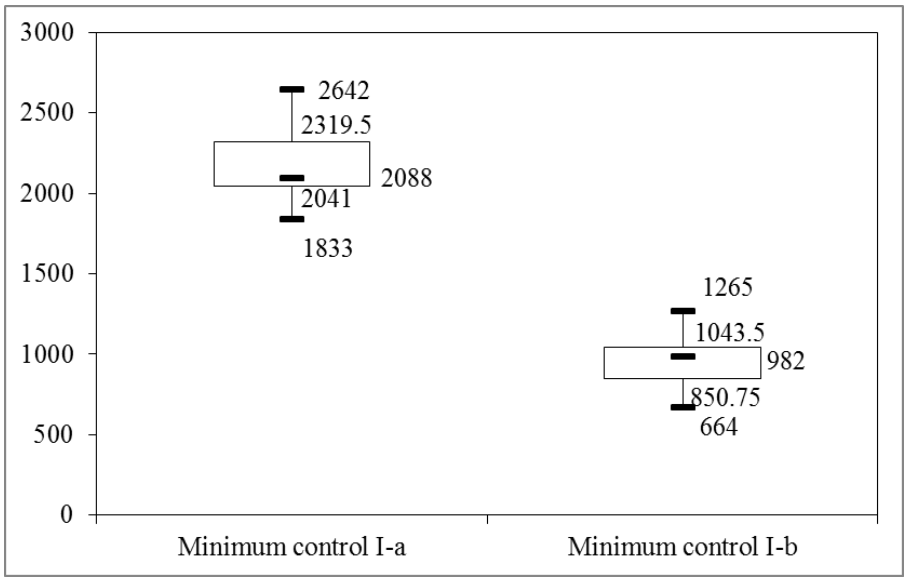


Figure 57. Total results corresponding to 30 tests of minimum control I-a and I-b. See also Table 24 of Annex 25.

Table 13. Characteristics of the environments in "Minimum control". The cells highlighted indicate the differences from case to case

Variables		Minimum control I-a	Minimum control I-b
Marriage	Male social status	Single, widower, divorced, married	Single, widower, divorced, married
	Female social status	Single, widow, divorced	Single, widow, divorced
	Male age at marriage	13#80 (gradual)	13#80 (gradual)
	Female age at marriage	8#75 (gradual)	8#75 (gradual)
	Priority male candidates	Current boldness+ current health+ current libido	Current boldness+ current health+ current libido
	Priority female candidates	Current health- current morbidity	Current health- current morbidity
	Female candidate conditions	Widows: current boldness, age 18#35	Widows: current boldness, age 18#36
	Conditions for marriage acceptation	Exogamy, fulfil 1 out of 3 conditions	Exogamy, fulfil 1 out of 3 conditions
	Marriage attempts per step	1	1
Divorce	Husband conditions	Low current rules-respect, high current libido	Low current rules-respect, high current libido
	Wife conditions	Low rules-respect, low current libido, high current morbidity	Low rules-respect, low current libido, high current morbidity
	Term	At least 3 years after marriage	At least 3 years after marriage
	Other conditions	None	None
Polygamy	Husband conditions	Age 40#60, high current reputation	Age 40#60, high current reputation
	Wife conditions	Age +40 or current morbidity. No children,	Age +40 or current morbidity. No children,
	Single female candidate	Single, widow, exogamy	Single, widow, exogamy
	Term	At least 3 years after marriage	At least 3 years after marriage
	Other conditions	Married to one wife only	Married to one wife only
	Marriage attempts per step	1	1
Length birth intervals		3	5

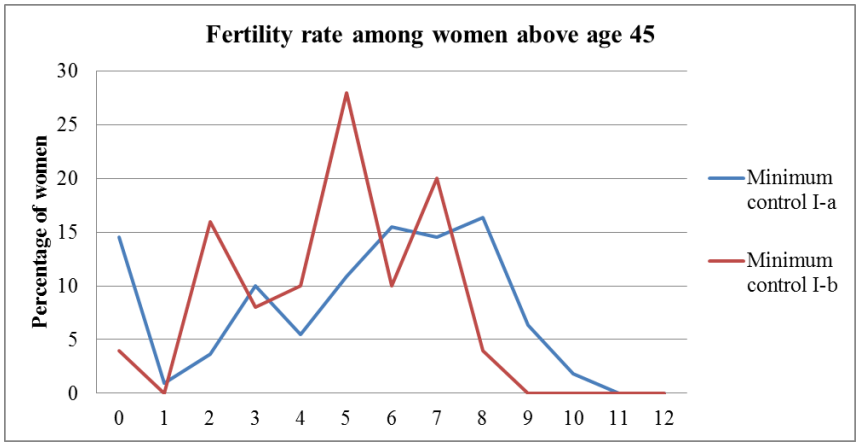


Figure 58. Fertility rates of the norms Minimum control I-a and I-b, represented by one average test out of a sample size of 30 tests in each case.

The attested slower demographic growth is also reflected in the fertility rate and population growth along the 150 years (Figs. 58 and 59; annual demographic growth chart in Fig. 91 of Annex 26). Minimum control I-a concentrates practically 45% of the post-reproductive women with 6 to 8 children, although another 15% remain childless. Comparatively, only 20% in Minimum control I-b had 7 children, whereas almost 30% gave birth to only 5.

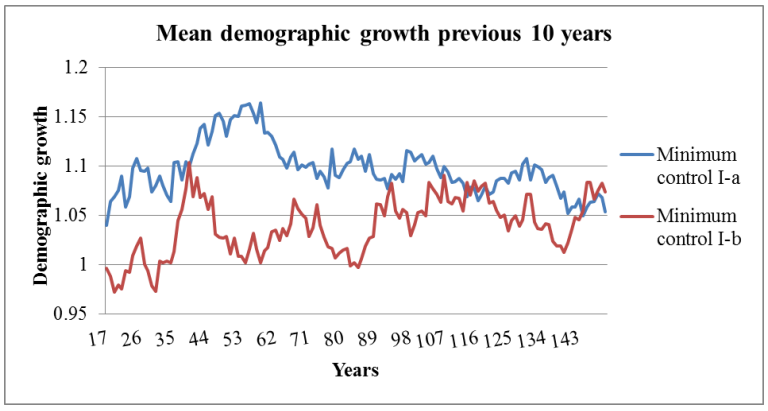


Figure 59. Mean demographic growth calculated on periods of ten years, represented by one average test out of a sample size of 30 tests in each case.

It is important to understand and to remember that behind the intended prolongation of breastfeeding or intended long spacing between births do not respond to any biological law of reproduction. Completely the opposite, they respond to the social choice and the social organization of fertility.

To conclude this section, I showed that the minimum expression of the social norms has an impact on the demographic growth of the populations as compared to the simulations in which only biological variables were considered. However, in any of the environments until now discussed the population size is not sustainable in the long-term.

Simulations: most restrictive social norms

In this section I show and discuss the results and patterns occurring in the simulations under the most restrictive norms within the context of the foraging populations (Annex 23). In the same manner, the biological parameters remain to be the same. On this occasion it has been possible to extend the simulations 450 steps (hence, 450 years). In order to assess the development of the cases depending on every social norm, I include separate environments in which I organize the social norms differently (Table 14). The results are shown in Fig. 60. In general, the populations present a very stable demographic growth and size, with a quite well balanced relation between fertility and mortality rates (Fig. 61; annual demographic growth chart in Fig. 92 of Annex 26).

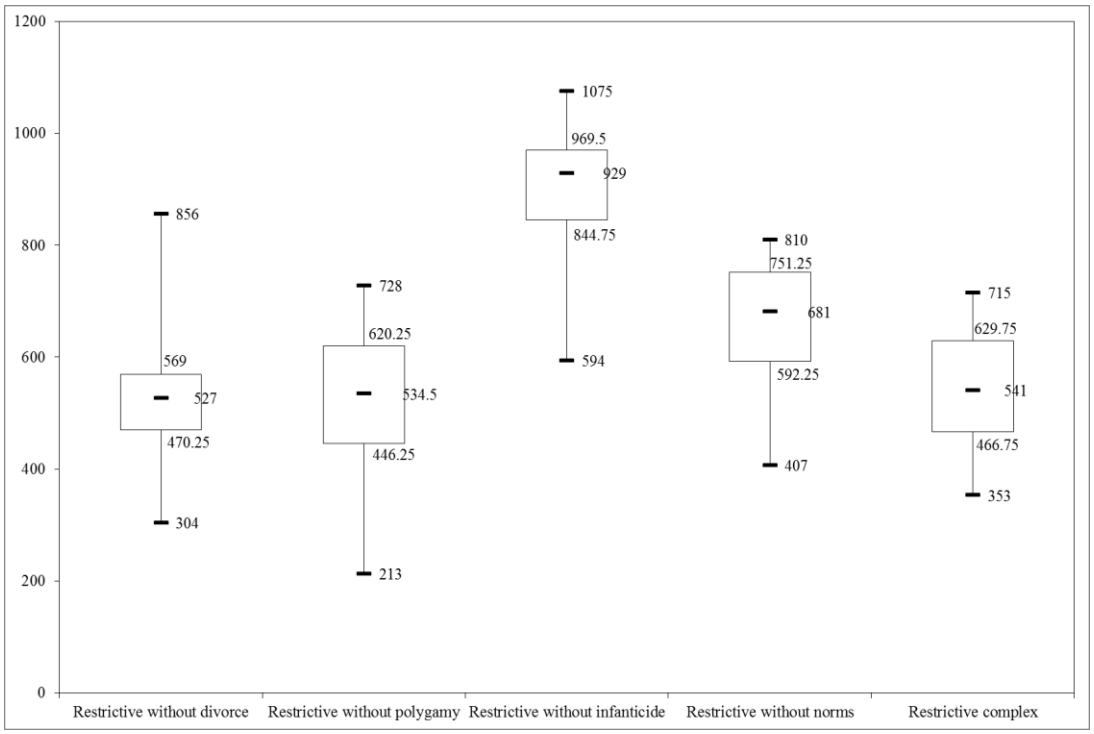


Figure 60. Total results of the simulations including the restrictive norms, and the modified environments to isolate the effect of every social norm.

Table 14. Characteristics of the environments in "Restrictive complex". The cells highlighted indicate the differences from case to case

Variables		Restrictive without divorce	Restrictive without polygamy	Restrictive without infanticide	Restrictive without norms	Restrictive complex
Marriage	Male social status	Single, widower, married	Single, widower, divorced, married	Single, widower, divorced, married	Single, widower	Single, widower, divorced, married
	Female social status	Single, widow	Single, widow, divorced	Single, widow, divorced	Single, widow	Single, widow, divorced
	Male age at marriage	22#80 (gradual)	22#80 (gradual)	22#80 (gradual)	22#80 (gradual)	22#80 (gradual)
	Female age at marriage	15#75 (gradual)	15#75 (gradual)	15#75 (gradual)	15#75 (gradual)	15#75 (gradual)
	Priority male candidates	Current boldness+ current health+ current libido	Current boldness+ current health+ current libido	Current boldness+ current health+ current libido	Current boldness+ current health+ current libido	Current boldness,+ current health+ current libido
	Priority female candidates	Current health -current morbidity	Current health -current morbidity	Current health -current morbidity	Current health -current morbidity	Current health -current morbidity
	Male candidate conditions	None	None	None	None	None
	Female candidate conditions	Widows: high current boldness, age 18#35	Widows: high current boldness, age 18#35	Widows: high current boldness, age 18#35	Widows: high current boldness, age 18#35	Widows: high current boldness, age 18#35
	Conditions for marriage acceptation	Exogamy, fulfil 1 out of 3 conditions	Exogamy, fulfil 1 out of 3 conditions	Exogamy, fulfil 1 out of 3 conditions	Exogamy, fulfil 1 out of 3 conditions	Exogamy, fulfil 1 out of 3 conditions
	Marriage attempts per step	1	3	3	3	3
Divorce	Husband conditions	-	Low current rules-respect, high current morbidity (1 out of 2)	Low current rules-respect, high current morbidity (1 out of 2)	-	Low current rules-respect, high current morbidity (1 out of 2)
	Wife conditions	-	Low rules-respect & high current morbidity, or low current libido (1 out of 2)	Low rules-respect & high current morbidity, or low current libido (1 out of 2)	-	Low rules-respect & high current morbidity, or low current libido (1 out of 2)
	Term	-	Less than 3 years after marriage	Less than 3 years after marriage	-	Less than 3 years after marriage
	Other conditions	-	None	None	-	None

Variables		Restrictive without divorce	Restrictive without polygamy	Restrictive without infanticide	Restrictive without norms	Restrictive complex
Polygamy	Husband conditions	Age +30, high current reputation	-	Age +30, high current reputation	-	Age +30, high current reputation
	Wife conditions	Age +35 or current health low. No children,	-	Age +35 or current health low. No children,	-	Age +35 or current health low. No children,
	Single female candidate	Single, widow, divorced, exogamy	-	Single, widow, divorced, exogamy	-	Single, widow, divorced, exogamy
	Term	Less than 3 years after last marriage	--	Less than 3 years after last marriage	-	Less than 3 years after last marriage
	Other conditions	Maximum four wives	-	Maximum four wives	-	Maximum four wives
	Marriage attempts per step	1	-	1	-	1
Infanticide	Conditions	Mother or newborn's health low	Mother or newborn's health low	-	-	Mother or newborn's health low
	Birth spacing	5	5	-	-	5

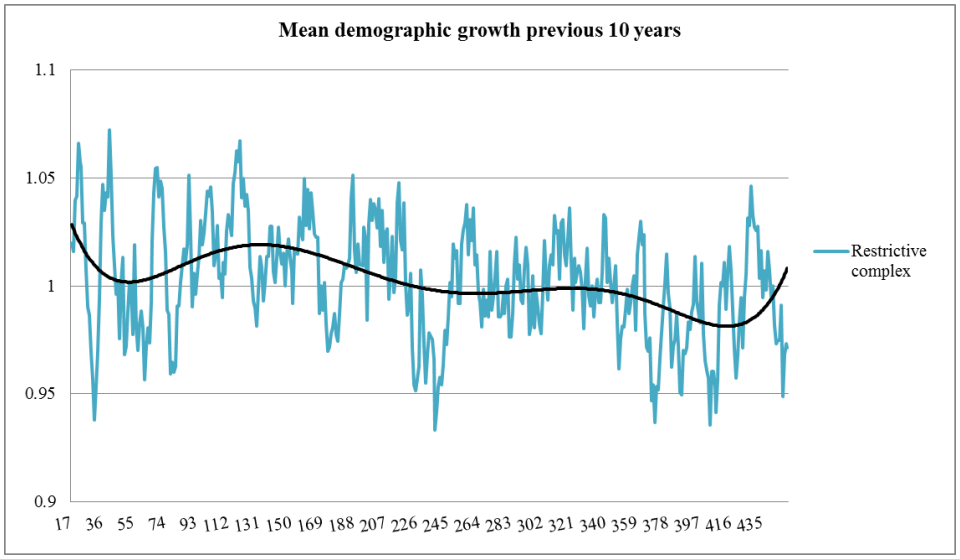


Figure 61. Mean demographic growth in the environment of Restrictive complex, represented by one average test out of a sample size of 30 tests in each case.

Clearly the norm of infanticide is the most effective in regulating demographic growth, but a delayed age at marriage and prolonged birth intervals may be likewise sufficient to hold a population growth small. The fertility rate is noticeably smaller in all cases, below 7 children per woman (Fig. 62). The effect polygamy may have is noticed when comparing the distribution of post-reproductive women in the monogamous setting (without polygamy) with those environments that do include polygamy –as seen before, the polygamous marriages absorb women who may have otherwise remained divorced or widow longer (Fig. 63).

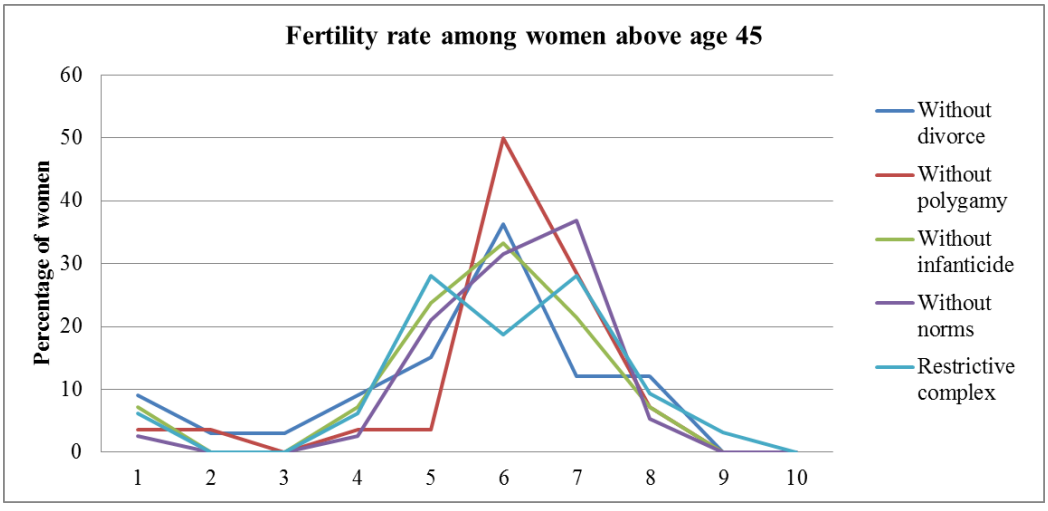


Figure 62. Fertility rates in the environments of Restrictive complex, represented by one average test out of a sample size of 30 tests in each case.

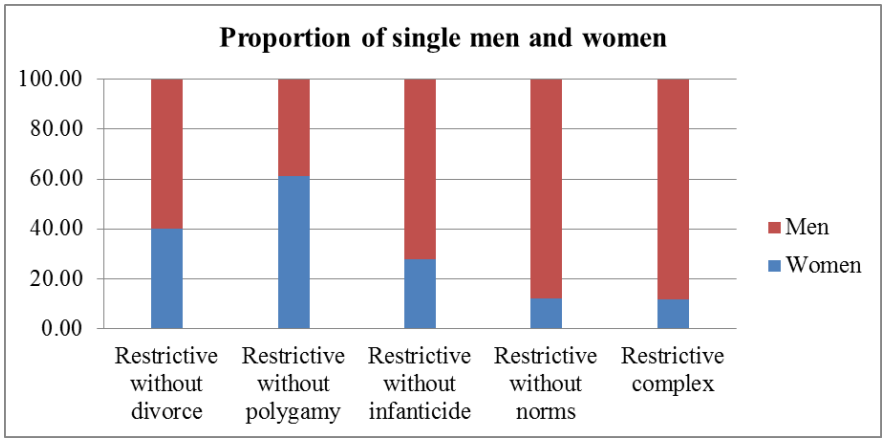


Figure 63. Proportion of single men and women from all restrictive environments (with and without norms), represented from one average test out of sample of 30 tests. See also Table 25 of Annex 25.

Simulating pastoralists

Following the same agenda established for the social norms associated to the hunter-fisher-gatherers, I have also organized the norms into two units for the pastoralist populations: less restrictive and most restrictive norms. The first includes the less restrictive norms, together with the same simulation context in which I exclude certain norms in order to assess the impact and variability. In the second I include the most restrictive norms, again including cases in which single norms are excluded to assess their impact and variability. As explained earlier, the initial artificial community contains the exact same population composition as the one used for the simulations of the hunter-gatherers. Other variables such as life expectancy and mortality probabilities also remain unchanged.

The variables called "reputation" and "current reputation" required of a reconceptualization to fit into the social behaviour of pastoralists. In the context of the simulations of the pastoralist populations, these two variables represent the amount of cattle an adult man has. In the context of the pastoralists, cattle was exchanged or slaughtered under certain social circumstances[83]. In

[83] The cattle of a family headman would be commonly used ritually in certain events of the life course of boys and girls, men and women (Kolb, 1738; Engelbrecht, 1936; Hoernlé, 1925; Mossop/Wikar, [1779] 1935; Schapera,

this manner, in the simulation the function of the variables "reputation" and "current reputation" is related to the social events of attainment of adulthood and marriage, borne by the father of the adolescents, and by the single man when asking for marriage. Paying special attention to Kolb's account (1789), he specifies that the eldest son may inherit all possessions from the father after the father's death, but if the eldest son marries while his father is still alive he will inherit only the proportional share with his other brothers, which is configured under the following formula, where reputation refers to the father's reputation:

$$\frac{reputation}{childrennmales + 1}$$

When the son becomes an adult, he received his shared according to the formula, and this share will automatically become his own "reputation" (his own cattle stock). Considering that cattle have its own demography, with unpredictably increasing or decreasing, the current reputation of a man will vary in every step in accordance to the following predefined formula:

$$reputation + \frac{reputation * configuredrandom}{1000} * \frac{currentrulesrespect}{5000}$$

The random configuration of this formula consists of a random increase (up to 16%) or decrease (up to 10%) of the reputation. This arrangement aims to incorporate the natural and at the same time occasionally unpredictable growth and decrease of the demographic size of the cattle stock. The variable of rules-respect is taken into account in order to include the agent's self-implication (a high rules-respect will increase the percentage added to the reputation, and low rules-respect will decrease the percentage added, unless the chance is negative).

In the next stage in life, any adult man will search for a wife, which on this occasion, he will have to purchase by paying the bride price. Instead of fixing the bride price to a specific amount of cattle (fixed amount of current reputation), it is calculated based on the female candidate's current reputation:

$$\frac{reputation}{2500} * 500$$

1965; Schapera & Farrington/Dapper, [1670] 1933; Schapera & Farrington/Grevenbroek, [1695]1933; Schinz, 1891; Schreyer, [1681] 1931; Stow, 1905).

In a different manner, the current reputation of a woman changes when she becomes adult (and single) following two formulas designed that combine several variables from her father, mother, and herself:

$$500 * \frac{health}{5000} * \frac{motherfecundity}{5000} * \frac{2400}{currentmorbidity}$$

$$500 * \frac{fatherreputation}{5000} * \frac{motherfertility}{5000} * \frac{2400}{currentmorbidity}$$

These two formulas will test the variability resulting from establishing the father's reputation[84] or alternatively the single woman's own health as variables defining the bride price. In any of the cases, in the event of a marriage, the price of the bride is subtracted from the single man's current reputation.

The remaining settings of the norms follow the same character as seen in the case of the foragers. Unfortunately, the amount of information found in the ethnohistorical sources connected to pastoralists was less detailed and for this reason the configuration of the simulations is less precise.

Simulations: less restrictive norms

The structure of every set of norms is detailed in Table 15. Every simulation in this section consists of a period with a length of 150 years. The results show a demographic growth lower as compared to the unit of simulations including only biological variables, but still excessive for such a short period (Fig. 64).

[84] The higher the father's reputation, the higher the price of the bride is and, therefore, the father's reputation increases greatly in accordance to the number of daughters he gives away for marriage. However, this formula lowers the possibilities for the daughter to find a partner wealthy enough to marry.

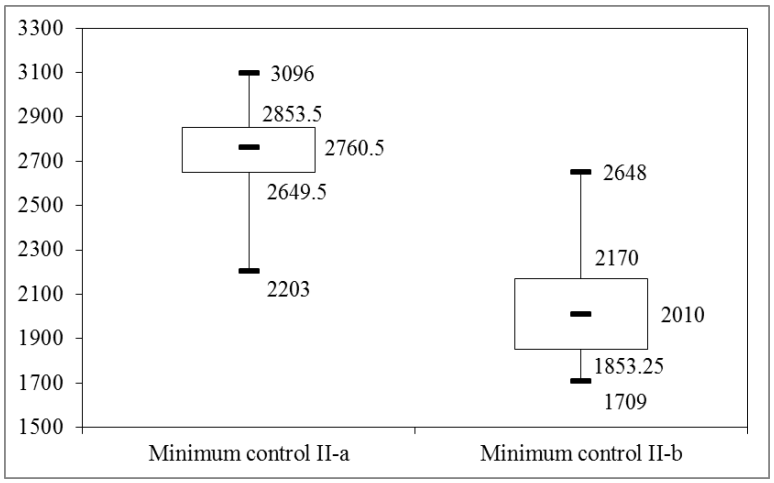


Figure 64. Total **r**esults of the simulations including the minimum restrictive norms II-a and II-b.

The fertility rates show a concentration of post-reproductive women around 8 to 9 children (Fig. 65). However, it highly surprising that, despite the large population size, after only 150 years both environments present more than 30% of women who remained childless. The explanation behind lays on the proportion of unmarried women as compared to the environments presented previously. In these two environments, the proportion of single people is equally represented by men and women (Fig. 66). It appears that the successful fulfilment of marriage became too complex and complicated that it leaves many potential women out of the reproduction engine.

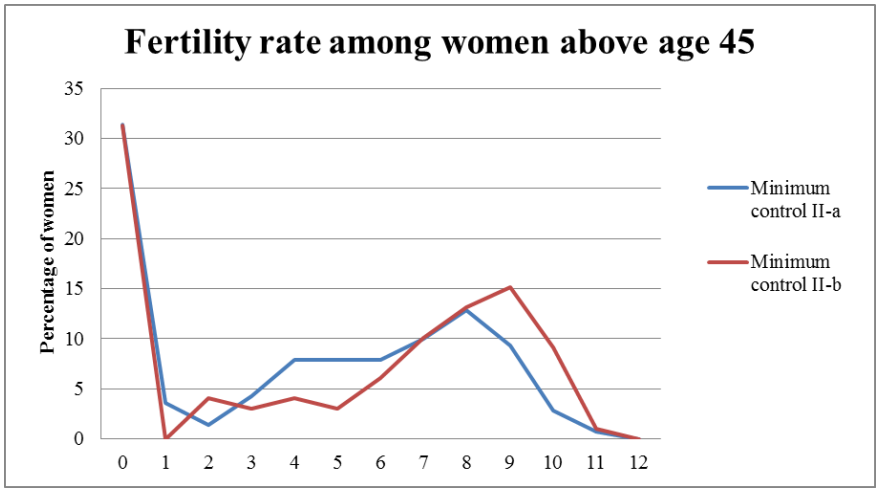


Figure 65. Fertility rates of the women above the age of 45 in the environments of minimum control, represented by one average test out of a sample size of 30 tests in each case.

Table 15. Characteristics of the environments in “minimum control" among pastoralists. The cells highlighted indicate the differences from case to case

Variables		Minimum control II-a	Minimum control II-b
Marriage	Girls to single	father_reputation-500	father_reputation-current_morbidity
	Boy to single	current_reputation+250	current_reputation+250
	Male social status	Single, Widowed	Single, Widowed
	Female social status	Single, Widowed	Single, Widowed
	Male age at marriage	20#80	20#80
	Female age at marriage	16#75	16#75
	Male reputation increase	reputation+reputation*configured_random/1000* current_rulesrespect/5000	reputation+reputation*configured_random/1000* current_rulesrespect/5000
	Single female current reputation	500*father_reputation/5000* mother_fertility/5000	500*father_reputation/5000* mother_fertility/5000
	Priority male candidates	High reputation	High reputation
	Priority female candidates	Current health- current morbidity	Current health- current morbidity
	Bride price	[woman’s] reputation/2500*500	[woman’s] reputation/2500*500
	Married man’s current reputation	reputation/(children_nmales+1)	reputation/(children_nmales+1)
	Widows	17#35	17#35
	Conditions for marriage acceptation	Exogamy, fulfil 1 de out 3	Exogamy, fulfil 1 de out 3
	Marriage attempts per step	3	3
Divorce	Husband conditions	Low current rules-respect, high current libido (1 out of 2)	Low current rules-respect, high current libido (1 out of 2)
	Wife conditions	Low current rules-respect & high current morbidity, or low current libido (1 out of 2)	Low current rules-respect & high current morbidity, or low current libido, (1 out of 2)
	Term	At least 3 after marriage	At least 3 after marriage
	Other conditions	None	None
Polygamy	Husband conditions	30#70, high current reputation	30#70, high current reputation
	Wife conditions	35#75, high current morbidity, 0 children	35#75, high current morbidity, 0 children
	Single female candidate	Single, restricted widow	Single, restricted widow
	Term	At least 3 after marriage	At least 3 after marriage
	Other conditions	maximum 2 wives	maximum 2 wives
	Marriage attempts	1	1
Infanticide	Conditions	[newborn] very low health	[newborn] very low health

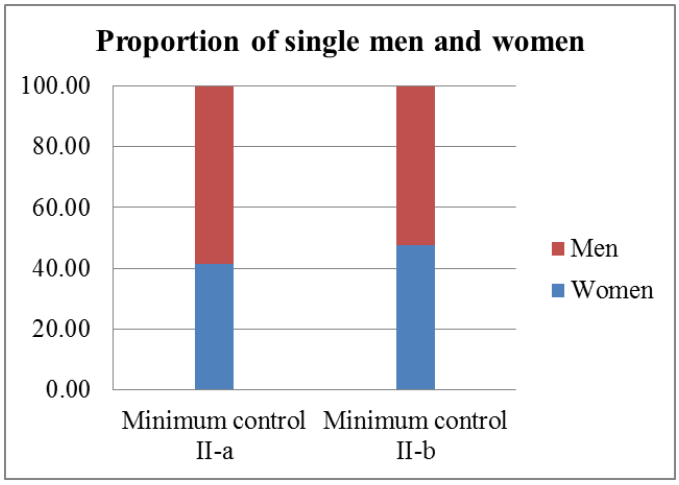


Figure 66. Proportion of unmarried people in the cases of minimum control, represented by one average test out of a sample size of 30 tests in each case. See also Table 26 of Annex 25.

The demographic growth shows a decreasing curve at the end of the simulation, nevertheless, it is very likely that it may follow a more or less stable development (Fig. 67; annual demographic growth chart in Fig. 93 of Annex 26).

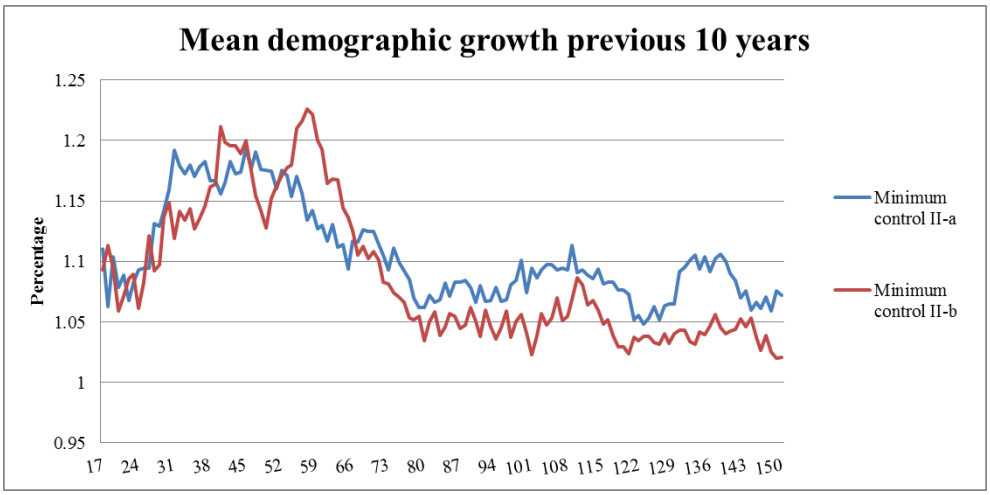


Figure 67. Mean demographic growth in the environment of minimum control among pastoralists, represented by one average test out of a sample size of 30 tests in each case.

Just as an overview, when removing individually each of the social norms included in these simulations, it is possible to further frame the demographic profiles obtained (Fig. 68):

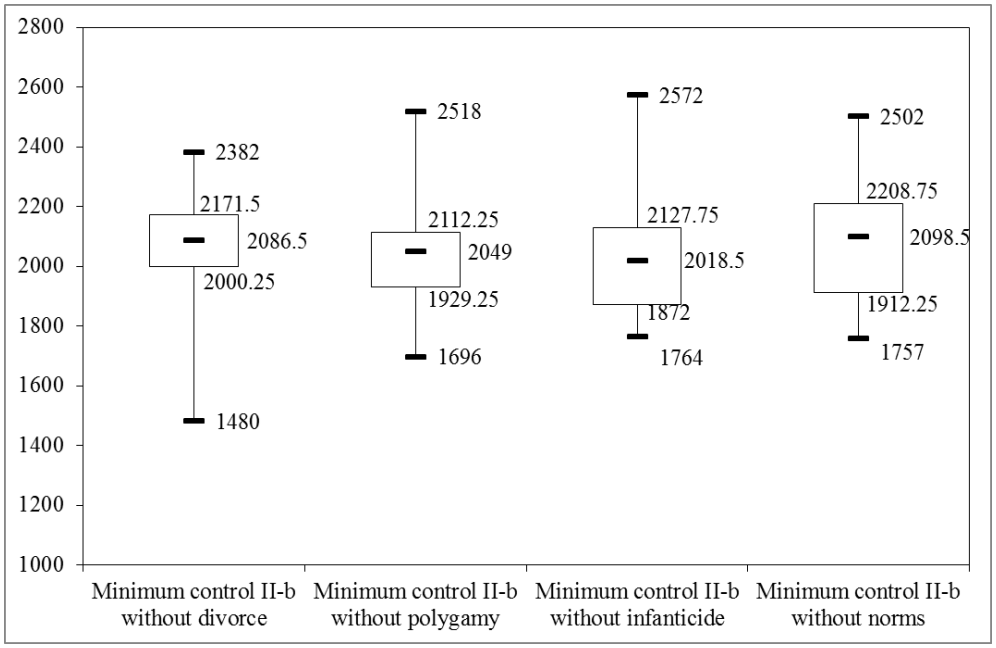


Figure 68. Total results of the simulations including the minimum restrictive norms, including cases excluding individually the social norms.

