

Doctoral Thesis

An Interwoven Visualization Platform For Assessing The Restoration Of Fragmented Landscape Structures

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Illustration of volume in 1931 dedicated to Guadarrama with the series of Guides Natural sites began National Interest, published on the initiative of Eduardo Hernandez-Pacheco.

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A girl at a Sewing Machine, Edward Hopper, 1921.

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Barcelona, I love you!

Abstract

The process of landscape restoration in highly polluted areas is influenced by complex interactions between a variety of environmental elements; these are interconnected through the comprehensive medium of the landscape structure which is made up of patches, corridors and matrices. In this study, I research landscape structure using an environmental monitoring model, configured with high-definition real-time visualization, to assess the process of controlling pollution and top-soil restoration in both restored and un-restored sites. Using a unique visual environmental impact assessment platform, I evaluate a simulation from July 1999 to July 2014. I conclude that, at 5m X 5m resolution from the Unmanned Aerial Vehicle (UAV), and 30 m X 30 m resolution from the Landsat satellite (combining GIS, ENVI, Rhino and Grasshopper software), the model captures the main features of observed surface temperature, vegetation and the hydrology variation in the research site. The finer visual representation of the complex surface temperature, vegetation variables and explicit hydrology simulation at different resolutions, significantly improves the efficient and comprehensive assessment of the restoration process, in particular with regard to the visualization analysis of the structure of the damaged landscape eco-system. The change in this during the restoration process is noteworthy; the growth of the vegetation patch and the trend of the surface temperature matrix for each five years are included in the new hydrology corridor. I conclude that there is great potential for improving the precision of the environmental impact assessment platform in restoration through using high-visualization models to develop such studies in the future.

1) I first discuss an insight into the current global conditions of severely fragmented landscape structures before researching restoration of the damage caused by different disturbance conditions. Therefore, in chapter 1, the themes of fragmented patch, corridor and matrix are discussed as cases which analyze the current heavily fragmented conditions of the landscape structure. This is necessary in order to understand the different fragmented landscape structures identified in chapter 1, which will enable the correct environmental index to be selected for each of the different fragmented structure assessments in Chapter 3.

2) Second, I research a number of restoration responses applied to different sites, different fragmented structures and different degrees and types of disturbance. In brief, I find that rules for landscape restoration may appear through experience, or even through failure, from which the right direction for future restorations may be learnt. The following restoration cases in Chapter 2 show that similar types of fragmentation can result in different conditions or statuses. These include restoring fragmented areas either back to their original natural status, or to a new modified status, or in other cases using no restoration, but just applying to them a new status and consideration as works of art. These different statuses lead to the discovery of further potential for restoration. One important question here is to find out which restoration method is the most suitable for each different problem and site.

3) Third, for finding the right approach to landscape restoration in different cases of fragile areas affected by the growing and transformation of cities, I need to build a comprehensive visualization platform, Environmental Impact Assessment (EIA), which we can apply not only to restored areas -to assess and control the effectiveness and evolution of the actions taken and of those in progress, but also to help find out the best alternatives for those sites where no action is taken so far. and un-restored sites. Therefore, in Chapter 3, we present two practical cases where we use our visualization platform to assess and control the situation in two landfill zones both of great landscape significance and both also quite close to important cities which have lately been through intense transformation processes: the Garraf landfill landscape restoration, near Barcelona, and the monitoring and assessment of the un-restored landscape of the landfill area near Lhasa, capital of Tibet.

Resumen de la Tesis

El proceso de restauración del paisaje en zonas altamente contaminadas se ve influido por las interacciones complejas entre varios elementos del medio ambiente; estos están interconectados a través del medio integral de la estructura del paisaje que se compone de corredores, pasillos y matrices. En este estudio, investigo la estructura del paisaje con un modelo de monitorización del medio ambiente, configurado con visualización en tiempo real de alta definición, para evaluar el proceso de control de la contaminación y la restauración de la capa superior del suelo en ambas zonas, restauradas y no restauradas. Usando una plataforma de evaluación del impacto ambiental visual unificada, evalué una simulación a partir de julio de 1999 y julio de 2014. Llego a la conclusión de que, con 5m X 5m de resolución del vehículo aéreo no tripulado (VANT), y 30 m X 30 m de resolución del satélite Landsat (combinando SIG, ENVI, Rhino y Grasshopper), el modelo capta las principales características de temperatura de la superficie observada, la vegetación y la variación de la hidrología en la zona investigada. La representación visual más precisa de la temperatura en superficies complejas, las variaciones de la vegetación y la simulación de la hidrología explícita en diferentes grados de resolución, mejoran significativamente la evaluación eficiente e integral del proceso de restauración, en particular, en relación con el análisis de la visualización de la estructura del ecosistema del paisaje dañado. El cambio experimentado durante el proceso de restauración es digno de atención; el crecimiento de la vegetación y la tendencia de la temperatura de la superficie de la matriz por cada cinco años están incluidos también en la nueva visualización de la hidrología. Llego así a la conclusión de que existe un gran potencial para mejorar la precisión de esta plataforma infográfica de evaluación del impacto ambiental en la restauración a través del uso de modelos de alta capacidad de visualización para desarrollar este tipo de estudios en el futuro.

1) Esta es la primera vez que se aborda en su conjunto el estado de las condiciones existentes de las estructuras del paisaje severamente afectadas, antes de investigar como reparar los daños causados por las diferentes condiciones de perturbación. Por lo tanto, en el capítulo 1, los temas del mosaico fragmentado, los corredores y la matriz se examinan como casos con los que analizar las condiciones existentes de fuerte fragmentación de la estructura del paisaje. Esto es necesario a fin de comprender las diferentes estructuras del paisaje fragmentado identificadas en el capítulo 1, lo que permitirá hallar el índice ambiental correcto para cada una de las diferentes evaluaciones de la estructura fragmentada en el Capítulo 3.

2) En segundo lugar, investigo una serie de las respuestas de restauración que se han aplicado a distintos lugares, estructuras fragmentadas y diferentes grados y tipos de perturbación. En resumen, me encuentro con que los criterios aplicables a la restauración del paisaje pueden aparecer a través de la experiencia, o incluso a través del fracaso, a través del cual podemos hallar la dirección correcta a seguir en futuras restauraciones. Los siguientes casos de restauración en el Capítulo 2 muestran que el mismo tipo de fragmentación puede dar lugar a condiciones o estados diferentes. Estos incluyen la restauración de áreas fragmentadas ya sea de vuelta a su estado natural original, o a un nuevo estado modificado, o en otros casos utilizando no la restauración sino meramente la aplicación a las mismas de un nuevo estatus como obras de arte. Estos diferentes estados conducen al descubrimiento de nuevas posibilidades de restauración. Una cuestión importante que el análisis y seguimiento infográfico que proponemos puede facilitar es ayudar a dilucidar qué método de restauración es el más adecuado para cada tipo de problemática concreta y cada distinto lugar.

3) En tercer lugar, para encontrar el enfoque y la estrategia adecuados para la restauración del paisaje en los distintos casos de áreas frágiles afectadas por el crecimiento y la transformación de las ciudades, hace falta implementar una plataforma de visualización integral para la Evaluación del Impacto Ambiental (EIA), que sea aplicable no solo a las zonas restauradas -para evaluar y controlar la efectividad y la evolución de las actuaciones realizadas y en curso- sino también como base para plantear alternativas en aquellas áreas en las que no se ha intervenido aún.

Así, en el Capítulo 3, presentamos dos casos prácticos de utilización de nuestra plataforma de visualización para evaluar la situación en dos zonas de vertedero situadas ambas en lugares de gran relevancia desde el punto de vista paisajístico y, también en los dos casos, próximos a dos ciudades importantes que han experimentado en los últimos años intensos procesos de transformación: la restauración paisajística del vertedero del Garraf, cerca de Barcelona, y la monitorización de la evolución de la zona de vertedero, aun no restaurada, en las proximidades de la ciudad de Lhasa, capital de Tibet.

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Introduction

Introduction

Preface

Because my hometown is located downstream from snow-covered mountains, I have loved nature since childhood. In 2009, I found my first job as a planner on the Tibet plateau, improving the infrastructure and exploration of rural tourism. I was required to undertake field research on a daily basis, and survey many poor and environmentally barren villages. However, as a tourist I was attracted by the amazing landscape, and forgot the tough environment. One particular day, I had to undertake field research at a village called Nimu, where I met a local official who was responsible as my local guide for the survey. He told me that he would retire the next month and return to his family in Beijing after 15 years of work stationed in Tibet. Then he said "today I'm so happy to meet you, and I want to show you my achievement over 15 years here in Tibet". Then we went together by car deep into the Gobi desert. When we passed a small forest, he lamented "look at these yaks! I have told these herdsman many times, that in the winter, they need to prevent them from entering this forest to eat the grass! Some of the yaks always escape there". Soon our car came to the top of a small mountain where there were only 3 Buddhist nuns in the little DSA NONNENKLO who were very happy to welcome us. The official proudly said "look at this well which I designed and built by myself, which has solved their problem of drinking water". Then we continued to another two small remote mountains where he had built another two wells. Finally, he let the driver take us to an amazing wetland; and when he stood beside this wetland, his expression became a little ashamed and agitated and he said "this wetland is very rare on the plateau, and its' ecological significance is very important! During my past 15 years as a hydraulic engineer, I feel guilty that I have only achieved two things - built three wells for nuns and convinced the government not to build a hydropower station downstream from this wetland. What a great wetland!" At that moment, my life was completely altered by this elder's statement.

