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Technoscience and (Critical) Digital Epidemiology. Towards new ontological shifts in the global management of biomedical emergencies

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Technoscience and (Critical) Digital Epidemiology

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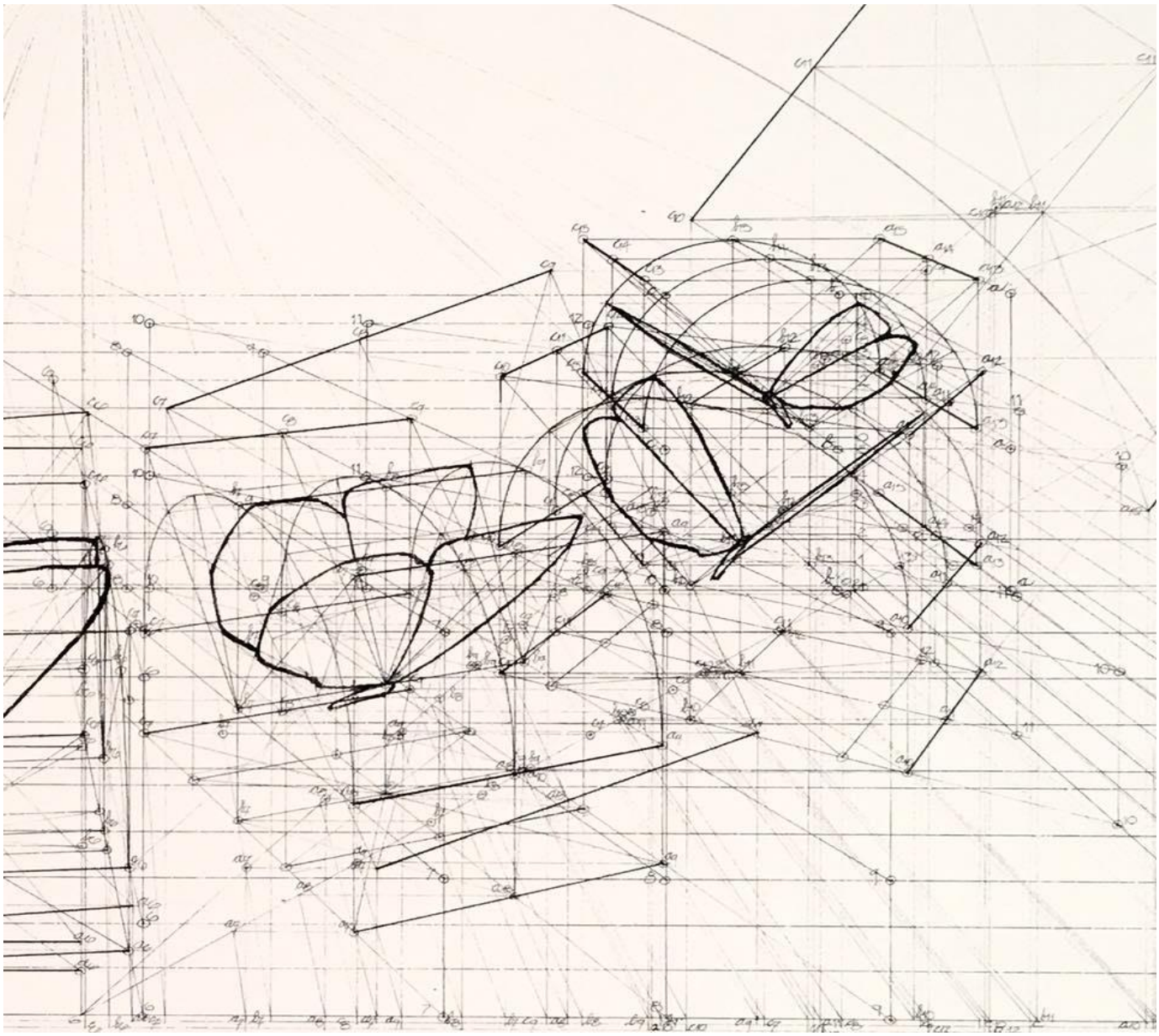

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Technoscience and (Critical) Digital Epidemiology. Towards new ontological shifts in the global management of biomedical emergencies

Tecnociencia y Epidemiología Digital (Crítica). Hacia nuevos cambios ontológicos en la gestión global de las emergencias biomédicas

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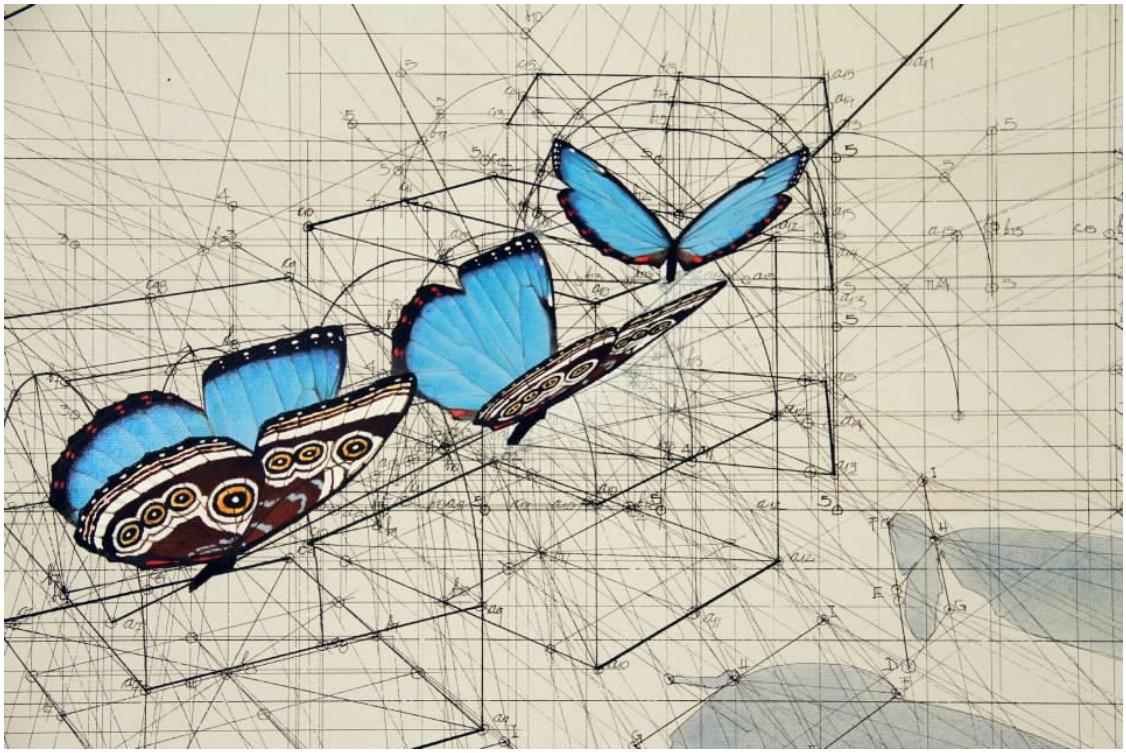
“A mathematician, like a painter or poet, is a maker of patterns” (G.H. Hardy, A Mathematician's Apology)



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SUMMARY

In the last two decade, in the literature are remarked several ontological mutations due to transposition of life science in a diversity of other scientific areas (e.g. artificial intelligence, cybernetics, mathematics, etc.). The present analysis focus on the impact of the 'digitalization' (*ref*. information and communication technologies) and the (new) tools provided from epidemiological background, where are being implemented standardized *preparedness* models to predict and optimize in front of possible future pandemic event. Within this technoscientific framework: life, bodies and corporalities dilute and molecular (social) experiences, by advising a peculiar techopolitical embodiment.

My research address the knowledge gaps of the epidemic techno-scientific models - beyond the consideration of efficiency of surveillance and security- by exploring the mutations that appear in the knowledge management models and focus on the new conditions of possibility given by the uses of ICTs (special focus on collaborative technologies). I investigate how epidemics are framed within the new technological approaches and the ways the proposals for future 'improvements' in global public health are challenging global and local social communities' policies.

I undertake the concept of 'digital epidemiology' (DE), seen from science and technology studies (STS) perspective, by developing a critical discourse analysis, based on different types of empirical data developed in Spain from 2013 to 2018 (in-depth interviews, focus groups, etc.), focused especially on three of the recent epidemic cases (Swine flu, Ebola, Zika). I focus on questioning how the design of epidemic social networks (e.g. content platforms, interactive maps…) are designed (as a way to approach knowledge for a community), constructed (technical and technological deployment) and how this assembly is approaching new conditions of possibility to narrate biomedical contents of public health to a broader global context. The empirical data is analysed based on three axis: a) the actors (human / non-human) that are (being) articulated; b) the technological resources required and c) the main networks of meaning (*subjectifiers*) on the situations of biological threat or epidemic/pandemic events.

My findings describe a range of mutations in the global management of biomedical emergencies. First, I examine the characteristics approached within the DE and their effects by describing how this modifies the engagement processes in social movements and technological approach in public health. Second, how boundaries are being renegotiated (e.g. biomedical spaces, expertise, actors involved), which constitutes the mutation of the spaces where it take place the mediation of epidemic deployment concepts. Third, I describe how the particular design, redefines the biomedical spaces and global geopolitical knowledge management, which are addressing new vulnerabilities (e.g. distinct access; edit and use of data; sensitive populations, etc.). Finally, besides the technological mapping utility, portraits and ethical debate adquire a broader uses of contents when articulated within collaborative technologies framework.

Keywords: *technoscience, digital epidemiology, data management, science and technology studies STS, global health, biopolitics, 2.0*

RESUMEN

En las últimas dos décadas, en la literatura están remarcadas varias mutaciones ontológicas, debido a la transposición de la ciencia de la vida, hacia una gran variedad de otras áreas científicas (por ejemplo, inteligencia artificial, cibernética, matemáticas, etc.). El presente análisis se centra en el impacto de la 'digitalización' (*ref*. tecnologías de la información y comunicación TIC) y las (nuevas) herramientas provistas a partir de antecedentes epidemiológicos, donde se implementan modelos estandarizados de '*preparedness'* (o preparación) para predecir y optimizar las respuestas frente a un posible evento pandémico futuro. Dentro de este marco tecnocientífico: la 'vida', los cuerpos y las corporalidades se diluyen y las experiencias (sociales) se molecularizan, remarcando que estamos frente un *embodiment* tecnopolítico peculiar.

Mi investigación plantea analizar las lagunas de comprensión de los modelos tecnocientíficos en epidemiología -más allá de la consideración de la eficacia de la vigilancia y la seguridad- y al explorar las mutaciones que aparecen en los modelos de gestión del conocimiento y que se centra en las nuevas condiciones de posibilidad que surgen a través del uso de TIC (enfoque especial en tecnologías colaborativas). En mi análisis observé como se enmarcan las epidemias dentro de las nuevas propuestas tecnológicas y como se plantean propuestas para futuras 'mejoras' en la salud pública global, que están desafiando las políticas de las comunidades sociales locales y globales.

Se propone utilizar el concepto de 'epidemiología digital' (ED), visto desde la perspectiva de los Estudios de Ciencia y Tecnología, mediante el desarrollo de un análisis crítico de discurso, basado en diferentes tipos de datos empíricos desarrollados en España entre 2013 y 2018 (entrevistas en profundidad, grupos focales, etc.), centrados especialmente en tres de los casos epidémicos recientes (gripe porcina, ébola, zika). Me centro en observar el cómo del **planteamiento 'ontológico'** de las redes epidémicas sociales (por ej. plataformas de contenidos, mapas interactivos...), cómo están **diseñadas** (como una manera de acercar el conocimiento de una comunidad), **construidas** (despliegue técnico y tecnológico) y cómo este **conjunto** plantea **nuevas condiciones de posibilidad** para describir los contenidos biomédicos de la salud pública en un contexto global más amplio. Los datos empíricos se analizan en base a tres ejes: a) los actores (humanos / no humanos) que están (siendo) articulados; b) los recursos tecnológicos necesarios y c) las principales redes de significados (*subjetivadores*) sobre situaciones de amenaza biológica o eventos epidémicos/pandémicos.

Mis hallazgos describen una gama de mutaciones en la gestión global de emergencias biomédicas. Primero, examino las características abordadas dentro de la ED y sus efectos al describir cómo esto modifica los procesos de participación en los movimientos sociales y el enfoque tecnológico en salud pública. En segundo lugar, cómo se renegocian los límites (por ej. espacios biomédicos, experticia, actores involucrados), lo que constituye la mutación de los espacios en los que tiene lugar la mediación de los conceptos de despliegue epidémico. En tercer lugar, describo cómo las particularidades de diseño, proponen redefinir los espacios biomédicos y la gestión del conocimiento geopolítico global, que abordan nuevas vulnerabilidades (por ej. acceso diferenciado; edición y uso de datos; poblaciones sensibles, etc.). Finalmente, además de la utilidad del mapeo tecnológico, remarcar que las representaciones y el debate ético adquieren un uso más amplio cuando los contenidos son articulados dentro del marco de las tecnologías colaborativas.

Palabras clave: *tecnociencia, epidemiología digital, gestión de datos, estudios de ciencia y tecnología STS, salud global, biopolitica, 2.0*

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Abbreviations

ANT Actor-Network Theory
CDC Centers for Disease Control and Prevention
EDCD European Centre for Disease Prevention and Control
ICT Information and Communication Technologies
IHR International Health Regulations
STS Science and Technology Studies
WHO World Health Organization

Glossary

Articulation (*ref. enrolment* ANT) – mechanism to fold and unfold layers of agents and significances within a determinate context of meaning
Agency (*ref.* ANT): social, economic and psychological features that adopt, mold or influence decisions and significance
Actants *(ref*. ANT): actors (human and non-human) that are socio-determinant in the articulation of a network or factors involved in the process
Bios: biopolitical approach on *life*
Black-box (*ref*. ANT): technical concept (precedent from cybernetics) that refers to any device, objects that can be plugged-in to provide input, output or transfer characteristics
Collaborative technologies (*ref*. learning collaborative systems): (open) technologies which provide spaces of negotiation of meanings and allow members to cope with the opportunities and challenges during a critical situation.
Critical digital epidemiology: critical cross-disciplinary perspectives on the disease modelling technologies used in global public health, which focus on the social and ethical implications of new surveillance 'future' approaches
Digitization: basic transcription of a document (e.g. text, image) from analogue format to digital version (*ref.* scan, photocopy
Digitalization: process which articulates digital technologies, users and data developed, by creating an additional semiotic-material environment
Enrolment (*ref*. ANT): translation process in which the roles are defined and actors accepted and take on their roles
Digital epidemiology (DE): methods and strategies used in epidemiology to support real-time infectious disease monitoring
Lay epidemiologist: 'lay expertise' knowledge and beliefs about health issues, which are constructed on subjective experience on knowledge developed '*by other means*' (that the formal official ones) through other type of sources of data or exchange of experiences (e.g. social networks, medical hacking)
Mediation or mediators (*ref.* ANT): entities which multiply differences existent in the socio-material context and characterized by the difficult capacity to predict the direction and nuances of their outputs and input in related areas of expertise
Preparedness: concrete research based on a set of actions that are taken, as precautionary measures in the face of potential disasters.
Risk technologies: information technology (IT) systems and data, which monitor risk and controls performance
Scenarios (*ref*. scenario-planning): strategic planning method, based on identifying possible factors which may combine in a complex context (e.g. epidemiological risk) providing distinct options for the 'future' management
Subjectifier: enablement of action, which refer to forces of multiplicity of possible agents and (might) create possibilities (not yet-actual) as political occasioning

TABLE OF CONTENTS

INTRODUCTION

If we were to make an *historical ontology* (Hacking, 2002) of the latest trends in health surveillance during the recent technological eras, we would remark that each of them pose nuances on how to approach ‘bios’ and populations management (Foucault, 2010; Harvey, 2008). In the present analysis, I focus on a slice of this broad perspective, more precisely on the 'archaeology of knowledge' (Foucault, 1970), which proposes to observe several nuances of the epidemiological views; where can be surprised several biopolitical models and the constant (re)definition the boundaries of the clinical perspective (Foucault, 2004). By doing so, with the intention to rescue different peculiarities that legitimize and allow the creation of the framework of 'truthfulness' (e.g. application of protocols to mark the performativity), which transform the 'social' and its respective management mechanisms. It is relevant to observe the 'epidemiology' as a socio-technical object (Tirado & Cañada, 2011), at the confluence between data models and populations management, as it operates in last century as a tool to respond to uncertainty and the inexorable defense of 'the living' (Castillo-Salgado, 2010).

In the thesis, I focus on the technoscientific *preparedness* models proposed in the latest two decades, within the framework of ‘global health’, as part of a *continuum* surveillance of the complexity of the *bios* (of life itself). The thesis proposes to enhance understanding of this new state of act of ‘biosecurity’ implemented in epidemiology, as foresight of the ontological mutation on *bios*, proposing an in-depth empirical research to observe in which ways this is being constructed as a social problematic in global health management.

I make a special remark on the 2009 pandemic event (swine flu AH1N1), which is remarked in the literature as a starting point toward the (new) conceptual mutation (Carlo Caduff, 2014), from the classical risk management (activated only *on* and *during*

a specific event), toward the declaration of a *permanent state of exception* (Anderson, 2017; Carlo Caduff, 2012); which is justified as a priority for global surveillance to survey all possible (new) infectious diseases (Collier, Lakoff, & Rabinow, 2004).

In the thesis is remarked also an normative mutations in global health related to requirement to (re)design and plan of ‘epidemiological intelligence’ (Krieger, 2000; Maureira, Tirado, Torrejón, & Baleriola, 2017), since the digital collaborative technologies escaped the boundaries of traditional knowledge management models (Chunara, Freifeld, & Brownstein, 2012; Wójcik, Brownstein, Chunara, & Johansson, 2014), marking blurry frontiers on actor’s legitimacy and types of subjects involved in the articulations.

Based in this assumption, the analysis starts from a historical overview on the main technological concepts based on the ‘digital’ transposition in epidemiology, seen from studies of science and technology perspective (particularly from the Actor-Network Theory framework). With the intention to propose an open debate for a multidisciplinary scientific community, beyond the classic 'laboratory' knowledge management (Latour & Woolgar, 2013), based on the capacity to identify objectively (e.g. mortality or mobility statistics) after the epidemic event has passed; towards observing how the ‘new’ epidemiology operates with an accelerated real-time surveillance and observing different scales (Ekman & Litton, 2007). This new approach defies the boundaries of definition of the conceptual and methodological approaches of biomedical spaces, based on which are outlined the new designs for future models that are implemented in ‘global health’ framework (e.g. digital epidemiology, scenario-planning, etc.).

Further on, I pose a critical reflection on questioning if the global health refers to the global rights to equitable access to health or is further more just a governance technological tool, where the knowledge on bodies, concepts and subjects dilute within

spaces that are defining our collective health. Further on throughout the thesis, are being unfold different level of analysis on the technologies as mediators in the negotiation of the *signifiers* (Latour, 2005), based on a two main gaps of the techopolitical governance: a) the discourse of 'global health' to acknowledge the main strategies to impact 'bios' and our vital experiences, and b) multiplicity of knowledge that start to intermingle from concepts as 'digital epidemiology' (Salathé *et al*., 2012) and its relations -with present and future - ethical, social, political or economic aspects.

As a special remark of my analysis in this thesis, based to my personal background, one of my dilemmas during the research was to observe alternative (new) conditions of possibility, sprouting from the gaps between theoretical design of 'fancy' models and their real implementation within communities at global level. By doing so, I observed if the technological proposals - seen as devices that allow new conceptual and methodological articulations – are proposing new boundaries from technoscience, beyond the (new) biomedical spaces, where these social discourses are being constructed.

The present thesis is developed in Spain during five years (2013-2018), from science and technologies studies (STS), approach based on Actor-Network Theory (ANT) framework, analysing the digital epidemiology (DE) as a peculiar and relevant space within the present conceptualization of the 'global health'. The concept of DE provides a capacity to visualize the complexity of the social phenomenon, beyond the merely technoscientific proposal (e.g. scenario-planning) and provide possibilities to observe the ontological transformations of the risk management in epidemiological surveillance (as a new 'epidemiological intelligence').

In the complexity of opening the black-box of the 'epidemiological surveillance', as proposed by the actor-network theory (ANT), in order to be able to define the central

axes that determine the ontological shifts, are observed several scales: a) *conceptual* through the 'scenario-planning; b) *performative* thought the practices and uses of knowledge and c) the *conditionings* of information management beyond the mere algorithms). Proposing the concept of DE as a space where there must be discussion and negotiation, which is including the emergent new voices and new articulations. Therefore, this thesis aims to identify the frameworks and the conditions of possibility, where the articulations of agents, subjects and subjectivities, spaces, technologies and meanings, are participating actively in the (re) negotiation of the definition of health.

The research proposal is framed within the recent interest to debate on the impact of the epidemiological parameters and models, which until now were the core definition for 'global health'. Mainly, this new trend focus to analyse which are the social and technological elements that are being articulated and are defining this context-based on core framework, since these events that are no longer considered as 'exceptional' (Collier and Lakoff, 2015; Tirado, Gómez, and Rocamora, 2015). I remark the importance of the research within this approach as it focuses on the social, legal and political level mutations in communities' management in global health, which might have direct implications for the next decades in defining the boundaries of the global health management.

The purpose of the present thesis is to analyse the processes through which (digital) information management defines global public health and its consequences in the definition of spaces and subjects. For this purpose, the following specific objectives are proposed:

- Describe the main actors (human and non-human) involved in the definition of (alternative) discourses on biological threats and pandemic events.

- Describe and analyse the technological and scientific material resources that are mentioned in the conformation of the uses that are given the mentioned technologies
- Describe and analyse the main frames of significance that are being establish within discourses on biological threats and pandemic events.

The analysis on '*Technoscience and (Critical) Digital Epidemiology. Towards new ontological shifts in the global management of biomedical emergencies'* is organized in 6 parts, in order to remark distinct development steps and reflections made during the research.