The percentage of childless women 45 years old and older increases significantly when excluding the social norms of divorce, polygamy and infanticide (Fig. 69). Another 15% remains unchanged around the peak of 8 to 9 children in all cases, except in the simulations without any social norms. Among the latter, it appears that the organization of marriage around the bride price as it has been conceptualized in these simulations shows a flattened distribution of the fertility rate, in which practically 50% of the post-reproductive women are distributed between 6 to 9 children.

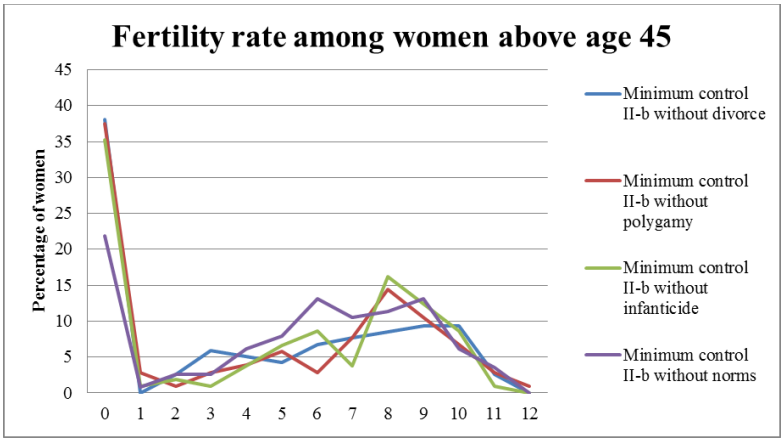


Figure 69. Fertility rates of the women above the age of 45 in the environments of minimum control represented by one average test out of a sample size of 30 tests in each case.

Interestingly, the proportion of unmarried women decreases when the social norms of divorce and polygamy combined are included, whereas with their absence the proportion increases (Fig. 70). In a manner it appears that these two social norms absorb or re-insert unmarried women into the pool of marriageable.

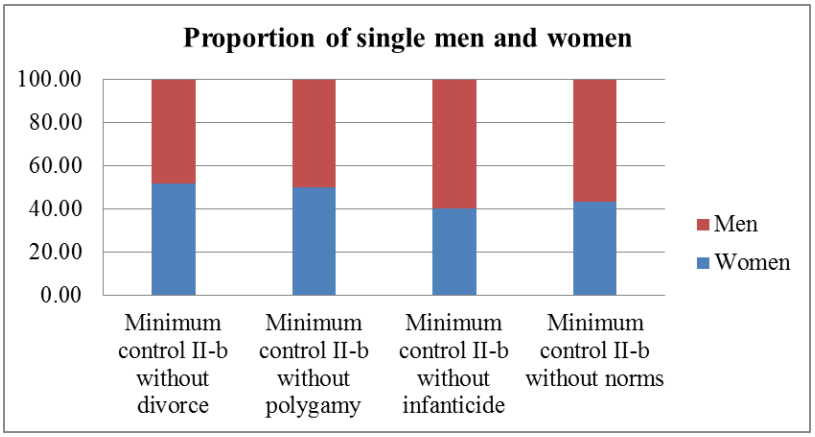


Figure 70. Proportion of unmarried people in the cases of minimum control, represented by one average test out of a sample size of 30 tests in each case. See also Table 27 of Annex 25.

On the overall, the demographic growth in all four cases is very similar (Fig. 71; annual demographic growth chart in Fig. 94 of Annex 26):

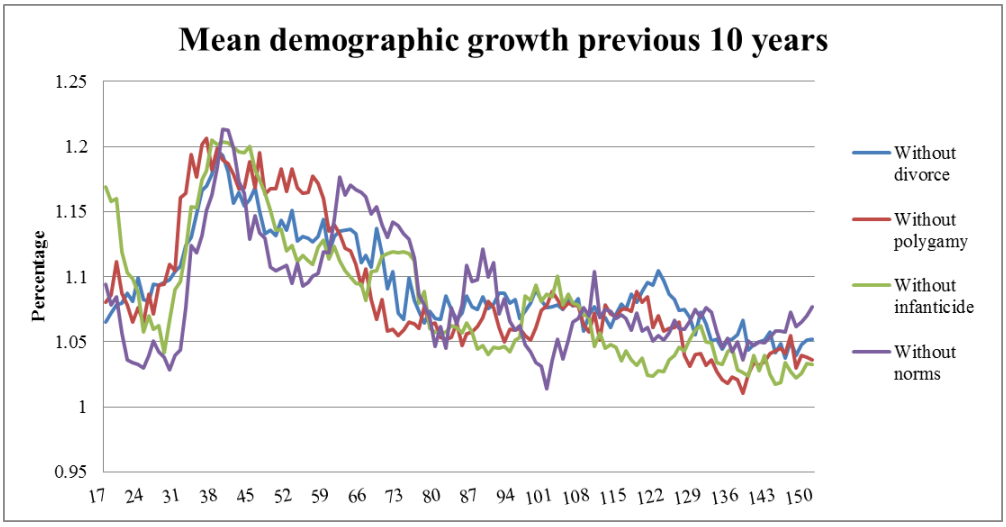


Figure 71. Mean demographic growth in the environment of minimum control II-b, represented by one average test out of a sample size of 30 tests in each case.

Simulations: most restrictive norms

In the Table 16, the specific characteristics of this last unit of simulation are exhibited. In the same manner as with the foraging populations, the birth intervals are set to 5 years. The results present a wide range of variability within which a population may remain stable for a period of 450 years, or is lead towards its extinction. The information from every social norm is not very accurate, as it brings forward such different results under the same circumstances (Fig. 72).

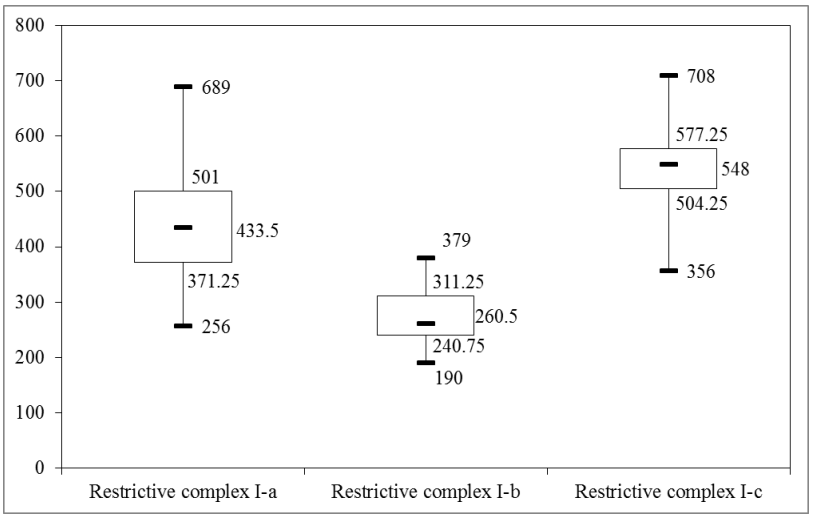


Figure 72. Total results corresponding to 30 tests of every environment of the restrictive norms among pastoralists.

Table 16. Characteristics of the environments in “restrictive complex" among pastoralists. The cells highlighted indicate the differences from case to case

Variables		Restrictive complex I-a	Restrictive complex I-b	Restrictive complex I-c
Marriage	Girls to single	father_reputation-200	father_reputation-current_morbidity	father_reputation-200
	Boy to single	current_reputation+250	current_reputation+250	current_reputation+250
	Male social status	Single, widowed	Single, widowed	Single, Widowed
	Female social status	Single, widowed	Single, widowed	Single, Widowed
	Male age at marriage	20#80	20#80	20#80
	Female age at marriage	20#75	20#75	20#75
	Male reputation increase	reputation+reputation* configured_random/1000*current_rulesrespect/5000	reputation+reputation* configured_random/1000* current_rulesrespect/5000	reputation+reputation* configured_random/1000*current_rulesrespect/5000
	Single female current reputation	500*father_reputation/ 5000*mother_fertility/ 5000	500*father_reputation/ 5000*mother_fertility/ 5000	500*health/5000* mother_fertility/5000* 2400/current_morbidity
	Priority male candidates	High current reputation	High current reputation	High current reputation
	Priority female candidates	Current health- current morbidity	Current health- current morbidity	Current health- current morbidity
	Bride price	[woman’s] reputation/2500*500	[woman’s] reputation/2500*500	[woman’s] reputation/2500*500
	Married man’s current reputation	reputation/ (children_nmales+1)	reputation/ (children_nmales+1)	reputation/ (children_nmales+1)
	Widows	18#35	18#35	18#35

Variables		Restrictive complex I-a	Restrictive complex I-b	Restrictive complex I-c
	Conditions for marriage acceptation	Exogamy, fulfil 1 de out 3	Exogamy, fulfil 1 de out 3	Exogamy, fulfil 1 de out 3
	Marriage attempts per step	3	3	3
Divorce	Husband conditions	Low current rules-respect, high current morbidity (1 out of 2)	Low current rules-respect, high current morbidity (1 out of 2)	Low current rules-respect, high current morbidity (1 out of 2)
	Wife conditions	Low current rules-respect & high current morbidity, or low current libido (1 out of 2)	Low current rules-respect & high current morbidity, or low current libido (1 out of 2)	Low current rules-respect & high current morbidity, or low current libido (1 out of 2)
	Term	At least 3 after marriage	At least 3 after marriage	At least 3 after marriage
	Other conditions	None	None	None
Polygamy	Husband conditions	30#70, high current reputation	30#70, high current reputation	30#70, high current reputation
	Wife conditions	35#75, high current morbidity, 0 children	35#75, high current morbidity, 0 children	35#75, high current morbidity, 0 children
	Single female candidate	Single, restricted widowed	Single, restricted widowed	Single, restricted widowed
	Term	At least 3 after last marriage	At least 3 after last marriage	At least 3 after last marriage
	Other conditions	Maximum 4 wives	Maximum 4 wives	Maximum 4 wives
	Marriage attempts	1	1	1
Infanticide	Conditions	Mother's bad health, newborn's bad health (1 out of 2)	Mother's bad health, newborn's bad health (1 out of 2)	Mother's bad health, newborn's bad health (1 out of 2)

In comparison with the unit of less restrictive norms among pastoralists, on this occasion the proportion of women among single people decreases considerably (Fig. 74). The increase of the bride price from restrictive complex I-a to I-b clearly conditions the demographic growth, which is corroborated with the slightly higher proportion of girls single in complex-I-b. Interestingly, fertility rate is higher in restrictive complex I-b than in I-a, which may be related to the bride price: younger and less morbid girls marry first and earlier, which in turn generates marriages in which divorce are unlikely to occur because the woman's current morbidity is very low. In a similar manner, the restrictive complex I-c is also governed by the health of the girl when calculating her current reputation –whereas in I-a the hegemony of the variable reputation hides any variable related to health or morbidity.

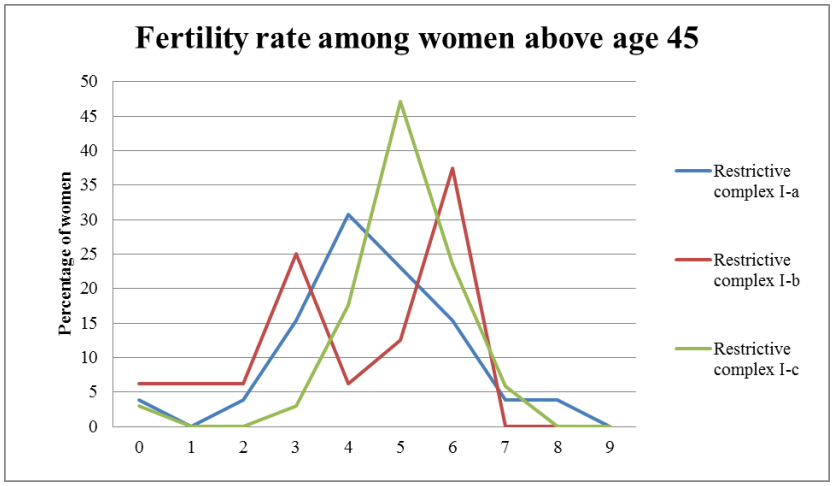


Figure 73. Fertility rates of the women above the age of 45 in the environments of maximum restriction, represented by one average test out of a sample size of 30 tests in each case.

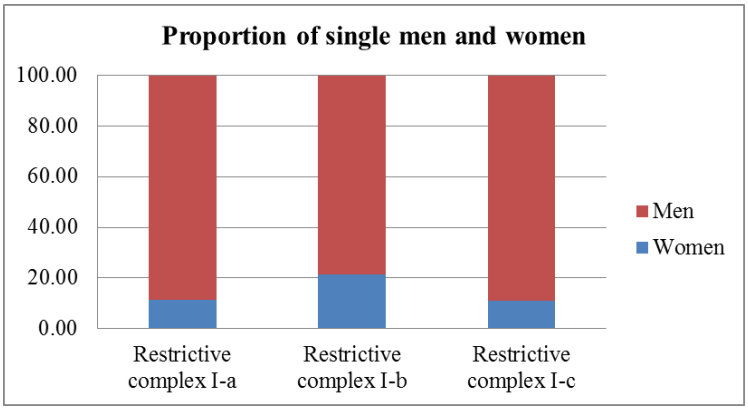


Figure 74. Proportion of unmarried people in the environments of maximum restriction, represented by one average test out of a sample size of 30 tests in each case. See also Table 28 of Annex 25.

Closely analysing the environment of restrictive complex I-b, the population size follows the same tendency previously discussed –it is either regularly stable or close to extinction (Fig. 75).

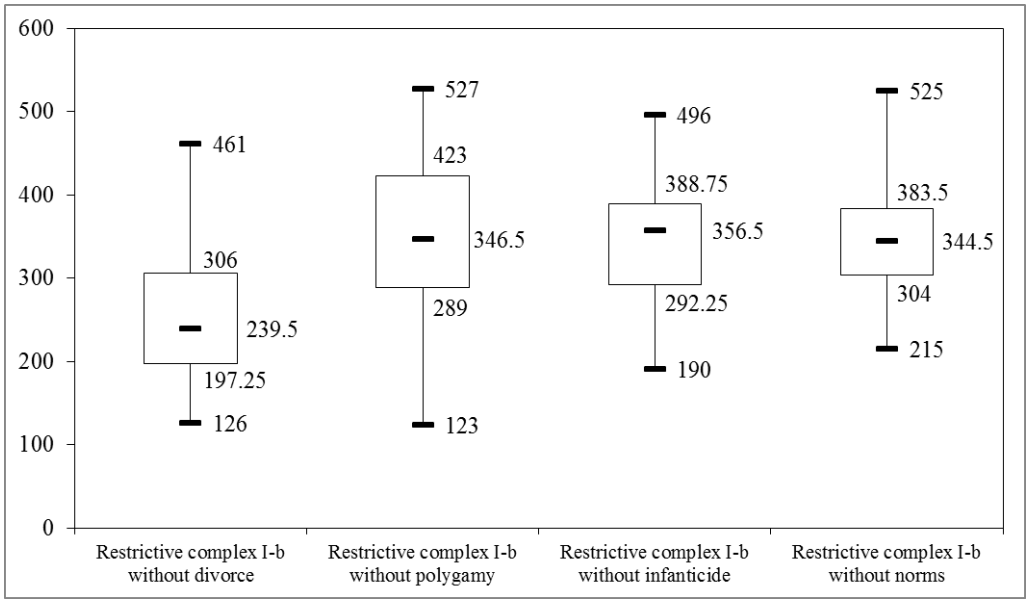


Figure 75. Total results of the restrictive simulations for pastoralists excluding one norm at a time.

In the fertility rates, there is a shift of the distribution of women along the number of children born, to an average of 4 children per women 45 years old and older (Fig. 76). The exclusion of the norm of infanticide transforms this average to 6 children per woman, demonstrating the efficiency of this social norm to regulate demographic growth. In both cases, fertility rates are clearly lower as seen in the less restrictive combinations.

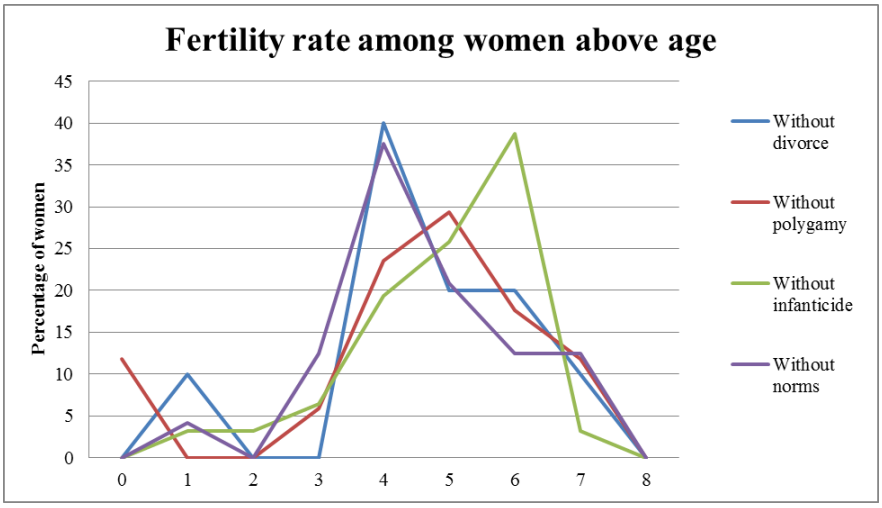


Figure 76. Fertility rates in the different settings of the environment restrictive complex I-b, represented by one average test out of a sample size of 30 tests in each case.

In the same manner, as in previous sections discussed, it seems that under the circumstances conditioned by the polygamy, this marriage system inserts more women into the reproduction engine, in comparison to the environments exclusively monogamous. This is attested in the proportion of men and women within the category of single (Fig.77).

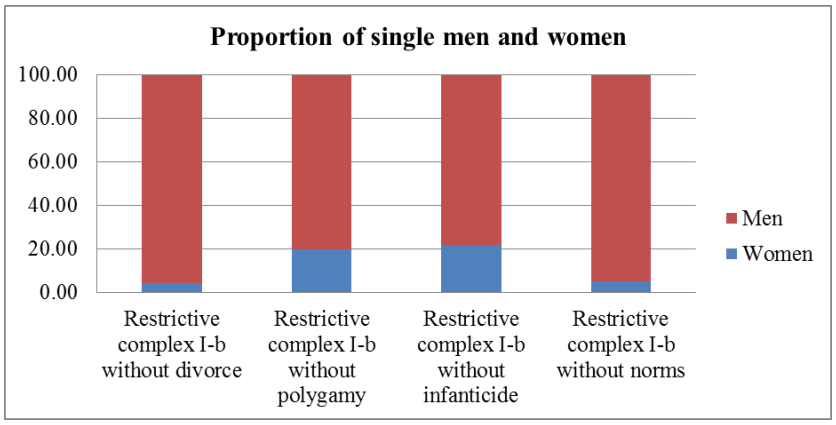


Figure 77. Proportion of single men and women in the restrictive simulations for pastoralists, excluding one norm at a time, represented by one average test out of a sample size of 30 tests in each case. See also Table 29 in Annex 25.

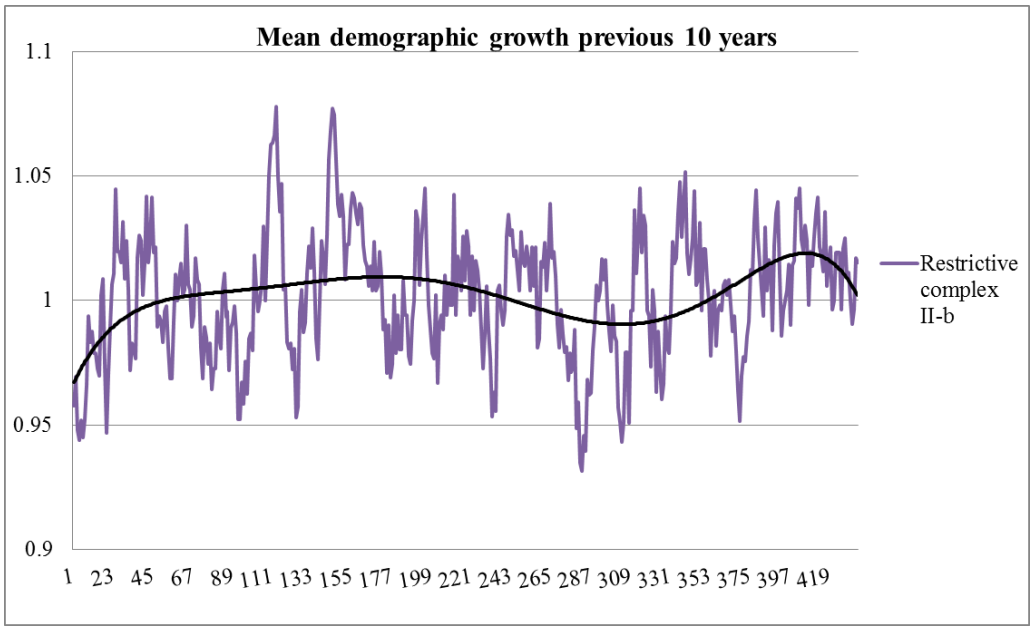


Figure 78. Mean demographic growth in the environment of restrictive complex II-b, represented by one test out of the 30, represented by one average test out of a sample size of 30 tests in each case. See Fig. 95 in Annex 26 for the annual growth rate.

Results and implications

I am aware that many aspects of the different demographic profiles analysed along this chapter have not been sufficiently discussed or not even mentioned. Unfortunately, a deeper and exhaustive analysis and of the different results would critically extend the discussion and digress the aim and focus of my doctoral thesis. The purpose here is to assess the impact of different social norms and verify whether they alone are sufficiently influential to shape the demographic growth. In a manner to conclude this chapter, I may point to some general observations:

- Clearly, in the absence of any social norm in charge to limit demographic growth, the populations experiment an impressive demographic growth within a period of 150 years.

- The incorporation of minimally restrictive social norms may condition the demographic growth, but the population still experiences a rapid growth within a short period of 150 years. This demographic profile is not attested in the ethnographies or in the archaeological record.

- The exclusion of widows or restricting widows to remarry soon seems to have an important effect on the demographic growth. The prolongation of widowhood excludes temporarily women who are still capacitated to reproduce.

- A high incidence of divorce also paralyzes the reproductive capacity of women, especially when the conditions for marriage give preference to younger and less morbid girls.

- In a monogamous and minimally restricted environment, the fertility rates show a pattern in which a great majority of women are distributed along a peak of reproductive capacity (generally around 9 children per women 45 years old and older). However, when incorporating the option of polygamous marriages in a restrictive environment, the distribution is spread between 4 to 9 children. From this pattern it may be concluded that women in a polygamous marriage may have lesser children

than the women in a monogamous marriage. Nevertheless, the proportion of unmarried women decreases with the polygamous marriages.

- A delayed age at marriage, but most important, prolonged birth intervals have a strong influence in regulating demographic growth.

- In a more restrictive environment, fertility rates decrease from 8-9 children per women to 5-8, and very few women older than 45 years would bear more than 8 children. Under these circumstances, the resulting populations do present a sustainable balance that assures the continuity of the group in the long-term.

- Infanticide is ultimately one of the most effective social norms in the short and long-term of the demographic development of a population.

- The possibilities of a comparison between the foraging populations and the pastoralist populations do not count with a solid basis. In the global picture, they present a very similar demographic pattern in the annual demographic growth (see Figs. 96 and 97 in Annex 26). In both populations, the minimum restriction presents to some extent the same effect. However, as seen in this chapter, the maximum restriction generates a greater distortion in the results of the pastoralist populations –probably because the information about pastoralists that I gathered from the ethnohistorical sources is scarce and diverse. In any of the cases, the effective role of social norms is clearly demonstrated.

Conclusions

There is an incongruity between the demographic data observed among contemporary HFGS (e.g. the existence of different growth rates, the capability of achieving high growing rates, and long-term demographic stability) and that of prehistoric HFGS (e.g. low population density, and a lack of demographic expansion). The low demographic density in the Pleistocene has been explained as a consequence of low technological capability, intrinsic biology, and ecological and climatic catastrophes. In addition to this, the foraging societies have been categorized to follow a natural fertility, in opposition to controlled fertility (control fertility is defined as the deliberate choice of stopping having children). For long, it has been neglected that population growth among HFGS can also be regulated by controlling the social relations and reproductive relations between men and women, accordingly to the socioeconomic roles they have and, hence, in accordance to a particular socioeconomic behaviour.

Therefore, the phenomenon under study and analysed in this doctoral thesis is the observed lack of demographic growth during the Palaeolithic (according to the archaeological materials), in contrast to the demographic profiles attested demographically and ethnographically. The problematic of this study is the apparent disparities between two independent sources of information (archaeological, ethnographic). Considering every segment of the entire phenomenon, not only environment or technology have to be considered, but also the socioeconomic behaviour. The aim of the doctoral thesis has been to approach this behaviour in order to identify patterns and interrelations. Methodologically, the archaeological materials seem to be mute, or at the moment the archaeologist is not able to understand them. Consequently, ethnography and modern demographic studies become the main source of information in order to frame comparatively quantitative demographic parameters, as well as the variability in the socioeconomic behaviour.

However, taking into account modern studies on contemporary HFGS is not sufficient. These studies are limited to their own time, this is, they present the main results obtained from a short-term observation and conditioned by its own historical context. I refer as short-term observation the period in which the researcher conducted ((un-)interrupted) his/her fieldwork, from which he/she gathered data about the life course of a few generations. This collection of

data is simultaneously distorted by the specific historical context the population under study finds itself, together with the biased focus of the researcher. Conclusively, these studies provide one picture, which actually belongs to a larger frame. This does not automatically invalidate the potential of these studies. In this manner, the chronological frame, synchronic and diachronic, is placed on the ethnohistorical accounts. The ethnohistorical accounts consist on ethnological descriptions left by travellers who explored under different motivations and circumstances different parts of the world outside of Europe. In this manner, from the ethnohistorical accounts it is possible to follow across time the character of the socioeconomic behaviour of the populations being described, discussing at the same time the potential biases introduced by the circumstances of the different observers. Naturally, the intrinsic character of these accounts lays a rather sceptical perception, by weighting the reliability of their content. Nevertheless, despite the bias contained, the inclusion of multiple accounts and the comparison of the quantitative and qualitative data offer a unique possibility of detecting patterns.

Finally, a narrative on the findings extracted from ethnographic and demographic studies, together with the data collected from the ethnohistorical accounts, does not provide a consistent argument regarding the socioeconomic behaviour of HFGS and its impact on demographic growth. For this purpose, I used a multi-agent based simulation system that allowed me to simulate demographic processes. In a few words, I assessed the effect and longer-term impact of specific social regulations of reproduction. It is thereafter expected that the result of the simulations may verify the hypothesis of the thesis: HFGS developed social norms that effectively regulated demographic growth, in order to prevent an excessive demographic pressure on the carrying capacity of the environment.

The thesis is organized in a manner that every segment of the phenomenon is revised. In chapter 1 (Demography and Palaeodemography) I revised the established theoretical frames that have strongly influenced the research on population dynamics towards proposals based on natural causation. Along history, there has been the awareness of the conflictive relationship between population and resources. One of the main works that has shaped the understanding of this interrelation was that of Malthus. In parallel, the history of humankind underwent through an analysis by the hand of Lubbock, Darwin, and Morgan, which lead to a classification of populations in accordance to their social and technological development –

within a lineal perception of development. From this inertia, Engels defined his theory on the origin of the family, which also presented a linear development of the organization of family from promiscuity to monogamy. Indisputably, as I show in the chapter, the study of prehistoric HFGS easily concluded that factors associated to technological complexity, biological adaptability and environment determined the development of the different species along the course of the Palaeolithic. After introducing an overview of this narrative in the transformation of populations and *cultures* in Europe and Asia during the Pleistocene, I then presented the suitability of the existing palaeodemographic studies, which come to conclude that HFGS were characterized by populations small in size and strongly dependant on the availability of natural resources. In a few words, the hypothesis based on biology, technology and environment finds confirmation in different palaeodemographic studies.

However, if this hypothesis has to be retained, one would expect that prehistoric HFGS were trapped in a continuous demographic growth that lead to demographic pressure on the carrying capacity of the environment and was then actually driven to an increase of mortality. After this catastrophic context, the population would return to a size suitable for the environment and will progressively start to grow demographically again. From this development and interrelation of two factors (resources availability and mortality rate), one would expect then that these prehistoric populations showed small genetic variations, but more important, it is expected to find in the genetic marks of the sudden decrease of population, also termed as bottleneck. This is not the only empirical evidence that puts at risk the established model of Palaeodemography, but specially the modern ethnographic studies on contemporary HFGS societies. The chapter 2 (Middle Range Theory) has exposed the existing variability of demographic profiles (life expectancy, mortality rates, fertility rates) among contemporary HFGS. I particularly take the variable of fertility rate, which is not dependant on natural causes –in opposition to mortality. The variability of fertility rates becomes the first hint that points that the demographic development of foraging societies is not constrained by natural factors, but mainly by socioeconomic factors. In order to put this segment of the phenomenon into context, I discuss the existing empirical data regarding the exclusively and universal biological variables involved in the human reproduction. Actually this data clearly points out that the biological potential of the human reproduction is incredibly high –the period in which a woman may develop secondary sterility is extremely low. The majority of the studies point out that lactation, which has been long considered to naturally supress

women's fecundity, actually does not act as a natural birth control. Therefore, the assumption that prolonged breastfeeding among contemporary HFGS was one of the main factors limiting the number of pregnancies per women turns to be empirically rejected.

Clearly, the probability of pregnancy depends mainly on the exposure to conception, which at the end is dependant to the social and reproductive relations established between men and women. As I argue in this chapter, from a Marxist point of view, the social relations defined between the members of a society, in the case of a HFGS, is directly correlated to the relations of production. In other words, the mode of production is not only defining the productive relationship of the components of the workforce, but it is clearly establishing the social relations between the same components. And, in extension, the social relations are defining the reproduction relations. Therefore, while it is accepted that labour is organized socially among these societies, it is important to acknowledge that reproduction is likewise socially organized. I take into account the analytical perspective which proposes that the organization of labour and the regulation of reproduction bring together a legitimization of a social inequality based on gender –the strategic division of labour relativizes not only the value of the product obtained but consequently also the value assigned to the people producing it.

In this manner, chapters 1 and 2 have shown the problematic under study and the precise interrelation to consider for studying the phenomenon. A simple narrative on this confrontation of evidences is not sufficient to support the hypothesis. In chapter 3, I described the methodology followed, which has combined the location of ethnohistorical sources, in which I identify diverse information regarding the social organization of reproduction in a context of a society which follows a mode of production based (mostly) on hunting, fishing and gathering. In chapter 4, I discussed the problematic to find and select a HFGS suitable for the purpose of this thesis. On the one hand, a great majority of former nomads and pre-industrial societies have shifted towards a sedentary life style and towards an agricultural or herding mode of production. In other words, a genuine reference of a hunting-fishing-gathering society that has not changed or has not been influenced by global socioeconomic transformations does not exist. Nevertheless, there are some cases, which do still present a mode of production mostly based on wild resources, although some other productive activities have been likewise incorporated, such as wage labour. Even more, not only the socioeconomic structures have changed, but also the life courses of the peoples by having

access to modern health care and schooling, just to mention a couple of examples. In this manner, I argue that a plausible start is revising the Ethnographic Atlas by Murdock, a database of more than 1000 societies he coded. In this atlas it is possible to compare the societies depending on the variables of interest. For my research purpose, I searched for the populations which have a mostly hunting-fishing-gathering mode of production, and among which agriculture or live-stock have a very small contribution. The mode of production is of great importance, because my perspective of analysis considers that in a mode of production based on natural resources there is a correspondence between the labour division and the social relations established among the members of the population. In parallel, it is very important that the group selected counts with a presence in the historical documents from which I can trace the descriptions left throughout different periods, and from different explorers –and later on, by ethnographers and anthropologists. However, it is indispensable that these ethnohistorical sources contain information regarding the social and economic organization of people, in a manner so that I can infer in aspects related to labour division and regulation of reproduction. Taking into account the existing studies which have considered ethnohistorical sources and the corresponding ethnoarchaeological sites, I decided to re-analyse the population of the southern Africa region, commonly known as Bushmen. Indeed, one particular group (Dobe !kung) has been extensively studied from social anthropology, linguistics and demography, generating the analogical paradigm of hunter-gatherers uncritically exploited in archaeological studies of prehistoric HFGS. Altogether, I decided to put under revision the population of Khoisan within the theoretical perspective and methodological approach I present in this thesis, including not only the hunters (San) but also the pastoralists (Khoi) –both populations had been closely connected throughout history. The decision for this particular group lies on mainly three points: they both practice a mode of production based on wild resources mostly, and on cattle breeding, in which the labour division is strongly based on gender; they are both organized in small groups of several families; and finally, the earliest reports about the inhabitants of southern Africa start in the late 15th century, leaving written accounts covering a time span of about 500 years, by the hand of different people who explored different regions. Finally, it may be of interest to compare the results (including demographic remarks) obtained from my research with those of the demographic studies on the same populations during the 1960s.

Between chapters 4 and 5, I included a summary of the archaeological and historical past of southern Africa, pointing to particular aspects of interest such as population migration, chronology of the introduction of domestic animals and which populations practiced agriculture. This overview includes as well the social and economic relationships established between the inhabitants of the region among themselves and towards the others, and among themselves and towards the colonialists. Interestingly, this review has highlighted the dynamism not only on social aspects, but also on economic features. Actually, some anthropologists have argued that the context of the southern African hunters and pastoralists is actually showing a society organized by class between the hunters and the pastoralists, but also between the hunters and pastoralists regarding the farmers (Bantu).