After that event, I began to re-plan my future direction, deciding to do something for the environment. Then I began to read about what the earth has become, I found over-exploited resources, city over-expansion, frequent natural disasters and human tragedy, and that the world is facing a growing number of crises in the battle of humanity against nature, of the power of nature versus man's ability to harness it. Man wins but the victory is pyrrhic. This anthropocentric view presents us with a quandary, that the more influence we exert upon our environment and the atmosphere, the more the earth surprises us by accelerating away from these influences. I felt despair, but then continued looking to find what humanity has done for our damaged earth.¹ I read of the Garraf landfill restoration project, the Siglujjurdur village avalanche restoration project, etc. and I felt more hopeful. However, I still didn't know what I could do for our earth? People cannot forget their roots, and as a landscape researcher, I know about landscape restoration, landscape structure and the significance of ecology.

However, the process of landscape restoration in highly polluted areas is influenced by complex interactions between different environmental elements; these are interconnected through the comprehensive medium of the landscape structure which is made up of patches, corridors and matrices. The change in the structure of this damaged landscape eco-system during the restoration process is noteworthy; more precise visual representation significantly improves the efficiency and comprehensive assessment of the landscape restoration process. I concluded that there is great potential for improving

¹ Milligan, B. (2015). Landscape Migration. Places Journal.

the accuracy of the environmental impact by designing an assessment platform for the restoration process by using high-visualization models to develop future studies. However, before beginning this long research journey, I still felt confused. One day, I looked at adventure programs where tourists followed the local guide to find dragon nets, and when an underground river appeared in front of them, they asked the guide "how can we get through this underground river?" The guide answered "we do not need to go through it; we just need to follow it". This wonderful answer brings me to a very important idea. I reflected and began to look for the source of my dream. In my mind, I remembered the big Sichuan earthquake in my hometown, as well as the many disasters that happened in the world over the past several years.

I found that at times of major disasters, one of the things most overlooked is the response to the disaster by living creatures itself. Three hours before the earthquake struck in the hardest hit area in Thailand, elephants in Khao Lak, screamed in fear. This area is hundreds of miles away from the earthquake that generated the tsunami. They trumpeted a second time an hour before the tsunami and moved to higher ground, even breaking chains that secured them. On some of the islands in Thailand, hermit crabs, which live on the sandy beaches, suddenly escaped to higher ground before the wave hit. Sri Lanka's Yala National Park was hit by surging floodwater, but there were no signs of any dead jackals, crocodiles, leopards, elephants, or deer, animals that have given the park worldwide fame. Eyewitness accounts indicate that dogs refused to go outside, flamingos left their coastal breeding grounds, and zoo animals rushed into their shelters and would not come out. The coastal region of Cuddalore, India had thousands of human casualties, but no dead buffaloes, goats, or dogs -- which are plentiful -- were found.

Another overlooked fact is that the responses and presence of wildlife helped to save human lives. For example, in one case a diving boat captain saw the ocean suddenly filled with dolphins and he followed them, escaping the wave. In San Souk, a fishing village, birds suddenly became frantic, and the villagers took notice and left, saving all 1,000 villagers. In many cases it was trees that people clung to that saved their lives. Areas that still had their coral reefs and mangrove trees along the coast were hit far less severely. Other forested areas acted as barriers to the full force of the wave.

In contrast, those areas where the coral reefs had been destroyed or the mangrove trees ripped out for hotel and aquaculture developments, were devastated. For example, in the Maldives more than 100 people lost their lives in a population of about 270,000, while in Phuket, with a similar-sized population the toll was 1,000. It is a well-known fact that the developed areas (i.e., areas where the natural wild life has been destroyed by mankind) were hit the most often and the hardest. Meanwhile, places such as Myanmar, where the mangroves remained intact, or India's state of Tamil Nadu, where there are dense stands of mangroves, suffered much fewer human casualties and damage to property. These so-called "coastal greenbelts" saved thousands of lives and reduced the damage in India, Sri Lanka, and Malaysia. Both the World Wildlife Fund and Friends of the Earth have taken note of this in the many regions hit by the wave.²

Suddenly, I realized that nature has no need for humans to do anything, it is just necessary to follow her to find the original meaning of life, and that this would form my future direction. Then I began my research journey to follow nature, and the following contents will explain a journey of a girl's self-understanding, and how this enabled her to weave a visual platform to assess environmental impact.

² Ioualalen, M., Asavanant, J., Kaewbanjak, N., Grilli, S. T., Kirby, J. T., & Watts, P. (2007). Modeling the 26 December 2004 Indian Ocean tsunami: Case study of impact in Thailand. *Journal of Geophysical Research: Oceans*, 112(C7).

Research Status

During the past half century of terrible natural disasters, a failing tourist industry, disastrous urban renewal and high unemployment, experts in many fields (geologists, ecologists, meteorologists, zoologists and botanists, amongst others), have begun to try various methods of restoration to address this quandary.

Geologists mostly apply GIS to do the macroscopic monitoring on large scale planning, while ecologists and agriculturalists mainly apply experimental methods and surveys to undertake microscopic monitoring. However, the most fragile areas fall between macroscopic and microcosmic analysis. These require a flexible platform for analysis at a different scale.

In recent years, many researchers have used Unmanned Aerial Vehicles (UAV) and radar to solve the difficulty of topography at different scales. However, fragile areas are constrained not only by topography, but also by vegetation, soil types, rainfall and rivers etc. We therefore need to monitor more of these types of environmental parameters in order to create a comprehensive analysis of the visual environmental impact assessment (EIA) for fragile landscape structures. However, the more types of parameters that are used in this platform, the more complex and difficult the work becomes. Until now there has not been a platform for the interdisciplinary assessment and comprehensive treatment of methods of restoration.

Research objectives

Considering the current state of research in this area, my main research objectives are the following:

- 1) To build a visualization platform to assess the restoration of fragmented landscape structures by combining remote sensing and visualization technology. This can reduce the need for manpower and material resources, and also provide a more efficient and comprehensive visualization platform (EIA) for landscape restoration.
- 2) This visualization platform maybe able to reactivate the original unassisted restoration capability in order to help the restoration of fragmented landscape structures in the future.

Research methodology

To obtain these research objectives, different methods are required. We identify and study, through surveying and other methods, in order to acquire data which is then analysed during each stage of the project's development. These experimental stages are described in the following three phases:

1) Studying the literature, books, theses and journals relating to the many visualization and ecological issues of relevance; discussions with my tutor, interviewing experts on key issues, and collecting case-study data in the field to determine the final direction of the research. (image 1)

2) After determining this research direction, I began to research the field of research. After agreeing with my tutor and relevant experts, I have determined the specific areas, regions and case studies. At each new stage in surveying relevant projects, and during the investigation itself, I have found further research questions which have lead on to further interviews, and adding notes about my own personal feelings and intuitions.

3) Following this investigation and integrating images and documentary material, I have approached the relevant company and conducted related research. In addition to applying related methodologies to the process of analysis, (such as multimedia, remote sensing, GIS analysis, drawing graphs, photography, photogrammetry, digital imaging, visual simulation, visual communication and geometric modelling and so on), I have evaluated a simulation from July 1999 to July 2014. This has led to the conclusion that at 5m X 5m resolution from the Unmanned Aerial Vehicle (UAV), and 30 m X 30 m resolution from the Landsat satellite (combining GIS, ENVI, Rhino and Grasshopper software), the model successfully captures the main features of observed surface temperature, vegetation and the hydrology variation in the research site. This provides a better visual representation of the complex surface temperature, vegetation variables and explicit hydrology simulation at different resolutions. This main results are presented in chapter 3. (image 2)