In the **first** part *Global health: (new) ontological articulation on 'digital'* is intended to offer a positioning on the contextualization of the 'global health' (as context for analysis), were I introduce the concept of *preparedness* as part of the governance technologies, which are used for strategic management in public health emergencies.

In the **second** part *Digital Global Public Health from the technoscience lens*, is intended to explain the theoretical framework used in the present analysis in order to propose an analysis on the ontological and conceptual tools, to be able to open the *black-box* of epidemiology, by using technology as a *mediator* (with special focus on *collaborative technologies*).

The **third** part *Methodology and research procedures* is intended to explain the methodological approach used for observing the contents and articulations of the black-box of digital epidemiology (DE). Here are described the main details on the sampling, research design, techniques, sources of data collection and the approach for the discourse analysis.

The **fourth** part *Results and data analysis* is described the specific context of digital, observing examples and relations between different current epidemic events (highly

mediated[1] in the last decade; e.g. Zika, swine flu, Ebola). Here I depict the DE as a new ontology in health area, with repercussions and articulations between agents, contents and subjects.

The **fifth** part *Critical digital epidemiology. Discussions on collaborative learning processes within the 'digital' laboratory* are described the main reflections derivate from the analysis. Here I argument the relevance of the present analysis within the framework of science and technology studies in global public health, as the new enablement redefine the overview on the biomedical emergencies and the configuration of new global biopolitical contexts.

In the final part *Conclusion and future research directions* are presented the main points of the analysis with the purpose to open a dialogue on security and surveillance models, from the models of global health that currently propose a configuration and a peculiar logic, which negotiates its techno-scientific, legal and ethical delimitations of the present and future *modus operandi* in health.

1 Amplified movement of information related to specific events (e.g. social networks, etc.)

I. GLOBAL HEALTH: (NEW) ONTOLOGICAL ARTICULATION ON 'DIGITALIZATION'

"Who writes, weaves. Text comes from the Latin, "textum" which means weaves. With threads of words we are saying, with threads of time we are living. The texts are like us: weavings that walk" (Eduardo Galeano)

Let's identify the *black-box* of the laboratory of what means 'global health'. *How do we propose to see it from outside the lab, precisely 100 years after the first registered pandemic of the 'Spanish flu' (1918)? How the 'global' concept acted as a mediator in the negotiation of the present meanings and approaches in epidemiology?* As remarked in literature (Tonne *et al.*, 2017) there are several gaps when we related it with 'public health' concepts, whose mechanisms where 'genuine' tecnoscientific-related to a context where assessment and response depend now on the wide range of innovative methods, techniques and technologies. *Which are the challenges that this black-box brings? How I approached this complex context? Which is the state of art on this box?*

In the present analysis I focus on the main techniques and technologies approached in epidemiology in the last two decades. From this tool box I select 2 'apparatuses': a) 'the digital' as an expression of mediator effect of the technology and b) the shifts after the 2009 pandemic event (swine flu or AH1N1) as remarked in literature. By doing so, in this chapter I review the main concepts on perspective on 'global health' seen as an ontological framework for epidemiology, were new traces of biopolitical approaches can be surprised within the governance technologies proposed and the strategies required for its implementation.

1.1. *Preparedness* as governance technology in global health

If the XX's century politics were based on awareness models (e.g. global human immunodeficiency virus) for the risk and population management (Foucault, 1977); it is to remark the change of the point of reference in the 'molecularization' of the politics (Harvey, 2008; Rose, 2009), which reflects the transcription into daily life and enrolment of diverse types of agents. It's relevant in the present debate to add a quick review of the risk approaches seen as a follow-up on the respective technologies they propose: the *risk-society* (Beck, 1992; Giddens, 1991), the *vital systems in biosecurity* (Collier and Lakoff, 2015) and *public health surveillance* (Choi, 2012; Morse, 2012).

The risk-society theoretical approach (Beck, Giddens, and Lash, 1994) had a high impact on social, political and economic decision making of the XX and early XXI, based on the proposal to identify the 'risk' as a core element which performed as an ontological, central explanatory principle for risk-work models as responses to 'uncertainty' (Giddens, 1991).

From the characteristic of this framework, I rescue for the present analysis two techopolitical techniques: **scenario-planning** [2] (from where depicted later on the *preparedness* approach) and **epidemiological intelligence** (from where depicted later on the *public health surveillance* approach and its 'digital' real-time formats). The reason to do so at this point of the analysis, is for support (the reader) to follow the explanation based on the historical connexions between approaches, techniques and technologies in the public health approaches.

The use of **scenario-planning** has encouraged to explore unique insights in decision making and deployments in crisis preparedness, which requires to identify a certain

2 Scenario-planning or scenarios refers to a decision-making technique used in different areas (e.g. politics, military). This consist of is a feasible description of a future state of the world, based on a set of assumptions (Gavier-Pizarro, Calamari, Piquer-Rodríguez, & Kuemmerle, 2014) which has the "purpose of focusing attention to causal processes and decision points" (Kahn & Wiener, 1967, p.33).

enactment, pathways and types of expertise (Bishop, P., Hines, A., and Collins, 2007) and considers the possible 'futures' as potential narratives (Godet, 2000). Within this framework, we remark in this analysis that especially over the past twenty years, the approach of *vital systems* (Collier and Lakoff, 2015) in (bio)security redefine the biopolitical approaches by posing several *preparedness* technologies (Collier *et al*., 2004), which focus on strategies "*to cope with public health emergencies*" (World Health Organization, 2013, p. 43).

The latest socio-historical period is characterized by an accelerated global migration (e.g. people, virus, data), brought the requirement in the public health surveillance to amplify the vision at global level. Based on this were reviewed several a classical approaches like **epidemiological intelligence[3].** I remark a special interest arise on this concept due to the "*global shared interests in and vulnerability to infectious diseases*" (St. Louis, 2012, p. 289). Understanding the issue of the (re)emergence of the debate on infectious diseases management as a complex context which proposes new challenges, but which also offers new possibilities in the governance of global health. The problem of governance in a global context provides a good example of the blurry boundaries of responsibilities of different agents involved. Furthermore, the intention on designing technological and methodological frameworks -from technical systems enhanced in the articulations of agents, spaces and *signifiers*- that pose challenges to the techopolitical proposals in the management of (digital) information in global public health.

For example, the case of 2009 pandemic event of swine flu A(H1N1)[4], which was declared in April 2009 as the first "*public health emergency of international concern*" (World Health Organization, 2009) due to its quick spread at global level[5]. The

3 The term was firstly mentioned in 1951 by Langmuir (Choi, 2012; Langmuir & Andrews, 1952) refers to the techniques used for the process to detect, assess and investigate public health events that may represent a threat for public health.

4 Similar type of infectious transmission as in the so called 'Spanish flu' in 1918

5 Actually was the first digital enrolment of a pandemic event, within the present normative framework, that could be observed on real-time on global expansion.

expansion of cases in different global areas, ended up with the activation of 'pandemic' making a global state of emergency[6].

In the present analysis I focus specifically on case of the pandemic event (from 2009/2010), which is considered that had a relevant impact on the shifts that appeared in the mediation of the techopolitical management of expert knowledge. At this point, I observe a normative mutation after these event around 'the digital' which firstly was considered an important 'noise', but in the next years caused several revisions of the proposal of the *International Health Regulations*[7] (WHO -International Regulation 2005; World Health Organization 2007, 2009, 2016), by including for the first time references on the real-time updates and digital dynamic knowledge management (Chan *et al.*, 2010; Jetté *et al.*, 2010; Katz and Dowell, 2015; Wilson, Brownstein, and Fidler, 2010).

1.2. Epidemiological intelligence and transformation of knowledge expertise in biomedical emergencies

In the last two decades, the field of biosecurity has experienced severe conceptual and performative transformations as digital techniques and technologies were being implemented as innovative and disruptive ways of working (Hartley *et al*., 2013; Carroll *et al.,* 2014; Collier *et al.,* 2004; Rose, 2007). These shifts emphasise a deep social mutation based on an ongoing ontological negotiation of the epidemiological surveillance models and propose a transversal tool for the future designs of *bios* (e.g. genomics to modify DNA, nanobots to optimise biotic functions, artificial intelligence

6 In the present analysis, I will not focus to define the description of the 6 levels marked by WHO from epidemic to pandemic (World Health Organization, 2009), either on the debates if was a truly 'pandemic' event as part of literature analysis mentions some years after the event passed.

7 The International Health Regulations (IHR) firstly proposed in 2005 by the World Health Organization's (WHO) to regulate and create an international law framework applicable in crisis situations.

bots to perform a sematic scan of virtual networks based on Internet searches mentioning flu symptoms, etc.) (Caduff, 2012).

Going beyond technological enthusiasm, this new context poses several controversies and gaps (Lakoff, 2015; Shaikh *et al.* 2015), on approaching a global vision (e.g. 'One Health'; Zinsstag, Schelling, Waltner-Toews and Tanner, 2011), where the 'global community' is required to implement procedures (as possible steps in a scenario) to be able to articulate actors and -intent to- facilitate deployment in situations of potential risk on a planetary scale (Castillo-Salgado, 2010; Hill-Cawthorne and Sorrell, 2016; Tirado, *et al.*, 2015).

These problematics makes it relevant to start a debate in the academic community on the epidemiology in the era of Big Data, by bringing into question two dimensions: a) the use of traditional epidemiological concepts; and b) how these are currently being approached in a global context, where the boundaries of the new epidemiological ontology transfigure our realities (Brown and Calnan, 2013; Chunara *et al.,* 2012a, 2012b; Hay *et al.,* 2013; Pesquita *et al.*, 2014). In this sense, our analysis discusses both dimensions, questioning how epidemiology became a metaphor to think about ourselves, by proposing to open the black-box of the clinical perspective (the expert observation and its performance) to observe how it was defined within scientific backgrounds (Foucault, 2007). I argue that a technoscientific approach was moulded during the negotiation process on expertise boundaries, and how technologies correlated.

These shifts are not due to new technologies by *their own means*, but to the performing of epidemiology as a social mediator, where expertise boundaries are deeply negotiated (Barker, 2010; Bauer and Olsén, 2009). In 1951, Alexander Langmuir (Langmuir and Andrews, 1952), working in US Center for Disease Control and Prevention (CDC), and in reference to biological warfare related to the Korean War, proposed the concept of 'epidemiological intelligence' to describe the exercise of collecting and using information

about the evolution of infectious diseases vectors. The concept was progressively enriched and, nowadays, involves a much broader palette of actors, associated with the capacity of tracing and visualization techniques and technologies for health risk prevention within the framework of global health, proposing a dynamic form of observation and visualization (Kostkova, 2013). However, *epidemiological intelligence* is a notion that needs to be completely reshaped today because: a) data science and future studies are starting to articulate global policies agenda using new tools such as scenario-planning or Big Data; b) social dynamics are defined within the dissemination of epidemiologic-related data generation and monitoring; c) analysis of the different type of implementation and procedures to put the biomedical contents into practice between experts and lay-people; and d) criticism of geo-strategic policies on the ethics of personal data management as generic epidemiological data. This awareness in the management of biomedical emergencies is shaping a new type of epidemiology, which proposes to overcome the gaps of traditional surveillance models.

Following this transformation, in the first part of the analysis, I emphasise on the key points of historical shifts of the biopolitical approach in biomedical emergencies (Braun, 2007; Caduff 2012; Esposito, 2008; Foucault, 2008; Lakoff, 2015): from the 'regulatory objectivity' of traditional epidemiology (Cambrosio *et al.*, 2009), towards the collective turn in biomedicine (Cambrosio *et al.*, 2014) of use of 'subjectifiers' (Frank, 2006; Tirado, Baleriola, Giordani and Torrejón, 2014). I argue that these shifts are not due to technology by *its own means*, but as performing as social mediator, which became imperative in the digitalization, permitting the conceptual mutations of epidemiology (Chew and Eysenbach, 2010); where the boundaries of the types of expertise of (new) possible actors are being reshaped and amplified (Barker, 2010; Bauer and Olsén, 2009).

In the second part, I propose to unfold the 'social' in the ambit of epidemiology (Krarup and Blok, 2011; Latour, 2005). To do this, I focus on how the participative technologies (*ref.* learning collaborative systems) provoked an epidemiological conceptual shift

(Szlezák *et al*., 2010; Barry, 2013), within the 'global health' project, which requires -besides the implementation of a wide range of complex systems and technologies- the participation and coordination of complex networks of global actors from different expertise backgrounds. I analyse how these shifts negotiate the boundaries of the 'expertise', and how these new technological abilities are proposing disruptive innovation through the generation of communities of knowledge and (open) sharing in biomedicine (Bowser *et al.*, 2013; Irwin and Wynne 1996; Prainsack, 2014; Prainsack and Buyx, 2016; Shaikh *et al.*, 2015).

In a third part, we observe the shifts in the epidemiological reason by analysing several data sources: personal interviews, focus groups, and content analysis of digital materials (e.g. scenario proposals, journalistic articles, blogs…). This discussion is based on three axes: a) active participation of the lay epidemiologist or non-health expert; b) articulation of heterogeneous types of data used in new digital knowledge management channels (mainly visual registries) and c) new uses of biomedical knowledge.

In the last part, I argue that the main mechanisms of the new ontology in epidemiology are not only reshaping the meaning of expertise, but that they create new dynamics in risk prevention and require reconfiguring the conceptual definition of global health policies. In this sense the 'digital epidemiology' -by involving different scales of expertise and actors- can be understood as a new 'intelligent' ontology in global health.

A little genealogy of epidemiology

One of the pioneer models from 20th century, which marked epidemiology definition, was John Snow's discovery of the Broad Street Pump (Snow, 1985). Traditional definition refers as "*relating exposure to an environmental agent such as a drug or infective agent has been to measure an overall risk*" (Shpilberg *et al.*, 1997, p.1). The model meant a new approach to infectious diseases based on statistics, focused on "*the*

application of the numerical method to living beings in all their social relations" (Guy, 1839, p. 39). Within a mathematical management of designs of patterns of life, disease, and death (Krieger, 2011) was defined as the first attempt to articulate a 'uniform nomenclature' applicable for all countries (in the First International Statistics Congress in 1853). This, later on in 1948, was denominated as the 'International Classification of Diseases' under the aegis of the newly founded World Health Organization (WHO) (Jetté *et al.,* 2010; Rosen, 1910).

Three elements are established as crucial in this model:

- First, the design of statistical models based on similar characteristics of infection (within types of risk involved) has as its main focus to identify a common denominator between distinct actors (clinical analysis, implemented in public health policies). The 'emergence' context starts to be defined once the 'patient 0' (initial source of an epidemic outbreak) (Fantulin *et al.*, 2015; McKay, 2014) protocols (as a technique for mapping context and required procedures) has been triggered, and when similar epidemiological histories are reviewed, and compulsory path routes are delimited under the responsibility of management of formal agents. For example, the case of swine flu (influenza) of 2009, was coordinated using similar characteristics to that of the flu epidemic 1918 (also called 'Spanish flu') (Anderson, 2017).
- Second, following the flow of the movement of knowledge (as techniques and technologies used) is exclusively carried out by experts in biomedical emergency management (e.g. transnational agencies and organizations; such as the WHO), which are setting limits to define strategies under international conventions (Maureira *et al.,* 2017). Within this approach, we note that in this logic of action underlines a clear differentiation between the expert narrative and those left out (the lay-people).
- Finally, the protocols are based on design and deliberate follow-up registries of epidemiological contents protocols that were initially presented with an 'abstract' language, and linguistic registers closer to the medical terminology than to the

general public (Castillo-Sepúlveda, 2015; Tirado and Castillo-Sepúlveda, 2011). However, since the first decade of the new millennium, the progressive role of digitization (e.g. scan process to transform analogue protocol into online documents) amplifies this process and undergoes important mutations. New formats and new uses of knowledge appear, which be articulated through the use of digital tools -digital content editing and devices of frequent use (e.g. inter-generational gap to register personal data…).

The role of *telemedicine* and *e-epidemiology* can be emphasised as one of the most important transformations in epidemiology. The first can be considered one of the initial models of digitalization of biomedical and epidemiological content, but still does not allow, or require, interaction between users, or possible adaptation of content. These models –similar to classical epidemiology logic- involve the use of a pre-defined tool box (e.g. protocols), but with remote use within a distinct geographical or temporal boundary (Moore, 1999; Güler and Übeyli, 2002). The second one, is considered as an evolution of telemedicine and focuses on the technical and technological basis, rather than on the uses given to the content by the end user. It is based on the technical transcription of the categories used later for the computer semantics coding and the role of participants; that is, lay people, start to be relevant in its way of working (Ekman and Litton, 2007).

This line of engagement with non-experts is consolidated with the emergence of the DDD (digital disease detection) tools, proposing something so ambitious as to rethinking Public Health Surveillance in order to improve timeliness of outbreak discovery (Brownstein *et al., 2009;* Eckhoff and Tatem, 2015; Kluberg *et al.* 2016*)*. A good example, is the case of HealthMap, which is a system that “uses disparate data sources, such as online news aggregators, eyewitness reports, expert-curated discussions, and validated official reports for disease outbreak monitoring and real-time surveillance of emerging public health threats [...], researchers, epidemiologists and software developers at Boston Children's, HealthMap monitor, organize, integrate, filter,

and disseminate online information about emerging diseases in nine languages through an automated process that is updated constantly" (Slabodkin, 2017). Finally, in recent years, we have seen the irruption of something called 'digital epidemiology' (Salathé *et al.,* 2012; Salathé *et al.*, 2013; Vayena *et al.,* 2015; Salathé, 2018).

This new approach is providing a holistic view in order to redefine risk practices within the global health field (beyond the mere technical aspects). Its main objective is the full participation of lay-people and, in addition, it raises the debate on the ethical issues of the technical *filters* used in the design of global health policy contents. Also, on how social networks are re-shaping the routes of risk communication, and public information on health threats. As seen in the following examples of participatory digital epidemiological systems: 'Influenzanet', 'Flu Near You', 'Flutracking', 'Medysis', 'Crowdbreaks', 'ProMed', 'biodiaspora', Google Flu Trends'. The mentioned examples have the ability of giving voice to new actors, which interlace lay epidemiologists (Collins, 2010; Frankel *et al*., 1991; Allmark and Tod, 2006) and experts far beyond traditional boundaries of expertise.

This new epidemiological technology blurs the traditional boundaries of clinical care and public health work, and raise questions about its implications" (Gagnon and Guta, 2012, p. 472) within an volatile global context of *real-time* biopolitics (Lakoff, 2015), where communities, viruses, and knowledge became accelerated processed data (Yates and Paquette, 2011).

In digital epidemiology (D'Ambrosio *et al*., 2016*),* connections are activated through technological *plug-ins* (Latour, 2005), as dynamic mediators (e.g. dynamic reconfiguration as an software update) to enable the visualization and the accelerated reading movement of the information. These new markers of subjectivity, so called

"subjectifiers" (Latour, 2005; Frank, 2006) enable latitudes to be created for actors beyond former boundaries of expertise and participation.

Digital epidemiology

Digital epidemiology involves a reconfiguration of boundaries of knowledge movement and the expertise in a digital context (e.g. new figures as 'data managers'), where we observe a difference in the flows and types of articulation used in data management, which offer new *significants* (Gavris *et al.*, 2016). Within this framework, it is absolutely relevant in how the participative technologies (*ref.* learning collaborative systems) provoke an epidemiological conceptual shift (Szlezák *et al.*, 2010; Barry, 2013) within the 'global health' project, which requires – besides the implementation of a wide range of complex systems and technologies (Margevicius *et al.,* 2016)- the participation and coordination of complex networks of global actors from different expertise backgrounds (Velasco *et al.,* 2014). The novelty of this approach resides in the ontological status of technology as mediator. In this sense, in the research I will analyse how these shifts negotiate the boundaries of the 'expertise', where new technological abilities are proposing disruptive innovation (Shaikh *et al.,* 2015) through the communities of knowledge generation and (open) sharing in biomedicine (Bowser *et al.*, 2013; Irwin and Wynne, 1996; Prainsack, 2014; Prainsack and Buyx 2016) because:

> Researchers have already started to develop methods and strategies for using digital epidemiology to support infectious disease monitoring and surveillance, or to understand attitudes and concerns about infectious diseases. But much more needs to be done to integrate digital epidemiology with existing practices, and to address ethical concerns about privacy. By 2020, there will be 6.1 billion smartphone users, so it is high time to get serious about digital epidemiology (Salathé, 2015, p.1).

However, digital epidemiology implies more than a mere debate on the digital active participation (Mossberger *et al,.* 2008; Tironi and Sánchez Criado, 2015; Wójcik *et al.,* 2014), instead it is a logic that focuses on the new voices in global health movement (Biehl and Petryna 2013; Szlezák *et al.*, 2010; Biehl, 2010; Shaikh *et al.*, 2015). This point emerges strongly in the specialized literature on biological threats (Castillo-Salgado, 2010; Katz and Dowell, 2015; Wilson *et al.*, 2010), highlighting the articulation of new spaces (Gavris and Tirado, 2017), which enhance the emergence of new voices and the articulation of new skills that reconfigure the context and the notion of expert (Prior, 2003; Van Loon, 2002; Collins, 2010; Kerr *et al.,* 2007).

Thus, digital epidemiology (DE) leads to two important questions about experts role in epidemics: a) who has to be recognised as expert in the science-society articulations promoted by infectious diseases vectors (Gavris and Tirado, 2018; Salathé, 2018; Salathé *et al*., 2012); b) who designs the infrastructures and tools on which DE relies upon (Rushton, 2011). Both questions show that the limits of the expertise are in constant negotiation where concepts (e.g. virology, bacteriological or molecular elements, prevention strategies, servers and managers of contents, technical or personal data, future local or global public health scenarios, etc.) are being designed on a multidimensional basis between formal and nonformal experts; or new actors human (e.g. data manager) and non-human ones (Big data, etc.).