Although it has not been possible to present to the exact detail all the information I have collected from ethnohistorical sources, I have combined chapter 6 with several annexes to present with transparency all the information to be used for the simulations. On the one hand, as I have already disused in chapter 2, I organized all social norms and information on socioeconomic behaviour from the ethnohistorical sources –when available- into mainly four categories: rites of passage, age at marriage, marriage, and child birth intervals. Each of these categories includes the social and economic roles of the men and women along their life courses. In the majority of the societies it is observed the practice of rites of passages that announce the transition from dependant (sub-adult, adolescent) to independent (adult) individual. The age at marriage is particularly important because it announces the entrance of the individuals into a union (marriage) within which the exposure of conception increases, as compared to the individuals who have not initiated a union. Within the category of marriage I basically incorporated the information regarding the practice of polygamous marriages or, contrarily, the practice of monogamous marriages only. Finally, the different information of the duration of the intervals between childbirths, which is not biologically constrained but socially controlled, is included in the last of the four categories. Altogether, I get to provide an overview of the arrangement of the social reproductive relations. Naturally, the reliability of the ethnohistorical sources (discussed in chapter 5) puts a question mark on every statement found. However, by looking at the data globally, chronologically and geographically, several patterns and recurrences are attested. I am in no position to declare which of the sources I studied is the most reliable and accurate, instead, I organized the data into two blocks: on the one hand, I arrange into one group the data which contains the less restrictive expression of

every social norm and, on the other hand, I arrange the data which contains the more restrictive expression of every social norm into another group. In all cases (the four categories, and the two blocks) are organized separately accordingly, once for the mostly hunters and once for the mostly pastoralists. I take the distinction between one group and another from the ethnohistorical sources, as it appears in the descriptions, which I combine looking upon the mode of production associated to the peoples being described.

After detailing in chapter 7 the preparation of the different elements to upload into the simulation system, I discussed the different results obtained in chapter 8. The possibilities of the simulation program and the outcome data of the simulations allow me to conduct microanalyses on demographic dynamics. However, in this thesis I focus on the transformations of the demographic growth depending on which social norms are applied, closely interrelated on the fertility rate of women under different circumstances. From the sample of 30 simulation tests, which contain variable results due to the combination of probabilistic and random factors, I took into account the maximum and the minimum results obtained, as well one case that may exemplify the average of the overall possibilities. This treatment offers the possibility to analyse and assess the statistical relevance of some factors not controlled to the exactitude (always present in social dynamics). The characteristics of the artificial population introduced into the simulation program consisted of a demographic size of 300 individuals of all ages for the first set of simulation without norms, and 529 individuals for the remaining sets of simulations, both populations organised in families and camps.

On the first place, the simulations which do not include any social regulation of the reproduction (and social norm) presented a great demographic increase within a period of only 150 years (a demographic size of at least 2000 individuals and up to 9000). This increase has not been attested in any of the demographic studies of pre-industrial societies, neither is it observed in the archaeological record. Hence, the results obtained under exclusively biological factors presents an unrealistic demographic growth, as there is no parallel in the historical accounts. However, these results are important to frame the transformation in the results obtained when applying social norms. On the one hand, I simulated several contexts in which I only incorporated the minimum expression of every social norm (when available). Although the demographic growth continues to be greater than any attested society within only 150 years, the result do show important differences as compared to the first set where

only biological parameters were included. Interestingly, already on this stage of the simulations I observed that the addition of difficult conditions for widows to remarry soon strongly affects the reproductive outcome (the population size remains below 3000 individuals). This is, in this setting it is clearly demonstrated that the demographic growth is closely related to the female reproductively active. By excluding certain women (widows) from the reproduction engine, the system is excluding also potential participants of the reproduction –whereas the exclusion of men would have a much lesser effect. This tendency is observed in both cases, those of mostly foragers and those of mostly pastoralists. It may be important to remind that in all the simulations the highest mortality rate known among pre-industrial societies is applied. In this manner, mortality rates alone cannot regulate the growth of a population towards a sustainable size.

More important, in the simulations in which the maximum expression of every norm is included I observed a clear shift in the demographic dynamics. On this respect, the populations present a very stable demographic growth, which has allowed me to extend the simulations to up to 450 years. I presume I could have extended it longer, but I considered that this time lapse was long enough and significant. Nevertheless, for both mostly foragers and mostly pastoralists, the populations remained within a reasonable demographic size –by reasonable I mean it did not exceed in more than 800 individuals. These sets of simulations have shown that it is possible via only social norms to control the population growth within a sustainable size.

The greatest of the surprises has been the effect of polygamy. My assumption was that polygamy would affect reproduction in a manner that the fertility rate would decrease –this result was obtained while working on the simulation of social norms from the Selk´nam HFGS of Tierra del Fuego. However, in the present simulations I have observed that under certain circumstances, polygamy supports demographic growth. My thoughts on this pattern is that polygamy supports the reincorporation of single, divorced and widowed women, who in a monogamous system and with impediments for remarriage would have remained unmarried longer. It is true that the conditions in the simulations favour the incidence of divorce and constrains the eligibility of widows to remarry (as compared to single and never married women). In a readjusted polygamous environment it has been seen that the fertility rate may

also be transformed towards lower values. Therefore, I conclude one single norm may have the opposite effects if combined with other different social norms.

In parallel, the results obtained in this thesis also show that the descriptions in the ethnographic record about the socioeconomic behaviour vary in such a degree that the range of variability in the demographic growths and fertility rates is likewise big. All together, the simulations and results obtained show that demographic growth is effectively regulated with social norms, but to be more precise, it is effectively regulated with social norms that affect the social and reproductive behaviour of women. Women are the subject at risk of conception, by controlling their exposure to conception it is controlled the active reproductive role they have within a society. In a monogamous system, the exposure to conception is limited to those women married to a man, meaning that it will depend on the number of men and women available for marriage. However, it is possible that within a polygamous system the proportion of women remaining unmarried decreases, and hence the proportion of women reproductively active is higher.

Therefore, the availability of women is an important factor that conditions the growing tendency of the entire population in the long term. Acknowledging this interrelation, it is clear that a population, whose subsistence is based on the wild resources, would develop several mechanisms that would regulate the sexuality of women and their role in reproduction. For instance, the practice of infanticide, which is to some extent common among many societies, presents a selective character in which it is more likely to expose or sacrifice female newborns than male newborns –according to several ethnographies, it is also true that when the people is asked about this practice they are not delighted. However, the establishment of such inequalities between sexes requires an ideological frame that legitimizes it and conveys the established organization towards the generations following.

Considering the theoretical frame, I consider that the division of labour organizes the roles of the people, which ultimately assures and supports the maintenance of the social inequality. The manner in which labour is divided (organized) is at the same time the manner in which the subjective value of the productive contribution of the individuals participating in the production is distributed. In this sense, for example, if hunting is considered of greater value for the community, the hunters sustain a higher social value among the groups; while devaluating the value of collecting vegetables or of small hunting, the gatherers sustain a

lower social value among the groups. In this sense, labour represents the means through which social relations and social behaviour are easily controlled. The difference in production activities according to sex makes it possible to set an interdependence (between the two sexes assuring reproduction) and at the same time to relativize the value of the product obtained, and by extension, the value assigned to the people producing it, which can be identified directly. The organization of labour, together with the regulation of reproduction brings together a legitimization of a social inequality based on gender.

Annexes 1-7: structure of the tables

The following tables correspond to annexes number 1, 2, 3, 4, 5, 6, and 7. The content of these annexes consist of the materials I extracted from the original sources I worked with. The extension of the information gathered from the original sources is too large to include it here in its entirety. Instead, I include a few quotations from each source –when available- to illustrate the type of information encountered, its character and content.

The tables are organized vertically following the chronology, and horizontally following the categories of social norm and social behaviour. The chronology in which each writer is classified corresponds to the period of the exploration –except for Isaac Schapera, who mostly did archiving work. The text in the cells is exact quotation belonging to the different written accounts explored (ethnohistorical and ethnographic). In order to make available the original text, I present the quotations in the language I found them. The cells left blank indicate the absence of clear information, implicitly or explicitly –the absence of information does not necessarily indicate that it did not exist, but possibly that the observer did not observe it or did not consider it to be relevant.

The tables are organized in the following manner:

1. Puberty rites and sexual abstinence
2. Age at first marriage
3. Types of marriages: monogamous, polygamous
4. Post-marital residence, divorce and remarriage
5. Birth spacing and child age at weaning
6. Infanticide practices
7. Presence or absence of induced abortion practices

Some of the labels of the subcategories are intuitive from the name given (e.g. Post-marital residence: Uxorlocality, Virilocality), others required to be simplified differently:

- The symbols "≤" and ">" establishes a relative measurement for equal/smaller than or greater than.
- "F" and "M" stand respectively for female and male.

- The category of puberty contains any information in which it is described the transition from pubescent into adulthood, and the transformation of their socioeconomic roles in the community, especially regarding reproduction.
- The category of sexual intercourse is relevant. The avoidance of sexual intercourse under certain circumstances affects the total exposure to conception. I subdivide the category of sexual abstinence in premarital or extramarital, pregnancy or postpartum, and finally connected to menstruation. Premarital or extramarital would point to cases of unmarried people, whether single, separated or widowed. In pregnancy or postpartum I include the practice of abstinence followed after conception and after the birth of a child. And finally, in the cases related to menstruation, I include descriptions in which some sort of sexual taboo is applied when the women are menstruating or in similar contexts, that intentionally reduce the coitus frequency and, hence, the probability of an effective pregnancy.
- The concept of marriage is basically that of a long-term union between a man and a woman, within which the exposure to conception increases –as in comparison to pubescent individuals, single, separated or divorced adults.
- Polygamous marriages are subdivided into three subcategories: "rare" refers to observations that describe polygamy to rarely happen (but not necessarily impossible); "usual" refers to observations that describe polygamy to be usual or a very common practice (not complicated); and "exceptional" shelters those observations that seem to imply that only certain men in a group were allowed to have more than one wife (this case may be connected to wealth, social reputation, or warfare).
- The information about post-marital residence, as the name itself announces, indicates the mobility of people depending on the formation of a union –whether uxor or virilocal.
- The category of divorce contains any reference describing the termination of a union under the terms of a separation, differentiated from the unions that terminate because of widowhood.
- Under the term of remarriage I include those references that indicate the possibility for a separated man or woman, or for a widow or widower, to enter into a new union (monogamous or polygamous). The importance to identify the possibility of a "divorce" and a "remarriage" allows me to assess the possibilities for a woman to

remain “unmarried” or widow and, therefore, the decrease of the probabilities of conception.

- I distinguish between birth interval and age at weaning. The birth interval is the length of the period between the birth of every child, regardless of the duration of lactation. The different information I came across in the sources is expressed in different ways, occasionally containing ambiguous descriptions. As a consequence, the same description may fit in different cells from different subcategories.
- Weaning age refers to the termination of breastfeeding. It is likewise expressed under different manners (e.g. “until the child is big”, “until the child walks”), but the implication of the formulation of the description may be illustrative of the duration (i.e. possibly two years).
- Within the category of infanticide I differentiate of the plausible “causes” of its practice. On the one hand, short birth intervals refer to those cases in which a child is buried or exposed in case the mother is still nursing the previous child (meaning that the period in-between births is too short to wean the first child and nurse the newborn). In many occasions I came across the practice of infanticide as related to cases of twins, in which one of them is buried –in case of a boy and a girl, there was always a preference to keep the boy. A third category comprises the practice of infanticide in case the child born is observed to suffer some sort of disease or physical malformation. Finally, one last category includes the cases in which infanticide is practiced after the mother dies shortly after giving birth –without any option to give the child in “adoption” to another woman. Clearly, it may be the cases that the writers are convinced that infanticide it is not practiced at all, in these cases it is incorporated into the subcategory “not practiced”.
- Regarding abortion, unfortunately there are barely 10 accounts that leave a reference on this topic, and most of the cases with fewer details. Consequently, I distinguish between “practiced” and “not practiced”.

Annex 1: Descriptions of puberty and sexual abstinence

Chrono -logy	Author/ Observer	Puberty		Sexual abstinence		
		F	M	Pregnancy/Post-partum	Menstruation	(Extra-)Premarital
17th Century	J. Schreyer		Wann die Manns-Persohn 18.19. biß 20. Jahr alt geworden … werden ihnen mit sonderlichen Ceremonien die fettesten Därmer mit dem Netze von einem Schöpse oder geschlachten Schaaffe ümb den Hals gehangen, welches sie eine Zeitlang zum Zeichen ihrer Männlichen Jahre also tragen (Schreyer, 1931:33). (pastoralists)			
	D. O. Dapper					It is a great scandal there to have an illegitimate child, although sometimes it does actually occur (Schapera & Farrington, 1933:67). (pastoralists)
	J. G. Grevenbroek		[T]he inhabitants of the remoter parts have learned the practice of circumcision […]involving the cutting away not only the prepuce but of the skin right up to the base of the abdomen. [...] [A]lso the natives near us must have acquired the practice of removing the left testicle (Schapera & Farrington, 1933:209). (pastoralists)			If any girls bears a child as a result of promiscuous intercourse, she becomes an object of contempt to all (Schapera & Farrington, 1933:199). (pastoralists)

Chrono-logy	Author/ Observer	Puberty		Sexual abstinence		
		F	M	Pregnancy/Post-partum	Menstruation	(Extra-)Premarital
18th Century	P. Kolb	The Boobies, from their Infancy up to the Time when this Ceremony is perform'd, which is generally about the Eighteenth Year, are confin'd to the Tuition of their Mothers, and live and ramble about constantly with 'em (Kolb, 1738:120). (pastoralists)	[T]hat no Man shall have Carnal Knowledge of a Woman before he is depriv'd of his left Testicle (Kolb, 1738:118). (pastoralists)	The Men are not only oblig'd to retire out of the Sight of their Wives in Labour, but likewise to withdraw from 'em, and not partake with them in any one Thing, while the Menses are upon them (Kolb, 1738:148) (pastoralists)	The Men are not only oblig'd to retire out of the Sight of their Wives in Labour, but likewise to withdraw from 'em, and not partake with them in any one Thing, while the Menses are upon them (Kolb, 1738:148). (pastoralists)	[T]hat no Man shall have Carnal Knowledge of a Woman before he is depriv'd of his left Testicle (Kolb, 1738:118). (pastoralists)
	A. Sparrman		It has been thought, for example, that these latter [youths] were, at the age of 10 years, by a kind of castration, deprived of tone of those organs... At present the men are by no means monorchides (Sparrman, 1789a:128-129). (pastoralists)			For it is said, that the unmarried part of the company, in the very middle of the dance, withdraw to a private place in couples successively and at different intervals, without giving the least subject of offence and scandal (Sparrman, 1789b:128-129). (pastoralists)

Chrono-logy	Author/ Observer	Puberty		Sexual abstinence		
		F	M	Pregnancy/Post-partum	Menstruation	(Extra-)Premarital
	H. J. Wikar	When a girl feels that her menstruation is about to begin, she remains sitting at home that day so that neither wind nor sun touches her. Her parents or friends, observing this, have to slaughter sheep and cattle for her, for fully 14 days, if they are rich; if they are poor they are let off with one (Mossop, 1935:83). (pastoralists)	Among men they occur when the boy attains manhood, the kneukelslagt. When he has killed a beast or prey, or a ferocious animal that can be eaten [rhinoceros, hippo, buffalo, snake, etc.] (Mossop, 1935:67) A young Hottentot must be initiated to manhood (Mossop,1935:93). (pastoralists)			
	F. Le Vaillant	La femme ou fille Gonaquoise qui s'aperçoit de son état, quitte aussitôt la hutte de son mari ou de ses parens, se retire à quelque distance de la Horde, n'a plus de communication avec eux; se construit une espèce de cabane, s'il fait froid, & s'y tient recluse jusqu'à ce que, purifiée par des bains (Le Vaillant, 1790: 56-57). (pastoralists)			La femme ou fille Gonaquoise qui s'aperçoit de son état, quitte aussitôt la hutte de son mari ou de ses parens, se retire à quelque distance de la Horde, n'a plus de communication avec eux; se construit une espèce de cabane (Le Vaillant, 1790: 56-57). (pastoralists)	Les filles n'ont jamais de commerce avec les hommes, avant d'être sont nubiles; &, dans ce cas, sitôt qu'un garçon convient à son cœur, elle reçoit de ses parent la permission d'habiter avec lui. (Le Vaillant, 1790: 57) (pastoralists)

Chrono -logy	Author/ Observer	Puberty		Sexual abstinence		
		F	M	Pregnancy/Post-partum	Menstruation	(Extra-)Premarital
19th Century	H. Lichtenstein	Sobald sich bei einem Mädchen zum erstenmale die Menstruation zeigt, muss sie sich in eine abgesonderte Hütte begeben, die sie während dieses Zustande nicht verlassen darf (Lichtenstein,1967: 427-428). (Bantu)	Sobald die Knaben anfangen, mannbar zu werden, werden sie beschnitten; diese Ceremonie geschieht nicht alljährlich, sondern gewöhnlich dann, wenn einer der Söhne des Oberhauptes das erforderliche Alter erreicht hat (Lichtenstein, 1967: 425). (Bantu)	In den ersten Wochen nach der Niederkunst sondert sich der Mann gänzlich von seiner Frau ab und hütet sich vor dem gemeinschaftlichen Gebrauche des Hausgeräthes (Lichtenstein, 1967: 435). (Bantu)		Noch weniger leidet die Ehre einer unverheiratheten Frauensperson durch vertrauten Umgang mit einem Manne, selbst dann, wenn sich Folgen davon offenbaren. Die ganze Schande wird, wenn die wirkliche Verheirathung der Beiden nicht Statt finden kann, durch eine Entschädigung an Vieh.. (Lichtenstein, 1967: 437). (Bantu)
	J. Campbell	Auch mit dem weiblich Geschlecht werden gewisse Ceremonien vorgenommen, ehe sie heirathen dürfen. (Campbell, 1823:240) (Bantu)	Einen ziemlichen Zeitraum vor der Beschneidung hindurch, erhalten die Knaben schwere Prügel und zwar, wie man dort sagt, um ihnen zu lehren, Männer zu seyn (Campbell, 1823:239-240). (Bantu)			
	T.Arbousset; F. Daumas		Il n’y a de circoncis que ceux dont les rapports sont très-fréquents avec les Caffres ou les Béchuanas (Arbousset & Daumas, 1842:502). (foragers)			

Chrono -logy	Author/ Observer	Puberty		Sexual abstinence		
		F	M	Pregnancy/Post-partum	Menstruation	(Extra-)Premarital
	G.W. Stow		They had no rite of circumcision like the Bachoana and Kaffirs, but when a boy entered upon the state of manhood a feast was held, and, according to the circumstances of the father, eight or ten oxen were killed in honour of the event (Stow, 1905:273). (pastoralists)			
	J. Chapman	Being now initiated into the mysteries of manhood and womankind … the old people honour them as their equals (Chapman, 1868:45). (Bantu)	[T]hey were going to the outskirts of the town, where the lads were undergoing similar ceremony, called bogoèra, to inflict on them a castigation, and, as it was termed, make men of them. (Chapman, 1868: 44-45) They [Damaras] practice the rite of circumcision by cutting off the little finger of each hand (Chapman, 1868: 341-342). (Bantu)			
	T. Baines	Thy are classed into these divisions from the time of their birth, and as the year of initiation comes on, the old commanding matrons insure them beforehand to all the household duties of their future life (Baines, 1864:174). (foragers)	This [ceremony], it seems, is a custom equivalent to circumcision of that particular division (Baines, 1864:174). (foragers)			

Chrono-logy	Author/ Observer	Puberty		Sexual abstinence		
		F	M	Pregnancy/Post-partum	Menstruation	(Extra-)Premarital
	H. Schinz	Sobald die Tochter die ersten Anzeichen der eingetretenen Menstruation wahrnimmt, teilt sie dies der Mutter mit und entflieht alsdann sogleich aus dem elterlichen Hause. […] [G]ewöhnlich wird sodann eine Kuh oder eine Ziege geschlachtet…(Shinz, 1891: 97). (pastoralists)	Die Beschneidung der Knaben und Entfernung der einen Hode wird, wenn beides vielleicht auch früher der Fall gewesen sein mag, doch sicher in unseren Tagen nicht mehr praktiziert. (Shinz, 1891: 98) (pastoralists)			
	S. Passarge	Die Mädchen sollen leine Schule durchmachen, aber der Eintritt der Reife wird auch gefeiert, und zwar bei den Aikwe durch den Elandbulltanz –duke. […]Ein Mädchen hatte die erste Menstruation gehabt, infolgedessen versammelten sich Männer und Frauen zu Aufführung des durch Sitte und Brauch vorgeschriebenen Tanzes (Passarge, 1907:101-103). (foragers)	Während der Trockenzeit, also der kältesten Zeit im Jahr, ziehen die mannbaren Knaben unter Aufsicht eines erfahrenen älteren Mannes in das Feld hinaus (Passarge, 1907:100-101). (foragers)			
	S. S. Dornan					Sexual intercourse by the lovers before marriage, though looked upon as wrong, is very often indulged in (Dornan, 1925:126). (foragers)
20th Century	H. Werner	Beschneidung ist weder bei Männer noch Weibern üblich (Werner, 1906:247). (foragers)	Beschneidung ist weder bei Männer noch Weibern üblich. (Werner, 1906:247). (foragers)			

Chrono-logy	Author/ Observer	Puberty		Sexual abstinence		
		F	M	Pregnancy/Post-partum	Menstruation	(Extra-)Premarital
	P. Trenk					Because the men and girls mostly immediately after the onset of puberty they usually enter marriage as virgins (Guenther, 2005:243). (foragers)
	H. Kaufmann	As soon as the girl has her fist period, neighbouring and befriended camps come together to conduct a fairly elabourate celebration (Guenther, 2005:88-89). (foragers)	Circumcision is not practiced. (Guenther, 2005:58) Several youths from neighbouring camps move off into the bush under the supervision of the doctor [...] Actual manhood … is not dependent just on participating in the initiation. In addition it requires killing the first head of a big game (Guenther, 2005:88-89). (foragers)	A married couple interrupts sexual relations only in an advanced state of pregnancy (Guenther, 2005:88). (foragers)		Pre-marital sexual relations seem hardly ever to occur (Guenther, 2005:87). (foragers)
	A. W. Hoernlé	[described in Schapera] (Hoernlé [Schapera], 1965[1930]:272-273) (pastoralists).	[described in Schapera] (Hoernlé [Schapera], 1965[1930]:282) (pastoralists).			Even sexual intercourse would not have been considered wrong (Hoernlé, 1925:22). (pastoralists)
	J. H. Wilhelm	They [girls] are declared ready for marriage after the onset of first menstruation [...] I was told women's dances take place at that time (Guenther, 2005:144). (foragers)	In the cold season the lads move off to a remote water hole, under the supervision of an older man, where they build a hut. It seems that at this place they are initiated into all of the details of sexual life(Guenther, 2005:143-144). (foragers)	After the birth of a child it seems that it is a rule for the man to refrain from intercourse for one year (Guenther, 2005:167). (foragers)		There is no premarital sexual intercourse (Guenther, 2005:144). (foragers)

Chrono-logy	Author/ Observer	Puberty		Sexual abstinence		
		F	M	Pregnancy/Post-partum	Menstruation	(Extra-)Premarital
	L. Fourie	As young girls (≠kham-khoidi) approach the age of puberty they are placed in a hut called ≠kham-khoidi or oaχai-khoidi oms in which they sleep a night. […] [T]hey all [married women] prepare to dance the |hawa-≠nab (menstruation dance)... Men are not permitted to watch the dance (Fourie, 1926: 57-58). (foragers)				
	D. F. Bleek	When a girl reaches maturity, the eland-bull dance is held in her honour (Bleek, 1928:23). (foragers)	When boys have learned to shoot and killed two or three head of big game, they go through an initiation ceremony (Bleek, 1928:23). (foragers)			

Chrono -logy	Author/ Observer	Puberty		Sexual abstinence		
		F	M	Pregnancy/Post-partum	Menstruation	(Extra-)Premarital
	V. Lebzelter	Mädchenweihen existieren trotz der Ableugnungen wohl überall und werden für jedes einzelne Mädchen abgehalten, sobald sie die erste Menstruation bekommt (Lebzelter, 1934:78). (foragers)	Zur Jünglingsweihe ziehen sich die Kandidaten mir drei Medizinmännern auf einen Monat in den Wald zurück (Lebzelter , 1934:6). Eine Jünglingsweihe im eigentlichen Sinne haben sie nicht mehr. Doch wird, wenn der Junge groß werden ist, ein Fest gemacht und Vieh geschlachtet(Lebzelter , 1934:15). Bei den Naron allerdings müssen sie erst die Jagdprüfung machen, bevor sie zur Knabenweihe zugelassen werden (Lebzelter, 1934:70). (foragers)	Wird eine Jagd beschlossen, so muß man schon die Nacht vorher Geschlechtsverkehr meiden (Lebzelter , 1934:7). Bis das Kind sitzen kann, darf der Ehemann der Mutter nicht beiwohnen(Lebzelter, 1934:68). (foragers)		Geschlechtsverkehr zwischen den Unbeschnittenen ist streng verboten (Lebzelter, 1934:63). Vorehelicher Geschlechtsverkehr scheint kaum vorzukommen. (Lebzelter, 1934:71, 72). (foragers)
	Oscar T. Crosby	One witness claimed that a girl having her first menstruation was placed in a separate hut in the care of an old woman -perhaps her grandmother (Crosby, 1931: 351). (foragers)	He claims that a bow-string is slackened by a boy when he shoots his first buck. […]The young hunter cannot speak to others, nor eat nor drink. "Thus the people know he has shot his first buck" (Crosby, 1931: 351-352). (foragers)	William says that Hereros do not copulate with a mother while the child is suckling. […]. He says this was once a Bushman custom, but they do not practice it now (Crosby, 1931: 353). (foragers).		A witness states that a child born before its mother's marriage may be given to the father of the latter want is. Otherwise it stays with the mother's people (Crosby, 1931: 351). (foragers).

Chrono -logy	Author/ Observer	Puberty		Sexual abstinence		
		F	M	Pregnancy/Post-partum	Menstruation	(Extra-)Premarital
	I. Schapera	As a rule boys and girls are not permitted to marry until they have reached the age of puberty, and have passed through the puberty ceremonies [citing Passarge, Kaufmann, Fourie] (Schapera, 1965 [1930]:105). (foragers) Normally a girls is not regarded as marriageable until she has reached the age of puberty and passed through the puberty ceremonies (Schapera, 1965 [1930]:244). (pastoralists)	Boys are subjected to the ceremony of initiation after reaching the age of puberty, and as soon as they are considered to have become proficient in hunting, especially in the pursuit of big game (Schapera, 1965 [1930]:122). (foragers) [N]or was a boy in the old days permitted to marry before he had been inedited into the ranks of the adult men (a custom now fallen into abeyance) (Schapera, 1965 [1930]:244). (pastoralists)		A husband, for example, might not have sexual intercourse with his wife during her periods, or even eat with her (Schapera, 1965 [1930]: 278-279). (pastoralists)	There is very little information about the relations of the sexes before marriage [refers to Kaufmann, Lebzelter, Dorothea Bleek, Trenk, Dornan] (Schapera, 1965 [1930]:102) (foragers) The sexual life of the Hottentots is no longer so strictly regulated as it seems to have been into the old days. (Schapera, 1965 [1930]: 241) (Schapera, 1965 [1930]: 259.) (pastoralists)
	J. A. Engelbrecht	The /habab. [...]When a girl had her first menses (Engelbrecht, 1936:163-164). (pastoralists)	The dorob. This is the name of the initiation ceremony which every Kora young man underwent before he was accepted in the company of the grown-up men (Engelbrecht, 1936:157-158). (pastoralists)	During the period when a mother was nursing her infant child the husband would sometimes have sexual intercourse elsewhere, though without the knowledge or consent of his wife (Engelbrecht, 1936:146-147). (pastoralists).		Between married people sexual intercourse of an irregular kind seems to have occurred more often; it was then also more often condoned, if not actually semi-legalized (Engelbrecht, 1936:146). (pastoralists)

Chrono-logy	Author/ Observer	Puberty		Sexual abstinence		
		F	M	Pregnancy/Post-partum	Menstruation	(Extra-)Premarital
	R. P. Ch. Estermann	Les filles, elles, doivent toutes passer par une cérémonie spéciale avant de pouvoir se marier. In peut la résumer ainsi: dès l'apparition de la première menstruation, la fille doit garder la hutte de ses parents pendant quatre jours (Estermann, 1946/49:717). (foragers)	Les !kung abhorrent la circoncision, pratiquée cependant dans presque toutes les tribus bantoues environnantes. […] Quand l'apprenti chasseur a la chance de tuer sa première antilope, il se frotte le front avec le sang de l'animal. […] Tout le monde se réjouit avec le jeune Nemrod, mais il n'y a aucune cérémonie (Estermann, 1946/49:717). (foragers)	Après la naissance d'un enfant, les conjoints doivent pratiquer la continence pendant une période qui va de trois à six mois (Estermann, 1946/49:718). (foragers)		La virginité n'est pas estimée, ou plutôt n'entre pas en ligne de compte (Estermann, 1946/49:718). (foragers).
	M. Gusinde	Pubertätsriten seit langen abhanden gekommen sind. (Gusinde, 1966:126-127). (foragers)	Pubertätsriten seit langen abhanden gekommen sind. (Gusinde, 1966:126-127). (foragers)			
	L. Marshall	When the important Ceremony of First Menstruation is performed, the girls may have been married for years (Marshall, 1959:350) (foragers)				Fornication must be very rare because there is practically no one to fornicate with. Almost all females are married except very young girls and leathery old grandmothers (Marshall, 1959: 360). (foragers)
	R. B. Lee					[T]he concept of virginity has no real meaning in the !Kung context. Most boys and girls will have some experience of sexual intercourse by age 15 (Lee, 1993: 91). (foragers)

Chrono-logy	Author/ Observer	Puberty		Sexual abstinence		
		F	M	Pregnancy/Post-partum	Menstruation	(Extra-)Premarital
	N. Howell		When the young man kills his first large animal, male and female, of each of the main species that the !Kung eat (kudu, eland, wildebeest), there is a ceremony and a celebration that involved tattooing the young man's face so that anyone who glances at him can see that he is an experienced hunter (Howell, 2010: 35-36). (foragers)			
	C. Valiente-Noailles	Girl' puberty called //áe/oá (meaning start to learn) (Valiente-Noailles, 1993: 94). (foragers)	Boy' puberty called njúbe (meaning this on who begins to grow up) (Valiente-Noailles, 1993: 94). (foragers)			There is no rule to prevent pre-marital sex [the important rule is that no sex is allowed before the girl has reached her puberty] (Valiente-Noailles, 1993: 98). (foragers)

Annex 2 : Descriptions of age at first marriage

Chrono-logy	Author/ Observer	Age at marriage			
		<16 F	>16 F	<18 M	>18 M
17th Century	J. Schreyer				Wann die Manns-Persohn 18.19. biß 20. Jahr alt geworden … werden ihnen mit sonderlichen Ceremonien…, welches sie eine Zeitlang zum Zeichen ihrer Männlichen Jahre also tragen, und zieren sich denn ferner nach ihren Vermögen, umb sich bey den Jungfrauen desto angenehmer zu machen, sind auch in solchen Ausbutzen sehr rüstig (Schreyer, 1931:33). (pastoralists)
18th Century	P. Kolb		The Boobies, from their Infancy up to the Time when this Ceremony is perform'd, which is generally about the Eighteenth Year, are confin'd to the Tuition of their Mothers.... Before this second Act of Legitimation they are not allow'd to set up for Men. Nor dare they offer to converse with such as are call'd Men, not even with their own Fathers (Kolb, 1738:120). (pastoralists)	The poor Hottentot consider, that their Sons may die before they arrive at the Age of Eighteen Years, which is the usual Time of Marriage. They have a Chance then by this Delay to save Charges: And by this they are wholly govern'd in the Matter (Kolb, 1738:118). (pastoralists)	

	A. Sparrman		The girls are not allowed to use any rings, till they are marriageable. A traveller, that was passing through the district of Zwellendam, endeavoured to assail the chastity of a Hottentot girl, about sixteen or seventeen years of age, but in every other respect quite a woman… the old people in her craal had not yet invested her with the privilege of wearing rings (Sparrman, 1789a: 136). (pastoralists)	Circumcision is in use among these Hottentots as well as the Gonquas and Caffres, and is performed upon youths at that period of life, when, to use their own expression, they are become half-men (Sparrman, 1789b: 120). (pastoralists)	
	F. Le Vaillant	Les filles n'ont jamais de commerce avec les hommes, avant d'être sont nubiles ; &, dans ce cas, sitôt qu'un garçon convient à son cœur, elle reçoit de ses parent la permission d'habiter avec lui (Le Vaillant, 1790: 57). (pastoralists)			
19th Century	H. Lichtenstein			Alle Kinder sind unrein, bis sie unter die Zahl der Erwachsenen aufgenommen werden, (welches bei dem männlichen Geschlecht durch die mancherlei Gebräuche, welche die Beschneidung begleiten, geschieht) [at the age of 12-14] (Lichtenstein, 1967:395, 417-418). (Bantu)	