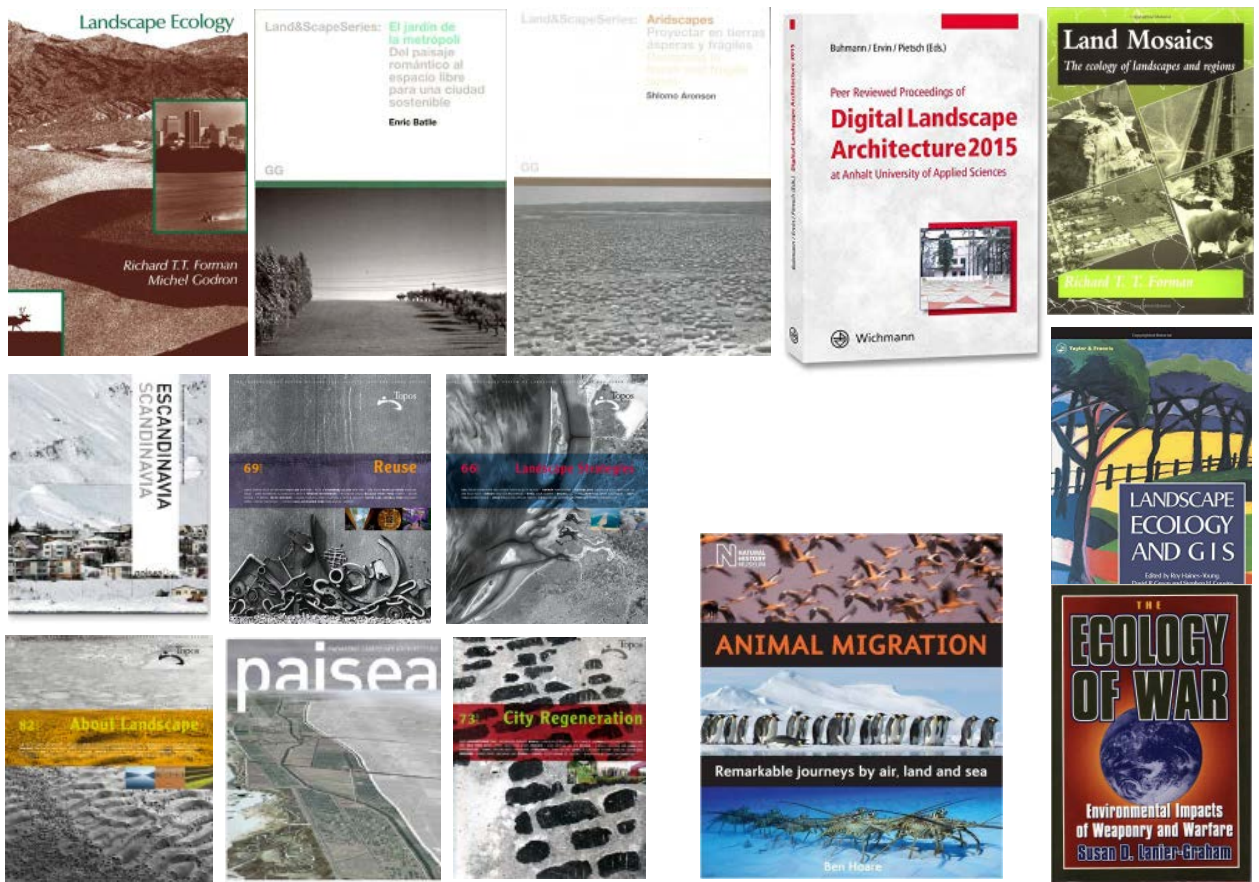


Image 1: A selection of the primary literature.

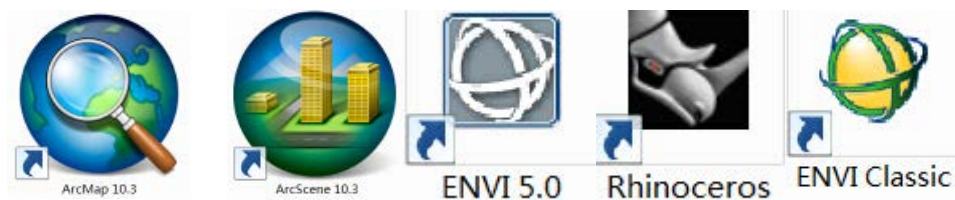


Image 2: Main softwares for analysing and visualizing modeling.

Chapter 1. The fragmented landscape structure

The fragmented landscape structure



1. The fragmented landscape structure

Fragmented landscape structure identify

Because of human pollution or nature disaster, which leads its landscape connectivity is damaged and the ecosystem become fragile. The landscape forms fragmented structure, includes fragmented patch, corridor and matrix. (Image 1.2)

Since 1900, because of the excessive exploitation of resources and city over-expansion, frequent natural disasters and damage to humanity are occurring all over the world with growing numbers of crises, which contribute to greater environmental degradation, rampant disease and bloody war. Landscape, however, is one way that contributes its strength to the world, protecting human kind's living environment and cultural heritage. There is an inseparable relationship between the ecological system, the landscape ecosystem and the inhabiting species, which directly influences the environmental state. Moreover, the landscape ecosystem is supported by the landscape structure, including patch, corridor, and matrix, which form important criteria with which to measure the ecological landscape status. If any part of the landscape structure has been damaged, the food chain will be broken and energy cycle will be fractured, which may lead directly to ecological fragmentation.

Because of the food chain, grazing animals form a link between vegetation and animal, which make the plant and its nutrients inseparable, and which is finally combined with the abiotic variables which have together formed the landscape. We can see that the entire ecosystem and its species are actually connected by the landscape which is mainly influenced by abiotic variables which include light, water, wind, temperature, topography amongst others. For instance, the wing of a bird owes its form to the wind; the fins of a fish owe their form to the water; giraffes have long necks to better deal with the conditions of a hot and dry environment. Therefore, we see that when abiotic variables are damaged by human disturbance, the landscape structure and ecological systems will be fragmented, directly causing the Landscape connectivity to fragment.

However, if we want to explore the right way to restore the landscape, we first need to have an insight into the present state of the condition of fragmentation before taking restoration action. Therefore, in this chapter, the following discussion selects the fragmented patch, the fragmented corridor and the fragmented matrix as cases to undertake this analysis of the present fragmented status of the landscape structure. (Image 1.1 The typical fragmented landscape structure case, in accordance with the classification of landscape structure and type of disturbance.)

Landscape connectivity, the extent to which a landscape facilitates the movements of organisms and their genes, faces critical threats from both fragmented and habitat loss. Many conservation efforts focus on protecting and enhancing connectivity to offset the

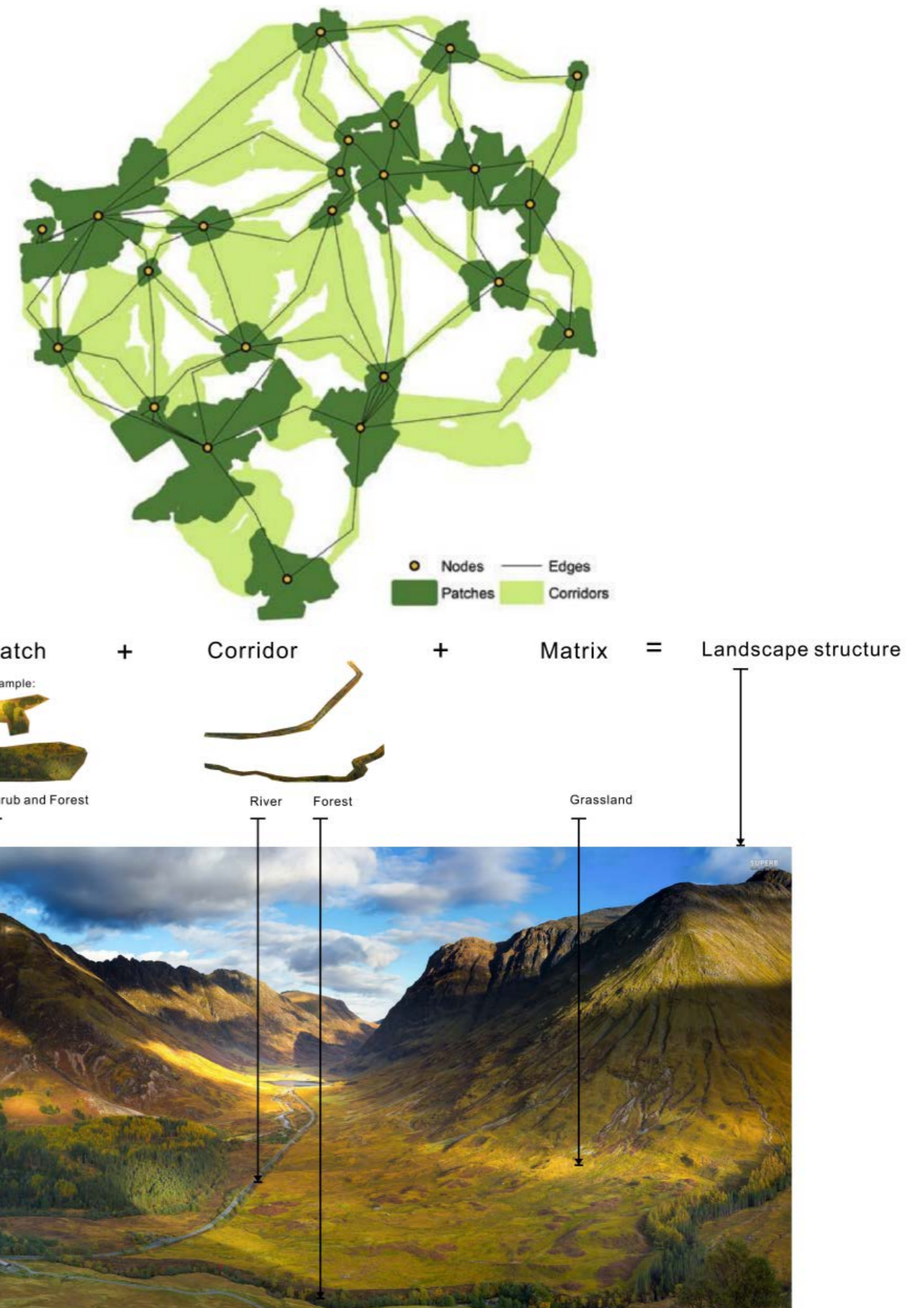


Image 1.2: The landscape structure connectivity formed by patch, corridor and matrix.