If, in the classical view, the lay epidemiologist (or non-expert) was seen as a passive recipient user, according to the digital epidemiology approach, this becomes a driving part of its own design and articulation dynamics, where humans and non-humans (e.g. chip, server, animal, mosquito, viral agent, etc.) are blended. Within the DE framework, I remark several shifts on how the stories about biomedical emergencies are being articulated (concepts, spaces, actors…) in the last two decades:

a) New channels used in digital knowledge management provide new conditions of possibility towards the articulation of heterogeneous types of data (visual, programing codes, audio, dots, etc.). (Eckhoff and Tatem, 2015; Brownstein *et al*., 2009)
b) New types of technologies used in visualization design (e.g. photography of epidemic outbreak, interactive maps, etc.) enable phases of implementation on global health proposals to be identified, which bring about constellations of new challenges (Carroll *et al.,* 2014)
c) New skills (e.g. programmer, data manager) bring into debate how knowledge articulates (Eysenbach, 2006, 2009)

Thus, DE is showing that future approaches in global health management requires inclusive models (Barker, 2010) to promote the involvement of the lay epidemiologist, as their involvement and active participation "*is likely to increase the effectiveness of public health work, as well as helping to ensure it is ethically sound*" (Allmark and Tod, 2006, p. 14)

Besides, digital spaces offered a transformation of the available formats; which gave new conditions of possibility to the uses of the contents and diverse articulation approaches. I refer here to the leap that allows the digitalization of content - and *a posteriori* 'the digital' as a dynamic that encompasses concepts as a whole in symbiosis- in the contrast between the types of past epidemiological records (e.g. statistical) and the new approaches, which propose a blended mix of types and levels of expertise (e.g. data manager, open data epidemiology, etc.).

Digital epidemiology, with a blend of digital tools, skills, active participation of different actors, real-time analysis, and the availability of data (at different points in time) have

led to the changing of biorisk conceptual boundaries (Harvey, 2008; Krieger, 2011), creating the following conditions:

a) A shift of logic on who and why are legitimised to design and use new tools and technologies (e.g. quantified self).
b) The conceptual negotiation is proposing new forms of attachment by articulating horizons where the affectation re-thinks the same conceptual and performative limits (e.g. biohacking).
c) New formats of presenting and producing information about biorisks have given rise to the lay epidemiologist; who now feel empowered and legitimised to contribute with what they observe and know.
d) New types of interaction with the biomedical contents are a result that can be observed in tools like digital mapping systems of epidemics (e.g. *HealthMap*), which cannot be compared with classic epidemiological mapping (Benet *et al.*, 2016; Choi, 2012).

To analyse this new reality, we propose the idea of *subjectifiers* (Latour, 2005; van Loon, 2012; Frank, 2006) as "enablements of action" (as opposed to objectifiers defined as "enablements of actuality"), which act as "forces of multiplicity and create possibilities that are not yet actualities, by means of which temporalities come into being [which] could also be referred to as 'political occasionings'"(van Loon, 2012).

I put forward three *subjectifiers* as axes to analyse the shifts of the epidemiological reason: a) lay epidemiologist or 'non-health experts' active participation; b) articulation of heterogeneous types of data used in new digital knowledge management channels (mainly visual imaginary registries) and; c) new uses of biomedical knowledge. To do this, I selected three case studies of the most recent epidemiological outbreaks (highly mediatised), due to their quick escalation at global level, digital information spreading and development of specific digital technological tools: swine flu A(H1N1); Ebola, and Zika.

1.3. On digital epidemiology: collaborative technologies are divergent innovation?

Starting from the assumption that digital epidemiology became relevant for the decision-making on knowledge production, experimentation and data collection, I propose the need to have a critical vision on how we conceive the articulation of 'thoughts' and 'emotions' during the process of design.

Digital epidemiology seen as a mediator technology (e.g. epidemiology and social sciences), poses new options to a multitude of gaps of classical epidemiology, but also raises a multitude of questions: *What this technologies really communicate? Who observes the observer(s)? Does anyone actively 'listen' to their production of knowledge and the articulations of agents? What geopolitical limits are being reflected? How are induced the values about vulnerabilities regarding 'non-access' to health systems, information and data (e.g. restrictions or lack of digital connection to user-friendly kits or "easy-tools")?*

I remark with special interest the new (social) movement which are raising the interest on the collaborative technologies, based on questioning if this technocientific context is providing a real empowerment of citizen science on *bios* by providing and supporting mediation of biomedical knowledge (e.g. medical humanities, qualified self, medical hacking, biohacking):

What approaches organize the articulations of practices or protocols and enable subjectivities?

II. DIGITAL GLOBAL PUBLIC HEALTH FROM THE TECHNOSCIENCE LENS

In the literature, when referred to present models used in global health management, it is observed that the deployment and implementation of these models and approaches are already establishing a semiotic-material distance already from their mere pre-design. The managements of the knowledge and experiences has a framework of approaching, 'feeling' the spaces for the users and collecting the data, which are already (pre)established based on the use of technical data criteria's from biomedical records and digital engineering (Cho, Mathiassen, and Nilsson, 2008; Hanseth, Jacucci., Grisot, and Aanestad, 2006; Latour, 1987; Moser and Law, 2006; Silvis and M. Alexander, 2014).

Let's open the black-box. But first, I propose to reflect on the following points: *How can technoscience approach this new context, with the challenges that bring within the framework of risk and health managements? How can social sciences could be included into the design part (not only observing from the outside, normally after the object was already constructed and used) to bring new insights and reflections?*

In this part, I propose to get closer to the specific features of the framework of 'global health' (as previously proposed in the first part), in order to comprehend which are the perspectives that we might find on this black-box of the digital epidemiology. For doing so, I propose two main objectives: a) to identify how and why are constructed the objects and the subjects on 'the digital' discourse in epidemiology beyond the mere description of the technologies implemented; and b) to identify the mechanisms of legitimation and their problematics in the risk knowledge management used in 'digital epidemiology'.

2.1. Technoscience in epidemiology: metaphors to think about ourselves

In order to find connexions point between epidemiology and technoscience, we propose to observe a case of 'infected' poster, designed by Ogilvy Brazil for the NGO Life Support Group. The so called 'infected HIV poster', became an agency which enrolled several agents, technologies and signifiers in order to raise awareness about one of the most widespread global epidemics[8]. The poster was just a piece of paper, but which represented the translation of a situation, its emotions (e.g. fear), agents (e.g. actors, virus, etc.) and technologies involved. The poster 'presents' itself as:

> *"My measurements are 40 by 60 centimeters. I was printed on high brightness paper. And my weight is 250 grams. I'm just like any other poster. Except for one thing: I'm HIV positive. It's exactly what you've just read. I'm living with the virus. At this point you may be taking a step back, wondering if I offer any danger." — The HIV-Positive Poster*

How can we 'touch' the materialities proposed by the new ontological proposals in epidemiology? I propose to consider these two scales: a) the technological support that allow the conceptual approach (scenarios) and b) the technical and digital support (digital epidemiology).

- I refer here by 'scenarios' to the conceptual approach used on risk work and global health reference. As seen from the critical lens of science and technology studies (STS), I consider that it is possible to examine how these mediation spaces are being proposed through the scenario-planning models as

8 NGO Life Support Group (GIV) proposal. For more details, check: http://www.upworthy.com/this-poster-is-hiv-positive-the-people-who-read-it-are-instantly-touched?c=ufb2

‘manageable’ tools. Also, how they became useful in controlling the increasing complexity of global health, by proposing the exploration of different paths on risk-work management. Also, the conceptualization of new possible ‘future’ methodologies, by covering the gap of the ‘technical discourse of risk’ which “*has become a rhetoric for the advocates of risk-based practice*” (Horlick-Jones, 2005, p. 294).

- I focus on the ‘digital epidemiology’ concept (Bakker, Martinez-Bakker, Helm, and Stevenson, 2016; D’Ambrosio, Tozzi , and Gesualdo, 2016; Salathé et al., 2012; Young, 2015) as the conceptual and technical support for observing the inscriptions of 'life' in data management models. This new type of ‘laboratory’ highlights the requirement to observe the negotiation spaces, where nowadays are being articulated different types of actors, with a diversity of types of expertise on crisis management. In this sense I have approached the analysis- theoretical and methodology- from the studies of science and technology (more precisely from the actor-network theory) by observing the articulation of epidemiology as a 'global' technology, which proposes acting as a 'super-tool' to propose new scales for surveillance of ‘life’ as an management device.

Which are the metaphors to define ourselves and the ‘bios’, when (we) are being designed, due to the decision on how it will be done the learning of data storage of the practices, the protocols experimentation (with data, ‘experiences’ and emotions)? Which visions of the world will appear in the proposed designs? Within this framework, it is questionable how and why new assemblies of agents appear, which makes me focus on how to observe the enrolment of the new meanings to be able to bring distinct observations on the elements of expertise, actors or ‘smart’ objects.

In the thesis, can be remarked a special interest on these new articulations in global health and epidemiological knowledge management discourses: to identify the networks of meanings between actors and technological resources and the (possible) trends in

knowledge management in others biological threats events (e.g. environmental). I highlight the relevance to observe this –especially from social sciences- since the 'global' models that are being implemented in health care produce a distant approach *on, to* and *from* the communities. Especially, the 'formal'[9] models which exclude the collaborative debates and the participation in the design process; but instead in which one are being sketched as a "*generic disease scenarios using data from past epidemics and public health emergencies were developed for use in prioritization exercises and a draft decision tree for determining when a novel disease would trigger an interim prioritization assessment were outlined"* (World Health Organization, 2016, p.21).

For doing so, in the analysis proposed in this thesis, I advise the use of the concept of 'digital epidemiology' (Bakker, Martinez-Bakker, Helm, and Stevenson, 2016; D'Ambrosio, Tozzi, and Gesualdo, 2016; Gavris and Tirado, 2018; Salathé et al., 2012; Young, 2015) since in this new context the definition of 'global health' is (re)negotiating of its main categories provokes blurry delimitations of the relations between experts and lay epidemiologists. The technology *by itself* does not become and ontological predefinitions, but there are required collaborative spaces to (re)negotiate *by other means*, which are the conceptualizations and relations within new fields that define the boundaries of the expertise (Gavris, Seebach, Torrejon, and Tirado, 2016).

2.2. New ontological exercises on life: scenarios and digital epidemiology

As remarked in the literature, during the last decade can be observed an negotiation of the concept of 'biosecurity' (Castillo-Salgado, 2010; Hill-Cawthorne and Sorrell, 2016; Rose, 2001), seen as a space where 'life' is marked off, where it is strongly emphasized the implementation of digitalization in all its scales and procedures. This

[9] By 'formal' I refer here to the public entities or actors involved in the public health management.

perspective rooted in these values are ultimately proposing how to conceptualize life, based on management processes which are defined through quantitative data, coding matrices and databases. According to the specialized literature, we would be facing a mutation that leads to a new ontology of the living.

Although it may seem that technological models – as seen in the design of data (e.g. data mining) or of scenarios (*ref.* proposed response management paths in front of a possible crisis, projected in ambiguous future temporalities) - are antagonistic with the classic readings of the biopolitical approaches (Foucault, 2009; Giorgi and Rodríguez, 2007), I remark that within the digitalization framework, the technological tools propose complex views on new heterotopic spaces (Foucault, 1984; Toro, 2008).

Within this context, its relevant to highlight the articulation of reconfigurations of flows of knowlegde and appear hybridiezed connexions (Seguel and Gavris, 2015), but which point in the same ontological conceptual direction as in the aforementioned classical readings on the biopolitical design on *life itself*. Consequently, in this new field of epidemiology, are appearing (new) major challenges for analysis of their social impact, how is it offering new ways of reading (e.g. data-research) and how and why they mean to redefine biomedical approaches (Barker, 2010; Bauer and Olsén, 2009).

In response to this challenge, I observed a new line of analysis that some authors denominate *biopolitics 2.0* (Gabrys, 2014; Lacy, 2008), proposed as a new trend to address the complexity of the social context that focuses on health, which is defined in the lasct decades as 'global' surveillance measure required in front of the constant acceleration of globalization processes. Based on this, were defined new scales of analysis and management 'measures' of the future (Caduff, 2008), where it was activated the articulation of new procedures and actors; but which in turn, have led also

to the appearance of joints that were not expected when digitizing the classic analog biomedical contents.

The articulation of these new spaces allows me to ask if we are facing a new ontology referring to the biotic. One in which the technocratic models of design of action procedures, such as *scenario planning* (Amer, Daim, and Jetter, 2013; Kahn H. and Wiener A. J., 1967; Schwartz, 1991) or of knowledge reaticulation such as *digital epidemiology*; are being presented as efficient and measurable realities that allow the facilitation of visualization and expert positioning to make decisions at differentiated and global scales, by using digitalized and automated quantitative data routines (e.g. Big Data, artificial intelligence) that until now were not especially relevant in the definition of the aforementioned reality.

From the conceptual framework of Science and Technology Studies (STS), particularly those focused on the analysis of epidemiology (Bauer and Olsén, 2009; Tirado and Cañada, 2011; Tirado, Gómez, and Rocamora, 2015; Tirado, Baleriola, Giordani, and Torrejón, 2014), an interesting opportunity is offered to analyze this framework. I consider such analysis as a novel exercise that points towards spaces of reflection in which social sciences and biomedical sciences can encounter and combine efforts. Thus, here I focus on conceptual framework, highlighting the role of *technology* as a translation agent and mediator, that is an inherent part of the same process. Its articulation becomes the *modus operandi* that allows to understand the delimitation of digital epidemiology as a new "*intelligent ontology*" (Caduff, 2012; Ferreira, Paolotti, Couto, and Silva, 2013) in global health.

Following, I propose to analyzed three key aspects which highlight the negotiation of the demarcation of the aforementioned ontology: a) the conformation of the biotic as mere matrix of data; b) the appearance of the so-called health *heterotopies* where the biotic and the virtual are blended and redefined; and c) the appearance of hybrid subjects and

subjectivities. This point will be further on analysed in the Part 4, were I will present based on empirical findings the connections between the conceptual framweork of *scenarios* (as a heterótopic approach applied in global health) and the trazability based on the digital epidemiology tools, which allows us to approach them as new mediators that surprise the mutations of their *translation* of the social. Also, in the Part 5, I will conclude on how this ontological mutation, by proposing that this new approach, allows to activate certain alarms about the alteration that the meaning of *life,* acquires within the realities and intelligences proposed by these new knowledge and how thse practices configurate.

Digital humanities and ontology of epidemiological models: between science and entertainment

In recent decades, epidemiology has been the subject of intense social and cultural analysis. An area so technified and specialized that demarcated this discipline for many decades, but apart from its approach of practical application from a sociocultural point of view (Seguel and Gavris, 2015; Tirado and Cañada, 2011; Tirado, Gómez, and Rocamora, 2015). This trend has recently been broken and are appearing new studies which have shown that epidemiology is a powerful reality builder. One of the areas in which this shift has taken place is that of the *digital humanities*.

The last decade has seen the blooming of this discipline, which operates at the intersection created by new forms of interaction, the technological constitution of unknown actors up to now and the production of new content. Joseph Raben mentions for the first time this concept in what was already a projection of a long-term scenario on the social transformation that information and communication technologies (ICT) would produce, in the conformation of the *digital humanities*, which would allow to include "*all the phases of the social sciences that emphasize the human*" (Prospect, 1966. p. 1).

The novelty of the present analysis lies in approaching the technological event, granting it the status or value of *mediator*. That is, with capacity to articulate and operate with the action and production of the realities. Based on the present analysis, I suggest that we can extrapolate also the interest to the expansion of new biomedical disciplines. And this due to two reasons. In the first place, it allows to characterize *by other means* the procedure and objective of the same. Second, it introduces elements of ethical assessment and social justice in its activity. A privileged example of this framework which I focus is the case of epidemiology.

Here I emphasize that traditionally, the classical epidemiology has been operated with three major dimensions: a) the circulation of infectious vectors; b) the transmission capacity of new or emerging vectors (e.g. virus), and c) the evaluation post-event of the feasibility and effectiveness of prevention and intervention strategies against pandemic or epidemiological crises (Boëlle, Ansart, Cori, and Valleron, 2011; Khan *et al*., 2009). I propose that based on the implementation of the digitalization processes, has appeared a mutation at a conceptual level in relation to the new forms of techno-scientific articulation due to the features of the technical background. This allows us to mention a fourth feature, which refers to the traceability of outbreaks on real-time and which allows the availability of the data in different geographic locations simultaneously (Gavris, 2015). From these dimensions, I emphasize that although epidemiology is a discipline that is applied *with* and *on* people, that attends to groups and prevents social panic phenomena, but its approach is purely technical and medical.

Under this precept, I propose to consider that the digital transformation has reached to it; what allows us to dare to characterize it as a discipline of the digital humanities, as it transforms its horizons of analysis because:

a) epidemics are not exclusively a biological and medical problematic; rather, they pose a phenomena that exhibit multiple dimensions, such as an actor constituted socio-

technically that shows different magnitudes linked and completely intermingled into a single overview which has meaning on its own (Tirado and Cañada, 2011).

b) such totality is not innocuous or indifferent to its upcoming of our daily life, but it profoundly transforms it by redefining the limits, where are erased the demarcations between the human and the animal, and what qualifies them as something political or natural; because the differences are being mixed between the local and global scales, and the boundaries between the *healthy* and the *pathological* are broken (Tirado *et al*., 2015).

c) the aforementioned breaks are not the prelude to a permanent state of practical and symbolic indefinition. On the contrary: they constitute the threshold for a later reconstruction of the aforementioned limits with other significances and meanings, which will reconstitute our ways of living and thinking about the quotidian context (Tirado, Baleriola, Giordani, and Torrejón, 2014).

d) thinking about the new epidemiology as a part of digital humanities, also opens the way to reconceptualize its behavior as a peculiar space, which Michel Foucault denominated *heterotopia* (Gavris andTirado, 2018).

Heterotopies as designs (future) for the bios

According to Michel Foucault (1994), the notion of *heterotopia* refers to *thematizing* an epoch, in which *space* takes over from *time* the definition of the main processes that characterize our reality (Foucault, 1999). In the case of the present analysis, it allows us to create a framework to conceptualize the transformations inferred by the practices and discourses of the digital epidemiology. This is due to the capacity that the 'digital' to give voice to "*other spaces*" (Gavris, Seebach, Torrejon, and Tirado, 2016) to a space within a space, which is precisely the definition of heterotopia. Therefore, its application to the field of health allows us to show how the "*analysis of other spaces constitutes a*

reflection from exclusion spaces where specific practices are carried out that seek to shape the modern subject as a result of power"[10] (Toro, 2008, p. 7-8). However, I emphasize that Foucault, refers to the *heterotopy* (1999) also as a line of flight, as a space that contradicts those conditions of power and that allows us to critically analyze history, creating aesthetic spaces of resistance and alternatives insights (e.g. popular festivals, circus, etc.).

Within this framework, I propose two complementary types of technologies to observe how emerging heterotopies are being articulated, where the new designs of future on *bios* appear in the new epidemiology. On the one hand, we have the *scenario-planning* (or scenarios) as a political strategy tool; that are proposed as design spaces where concepts, possible actors and strategies are articulated and conceptually projected within a future contextualization. On the other hand, the permanent epidemiological digitalization as a hybrid technological framework, which crosses the boundaries of the *virtual* and the *real* by becoming a radial articulations (by activation points) in the management of knowledge, that assigns proximate concepts and strategies to the citizenship.

Digital transposition of global public health scenarios

The concept of *scenario-planning* already has a complex history of several decades, in which there is a wide variety of definitions and applications (Amer *et al.*, 2013). One of the pioneers (Kahn and Wiener, 1967) defines the scenarios as an *"attempts to describe in some detail a hypothetical sequence of events that could lead plausibly to the situation envisaged*" (p. 262). In addition, considering the scenarios as tools to define a multiplicity of possible alternative futures, it is argued that they are "*carefully*

[10] Author's translation

constructed stories about the future intended to help people make better decisions in the face of uncertainty" (Lempert, 2007, p. 101).

Be that as it may, a scenario is much more than a mere fiction. As point out by Van Doorn and Van Vught (1983), the scenarios are proposals whose articulation it's so complex and involves so many variations that their implementation cannot occur outside of technological support. The articulation between the story and the technology, provides meaning and trade to the first, which will not develop without the appearance and mediation of the second one.

This blend acquires a special relevance in the life sciences, where the scenarios have replaced the classical trees of calculation of risk and the measurement of probabilities in the production of knowledge; and have become the epistemic matrix of practices and discourses. There are two main approaches in the design and implementation of scenarios in these disciplines: a) focused on the analysis from data populations (e.g. Big Data, data mining) and b) focused on the affectation of the *individual,* where the individual itself becomes a first-hand data generator (e.g. Quantified Self).

Epidemiological digitalization

Digitalization in epidemiology has been a constant and persevering process in recent decades. Its procedures and knowledge techniques started to articulate from the tools offered by the information and communication technologies: from devices for traditional photographs to complex applications of computer (e.g. databases, 3D printers, etc.); where the collection of data appears on real-time, accentuated by the deployment of *apps* on portable devices available to experts and non-experts (e.g. 'smart' mobiles).

For some authors (Gavris, Seebach, Torrejon, and Tirado, 2016; Rudnicki, 2017) this implies the emergence of a new articulation of knowledge and medical-epidemiological practices at different scales, using processes of involvement and participation of citizens. This approach was denominated *digital epidemiology* (D'Ambrosio, Tozzi, and Gesualdo, 2016; Salathé et al., 2012), stating that surveillance becomes a synthesis of temporalities that allow drawing lines to allow a conceptual dynamic articulation. Within this framework, the knowledge that is articulated became part of the management of biomedical emergencies, where an attempt is made to resolve gaps of traditional surveillance models (e.g. discrepancies of time periods between the detection of an emergency and its action).