	J. Campbell	Auch mit dem weiblich Geschlecht werden gewisse Ceremonien vorgenommen, ehe sie heirathen dürfen (Campbell: 1823:240). (Bantu)		Einen ziemlichen Zeitraum vor der Beschneidung hindurch, erhalten die Knaben schwere Prügel und zwar, wie man dort sagt, um ihnen zu lehren, Männer zu seyn. […] Die Ceremonie wird nicht zu periodisch wieder-kehrenden Zeiten … vielleicht hängt dieß der Anzahl der über 12 Jahr alten Candidaten ab (Campbell: 1823:239-240). (Bantu)	
	T.Arbousset; F. Daumas	Dans ce pays-ci, les Bushmen se marient à âge moins précoce que les Caffres et es Béchuanas, savoir à dix-huit ou vingt and, au lieu de treize à quinze (Arbousset & Daumas, 1842:492-493). (foragers)		Dans ce pays-ci, les Bushmen se marient à âge moins précoce que les Caffres et es Béchuanas, savoir à dix-huit ou vingt and, au lieu de treize à quinze (Arbousset & Daumas, 1842 :492-493). (foragers)	
	J. Chapman	The females are generally betrothed while mere children, or even infants –sometimes even before they are born.[...] [O]ur attention was directed to the female candidates for circumcision, or the "boyali", consisting of some fifty girls, about the age of fourteen... (Chapman, 1868: 43,45). (Bantu)		[T]hey [girls] were going to the outskirts of the town, where the lads were undergoing similar ceremony, called bogoèra, to inflict on them a castigation, and, as it was termed, make men of them (Chapman, 1868: 45). (Bantu)	

	T. Baines	This [ceremony], it seems, is a custom equivalent to circumcision of that particular division of the young girls who had attained the age of twelve or fourteen a nearly the same time. […] [T]he old commanding matrons insure them beforehand to all the household duties of their future life (Baines, 1864:174). (foragers)			
	F. Bachman		Lina ist jetzt 20 Jahre alt, und eigentlich sollte sie Klaas der Zimmermann heirathen, denn sie sind schon seit Jahren ein erklärtes Paar. […] Kostet es doch auch Geld (Bachman, 1899:97). (pastoralists)		
	H. Schinz	Sobald die Tochter die ersten Anzeichen der eingetretenen Menstruation wahrnimmt, teilt sie dies der Mutter mit und entflieht alsdann sogleich aus dem elterlichen Hause. […] [W]odurch es sich nun erst den Charakter unbestreitbarer Heiratsfähigkeit erwirbt (Schinz,1891:97). (pastoralists)			
	S. Passarge	Die Mädchen sollen leine Schule durchmachen, aber der Eintritt der Reife wird auch gefeiert, und zwar bei den Aikwe durch den Elandbulltanz –duke (Passarge, 1907:101). (foragers)		Die Pubertätszeit bedeutet für den Buschmann einen wichtigen abschnitt in seinem Leben. […] Nach Empfang dieser Weihe sind die Knaben Männer geworden, dürfen heiraten und an den Beratungen und Tänzen der Männer teilnehmen (Passarge, 1907:100). (foragers)	

20th Century	P. Trenk	Girls marry soon as they are mature; at that point they are allowed to wear a necklace (Guenther, 2005:243). (foragers)		Because the men and girls mostly immediately after the onset of puberty they usually enter marriage as virgins... (Guenther, 2005:243). (foragers)	
	H. Kaufmann	[F]or girls [the approximate age of marriage]. thirteen and sixteenth (Guenther, 2005: 86). (foragers)		The approximate age of marriage for men is sixteen and eighteenth. (Guenther, 2005: 86). (foragers)	
	E. Seydel	[Ehen werden] von den Mädchen schon mit 13 Jahren (Seydel, 1910:24-25). (foragers)		Ehen werden von den Männern meist im Alter von 18 Jahren geschlossen (Seydel, 1910:24-25). (foragers)	
	J. H. Wilhelm	The average marriage age is twelve to fourteen years for the women and fourteen to sixteen for the man. […] In the Kaukau veld I saw a girl of at most ten years who had been captured during the night in my presence (Guenther, 2005:144-145). (foragers)		The average marriage age is twelve to fourteen years for the women and fourteen to sixteen for the man (Wilhelm, 1954:144-145). (foragers)	
	D. F. Bleek	Some girls marry very young, before they have reached the age of puberty (Bleek, 1928:33). (foragers)	Others [girls] are unmarried at seventeenth or eighteenth (Bleek, 1928:33). (foragers)		Youths seem to marry at about eighteenth to twenty-one (Bleek, 1928:34). (foragers)
	V. Lebzelter	So kann man auch kleine Mädchen schon heiraten, die eder Mann dann bei sich aufwachsen läßt, bis sie geschlechtsreif werden (Lebzelter,1934:11). [ǂAuin] Mädchen [heiraten] zwischen 13 und 16 Jahren (Lebzelter , 1934:71). (foragers)		ǂAuin: Männer heiraten etwa zwischen 16 und 18 Jahren (Lebzelter , 1934:71). (foragers)	

	I. Schapera	[A]mong the Kung marriage takes place at quite an early age. [citing Kaufmann and Bleek] (Schapera, 1965 [1930]:105) (foragers) Normally a girls is not regarded as marriageable until she has reached the age of puberty and passed through the puberty ceremonies (Schapera, 1965 [1930]:244). (pastoralists)	Among the Naron and the Auen, for example, most people are married by the time they are twenty, many of them, indeed when they are several years younger[citing Kaufmann and Bleek](Schapera,1965[1930]:105). (foragers)	[A]mong the Kung marriage takes place at quite an early age. [citing Kaufmann and Bleek] (Schapera, 1965 [1930]:105) (foragers) [N]or was a boy in the old days permitted to marry before he had been inedited into the ranks of the adult men (a custom now fallen into abeyance) (Schapera, 1965 [1930]:244). (pastoralists)	Among the Naron and the Auen, for example, most people are married by the time they are twenty, many of them, indeed when they are several years younger [citing Kaufmann and Bleek](Schapera,1965[1930]:105). (foragers)
	J. A. Engelbrecht	The /habab. [...]When a girl had her first menses... (Engelbrecht, 1936:163-164). (pastoralists)		The dorob. This is the name of the initiation ceremony which every Kora young man underwent before he was accepted in the company of the grown-up men (Engelbrecht,1936:157-158). (pastoralists)	The dorob. This is the name of the initiation ceremony which every Kora young man underwent before he was accepted in the company of the grown-up men (Engelbrecht, 1936:157-158). (pastoralists)
	R. P. Ch. Estermann	Dans certaines régions, le mariage a lieu immédiatement après la cérémonie de la puberté (Estermann, 1946/49:718). (foragers).			
	L. Marshall	The age of the young people varies greatly. […] When the important Ceremony of First Menstruation is performed, the girls may have been married for years. [...] [B]ut we have known several girls to be somewhat older (Marshall, 1959:350). (foragers)		Boys are considerably older than girls before their parents betroth them. […] Boys appear to be usually around twelve to fourteen or fifteen before they are betrothed (Marshall, 1959:350). (foragers)	

	R. B. Lee	Traditionally, girls were married at ages 12 to 16, boys at 18 to 25. In certain regions such as southern Nyae Nyae … even younger, 10, 9 or even 8 years of age! (Lee, 1993: 81). (foragers)	By the 1960s and 1970, the age of marriage had increased somewhat. Marriage of the very young had ceased altogether … and the girls tended to marry between 15 and 18 (Lee, 1993: 82). (foragers)		Traditionally … boys [were married] at 18 to 25 (Lee, 1993: 81). By the 1960s and 1970, the age of marriage had increased somewhat. […] Boys were further delayed in finding spouses, and their marriage age had increased to 22-30 (Lee, 1993: 82). (foragers)
	Biesele et al.	The behaviour of men was certainly dominating and coercive to women in many instances, and the traditional system of marrying pre-pubescent girls to grown men- even men who already had one wife- made for a complex sexual politics with many familiar themes (Konner & Shostak, 1986:73). (foragers)			
	N. Howell		This stage of life lasts from a mean age of 16.6 at menarche, a mean age of 16.9 at first marriage, and ends at a mean age of 21,4 at the birth of the first child (Howell, 2010: 32). (foragers)		Men have a considerably longer adolescence than women, as even the youngest husbands are at least 22 and the mean age at marriage for men is 26.7, with the birth of the first child a few years later (Howell, 2010: 32-33). (foragers)
	C. Valiente-Noailles	Age 13 for girls and 16 for boys. It is time when they can get married (Valiente-Noailles,1993:86). (foragers)		Age 13 for girls and 16 for boys. It is time when they can get married (Valiente-Noailles,1993:86). (foragers)	

Annex 3: Descriptions of type of marriages

Chrono-logy	Author/ Observer	Monogamy	Polygamy		
			Rare	Usual	Exceptional
17th Century	J. Schreyer			Und daß solches die Generation verhindere, siehet man daher, dieweil sie mit 2. Und 3. Frauen (denn die Polygamia ist hier gemein) (Schreyer, 1931:32) […] Ist er reich am Viehe, so nimmet er wol 2.3 Weiber. (Schreyer, 1931:38-39) (pastoralists)	
	D. O. Dapper	On the other hand the koehque or king Oldasoä, who died in 1661 after a long and lingering illness, never had more than a single wife (Schapera & Farrington, 1933:25). (pastoralists)		The subordinate king Gonnomoä our countrymen call the Black Captain ... married to three wives by whim he has begotten many children (Schapera & Farrington, 1933:25). (pastoralists)	
	W. Ten Rhyne				[T]hose who are richer practise polygamy (Schapera & Farrington, 1933:145). (pastoralists)
	J. G. Grevenbroek			[F]or these native generally have several wives, each living separately in her own hut (Schapera & Farrington, 1933: 205). (pastoralists)	
18th Century	P. Kolb				This Custom [polygymy] obtains only among the Rich Hottentots. […]Yet do we rarely find a Richest to have more than Three Wives (Kolb, 1738:156,157). (pastoralists)

Chrono-logy	Author/ Observer	Monogamy	Polygamy		
			Rare	Usual	Exceptional
	A. Sparrman		I likewise at this time saw an instance of the polygamy practiced by the Hottentots, a practice, whoever, which is said to be very rare among them. An old Hottentot had married two wives, and seemed in a manner very proud of the possession of them, as doing credit to his manhood (Sparrman, 1789a:256). (pastoralists)		
	H. J. Wikar			[A]t least two [wives], but also three, four, or five, and there were instances of a man's having six wives. [...] The women do not take part in the war and that is why the man who survives as conqueror becomes rich both in cattle and in wives (Mossop, 1935:29). (pastoralists)	Some who are rich marry more, besides all the women they simply take and have in addition (Mossop, 1935:91). (pastoralists)
	F. Le Vaillant	La polygamie ne répugne point aux Hottentots; mais il s'en faut de beaucoup qu'elle soit généralement établie chez eux; ils prennent autant de femmes qu'ils veulent, c'est-à-dire en proportion de leur tempérament ; ce qui reduit ordinairement ce besoin a une seule (Le Vaillant, 1790: 61). (pastoralists)	La polygamie ne répugne point aux Hottentots; mais il s'en faut de beaucoup qu'elle soit généralement établie chez eux; ils prennent autant de femmes qu'ils veulent, c'est-à-dire en proportion de leur tempérament ; ce qui reduit ordinairement ce besoin a une seule (Le Vaillant, 1790: 61). (pastoralists)		

Chrono-logy	Author/ Observer	Monogamy	Polygamy		
			Rare	Usual	Exceptional
	J. Barrow			Es schien gewöhnlich zu seyn, daß ältliche Männer zwei Weiber, eine Alte, die keine Kinder mehr zu bekommen Hoffnung hatte, und eine Junge hatten (Barrow, 1801:338). (foragers)	
19th Century	D. G. van Reenen				Gaike arrived with his retinue, his mother, two wives and in addition a few other women (Murray, 1937:173). (Bantu)
	H. Lichtenstein	Die mehrsten Koossa haben nur eine Frau, die Könige aber und die Oberhäupter der Kraale vier, fünf und darüber. (Lichtenstein, 1811: 429) (Bantu) Vielweiberei ist nicht gegen das Herkommen, doch hörte ich von Keinem, der mehr als eine Frau gehabt hätte (Lichtenstein, 1967: 414). (pastoralists)	Vielweiberei ist nicht gegen das Herkommen, doch hörte ich von Keinem , der mehr als eine Frau gehabt hätte (Lichtenstein,1967: 414). (pastoralists)	Die Zahl der Weiber ist durch kein Gesetz eingeschränkt und richtet sich allein nach dem Reichthum des Mannes. Indessen haben doch nur Wenige mehr als zwei Weiber, nur einzelne Fürsten giebt es, die ihrer sechs bis acht halten (Lichtenstein, 1967:435). (Bantu)	Die mehrsten Koossa haben nur eine Frau, die Könige aber und die Oberhäupter der Kraale vier, fünf und darüber (Lichtenstein, 1967: 429). (Bantu)
	J. Campbell			Die Männer haben oft 4 bis 5 Weiber und vertauschen diese häufig unter einander. (Campbell, 1823:13) (foragers) Die Großen des Landes haben meist 2 bis 3 Frauen (Campbell, 1823:32). (Bantu)	
	T.Arbousset; F. Daumas		Les cas de polygamie sont rares, et ceux adultère moins communs que chez les autres naturels du pays (Arbousset & Daumas, 1842:502). (foragers)		

Chrono-logy	Author/ Observer	Monogamy	Polygamy		
			Rare	Usual	Exceptional
	G.W. Stow	It would appear that there was no uniform custom with regard to either marriage or polygamy […]It is said that owing to the extreme jealousy and passionate disposition of the women, some of the tribes never took more than one wife. (Stow, 1905:95). (foragers)		[A]mong the greater portion of them a plurality of wives was allowed, the number being mainly regulated by the force of circumstances, such as the abundance or otherwise of food, the position and influence of the man, and his power at attaching a number of women to himself (Stow, 1905:95). (foragers)	The young men frequently consented themselves with one, while few of middle age had less than two, a young and an old one (Stow, 1905:95). (foragers)
	J. Chapman			[S]ome [men] having as many as ten or twelve, and even twenty wives –as many as they can afford to purchase and maintain (Chapman, 1868: 341). (Bantu) [T]hey have a plurality of wives, which they also obtain by purchase (Chapman, 1868: 258). (foragers) The Hottentots practice polygamy (Chapman, 1868: 329-330). (pastoralists)	
	T. Baines				This morning Makātá, a headman of the Makoba, brought over four or five of his wives to be photographed (Baines, 1864:393). (Bantu)
	G. T. Fritsch	Als man an Moshesh, der zum Christenthum bekehrt werden sollte, die Anforderung stellte, seine überzähligen Frauen zu entlassen, fagte er ganz naiv (Fritsch, 1868: 124). (Bantu)		Die Frauen werden regelmässig von dem Aeltern durch Kauf erworben, und der Begüterte schafft sich deren so viele an, als sein Besitzstand ihm erlaubt (Fritsch, 1868: 124). (Bantu)	
	H. Schinz			[D]ie Hottentotten ursprünglich der Polygamie gehuldigt; wenn wir dieselbe heute aber nicht mehr finden	

Chrono-logy	Author/ Observer	Monogamy	Polygamy		
			Rare	Usual	Exceptional
				(Schinz, 1891:96). (pastoralists)	
	S. Passarge			Bei den Buschmännern besteht Vielweiberei, und zwar heiratet der Mann sehr häufig die Schwestern und Cousinen seiner ersten frau (Passarge, 1907:106). (foragers)	
	H. Vedder; A. Unterkötter			Uebrigens gestattet die Vielweiberei die Schonung der säugenden Mutter, so daß der Kindesmord keineswegs häufig vorkommt (Vedder & Unterköter, 1937: 19). (foragers)	
	S. S. Dornan	Polygamy was not the rule (Dornan, 1925:54-55). (foragers)			[A] strong man might have more than one wife. (Dornan, 1925:54-55) The chiefs used to have a great many wives (Dornan, 1925:124). (foragers)
20th Century	P. Trenk	The Bushman practise monogamy. (Guenther, 2005:242). (foragers)			
	H. Kaufmann	The Auin at Rietfontein all have only one wife (Guenther, 2005:88). (foragers)		The Auin at Gam have an average of two, occasionally even five, wives. (Guenther, 2005:88) (foragers)	
	E. Seydel			Polyandry and polygyny are practised in the latter case women are bought (Guenther, 2005:233). (foragers)	
	A. W. Hoernlé	In the past the Hottentots were polygynists […] Nowadays they are ostensibly monogamists (Hoernlé, 1925:16) (pastoralists).			

Chrono-logy	Author/ Observer	Monogamy	Polygamy		
			Rare	Usual	Exceptional
	J. H. Wilhelm	As a rule the Bushman has only one wife (Guenther, 2005:145). (foragers)	One seldom finds two, and if so, they are usually sisters or cousins (Guenther, 2005:145). (foragers)		
	L. Fourie			Among all the groups each man has two wives as a rule. The wives may or may not be related [..] Polyandry is not met with (Fourie, 1926:59). (foragers)	
	D. F. Bleek	Monogamy is the rule, but a second wife is not considered wrong among the Naron (Bleek, 1928:34). (foragers)		I was told that it is better for a man to marry a younger sister of his first wife (Bleek, 1928:34). (foragers)	
	V. Lebzelter	Monogamie ist die Regel, in erster Linie wohl durch die wirtschaftlichen Verhältnisse erzwungen. (Lebzelter , 1934:77) Die Ehe ist teils monogam, teils polygam (Lebzelter, 1934:103). (foragers)	[W]o Polygamie herrscht, ist die erste Frau die Hauptfrau (Lebzelter , 1934:9). Ich kenne einen einzigen Fall, wo ein Mann zwei Schwestern zu Frauen hatte (Lebzelter, 1934:29-30). (foragers)	Ein Mann kann so viele Frauen haben, als er will. Die erste Frau wird nicht gefragt, wenn sich der Gemahl weitere Gattinnen nehmen will (Lebzelter , 1934:11). Die Ehe ist teils monogam, teils polygam. (Lebzelter , 1934:103). (foragers)	
	Oscar T. Crosby		I am told by one witness that there is no condemnation of polygamy in the social code but that it is relatively rare, as it would introduce too man mouths to be fed (Crosby, 1931: 353) (foragers)	A man may marry four or five sisters in order successively. [...] [polyandry] No. Impossible (Crosby, 1931: 352). (foragers).	

Chrono-logy	Author/ Observer	Monogamy	Polygamy		
			Rare	Usual	Exceptional
	I. Schapera	The Cape Bushmen are now said to be monogamous, but polygynous marriages also have been recorded by earlier writers [citing, Bleek and Barrow] (Schapera, 1965 [1930]:103). (foragers) Nowadays the Hottentots are ostensibly monogamists (Schapera, 1965 [1930]:252). (pastoralists).	Among the Kung a second wife may be taken, if the first consents… polygynous marriages are extremely rare [citing, Lebzelter] (Schapera, 1965 [1930]:104) Polygynous marriages are also found among the !O Kung of Angola and among the Heichware, but are here said to be comparatively rare [citing, Bleek] (Schapera, 1965 [1930]:104). (foragers)	The Cape Bushmen are now said to be monogamous, but polygynous marriages also have been recorded by earlier writers [citing, Bleek and Barrow] (Schapera, 1965 [1930]:103]). (foragers) All Hottentot tribes formerly permitted polygyny, which however, was not practised to any great extent. More than two wives were seldom found. (Schapera, 1965 [1930]:230). (pastoralists).	We are told , however, that chiefs among the Naron mostly had two wives, so that here it maybe partly associated with rank [citing, Bleek, Fourie, Barrow] (Schapera, 1965 [1930]:104). (foragers) [O]only the more powerful and wealthy [Hottentot] men appear to have had more than one wife (Schapera, 1965 [1930]:251) . (pastoralists).
	J. A. Engelbrecht	[T]he practice of taking two wives is rare even to-day (Engelbrecht, 1936:129). (pastoralists)	[T]he practice of taking two wives is rare even to-day (Engelbrecht, 1936:129). (pastoralists)		
	R. P. Ch. Estermann	On peut affirmer hardiment que le vrai mariage !kung est matrilocal, indissoluble et monogame (Estermann, 1946/49:718). (foragers).			
	M. Gusinde	Zeitlich weit von heute entfernt begnügte sich jeder unserer Männer mit einer einzigen Ehefrau (Gusinde, 1966:126). (foragers)	Mir sind nur 3 Männer als polygyn bezeichnet worden (Gusinde, 1966:125). Unter alle Ehen, die ich persönlich angetroffen habe, fand ich bloß eine einzige, in der ein kaum 30jährige Mann mit zwei Frauen gleichzeitig lebte (Gusinde, 1966:182). (foragers)		

Chrono-logy	Author/ Observer	Monogamy	Polygamy		
			Rare	Usual	Exceptional
	L. Marshall			Polygyny is the ideal form of marraige among the !Kung.[…]The number of wives a man may have is not regulated by social rules but by his ability to obtain and support them. This limits him usually to one. None of the nine polygynists in the band had more than two (Marshall, 1959:345, 346). (foragers)	
	R. B. Lee	In a sample of 131 married men in 1968, 122 (93 percent) were living monogamously, 7 (5 percent) were living polygamously (6 with two wives, 1 with 3), and 2 (2 percent) men we reliving in a polyandrous union, sharing 1 woman (Lee, 1993: 84). (foragers)	Polygyny (marriage of 1 man to 2 or more women) is uncommon (Lee, 1993: 84). (foragers)		All 7 polygynous men are healers, and 5 of 7 have reputations as being among the strongest and most effective healers in the Dobe area (Lee, 1993: 85). (foragers)
	Biesele et al.			[T]he traditional system of marrying pre-pubescent girls to grown men-even men who already had one wife-made for a complex sexual politics with many familiar themes (Lee, 1986:85). (foragers)	
	N. Howell		Polygamy is permitted by the !Kung, but it is not a preferred marriage pattern (Howell, 2000: 230) (Howell, 2000: 272). (foragers)		
	C. Valiente-Noailles		The custom allows a man to have two women, but it is unusual. (Valiente-Noailles, 1993:101). (foragers)		

Annex 4 : Descriptions of post-marital residence, divorce and remarriage

Chrono-logy	Author/ Observer	Postmarital residence		Divorce	Remarriage
		Uxorlocality	Virilocality		
17th Century	D. O. Dapper				When someone has died … have the little finger of the left hand chopped off to be laid in the grave with the dead persons. [N.B. The practice of finger mutilation by the Hottentots is confirmed by many later writers … [for example] (a) by women who had lost their husbands, and were wishing to remarry] (Schapera & Farrington, 1933:63). (pastoralists)
	J. C. Hoffmann				[I]hre Weiber, wie viel Heirathe sie nach einander träffen, so viel Glieder von ihren Fingern beissen müsten. (Hoffmamn, 1931:30-31) (pastoralists)
	W. Ten Rhyne			[T]hey put the women away and make a divorce (Schapera & Farrington, 1933:147). (pastoralists)	Their wives have one finger joint, beginning from the first of the little finger, cut off for every man they have (Schapera & Farrington, 1933:145). (pastoralists)
	J. G. Grevenbroek		[T]he bridegroom, accompanied by the kinsfolk and connections of both, by the bridesmen and his friends, leads the bride to his home (Schapera & Farrington, 1933:203). (pastoralists)	A disobedient wife he beats, one whose badness is beyond reform he puts away (Schapera & Farrington, 1933: 207). (pastoralists)	

Chrono-logy	Author/ Observer	Postmarital residence		Divorce	Remarriage
		Uxorlocality	Virilocality		
18th Century	P. Kolb			A Man may be divorc'd from his Wife, and a Woman from her Husband, upon shewing such Cause as shall be satisfactory to the Men of the Kraal where they live (Kolb, 1738:158). (pastoralists)	A Man, divorc'd from his Wife, may marry again when he pleases. […] A Woman, divorc'd from her Husband, cannot marry again while He lives. (Kolb, 1738:159) The Hottentots who liv'd far from the Cape...that a Hottentot Woman, for every Marriage after her First, loses the Joints of a Finger (Kolb, 1738:310). (pastoralists)
	H. J. Wikar			[N.B. [F]or marriage may be dissolved by mutual consent] (Mossop, 1935:89). (pastoralists)	If a brother dies the surviving brother has to marry his brother's widow […] Should the father die the eldest son must marry the father's youngest wife, but not the oldest wives (Mossop, 1935: 29). (pastoralists)
	F. Le Vaillant		Les filles n'ont jamais de commerce avec les hommes, avant d'être sont nubiles; &, dans ce cas, sitôt qu'un garçon convient à son cœur, elle reçoit de ses parent la permission d'habiter avec lui. (Le Vaillant, 1790: 57) (pastoralists)	[C]ar, s'il survient comme je viens de le dire, quelque différend dans la ménage qui ne puisse s'appaiser que par la séparation, elle est bientôt prononcée ; on se quitte, & chacun de son côté cherchant fortune ailleurs, est libre de se remarier (Le Vaillant, 1790: 59-60).(pastoralists)	[C]ar, s'il survient comme je viens de le dire, quelque différend dans la ménage qui ne puisse s'appaiser que par la séparation, elle est bientôt prononcée ; on se quitte, & chacun de son côté cherchant fortune ailleurs, est libre de se remarier (Le Vaillant, 1790: 59). (pastoralists)

Chrono-logy	Author/ Observer	Postmarital residence		Divorce	Remarriage
		Uxorlocality	Virilocality		
19th Century	H. Lichtenstein			Ehescheidungen sind höchst selten von Verstossung weiss man gar nicht (Lichteinstein, 1967:436). (Bantu) Selbst das Familienband ist durch kein Gesetz geheiligt, die Frau nicht unauflöslich an den Mann gebunden, sondern wenn ers ihr verstattet, mag sie gehen, wohin sie will und einem Andern folgen […] Ein jeder verlässt nach Belieben seine Horde und schliesst sich gelegentlich einer andern an (Lichteinstein,1967:81-82). (foragers)	Schreitet eine Wittwe zur zweiten Ehe, so sind damit abermals Vortheile für die Aeltern verbunden, denen der Bräutigam eine gewisse Anzahl Kühe geben muss, die aber doch allemal geringer ist, als bei der ersten Verheirathung (Lichtenstein, 1967: 434). (Bantu) Ein jeder verlässt nach Belieben seine Horde und schliesst sich gelegentlich einer andern an (Lichteinstein,1967:81-82). (foragers)
	J. Campbell				Wenn ein Mann stirbt und eine Wittwe hinterläßt, so muß ein Verwandter desselben sie heirathen (Campbell, 1823:246). (Bantu)
	T.Arbousset; F. Daumas				Les veuves trouvent difficilement un second mari (Arbousset & Daumas, 1842:502). (foragers)
	G.W. Stow			The tie could be dissolved whenever the incompatibility of the pair became insupportable(Stow, 1905:95-96). (foragers) The man has undoubtedly the same right to put away the wife as the wife has to leave the husband (Stow, 1905:260). (Bantu)	

Chrono-logy	Author/ Observer	Postmarital residence		Divorce	Remarriage
		Uxorlocality	Virilocality		
	J. Chapman	After this couple are proclaimed husband and wife, and the man goes to live with his father-in-law for a couple of winters [bride service] (Chapman, 1868:259). (Bantu)	[after bride service]		
	T. Baines				John Harris was returning from a matrimonial negotiation on behalf of some Hottentot, whose name was embellished with the prefix of Dik (thick or fat), a widower, who as usual affected great diffidence, but had said 'Yes', after saying 'No' just long enough (Baines, 1864:67). (pastoralists)
	S. Passarge	Der Mann schließt sich der Familie seiner Frau an und wird ein Mitglied der anderen Sippe (Passarge, 1907:106). (foragers)	Nur bei der Heirat eines Familienoberhauptes hat die Frau zur Sippe des Mannes überzugehen (Passarge, 1907:106). (foragers)		
	H. Vedder; A. Unterkötter			Wie dein Vater deiner Mutter die Treue gehalten und sie nicht verlassen hat, so sollst du dein Weib auch nicht verlassen (Vedder & Unterköter, 1937: 19). (foragers)	Stirb ein Mann, so erbt der Bruder den Bogen. Mit dem Bogen erhält er auch Frau und Kinder des Verstorbenen. Ist kein Bruder vorhanden, so steht es schlimm um die Witwe (Vedder & Unterköter, 1937: 20). (foragers)
	S. S. Dornan	...but the young man has to go and live with his father-in-law for some time, perhaps for two or three years {bride service] (Dornan, 1925:126). (foragers)	[after bride service]		

Chrono-logy	Author/ Observer	Postmarital residence		Divorce	Remarriage
		Uxorlocality	Virilocality		
20th Century	P. Trenk			Divorce is possible only in case of adultery or infidelity of the woman (Guenther, 2005:242). (foragers)	Marriage is allowed immediately after the divorce, not, however, after the death of a spouse, in that event, they have to wait for about half a year (Guenther, 2005:243). (foragers)
	H. Kaufmann		The woman joins the family or camp of her husband, not the other way around. (Guenther, 2005:87) (foragers)	Divorce is rare and happens only when the wife has become too old. (Guenther, 2005:87) (foragers)	Widows, as well as divorced women are permitted to remarry after a certain length of time. (Guenther, 2005:87) (foragers)
	E. Seydel		[U]nd [die junge Frau] folgt dem Manne nach dessen Wohnsitz. (Seydel, 1910:25)(foragers)	A man is allowed to divorce his wife if she proves unfaithful or infertile. (Guenther, 2005:233) (foragers)	
	A. W. Hoernlé		[temporarily matrilocal, permanently virilocal] (Hoernlé [Schapera] , 1965 [1930]:251) (pastoralists)		To his wife's sister, a man behaved much as he would to his wife, and even at present day intercourse with them is common, if they are unmarried or widowed. […] A woman considered her husband's younger brothers as her husbands, and used in the old days to be inherited by one of them (Hoernlé, 1925:23). (pastoralists)
	J. H. Wilhelm	The young couple spends their honey-moon at the camp of the man's in laws, where they stay about a year [bride service] (Guenther, 2005:145). (foragers)	After the birth of the first child the man moves back to his own band (Guenther, 2005:145). (foragers)	The dissolution of the marriage follows after the death of one of the marital partners. […]If a divorce takes place, the cause is … ongoing quarrels between the wives (Guenther, 2005:146). (foragers)	If a woman's husband has died, she has to first wait for a year before she is allowed to enter in a new marriage […] A man whose wife has died also seems to remain unmarried for some length of time. (Guenther, 2005:146). (foragers)

Chrono-logy	Author/ Observer	Postmarital residence		Divorce	Remarriage
		Uxorlocality	Virilocality		
	L. Fourie	However, the parents of the bride are very old and poor in the primitive sense of the word the husband may be required to remain with the groups of his parents-in-law (Fourie, 1926: 59). (foragers)	[It] is patrilocal. (Fourie, 1926: 59) (Fourie, 1926: 60). (foragers)	Separation of husband and wife may take place under various circumstances, for example, when a woman is childless (Fourie, 1926:60). (foragers)	
	D. F. Bleek		Marriage is nominally by capture. The word "to marry" means also "to fetch" and "to catch". The women said, a man seizes a girl of another village, an takes her to his village, and thereby she is married, whether she likes it or not (Bleek, 1928:33). (foragers)	One sees couples who have grown old together, on the other hand one hears of case of desertion on either side. If there are no children no one worries about tit (Bleek, 1928:34). (foragers)	People who have separated are not ostracized. Both parties generally marry again. […] Widows often return to their own village. They mostly marry again, when young enough.(Bleek, 1928:34). (foragers)
	V. Lebzelter	Nach der Hochzeit zieht das junge Paar zur Werft der Brauteltern und bleibt manchmal jahrelang dort (Lebzelter, 1934:72). (foragers)	Da kehrt dann der Ehemann zu seiner jungen Frau bzw. deren Sippe zurück und bringt die Frau samt dem Kind zur eigenen Sippe, wo sie aufgenommen werden (Lebzelter, 1934:28). (foragers)	Die Ehe ist bis zur Geburt das erstes Kindes trennbar, nachher nicht mehr (Lebzelter, 1934:9). Die Ehe ist untrennbar (Lebzelter, 1934:71). [Die Ehe], doch trennbar (Lebzelter, 1934:89). (foragers)	Leviratesehe ist üblich […] Eine Verpflichtung der Schwagers für die Witwe zu sorgen oder sie zu heiraten besteht nicht (Lebzelter , 1934:76). Stirbt die Ehegattin, dann muß der Witwe eine Schwester seiner Frau heiraten, falls diese damit einverstanden ist (Lebzelter, 1934:41). (foragers)
	Oscar T. Crosby	The widow of an elder brother, if married to a man from another kraal, cannot be taken away; the husband becomes a member of the wife's kraal and a brother of the real cadet (Crosby, 1931: 352). (foragers)	The widow of an elder brother, if married to a man from another kraal, cannot be taken away; the husband becomes a member of the wife's kraal and a brother of the real cadet (Crosby, 1931: 352). (foragers)		A man may not marry his aunt, but may marry his widowed aunt-in-law. A younger brother may not take his elder brother's widow, but an elder brother is permitted to take his younger brother's widow, thus having two wives (Crosby, 1931: 352). (foragers)