³ Rudnick, D. A., & Merenlender, A. M. (2012). The role of landscape connectivity in planning and implementing conservation and restoration priorities.

impacts of habitat loss and fragmented on biodiversity conservation, and to increase the resilience of reserve networks to potential threats associated with climate change. Loss of connectivity can reduce the size and quality of available habitat, impede and disrupt movement (including dispersal) to new habitats, and affect seasonal migration patterns. These changes can lead, in turn, to detrimental effects for populations and species, including decreased carrying capacity, population declines, loss of genetic variation, and ultimately species³.

Due to such human disturbance, ecological systems have become very disrupted, and these fragmented landscape structures have spread all over the world. This chapter we will choose some typical fragmented structure cases, which are mainly located in America, Canada, Brasil, China, Honduras, Sumatra, Spain, Kenya, Italy, Iceland, France, Afghanistan, New Zealand, Nicaragua, Singapore, Japan, Faroese, Indian Ocean, Peru, Russia. Therefore, in every below section, before analyzing fragmented landscape structure as a whole, we must examine in precise terms the fragmented characteristics of the patch, corridor and matrix to help find how heavy landscape fragmentation we are facing. (Image 1.3)

1.1 The fragmented patch

Patch Identify

Many objects are paths, including quilts, mosaics, soil, and clouds in the sky. However, patch as a nonlinear surface area is differing in appearance from its surroundings. Patches vary widely in size, shape, type, and boundary characteristics. In addition, patches are often embedded in a matrix, a surrounding area that has a different species structure or composition. Normally, patched in a landscape are plant and animal communities, that is, assemblages of species. However, some patches could be lifeless, or at least contain primarily microorganisms, and are then much more prominently characterized by the presence, for example, of rock, soil, pavement, or buildings. From the view of patch size, shape, number, frequency and configuration in the landscape, we could re-understand the landscape fragmentation.

Moreover, from the view of fragmented patch formation, we could find the environment resource patches become less, the human disturbance patches become more. Human activities cause disturbance patches. Burning in forests, shrimping in wetland, landfill nearby city, nature disaster in city, war in city and strip mining for surface coal or minerals are examples of widespread disturbance patches on earth.

Patches under the disturbance of nature disaster and humanity damage are generally the patch types that most rapidly disappear, e. g. earthquake, avalanche, terrorist attack. That is, they have the highest patch turnover rates, or the lowest average age or persistence time. However, patches are also formed by chronic disturbance that persists for a long



Image 1.3: The typical fragmented landscape case in the world under different type of disturbance.

time, e. g. patches under the disturbance of resources over-exploited, city over-expansion. Certain life rubbishes occurs every day at a spot, or an unplanted mountain is mining repeatedly. Due to disturbance from natural disasters and damage by humans, patches are generally the type of landscape structures that disappear most rapidly, through earthquakes, avalanches, and terrorist attacks for example. That is, they have the fastest patch turnover rates, or in other words, the lowest average age or persistence time. However, patches are also formed by chronic (or repeated) disturbance that persists for a long time, e.g. patches disturbed by the over-exploitation of resources and the over-expansion of cities. In such cases the successional process is continually or repeatedly set back or restarted, and a kind of stability within the patch may result. This type of disturbance patch has a long persistence time⁴. Following typical cases will show different types of fragmented patches under different disturbance.

1.1.1 The fragmented patch under the resources over-exploited disturbance

Solar energy exploitation disturbance

Ivanpah Solar Electric Generating System, America

The Ivanpah Solar Electric Generating System is a concentrated solar thermal plant in the California Mojave Desert, 64 km (40 miles) southwest of Las Vegas, with a gross capacity of 392 megawatts(MW).[6] It deploys 173,500 heliostats, The facility formally opened on February 13, 2014, and it is currently the world's largest solar thermal power station. In 2010, the project was scaled back from the original 440 MW design, to avoid building on the habitat of the desert tortoise. (Image 1.5)

The site is visible from adjacent Mojave National Preserve, Mesquite Wilderness, and Stateline. The project generated controversy because of the decision to build it on ecologically intact desert habitat. the facilities are fenced off to keep some terrestrial wildlife out, and initial studies indicate that birds face the risk of collision with the heliostat mirrors or from burning in solar flux created by the mirror field. In 2012, the National Parks Conservation Association (NPCA) issued a report on the project, citing water concerns, damage to visual resources, and impacts on important desert species. (Image 1.6)



Image 1.5:

Ivanpah Solar Electric Generating System, Steve Marcus, 2014.



Image 1.6:

Biologists working for the state estimated that 3,500 birds died at Ivanpah in the span of a year, many of them burned alive while flying through a part of the solar installment where air temperatures can reach 1,000 degrees Fahrenheit 540 °C, the Wall Street Journal,2015.

⁴RICHARD,T. y Forman, M. (1986). Landscape Ecology. America: Wiley, p.87-94.

⁵Ivanpah Solar Power Facility. (July 22, 2013). Retrieved April 22, 2015 from Wikipedia, the free encyclopedia: https://en.wikipedia.org/wiki/Ivanpah_Solar_Power_Facility

Mine exploitation disturbance

Bingham Canyon Mine break, America

At 9:30 pm on April 10, 2013, a landslide occurred at the mine. It was the largest non-volcanic landslide in the history of North America. Around 65–70 million cubic meters (2.3×10^9 – 2.5×10^9 cuft) of dirt and rock thundered down the side of the pit. Understanding that the mine's steep walls made it a high risk for landslides, an interferometric radar system had been installed to monitor the ground's stability. As a result of warnings produced by this system, mining operations were shut down the previous day in anticipation of the slide. There were no injuries. The massive slide is expected to cut production of mined copper by 100,000 tonnes (110,000 short tons). A second slide caused an evacuation of 100 workers on September 11, 2013. (Image 1.7)

Olympic Mountains Mine, America

On Puget Sound southwest of Tacoma, the 950-acre land mass about 40 miles south of Seattle began as bluffs overlooking the waters of the Puget Sound and the Olympic Mountains before turning into a mine at the turn of the twentieth century, eventually becoming the nation's largest producer of gravel. By the 1970s, the area's groundwater became so polluted with waste runoff that the US Environmental Protection Agency required Pierce County to build a wastewater treatment plant to clean up the area. The sewage plant, which opened in 1984, serves 250,000 Pierce county residents to this day. (Image 1.8) Ten years later, the mine had no more gravel to extract and the owners put the land up for sale. This site has been restored, the detail restoration status could read at [page100](#).

Image 1.7:

A landslide at Kennecott Utah Copper's Bingham Canyon Mine, Ravell Call, 2013.