It is relevant to remark here the difference between the concept of *digital epidemiology* and other similar ones as *telemedicine* or *e-epidemiology*. *Telemedicine* is displayed on a similar linear logic as the classical epidemiology for the content dissemination (from point A to B); is one of the first models of digitalization of biomedical and epidemiological contents, but it does not allow interaction between users, nor does it allow the modification of the contents. On the other hand, *e-epidemiology* (for some authors *epidemiology 2.0*) focuses more on the technical and technological basis, than on the impact and use that the end user gives to the content (Brownstein, Freifeld, and Madoff, 2009); it works as a technical transcript of the categories used later on for the semantic coding (Ekman and Litton, 2007).

On the contrary, *digital epidemiology* (Salathé *et al.*, 2012; Vayena, Salathè, Lawrence, and Brownstein, 2015) provides a holistic view that has an impact even in the conceptualization of risk practices in the field of global health (beyond the mere technical devices). Within this approach, the connections are activated through the subjects (that are getting connect) as *plug-in* or technological complements (Latour, 1990, 2005), allowing the visualization and the accelerated movement of the information

"*to identify spatiotemporal patterns, where knowledge about the drivers of disease dynamics is most urgently needed"* (Bakker, Martinez-Bakker, Helm, and Stevenson, 2016, p. 6693).

However, the typical characterizations of the digital epidemiology ignore that all the technical apparatus of the same operates thanks to the intensive use of scenarios. Therefore, both concepts cannot be separated, because they are the sources of heterotopies that we mentioned previously that both are responsible for the design of a future that affects the present, redefining in its articulations the concept of *life* itself (Gavris and Tirado, 2018).

The design of the future approaching

The new approaches of digital disease detection tools are raising the need to rethink surveillance from a space denominated *global public health*. The digital epidemiology contributes actively to this objective and does so by offering 'meeting' spaces (theoretical and empirical), in which the application in technological formats of the reference scenarios (e.g. projection over a decade of citizenship and public health models), by proposing a relatively new field of research which appears in the last decade within an interdisciplinary conceptual delineation. In addition, the digital epidemiology questions how the *filters* (*ref.* computer technical for semantic pre-defined categories) are created and used in the design of the contents of global health policies. Furthermore, as highlighted in the literature, this opens up the "*give access to new sources of data and allow to extract meaning from unstructured and complex information*" (D'Ambrosio, Tozzi and Gesualdo, 2016, p. 37).

The main novelty lies in the transversal articulation of the interconnected elements, which affect multiple levels of the assessment and intervention process in case of

emergency (Gavris, Seebach, Torrejon, and Tirado, 2016; Gavris and Tirado, 2018). I refer, for example, to the conceptual and performative mutation that the new technological platforms pose (e.g. HealthMap, BioCaster, EpiSPIDER, Twitter, Wikipedia, etc.), which allows the interaction between biomedical or social or political elements. That shift, from being articulated based on (from a classical linear logic of data management to a logic of radial) a dynamic communication, where they are (re) constructed by points of temporary and random activation (Burt, 1992).

This new approach emphasizes the radial articulation of the new *mediators*, where we identify new agencies that allow to appear spaces of translation and mediation. For example, the *data managers* (*ref.* technical managers responsible for web content design) gain importance in the digital field, by promoting alternative ways of proposing new spaces, which allow new voices to emerge. Also, when the articulation of new skills reconfigure the context.

The digital epidemiology approaches the *scenarios* used by technicians and specialists to create valid epistemic knowledge for citizens. It does so, through the enormous technological apparatus based on apps, computer programs, games, etc. Further on, the ultimate goal of integrating this into a monitoring process that would be constant and perpetual. The option of registering data on diseases, symptoms or signals in a mobile application, which are immediately reflected on an interactive map (e.g. Healthmap, Google Flu), is a reality that reconfigures our conception of epidemiological surveillance (Gavris and Tirado, 2018). Within this framework, we become a constant observation of ourselves, its environment and of how the data registry allows a full traceability of data *a posteriori*.

2.3. Theoretically-informed research

The theoretical framework developed until now is intended to provide a particular entry point into the analysis of the global extension of the digital epidemiology, beyond the

mere review of the (governance) technologies implemented in the management of infectious diseases.

Based on the assumption that collaborative technologies provide a relevant critical perspective and influence the global regulations, which provide negotiation spaces on the boundaries of the present context. The analysis I propose offers an approach to conceptualize these approaches within a social, ethical and political agenda. As outlined before, the aims of this present analysis focus on: a) explore alignment and divergent discourses on the ‘digital’ epidemiology within governance technologies approached recently in biosecurity; b) observe the collaborative technologies within the framework of the risk technologies, by providing a framework on how this enable (new) emergent approaches in global management of biomedical emergencies.

The implication of the biopolitical framework in observing and understanding of the (new insights in) global configuration of governance, provided through the implementation of the digital technologies in risk management. In this sense understanding the approaches on the regulation of *bios* approaches provides a potential overview on the global inequalities in health. In the next part, I describe the methodological approach I undertook to observe the research objective proposed.

The research, based on qualitative methodology, seeks to understand the conceptual negotiations of global health and is proposing the surprise the complexity of these context by designing a triangulation of three types of sources. Based on the main objectives of the research where identified three observation ‘positions’: a) *preview* based on the how the 'image-action' is proposed as an image of the world (observing scenario proposals from areas related to the subject, to observe the routes of the logical framework behind them); b) observe the 'image-action' of which type of technical and technological resources are proposed (analysis of digital materials and virtual ethnography) and c) observe informants positioning (in-depth interviews and focus

groups, in the search of types of actors and their narratives). Therefore, the field work is carried out within the framework of the deployment of the attempt to conceptualize the epidemiological traces in the technoscience, which was developed between 2013 and 2018.

As a special remark, I mention the following characteristics as relevant in understanding the design and approach of the analysis of the research:

a. Methodological design is focused on the multiple nature of the complex object of study, being versatile in terms of the phases of development and approach to the object of study; without being conceived as linear phases, but intertwined to the drifts during the research process

b. with the pretence of an in-depth analysis of the object of study, different nuances were traced to surprise its complexity, as a set of a space-time research object that entails the search for the singularities between the qualitative leaps of local-global scales, to define the design approach; and the collection and analysis of data.

c. Gender and sensitive population

III. METHODOLOGY AND RESEARCH PROCEDURES

In the previous parts, I observed the relevant concepts and the main outlines the theoretical framework to provide a background to understand the digital technologies as part of the ontological negotiation of the boundaries of global health and the definition of the 'new' epidemiology. This framework intended to offer a specific emphasis on biopolitics at global level, which is analysed here is based on a triangulation of data sources, based on using as a tool the concept of 'digital epidemiology'. For doing so, this part of the thesis outlines the description of the sampling strategy and data collection; and the critical discourse analysis. In the last part, I make a quick review on the reason to opt for this analytic strategy and the main choices made during the research period.

The origin of the present study, derives from the research developed during the master's degree on the mutations that were approached from the use of internet during the 'pandemic' event of swine flu in 2009[11]. The interest in the phenomenon arose from observing the gaps and the problematics posed by the digitalization extension in the public arena transcending the field of health.

During the first year, the first idea was to approach 'ethical hacker' movements (Farsole, Kashikar, and Zunzunwala, 2010), which I approached as a category to define innovative generators of technological changes, which are involved in many social movements, but are rarely cited when talking about 'global' expansion of 'health'. As observed in several cases (see several case mentioned on Annex E), part of these

11 The research 'Technoscience in a pandemic context', was developed within the framework of the Master in 'Research and Psychosocial Intervention' (Autonomous University of Barcelona, Spain), between 2012-2013, focused on the 2009 pandemic swine flu event and the psychosocial mutations arising from the use of TICs.

practices have marked traces for subsequent trends or 'scenario' in the use of information management techniques in global health.

After the review of the research aim (from 2nd year on) I decided to amplify the observation area and the fieldwork; even thou I kept the idea to check the approaches that are determined as 'problematic' in order to observe 'new voices', which propose (new) uses of technology from *bottom-up* (non-formal) as relevant for the critical debate as they propose and provoke trends (in some cases) which appear later on in formal[12] practices (e.g. see quantified self, biohacking). In defining this distinction, I developed the four main objectives, highlighting nuances between the formal (normative and administrative actors) and the non-formal (heterogeneous, hybrid, radial connections, multiple expertise).

- Describe and analyse the main actors (human and non-human) involved in the definition of (alternative) discourses on biological threats and pandemic events.
- Describe and analyse the technological and scientific material resources that are mentioned in the conformation of the uses that are given the mentioned technologies
- Describe and analyse the main frames of significance that are being establish within discourses on biological threats and pandemic events.
- Identify the new alternative narratives about biological threats and pandemic events depicted from digital epidemiology or collaborative technologies movements (e.g. medical hacking)

As it is easy to notice, it was difficult to approach a phenomenon that is transversal to several disciplinary areas, which made me decide to select from the wide range of approaches, the concept of 'digital epidemiology' (as campfire place; to observe the

12 By 'formal' (actor, practices, etc.) I refer here to public and official actors easily identifiable, based on the public functions they develop and represent (e.g. WHO, doctors, etc.).

deployment of slices of technological use and biomedical knowledge) based on approaching the fieldwork from conceptual visions projected from the last three decades in the epidemiologic scenarios (as lighthouse; to observe the main lines and concepts of interest). Based on this I observed how all this complexities appear into our daily practice as possible techniques or instructions for use.

The aim of this analysis has not been at any time to analyse and responds to all the social challenges and legal and ethical dilemmas, posed by the use of the digital in the transformation of the biotic, but to observe its unique characteristics of the phenomenon to get closer to the idiosyncrasy of the problem studied. Therefore, instead of proposing a generalization based on the transposition of the object out of context, I used a multimodal analysis is proposed and surprise different nuances of the same.

3.1. Introduction to the object of study

The research is proposed as part of a research on epidemics and biopolitics, that was developed (2013-2018) within the framework of the research group *Science and Technology Studies Barcelona* (STS-b)[13], where it was developed an analysis on the current epidemiological models and new trends in the knowledge management in 'global health' framework, to clarify issues related to biosecurity and the management of biomedical emergencies. Respectively it is linked to the '*Health and Technoscience research project. Citizen Participation in the processes of social appropriation of knowledge and technological design'*[14].

I want to emphasize that the research design derives from my personal and professional path-during the latest two decades- and interest in new information and

[13] https://barcelonasts.wordpress.com

[14] Project financed by the Ministry of Economy and Competitiveness of the General State Administration (CSO2014-59136-P)

communication technology[15]; psycho-pedagogy[16]; knowledge network design and development of knowledge community networks[17]; and research and psychosocial intervention[18]. Based on this, I have developed two axes to proceed my *modus operandi* in the sampling strategy, data collection and analytic strategy: a) from those who 'design' knowledge for future communities and b) from the sensitive groups, as this 'strategic' use of knowledge has impact on their realities beyond the mere technical deployment of 'the digital' in 'preparedness' strategies.

3.2. Data selection criteria

Given the theoretical framework and methodological strategy, the following questions where framed during the research:

- *How digital tool proposed in infectious disease management have impact of the ways we construct the 'realities' about the health of the community and ourselves?*
- *Which are the discursive strategies (e.g. language, colours and movements) applied thought the techniques and technologies (e.g. gamification) used in the construction of these 'realities'?*
- *What do this strategic management of knowledge on 'bios' suggest us on how we should approach social and political (future) contexts?*

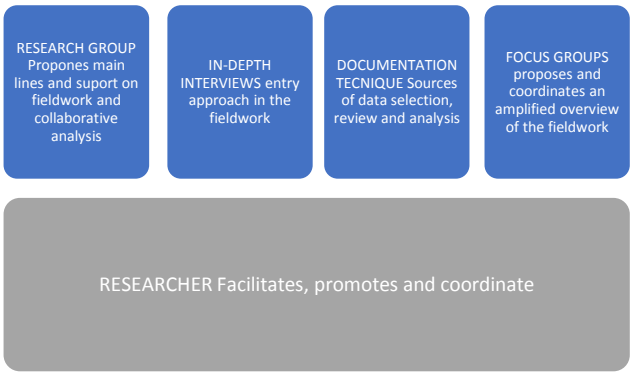
[15] Postgraduate in Management and Consultancy in Information and Communication Technologies (Open University of Catalonia, Spain)
[16] Degree in Psychology and Educational Sciences, specialization in Pedagogy (Babes Bolyai University, Romania)
[17] Specialization of Designer of Social Knowledge Networks (FeRS, CITILAB Cornellà-Barcelona, Spain)
[18] Master in Research and Psychosocial Intervention (Autonomous University of Barcelona, Spain)

During the progress of the research, was developed a table of selection criteria (see annexes A-C) and its respective classification according to relevance were refined and belonged to the analysis. Based on the main objective, were:

- identified several criteria's and subcriterias on: a. actors involved; b. technologies proposed or deployed and c. *signifiers* (or networks of articulation of meanings)
- reviewed theoretical and case studies on similar experiences in the field at global level; trying to identify different nuances between types of research and application.
- reviewed 'analogue' and 'digital' materials based on the following language search criteria (based on personal path): English, Spanish, Romanian, Catalan, French and Italian.

3.3. Data collection techniques

For this purpose, I developed an analysis diagram has been developed to be able to triangulate information from sources of different formats, to observe trends in the last two decades on: a) types of subjects that are mentioned; b) referring techniques and technologies and c) the intertwining networks of meanings; with special focus on the mutations that they pose; to observe how the main mechanisms of the new ontology in health are articulated, where the relationships between global health policies are reconfigured.



The role of the researcher is highlighted as a guide for the decisions made, the sampling cuts and the way of design and development of the field work.

3.3.1. In-depth interviews

In the first phase of the research, the interview technique had a double purpose as it was also entry in the field, to observe how the impact of ICTs on epidemiology is raised by experts in different fields, on the 2009 swine flu 'pandemic' event. The participants in the interviews were selected as: "*people who are the only ones who can be informants because they are experts in an area or were privileged witnesses of an event*" (Weiss, 1994, p.17).

During 2013 – 2014 were developed three in-depth interviews (n = 3) in Spain:

- more than 30 years old, with professional experience in healthcare areas (or related) and using collaborative technologies
- sampling of participants: 'snowball' technique
- heterogeneous profiles: a. 1 epidemiologist, involved in expert and lay people networks during the 2009 event; b. 1 PhD veterinarian, familiar with the use of collaborative technologies, active in projects during the various epidemiological outbreaks (e.g. bird flu, bovine spongiform encephalopathy, etc.) and c. 1 manager of medical (bio) data on digital platforms

The semi-structured interviews was developed individually. It was conducted during approximately one hour according to a script[19]. Afterwards, was given the opportunity to review the transcribed version with the option to highlight or modify details. The interviews were conducted face-to-face (Barcelona area) and online (via Skype), in Spanish and English. It is noted that each of the informants was informed of the objectives of the interview and the framework of the approach; respectively on the treatment and confidentiality of the persons interviewed.

[19] See Annex D

3.3.2. Focus groups

Within the framework of the research group, were developed three phases with the other eight researchers involved during this period in the POBICS[20] project: design, development and analysis. Important to note that each had a different role in each session: interviewer (guiding the group's discussion) or observer (pointing reactions and comments).

In the first phase, the script[21] was developed on possible topics (derived from theoretical and empirical work personally developed by each one of the members of the group) and proposed as multimodal analysis[22].

During 2015– 2016 were developed 10 focus groups (n = 50) in Spain,

- Phase I: sampling of materials: selective collection of contents in relation to the objectives of the research, where routines and possible disruptions, problematics and plots of meanings that appear in practice were observed and analysed. For example, types and relationships between actors that appear (or on the contrary disappear), the techniques or technology that are used and construction of meanings about the embodiment of conceptual approaches (for example, One Health).
- Phase II: 15 heterogeneous focus groups (n = 50; sampling on 'snowball' technique) were developed in several Spanish cities (Barcelona, Bilbao, Almeria), with experts in data management, social researchers, veterinarians,

[20] www.pobics.com
21 See annexes
[22] Provided a collection of visual, embodied, and spatial environments, provoking critical thinking on their meaning and the relationships between these (e.g. audio, video, images, infographics, etc.).

university students and professors, journalists, feminist activist groups, etc. It is noted that each of the informants was informed of the objectives of the investigation; respectively on the treatment and confidentiality of the persons interviewed.

  - Each session lasted 1-2 hours and attended 3-6 people to allow and facilitate discussion. The session started with a reflection on what each of the participants understood by "*epidemiology*", which it was followed by montage of a trailer cut from a Hollywood movie of an imminent contagion and several recent photographs and infographics depicting 'epidemic events' available on Internet. A posteriori, after each one debated on their reflections, emotions and associated experiences. After this, without any instruction were placed on the table several ambiguous words (e.g. "data"). The debate finalized with the possibility to comments the main point of their conclusions or reflections.

- Phase III: Third phase, joint analysis was done in the group of each of the audios from the focus groups

3.3.3. Documentation technique

During 2013-2017, a selective collection of documentation was developed, in order to observe and approach the articulation of the formal and non-formal discourses in relation to the research objectives. It has been carried out a review and organization of documentary sources (both individual and as part of the research group), which allowed me to familiarize myself, to the types of networks of meaning (*signifiers*) and to facilitate the decision making on the data selection. Respectively, the following documentary sources have been identified, reviewed and analysed (see annex E):

- Scenarios and reports from various institutions (e.g. CDC, ECDC, WHO)

- Normative frameworks, with a specific focus on those that mention mutations in epidemiology in relation to collaborative technology and 'the digital' (e.g. WHO)
- Varied materials with digital support (e.g. news, blogs, articles, photography, infographics, etc.)
- Contents of virtual platforms (e.g. HealthMap, Wikipedia, etc.) designed and/or used by experts and lay epidemiologists (non-experts) in topics related to technologies and epidemiology

3.3.4. Researcher's role

The roles assumed during the fieldwork were as *interviewer* in personal interviews and focus groups, but also on the position of *participant observer* during its design, development and joint analysis within the framework of the research group.

It is mentioned that previously and during the period of development of the research (2013-) the researcher has worked also in management of training proposals in diagnostic area. This allowed me to approach more in depth the area of epidemiology, the specific idiosyncrasy and specific meanings (in Spanish and English). Also the first years, I made several online courses on basic notions of epidemiology and digital epidemiology; which allowed me to identify how actors, technologies and perspectives were approached.

During the fieldwork, I introduced myself as a ‘PhD student’, explaining as a research objective the intention to observe the impact of ICT’s on global health and epidemiology. In the case of the interviews (for being in the exploratory phase and even more related to the 2009 event) the questions were centred on this phenomenon as a case study. In the case of the focus groups, as part of a more general approach of the research group, the questions (using multimodal contents: video, photos, labels of abstract concepts)

were raised on the trends of uses of (bio) medical data and actors and technologies that intertwine.

Finally, understanding basic notions of the analysis context, I positioned myself in different roles during the research development period in the definition and progressive negotiation.

3.4. **Critical discourse analysis**

I opted for using the **critical discourse analysis** to observe the different types of data sources, in order to investigate the articulations of significance around the digital epidemiology as part of the technological present approach in global health. It was opted to use this type of technique for the analysis in order to clarify the description and analysis's of the collaborative technologies within the framework of the technological articulation of agents, techniques and nuances provides by the subjectifiers involved.

Within this framework I propose to see 'digital epidemiology' as an object, defined by the system of the discourses which articulate around it. For doing so, during the different stages of data collection it was developed a saturated[23] 'analysis' based on different sources of data (text, interviews, focus groups, images, etc.) in order to have a more complete overview on:

- the types of subjects which are enrolled in the mediation technological process in new articulation of the framework of the 'new' epidemiology
- the socio-political context where the (new) deployment of agents are taking place

23 Based on different types of sources, in order to surprise and involve nuances which define the object in its complexity of articulations.

- the type of expressions of the governance dispositive deployed as strategic to transmit and coordinate different positioning
- the coherent system of significance (*signifiers*) which related the facts and events, which give meaning the textual expression
- the political nuances of the rhetoric's behind the scenes of the impact of the technology on our daily practices in health.

The analysis is proposed as opening the 'laboratory', to explore the routes of the knowledge management in digital epidemiology and by exploring the role of collaborative technologies in the definition of alternative narratives about biological threats and pandemic events. As Barry mentions "*the challenge of designs and technical practices*" is the ability to "*open new objects and places of politics*" (Barry, 2013, p. 9) by taking the laboratories 'out on the street' to generate data and information that enrich the interpretations and facilitate the transfer of knowledge, participation and involvement in the production of knowledge.

I mention here a couple of details refereeing to the limits of the present analysis:

- by 'lay epidemiologist' I focus on the approach of new spaces, not whether the types of information are scientifically correct (*ref.* biomedical knowledge)
- in the intention to observe 'by other means' the agents and technologies involved in defining the boundaries of the field of global health, I assume that this provide creative and committed (new) voices and experience from the field

Also, I remark several aspects that that I did focused on during the developments of different phase:

- gender sensitivity: on the ways the subjects are being approached. Also, if are being able to participate within the same level of empowerment within creation of

processes of policies or design of technological approaches on *bios* (e.g. zika and young women)

- technological 'vulnerable' communities: the subject excluded or which have partial information or are directly affect them directly or indirectly (e.g. 'outdated' technological skills of elders or low income communities which affects their access to health services)

The concrete process of analysis had several phases (see annexes A-E):

Phase I organizing data:

- ordering the type of different types of data in 3 main area: identified three observation ‘positions’: a) preview pre-'image-action' (e.g. scenario proposals); b) tech savvy 'image-action' (e.g. documentation technique on ‘digital’ normative shifts, social platforms, (open source or formal) interactive maps for epidemic localization, etc.) and c) informants (e.g. in-depth interviews and focus groups).
- transcription of the materials (interview and focus groups)
- repeated reading of the different sets of materials

Phase II preliminary analysis to identify main topics and discourses related:

- identifying main topics (further on denominated as ‘axis’)
- observing and analysis the intertextuality of the discourse analysis between different sources of data
- identifying main topics (codes) to analyse and select the fragment of the texts
- description of the main topics (axis/categories/subcategories)
- description of the relation between codes and the research objectives

Phase III preliminary analysis on main elements:

- observing recurrent or diversifying connotations on the topics

- identify the types of technologies or agents referred to in the statements, permitting to analyse the role and significances of the elements in the production if knowledge
- identify the types of effect on the main discourses towards each of the actors involved (e.g. decisions on types of health procedure during flu or SARS event period, Zika '*responsabilized*' or free sexual decision, etc.)