Chrono-logy	Author/ Observer	Postmarital residence		Divorce	Remarriage
		Uxorlocality	Virilocality		
	I. Schapera	After marriage, as we have seen, the young couple may remain for some time with the wife's parents before finally taking up their residence in the husband's group (Schapera, 1965 [1930]:109) (foragers). [T]he husband continues to live with his wife at the home of her parents for at least a year after the marriage (Schapera, 1965 [1930]:50-251). (pastoralists).	After marriage, as we have seen, the young couple may remain for some time with the wife's parents before finally taking up their residence in the husband's group (Schapera, 1965 [1930]:109) (foragers). [T]he husband continues to live with his wife at the home of her parents for at least a year after the marriage (Schapera, 1965 [1930]:50-251). (pastoralists).	Among the Auen divorce is rare, and only takes place when the wife is too old; she may then simply be sent to her people. [...] Among the Namib Bushmen divorce may result only from barrenness or adultery, and is at the discretion of the husband [citing Kaufman, Fourie, Trenk] (Schapera, 1965 [1930]:111). (foragers) The only ground for divorce is ill-treatment, which has to be proved to the satisfaction of the tribal council (Schapera, 1965 [1930]:253). (pastoralists).	[Schapera refers to Arbousset, Bleek, Kaufmann, Trenk, and Lebzelter's descriptions, including levirate, sororate and the slower remarriage after widowhood] (Schapera, 1965 [1930]:111-112). (foragers) Even now it is customary that after the death of a man his brother takes the widow into his hut [...]The survivor of a marriage, whether man or woman, is not permitted to remarry until at least a full year has elapsed since the death of the other partner (Schapera, 1965 [1930]:254). (pastoralists)
	J. A. Engelbrecht	Formerly the newly-married couple did not leave the wife's parental home for some time, at least not until after the first child had been born to them (Engelbrecht, 1936:135-136). (pastoralists)	Later it became the custom with at least some to take the wife away directly after marriage and to bring her back when the baby was about to be born (Engelbrecht, 1936:135-136). (pastoralists)	If a wife returned to her parents owing to domestic trouble, she would quite probably be sent back and further developments if any, be awaited. (Engelbrecht, 1944:144). (pastoralists)	When a husband died, his wife went into partial retirement for a period which formerly lasted a year (or as long as her bed was still "hot"), but which is now very much less. There was nothing to prevent her from going about her daily duties, but intercourse was restricted to the family of her deceased husband. (Engelbrecht, 1936:137). (pastoralists)
	R. P. Ch. Estermann	On peut affirmer hardiment que le vrai mariage !kung est matrilocal, indissoluble et monogame (Estermann, 1946/49:718). (foragers)			Les veuves, surtout si elles ont des enfants, souvent ne pensent plus à se remarier (Estermann, 1946/49:718). (foragers).
	M. Gusinde		Das Mädchen tritt in diejenigen des erwählten jungen Mannes über und wird seitdem von jedermann als zugehörig zur	Wenn sich zur Neuzeit der eine Ehepartner vom anderen getrennt hat, geschah dies als ein spärliche Ausnahme und unter Einflüsse, die es	

Chrono-logy	Author/ Observer	Postmarital residence		Divorce	Remarriage
		Uxorlocality	Virilocality		
			Gruppe seines Gatten betrachtet bzw. behandelt (Gusinde, 1966:125). (foragers)	ehedem nicht gegeben hat (Gusinde, 1966:182). (foragers)	
	L. Marshall	The bride-service is indefinite. Informants told us a man must stay with his wife's people until three children have been born.(Marshall, 1959: 352) (foragers)	[after bride service]	If a girl complained to her parents and the parents took her back and sent the young husband away, he might have to wait for years again for another bride to grow up. [...] The couple may divorce without formality, by mutual consent or by one spouse simply leaving the other (Marshall, 1959:350,358). (foragers)	No restriction of time is put upon the remarriage of a widower, but a widow should not remarry until one rainy season has passed. She is then considered clean and may marry again (Marshall, 1959:357). (foragers)
	R. B. Lee	Only after several children are born can he take his wife and family back to his own people. Frequently, after 8 to 10 years of bride service, the couple elects to stay with the wife's people (Lee, 1993:81). (foragers)	Only after several children are born can he take his wife and family back to his own people. Frequently, after 8 to 10 years of bride service, the couple elects to stay with the wife's people(Lee, 1993:81). (foragers)	Given the realities of divorce and life expectancy, many Ju/'hoansi, male and female, find themselves without partners in middle or old age (Lee, 1993: 86). (foragers)	[M]any do remarry, and for those who do, these second (or third) marriages often prove to be happy and fulfilling (Lee, 1993: 84-85). (foragers)
	Biesele et al.				Note that the !kung joke with spouses and with spouses' siblings of the same sex. This relationship is allowed because a man's wife's sister (or brother's wife) is herself a potential wife (Lee, 1986:85) (foragers)

Chrono-logy	Author/ Observer	Postmarital residence		Divorce	Remarriage
		Uxorlocality	Virilocality		
	N. Howell	The !kung believe that the young couple should live in the village with the girl's parents, not just until the first birth but until several children have been born to the couple (Howell, 2010: 37). (foragers)	[T]he !Kung groups as a whole is classified as patrilineal and patrilocal. (Howell, 2010: 37). (foragers)	A young man who tries to force his child bride into a sexual relationship before she is ready is likely to find himself divorced and back at home, while his parents try to find another bride for him. (Howell, 2010: 36) Most of the polygamous marriages, even if established for a while, are unsuccessful (Howell, 2000:270-272). (foragers)	[T]he pattern of remarriage is somewhat different for marriages that end in divorce and those that end in widowhood. Divorced women remarry more quickly. [...]The widowed women, who remarry more slowly and more often do not remarry, tend to be older than the divorced women (Howell, 2000: 241). (foragers)
	C. Valiente-Noailles			A woman may be so described is she fails to play her part as [work]. […] If the man fails to play his part [work] he still also runs the risk of being divorced. […]Adultery seems to be the main cause of conflict (Valiente-Noailles, 1993:101). (foragers)	

Annex 5: Descriptions of birth spacing and weaning age

Chrono-logy	Author/ Observer	Birth interval		Weaning age	
		≤ 1 year	>1 year	≤ 1 year	>1 year
17th Cent.	J. Schreyer		[S]elten über 4. Kinder bekommen (Schreyer, 1931:32). (pastoralists)		
18th Cent.	P. Kolb			When the Child is about six Months old, she weans it (Kolb, 1738:165). (pastoralists)	
19th Century	H. Lichtenstein	Die Kafferinnen sind sehr fruchtbar, besonders die, welche die einzigen Frauen eines Mannes sind. Solche haben im Durchschnitt acht bis zehn Kinder (Lichtenstein, 1967:436). (Bantu)	Die Kafferinnen sind sehr fruchtbar, besonders die, welche die einzigen Frauen eines Mannes sind. Solche haben im Durchschnitt acht bis zehn Kinder. (Lichtenstein, 1967:436)(Bantu)		Gesunde Mütter stillen ihre Kinder gewöhnlich bis sie zwei Jahre alt sind (Lichtenstein, 1967:424). (Bntu)
	J. Campbell	Einige unserer Hottentoten sahen bei einem Kraal 8 Kinder, die sämmtlich einer Familie angehören und gesund und wohlbleibt waren (Campbell, 1823:177). (foragers)	Einige unserer Hottentoten sahen bei einem Kraal 8 Kinder, die sämmtlich einer Familie angehören und gesund und wohlbleibt waren (Campbell, 1823:177). (foragers)		
	G.W. Stow	[A] Bushman, his wife, a younger brother, two daughters, eleven and twelve years of age, and a child of about eighteenth months, which the mother still continued to suckle (Stow, 1905:49). (foragers)	[A] Bushman, his wife, a younger brother, two daughters, eleven and twelve years of age, and a child of about eighteenth months, which the mother still continued to suckle (Stow, 1905:49). (foragers)		[A] Bushman, his wife, a younger brother, two daughters, eleven and twelve years of age, and a child of about eighteenth months, which the mother still continued to suckle (Stow, 1905:49). (foragers)
	F. Bachman		Die Kinder in einer Hottentotten-Familie folgen einander meist nicht so schnell als bei den Boeren (Bachman, 1899:97). (pastoralists)		Bis zu seinem vollendeten zweiten Lebensjahre hatte ihn seine Mutter an der Brust genährt (Bachman, 1899: 89). (pastoralists)

Chrono-logy	Author/ Observer	Birth interval		Weaning age	
		≤ 1 year	>1 year	≤ 1 year	>1 year
	H. Schinz				Das Kind … wird unter Umständen bis ins vierte Jahr gestillt, ja oft liegt das erste noch an der Brust, wenn schon ein zweites und drittes geboren ist (Schinz, 1891:97-98). (pastoralists)
	S. Passarge		Die Ernährung und das Aufziehen des Kindes erfolgt nur dann, wenn die Mutter genügend Nahrung hat, also selbst in genügendem Ernährungszustand sich befindet, und wenn das letzte Kind bereits so weit entwickelt ist, daß es sich selbst Wurzeln und Knollen graben, Melonen usw. sammeln kann (Passarge, 1907:99) (foragers)		Die Ernährung und das Aufziehen des Kindes erfolgt nur dann, wenn die Mutter genügend Nahrung hat, also selbst in genügendem Ernährungszustand sich befindet, und wenn das letzte Kind bereits so weit entwickelt ist, daß es sich selbst Wurzeln und Knollen graben, Melonen usw. sammeln kann (Passarge, 1907:99) (foragers)
	H. Vedder; A. Unterkötter		[J]edes Kindchen, wenn es geboren wird, bevor das ältere Brüderchen oder Schwesterchen drei Jahre alt ist, lebendig begraben wird, ohne je die Mutterbrust berührt zu haben (Vedder & Unterköter, 1937:18). (foragers)		
	S. S. Dornan		Childbearing seems to stop at an early age, and one seldom sees more than three or four children in any family (Dornan, 1925:129). (foragers)		

Chrono-logy	Author/ Observer	Birth interval		Weaning age	
		≤ 1 year	>1 year	≤ 1 year	>1 year
20th Century	H. Kaufmann		I have noticed two to three children with most of the women, whose age difference is always two to three years (Guenther, 2005:87). (foragers)		[T]he mother is still nursing a child, which she does until the third year of the child's life. (Guenther, 2005:49-50) (foragers)
	J. H. Wilhelm		[T]he children are about two years apart in age (Guenther, 2005:142). (foragers)		[W]hen a woman, who nurses her child up to its third years (Guenther, 2005:142). (foragers)
	D. F. Bleek		But on an average the women do not rear more than three children (Bleek, 1928:31). (foragers)		Till the youngster is weaned at three or four years it is her constant companion, coming for a drink every half-hour if it pleases, and giving her an additional burden to carry wherever she goes (Bleek, 1928:31). (foragers)
	L. Fourie		A woman seldom had more than five children but as a rule only two or three (Fourie, 1926:60). (foragers)		The child suckles until it is able to walk well (Fourie, 1926:60). (foragers)
	V. Lebzelter				Die Kinder werden lange gestillt, ältere Säuglinge lernen mit den Fingern die Milch aus der Brust herausdrücken oder ziehen mit den Zähnen an den lederharten Warzen (Lebzelter, 1934:29). (foragers)
	I. Schapera		On average women do not reared more than two or three children, although among the Naron Miss Bleek found one or two middle-aged women who counted up to five children they had reared [citing Bleek] (Schapera, 1965 [1930]: 116-117). (foragers)		Children age nursed by their mothers till about three or even four years old (Schapera, 1965 [1930]:116). (foragers). A child is often suckled by its mother till three or four years old (Schapera, 1965 [1930]:268). (pastoralists)

Chrono-logy	Author/ Observer	Birth interval		Weaning age	
		≤ 1 year	>1 year	≤ 1 year	>1 year
	J. A. Engelbrecht		Andries adds that or the sake of the next child, which would otherwise suffer from ill-health, a husband is not supposed to resume marital relations until the baby is about eighteen months old (Engelbrecht, 1936:141). (pastoralists)		
	L. Marshall		They generally space their children at least two and often four or five years apart (Marshall, 1960:327). (foragers)		They believe that a child should nurse till it is three or four years old at least. We have seen six- and seven-year-olds standing to nurse (Marshall, 1960:329). (foragers)
	R. B. Lee		Nomadic !kung women have an average interval between live births of almost 4 years (Lee, 1980:322).		When combined with the practice of long nursing and late weaning, one might see the amazing situation, in the words of one informant, of "a girl going from her mother's breast to her husbands' bed in one day". (Lee, 1993:81). (foragers)
	N. Howell		In my data, birth intervals average forty months to forty-one months when the first child survives, and less when the earlier child dies (Howell, 2010: 27). (foragers)		From the age of weaning, approximately age 3 to 5... (Howell, 2010: 28). (foragers)
	C. Valiente-Noailles	In older times they left the first child to get big before having another one, but nowadays they are less careful. Sometimes a baby is born every year (Valiente-Noailles, 1993:83). (foragers)			Fed from the breasts until starts walking and often up to age two or even three (Valiente-Noailles, 1993:89). (foragers)

Annex 6: Descriptions of the practice of infanticide

Chrono-logy	Author/ Observer	Infanticide				
		Shot birth interval	Twins	Malformed birth	Death of mother	Not practiced
17th Century	J. Schreyer		[W]ann sie Zwillinge bringen, daß sie aus Furcht der Mühe, das eine Kind in die Erden scharren, das andere leben lassen (Schreyer, 1931:39). (pastoralists)		Wann die Frau gebähret, und stirbt nach der Geburt, so wird das lebendige Kind mit der todten Mutter begraben, welches auch geschicht (Schreyer, 1931:39). (pastoralists)	
	W. Ten Rhyne		[I]f a mother bears twins, a male and a female, by the law of their race they killed the latter in the cradle (Schaapera & Farrington, 1933: 143). (pastoralists)			
	J. G. Grevenbroek		If a woman among them bear twins, they rear them, giving them to the mother to be cherished and fed. In this they differ greatly from the nearer tribes ... (Schaapera & Farrington, 1933: 181). (pastoralists)		If the mother dies in labour immediately after giving birth, they bury her at once with the embryo of infant, even if alive […] [A] father who is rich in cattle hires a nurse for the little daughter who has survived (Schaapera & Farrington, 1933: 183). (pastoralists)	

Chrono-logy	Author/ Observer	Infanticide				
		Shot birth interval	Twins	Malformed birth	Death of mother	Not practiced
18th Century	P. Kolb		[T]he worst featur'd of the Two is buried alive, or expos'd on the Bough of a Tree, or among Bushes. (Kolb, 1738:144) [...]For the Girl is certainly condemn'd, if either Scarcity of the Mother's Milk, or Poverty, be alleg'd against bringing up Both (Kolb, 1738:144). (pastoralists)			
	A. Sparrman				That same year, and on the same spot, where I then lived, immediately before my arrival, the following instance [burial of one of twins] had occurred (Sparrman, 1789a: 257). (pastoralists)	

Chrono-logy	Author/ Observer	Infanticide				
		Shot birth interval	Twins	Malformed birth	Death of mother	Not practiced
	F. Le Vaillant		C'est la crainte de ne pouvoir nourrir ses jumeaux, & de es voir périr tous deux, qui a porté quelques mères en à sacrifier un ; au reste, les Gonaquois sont exempts de ce reproche, & je les ai vus s'indigner de ma question (Le Vaillant, 1790: 50). (pastoralists)		[S]i, par un exemple extrêmement rare, on ne pouvoir accorder la vie qu'à l'un des deux, certes d'horribles distinctions n'ordonneroient point l'assassinat d'une mère, & l'enfant ne feroit pas épargné (Le Vaillant, 1790: 50). (pastoralists)	[C]e crime contre Nature est fort rare & révolte ces Nations [...] C'est donc calomnier ces peuples que de donner comme une pratique constante quelques actions barbares qu'ils désavouent & démentent si bien par leur conduite: j'ai rencontré dans plus d'une Horde, des mères qui nourrissoient leurs jumeaux & ne m'en paroissoient pas plus embarasseés (Le Vaillant, 1790: 50-51). (pastoralists)
	J. Campbell		Gebährt eine Frau Zwillinge, so wird eins von den Kindern getödtet (Campbell, 1823:242). (Bantu)			
	G.W. Stow			Bushmen will kill their children without remorse on various occasions, as when they are ill-shaped (Stow, 1905:51). (foragers)		

Chrono-logy	Author/ Observer	Infanticide				
		Shot birth interval	Twins	Malformed birth	Death of mother	Not practiced
	H. Schinz			[D]ie Buschmänner Neugeborene, die entweder mit einem Gebrechen behaftet sind oder die die Mutter aus Mangel an Milch nicht zu ernähren vermag, aussetzen (Schinz, 1891:395). (foragers)		
	S. Passarge	[W]enn das letzte Kind bereits so weit entwickelt ist, daß es sich selbst Wurzeln und Knollen graben, Melonen usw. sammeln kann. Ist das nicht der Fall, so wird das Neugeborene klebendig begraben (Passarge, 1907:99). (foragers)			Stirbt eine Frau infolge der Entbindung, so wird das Kind mit ihr beerdigt (Passarge, 1907:99). (foragers)	
	H. Vedder; A. Unterkötter	[D]aß jedes Kindchen, wenn es geboren wird, bevor das ältere Brüderchen oder Schwesterchen drei Jahre alt ist, lebendig begraben wird, ohne je die Mutterbrust berührt zu haben (Vedder & Unterköter, 1937:18) . (foragers)				Uebrigens gestattet die Vielweiberei die Schonung der säugenden Mutter, so daß der Kindesmord keineswegs häufig vorkommt (Vedder & Unterköter, 1937: 19). (foragers)

Chrono-logy	Author/ Observer	Infanticide				
		Shot birth interval	Twins	Malformed birth	Death of mother	Not practiced
	S. S. Dornan		[A]nd the Masarwas say that they [twins]are very seldom born. Probably, like many other native tribes, one or both are destroyed at birth (Dornan, 1925:129) . (foragers)	If the child is stillborn or defective in any way it is not encouraged to live, though that such children are willfully destroyed all Bushman that I have questioned indignantly denied (Dornan, 1925:129). (foragers)		[T]hough that such children are willfully destroyed all Bushman that I have questioned indignantly denied (Dornan, 1925:129). (foragers)
20th Century	P. Trenk					People do not expose or kill cripples children, however, abortion is permitted (Trenk, 1910:243). (foragers)
	H. Kaufmann	Here I would note that newly born children are killed every time the mother is still nursing a child (Guenther, 2005:49-50). (foragers)	When twins are born, which apparently happens very rarely, one child is killed (Guenther, 2005:90). (foragers)			
	J. H. Wilhelm	Sometimes, when a woman, who nurses her child up to its third years, gets a second child and not enough food is available for both children, the second child will be buried alive(Guenther, 2005:142). (foragers)	Twin births are very rare; however, one case is known to me where one of the children was immediately buried (Guenther, 2005:142). (foragers)	Only one rarely finds crippled Bushman (Guenther, 2005:142). (foragers)	If the woman dies in childbirth, mother and child are buried together (Guenther, 2005:142). (foragers)	
	L. Fourie					Child murder is not practised (Fourie, 1926:60). (foragers)

Chrono-logy	Author/ Observer	Infanticide				
		Shot birth interval	Twins	Malformed birth	Death of mother	Not practiced
	D. F. Bleek	[T]hey "throw away" any baby born too soon, sometimes one, sometimes two between the children they rear (Bleek, 1928:31). (foragers)	Twins are rare […] a middle-aged man remembered the birth of a twin boy and girl at a distance. Both children had been reared to adolescence, then the boy died (Bleek, 1928:30). (foragers)		Should the child live and the mother die, some woman may try to suckle it with her own, I am told, but more often the baby is buried with the mother, especially among the wilder clans (Bleek, 1928:30). (foragers)	
	V. Lebzelter	Bei den Naron kommt übrigens auch Kindesmord vor (Lebzelter, 1934:72). (foragers)	Zwillinge (Hoi-holi) sind unerwünscht, bei den Nogau wird eines getötet (Lebzelter, 1934:68). (foragers)			[T]rifft [infanticide]für die von mir besuchten Sippen angeblich nicht zu (Lebzelter , 1934:29). (foragers)
	Oscar T. Crosby				"We could not care for it as it was only a few days old, so we buried it with its mother". The police officer though it his duty to arrest all. They were taken for trial, imprisoned, and, later, set free (Crosby, 1931: 353). (foragers).	Their destruction before or after birth, is then determined by threatening starvation (Crosby, 1931: 353). (foragers).

Chrono-logy	Author/ Observer	Infanticide				
		Shot birth interval	Twins	Malformed birth	Death of mother	Not practiced
	I. Schapera	In such a case the new child is, as the natives euphemistically put it, "thrown away" [citing Passarge, Kaufmann, Bleek, Fourie](Schapera, 1965 [1930]:116). (foragers) Should another child be born before the first is weaned, the latter is handed over to another woman, generally a near relative of the mother. (Schapera, 1965 [1930]:268). (foragers).	Among the Auen and the Heikum one of twins is invariably killed by being buried immediately after birth (Schapera, 1965 [1930]:114-115). (foragers) Twin births among the Naman are to-day regarded as unlucky, but the children are not killed, nor are there any special ceremonies connected with them (Schapera, 1965 [1930]:266). (pastoralists).	The exposure or killing of deformed children does not seem to occur in any of the tribes (Schapera, 1965 [1930]:115). (foragers) Misshapen or deformed children, on the other hand, especially girls, were, acceding to some writers on the Cape Hottentots, buried alive (Schapera, 1965 [1930]:266). (pastoralists)	[T]he death of the mother in childbed usually also meant the burial with her of her living baby, unless some other woman could be found to suckle it (Schapera, 1965 [1930]:266). (pastoralists)	
	J. A. Engelbrecht					It is stated that twins had always been rare, but that they were considered to bring good luck (Engelbrecht, 1936:140). (pastoralists)
	L. Marshall	The !kung limit their population by infanticide (Marshall, 1960:327). (foragers)				
	R. B. Lee	Under most foraging conditions the !kung are able to maintain very low fertility through long birth spacing with a rate of infanticide of less than 2% [Howell, 1976] (Lee,				

Chrono-logy	Author/ Observer	Infanticide				
		Shot birth interval	Twins	Malformed birth	Death of mother	Not practiced
		1980:322). (foragers)				
	N. Howell			[a birth at one of the major cattleposts in the late 1950s:] When the child was seen to have six toes and an extremely small head, the !kung women, including the mother, wanted to smother it, but the Bantu women found this unacceptable#. (Howell, 2000: 119-120). (foragers)	Six cases of infanticide were acknowledged among the 500 live births to the living women reported in 1968. In one the father died during the pregnancy, in another an old woman had seen her two previous babies die from her failure to produce sufficient milk, and in a third the baby had a wrong "father". (Howell, 2000: 220). (foragers)	I know of only one case in which the mother died in childbirth and the child survived, raised by her maternal grandmother on cow's milk (Howell, 2010: 24). (foragers)

Annex 7: Descriptions of the practice of abortion

Chrono-logy	Author/ Observer	Abortion	
		Practiced	Not Practiced
19th Century	S. Passarge	Man hört auch oft die Behauptung aussprechen, daß die Buschmannfrauen eine Medizin hätten, um die Konzeption zu verhindern. Davon wollen diese selbst aber nichts wissen. Möglicherweise handelt es sich um Abortivmittel (Passarge, 1907:1000). (foragers)	
20th Century	P. Trenk	People do not expose or kill cripples children, however, abortion is permitted (Trenk, 1910:243). (foragers)	
	H. Kaufmann	An abortion is sometimes induced by treading on the womb of the pregnant woman (Guenther, 2005:88). (foragers)	
	L. Fourie		Child murder is not practised (Fourie, 1926:60). (foragers)
	D. F. Bleek	When their time is at hand, they slip off with an old woman to a lonely spot, and try to force on the birth by massage. The child is sometimes still-born, but whether alive or not, it is at once buried by the old woman(Bleek, 1928:31). (foragers)	
	V. Lebzelter		Die Buschmänner kennen keine Vorbeugungsmittel gegen Schwangerschaft und sehr bald nach der Ehe befindet sich auch die junge Frau schon in anderen Umständen (Lebzelter, 1934:30). (foragers)
	Oscar T. Crosby	Abortion (generally for the unmarried girl) by medicines and by manipulation is quite frequently practised, even though not suggested by famine. (Crosby, 1931: 353) (foragers)	
	I. Schapera	Abortion, however, is often induced by treading on the body of the pregnant women (Schapera, 1965 [1930]:115). (foragers) Women who do not want children achieve their aim mainly by abortion, which is not infrequently practiced (Schapera, 1965 [1930]:260). (pastoralists)	
	J. A. Engelbrecht	Women sometimes purposely avoid, and still more, remove pregnancy, not only after illicit intercourse, but also when they disliked their husbands, or when they are afraid to face the dangers accompanying childbirth (Engelbrecht, 1936:141). (pastoralists)	
	C. Valiente-Noailles		Abortion is not practiced. (Valiente-Noailles, 1993:87) (foragers)

Annex 8: Syntax in the simulation program

In this annex I exemplify the syntax format given to the data incorporated into the simulation system, with the example of the norm of marriage (any other variables, follow the same mechanism and structure).

Below (Fig. 79), I show and describe an example of how every social norms is established, with every part of the syntax, and manner in which connect to the general environment of the simulation.

```
<norm>
<nom>normal_marriage_trial</nom>
        <combinable>yes</combinable>
        <has_partner>yes</has_partner>
        <priority>(health+rulesrespect*8/10+reputation*2/10)</priority>
        <precondition_success>launch_acceptation</precondition_success>
        <precondition_candidate>receptor_conditions</precondition_candidate>
        <precondition>normal_marriage_launching</precondition>
        <limit>5750</limit>
        <repeat>1</repeat>
        <success>final_marriage_acceptation</success>
        <failure>nulla</failure>
</norm>
```

Figure 79. Example of a plausible norm for marriage incorporated in the system

This nom contains 3 preconditions to be fulfilled (Fig. 80), 3 conditions which place the norm in the context[85], the weight of the norm[86], the repetitions allowed[87], and the two consequences (success or failure).

[85] The option "<combinable>" indicates that the norm depends on limitations which are compatible to other norms. If it is indicated that the norm is not compatible, it means that it is associated to exclusive limitations. The condition "<has partner>" in a norm sets a correlation between an agent and a candidate, both have to fulfil some conditions separately and mutually. The system organizes with the condition of "<priority>" the list of female candidates according to, in this particular case, the combination of health, reputation and rules-respect (i.e. 80% of the variables of health and rules-respect combined, and 20% of the variable of reputation, corresponding to the female agents).

[86] The number indicated in «limit» is the weight of the norm. Each precondition and each limitation have also their own weight. To every limitation correctly fulfilled, their weights are added up. If their total reaches the weight of the precondition within which they are included, the precondition is then validated (if the sum does not reach the weight

```
<precondition>
        <nom>normal_marriage_launching</nom>
                <limitation>first_step</limitation>
                <limitation>condition_first_instance_marriage</limitation>
                <limitation>second_step</limitation>
                <limitation>condition_second_instance_marriage</limitation>
                <limitation>third_step</limitation>
                <limitation>condition_third_instance_marriage</limitation>
                <limitation>fourth_step</limitation>
                <limitation>condition_fourth_instance_marriage</limitation>
                <limitation>steps</limitation>
                <limitation>sex_launcher</limitation>
                <limitation>age_launcher</limitation>
                <limitation>social_status_launcher_s</limitation>
                <limitation>social_status_launcher_w1</limitation>
                <limit>5750</limit>
</precondition>
 <precondition>
        <nom>receptor_conditions</nom>
                <limitation>sex_receptor</limitation>
                <limitation>age_receptor</limitation>
                <limitation>social_status_receptor_s</limitation>
                <limitation>social_status_receptor_w1</limitation>
                <limitation>different_family</limitation>
                <limit>4600</limit>
</precondition>
<precondition>
        <nom>launch_acceptation</nom>
                <limitation>higher_reputation</limitation>
                <limitation>higher_current_reputation</limitation>
                <limitation>older_launcher</limitation>
                <limitation>male_widows</limitation>
                <limitation>widow_priority</limitation>
                <limit>300</limit>
</precondition>
```

Figure 80. Example of preconditions included in the norm for marriage.

In order to offer a detailed description, a continuation each precondition is dissected, starting with the precondition of "normal marriage launching".

---

of the precondition, the precondition is not validated). This same logic applies to the weight of the different preconditions included in a norm: the weight of the preconditions fulfilled is added up, expecting to meet the required weight of the norm. The norm is not validated in case there is at least one precondition that is not fulfilled.

[87] <Repeat> specifies how many times is the agent allowed to use this norm in each step, (how many times can a male agent ask the system to pair him with a female agent). In case the consequence of the norm is a failure, the agent will have to wait until the next step of the system to use this norm again.

```
<limitation>
        <nom>first_step</nom>
                <tipus>interval</tipus>
                <variable>pas</variable>
                <interval>0#0</interval>
                <pes>60</pes>
</limitation>
<limitation>
        <nom>condition_first_instance_
        marriage</nom>
                <tipus>interval</tipus>
                <variable>formula</variable>
                <formula>(health*3/10+reputation*7/
                10)</formula>
                <interval>5000#20000</interval>
                <pes>40</pes>
</limitation>
<limitation>
        <nom>second_step</nom>
                <tipus>interval</tipus>
                <variable>pas</variable>
                <interval>1#1</interval>
                <pes>62</pes>
</limitation>
<limitation>
        <nom>condition_second_instance_
        marriage</nom>
                <tipus>interval</tipus>
                <variable>formula</variable>
                <formula>(boldness+health)/2*7/10+(
                reputation+rulesrespect)/2*3/10</form
                ula>
                <interval>3501#7000</interval>
                <pes>38</pes>
</limitation>
```

```
<limitation>
        <nom>third_step</nom>
                <tipus>interval</tipus>
                <variable>pas</variable>
                <interval>2#2</interval>
                <pes>64</pes>
</limitation>
< limitation>
        <nom>condition_third_instance_
        marriage</nom>
                <tipus>interval</tipus>
                <variable>formula</variable>
                <formula>(boldness+health)/2*7/10+(
                reputation+rulesrespect)/2*3/10</form
                ula>
                <interval>1501#3500</interval>
                <pes>36</pes>
</limitation>
<limitation>
        <nom>fourth_step</nom>
                <tipus>interval</tipus>
                <variable>pas</variable>
                <interval>3#3</interval>
                <pes>66</pes>
</limitation>
<limitation>
        <nom>condition_fourth_instance_
        marriage</nom>
                <tipus>interval</tipus>
                <variable>formula</variable>
                <formula>(boldness+health)/2*7/10+(
                reputation+rulesrespect)/2*3/10</form
                ula>
                <interval>0#15</interval>
                <pes>34</pes>
</limitation>
<limitation>
        <nom>steps</nom>
                <tipus>interval</tipus>
                <variable>pas</variable>
                <interval>4#10000</interval>
                <pes>100</pes>
</limitation>
```

Figure 81. Part 1. Limitations included in the precondition “normal marriage launching”

In the first set of limitations (Fig.81) only one combination of two limitations is needed. These limitations are related exclusively to the steps of the simulation. The purpose of this structure is to limit during the first steps the number of agents in risk of marrying, in order to avoid a *boomer* event. At the start of the simulation there is a high probability that 60% of the population marries, which would lead to a sudden increase of the total fertility rate in the next two to three steps. However, by limiting the number of agents (depending on their currant social or biological variables) it is possible to reduce its impact. In this manner, it is mandatory the system to count a weight of 100 from this set of limitations.

```
<limitation>
        <nom>sex_launcher</nom>
                <tipus>valor</tipus>
                <variable>sex</variable>
                <valor>M</valor>
                <pes>5000</pes>
</limitation>
<limitation>
        <nom>age_launcher</nom>
                <tipus>interval</tipus>
                <variable>age</variable>
                <interval>17#75</interval>
                <pes>500</pes>
</limitation>
```

```
<limitation>
        <nom>social_status_launcher_s</nom>
                <tipus>valor</tipus>
                <variable>social_status</variable>
                <valor>single</valor>
                <pes>150</pes>
</limitation>
<limitation>
        <nom>social_status_launcher_w1</nom>
                <tipus>valor</tipus>
                <variable>social_status</variable>
                <valor>widowed</valor>
                <pes>150</pes>
</limitation>
```

Figure 82. Part 2. Limitations included in the precondition “normal marriage launching”

The second part of limitations within the precondition under analysis basically includes several specific conditions concerning the profile of the male candidate agent which must be fulfilled. These conditions are his social status (single or widow), the minimum marriage age (17 years of age) and the sex (male). Therefore, the “first step” and “instance for marriage first step” (100), the “sex” of the agent (5000), the “age” of the agent (500), and “social status” of the agent (150) equal to 5750, the amount necessary to validate the precondition. As shown, the calculation is precise, meaning that if any of the limitations is not fulfilled, the precondition will not be validated, and automatically the *marriage proposal* would fail.

The next precondition is that containing the conditions regarding the receptor, in this particular case, a female agent (Fig. 83).

```
<limitation>
        <nom>sex_receptor</nom>
                <tipus>valor</tipus>
                <variable>sex</variable>
                <valor>F</valor>
                <pes>3000</pes>
</limitation>
<limitation>
        <nom>age_receptor</nom>
                <tipus>interval</tipus>
                <variable>age</variable>
                <interval>16#75</interval>
                <pes>1000</pes>
</limitation>
<limitation>
        <nom>social_status_receptor_w1</nom>
                <tipus>valor</tipus>
        <variable>social_status</variable>
                <valor>widowed</valor>
                <pes>300</pes>
</limitation>
<limitation>
        <nom>different_family</nom>
                <tipus>valor</tipus>
            <variable>familianuclear</variable>
                <valor>different</valor>
                <pes>300</pes>
</limitation>
<limitation>
        <nom>social_status_receptor_s</nom>
                <tipus>valor</tipus>
             <variable>social_status</variable>
                <valor>single</valor>
                <pes>300</pes>
</limitation>
```

Figure 83. The set of limitations included within the precondition "receptor conditions"

The limitations request the receptor agent to be a female agent, with an age between 16 and 75 years, single or widow, and from a different family. In this case, the weight for validation must be of at least 4600. If any of these limitations is not fulfilled, independently of which one, the precondition will not be validated.