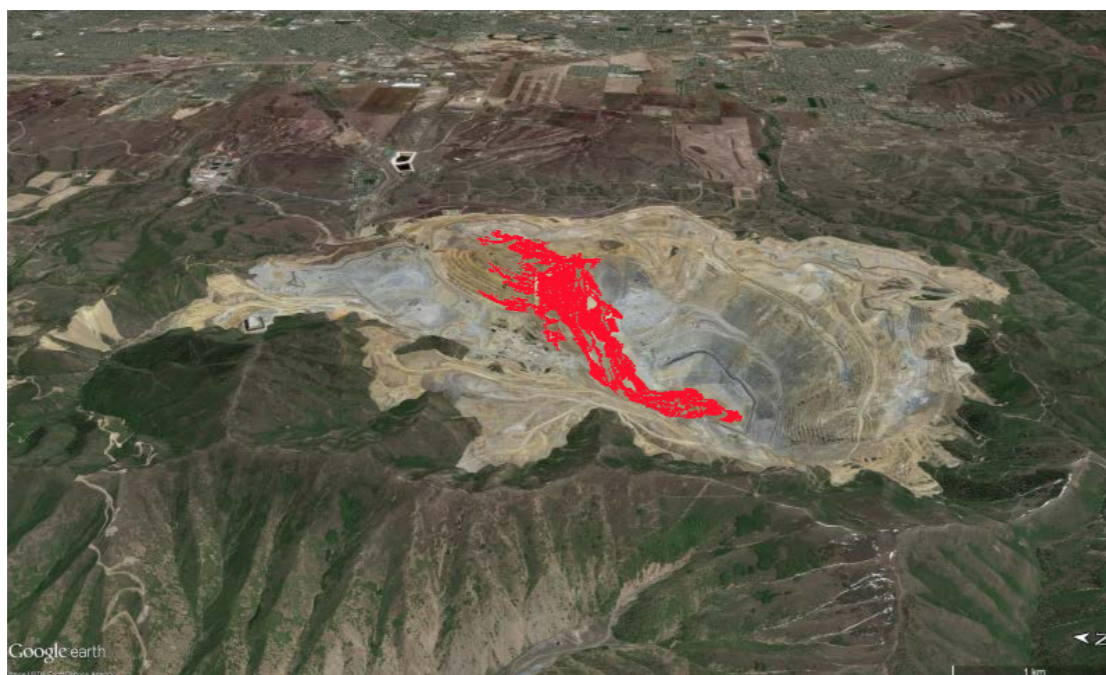
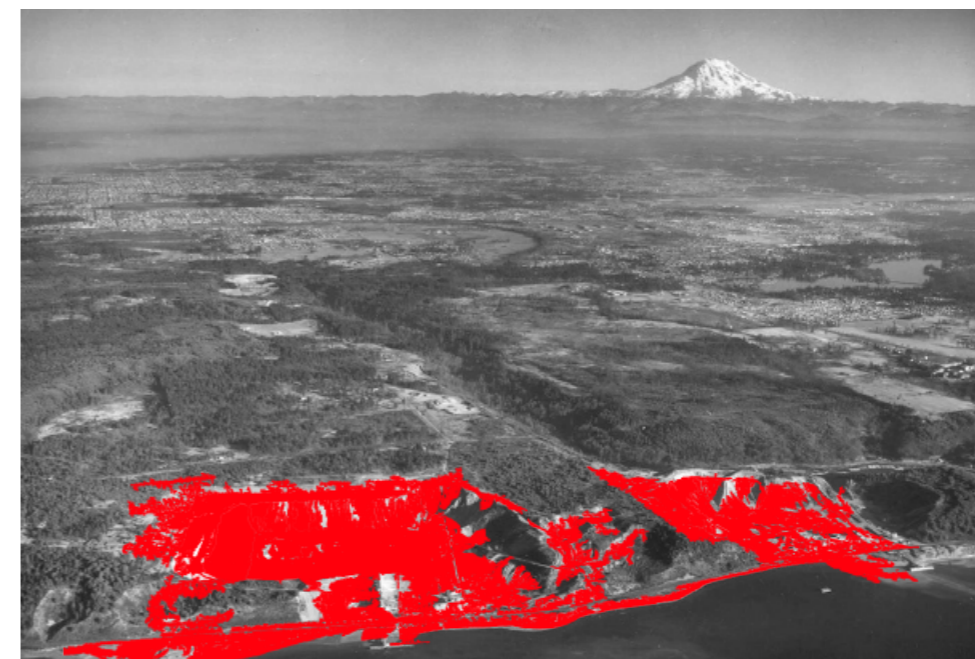


Image 1.8:

The current site of Chambers Bay golf course used to be a gravel mine, more than 165 million tons of aggregate were dug out of the Steilacoom site, also timber operations circa, Pierce County, 1940.



Flambeau Mine, America

The Flambeau deposit existed at very shallow depth. Depth to bedrock at the mining site ranged from about 15 to 40 feet. Glacial sand, gravel and till overlaid Cambrian sandstone, which in turn sat above the weathered Precambrian metamorphic rocks containing the Flambeau deposit.

Material removed from the pit was directed to one of several stockpiles on the site. A separate stockpile was created for the glacial overburden, sandstone, weathered bedrock and low-sulfur waste rock containing less than 1 percent sulfur. These materials were stored in an unlined 40-acre facility just north of the open pit. High-sulfur waste rock and other material containing greater than 1 percent sulfur, which was capable of generating acid drainage, was stored on a lined 27-acre stockpile area south of the pit. The high-sulfur stockpile was underlain with a plastic membrane liner and leachate collection system to prevent migration of potentially contaminated water from entering the groundwater system.

Groundwater flowing into the open pit was collected in sumps and pumped to holding ponds on the surface. Runoff from the ore stockpile/crusher area and waste rock piles as well as leachate from the high-sulfur waste rock storage facility was also directed to the same holding ponds. This water was then transported to a wastewater treatment facility and ultimately discharged to the Flambeau River upon meeting DNR state permit limits. The water treatment facility used lime neutralization, sulfide precipitation and filtration as the main treatment technologies. Over the life of the mining operation, discharge from the treatment facility averaged about 300 gallons per minute. (Image 1.9) This site has been restored, the detail restoration status could read at [page102](#).

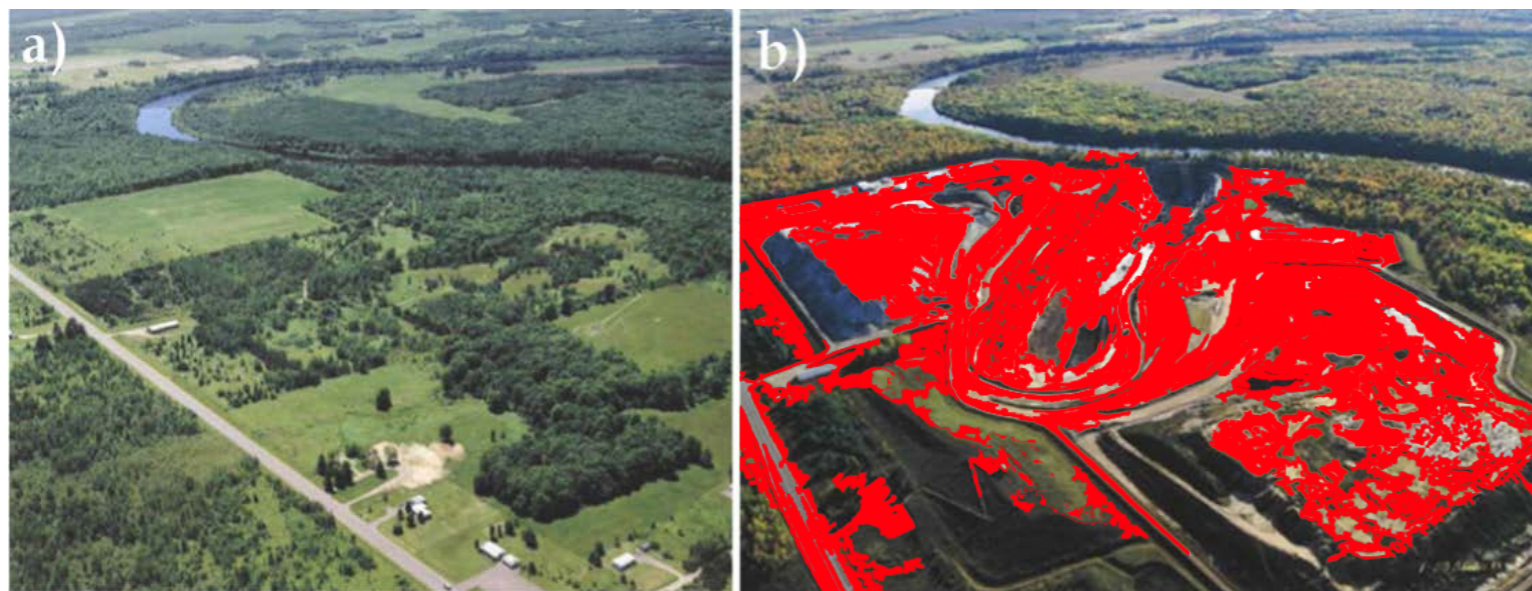


Image 1.9: Flambeau Mine Site: a) before mining (1991), b) during mining (1996).

Chen Mountain Quarry, China

Quarry Garden is located at the center of Shanghai Chen Mountain Botanical Garden, covering an area of 4.26 hectares (10.53 acres). Chen Mountain is isolated in the Garden and is nearly 70 meters (229.7 feet) high. Its appearance has been greatly destroyed and two east-west quarries are formed between the early 20th Century and the 1980s due to quarrying. One deep pool is left in the west quarry after the hill is explored and excavated into the ground. This site has little vegetation cover and lean species but severe rock weathering and water and soil loss. This site has been wholly abandoned with the Deep Pool fenced against people over the past twenty years. (Image 1.10) This site has been restored, the detail restoration status could read at [page157](#).