Based on this preliminary analysis I developed 5 axes of discursive analysis, which permit to observe and approach the analysis on the digital epidemiology within the framework of the global management of biomedical emergencies: mapping (new) voices; algorithms in biopolitics and vulnerabilities in global health.

Further on in the part 4, I present based on the 5 axes as tools to define a main overview on the result and data analysis.

IV. RESULTS AND DATA ANALYSIS

"Light produces colours: the colours do not turn on the light"
(Ruben Dario, *Azul*)

Related to the topics previously introduced in the previous sections of the thesis, I present in this part the results of the analysis of a concrete case of deployment of the technologic model of 'digital epidemiology' in global public health, based on the analysis developed from Spain between the years 2013 and 2018.

As writing strategy of the present analysis (to facilitate reading), I present below the categories and subcategories linked to the objectives of the research. The analysis is based on 5 axes that allow to understand the problematics of digital epidemiology in the context of management of biopolitical models in biosafety and risk management in global biomedical emergencies:

- The first axis 'Mapping (new) voices' refers to actants (humans and non-humans) as determinant for the socio-materials articulation of the present context or 'future' one's (as proposed in models as scenario).

- The second axis 'Invisible algorithms, invisible politics', proposes to question if the technologies are genuinely *tech savvy* (mere technological enthusiasm) or they respond to predefined biopolitical strategies.

- The third axis 'Mobilizing vulnerabilities in global health' refers to identifying the formal and non-formal signifiers which approach the negotiation of the spaces and nuances on global health, by identifying and involving in collaborative approaches distinct local communities.

- The fourth axis 'The design of living' refers to the (deep) changes of the conditions of possibility proposed from the new biomedical framework and the global knowledge management (e.g. communities as heterotopies within a virtualized reality; bios as mere data management).

- The fifth axis 'The new epidemiological intelligence' refers to observing the features of the new *modus operandi* of expertise on epidemiology and how the subjectifiers modify and introduce to conditions of possibility in the negation of biomedical spaces.

In the last two, are addressed the ontological mutations in the design of life and the articulation of the technocientific models.

In the following pages, I present a review through the different components that articulate the understanding of digital epidemiology as a complex concept and concrete transposition of the political governance models in health and life management.

4.1. 'Mapping (new) voices'

The results that constitute this first axis, emphasis on identifying the actants that shape the overview used to define the observation point on the impact of technology in global public health; considering it as relevant semiotic-materials articulation where takes place the (re)negotiation of the area of epidemiological knowledge. It refers to actants

(humans and non-humans) as determinant for the socio-materials articulation of the present context or ‘future’ one’s (as proposed in models as scenario).
The axis is focus on 3 categories as it follows:

1. the networks of meaning linked to the concept of ‘health’ and ‘epidemiology’, the definitions and counter positions mentioned by the interviewee or that arise in the observed materials, to define them as *subjectifiers* of parts of the network(s)
2. political-legal framework in which agents propose their positioning and specific conditions under the technological framework of health management
3. dynamic organization of knowledge - between 'technology' and 'health' -of different scales of actors involved on digital epidemiology, which interconnected several areas of expertise and scientific knowledge

Projecting scenarios as mapping strategies

I will start this part with a short analysis based on two fragments from a scenario to observe how the actors (present or possible future ones) are being surprised in the mentions. Within this framework, I include the so-called ‘missing geographies of health care’ (Connell and Walton-Roberts, 2016) in order to surprise also the boundaries of the definition of risk-worker (e.g. doctors, nurses, psychologist, social workers, veterinarians, educators, IT, ICT etc.) within the amplified biopolitical ‘panopticon’, where appear global approaches on how to ‘molecularizing’ and uniform elements involved (e.g. One Health).

I propose to observe here two examples on how the ‘future’ was proposed and designed in 2002. I used precisely this example since we might recognize their application in the nowadays quotidian life. First defines the context in which the elements and actors (will) articulate, based on a proposed network of meanings:

The World of 2022 is a global knowledge village of 8 billion people. The global economy brings advantages for some; faster economic growth for multinational enterprises, sharing of knowledge and open communications on a global scale, cultural exchange and contact [...] There is a harsh divide between the health of the rich, who expect to live healthy lives until their 80s and the poorest, who have a life expectancy of little more than half this.

Failure to take early action on the misuse of antibiotics resulted in pandemics of infectious diseases in the teeming mega-cities of poor countries, for which "affordable" counter measures had become ineffective [...] International agreements have finally given more than lip service to health as a basic human right. The World Health Organisation has considerably greater funding and power to intervene to protect health rights. Trade agreements under the auspices of the World Trade Organisation now include measures to counter the disadvantage suffered by poor countries as a result of globalisation[24] (Lister G., 2002, p. 2)

The second fragment extracted from the same pack of scenarios proposes the 'patient' within a technological framework of expertise and formal well defined network of meanings, where the possible *subjectifiers* of the actors are not considered:

Patients are no longer passive recipients of care; they are informed and demanding consumers. They demand better information about their condition, the treatment options and the performance of clinical teams. They are also well organised. The Netherlands led the way with one in five citizens participating in patient consumer groups by 2000 and a well-

[24] scenario 1 denominated 'The World of 2022'

developed structure to support patient rights at local and national levels[25]
(Lister G., 2002, p.4)

As a main overview, on how scenarios are projected as mapping strategies, I propose the following fragment of one of the interviews to refer to how the socio-material configurations are proposing distinct ways to think about ourselves and the health in the future:

I do not know if this type of practice will have an impact on the forms of participation at the public level, but I think that all this is a baby that is just beginning to walk [...] Just as I participate anonymously writing and participating…there might have been people from different countries or international organizations…who were listening to what was said there…officials [...] It is possible that it was used as an echography device to know what is happening in a pregnancy…which would allow plans to be made nationally or internationally, with an enriched point of view. On the other hand I think this has been a very brief and very initial experiment. It may be that over time the forms of citizen participation will increase to levels that we cannot even imagine[26]

personal interview, dr. epidemiologist active participant in alternative networks, 2013

Positioning's on defining 'epidemiology'

[25] scenario 4 denominated 'The Patient of 2022'
[26] Author's translation

I remark here 2 fragments as types of statements I identified during the research about how it's being approach the concept of 'epidemiology' in relation with the 'global health' framework (e.g. One Health, IHR, etc.).

As highlighted in the next example, the state of interest on biomedical knowledge has mutated during the last decade, which involved a different articulation of actors and types of expertise:

> *I just think that the way to see the impact…is that people are more interested in what is really happening at the epidemiological level. This was not mentioned before! Then there may be a social pressure, with respect to certain communities. This social pressure will cause local governments to act in one way or another by favoring or disfavoring some policies. For example, research policies…or social policies for certain areas.*[27]
>
> personal interview, PhD Veterinary Dr./academic, 2013

But also, that the rapid implementation of technologies created gaps on defining the usefulness and practices which define the framework of 'truthfulness' for legitimization of distinct actors while they articulate in networks of meanings:

> *"The state" could transcribe the technical information into information that may be accessible by the user. Currently the information can arrive so quickly that there is no such transcription…and the end user can misinterpret the information that arrives*[28]
>
> personal interview, PhD Veterinary Dr./ academic, 2013

[27] Author's translation
[28] Author's translation

Main agents drawing boundaries in biomedical knowledge management

I present 2 fragments from an interview which remarks several types of statements on identifying main actors, which are mentioned that are involved in the definition of (alternative) discourses on biological threats and pandemic events.

The first one connecting the zoonotic (veterinary epidemiology) to human agents who articulate around the types of information and agents related that define themselves and their fields of expertise:

> [ref. 2009 swine flu] *At the beginning of 2000, I was working at the University of S. S. in Bolivia... as a veterinarian. The information that we received…was through the official bulletins of the State…and all the information that arrived through these organisms was filtered by the university for the general public. But unlike…in 2009... I was working as a veterinary clinician in Catalonia and the information I received was all the information that existed through the internet and through the media. Especially through the internet, open press… and if he wanted to find more…through these scientific search engines…such as through PubMed…which is a serious scientific search engine. In this case also the College of Veterinarians was informing us…sending the epidemiological reports*[29] *[30]*
>
> personal interview, PhD Veterinary Dr./academic, 2013

[29] A brief Info on the state of the situation (e.g. new cases, recommendations for path of action depending on the role)
[30] Author's translation

The second one, focus on how the articulation of knowledge and agents, is offering a different approach once the it is technology mediated, by expanding the boundaries of the dues and responsibilities of the actors involved:

> [ref. 2009 swine flu] *Checking the characteristics of the pandemic crisis…which was technologicalized online…it is important to talk about rights and duties…because new forms of may appear at the level of citizens. For the first time, so many actors have participated …. Agents…let's say "official"…the sanitary agents who were in charge of sanitary control. But nevertheless…other people have also participated…who either had some interactions knowledge…or maybe any knowledge…The latter ones…although they were not directly linked to any control bodies…but they did express their opinion* [31]
>
> personal interview, PhD Veterinary Dr./academic, 2013

Defining subjects and shifting subjectivities

In the lines below I present 4 fragments from interviews to highlight several types of statements, which I identified during the research on how are being defined the subjects and their subjectivities. Also, how it is mentioned that this are involved in negotiation statements about biological threats and pandemic events as depicted from digital epidemiology or similar technoscientific movements (e.g. medical hacking, *Quantified Self*, etc.).

The first one refers to the scales that legitimize the knowledge and the positioning of the 'formal' actors:

[31] Author's translation

An advantage of veterinarians…is that we have been trained…quite well in what is zoonosis…the transmission of diseases from animals to people…For that reason we have at least a basic knowledge of how things work. That gives more peace of mind [32]

personal interview, PhD Veterinary Dr./academic, 2013

The second one, focus on how the agents define themselves based on the articulation and uses they give to the data:

The main advantage of new technologies…in general…but here specifically in a case of crisis…could be the availability of information on real-time…because there is a constant flow of information [...] I think there is no longer control of information like it used to be from behalf of the sanitary units… in which the information was given gradually…currently with these networks…the information flows so fast…that there is no control or is very difficult to control by the health authorities[33]

personal interview, PhD Veterinary Dr./academic, 2013

The last ones focus on how are being approached and proposed different contexts, where the subjectivities are being fold and unfold based on distinct factors and interests involved:

It is difficult to assess…because each pandemic has its own characteristics…in this case…when we talk about respiratory diseases

[32] Author's translation
[33] Author's translation

or high transmissibility…we start from the premise that they have a high risk and that they are very particular… It's very different…if we speak of a spongiform encephalitis that its transmission is so slow…because it occurs through eating contaminated meat…But if it is already a pandemic…because it is present on 5 continents…the control policies are totally different. The information policies that are given to the citizens…will be totally different. For example…during mad cow disease in the early '90s…people did not even want to eat meat…Now who does not eat meat? Who even spoke about the mad cow in the last 2 years? The disease is still present! Is it being controlled? Are controls still being carried out on what is animal food? Yes, but the disease is still present. But is there anyone who is scared of the disease of mad cow disease? [34]

personal interview, PhD Veterinary Dr./academic, 2013

The methodological proposal I did…on how to confront a serious pandemic in the Macaronesia[35] Islands...was published under a Creative Commons license in 2011…which I made it after having studied the methodology proposed by Vinay Gupta…on the simple maps of critical infrastructures…the system is a very simple method to review the priority [...] I elaborated the document outlining the state of the world on the issue…as far as I know… I do not know if there are some secret plans in any government…or any world organization… but I reflected the elements of preparation that I know…I reflected there…everything that I had recompiled from listening to the people of fluwiki…and in the electronic communities. There is a part of what I wrote there…. Based on what I learned …thanks to participating in the electronic communities. That aspect is very interesting…because it is an example…that people

[34] Author's translation
[35] Fictional island where the collaborative plan is proposed

who are in official positions learned from citizens who are not in official positions[36]

personal interview, dr. epidemiologist active participant in alternative networks, 2013

4.2. 'Invisible algorithms, invisible politics'

The results that constitute this second axis, emphasis on questioning if the technologies are genuinely *tech savvy* (mere technological enthusiasm) or they respond to predefined biopolitical strategies.

The axis is focus on 3 categories as it follows:

1. requirement to observe under a critical prism the criteria of 'efficiency' of the technological models in relation with the legitimacy to take decisions on bios beyond giving a mere data management solution
2. to observe and question who designs the 'fancy' systems, and which are the requirements and the reasons behind it on using communities data
3. to observe how approaches are made from gender issues, as part of the design configuration of the approach

I will start this part with a short analysis based on one example on how the 'future' was proposed and designed in 2002, since we might recognize their application in the nowadays quotidian life; with the intention to question the role of the technologies in the design and implementation of biopolitical technoscientific proposals:

[36] Author's translation

"The pace of advance of medical devices has accelerated over the past 20 years.

The take up of medical advances in Europe is dependent on two factors: the pace at which medical practitioners can learn and apply new skills, and the rate at which health systems can afford these developments. The first way in which health systems of 2022 reduce costs is by shifting more diagnosis, treatment and care to the primary care sector and home care [...]These services ensure that they have the information to manage their own health and can make optimal use of health and care services. Other developments include:

- *Portable patient diagnostic devices and tests*
- *Patient monitoring devices and services including bio-inplants*
- *Patient knowledge based systems "Home health advisors"*
- *Telemedicine services using video links and sensors*
- *Patient education and support for empowerment based behaviour change*
- *Physical and mental wellness programmes.*

[...]

Medical practice is supported by knowledge-based systems using the Internet to give access to the latest best practice solutions and outcomes. Knowledge based systems also support self care and nursing care. For poor countries specialised knowledge based systems provide support that is sensitive to local needs, culture and resources, this is an important knowledge benefit for poor countries."[37] (Lister G., 2002, p.5)

As a main overview, I propose the following fragment of one of the interviews to refer to how the technological configurations are proposing distinct ways to observe and to define social 'realities':

[37] scenario 5 denominated 'Medical Technology'

Through the content that was generated in the networks…a multidimensional image was created…that is more than a simple x-ray. It is a scanner! […] Perform an MRI can create different images in a short time about the same situation…such as through the content of virtual networks on the case of the pandemic…If you track you find different perspectives… both formal…and let's say alternatives…through peer to peer communities…but most of those who were active…on the alternative platforms were a mix…Experts! And also not experts! Profanes! [38]

personal interview, PhD Veterinary Dr./academic, 2013

Frameworks to mold objects from the 'digital'

I present 5 fragments from 2 interviews, as examples to highlight 3 main concepts relevant on the construction of the 'objects' on 'the digital' in epidemiology area, beyond the mere description of the technologies implemented.

First one refers to the ethical frameworks where the information and knowledge is being folded and unfolded:

I think that this information…it was very badly interpreted...and has been taken advantage of by some areas [...] I wonder if there was really a manipulation of the information or simply the information was allowed to flow[39]

personal interview, PhD Veterinary Dr./academic, 2013

[38] Author's translation
[39] Author's translation

The way in which a person will respond…to what you post on the Internet…and the content of what you publish through social networks is an ethical problem. I believe that ethics…is difficult to control…because ethics is limited by the principles and values that oneself has. That is…you as an individual…have your own ethics…but my neighbor who lives next door…has his own ethics too…but ethics serves only for his own background! But maybe…not for mine[40]

personal interview, PhD Veterinary Dr./academic, 2013

Secondly, which are the boundaries that define and imply the concepts of citizenship and how the elements (e.g. devices, concepts) articulate around the formal and collaborative technologies:

The new technologies…are a new tool…that is being experimented in the different areas…how it can be used…it has been shown that it can be useful in things that we never imagined could be used before…but it has been seen…that it can be a tool that has given good results in its use…But there must be a control of all this information! Especially in epidemiology…because you cannot publish so many things just because... by free will of people…there has to be some restriction mechanism to avoid…what is panic…or at least…encourage that the "official" means of information …should have as much impact…as free information generated through social networks [41]

personal interview, PhD Veterinary Dr./academic, 2013

This form of participation with a technological base…do I believe that is creating other types of citizenship? I believe that citizenship has always

[40] Author's translation
[41] Author's translation

existed…It is the ability to collaborate among those who are doing different things within society…the technological base…allows breaking the isolation that exists between some citizens and others…in this case, between citizens who are not experts…and those who are experts…in fact…in practice it has happened that non-expert citizens have become experts by asking questions and learning…technology facilitates all this on a global scale [42]

personal interview, dr. epidemiologist active participant in alternative networks, 2013

Finally, how the new tools and new skills provide new types of rearticulation, where realities fold and unfold:

In comparison with other cases of flu…we have this new context…due to the added element of new technologies…that allowed other types of interaction…people participated…as we always participate with each other…communicating among ourselves…in the family environment…at work…in schools…and receiving a lot of information from the media... the active participation in networks…was not as intense in 2009…as it would have been in 2013…now…people use more…twitter…and more people have Facebook…and there is higher percentage of people participating... Anyway…what I saw…it we saw it was an embryo…people who asked questions normally in the…cafeteria…but [online] in an electronic version [43]

personal interview, dr. epidemiologist active participant in alternative networks, 2013

[42] Author's translation
[43] Author's translation

Surveillance technologies as governance techniques

In order to observe how the arguments that define Digital Disease Detection (e.g. digital epidemiology 'digital' tools) as a 'global' governance strategy, I propose in the lines below 2 examples to observe how the technologies 'creates' frameworks where subjectifiers become conditions of possibility in the negation of 'health', where bios should be seen furthermore that just a mere data management, where the new networks of meaning interact with knowledge's and health practices:

> *I think that…that the speed with which the information was moving…and the response from behalf of the governments…made the fear exaggerated…because the first data…indicated that it was a disease that was highly aggressive and deadly [...] It was enough that…that a person sneezes in this room and another one was already infected [...] In this situation the answers were given while the events were taking place…on the part of the governments…and the sanitary authorities. But only in the end…it was possible to assess…to have a general perspective…what has happened with this pandemic. Based on the data collected it was determined that it was a very aggressive disease for certain groups that has higher probability to die…but not for the general population…as it had been said…at the beginning of this pandemic.*[44]
>
> personal interview, PhD Veterinary Dr./academic, 2013

> *My experience with open knowledge….was much earlier…it started…in this area of the pandemic…since 2005…the year when I undertook a very small personal initiative [...] The previous year…2004…there had been in Indonesia a tsunami that had very serious effects…and because of which hundreds of people died…during that period there were many*

[44] Author's translation

people who used Wikipedia…to add pages with information about what was happening…how much help it was needed…and where it was needed… Everything was organized on a wiki page…with citizen collaboration…that blackboard became a collective blackboard…that we could all use and read…In other words…it was the place where everyone read…and everyone wrote…based on that experience…when in 2005…the World Health Organization…updated its plans for an influenza pandemic…and asked member states to develop their own plans…I thought we should be able to use Wikipedia to work on preparing for the pandemic…So I made a small modification to the Wikipedia wiki page and communicated it in a technical forum…ProMEDmail.[45]

personal interview, dr. epidemiologist active participant in alternative networks, 2013

Technoscientific articulations around 'data' algorithms

I present 2 fragments to highlight how the technological and scientific material resources that are mentioned in the conformation of the uses which are given the mentioned technologies:

The greatest difference of this pandemic…in comparison with the other previous ones…is the technological component…I think the biggest difference…that it was a pandemic monitored in real time! Previously…in the pandemics…you could not have the information on real-time. What normally happened was…that the pandemic was occurring…and the evaluation of it…was already taking place when we were already in the final stages. Instead…now we could now see on a real-time map…how the virus was spreading from country to country…from continent to

[45] Author's translation

continent…So that was one of the biggest changes… since it was the first time… the epidemiologists could have the opportunity...to do their studies on real-time. Normally epidemiologists work a posteriori…using their statistical data to draw conclusions. In 2009…the data were real…and could be analyzed immediately to take the appropriate measures[46]

personal interview, PhD Veterinary Dr./academic, 2013

This was a very particular epidemic…Worth the term…pandemic in real-time! During this…the information was given on real-time…and the epidemiologic policies…and for health control…were also given on real-time. There could have been successful policies…and other policies that were not as successful…but it was the first time that a situation had occurred in this way…I believe that…all the information that has been collected during this period…that has been considered pandemic or epidemic…will give a lot of information to scientists…to assess what has happened…and everything that has happened within the social networks…how social networks have been activated during this pandemic. It will also give a lot of time for many studies and evaluations[47]

personal interview, PhD Veterinary Dr./academic, 2013

If we approach digital epidemiology as a particular phenomenon, through the visualization of its socio-technical networks, defining trajectories by association and substitution of actants, defining actants by all the trajectories in which they enter (Latour, 2005). Respectively, in the present analysis I observed following three insights:

[46] Author's translation
[47] Author's translation

a) the new technologies implemented to **visualize and control** imminent problematics (preparedness), became transversal to the all areas (e.g. politics, economics, education, etc.).
b) even thou there are several study lines related to epidemiology and new technologies there are still few critical social studies going beyond the technological enthusiasm, requiring attention to the present low critical reflection on the impact on the vulnerable communities and local peculiarities when 'global' programs are deployed.
c) within this framework, I started to speculate whether the global frameworks of the (digital) epidemiology are preconceived geopolitical configurations to design how to visualize and how to use data afterwards, demarcating global health status for decision- making.

In this way, it has been emphasized that the new forms of digital epidemiology allow, the emergence of multiple articulations and nuances (due to the existence of the data that allows its use by the general public), but, in a way simultaneous, to be a continuous source of information for the `experts` according to the classical view.

4.3. 'Mobilizing vulnerabilities in global health'

The results that constitute this third axis, emphasis on identifying the formal and non-formal signifiers which approach the negotiation of the spaces and nuances on global health, by identifying and involving in collaborative approaches distinct local communities.