The last precondition is that of the "acceptance" of the marriage. In this precondition the limitations are established in a way that the system review the profile of the involved agents and the environment (Fig. 84). In this case the validation of this preconditions requires only one limitation to be certain.

```
<limitation>
        <nom>higher_reputation</nom>
                <tipus>valor</tipus>

        <variable>reputation</variable>
                <valor>greater than</valor>
                <pes>300</pes>
</limitation>
<limitation>
       <nom>higher_current_reputation</nom>
                <tipus>valor</tipus>
        <variable>current_reputation</variable>
                <valor>greater than</valor>
                <pes>300</pes>
</limitation>
<limitation>
        <nom>male_widows</nom>
                <tipus>valor</tipus>
        <variable>social_status</variable>
                <valor>widowed</valor>
                <pes>300</pes>
</limitation>
<limitation>
        <nom>widow_priority</nom>
                <tipus>valor</tipus>
        <variable>var_general_purpose1
       </variable>
                <valor>less than</valor>
                <pes>300</pes>
</limitation>
```

Figure 84. The set of limitations included within the precondition "launch acceptation"

In this example, the *marriage proposal* is accepted if the male agent has greater reputation than the female agent, or, if the current reputation of the male agent is higher than the current reputation of the female agent, or, if the male agent is widow (in the sense that a widowers have preference for a second marriage), or if the female agent is widow (establishing a preference for widows and widowers to marry). Any of the limitations weighs 300, which is the quantity necessary for the validation of the preconditions –only of 1 of the 4 limitations is necessary.

Altogether, when all three preconditions are validated, the norm of marriage is activated. If any of the preconditions is not validated, even if the other two are, the norm marriage is not activated. Depending on this two possibilities, the norms have two consequences labelled as "success" and "failure".

```
<consequence>
        <nom>final_marriage_acceptation</nom>
                <social_status>married</social_status>
                <parella_social_status>married</parella_social_status>
                <current_reputation>current_reputation+200</current_reputation>
                <parella_current_reputation>parella_current_reputation+200</parella_current_reputation>
                <current_rulesrespect>current_rulesrespect+100</current_rulesrespect>
                <parella_current_rulesrespect>parella_current_rulesrespect+100</parella_current_
                rulesrespect>
                <var_general_purpose2>var_general_purpose2+1</var_general_purpose2>
                <action>marriage</action>
</consequence>
```

Figure 85. Example of consequence for the norm of marriage after fulfilling all preconditions

In Fig. 85 an example of a set of consequences activated when the norms marriage is activated. In the case here exposed, several social conditions will change according to the formulas prepared (e.g. "social status" married, "current reputation" increases 200), following the interest or emphasis intended to give to the simulation. In any of the cases, the consequences affect both agents involved in this norm. Below, an opposite case of consequence is shown (Fig.86), in which "current rules-respect" decreases 100.

```
<consequence>
        <nom>nulla</nom>
                <current_libido>current_libido</current_libido>
                <current_rulesrespect>current_rulesrespect-100</current_rulesrespect>
</consequence>
```

Figure 86. Example of consequence for the norm of marriage when the preconditions are not fulfilled.

Annexes 9-20: Life courses of foragers and pastoralists

In the following 12 annexes, I present in a visual format the distribution of the information and the main reports over every stage of the life course of men and women.

The distribution of the data is first organized depending on the population it corresponds to (mainly foragers or mainly pastoralists), and within each population I separate men and women's life courses. I arbitrarily organize the data separated in centuries:

9. Life course of a foraging man in the 19th century
10. Life course of a foraging man in the 20th century
11. Life course of a foraging woman in the 19th century
12. Life course of a foraging woman in the 20th century
13. Life course of a pastoralist man in the 17th century
14. Life course of a pastoralists man in the 18th century
15. Life course of a pastoralist man in the 19th century
16. Life course of a pastoralist man in the 20th century
17. Life course of a pastoralist woman in the 17th century
18. Life course of a pastoralists woman in the 18th century
19. Life course of a pastoralist woman in the 19th century
20. Life course of a pastoralist woman in the 20th century

On the one hand, a few natural variables are indicated in every stage of the life course (e.g. infantile mortality, miscarriage). On the other hand, the categories of social stages in the life course frame every transformation of the socioeconomic role of the individual. These social categories follow the structure as described in chapter 6 and figure 11 and table 3.

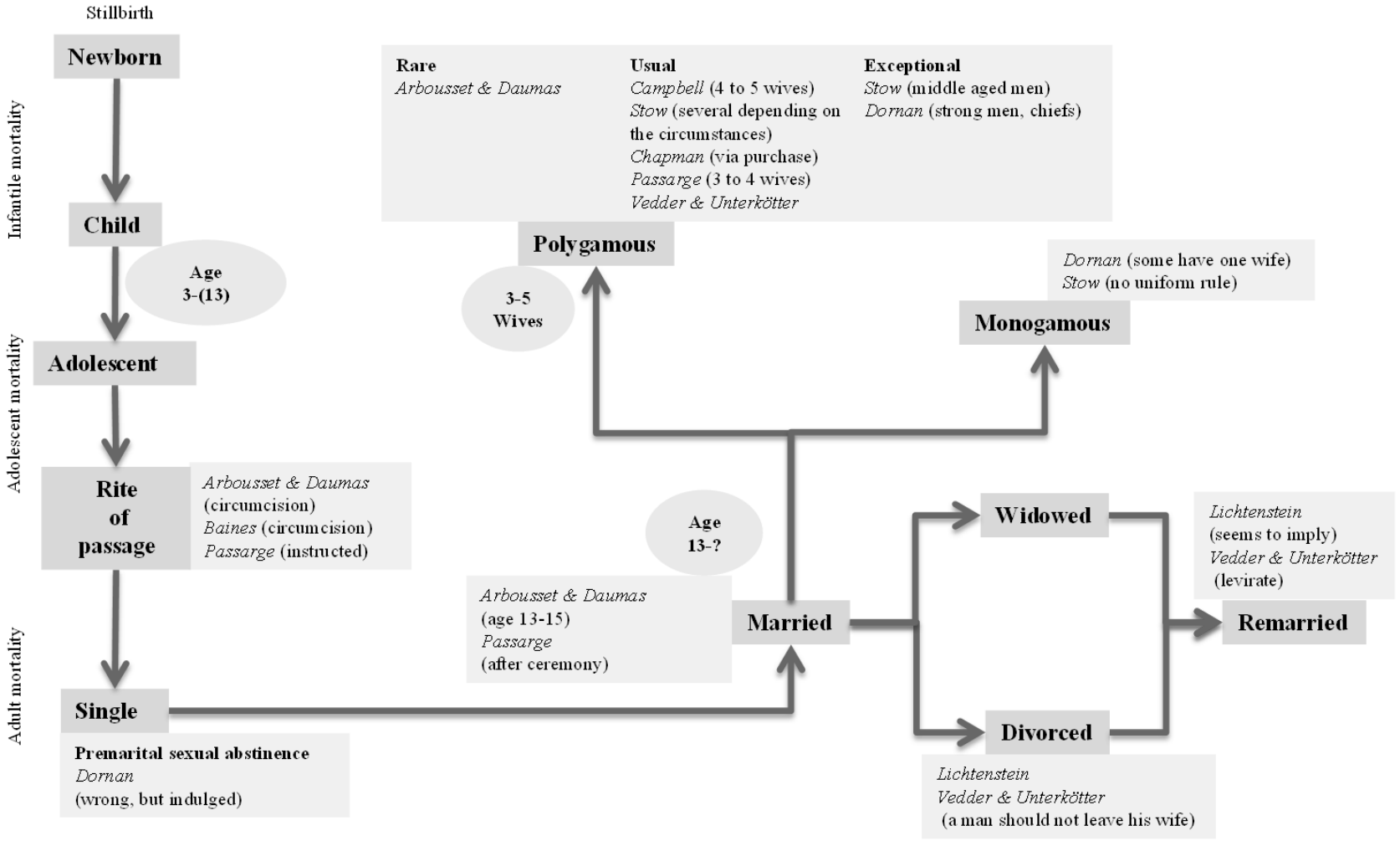
Across all these levels, I incorporate the names of the explorers, writers, reporters, scientists who left any reference about every particular stage, with a simplified reference to their specific contribution (e.g. polygamous is exceptional as depending to the age of the man). In several occasions, there is not a single report of the different aspects I include. In such cases I indicate it with "no information available".

In the life course of women, I include the information concerning breastfeeding and birth spacing, as well as the practice of infanticide and induced abortion –when applicable. In the life course of men, I include the types of marriages, from monogamous to polygamous, the latter subdivided in “rare”, “usual, and “exceptional”.

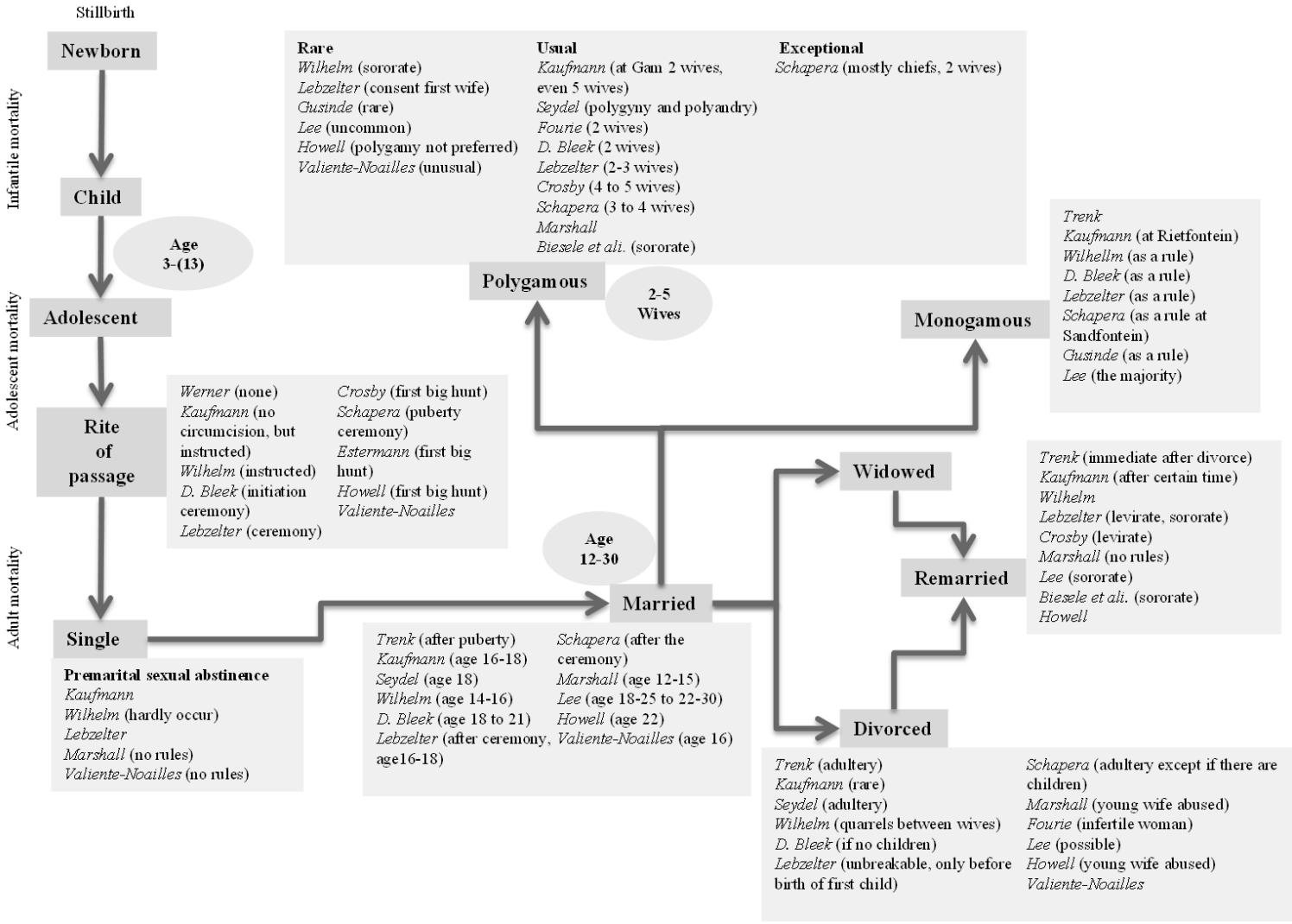
The purpose of these annexes is, on the one hand, to visually provide a general and summarized schema of the social transitions of the men and women along their life course, and, on the other hand, how these transitions may be relatable to the organization of reproduction.

The organisation of these life courses in single centuries is arbitrary and has no other purpose than turning the information more accessible. I suggest the reader to combine the information here presented with the annexes 1 to 7, in which all original descriptions are included, and with the annexes 21 to 24, in order to grasp the organization of the data for the agenda of simulations.

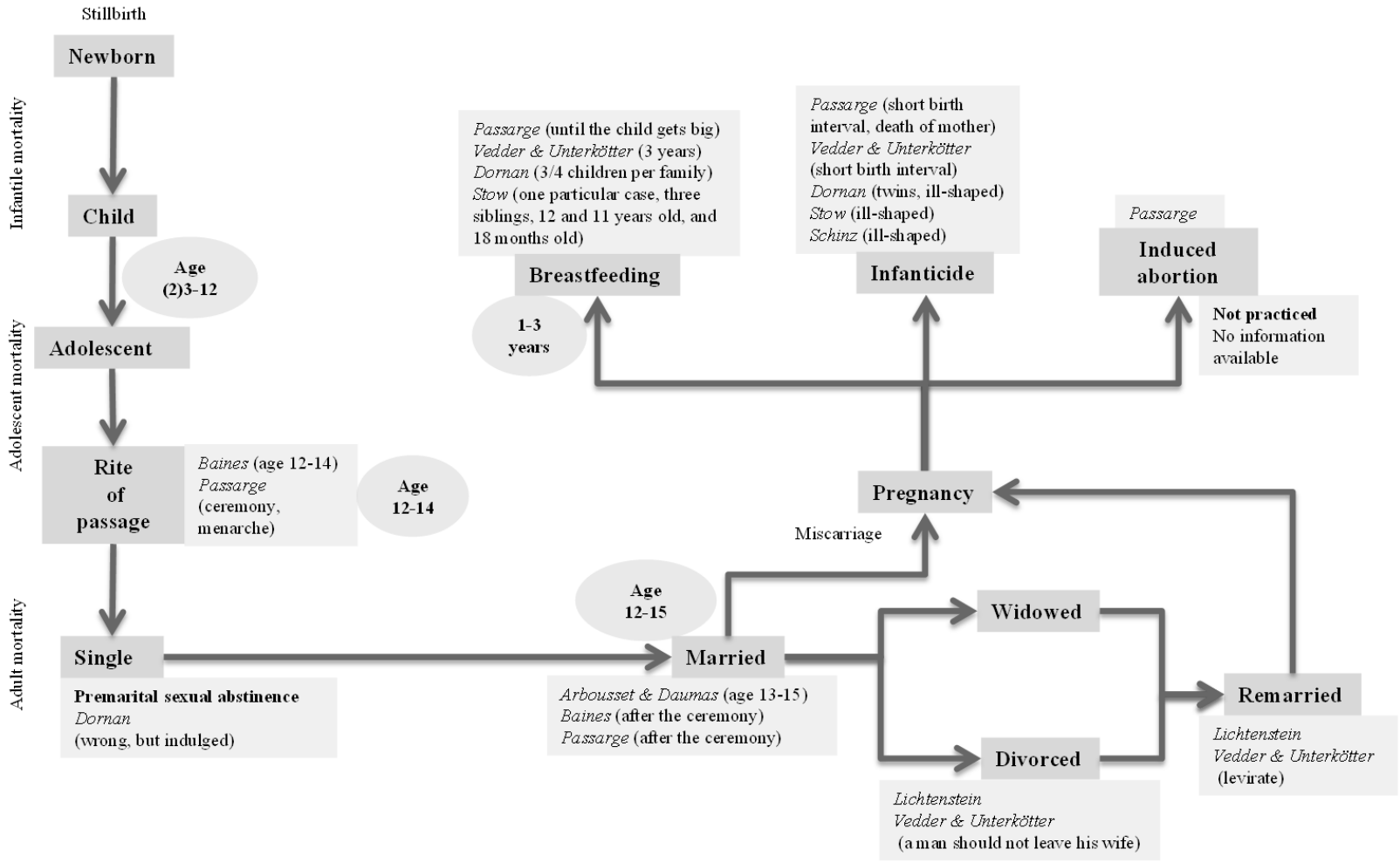
Annex 9: The life course of a foraging man in the 19th century



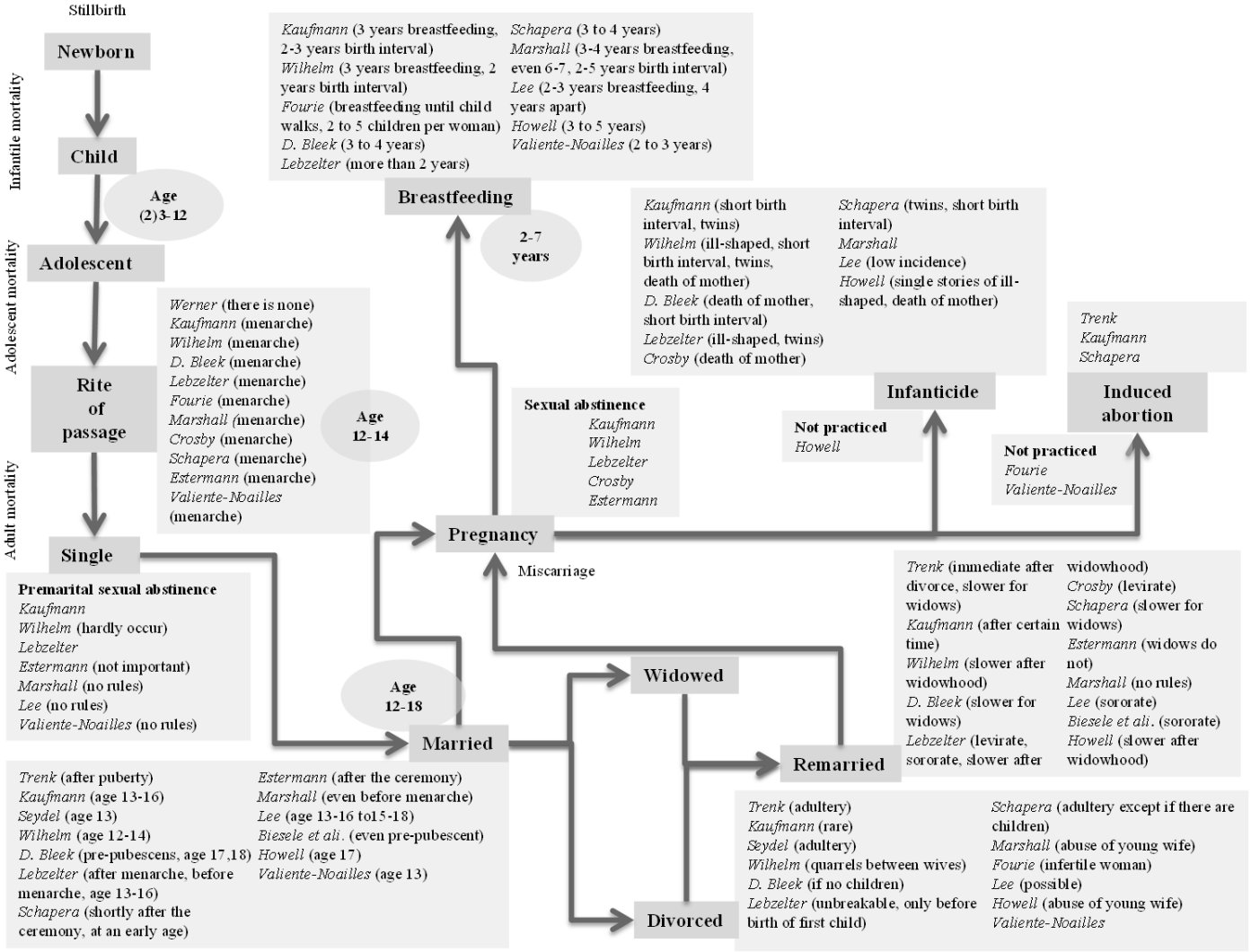
Annex 10: The life course a foraging man in the 20th century



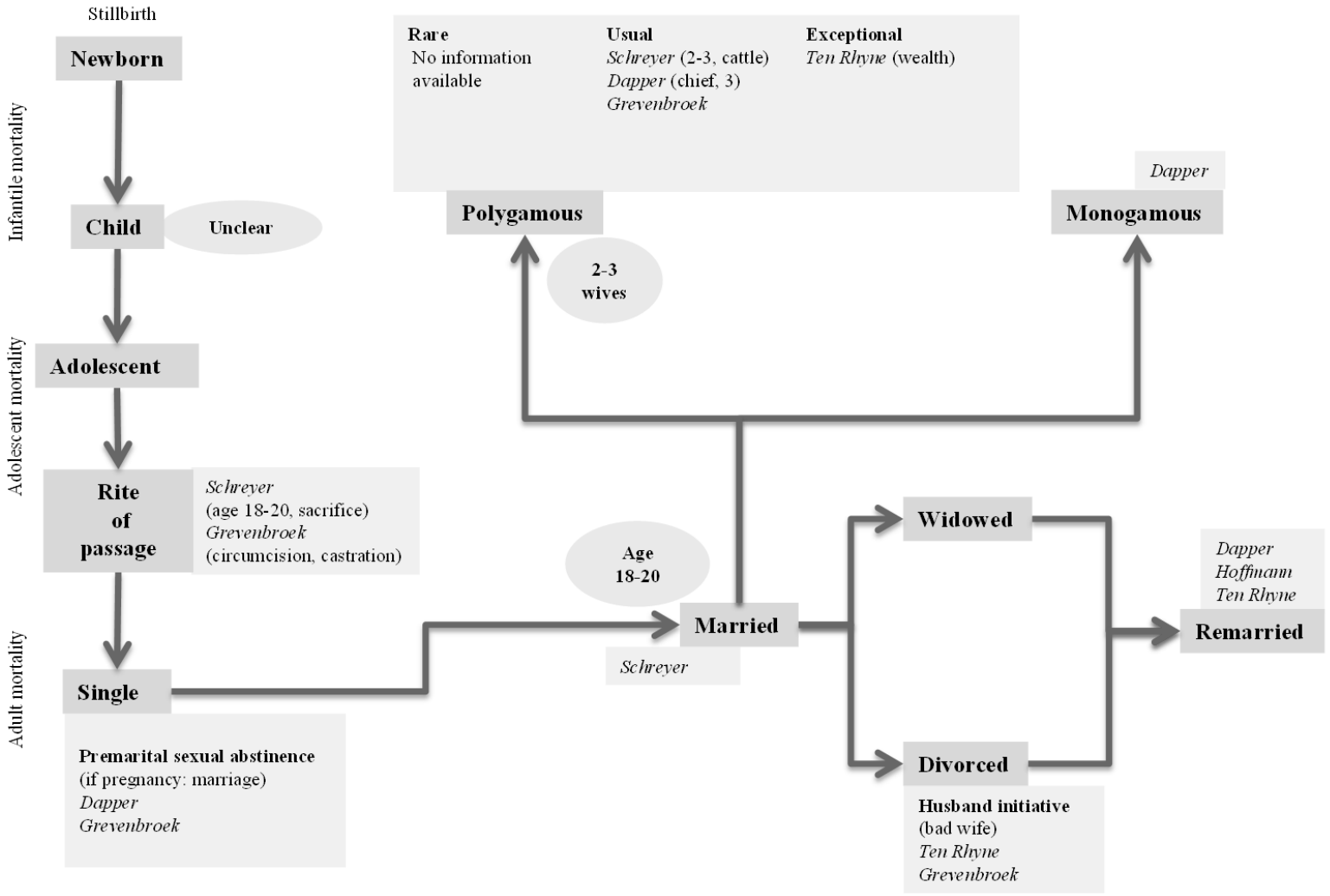
Annex 11: The life course of a foraging woman in the 19th century



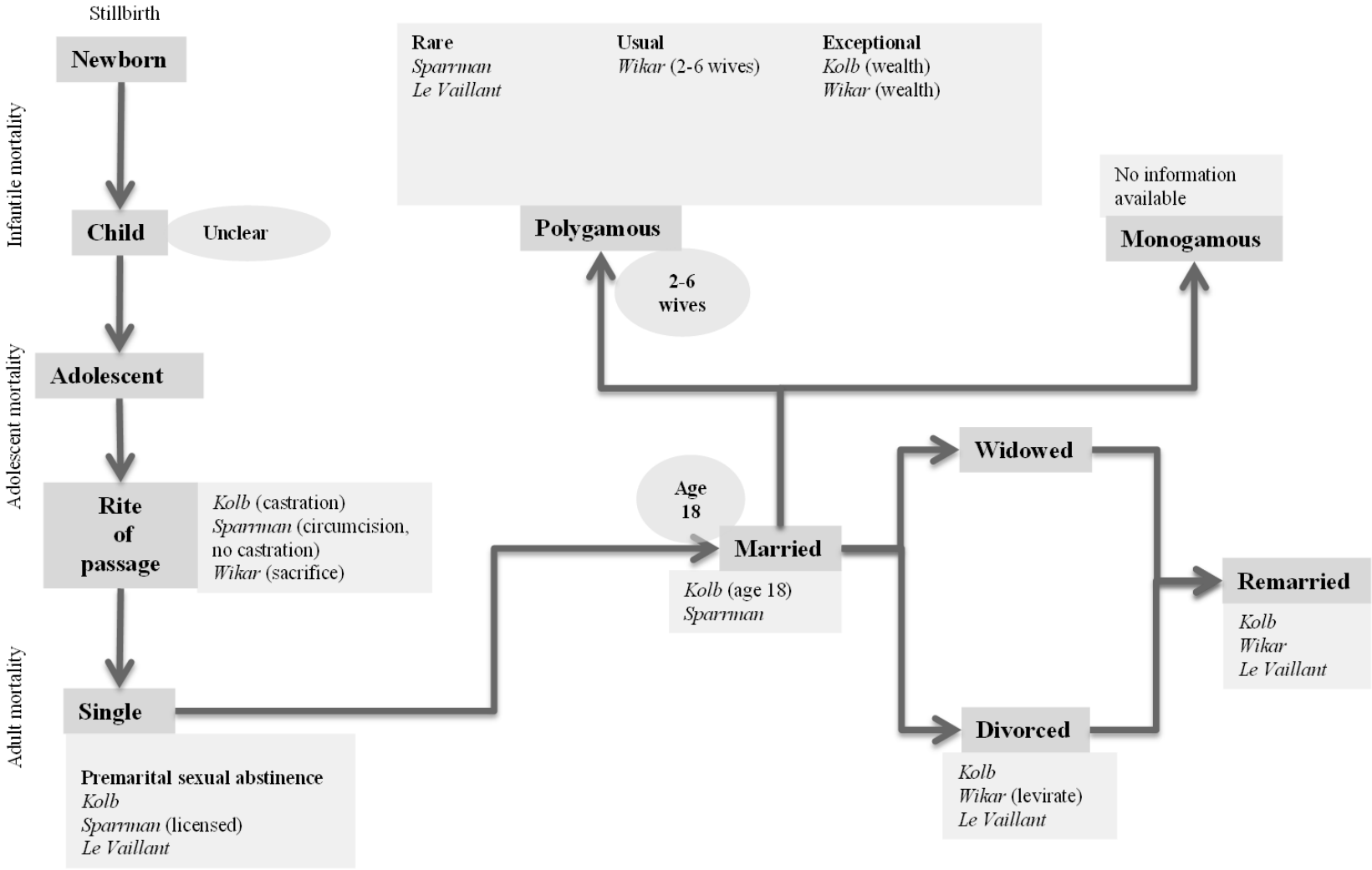
Annex 12: The life course of a foraging woman in the 20th century



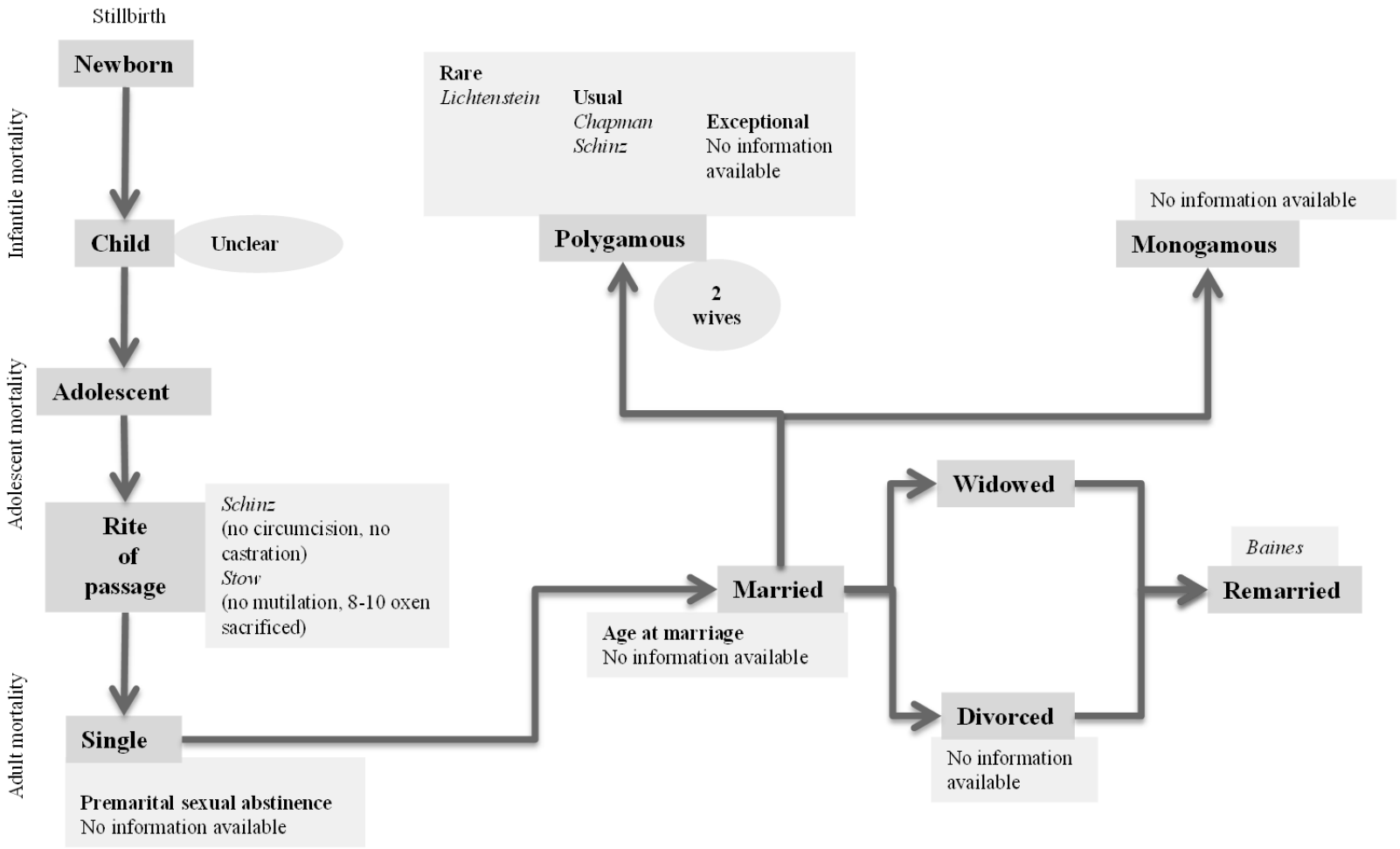
Annex 13: The life course of a pastoralist man in the 17th century



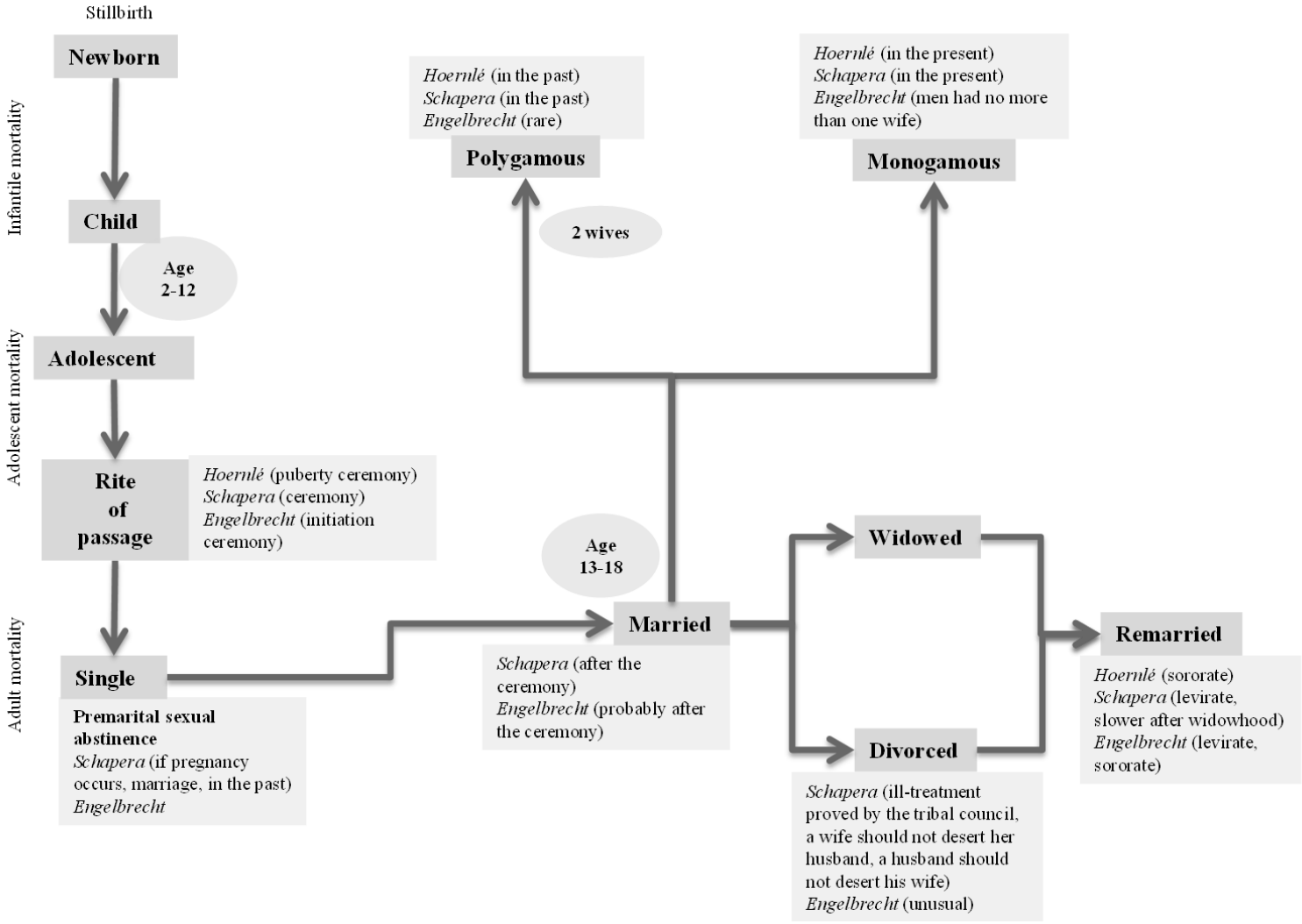
Annex 14: The life course of a pastoralist man in the 18th century