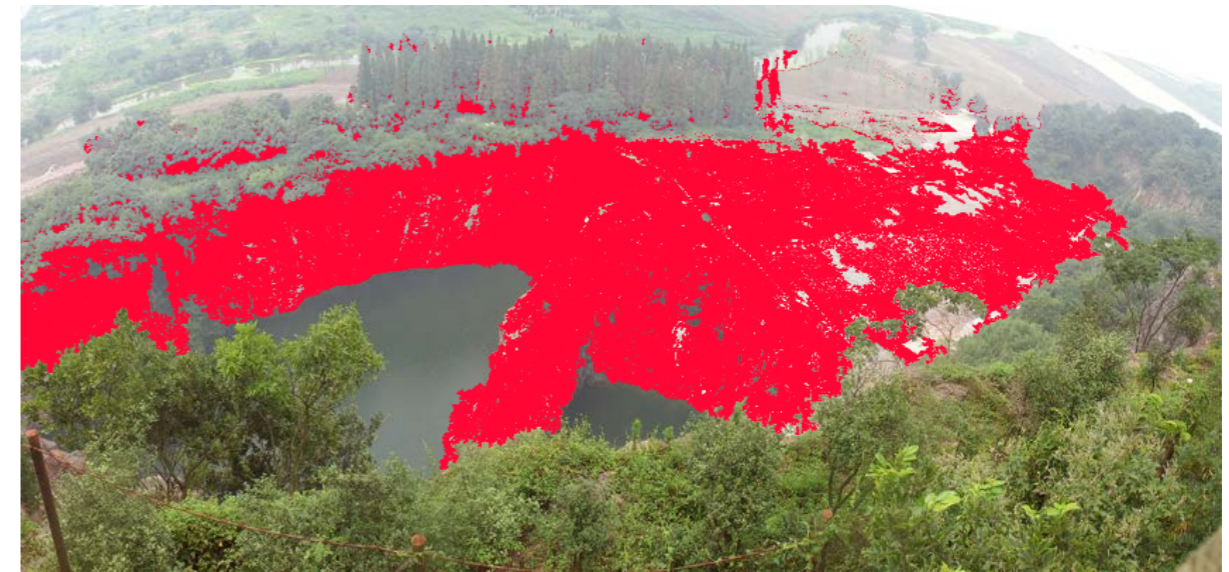


Image 1.10: Chen Mountain Quarry, 2006.

Agriculture disturbance

The Napa Sonoma Marsh, America

The Napa Sonoma Marsh is a wetland at the northern edge of San Pablo Bay, which is a northern arm of the San Francisco Bay in California, United States. There are 11,250 acres of former industrial salt ponds needed to be restored. Only a decade ago the area was a dry, desolate expanse of mud caked with white salt crystals. Since the Gold Rush of 1849, San Francisco Bay has shrunk by a third, as people don't like, dredged and filled its waters to create hay fields, housing subdivisions like Foster City, even airport runways.⁶

Urgency Significantly increasing salinities and declining ecological value in thousands of acres of ponds, Opportunity to use recycled wastewater if integrated into water projects currently being developed, Deteriorating levees, which could lead to levee breaches, high-saline discharges, and potentially fish kills, Deteriorating water control structures, reducing options for habitat management, Increased future restoration cost associated with site deterioration, Rising maintenance costs associated with deteriorating levees and water control structures, Escalating pumping costs as energy costs rise.⁷ (Image 1.11) This site has been restored, the detail restoration status could read at [page141](#).

⁶ Massive new wetlands restoration reshapes San Francisco Bay. (August 29, 2013). Retrieved April 22, 2015 from The mercury news: http://www.mercurynews.com/ci_23977411/massive-new-wetlands-restoration-reshapes-san-francisco-bay

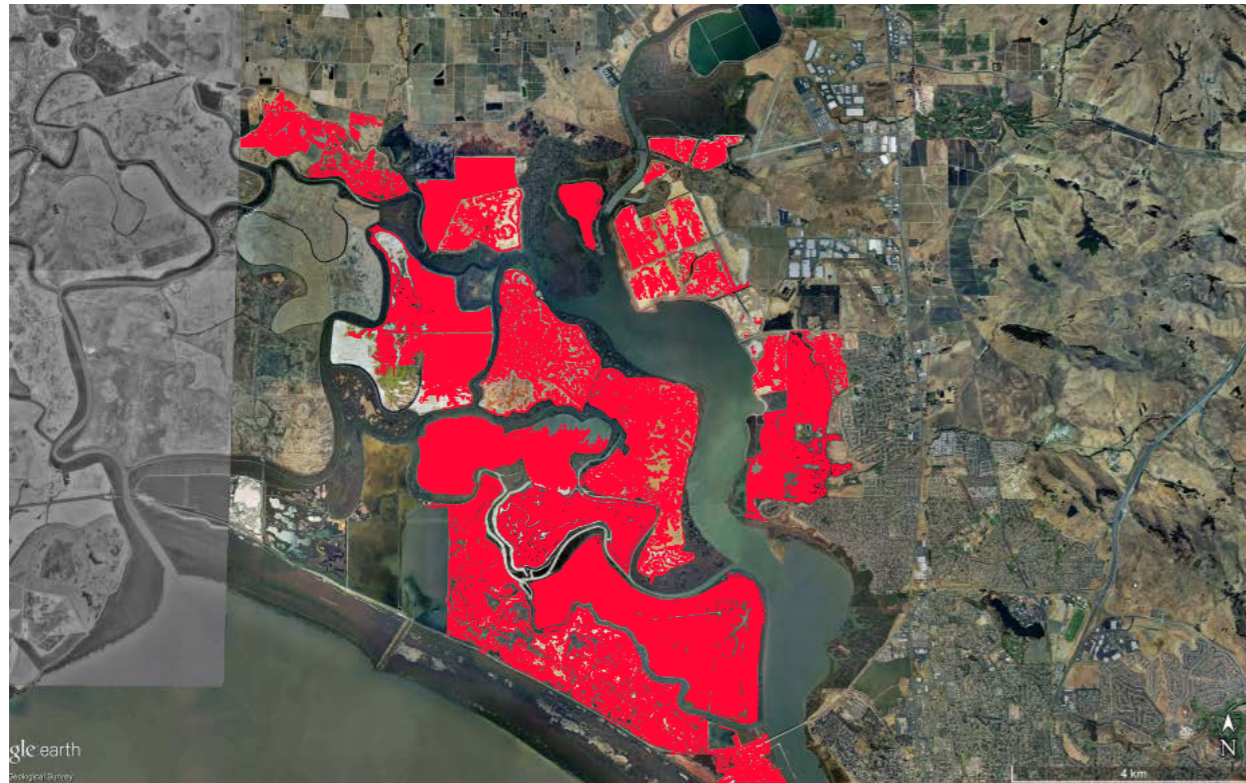


Image 1.11: The Napa Sonoma Marsh satellite images, 2003.

Ni-les'tun Tidal Marsh, America

The grazing and reclamation lead the Ni-les'tun Tidal Marsh to soil erosion. (Image 1.12,1.13) This site has been restored, the detail restoration status could read at [page144](#).

Shrimp aquaculture, Honduras

Shrimp aquaculture came to Honduras in the early 1970s, but the industry underwent vast expansion in the past two decades to become a major industry. Honduras is one of the top exporters of shrimp from Latin America. To create shrimp farms, coastal deltas are transformed from mangrove swamps into large holding ponds, which are then stocked with hatchery-raised or wild-caught shrimp brought in from the Gulf of Fonseca.

This pair of Landsat images shows the widespread conversion of natural mangrove swamps to shrimp farms along Pacific Coast of Honduras between 1987 and 1999. (Image 1.14) Deep blue colors show water features, including the Gulf of Fonseca and flooded river deltas. Pale pink is non-vegetated land. Shades of green show vegetation, ranging from the deep greens of swampland to the brighter greens of forested hillsides. The shrimp farms appear as rows of rectangles. In the older image (bottom), mangrove swamps wander through the estuaries of several rivers as they reach the Pacific coast. At least one major shrimp farm can be seen in the upper left quadrant, verifying that shrimp farming was already underway at the time. By 1999 (top image), much of the region had been converted to blocks of shrimp ponds.