The axis it is focus on 3 categories as it follows:

1. 'digital epidemiology' as object that fold and unfolds as part of different systems of social understanding

2. required technological new *signifiers* (privacy, social justice and beyond) in the management of health systems related to political, social and economic aspects
3. to observe how approaches of the design configuration of the approach become inclusive or exclusive for certain groups (focus on sensitive groups or communities)

I will start this part with a short analysis based on one example on how the 'future' was proposed and designed in 2002, since we might recognize their application in the nowadays quotidian life; with the intention to observe which signifiers are approach the negotiation new DE approaches, how they are being approached and proposed as part of systems of social understanding. Also, if the approaches inclusive or exclusive:

> "*Healthcare has always been knowledge-based. In the year 2002 clinical staff spent 25% of their time dealing with patient records and information. In 2022 this process is much easier, medical staff record patient history, diagnostic and treatment decisions as they talk with the patient, using an intelligent system that picks out relevant information, confirms and collates it. This and other diagnostic applications are possible because of the development of neural networks using solid state computing. Use of information and communication technology is the third way of improving the effectiveness, quality and efficiency of health services [...] A major step forward was achieved when health systems introduced web-based three tier solutions. This architecture provides access from local users' systems through web and browser technology to health information and data analysis support tools. While this was technically possible before 2010, issues concerning the confidentiality of patient and clinician records and delays in retraining medical staff, meant that the full*

potential of communications and information technology was only realised by 2015"[48] (Lister G., 2002, p.7).

As a main overview, I propose the following fragment of one of the interviews to refer to how the socio-material articulation of (new) actors and (new) technologies propose the need to identify gaps and vulnerabilities of the 'digital epidemiology' towards collaborative approaches:

In the USA…it was proposed…a line of preparation…similar to the line of the document that I propose for Macaronesia…which would be like a preparation… in which would participate...the levels of government…which are closest to citizens…If citizens…citizens' associations…families and networks of friends are involved…they will all increase their capacity to help each other in an unfortunate situation…That is… this type of preparation that has nothing to do with producing vaccines…but has to do with caring for the neighbor…I have not seen this yet how it works…and I have not seen that there is a very clear atmosphere in favor of this…I would like that to happen! Because it can be useful generally speaking …I think that in the future there may be unfortunate circumstances…in a lot of places…and the fact that… society is capable of helping each other…is good in any case…including in a pandemic! Although I know that a pandemic is a very concrete example…in which I went into depth…but there are so many more causes of systemic catastrophe[49]

personal interview, dr. epidemiologist active participant in alternative networks, 2013

[48] scenario 7 denominated 'Information and Health'

[49] Author's translation

'Legitimacy' negotiation

In the lines below, I propose several examples on different types of statements I identified on possible types of mechanisms of legitimacy and their problematics in the management of risk information.

First, I remark that through the technocratic design itself, these proposals re-approached the position of the stakeholder's involved (e.g. public health officials, health risk workers, doctor-epidemiologists, data epidemiologists):

> *The dynamics…depend on the social group that uses that information…These dynamics… will also depend on the cultural field…in which the information is being given…and which you consider to be your own…from your cultural point of view…but it cannot be applied to all the groups*[50]
>
> personal interview, PhD Veterinary Dr./academic, 2013

The inscription of *life itself* goes further than describing the *bios*, by connecting multiple scales and proposing new conditions of possibility for new biomedical spaces and multiple new voices in the field of global health and its knowledge management:

> *As a citizen…I think it could become problematic…because citizenship as such does not necessarily have the technical…or scientific training…and a lot of information can scare the ordinary person…if there is not adequate technical information…to explain and filter it*[51].
>
> personal interview, PhD Veterinary Dr./academic, 2013

[50] Author's translation
[51] Author's translation

I think the responsibility of judging…whether what you are reading is prudent…falls on the reader…because the writer can be […] a person with bad intentions…or simply with intentions very different from those of the reader. To give credibility to the information…that one contributes…if possible…he would have to provide a link about what he is saying…For example, if you say that a certain virus might produce a pandemic….you better put a link to some authority or a scientist who says it and explain why! [mimic highlighting the last point] [52]

personal interview, dr. epidemiologist active participant in alternative networks, 2013

As observed in the fragments below, the concept of 'digital epidemiology' acts as a potential object, that folds and unfolds as part of different systems of social understanding:

During 2009, different types of practices appeared…online…offline…commenting on the official actions [...] From the statistical point of view, vaccination of a hundred thousand people […] is much more beneficial [...] we have rescued or avoided dying in 99999 people…which means…from the statistical point of view… that it's worthwhile carrying out a generalized vaccination[53]

personal interview, PhD Veterinary Dr./academic, 2013

If you were adding in virtual search engines….swine flu…or new flu…you were finding info…a lots of everything…from very specialized…to profane people…who added so many nonsense. I

[52] Author's translation
[53] Author's translation

wonder…how one can give them legitimacy…because I know that a person is specialized because I have seen it in a PubMed article. But a person only reads the information directly on the networks…or does not have that information…Who should we believe? More likely than the first that appears on the Google search list… or will you believe the last one that appears among the firsts? These are the ones that are supposed to be the most visited…and that is why they are there…and therefore they should be the most credible! But is that true? Maybe it's just a lay people who has placed some nonsense…that was 'liked' by a million people…and that is why it comes first in the list. It may be that this information is not true, but simply to the Google search algorithm. It just has put there [54]

personal interview, PhD Veterinary Dr./academic, 2013

Networks of significance

In order to observe which types of statements appear and to identify the **main frames of significance,** I focus on how this are being established within discourses on biological threats and pandemic events (e.g. formal, non-formal, citizenship, biological o informational).

The 'access' to the negotiation of the definition of processes, during different temporalities of its development, facilitates the comprehension of the framework use in describing the epidemiological processes, based on their peculiarities (e.g. similar swine flu with Spanish influenza due to the type of transmission of infection by respiratory route):

[54] Author's translation

In this critical case…the new technologies…such as open knowledge networks…have helped to really assess…how the epidemic happened during the actual epidemic process…That is to say…unlike the previous pandemics…it did not take several months…to reach the conclusion…that this epidemic was not as deadly…as had been predicted at the beginning[55]

personal interview, PhD Veterinary Dr./academic, 2013

Unlike other epidemics…of other years…this information from A (H1N1)…came to light… and could have been taken into account…or not! I think that depending on the degree of information…and even the degree that was given to that information…could affect the behavior of the population in general…or the behavior of the states. Based on these reactions…and how the states reacted…trying to regulate this! This was complicated because it was the first time…when so many actors had participated…at the same time ….and a flow of information that could not be controlled[56]

personal interview, PhD Veterinary Dr./academic, 2013

Alternative narratives in and from technoscientific movements

In the following lines, I propose several fragments from interviews to highlight some of the types of statements I identified on (possible) new alternative narratives on biological threats and pandemic events, as depicted from distinct technoscientific movements:

[55] Author's translation
[56] Author's translation

In the context of this pandemic…the practices that the technological component has allowed…may have had an impact at the medium-term or long-term level…Yes!...they have had a very important impact…why?...Because they have mobilized part of the population that was not mobilized before…In other words, in the past, epidemiologists were the ones who gave the information…then that information was passed on to the doctors…and the doctors passed it on…to the patients or the press. Instead…now…through these new information technologies…it happened so fast…that it did not follow the regular course of information…This…has sometimes mobilized people who could be "more expert"! [mimic gesture to indicate something approximate]… or have some experience in certain areas…that has allowed increasing the degree of information…and knowledge of certain areas.[57].

personal interview, PhD Veterinary Dr./academic, 2013

I remark here the relevance to observe the communicative feature, due to its peculiarities and subjectivities involved to explain experiences of outbreaks, types of actors or technologies as they have been fluctuating in different contexts, discover and understand plots of personal meanings or of specific areas:

Hacktivist practices…that have been proposed through alternative networks…propose new types of practices in a critical case…In this case…of A (H1N1) in 2009…there were so many groups that gave information…but the question is who has to be taken into account as a valid answer…A serious answer! If there is a group of 500 people…who are against vaccines…who comment on these vaccines… that are bad …or…can cause meningitis diseases…or the death of patients…do we

[57] Author's translation

have to take them seriously? In this case…is the responsibility of each one of us…since there is already an ethical problem…and it is difficult to assess the ethical problems.[58]

personal interview, PhD Veterinary Dr./academic, 2013

Peer-to -peer communities…I think they allow three things. First, they allow collaboration between equal citizens…but each of them has something different to ask or to contribute…collaboration between equals and…collaboration between diverse ones. Second…the electronic communities allow a certain degree of anonymity that allows…as in my case…as a technician and as a specialist in this field of epidemiology …to be able to ask questions that I would not have been able to do bareheaded…Third…collaboration between people who are working for the government and people who are not…We have saw it also in Edgeryders ... but it also happened to a certain extent in the subject of pandemic preparation…although I did not see it directly…but what they were doing in the United States…where it was proposed the possibility of a dialogue…more or less open…at the official level between the technicians who worked for the health administration…and the self-selected citizens…due to their interest in the matter [59]

personal interview, dr. epidemiologist active in alternative networks, 2013

As remarked previously in the analysis, the types of use given to the digital spaces are posing to urge the social policies around health and not only, as the deep change of information management, is affecting new temporalities and risk-work procedures that "*disrupt the idea, so important to global health security in particular and to preparedness*

[58] Author's translation
[59] Author's translation

overall", where these "***technologies produce other kinds** of time— not simultaneous 'real time', but rather discontinuous, proliferating present moments*" (Ortiz *et al*., 2011, p.298).

4.4. The design of the *bios*

For this scale of the analysis, I use three axes of analysis: a) *bios* as data; b) health *heterotopies* where both the living and the virtual are (re)defined; and c) *subjects* and their *subjectivities*. To illustrate each axis I propose to observe several examples of scenario, which highlights the conceptual transformations and practices that are proposed. In each category I will expand the analysis based on three subcategories.

Bios as data

Bios, a concept of Greek origin, proposes two definitions. On the one hand, it can be understood as a focus on life; and, on the other hand, understood as BIOS (*ref.* system of starting up computer systems) that allow the articulation of different scales of elements which pose approaches about *life*. The same concept of digital epidemiology encompasses both, but also requires attention to the conceptual transformation of biological threats. The analysis starts from a scenario that refers to the use of scientific data vs. citizen science; that allows us to observe a posteriori three subcategories that define the new deployment of approaches to life through the implementation of technological models:

> "[...] references a database linked to thousands of citizen science projects and quickly identifies three similar, local projects. Will, the local residents,

> and the leaders and participants of the local projects join forces to accelerate data collection and interpretation. They share their data with the most appropriate data repository, export local data as needed, and even expand their efforts to include biodiversity monitoring " (EPA[60], 2016, p. 12)

First, there is a mutation in the (bio) politics of events (e.g. protest in support of the Ebola 'infected' nurse), proposing how to think and how observe the ways the contents and daily experiences are now getting articulated around special events. Also, how new interactions appear with the same epidemiological content and the escalation for support within demonstrations and social networks. For example, in the case of the 'infected' nurse in Spain, during the Ebola epidemic in 2014 is highlighted the articulation of disparate contents (e.g. the dog, the neighbors, the elevator, etc.), in order to observe the experiential discrepancy of the nurse's neighbors, that once diagnosed the 'infected nurse' was hospitalized:

> *[...]They could not get over the surprise when El Confidencial confirms that their neighbor and her husband are isolated [...] 24 hours after the outbreak of the disease in Spain, nobody has come to the epicenter of the epidemic to report what happened*[61]
>
> El Confidencial, 2014[62]

[60] Environmental Protection Belongs to the Public - A Vision for Citizen Science at EPA https://www.epa.gov/sites/production/files/2016-12/documents/nacept_cs_report_final_508_0.pdf

[61] Author's translation

[62] https://www.elconfidencial.com/espana/2014-10-07/los-vecinos-de-la-enferma-de-ebola-no-ha-venido-nadie-a-desinfectar-el-edificio_230111/

Secondly, I propose to question whether there is a redefinition of the concept of *humanity* through the new approaches on social connections and the political status, arise especially through the use of the digital platforms (e.g. concepts of *friend*, *citizen* or *community*). Here I highlight boundaries proposed through the definition of the *digital humanities* [63] as spaces where co-creation implies *"teamworkand "production" standards that imply specialization become defining features of the digital turn in the human sciences*" (p. 4).

Finally, the promotion of health (self)surveillance transforms us into a new *cyborg* that generates data, it (self)quantifies and is processed in data flows that are oblivious to the qualitative nuances of the social context where they were generated (e.g. *quantified self*[64]); where the *bios* and ourselves we transform into an algorithm:

> *The greatest difference of this pandemic, in comparison with the other previous pandemics, is the technological component. I think that the biggest difference was…that it was a pandemic monitored in real-time! Previously in the pandemics you could not have the information in real time* [65]
>
> personal interview; veterinary, 2013

As it was observed in the analysis above, the *biotic* lacks phenomenological and integral components. It is a display of data that can be fragmented, recomposed, analyzed and deterritorialized from the specific spaces in which it deploys its activity.

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[63] http://www.humanitiesblast.com/manifesto/Manifesto_V2.pdf

[64] http://quantifiedself.com/

[65] Author's translation

Heterotopies in health

I question how from a *scenario* are deployed the types of 'readings, which are propose further on for the future rearticulation of distinct elements through technological mediation, where is transmitted as a *signifier* also a future delineation on the boundaries of concepts on *humanity* and *social professionals*. For this purpose, I propose to check the following fragment of a scenario, which proposes a technological *innovation* in the field of virtual mental health care:

> "All mental health care, with the potential exception of emergency care, would be provided online and by virtual mental health professionals. The virtual professional would not be a human being, but an avatar with artificial intelligence. It would be reliable, always available, and equipped with the best information on evidence-based interventions. It would never forget anything the patient has ever said, and be able to communicate in any style that the patient might prefer.Patients would be able to choose the gender, age, ethnic group, appearance, and other characteristics of the virtual professional. The software could be developed on the basis of the best available mental health-care expertise and evidence and it would provide data for consistent quality improvement.This virtual form of care would be available all over the world, would not require any professionals for local services, and would therefore cost very little. It would be eco-friendly because patients would not need to travel to access mental health care. Patients might also wish to present themselves with different characteristics and as different virtual patients to different virtual professionals [...] Some patients might still want some contact with real human beings to supervise or validate their interactions with the virtual clinicians. The software developer might need to take responsibility for

> malpractice and have the power to charge costs for access to clinical services. Research would be mainly focused on the quality improvement of software programs utilising process and outcome data.Human facilitators could help patients navigate the software. However, virtual care would drastically reduce the human workforce required and the need for training in mental health care provision." (Giacco *et al.,* 2017, p. 3)

Reading this fragment of the scenario, it opens up a range of questions about the future of personalized medicine: *What health issues are delimited? Why does it propose a transversal observation of the same patient that requires attention* ***sine qua non*** *and at any time? Will the human facilitators be doctors, psychologists or content managers?*

In the first place, I propose that the relationship between the biotic and the virtual is redefined in the heterotopic spaces that are opens up by the digital epidemiology. This mutation is very clear in the debate on the challenges and processes posed by recent artificial intelligence (AI) designers, but which requires that the *makers* (*ref.* IT[66] or ICT technicians who articulate a *chip* from a conceptual level to its implementation) are getting closer and getting support from the social sciences, towards a more critical vision about the implementation of technological processes and the gaps that could arise in the medium-long term where "*research based on technology is usually driven by hard data. However, humans are unpredictable, and when they are building AI, they are faced with the additional unpredictability of an unknown space*" (EPIC 2017[67])

The scenarios that are being adopted, mark positioning path for the experts, marking a mutation from the technological design itself, that is posed to the suggested use for the platforms, forms of articulation of contents and agents involved (including scales and

[66] Information technologies
[67] https://www.epicpeople.org/people-who-build-with-ai/

temporalities). These, *a posteriori* are traceable thanks to the *inscription* of virtual data, that are easy to be tracked regardless of the location and timeframe in which they were generated. For example, in one of the interviews about the 2009 swine flu, it is mentioned that: "*doing it through the virtual community allows us to explore a possibility, a scenario*" (personal interview; epidemiologist medical, 2013)[68]

In the second place, it is highlighted that a new digital cinematographic *aesthetic* is emerging in recent years (e.g. explosion of images, infographics and documentaries (non)experts on epidemiological issues); where for example the projects become *apps* to: "*incentivize geographic citizenship* [is key] *to capture and analyze the information collected by citizens and scientists*[https://eurecat.org/fem-ciencia-ciutadana-a-traves-del-mobil/"] (EURECAT, 2017)

Finally, the limits of the experience are renegotiated in future projections of scenarios, which propose to take a leap *between* scales, in the deployment (folding and unfolding of the concepts) of local or global public health strategies. I propose as an example the questioning about the definition of *health*, based on three post-Brexit scenarios and their respective implications where "*the potential impact on heath and health care will be substantial [...] while the civil service appears to be struggling to cope, especially within the Department of Health, which has experienced large scale redundancies*" (Fahy *et al*., 2017, p.1). In addition, is highlighted the performance as mediator of the technology, which allows 'jumps' between scales (types of knowledge or agents involved), where "*non-expert citizens have become experts based on asking questions and learning. Technology facilitates all this on a global scale*" (personal interview, epidemiologist, 2013).[69]

[68] Author's translation
[69] Author's translation

Spaces within spaces, which pose the dynamics of action proposed by the digital epidemiology, where many elements are negotiated and assembled; for example, the ways of observing and reading information (e.g. infographic) or how to approach a phenomenon and to understand how it is (being) a subject proposed and defined.

Subjects and subjectivities

I propose to start the debate on this topic, starting with reflection on how digital epidemiology (DE) proposes to mold subjects, based on a problematic normative proposal, which was proposed as a bridge between two conceptual horizons, towards a horizon where *users* could decide on their own data that defines them. I give here the example of the *Right to Oblivion Law (or the right to be forgotten)*, proposed in 2014 by the European Union[70], which operates as an excellent scenario to highlight the challenges posed by the DE in terms of defining new subjects of action and other subjectivities, their implementation in health, their respective involvement in content management and its application in practice.

To go a step further, I propose for the present analysis to use a fragment of one of the EPIC (Center of Expertise on Animal Disease Outbreaks*)* scenarios*,* in order to bring into the debate the questions that this law might poses for the future of global health. For example, according to the following case proposed in the scenario, under the protection of this law we could find "*biased information*" about personal or contextual epidemiological data, where "*the new legislation for the protection of data for future use [...] has important implications for surveillance and epidemiological studies" and "requires active consent for the use of data*" (EPIC, 2014).

[70] http://www.europarl.europa.eu/sides/getDoc.do?type=TA&reference=P7-TA-2014-0212&language=EN

First of all, it should be highlight that the digitalization allows the emergence of new forms of participation in biomedical emergencies. We propose as an example the analysis on the new reference elements to define the (possible future) patients:

> "*as individuals are starting to measure, track, experiment, intervene, treat and research their conditions and symptoms, genomes, biomarkers, behavior and environment, both individually and in collaboration with others*" (Swan, 2009, p. 521).

Second, it should be mentioned that in recent years there has been an intense debate in the literature on the (re)definition of the *subject*, debates arise -within the framework of social movements associated with new technologies on information and knowledge (ICT)- on concepts as *public goods*, *(open) science* and *knowledge dissemination*:

> *what we are talking about now is very important…because there is a convergence between technology ... big data [and health that] is going to magnify all this in a dimension that maybe we did even expect it [...] 15 years ago, we did not imagine what would happen with this…with the internet [...] this inability to visualize ... of the majority ... the magnitude of the problem [...] but also all the training and empowerment of the citizen can play in our favor*
>
> focus group; activists in social movements; 2016

Finally, I consider relevant to point out the changes posed by the direct affectation of citizenship. For example, the reaction to a global health crisis of the 2009 pandemic, when "*during this period I felt the need to participate in these communities, but at the*

same time felt the responsibility at the professional level" (personal interview; epidemiologist, 2013).

If we add the new conceptions about communities (according to the interactions they pose) and the disruptions they pose (Latour, 2005), I sustain that digital epidemiology is actively involved in the construction of subjects and subjectivities. Its implementation offers a new type of subject, active, involved in a permanent observation, focused on surveillance in front of possible biological threats. Furthermore, a subjectivity linked to risk and a type of (possible) threat displaced in the (possible) future, which might be amplified to a (possible) global scale.

To remember the future...

In recent years, several works have coincided in pointing out that the Foucauldian proposals on biopower need to be revised (Braidotti, 2007; Collier and Lakoff, 2015; Harvey, 2008; Morton and Bygrave, 2008). Among the various arguments that have been presented for such a reformulation, I highlight here the one that focuses on the emergence of the biomedical sciences and on the reconceptualization they suppose of the notion of *bios*.

However, in the previous part I have argued that this is not the only transformation that the concept is suffering in our present. 'Devices' like the digital epidemiology undertake a similar performance. The only difference with the proposal of authors as Nikolas Rose (2009) is that life does not become 'molecularized', but rather becomes a trajectory, which unfolds by articulating different scales and that is, fundamentally, something representable through maps, diagrams, etc. In other words, we are in front of the emergence of a new ontology of the *bios*.

4.5. The new epidemiological intelligence

As mentioned, the notion of subjectifier enables us to identify a new *modus operandi* of expertise in epidemiology, and allows understanding the boundaries of the digital epidemiology as a new intelligent ontology in global health. The next three sections describe these subjectifiers.

Lay epidemiology and (digital) collaborative technologies

Speaking in general terms, the use of (digital) collaborative technologies is offering a more visible and open debate on scientific knowledge; and in the case of traditional epidemiology is leading to a deep transformation. As shown in the first part of the analysis, this context has led to the emergence of new types of expertise, and has repercussions on the definition of citizenship.