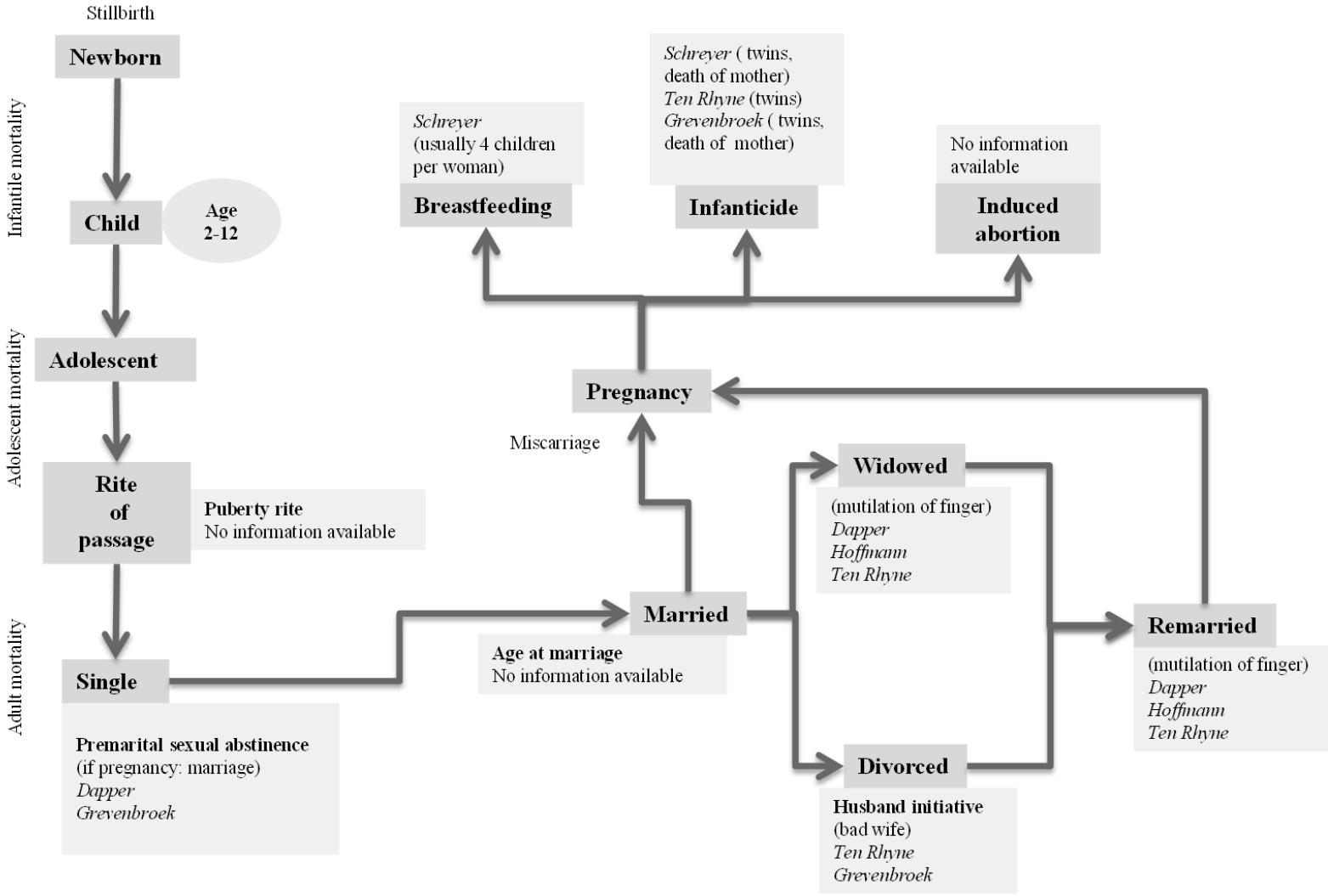
Annex 15: The life course of a pastoralist man in the 19th century



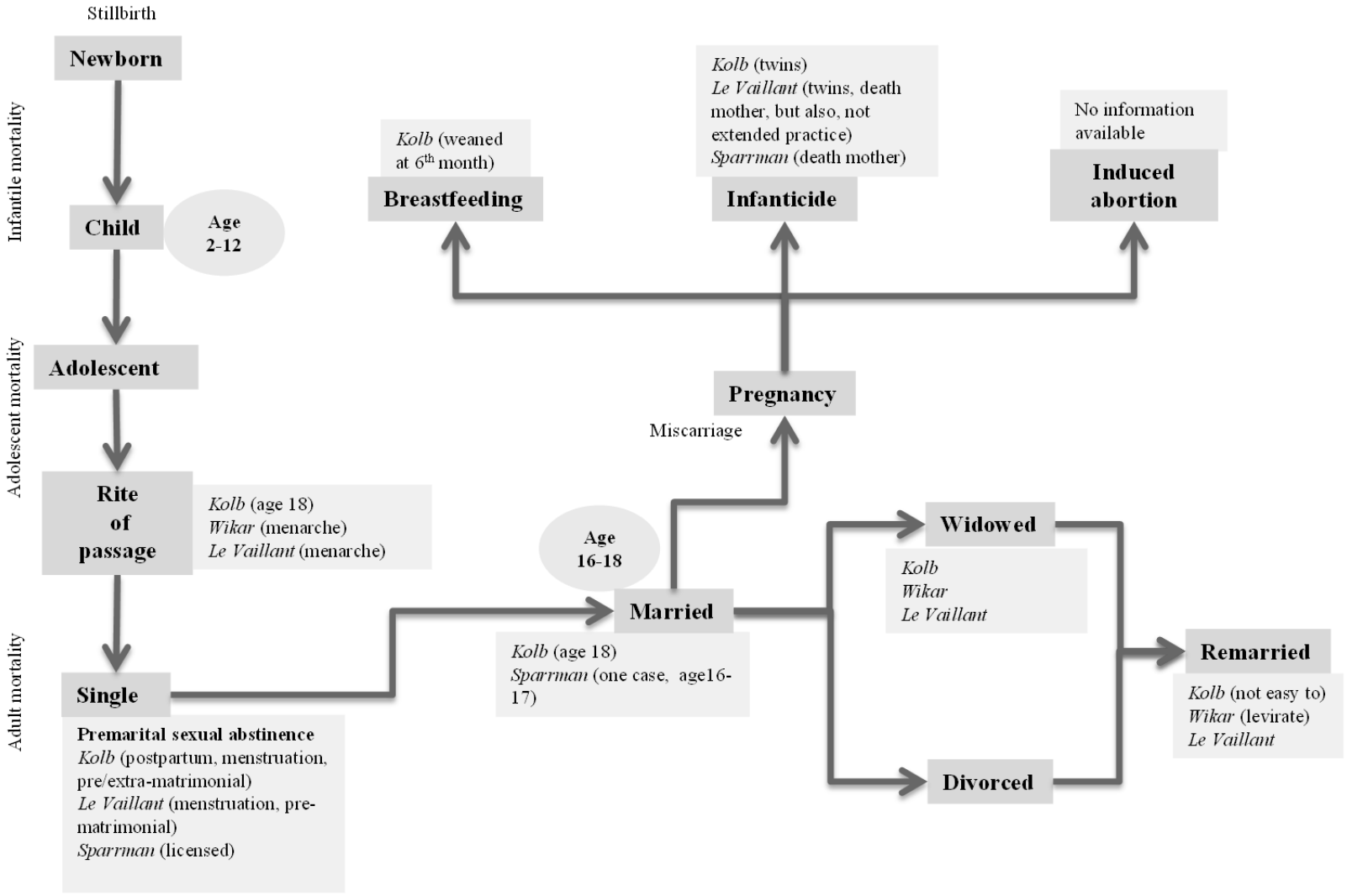
Annex 16: The life course of a pastoralist man in the 20th century



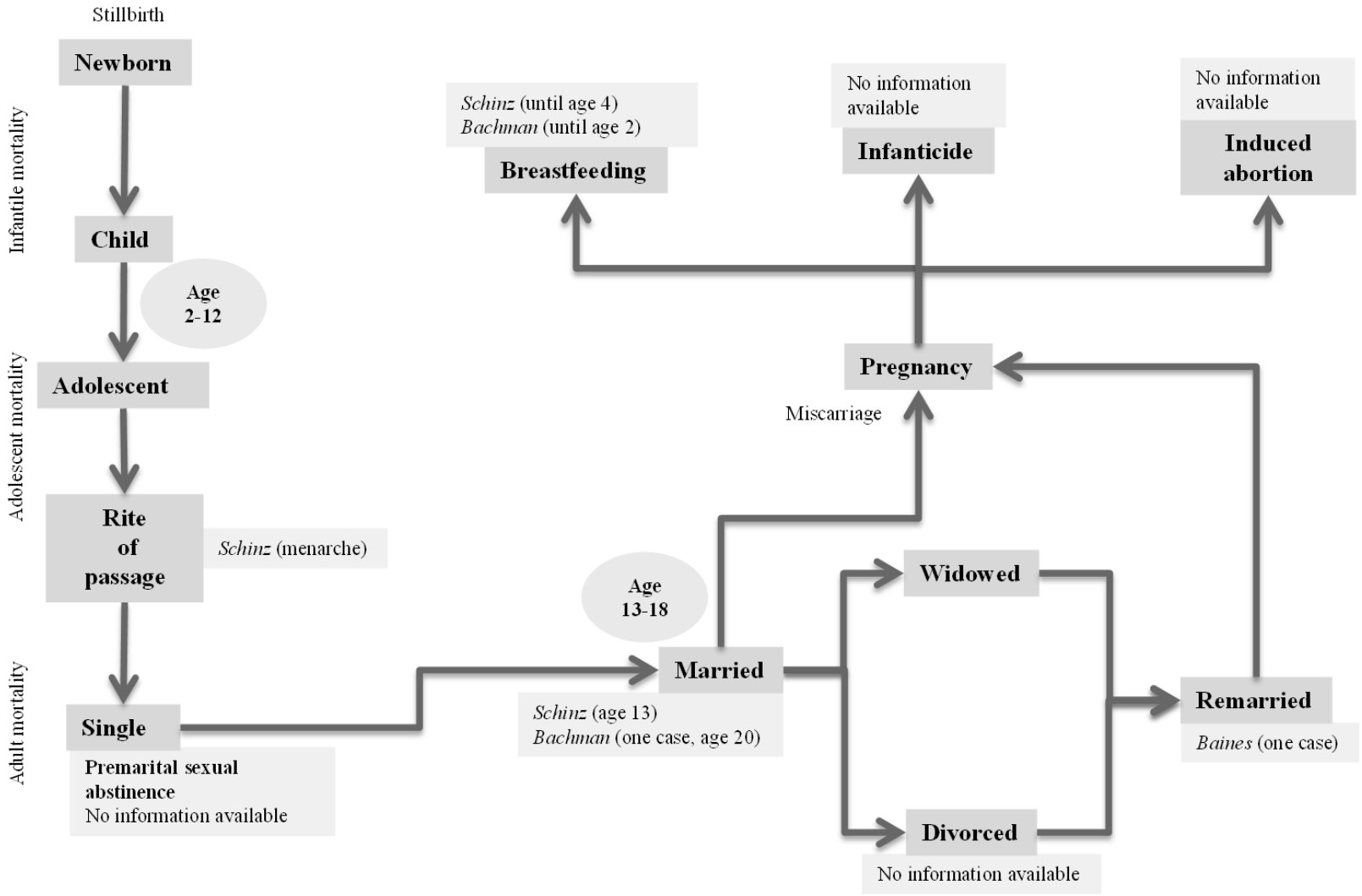
Annex 17: The life course of a pastoralist woman in the 17th century



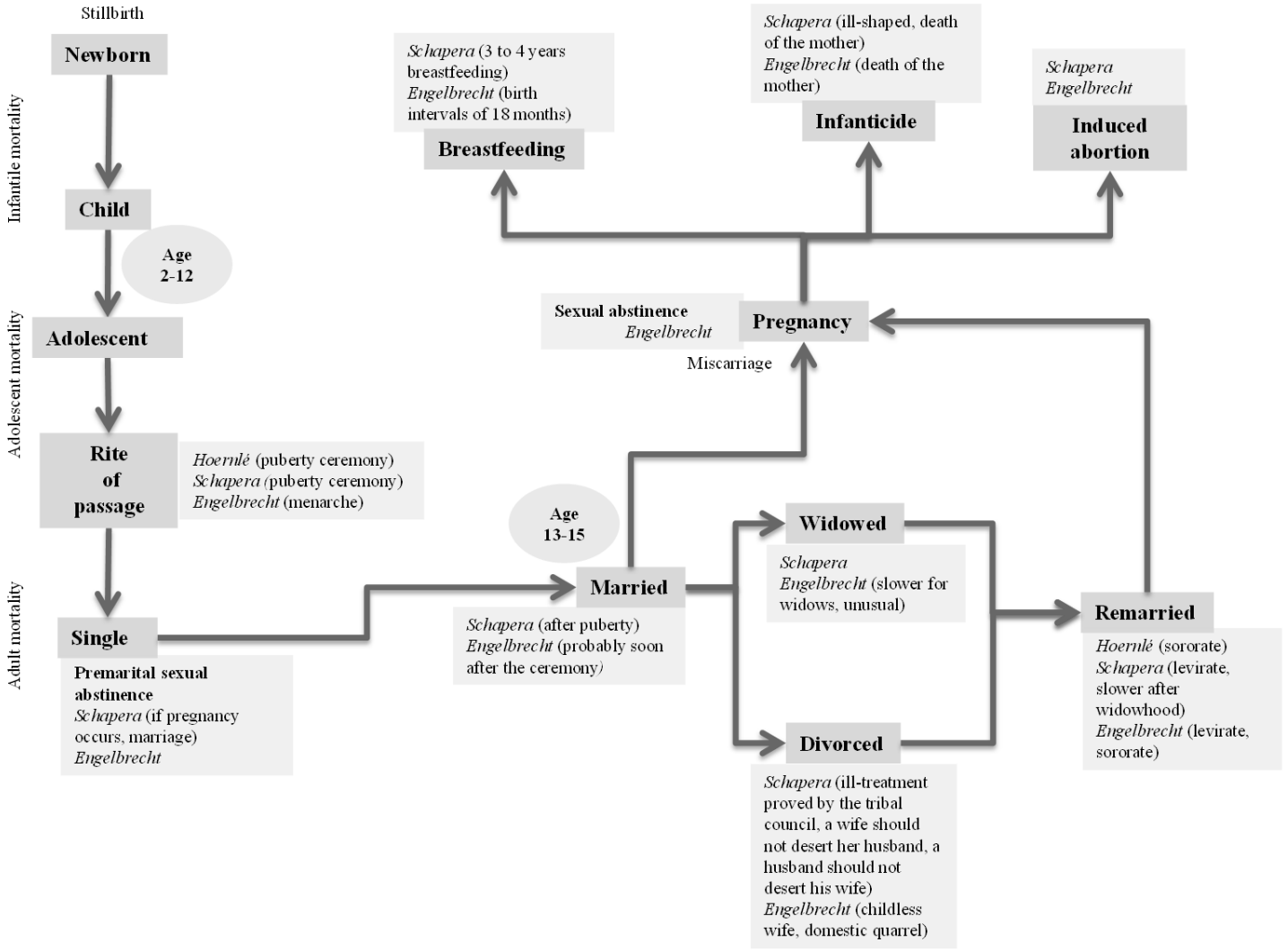
Annex 18: The life course of a pastoralist woman in the 18th century



Annex 19: The life course of a pastoralist woman in the 19th century



Annex 20: The life course of a pastoralist woman in the 20th century



Annexes 21-24: Minimum restriction and maximum restriction

In chapter 7, I discussed the uneven chronological, geographical and typological distribution of the data I collected. Consequently, the information gathered from the ethnohistorical sources and ethnographic studies is restructured in two blocks: the less restrictive expression of a norm, and the more restrictive expression of the same norm. In this manner, from the simulation exercises it is possible to extract what may be the minimum effect of a social norm, and the maximum effect of the same.

This schema is organized separately for both populations, in accordance to the mode of production (mostly foragers, mostly pastoralist) associated to the specific social behaviour described.

The social categories remain to be the same as described in chapter 6: Age at marriage for men and for women (including any reference from the transition from puberty into adulthood), types of marriages (monogamous, polygamous), the possibility of separation and remarriage (after separation or after widowhood), child spacing (including the duration of breastfeeding), and infanticide (including induced abortion).

The tables are organized in a manner that on the right side there is a check-box to follow the chronology in which the expression of the norm is found. When the cell is coloured, it is indicating that the specific information (expressed in a way or another) is found in that particular century. When the cell is left blank, it is indicating that such information is not available or found. In order to connect it with the original sources, I include the names of the explorers and scientists, so that it is possible to return to annexes 1 to 7.

Annex 21: The minimum restriction among pastoralists

Pastoralists	Minimum Restriction	17th	18th	19th	20th
Age at marriage	Female: 1. Early reports describe rites of puberty usually connected to menarche, which may be considered as a step prior to marriage (Kolb, 1738; Le Vaillant, 1790; Mossop/Wikar, [1779] 1935). Also found in the description by Schinz (1891). 2. Hoernlé (1930) and Engelbrecht (1936) refer to rites of puberty. 3. Schapera (1965) says that a girl normally is not regarded as marriageable until she has reached the age of puberty and passed through the puberty ceremony (Schapera, 1965).				
	Male: 1. Schreyer ([1681]1931) and Grevenbroek (Schapera & Farrington, [1695] 1933) mention that the practice of a ceremony among boys exists. Schreyer ([1681] 1931) implies that after the ceremony the man shall find a wife, but Grevebroek ([1695] 1933) does not sufficiently clarify it. 2. Hoernlé (1925) and Engelbrecht (1936) refer to rites of puberty. 3. Schapera (1965) states that the Hottentots no longer observe any special rites connected with the attainment of maturity among boys.				
Marriage	Monogamy: 1. Dapper (Schapera & Farrington, [1670] 1933) and Le Vaillant (1790). Although, Dapper refers to one particular chief who was married exclusively to one wife. 2. Hoernlé (1925), Schapera (1965) and Engelbrecht (1936) explain that in the present monogamy is predominant.				
	Restricted polygamy: 1. Sparrman (1789a) explains about one old man married with two wives. 2. Ten Rhyne (Schapera & Farrington, [1686] 1933), Kolb (1738), and Wikar (Mossop, [1779] 1935) associate polygamy to the wealthy (in cattle) men. The bride price would have consisted of 2 to 3 oxen (Kolb, 1738), or 2 milk cows specifically for the mother-in-law, and cattle for the father-in-law Wikar (Mossop, [1779] 1935).				

Pastoralists	Minimum Restriction	17th	18th	19th	20th
	Polygamy is rare: 1. Polygamy does not go against customs, but is observed to rarely occur (Lichtenstein, [1811] 1967; Le Vaillant, 1790) 2. Schinz (1891), Hoernlé (1925), Schapera (1965) and Engelbrecht (1936) indicate that the practice is dying out.				
Divorce and Remarriage	Divorce: 1. Ten Rhyne (Schapera & Farrington, [1686] 1933) and Grevenbroek (Schapera & Farrington, [1695] 1933) seem to indicate that it is more common for a husband to divorce his wife. 2. Engelbrecht (1936) defines it as unusual. 3. Schapera (1965) associates it to the ill-treatment of the spouse, although they should not separate.				
	Remarriage: 1. Dapper (Schapera & Farrington, [1670] 1933), Hoffmann ([1680]1931) and Ten Rhyne (Schapera & Farrington, [1686] 1933) explain that a woman who shows a specific amputation on one or more fingers is indicative that she is widow or that she remarried. 2. Wikar (Mossop, [1779] 1935) and Le Vaillant (1790) describe that it is possible to marry again, but they do not make precise the circumstances around. 3. According to Hoernlé (1925), Schapera (1965) and Engelbrecht (1936), levirate and sororate is an option for widowed people, although widows remarry slower.				
Child spacing	Early: 1. This type of information is not only scarce, but also different from writer to writer. Schreyer ([1681]1931) comments that he observes around 4 children in every family. This statement is conflictive, because he also explains polygamy to be common, and consequently it is unclear whether he says that there are around “4 children for every woman” or “4 children for every family including more than one wife”. 2. Only Kolb (1738) explains that children are weaned at the 6th month after born, which would imply that children follow one to another close in birth				
Infanticide	1. Le Vaillant (1790) explains that infanticide is not a generalized practice.				

Annex 22: The maximum restriction among pastoralist

Pastoralists	Maximum restriction	17th	18th	19th	20th
Age at marriage	Female: 1. Sparrmann (1789a) described one particular case of a girl who at the age of 16-17 was not married. 2. Kolb (1738) explains about a ceremony around the age of 18, prior to marriage.				
	Male: 1. Only Schreyer ([1681] 1931) implies that a man shall marry after the rite of passage, which takes place at the age 18-20, coinciding with Kolb's (1738) estimations. 2. Sparrman (1789b) refers to a rite of passage that may connect with adulthood.				
Marriage	Polygamy: 1. Schreyer ([1681] 1931) states that polygamous marriages are common, with an average of 2 to 3 wives. 2. Grevenbroek (Schapera & Farrington, [1695] 1933) also describes polygamy to be usual, but he does not specify the exact number of wives a man can marry. 3. Wikar (Mossop, [1779] 1935) counts up to 6 wives. 4. Chapman (1868) describes the pastoralists to be mostly polygamous.				
	5. Wikar (Mossop, [1779] 1935) also connects polygamy as a result of warfare, in which case the victorious men would capture cattle and women.				
Divorce and	Divorce: 1. Kolb (1738) and Le Vaillant (1790) indicate that separation usually results from mutual agreement.				

Pastoralists	Maximum restriction	17th	18th	19th	20th
Remarriage	Remarriage: 2. Dapper (Schapera & Farrington, [1670] 1933), Hoffmann ([1680] 1931) and Ten Rhyne (Schapera & Farrington, [1686] 1933) explain that a woman who shows a specific amputation on one or more fingers is indicative that she is widow or that she remarried. 3. Wikar (Mossop, [1779] 1935) and Le Vaillant (1790) describe that it is possible to marry again, but they do not make precise the circumstances around. 4. Kolb (1738) is the only one to explain that a woman cannot remarry as long as her first husband is still living. 5. Solely Wikar (Mossop, [1779] 1935) mentions the common practice of levirate, as well as Hoernlé (1925), Schapera (1965) and Engelbrecht (1936), who also refer to the practice of sororate and specify that widows remarry slower.				
Child spacing	Late: 1. Schreyer ([1681] 1931) observed around 4 children in every family. This statement is conflictive, because he also explains polygamy to be common, and consequently it is unclear whether he says that there are around "4 children for every woman" or "4 children for every family including more than one woman". 2. Bachman (1899) and Schinz (1891) explain that breastfeeding lasts from 2 to 4 years. 3. Schapera (1965) described 3 to 4 years breastfeeding.				
Infanticide	1. A common practice in the case of twins (Kolb, 1738; Le Vaillant, 1790; Schapera & Farrington/Grevenbroek, [1695]1933; Schapera & Farrington/Ten Rhyne, [1686]1933; Schreyer, [1681]1931). 2. In the case the mother died shortly after giving birth (Engelbrecht, 1936; Le Vaillant, 1790; Schapera & Farrington/Grevenbroek, [1695]1933; Schapera, 1965; Schreyer, [1681]1931; Sparrman, 1789a). 3. In the case of ill-shaped (Schapera, 1965).				

Annex 23: The minimum restriction among foragers

Foragers	Minimum restriction	19th	20th
Age at marriage	Female: 1. The majority of the accounts agree that girls marry at an early age, between 12 and 16 (Arbousset & Daumas, 1842; Lebzelter, 1934; Lee, 1993; Guenther/Kaufmann, [1910] 2005; Guenther/Wilhelm, [1954] 2005; Valiente-Noailles, 1933). 2. Others express it in terms of "a girl shall marry after the puberty ceremony" (Baines, 1864; Estermann, 1946; Guenther/Trenk, [1910] 2005; Marshall, 1959; Passarge, 1907; Schapera, 1965). 3. In comparison to these, some travellers have seen pre-pubescent girls already married (Bleek,1928; Marshall, 1959; Lebzelter, 1934)		
	Male: 1. Arbousset and Daumas (1842) insist that they marry early, between 13 and 15, and Passarge (1907) and Schapera (1965) indicate that they are fit for marriage after the ceremony into manhood. 2. The descriptions of the 20th century point to an age at first marriage between 12 and 18 (Lebzelter, 1934; Marshall, 1959; Guenther/Kaufmann, [1910] 2005; Guenther/Wilhelm, [1954] 2005; Seydel, 1910; Valiente-Noailles, 1933). Trenk (Guenther, [1910] 2005) explains they marry after the onset of puberty –therefore, at an early age.		
Marriage	Monogamy: 1. Stow (1905) explains that "some" groups are monogamous, and "other" groups can be polygamous –having as many wives as they can. 2. This is the same case obtained from the accounts by Lee (1993) and Kaufmann (Guenther, [1910] 2005). 3. Others authors point monogamy to be an established rule (Bleek, 1928; Guenther/Trenk, [1910] 2005; Guenther/Wilhelm, [1954] 2005; Gusinde, 1966; Lebzelter, 1934; Schapera, 1965).		
	Restricted polygamy: 1. Stow (1905) and Dornan (1925) additionally explain that polygamy may be only possible to middle-aged men or to strong men –hence, it may be possible that certain social factors condition its applicability. 2. Completely different is the conclusion by Lee (1993), who explains that the few polygamists he met were all healers, this is, men who had a very specific, and maybe even hierarchical, role within the group. 3. Schapera (1965) also associates it to chiefs		

Foragers	Minimum restriction	19th	20th
	Polygamy is rare: 1. Arbousset and Daumas (1842), Gusinde (1966), Lee (1993) and Valiente-Noailles (1993) describe polygamy to rarely happen. 2. Finally, Howell (2010) comments that the polygamous marriage is not preferred.		
Divorce and Remarriage	Divorce: 1. Vedder and Unterkötter (1937) comment on one particular interview with a man who said that a husband should not divorce his wife. 2. Kaufmann (Guenther, [1910] 2005) adds that it rarely happens		
	Remarriage: 1. Kaufmann (Guenther, [1910] 2005) indicates that, whether the woman is divorced or separated, she will remain unmarried for certain length of time. 2. This reference to a period of "waiting", Wilhelm (Guenther, [1954] 2005) says only widows and widowers have to wait some time before marrying again. 3. Howell (2000) and Marshall (1959) coincide in that only widows remarry slower than divorced or widowers		
Child spacing	1. Campbell (1823) describes a family with 8 children. The details whether they belonged to the same mother and, if so, how old was the mother are unknown. It may seem that the interval between births is low. 2. Stow (1905) describes one particular family within which two different conditions are given. In the family there were three siblings, the older were 12 and 11 years old, and the youngest 18 months old. The two older siblings exemplify a birth spacing of 1 year or less, while the new-born is at least 9 years apart from the two older. Clearly, it is unknown whether this long birth interval was intentioned, or whether the mother had miscarriages in between, or if the father was absent for some time (e.g. working at a cattle post). 3. Only Valiente-Noailles (1993) refers to the possibility that children may be born every year to the same mother		
Infanticide	1. Lebzelter (1934) describes regional variation. 2. Both Trenk (Guenther, [1910] 2005) and Fourie (1926) indicate that child murder is not practiced. 3. Fourie (1926), Lebzelter (1934) and Valiente-Noailles (1993) say clearly that abortion does not exist.		

Annex 24: The maximum restriction among foragers

Foragers	Maximum restriction	19th	20th
Age at marriage	Female: 1. D. Bleek (1928) describes that some girls marry at the ages of 17 and 18. 2. Lee (1993) notes that by 1960s and 1970s the age at marriage is delayed to 15-18, coinciding with Howell's observations (2010).		
	Male: 1. D. Bleek (1928) describes the ages to be comprised between 18 and 21. 2. Lee (1993) and Howell (2010) also establish a later age at marriage, between 18 and.		
Marriage	Polygamy: 1. Lebzelter (1934) specifies that a man must first obtain the approval of his first wife to marry a second wife. 2. Polygamous marriages (on average two wives) were usual and widely spread (Barrow, 1801; Bleek, 1928; Chapman, 1868; Fourie, 1926; Lebzelter, 1934; Lee, 1993; Marshall, 1959; Stow, 1905; Vadder and Unterköter, 1937). Kaufmann (Guenther, [1910] 2005) describes they marry usually 2, but he has also seen husbands with 5 wives. Campbell (1823) and Crosby (1931) count up to 4 or 5 wives, and Passarge (1907) and Schapera (1965) between 3 and 4. 3. Some groups are monogamous, and other groups can be polygamous (Guenther/Kaufmann, [1910] 2005; Lee, 1993; Stow, 1905).		
Divorce and Remarriage	Divorce: 1. Lichteinstein ([1811]1967) explains that husband and wife have the choice to divorce and join another band, whereas Marshall (1959) refers to it to be the result of mutual consent. 2. Stow (1905) specifies that the husband has the choice to divorce. Valiente-Noailles (1993) describes divorce to be the consequence of a man and woman failing to fulfil their duties as husband and wife. 3. Others describe quarrels or adultery to be the reasons causing the divorce (Guenther/Trenk, [1910] 2005; Guenther/Wilhelm, [1954] 2005; Howell, 2000; Seydel, 1910). 4. Fourie (1926) and Lee (1993) explain that divorce results from different circumstances. 5. Lebzelter (1934), Bleek (1928) and Schapera (1965) explain that divorce is only possible before the first child is born. 6. Gusinde (1966) incorporates a chronological perspective, explaining that previously it was not possible as compared to the time he did observe it.		

Foragers	Maximum restriction	19th	20th
	Remarriage: 1. Remarriage is easier and less complicated after separation (Guenther/Trenk, [1910] 2005). 2. Wilehlm (Guenther/ [1954] 2005) explains that polygamy may be the result of a man marrying his deceased brother's wife which, he adds, seldom happens. 3. In several cases, the practice of remarriage is connected to the practice of levirate (Crosby, 1931; Lebzelter, 1934) and sororate (Lebzelter, 1934; Lee, 1993). 4. Remarriage is mostly a post-widowhood even as described by Arbousset and Daumas (1842) and Vedder and Unterköter (1937). 5. According to Bleek (1928) widows remarry slower, and to Estermann (1946) they do not marry at all.		
Child spacing	1. Dornan (1925) explains that there are 3 to 4 children per family, indicating long birth spacing. 2. Stow (1905) describes one particular family within which two different conditions are given. In the family there were three siblings, the older were 12 and 11 years old, and the youngest 18 months old. The two older siblings exemplify a birth spacing of 1 year or less, while the new-born is at least 9 years apart from the two older. Clearly, it is unknown whether this long birth interval was intentioned, or whether the mother had miscarriages in between, or if the father was absent for some time (e.g. working at a cattle post). 3. The majority of the accounts seem to agree that the interval between the birth of children is greater than 1 year: born 2 years apart (Guenther/Wilhelm, [1954] 2005), at least 3 years apart (Howell, 2010; Vedder & Unterköter, 1937), between 2 and 3 years apart (Guenther/Kaufmann, [1910] 2005), from 3 to 4 years of breastfeeding (Bleek,1965; Schapera,1965), 4 birth spacing years (Lee, 1979), sometimes even 5 years (Marshall, 1960).		

Foragers	Maximum restriction	19th	20th
Infanticide	1. Because of a short birth interval between children (Bleek, 1925; Guenther/Kaufmann, [1910] 2005; Guenther/Wilhlem, [1954] 2005; Passarge, 1907; Vedder & Unterköter, 1937). 2. In the case of ill-shaped children (Dornan, 1925; Guenther/Wilhlem, [1954] 2005; Schinz, 1891; Stow, 1905). 3. The mother died shortly after giving birth (Bleek, 1925; Crosby, 1931; Guenther/Wilhelm, [1954] 2005; Passarge, 1907). 4. Birth of twins (Dornan, 1925; Guenther/Kaufmann, [1910] 2005; Guenther/Wilhelm, [1954] 2005; Lebzelter, 1934). Howell (2010) explains how Bantu women took the child of a Bushman woman who was about to smother it because it had six toes. 5. Vedder and Unterköter (1937) explain that polygamous marriages may save the child's live because the other wife can take care of it in case its own mother could not –partially coincident with Howell's (2010) description. 6. The mother died shortly after giving birth (Bleek, 1925; Crosby, 1931; Guenther/Wilhelm, 2005 [1954]; Passarge, 1907). 7. Passarge (1907) and Schapera (1965) explain that the people seem to know some sort of abortive drugs –the question to add to this is what their actual effect are.		