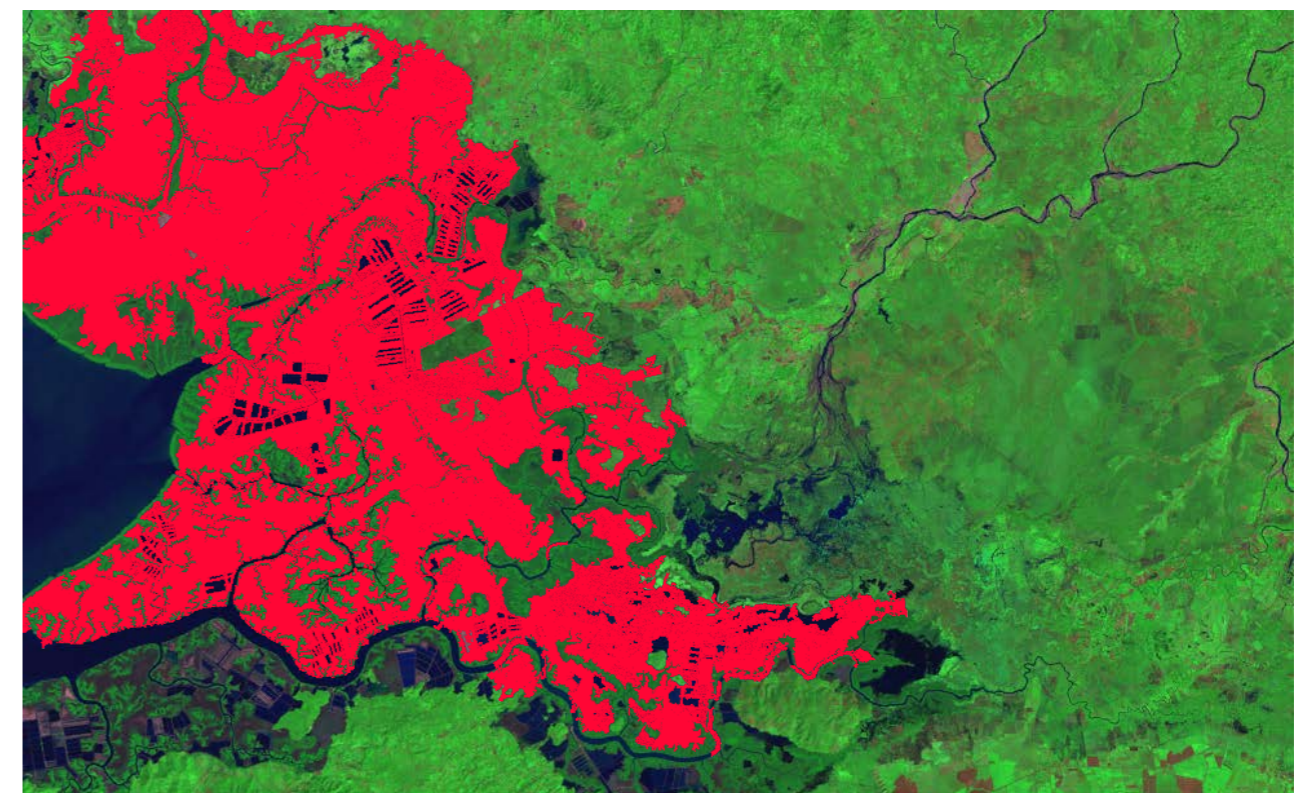


Image 1.14: The Gulf of Fonseca Landsat images top (1999) and bottom (1987).

While shrimp aquaculture has provided economic options in developing Latin American countries, the industry creates some environmental and social problems. Mangrove destruction degrades water quality, reduces habitat for fish (pitting shrimp farmers against those whose livelihood depends on fishing), increases the risk of inland flooding, and

⁷ Takekawa, J. Y., Miles, A. K., Schoellhamer, D. H., Martinelli, G. M., Saiki, M. K., & Duffy, W. G. (2000). Science support for wetland restoration in the Napa-Sonoma salt ponds, San Francisco Bay estuary, 2000 Progress Report. Unpubl. Prog. Rep., US Geological Survey, Davis and Vallejo, CA.

displaces coastal communities. The ponds themselves can contaminate the surrounding environment with too many nutrients (from fish meal fed to the shrimp), waste, and antibiotic residues. Also, the industry relies heavily on wild-caught shrimp, either larvae that have reached a given level of maturity or else pregnant females, which are transferred to the protected ponds. When done on industrial scale, the harvesting of wild shrimp in the Gulf can harm other fisheries because the nets pull up fish or other aquatic creatures that die and are discarded. National and international programs are underway to make shrimp farming both economically viable and more environmentally sound.⁸ A study in the wake of the 2004 tsunami of Aceh, Indonesia, which killed 220,000 people living near the Indian Ocean, cited models showing that 30 coastal trees per 100 square meters may reduce the flow of a tsunami by 90 percent, according to a 2005 report in the journal Science.

Mangrove communities could protect the coast from storms. Mangroves can reduce water levels by up to half a metre for each kilometre of mangrove that the storm surge passes through. This implies that relatively wide mangrove belts will be needed to reduce storm surges.⁹ The mangroves will not only protect the shoreline from storm damage and monsoon winds, waves and floods but reducing the amount of carbon dioxide in the air creating a healthier environment along the shore. Coastal wetlands, which include mangroves, tidal marshes and seagrass meadows, remove carbon from the atmosphere and lock it into the soil. Unlike terrestrial forests, coastal wetlands continually build carbon pools, storing huge amounts of carbon. If coastal wetlands are drained, for example to convert the land for agricultural use, they emit large amounts of CO₂ into the atmosphere. Coastal wetlands are vital habitats. Not only do they sequester vast amounts of CO₂, they also provide coastal communities with essential shelter from storm damage and flooding.¹⁰ (Image 1. 15)

As a foundation for conservation planning, remote-sensing ecologist Chandra Giri of the U.S. Geological Survey's Center for Earth Resources Observation and Science led a team of researchers who used Landsat images to map the extent of mangroves in tsunami-affected countries and to determine the rate and causes of deforestation from 1975 through 2000. "The most important result obtained from South and Southeast Asia is that agriculture is the main factor responsible for mangrove destruction," said Giri. That finding was contrary to the widespread belief that shrimp farming was the primary cause of deforestation.¹¹ (Image 1. 16) This site has been restored, the detail restoration status could read at [page130](#).

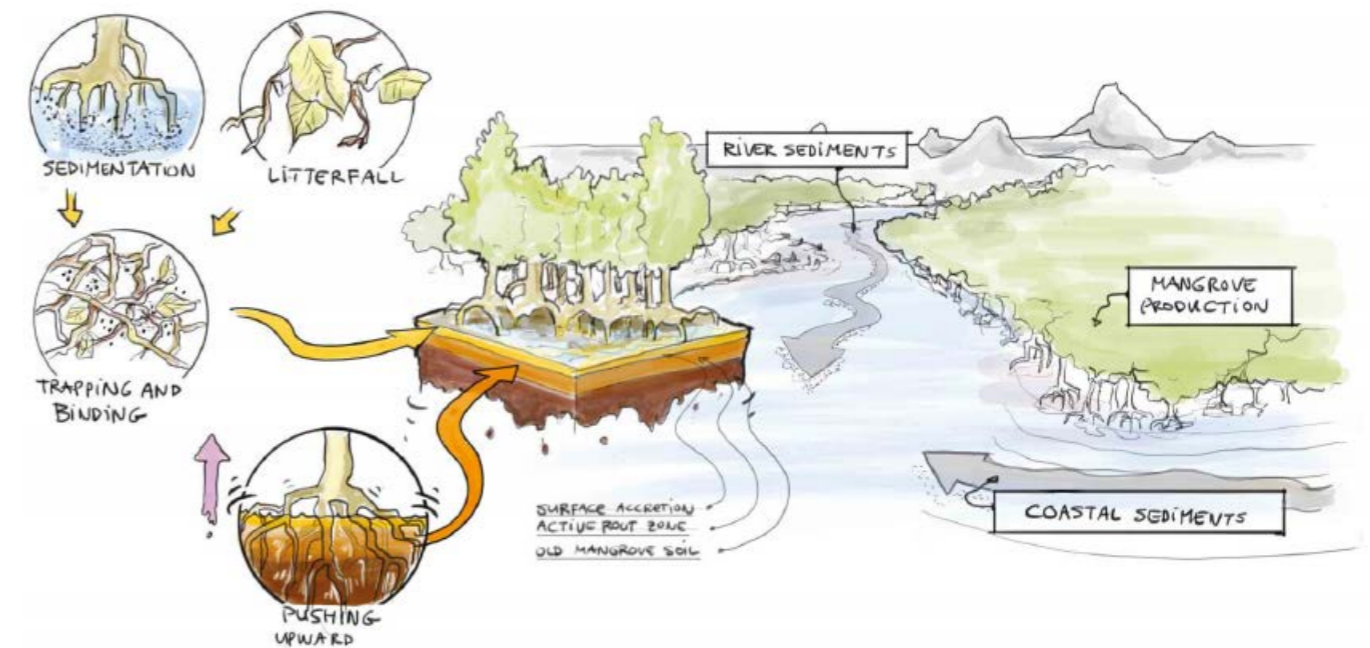


Image 1. 15: Mangroves for coastal defence, Spalding. M, 2012.