Several concepts underline how this new expertise re-defines the biomedical arena: *citizen science* (Prainsack, 2014; Prainsack and Buyx 2016; Savio *et al*. 2017), *scientific citizenship* (Irwin 2006; Irwin and Wynne, 1996) and *ICT infrastructure* (Bowen, 2005; Bowen, 2008). These ideas mark new trends in the promotion of "*collective intelligence outcomes in three broad categories of public health care; health promotion, health research, and health maintenance*" (Prpic, 2015, p.1) that might be used as a form to capture this new potential for participation.

First, since the beginning of the 2000's, performances such as peer-to-peer (P2P) introduce new challenges into the definition of the new types of articulations that may appear; and that can be activated promptly and in a moment of crisis. The multimodal articulation is "*redefining global health care delivery*" (Kim *et al.,* 2013). Also, as

mentioned by Polašek *et al.* (2009), it became a emergent source for multidisciplinarity, aiming to supplement global health proposal deployment in a crisis case (and not only) with new emergent ideas closer to the daily effective implementation. We observe in the last years a mutation of *modus operandi* of formal actors (precisely defined by traditional definition), starting to be aware of the risk, but also the potential of these new approaches:

> [talking about the P2P communities active participation during the pandemic event of swine flu in 2009] *Peer to peer communities […] allows collaboration between equal citizens…but each of them has something different to ask or to contribute…collaboration between equals and collaboration between different… […] even thou at that moment, personally I was not sure and I could ask without having to say that I was a public health technician in charge of the public health of my community. In this way, I could manifest my ignorance*[71]
>
> personal interview, epidemiologist involved in P2P citizen networks, 2013

Second, new elements such as everyday life images and maps create new forms of consumption, identification with biorisks context (closer semantic appropriation) and invoke and legitimise non-experts to act and participate in global biorisk surveillance and prevention. These elements 'give voice' to new types of actors; where the implementation of risk prevention plans (e.g. protocols in health crisis cases) is starting to open spaces for negotiation the semantic distance between experts and lay-people:

> *In 2004, there was a tsunami in Indonesia that had very serious effects, and during which hundreds of thousands of people died. During that period there were many people who used Wikipedia, to add pages with information about what was happening, how much help was needed and where it was needed. All that organised around the wiki pages with citizen collaboration!*

[71] Author's translation

That blackboard became a collective blackboard! That we could all use and read […] Based on that experience…when in 2005…the World Health Organization updated its plans for an influenza pandemic…it asked the member states to develop their own plans. I thought we should be able to use Wikipedia to work on preparing for the pandemic. So I made a small modification to a wiki page of Wikipedia and communicated it in a technical forum proMEDmail [72]

personal interview, epidemiologist involved on citizen networks, 2013

Finally, the active participation of non-experts can serve as a meaningful resource in order to accelerate early detection of disease outbreaks. Bundling this information which can facilitate the management of the biomedical threat and helping to identify points of infection (Salathé *et al.*, 2013).

Subjective agents may be specific in a given context, but they stand out as hybridised figures during the movement which articulates around the dynamic definition of the context. This allows rapid mimicking (mostly temporary activation points) of the characteristics of crisis situations, even from the emergent phases. For example, a case from 2013, on 'Sina Weibo' (similar to Twitter) network published an image of a medical record of a patient (medical record) suspected of H7N9 infection in China uploaded by a hospital worker. This was quickly deleted, but raised awareness of the mutation on "hierarchies of traditional public health infrastructures, geographic communication barriers, and geopolitical obstacles" (Salathé *et al.*, 2013, p.2)

Heterogeneous digital knowledge management: ideas, devices and communities

[72] Author's translation

If the traditional epidemiology was perceived as a high semantic distance between lay people opinions and biomedical knowledge (Allmark and Tod, 2006; Boëlle *et al*., 2011; Ekman and Litton, 2007); in the digital epidemiology, the biomedical contents appear articulated in different formats, trying to become accessible and closer to non-experts opinions. In this way, new epidemiological contents use visual references (e.g. photos, infographics, global or local scale digital maps) and daily resources (e.g. ads, comics…) trying to give (sensation of) accessibility and nearness to the everyday life, and doing this it is promoting the emergency of new actors in biorisk surveillance and prevention. This new approaches provide new forms of consumption of biomedical information and creates "*enablements of action*" (van Loon, 2012, p. 197) and forms of affectation with the following traits.

First, the new articulations (e.g. gamified epidemiological interactive map) facilitate a new way of reading and to mediate translation of biomedical knowledge by diverse network of global actors. In one of the interviews, appears the following metaphor to understand the mentioned transformation:

> *Through the content that was generated in the networks, a multidimensional image was created that is more than a simple x-ray. It's a scanner! An x-ray gives you an image, but not in real time. Because it is a photography...that you have to process, reveal ... and see it. In contrast, a CT[73] or MRI[74] scan, you can see the image while the patient is in the machine on real time. In these cases it is the last measure that allows you to see how it is the inside of the organism... immediately. You are processing the image by viewing it on a screen. Formerly it was necessary to take the X-ray image...by the radiologist…which took the X-ray plate and went to a development room. The patient had already dressed and was waiting outside [...] Performing an*

[73] Computed Tomography scan: computer-processed combinations of many X-ray measurements
[74] Magnetic Resonance Imaging (MRI): medical imaging technique used in radiology to visualize the anatomy and the physiological processes involved

MRI can create different images in a short time about the same situation...such as through the content of the virtual networks on the case of the pandemic. If you track ... you find different perspectives, both formal and... Let's say alternatives...through peer to peer communities. But all of those that were active on the alternative platforms were a mix...Experts! And also no experts![75]

personal interview, veterinary, 2013

Second, new agents involved in data generation are being used for the promotion of (self) health surveillance (e.g. 'Quantified Self' movement). They transforms communities into a kind of new cyborg or actor-network in which it is the person who generates data, but the final uses of data flows can be unrelated to the qualitative nuances of the context social where these were generated. Within this context, the conceptualisation of the bios transforms us into an algorithm affecting global health policy design:

The great difference on this pandemic, in comparison with the other previous pandemics, is the technological component. I think the biggest difference was that it was a pandemic monitored in real time! Previously in the pandemics...you could not have the information in real time. What normally happened was that the pandemic was occurring and the evaluation of it was taking place in the final stages. Instead, now we could see on a real-time map...how the virus was spreading from country to country, from continent to continent [...] Normally epidemiologists work a posteriori using their statistical data to draw conclusions... but in 2009, the data were real and could be analysed immediately to take the appropriate measures. I

[75] Author's translation

think that the speed with which the information was moving...and the response from the governments...made the fear very exaggerated [76]

personal interview, veterinary; January 2013

Finally, the critical political potential that social networks and the use of digital devices play is going beyond the mere technical deployment, since they have allowed new actors to spread information and to engage with problems that seemed before miles away. Initiatives such as 'biodiaspora' 'Influenzanet', 'Flu Near You', 'Crowdbreaks', 'ProMed', or 'Google Flu Trends' are remarking the potential to capture and channel these new dynamics which "*reshaped the routes on which risk communication and public information about health threats spread among the population*" (Salathé *et al.*, 2013).

As an example, I remark the debate generated into academic community by a research on Wikipedia that was seen as channel of dynamic participation and that had an explosion of reactions in the digital media (Generous *et al.*, 2014). Although the study highlights many limitations, it identifies new uses for epidemiological cases and management of biomedical threats. As Croates (2014) remind us: "*the unprecedented growth of global access to the internet, we are only at the beginning of what will be a major shift in epidemiology*" (Coates, 2014).

New uses of biomedical knowledge

As mentioned in the first part, the digital epidemiology proposes new ways to approach biomedical spaces, by enhancing the emergence of new voices and the use of types of

[76] Author's translation

new abilities which can reconfigure the context. In this sense, I point out to the massive use of devices such as mobiles, and respectively the development of basic skills of content management proposes new challenges and opportunities for biomedical threats management. For example, one of the latest debates on ICT implemented on global health is about ethical and user-friendly UX (user experience) policy for devices and its uses for (personal) health care management (Denecke, 2017). These new technologies suppose: a) an interactive collaboration with the biomedical contents, b) a redefinition social movements associated to ICT, and c) a renegotiation of boundaries of definition of who defines expertise and legitimised agents.

The new types of interaction with the biomedical contents can be observed in the uses given to tools as those used for digital mapping systems of epidemics (e.g. *HealthMap, Google Flu*). This model provides protagonist sensation to its users (gamification effect), to generate points of activation (digital reports of possible cases of infection) on real life maps in distinct areas of the world.

The same technology becomes a mediator, which facilitates the analysis and offers an interpretation dependent on the codified meanings which act as subjectifiers, mediating boundaries between expert and lay people. For example, I highlight how it is being moulded the conceptual mutation (besides the mere technical aspects), that imply significances and performance that derive from comments such as the following mentioned in one of the focus groups: "*When you click a dot in Mexico it opens the virus*" (M.P, participant focus group 2015). A person who has basic expertise on using digital tools 'knows' that it refers to an activation code (of a case or area affected by a virus), and that in some digital mapping models, by clicking on a ‘dot’, an extra pop-up window will appear with context information. These sorts of initiatives are, in fact, establishing new rules to redefine notions such as 'public goods', 'science' and

'dissemination of knowledge' especially from social movements associated with new technologies of information and communication (ICT):

> E1: [speaking about the use of a 'Pandemic' board game, but explained with daily personal examples] *you have to see things with perspective [...] above all you have to see the topics on biodata ... that we are very ignorant ... that is the last privacy point we still have...which is our body ... you buy a [device] and...How cool! ... You are looking at the heart rate, phases of sleep [...] imagine a large database of us delivered in an innocent way [...] but...Who has the power on it*
>
> E2: *what we are talking about now is very important, because there is a convergence between technology ... big data [...] will magnify all this in a dimension that perhaps we can't imagine [...] 15 years ago we could not imagine what would happen with this with internet [...] that incapacity to preview ... of the most of us...of the magnitude of the problem [...] but all the training and empowerment of the citizen can play in our favour [...] in 5 years I think people will be able to decide in which network they want to share their data ... in terms of protecting their own private data*[77]
>
> focus group, experts and activists in social movements and ICT; 2016

Thus, in the last few years, in the field of health care observe a renegotiation of boundaries of who and why defines expertise and legitimised agents. The development of the mentioned new devices (e.g. smart mobiles, tablets, drones, etc.) to manage epidemiological contents has allowed reaching out to new audiences and help on a far broader level. On the one hand, such developments to a better integration of former amateurs and their knowledge can be led back to the better accessibility of non-expert

[77] Author's translation

audiences. On the other hand, it is the type of information that is used and produced with such devices that has opened a door to contributions from different social actors. This transformation goes beyond traditional epidemiology in a lot of senses, but there are still a lot of unknowns on using algorithms to understand what people really are communicating (Fung *et al.,* 2013; Fung *et al.,* 2015).

Through this part of the thesis I have argued on the potential of the digital epidemiology is a complex governance technique, based on specific discursive techniques, which positions *bios* within the expansion of the techno-scientific possibilities. Within the preparedness framework, the 'risk' assumption became an ongoing possible factor, furthermore that just mere measurable features.

What does it mean to approach models into policies and further on into practices? How discourses are being represented? Under which circumstances? How effective are the collaborations between different types of expertise? Are only sporadic and superficial articulations or, on the contrary, possible traces for future lasting cooperation?

V. CRITICAL DIGITAL EPIDEMIOLOGY. DISCUSSIONS ON COLLABORATIVE LEARNING PROCESSES WITHIN THE 'DIGITAL' LABORATORY

"Technology is neither good nor bad; not it is neutral"

(Melvin Kranzberg)

In this part of the thesis I make a short review on the five axes proposed here in the analysis, based on which I will propose several insight as main point for the debate. In line with the analysis on the concept of 'digital epidemiology' as a biopolitical approach, where boundaries expanded from the five axes proposed in the analysis, I have argued the relevance to observe and identify new type of articulation between agents and how this articulate knowledge on bodies, data and populations. Furthermore, I insist on the necessity to approach a further on concept of 'critical digital epidemiology' as an cross-disciplinary perspectives on the disease modelling technologies used in global public health, which focus on the social and ethical implications of new surveillance 'future' approaches.

The first axis 'Mapping (new) voices' referred to *actants* (humans and non-humans) as determinant agents in the socio-materials articulation of the present context or 'future' one's and it was focused to observe mainly the following features: a) possible networks of meaning linked to the concept of 'health' and 'epidemiology'; b) shifts in the political-legal framework of (digital) health management and c) features of the dynamic organization of knowledge (expertise and scientific knowledge).

I consider the *'Mapping (new) actors'* is an essential element to observe the articulation of networks of meaning that derive from the construction of different objects and

technologies implemented in the proposals of global public health; and the respective impacts of these in the appearance or disappearance of agent articulations ('dominant' or 'vulnerable' according to different angles of analysis). As it was observed in the previous parts of the thesis, the digital epidemiology is opening a new era where are sprouting (new) types of collaboration and interaction between actors and the environment, it support me to sustain that the collaborative technologies and the participative approaches are proposing alternative 'humanized' options in front of the highly technified options proposed in 'formal' technoscientific proposals (e.g. scenarios, interactive maps, use of personal data, etc.).

As remarked in one of the interviews:

> *I think that....the citizen participation would be facilitated more...it is required that the citizens themselves...get caught up in it...I think we have a duty to ask ourselves what we can do personally. It is not only the right to ask what the government is doing! On many occasions the contributions will be small...but it's an important one [...] the idea is that in a catastrophic situation everyone has to contribute*[78]
>
> personal interview, epidemiologist involved on citizen networks, 2013

The second axis 'Invisible algorithms, invisible politics', proposed to observe and question if the technologies are genuinely *tech savvy* (mere technological enthusiasm) or they respond to predefined biopolitical strategies; and it was focused to observe mainly the following features: a) critical view of 'efficiency' criteria of the technological models; b) who, why and how defines the designs of 'fancy' systems use communities data; and c) to question if the design configuration of the approach gender issues.

[78] Author's translation

I consider that the relevance to observe the *'Invisible Algorithms, Invisible Politics'* is related to the negotiation and technological mediated spaces, since the formal regulatory frameworks (e.g. state, transnational organizations, etc.) and people involved in closed or collaborative technologies are constituted as agents that allow mediation and decision-making on how to they mark the processes of implementation of technical processes in daily life. Respectively, the assumed responsibilities in the ontological definition of global health beyond the classic boundaries of the State, where the relevance attributed to collaborative technologies appears within the framework of reproduction of social systems of knowledge management as a part of the management of *bios*. As it was mentioned previously, the definition of the 'epidemiology' (and where digital epidemiology defines its own boundaries too) context mutated after the 2009 pandemic event, as its remarked by different actors (epidemiologists or lay epidemiologists) and is relevant to take into account the role played by digital networks and the involvement of citizens in the management of epidemics, in the preparation and transmission of information related to threats biological (Scholl, Patin, and Chatfield, 2012).

The third axis 'Mobilizing vulnerabilities in global health' focus on observing which are the formal and non-formal *signifiers*, which approach the negotiation of the spaces and nuances on global health, by identifying and involving in collaborative approaches distinct local communities; and it was focused to observe mainly the following features: a) 'digital epidemiology' part of systems of social understanding; b) technological new *signifiers* in the management of health systems and c) question if the design configuration are inclusive or exclusive.

I consider that it is relevant to approach the '*Mobilizing vulnerabilities in global health'*, since it highlights the complexity and richness of the technological discourses, as instances beyond the scientific evidences where spaces of legitimation of knowledge are negotiated. Respectively, operates as a mechanism for the governance of the

knowledge, which allows managing and including multiple agents. As this is proposed, appears the pretension of effectiveness of the proposed systems to avoid risks.

Within this framework, the notion of *subjectifiers* pose to identify characteristics of the new *modus operandi* of expertise in epidemiology as a new intelligent ontology in global health (Gavris and Tirado, 2018), where is necessary to: a) observed how the new heterotopies in health where both the living and the virtual are defined, are starting to affect the quotidian life, but also and the health policies approached for the next decades; b) observed how are being proposed and applied the proposals retrieved from types of articulation of lay epidemiologists and (digital) collaborative technologies and c) observe how is being approached the heterogeneous digital knowledge management, which articulates ideas, devices and communities.

As remarked in one of the interviews:

> *The practices and actors...that I think may be important in this context...are perhaps the health units of multinational organizations...such as the World Health Organization or specific specialized committees... However...it was shown that at certain times...members of these committees were also advisory members of some pharmaceutical companies...Then...the ethical part influences it very relevant!* [mimic gestures to highlight] *I wonder how important this can be in deciding...which actors are important...and what role they should have* [79]
>
> personal interview, veterinary Phd/ academic, 2013

[79] Author's translation

Finally, I have argued the relevance of observing disruptive practice of collaborative technologies within the framework of formal 'global health', as part of social and political expression of the present semiotic-material context of techniques and technologies used in epidemiology. This approach it was observed within terms of their implication for theoretical ad methodological understanding on global biopolitics.

The fourth axis 'The design of living' refers to the (deep) changes of the conditions of possibility proposed from the new biomedical framework and the global knowledge management; and it was focused to observe mainly the following features: a) bios as mere data; b) communities as heterotopies within a virtualized reality and c) how are designed and proposed (new) subjects and (new) subjectivities.

Related to the 'future' projected on technoscientific approaches, the use of scenario brings to light the need for a growing consensus that collaborative research is "*morally and ethically necessary*" (Rappaport, 2008, p. 2), since are ontological spaces where are defined the conceptual differences between experts and lay people. But, within 'critical digital epidemiology' these boundaries are being renegotiated, as both types are "*emergent logical forms that reflect a range of situational considerations*" (Horlick-Jones, 2005, p. 266), required for the reconciliation between the theoretical and empirical frameworks (T. Horlick-Jones, Rowe, and Walls, 2007; Tom Horlick-Jones and Prades, 2009).

Connected to the previous axis, when referring to the *bios* transformed into an algorithm, I emphasize that the biotic becomes somewhat controversial, insofar as it constitutes a permanent threat, where life is monitored as a source of risk, where a space is opened in the future in which a perpetual threat is formed; where: "*we do not know what will happen, but we know that sooner or later something serious will happen due to the infection between species*" (veterinary interview, 2013).

The fifth axis 'The new epidemiological intelligence' focused on observing the features of the new *modus operandi* of expertise on epidemiology and how the subjectifiers modify and introduce to conditions of possibility in the negotiation of biomedical spaces; and it was focused to observe mainly the following features: a) lay epidemiology and (digital) collaborative technologies; b) heterogeneous digital knowledge management: ideas, devices and communities; and c) new uses of biomedical knowledge.

Within this framework, I sustain the concept of 'critical digital epidemiology' within the framework of digital humanities, in search of forms of resistance and how the possible approaches coming from collaborative technologies could transform ontological and epidemiological definition of 'global health'.

As mentioned in the previous chapters of the thesis, it is relevant to illustrate the technoscientific construction of the processes of epidemiology, based on the transposition proposed through the 'the digital', into the frames and scenarios of the new ontological shifts, which imply distinct signifiers and materialities in the global management of emergencies biomedical.

Based on the analysis, I consider relevant to remark that for future research lines, it is important to observe the discursive construction of technologies, which propose collaborative participation in the construction of scenarios and digital epidemiology 'platforms', are based on several scales:

I. the networks of meaning of the discourse of need of models to control the 'global' complexities where boundaries are being challenged to (be) legitimized within the new biomedical spaces (e.g. scientific, lay people, alternative actors)

a. "*Global health" concept seen as a complexity, is poses to be guided through 'dashboards'*, through governance techniques and technologies that are key in the management of systems to see the world, in an accelerated movement and future environmental context associated with problems of global epidemiological health, which requires the emergence of a new intelligence of epidemiology
b. The use of ICT technologies (as digital epidemiology) within the challenging present new global context (e.g. quick data and people migration, climate change) pose the *request to redefine which are the actors involved and their responsibilities*. In the framework of the present analysis (subjectifiers), it's relevant to observe new trends on how they are requested to respond within epidemic crisis situations

II. Need not to lose focus on the vulnerable communities (e.g. sensitive groups within crisis situations; e.g. women, migrants)
    a. Responsibilities of actors, through binding techniques or technologies for the attribution of subjectifiers, both in the practice of risk-workers in global health and in daily practice
    b. *Networks of meanings of potential viral actors*, in an eternal search to be healthy and self-sufficient, encourages the use of technology, but the use and the networks of meanings can be vanishing lines, towards a transformation of expert knowledge in biomedical emergencies
III. How digital epidemiology marks paths and new trends in artificial intelligence with the next years which will have effects on social perspective of health and how we approach ourselves within its frameworks of meanings
    a. *Expansion of boundaries of the biomedical spaces*, which acquire a broadening of the reading gaze -from the reflected bio-political characteristics- in psychosocial practice and intervention
    b. The arguments used for the promotion of 'global health' behind the new *epidemiological models act as governmental technologies*, which propose

a transversal involvement of different scales of actors (e.g. digital epidemiology) bring into debate new opportunities, but also *new challenges in approaching the digital humanities* towards social inclusion, dignity and social justice.

Referring to hybrid *subjects*, where life understood from its inter-species link mobilizes different institutions and levels of action on the same plane; where the representation as a trajectory establishes vectors that cross and combine in common totalities all those different instances and scales. Probably the greatest expression of this equality is the set of expressions *One Health* , *Global Health* or *One World One Health* that reflect the spirit of an interdisciplinary movement that advocates the development of medical-biological sciences that address the need for global welfare that does not establish definite ontological differences between human beings, animals and the environment.

Which differences would appear between different framing of priorities between designs from distinct global areas? Which fames of governance will allow the management of 'biotic' approaches?

The research has explored the ontological transformation in the relationship between expert and non-expert knowledge and the role of technologies involved, focusing on the digital epidemiology as a new intelligence in global health. As concluding remarks, I underline that this mutation is mediated by technology (Latour, 1990), and provides a completely unfolding of the 'social' (Krarup and Blok, 2011; Latour, 2005), where the participative technologies (*ref.* learning collaborative systems) have a relevant role in the definition new relevant actors and construction of the discourses that are defining in the process of generating epistemic knowledge (Szlezák *et al.,* 2010; Barry, 2013). This transformation is relevant in the field of Science and Technology Studies and in the

ethical evaluation and a new research on the challenges that are raising recently from these disciplines.