Annex 25: Additional tables complementing the chapter 8-Results

In the following annex I present some specific data from the simulations, elaborated from one average test taken out of the sample of 30 tests from each environment simulated. For each of them, I include a table in which I indicate the following information:

1) The resulting population size (absolute numbers)
2) The annual growing rate as:
   $(\frac{resulting\ population\ size - original\ population\ size}{years\ of\ simulation})/original\ population\ size$
3) The fertility rate (calculated from the mean number of children per woman in the resulting population)
4) The percentage of single men and women (calculated from the absolute population)
5) The percentage of widows (calculated from the absolute population).

Using the weight of chi-squared statistics[88], the number of single men, single women and widows clearly show that the observed frequencies differ from the theoretical expected frequencies not as a result of a biased error or randomness, but because of the effect of the social norms I used. In the following tables, I highlighted in **bold** the higher weights of the different attributes listed in the table: the higher contributions to the distance of chi-squared are marked in **red** if the values express defect (negative value), and in **green** if the values express surplus (positive).

[88] The chi-squared statistic summarizes the discrepancies between the expected number of times each value occurs and the observed number of times each value occurs, by summing the squares of the discrepancies, normalized by the expected numbers across all sets.

Table 17. Results of one average test out of the sample of 30 tests from No norms I

	No norms I-a	No norms I-b	No norms I-c	No norms I-d
Size resulting population	2815	2876	6759	6457
Annual growing rate	0,06	0,06	0,14	0,14
Fertility rate	7.05	7.19	7.07	7.24
Single (M)	0.92 %	1.32 %	0.98 %	2.34 %
Single (F)	0.04 %	**1.56 %**	0.61 %	**0.00 %**
Widows (F)	0.00 %	0.00 %	**0.31 %**	0.00 %

Table 18. Results of one average test out of the sample of 30 tests from No norms II

	No norms II-a	No norms II-b	No norms II-c	No norms II-d
Size resulting population	3484	3090	3273	7962
Annual growing rate	0,07	0,06	0,07	0,17
Fertility rate	7.77	7.33	7.43	7.48
Single (M)	1.26 %	1.17 %	0.82 %	1.00 %
Single (F)	0.00 %	**2.04 %**	0.46 %	**0.01 %**
Widows (F)	**0.00 %**	1.04 %	1.13 %	0.75 %

Table 19. Results of one average test out of the sample of 30 tests from No norms III

	No norms III-a	No norms III-b	No norms III-c
Size resulting population	3462	3047	2930
Annual growing rate	0,07	0,06	0,06
Fertility rate	7.14	6.24	5.78
Single (M)	1.01 %	1.25 %	0.96 %
Single (F)	1.36 %	2.56%	2.15 %
Widows (F)	**0.35 %**	**7.75 %**	**7.30 %**

Table 20. Results of one average test out of the sample of 30 tests from Low control

	Low control I	Low control II	Low control III	Low control IV	Low control V
Size resulting population	5950	5555	5401	3997	4737
Annual growing rate	0,07	0,06	0,06	0,04	0,05
Fertility rate	7.42	7.15	7.59	6.81	7.06
Single (M)	**0.96 %**	1.17 %	1.39 %	**2.65 %**	1.88 %
Single (F)	0.03 %	0.00 %	0.04 %	0.03 %	0.00 %
Widows (F)	**1.65 %**	2.54 %	**1.52 %**	**4.80 %**	**4.33 %**

Table 21. Results of one average test out of the sample of 30 tests from Divorce

	Divorce I	Divorce II	Divorce III
Size resulting population	1417	1642	2388
Annual growing rate	0,01	0,01	0,02
Fertility rate	5.80	6.29	5.52
Single (M)	2.89 %	**0.91 %**	**7.62 %**
Single (F)	**0.21 %**	2.62 %	3.69 %
Widows (F)	7.76 %	5.66 %	4.44 %

Table 22. Results of one average test out of the sample of 30 tests from Widows, compared to No norms I-d, No norms II-a, Polygamy I and Polagamy IV

	Widows	No norms I-d	No norms II-a	Polygamy I	Polygamy IV
Size resulting population	2038	6457	3484	1850	715
Annual growing rate	0,02	0,14	0,07	5.79	4.36
Fertility rate	6.75	7.24	7.77	0,02	0,002
Single (M)	1.18 %	2.34 %	1.26 %	0.92 %	**7.83 %**
Single (F)	**4.02 %**	**0.00 %**	**0.00 %**	**4.70 %**	0.70 %
Widows (F)	**5.10 %**	**0.00 %**	**0.00 %**	**4.70 %**	**7.13 %**

Table 23. Results of one average test out of the sample of 30 tests from Polygamy

	Polygamy I	Polygamy II	Polygamy III	Polygamy IV	Minimum control-monogamous
Size resulting population	1850	2117	794	715	893
Annual growing rate	0,02	0,02	0,003	0,002	0,004
Fertility rate	5.79	5.29	4.51	4.36	4.84
Single (M)	**0.92 %**	**9.21 %**	5.04 %	7.83 %	8.96 %
Single (F)	**4.70 %**	**0.80 %**	1.01 %	0.70 %	0.78 %
Widows (F)	4.70 %	6.94 %	6.80 %	7.13 %	8.06 %

Table 24. Results of one average test out of the sample of 30 tests from Minimum control among foragers

	Minimum control	Minimum control II
Size resulting population	2167	936
Annual growing rate	0,02	0,005
Fertility rate	5.3	4.72
Single (M)	**10.84 %**	**7.48 %**
Single (F)	0.74 %	0.96 %
Widows (F)	**9.69 %**	**6.30%**

Table 25. Results of one average test out of the sample of 30 tests from Restrictive complex among foragers

	Restrictive without divorce	Restrictive without polygamy	Restrictive without infanticide	Restrictive without norms	Restrictive complex
Size resulting population	530	517	901	674	543
Annual growing rate	0,000004	-0,00005	0,00156	0,0006	0,00006
Fertility rate	4.45	5.04	4.69	5.11	4.91
Single (M)	1.70 %	**1.35 %**	2.89 %	4.30 %	**6.81 %**
Single (F)	1.13 %	**2.13 %**	1.11 %	**0.59 %**	0.92 %
Widows (F)	**5.09 %**	3.09 %	4.55 %	4.15 %	**2.76 %**

Table 26. Results of one average test out of the sample of 30 tests from Minimum control II among pastoralists

	Minimum control II-a	Minimum control II-b
Size resulting population	2735	2024
Annual growing rate	0,03	0,02
Fertility rate	4.61	5.30
Single (M)	7.20 %	9.93 %
Single (F)	**5.08 %**	**8.99 %**
Widows (F)	6.33 %	5.09 %

Table 27. Results of one average test out of the sample of 30 tests from Minimum control II without norms among pastoralists

	Minimum control II-b without divorce	Minimum control II-b without polygamy	Minimum control II-b without infanticide	Minimum control II-b without norms
Size resulting population	2251	2049	2026	2098
Annual growing rate	0,02	0,02	0,02	0,02
Fertility rate	4.69	4.88	5.07	5.62
Single (M)	8.84 %	8.74 %	9.62 %	9.82 %
Single (F)	**9.55 %**	8.69 %	**6.52 %**	7.53 %
Widows (F)	5.91 %	5.08 %	6.22 %	5.86 %

Table 28. Results of one average test out of the sample of 30 tests from Restrictive complex I among pastoralists

	Restrictive complex I-a	Restrictive complex I-b	Restrictive complex I-c
Size resulting population	446	268	539
Annual growing rate	-0,00035	-0,00110	0,00004
Fertility rate	4.46	4.13	5.00
Single (M)	5.16 %	**12.31 %**	5.94 %
Single (F)	0.67 %	**3.36 %**	0.74 %
Widows (F)	5.61 %	5.97 %	**0.37 %**

Table 29. Results of one average test out of the sample of 30 tests from Restrictive complex I-b without norms among pastoralists

	Restrictive complex I-b without divorce	Restrictive complex I-b without polygamy	Restrictive complex I-b without infanticide	Restrictive complex I-b without norms
Size resulting population	251	346	342	346
Annual growing rate	-0,00117	-0,00077	-0,00079	-0,00077
Fertility rate	4.60	4.59	4.90	4.58
Single (M)	**5.94 %**	6.68 %	8.76 %	**5.78 %**
Single (F)	0.74 %	1.30 %	**0.40 %**	**1.45 %**
Widows (F)	0.37 %	2.60 %	5.18 %	3.18 %

Annex 26: Annual demographic growth, polynomial graphs

Simulations without norms

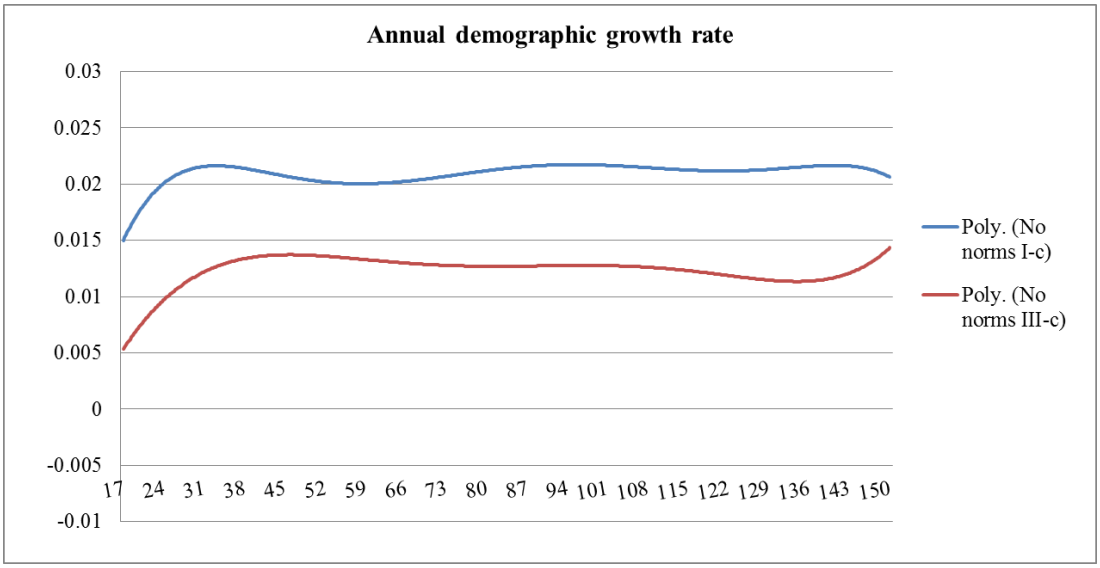


Figure 87. Annual demographic growth of no norms I-c and no norms III-c.

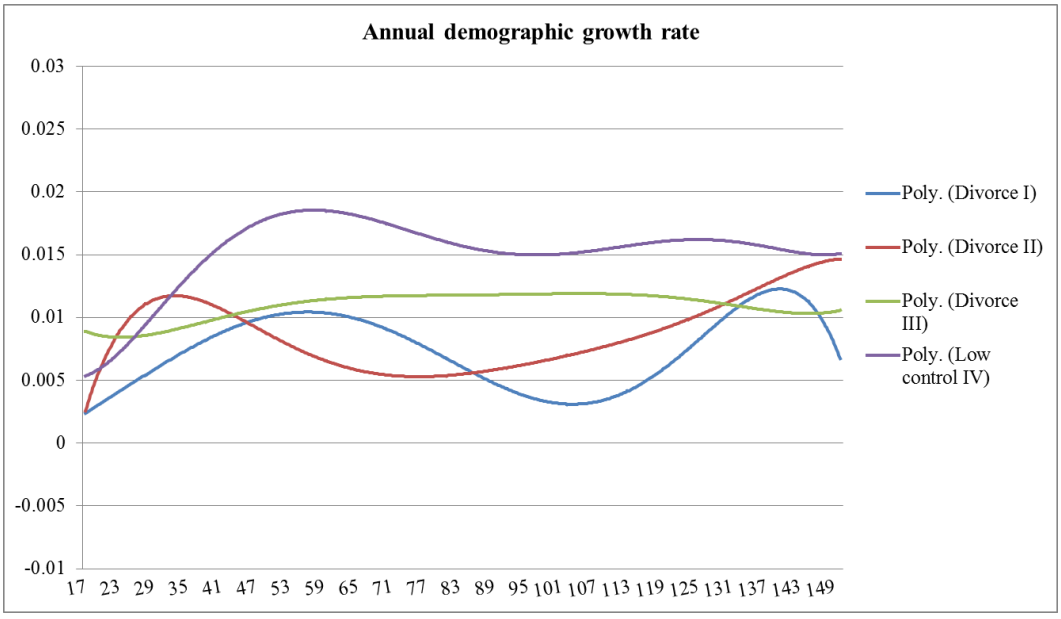


Figure 88. Annual demographic growth of Divorce and Low control IV.

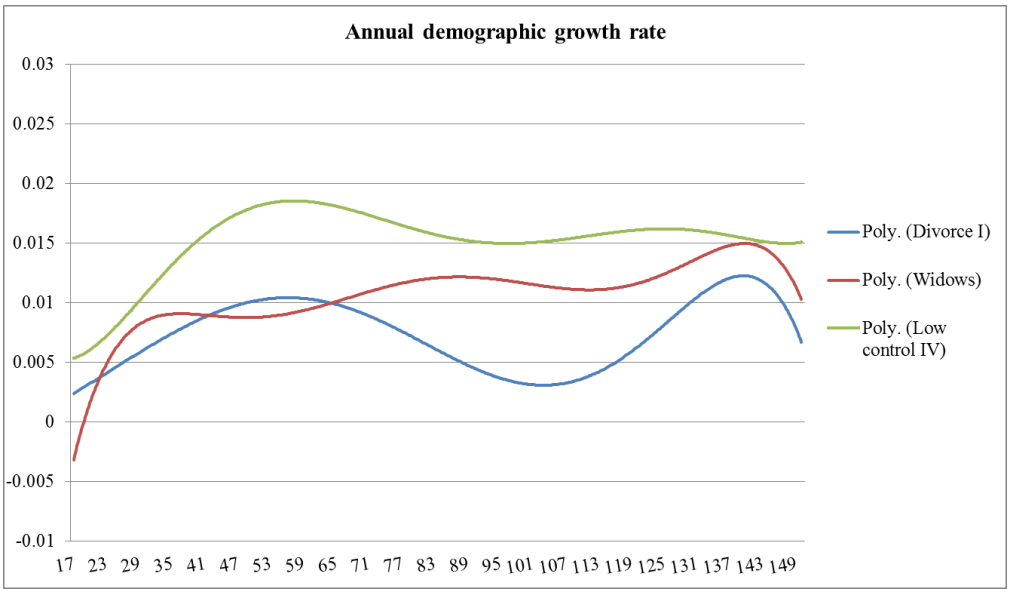


Figure 89. Annual demographic growth of Divorce I, Widows and Low control IV.

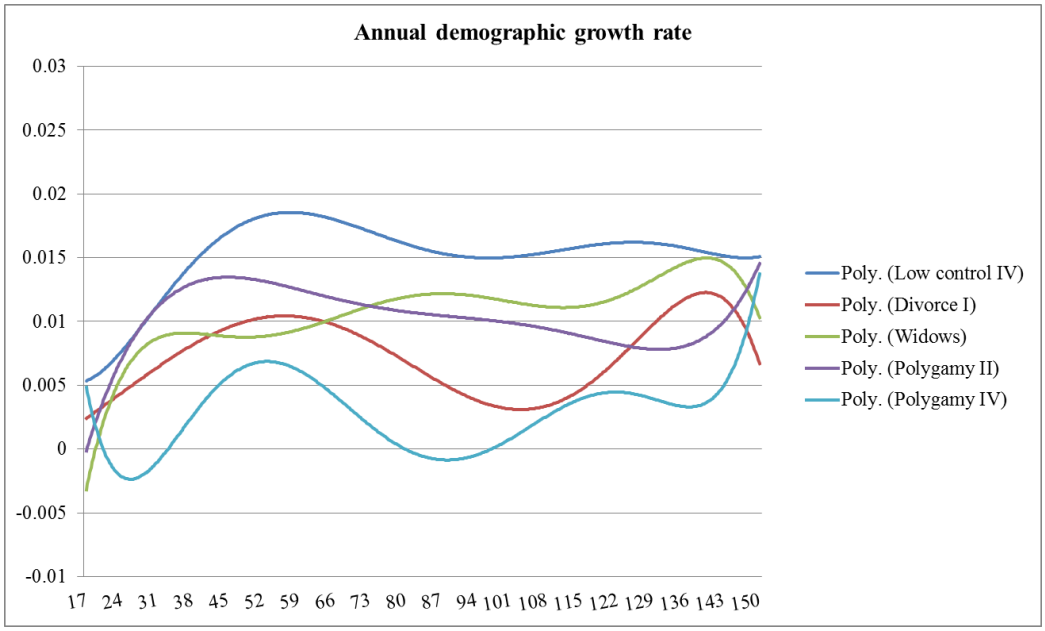


Figure 90. Annual demographic growth from tests of the simulations of Divorce, Widows, Low control and Polygamy

Simulating hunter-fisher-gatherers: less restrictive social norms

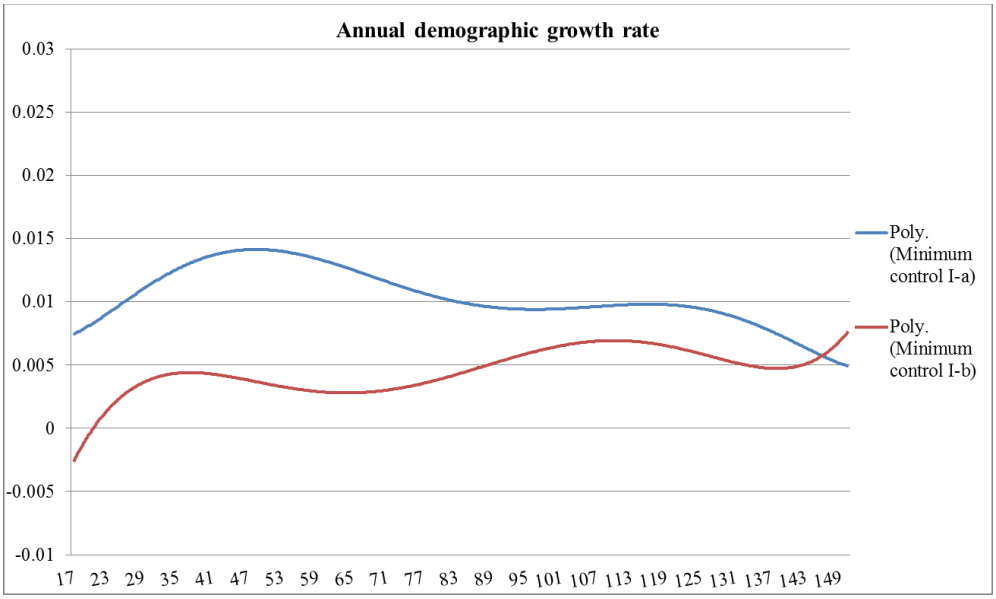


Figure 91. Annual demographic growth of Minimum control I-a and I-b

Simulating hunter-fisher-gatherers: more restrictive social norms

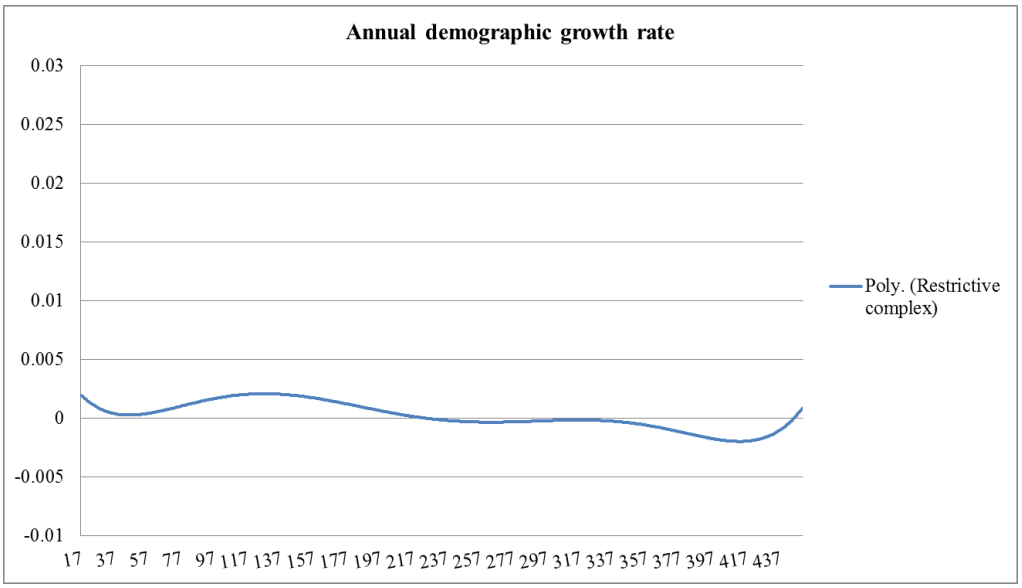


Figure 92. Annual demographic growth of Restrictive complex

Simulating pastoralists: less restrictive social norms

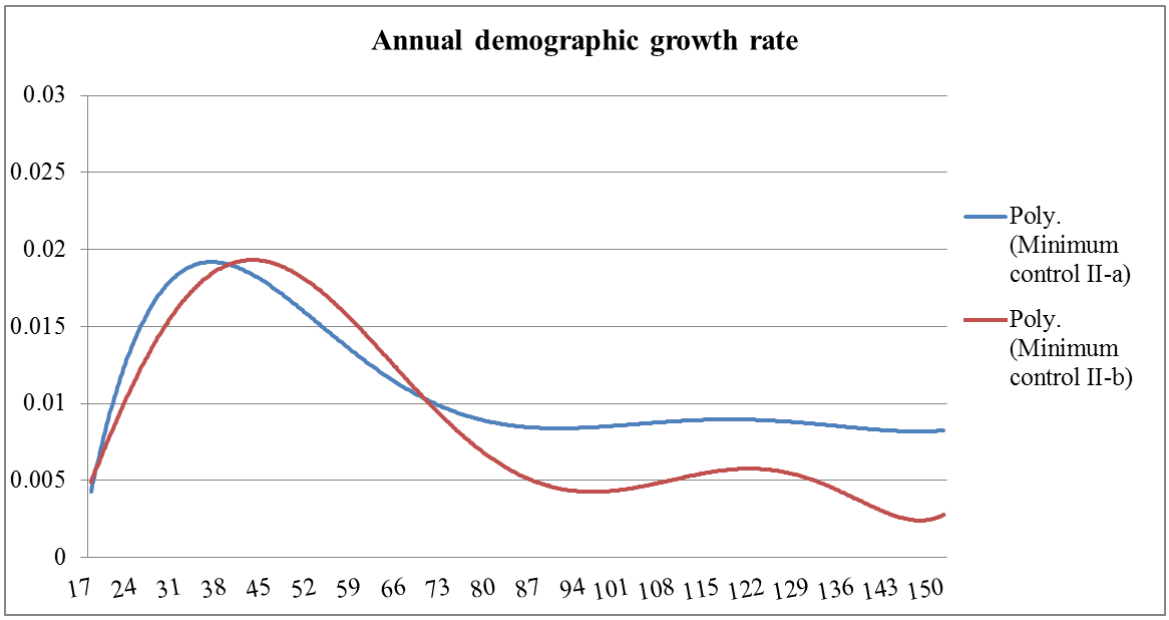


Figure 93. Annual demographic growth of Minimum control II-a and II-b

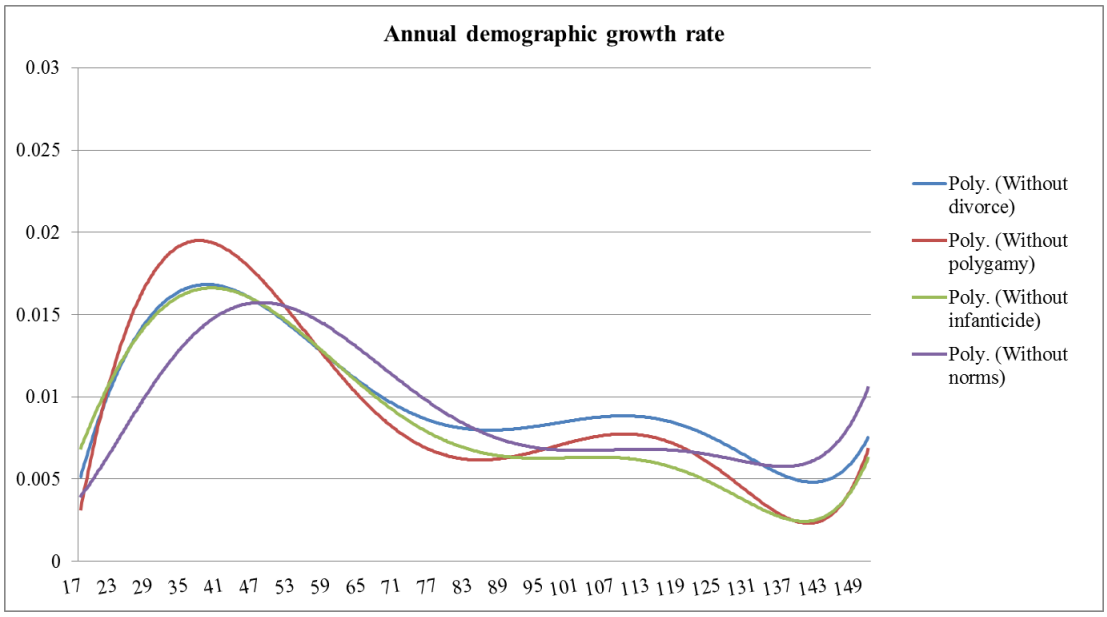


Figure 94. Annual demographic growth Minimum control II-b without norms

Simulating pastoralists: more restrictive social norms

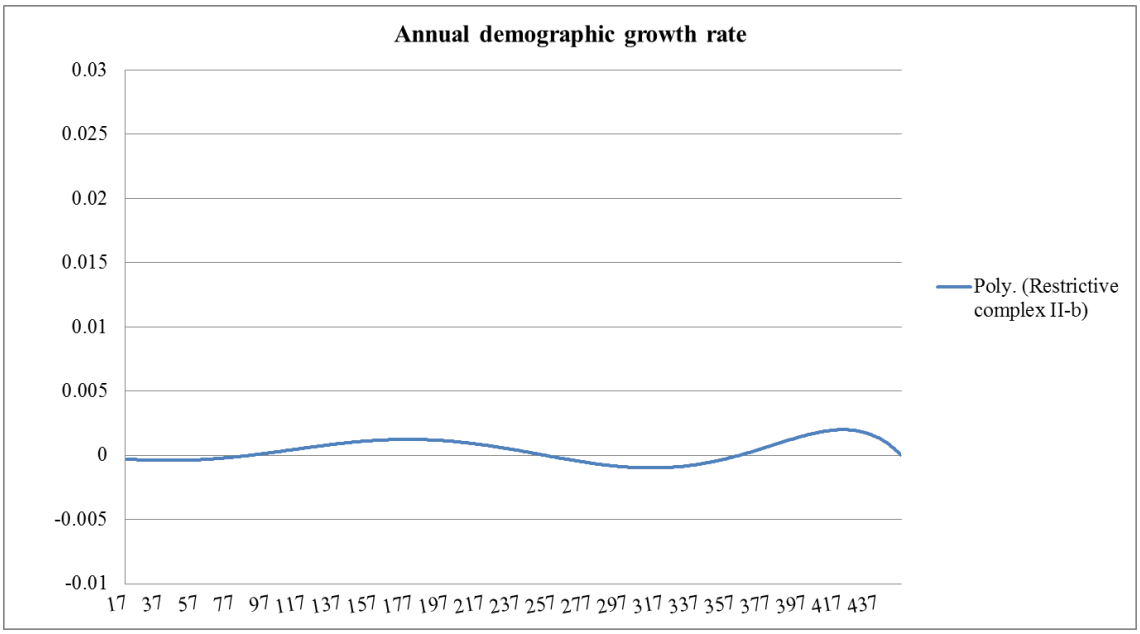


Figure 95. Annual demographic of Restrictive complex II-b

Comparative: less restrictive social norms

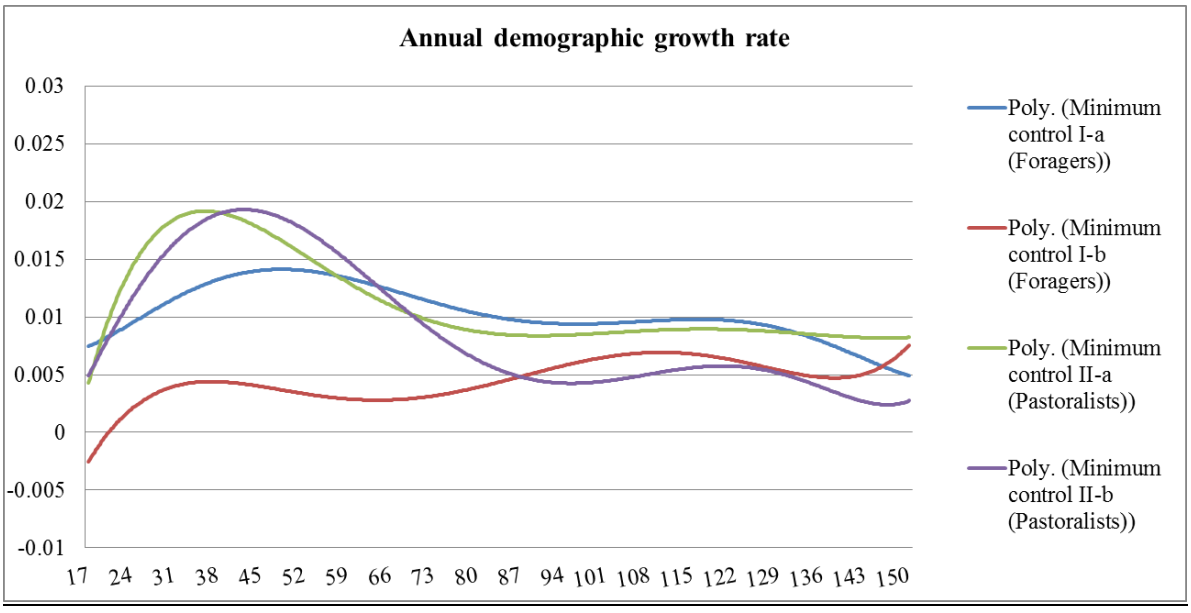


Figure 96. Comparison annual demographic growth rate between forager and pastoralists, from the simulations with the less restrictive social norms

Comparative: more restrictive social norms

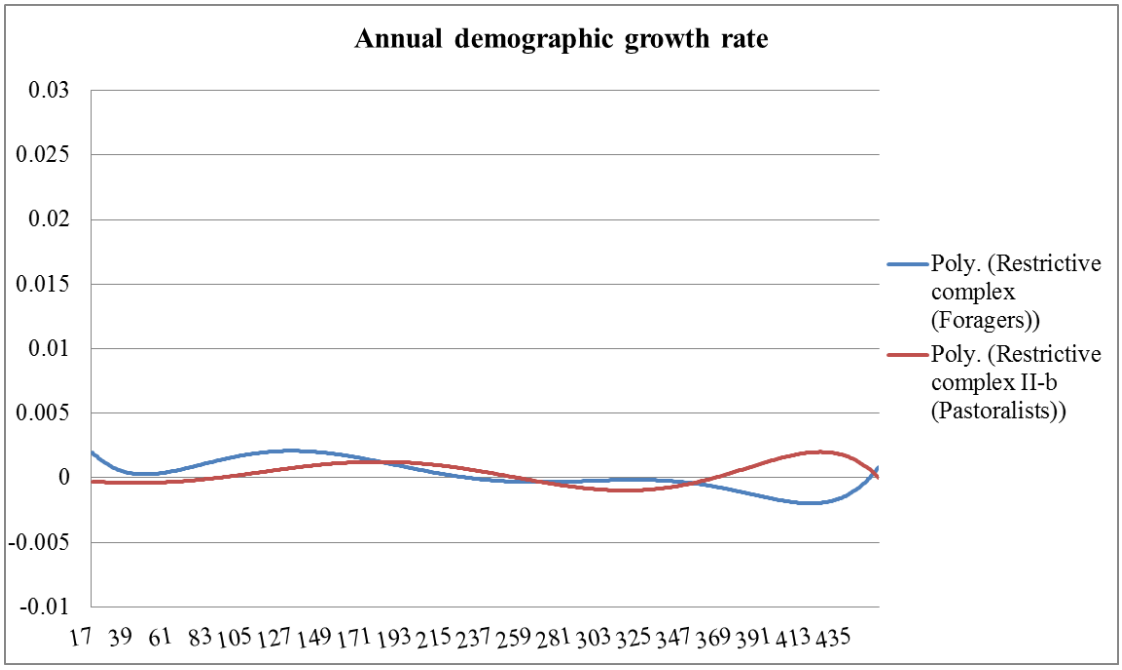


Figure 97. Comparison annual demographic growth rate between forager and pastoralists, from the simulations with the more restrictive social norms

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