It is important to mention the challenges brought about by these ontological shifts in the biopolitical approach existing in the management of expert knowledge in biomedical emergencies. In this sense, in the analysis it was observed the notion of *subjectifier,* as a tool to describe how the epidemiology intrusively proposes a new social *modus operandi*. Also, have shown that there is a prerequisite to go beyond the techno-scientific techniques and to have a critical view on the role of the involvement of the lay epidemiologist in the design of new processes closer to the daily life, if we want become much more effective in cases of global crisis.

The onset to consider epidemiology as metaphor to think about a subject (and about ourselves) in that its clinical and statistical approach opens new frontiers on approaching the individual 'subject' and its position in populations. However, digital epidemiology now deploys its field of action into a bigger scale, but within a framework where the normative (legal and political) are still under development (e.g. General Data Protection Regulation law). As an example of the extension of this mutation, is important to see how this will impact also the global health management (in which management models are already connecting in long-term global health scenarios). Also, the relation with other field as climate change, which are becoming one of the "biggest global health threat of the 21st century", which requires a new social demand on inclusive models that promote a complete engagement of lay people in the effectiveness of public health work *(Coste*llo et *al.,* 2009).

Finally, I consider that it is relevant to propose a multidisciplinary debate on the negotiation processes (beyond the mere technological part) in order to reconfigure the conceptual definition of global health policies, by involving the social scientifics to

observe the complexities of this new peculiar historical context, where big data transforms more than just the perception of the ‘global health’ and proposes new spaces to create new dynamics in risk prevention.

VI. CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

Through the analysis presented in the previous parts of the thesis, it was proposed to observe the process of knowledge construction on the technological *plug-in* (Latour, 2005) of the implementation of 'the digital' on ‘bios’ within the epidemiology framework, as part of the development processes of construction of the global public health.

In this last part, I highlight and propose to observe several aspects that emerge from my present analysis, which I consider relevant as a point of reflection in this field, with the purpose of inviting a multi-disciplinary critical debate that includes the scope of science social issues beyond mere consultations in: a) the process of designing processes of knowledge (e.g. scenarios) and b) subsequent evaluation of the effects of technological impact, especially in important process that affects our daily practices such as health and our own vision of the world of governability of 'life'.

My research had as objective to contribute to an in-depth empirical analysis based on theoretical reflection of biopolitical frameworks, including ‘digital’ wide range of implications on the management of ‘technologies of risk’, where I observed how the discourses of preparedness propose frame of possibilities for different types of actors.

Is not that the technology *by itself* that has become part of the ontological predefinitions, but there are implicit reasons and required collaborative spaces to negotiate *by other means* the conceptualizations and relations within new fields of expertise (Gavris, Seebach, Torrejon, and Tirado, 2016). As it was stated in the objectives and analysis developed in this thesis, the technologies become mediators of social processes taking the example of epidemiology in context of the conceptualization of 'global health'. For

this purpose, the concept of digital epidemiology has been used as a reference concept where we can observe how they articulate: agents, technologies and subjectifiers.

Which are the discursive constructions to define the new biopolitics frames? Within this framework, collaborative technologies were observed 'by other means' as peculiar forms of bottom-up governance insights, which incorporate, in complex epidemiological models, different dynamics at the level of articulation speed, mediation of contents and forms interaction that define networks of meaning?

For doing so, in this part I mention again the key aspects that I consider relevant that were mentioned in different parts of the thesis, posed in the initial part connected to the theoretical approach, but also in the second part to the methodological procedure and the proposed analysis.

To conclude this analysis, I would like to highlight 3 insights that I consider emblematic.

First, the conditions of possibility given through the construction of digital epidemiology and its technological response structures allow the articulation of discursive concepts of governance techniques as scenarios, in a context where 'preparedness' becomes an emergency in the implementation of guidelines of continued engagement. Whereas is relevant tracing the implementation of a scenario on the implementation of a type of platform design or interactive map is a 'make visible' the surveillance.

Digital epidemiology is not only reshaping the meaning of expertise, but it is also creating new dynamics in risk prevention and reconfiguring the conceptual definition of global health policies. In this sense, this new epidemiology -by involving different scales

of expertise and actors- can be understood as a new intelligent ontology in global health for different reasons:

- these mutations on defining the boundaries of expert knowledge as we have observed, can be defined as phenomena of subjectivities or subjectifiers (Latour, 2005), which articulate as a connection point, and act as markers of the framework of knowledge. Respectively, they allow comprehending the conceptual transformations of expertise in biomedical emergencies and epidemiology, and promotion of active participation by the lay epidemiologist.
- the articulation of heterogeneous types of data used in new digital knowledge management channels (mainly visual registries), stimulates the subjectifier ability to visualise its way of working. Digital epidemiology is making directions towards new fields, unfolding areas of concern from an ethical perspective (Vayena *et al*. 2015; Leonelli, 2016).
- the new uses of biomedical knowledge in a complex and fast-moving context for predictive proposals on biomedical threats at the global level could also be referred to as "political occasions, and the subjectifiers can be understood as a way of describing and analysing such occasions" (van Loon, 2012).

Second, the ethical and normative regulation of the boundaries of the 'digital epidemiology' as preparedness governance technique, require a critical overview of it impact beyond being a mere strategic planning, as it transcend the boundaries of the political framework and is becoming an socio-technical articulation reflected on the way we materialize how we will depict and define 'health' in the near future. Furthermore, it is relevant to highlight which are the relevant authorities, which allow the transcription of ontological construction of epidemiology as social emergence.

Finally, the discourse of 'global' that create zones of 'vulnerability' with varying effects depending of the types of interaction with content (knowledge and practices) and

necessity of attention on the local 'resilience' capacity towards a more global social justice (including digital humanities). Here I emphasise the need to rescue the multiple voices, and the importance of collaborative models in global health designs. Health, at the end of the day, is a set of stories circulating between bodies and signs, and these stories are subjective matter, as they offer people terms and concepts to self-describe their reality and their present, their pain, or their happiness (Frank, 2006).

As a main point for future research, I remark it as relevant to mention that when referring to ontological exercises of the living, which set out the scenarios in digital epidemiology, a have highlighted in the analysis of this article that the scenarios act as an epistemic matrix of practices and discourses, marking decades ago the directions of implementation of the conceptual approaches. The articulations were enhanced by *technology,* which acts as an agent of translation and an inherent mediator of the same process, proposing ED as a new *intelligent ontology* (Collier, 2012; Ferreira, *et al.*, 2013) in global health. Where the new spaces, beyond the mere technical deployments, provoke deep conceptual mutations, because -on cases such as the 2009 pandemic- " *all the information that has been collected [...] will give a lot of information to scientists to be able to assess what has happened and everything that has happened with social networks ... how social networks have been activated during this* " (veterinary interview, 2013).

Furthermore, as a global vision, I consider important to sustain that the notion of life acquires its full meaning inside two different sets of elements: a) it can only be apprehended and identified thanks to security protocols, surveillance and tracking devices, statistical data that are elaborated in epidemiological surveillance centers, images that represent infectious vectors, medical tests, etc. and b) its definition becomes full when it is linked to the movement of information and its representation in databases and graphics. That is, the ED breaks with the nineteenth-century vitalist image of common sense that shows the living as a power that is beyond the scope of

any regulation or complete systematization, as a set of material elements, norms and regulations. If there is code you can talk about life, if not, we enter the terrain of “the indefinable ".

The digital epidemiology is a discursive and practical device that does not limit itself to redefining the notion of security or surveillance. Raising a reading about the scenarios used in ED, as a notion of border (Latour, 1987), does not refer to a dividing line, but rather emphasizes that biotic in our last great frontier. However, its limits go far beyond those of traditional politics and make up a true biopolitical project. Life is a permanent relationship and exchange of information and therefore a constant limit. The living extends to all corners of our environment and transforms the planet into a gigantic liminal space. But bordering on what?

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ANNEXES

A. Annexes ‘On coding the framework of the analysis’

During different parts of the research were developed several funnels to define purpose and to define the specific focus of the present analysis. In this annex there are 3 of the tools used during this process.

- **Annex: refers to the** first phase conceptual delimitation
    - A.1. Define the gaps and the niche of the present analysis
    - A.2. Define focus on actors
    - A.3. Define focus on technologies
    - A.4. Define networks of meaning

In each of them you will find an arrow that indicates the evolution during the definition of the terms and in the **[CO]** which is the justification of it.

Note: the following codes refer to the search filters used (ICT derived)

- ***AND:*** including
- ***OR***: option
- ***IN*:** in a specific context or frameworks

A.1. Define the gaps and the niche of the present analysis

Concept	[co]	Concept	[co]	working terms
“public health” “global public health“	Criteria are maintained for cross-cutting, but specific interest on the development of the 'global' concept associated with most of the technical proposals-scenario and platform-technologies or epidemiological systems	“Epidemiology”	Excussion criterion: not HIV, communicable or not communicable as criteria; but maintaining the criterion of global and debates raised by the movements and social groups related to them	infectious diseases that have had or have escalated in the networks and / or mass media in recent years
“digital public health” “digital global public health“	Focus on technologies used in epidemiological models	“Epidemiology”	coincides with periods of development of Early Digital Detection projects (since 2000)	outbreaks of specific types of infectious diseases that in recent years had accelerated escalation on (social) networks: • 2004 "bovine spongiform encephalopathy" or "mad cow disease"; • 2005 "bird flu" or "influenza A (H7N9)"; • 2009 "swine flu" or "influenza A (H1N1)" or "swine flu"; • 2015 "ebola"; • 2016 "zika"

A.2. Define focus on actors

Concept	[co]	Concept	[co]	working terms
“hacking” AND “global health”	Interest is focused on constructive practices, which are positive at the community level and / or global health	“hacker social” AND “salud global” OR “epidemiology”	excluded as a criteria but maintaining the criterion of alternative movements and technical debates and technologies proposed by the movements and social groups related to these	"Actors" and "epidemiology" (associated with ‘digital’)
"Alternative actors" and "health"	Very large and ambiguous strip	"Formal actors" and "non-formal actors" and "epidemiology"	Criteria of alternative movements are maintained, observing related sensitive groups (women, immigrants, etc.)	"Formal actors" AND "non-formal actors" IN "digital humanities"

A. 3. Define focus on technologies

Concept	[co]	Concept	[co]	working terms
"Internet" / "social networks"		"Collaborative technologies"	the concept derives from *collaborative learning systems* used in management of information systems and new digital models of teaching and learning	"Collaborative technology" AND "epidemiology"
"Internet" / "social networks" AND "epidemiology"	Different platforms and specific apps are identified	systems AND specific platforms	Different related concepts are identified: Digital Disease Detection DDD; epidemiological intelligence; e-epidemiology; telemedicine, etc.	“digital epidemiology”
"information management of systems" AND "Global health"		“design” [seen as conceptual approach] AND “information systems” AND “epidemiology”		"Scenarios" AND "Global health" AND "epidemiology"

A. 4. Define networks of meaning

ACTORS	TECHNIQUES	TECHNOLOGIES
Unit of observation: agents involved *Focus of observation:* • **Formal** e.g. research centers; design of systems and technology for surveillance and early detection • **Non-formal** e.g. citizens using Wikipedia to inform on a crisis situation; creating patterns of interaction with other users and abstract content; creating networks of meaning trough interaction	Unit of observation: **scenarios** *Focus of observation:* • **how to see it** • **how to read it** • **how to interpret it** • **how it was implemented** • **how it was interpreted when and after it was implemented**	Unit of observation: **early detection digital platforms** *Focus of observation:* • **how to see it** (e.g. iconographic or codes) • **how to read** (e.g. trigger points on a map) • **how to use it** (e.g. take pictures or write a note about someone with possible symptoms)

B. Annexes: On identifying the actors of interest

During different parts of the research were developed several funnels to define which are the actors involved in the specific focus of the present analysis.

In this annex there is 1 of the tools used during this process.

- **Annex b:**

  B.1. Identify actors that focus on gaps and issues of interested related to the niche decided to be observed in the present analysis

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Name	Basic concepts	Area	Language	LINK
Hacking Medicine	Global Health, Primary Care, Telemedicine and Portables (Wearables)	NA	En	http://hackingmedicine.mit.edu/ coordinated by Massachusetts Institute of Technology MIT; Association of mixed entities (formal and alternative)
Health Hack Academy	Expert co-creative reflection space (think tank)	Dk	EN	http://healthhackacademy.se/
Hacking Health	They use the term "hacking" (avoiding the hacker concept they consider to have negative valences) to "challenge finding solutions to seemingly ingrained problems by testing innovative concepts and ideas through the rapid construction and trial of incipient and low cost prototypes"	CA	ES/ FR	http://www.hackinghealth.ca/about/about/ asociación de entidades mixtas (formales y alternativas)
Human-Centered Design	Kits open-source de herramientas para nuevas soluciones de trabajo en el campo en desarrollo internacional - uso código abierto y Tecnologías Colaborativas	Global		http://www.ideo.com/about/ Association of mixed entities (formal and alternative)
FemHAck	"The lack of women, queer and trans people and diversity in general in the technological fields and more specifically in hacking is serious. To change this situation, a critical approach to technologies, tech / hacker culture, among others, is necessary " - use of open source and Collaborative Technologies	Global	EN/ES/PR /GR/FR/DE	https://f3mhack.org/index.php/es/
Lela Coders (Donestech)	Women programmers and women hackers - Free software and the development of techno-political practices with technologies	Iberia LatAm	CAT/ ES	http://www.donestech.net/ca/news/yorobu_%C2%BFpor_qu%C3%A9_las_mujeres_son_invisibles
Wikipedia	Open Wiki on gender-gap (2014-2015) for the visibility of techno-political practices with open technologies Tool actively used during analyzed event	Global	EN	https://en.wikipedia.org/wiki/Wikipedia:WikiProject_Countering_systemic_bias/Gender_gap_task_force/Media_and_research
Global voices	Open source citizen journalism Tool actively used during analyzed event	Global	40 languages	http://es.globalvoicesonline.org/
Code for America	Digital governance with open source; with modified tools, platforms, skills and government practices Tool actively used during analyzed event	NA	EN	https://www.codeforamerica.org/about/

C. Annexes: On identifying codes for analysis

During different parts of the research were developed several funnels to identify the main axes of the present analysis. Also, to define the codes and categories and subcategories of analysis used in the analysis.

In this annex there are 1 of the tools used during this process.

- **Annex c:**

  C.1. Identify the issues of interested related to the niche decided to be observed in the present analysis

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Axis I: Mapping (new) voices'	AxisII: 'Invisible algorithms, invisible politics'	AxisIII:'Mobilizing vulnerabilities in global health'
• **CATEGORIES Axis I:** • the networks of meaning linked to the concept of 'health' and 'epidemiology' • (shifts in) political-legal framework of health management • dynamic organization of knowledge (expertise and scientific knowledge) **•SUB-CATEGORIES axis I** •a) Identify the statements approached in several scenarios proposals (3 diffent data sources) observing how are approached the (possible) articulacionts between actors and spaces (e.g. geopolitical, digital, etc.) •b) Identify the statements about epidemiology in the 'global health' approach (e.g. One Health, IHR, etc.) •c) Describe the main actors (human and non-human) which are mentioned that are involved in the definition of (alternative) discourses on biological threats and pandemic events •d) Describe the subjects and their subjectivities which mentioned that are involved in negogiationg statements about biological threats and pandemic events depicted from DE or similar technoscientific movements (e.g. medical hacking, Quantified Self, etc.)	• **CATEGORIES Axis II: :** • critical view of 'efficiency' criteria of the technological models • who, why and how the designs of 'fancy' systems use communities data • question if the design configuration of the approach gender or sensitive groups issues **•SUB-CATEGORIES axis II** • a) Analyse the construction of objects on 'the digital' in epidemiology beyond the mere description of the technologies implemented •b) Scenarios: digital traces as "memories for the future" •c) Identify the arguments that define DDD (Digital Disease Detection) as a 'global' governance strategy that creates subjectivity and conditions of possibility in health 'bios' seen as mere as data •d) Describe and analyse the technological and scientific material resources that are mentioned in the conformation of the uses that are given the mentioned technologies	• **CATEGORIES Axis III:** • 'digital epidemiology' part of systems of social understanding • technological new signifiers in the management of health systems • question if the design configuration are inclusive or exclusive **•SUB-CATEGORIES axis III** •a) Identify the mechanisms of legitimation and their problematics in the management of risk information (classic and DE) •b) Scenarios: mutations of "the living" in everyday practice •c) Describe and analyse the main frames of significance that are being establish within discourses on biological threats and pandemic events. •d) Identify the new alternative narratives about biological threats and pandemic events depicted from DE or similar technoscientific movements (e.g. medical hacking)

D. Annexes: On identifying methodological tools and techniques

During different parts of the research were developed several funnels to identify the main axes of the present analysis. Also, to define the codes and categories and subcategories of analysis used in the analysis.

In this annex there are 2 of the tools used during this process.

- **Annex d:**
    - D.1. Interview script
    - D.2. Focus group script

D.1. Interview script

Good morning! Thank you very much for your help. I am part of a research team of the Autonomous University of Barcelona. I am interested to know about your experience in relation to the pandemic period. There are no good or bad questions. Such only opinions: all of them are timely and respectable. That is why I would like to keep the dialogue as relaxed as possible. The duration of the interview will be approximately 50 minutes. I would like to request your permission to record in audio to facilitate the transcription. Afterwards, you will receive the interview to be able to modify it and / or add details.

I would like to start with a slightly more general question
What aspects would you highlight as more positive (genuine) of the communities of equals in a crisis like the pandemic? Which are the advantages and disadvantages? What difficulties do you face as a citizen in a pandemic case? What types of impact can P2P communities have and / or use of hacker ethics? What do you understand by P2P communities?

What previous experiences have had in participation processes (global and / or local level)? Do you think that P2P communities can be a model of public participation? And in a crisis like the pandemic? What type of information is used? How does this information move in general? And in the critical case of the pandemic?

How are the decisions made? How the proposals discussed or what are gives legitimacy to the information? What are the specific technical aspects of P2P communities?

What are the possible impacts? What risks (technological, environmental, social ...)? Which are the benefits (economic, social, international dimension ...) What is the impact on "those who arrive" at the level of social cohesion?

What actors should participate? What values should be represented? What interests should be represented? What forms are used to establish participation? At what point should participation begin? And in a critical case? During how much time? During or also after? Who should lead the participation process? Which are the rights and responsibilities? What role would you be willing to assume?

As a final reflection, in what way do you think that new technologies have had a medium-term impact on citizen management in a crisis situation? At the level of P2p communities? At the creation level of commons? At the level of public policies?

Thank you very much for your help.

D.2. Focus group script

Thank you and welcome (Presentation of the moderators, focus and duration of the session)
_____ (moderator 1) Today we are here to talk about epidemics. The objective is to comment on their perceptions and the images that you have seen in recent years about epidemics. We are not here to share information, or to give you our opinions. Your perceptions are what matter. There are no correct or incorrect or desirable or undesirable answers.*
_____ (moderator 2) will take notes and record the discussion audio. Everything will be confidential and nobody will know who said what. We would like it to be a group discussion, however, I would appreciate it if only one person speaks at a time. The debate will be approximately 1 hour.*

We would like to start by commenting that you understand EPIDEMIOLOGY.
[CO: In the case of an expert in the medical area: If they had to explain to someone what the epidemics are, what would they say?]

2. Science fiction
Let's see a short that we will comment later: What attracted the attention of the video? Why? What sensation did you get to see the video?

3. Science fiction- Reality
We continue with some images...Science fiction? *[CO: Text mix SF & real in presentation images]* Think of the last few years in the images you saw in relation to the epidemic
Possible concepts and topics:

- DATA: new different health data types (body signals such, HR tracking, lab results, genomics), what are the metaphors and criteria for the data to be "interesting", "desirable" for the consumers themselves, who should have access and/or interpret these, why
- SERVICES: will health information provide / make possible in the future (5 years); what discourses and by which metaphors do they make the future graspable for themselves; what are the reference services or business do they use in thinking through new possibilities
- FUTURE THREAT: Explore the ways in which people interpret new threats to their own health: internal causes (genetic risk, lifestyles ...), causes outside the body (new epidemics, bioterrorism ...)

4. Reality
What do you think about epidemics? Prioritize future needs, desires & tensions; identify most relevant imaginary directions for the three areas; Materialize winning future imaginaries: identify compelling language and visual cues (pre-worked material), create mindmaps / moodboards / future imaginary boards with ideals and fears for later semiotic analysis
5. Closure: Although we were commenting on many different opinions. Does anyone want to add or clarify an opinion on this? Is there any other information about your experience with or after the workshops that you think will be interesting to comment on?

Thank you very much for coming this afternoon. Your time is much appreciated and your comments have been very useful.

E. Annexes (CD format)

A. THEORETICAL FRAMEWORKS & EXAMPLES

a. Formal agents:
   i. Center For Disease Control And Prevention (North America)
   ii. 'Diario Medico'(España)
   iii. World Health Organization (International)
   iv. Promed mail
   v. ECDC

b. Expert 'amateur' – Informational citizens
   i. Tsunami case 2004
   ii. Others

c. Digital epidemiology
   i. Eurosurveillance
   ii. Participatory & collaborative systems
   iii. Others

d. Epidemic intelligence
   i. Formal
   ii. 'Subjectifiers'

B. METHODOLOGY & TECHNIQUES

a. Interviews
   i. Audio & transcription (n=3)

b. Focus Groups
   i. Audio (n=50)
   ii. Profiles table
   iii. Tools used: montage with video and photos; labels with main concepts

c. Thematic analysis:
   i. Scenarios : examples of scenario packs; strategic tools; documents and news related
   ii. Normative: examples of laws; strategic reports; documents and news related
   iii. Agents
   iv. Blogs
   v. News
   vi. Images (e.g. references to epidemic image, maps, paints and photographic representation)
   vii. Devices