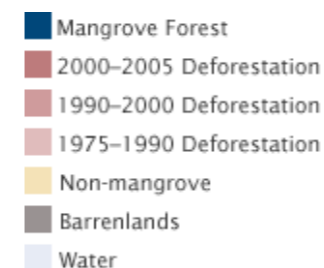
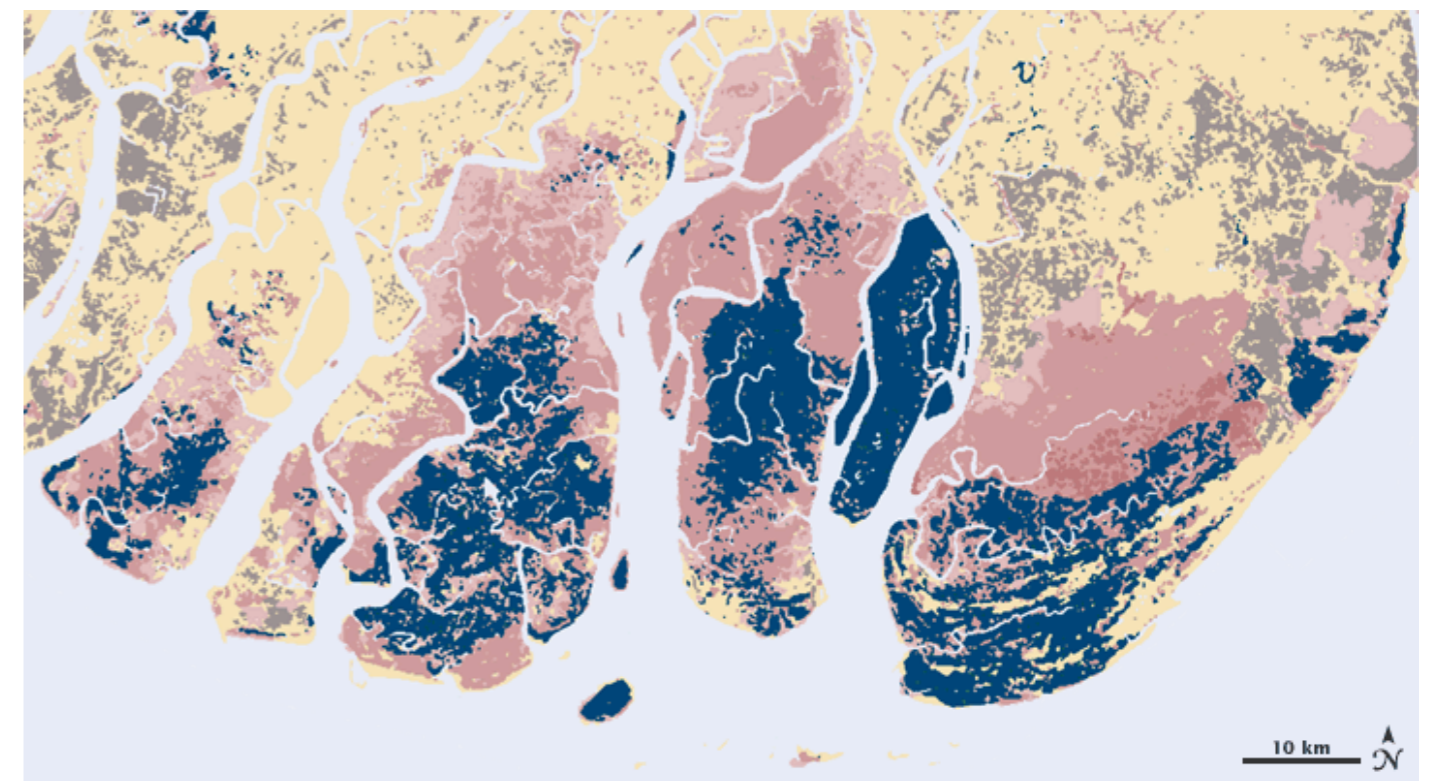


Image 1. 16:

USGS ecologists produced this map of mangrove deforestation in Burma's (Myanmar's) Irrawaddy Delta using an older version of the Global Land Survey dataset. Recent improvements are allowing them to map mangrove deforestation worldwide. (Map adapted by Robert Simmon from Giri et al, 2008.)

⁸ United Nations Environment Programme. (2005). One Planet, Many People: Atlas of Our Changing Environment.

⁹ Giesen, W., Wulffraat, S., Zieren, M., & Scholten, L. (2007). Mangrove guidebook for Southeast Asia. FAO Regional Office for Asia and the Pacific.

¹⁰ Ruth Hendry. (April 11, 2011). Damaged coastal wetlands means bad news for our climate. Retrieved April 22, 2015 from Earthtimes: <http://www.earthtimes.org/climate/damaged-coastal-wetlands-means-bad-news-climate/701/>

¹¹ Evaluating Mangroves After the 2004 Indian Ocean Tsunami (Sept 23, 2011). Retrieved April 22, 2015 from Nasa: <http://earthobservatory.nasa.gov/Features/GlobalLandSurvey/sb3a.php>

Burning lowland forests, Sumatra

On September 5, 2015, the Operational Land Imager on the Landsat 8 satellite acquired this image of smoke billowing from fires in Jambi Province on the Indonesian island of Sumatra. The false-color image was made with a combination of visible (green) and infrared light so that fires and freshly burned land stand out. Fires glow orange, and newly burned land is dark red. The blue smudges running diagonally across the image are smoke. (Image 1.17) Bare soil or older burn scars are a lighter shade of red. Clouds are white. The lower image shows a broader view of the area. The fact that the fires burned within well-defined rectangular grids suggests that these were agricultural fires intentionally set by growers. According to land-use maps published by Global Forest Watch, the fires are burning within a palm oil plantation. Palm oil production is highly profitable, and the commodity is an important export for Indonesia, the world's largest producer. The Jakarta Post reported that heavy smoke from the fires in Sumatra has caused levels of air pollution to spike throughout the island and in parts of Malaysia.

The widespread burning of lowland forests on Borneo as well as southern Sumatra, as seen in this image taken by the MODIS instrument on the Aqua satellite, is an annual, manmade occurrence. People use fires to manage agricultural lands which in this part of the world includes large palm tree plantations. Sometimes these fires burn out of control. In addition, there are other fires that started accidentally during activities like logging and also quickly get out of control. Another method of wildfires comes from lightning strikes in dry, hot areas. This being an El Nino year Indonesia is experiencing lower than average rainfall which can turn in a severe drought. Forests which are usually swampy dry out leaving behind a rich abundance of fire fuel in the form of peat, both intentional and accidental fires can quickly grow out of control. When peat dries it is quite flammable. Burning peat also generates a huge amount of thick, dark smoke. This thick smoke produced by these fires contributes to the greenhouse gas emissions worldwide.

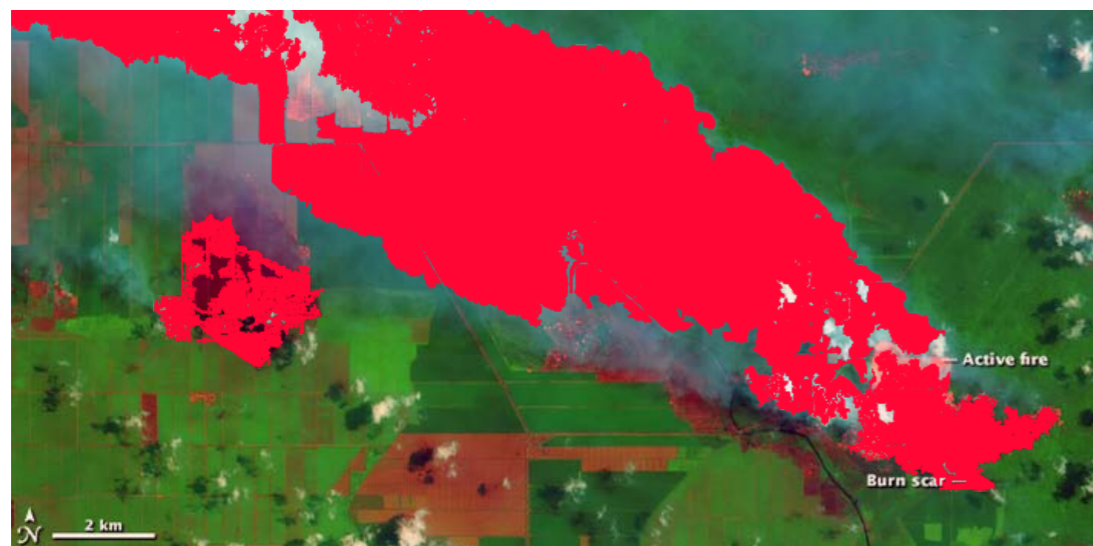


Image 1.17: Landsat8 satellite collected this natural-color image on September 23, 2015. Actively burning areas, detected by thermal bands analysis, are outlined in red.

1.1.2 The fragmented patch under city over-expansion disturbance

Landfill disturbance

Garraf Landfill, Spain

In 1972, Barcelona City Council published a public call for tenders for the management of a new controlled landfill site located in the Garraf massif. The groundwork started at the end of 1973. The Garraf controlled landfill site was officially inaugurated, and the first waste was deposited in 1974. The recovery plants come into service. The volume accumulating over the thirty two years of life of the garraf controlled landfill site is of 26,676000 ton from 1974 to 2006. The deposition of waste has meant that, in some parts of the valley, its elevation has reached 80 m (central area).¹²(Image 1. 18, 1.19)

This site has been restored, the detail restoration status could read at [page104](#).



Image 1. 18: Garraf Landfill, 1974.

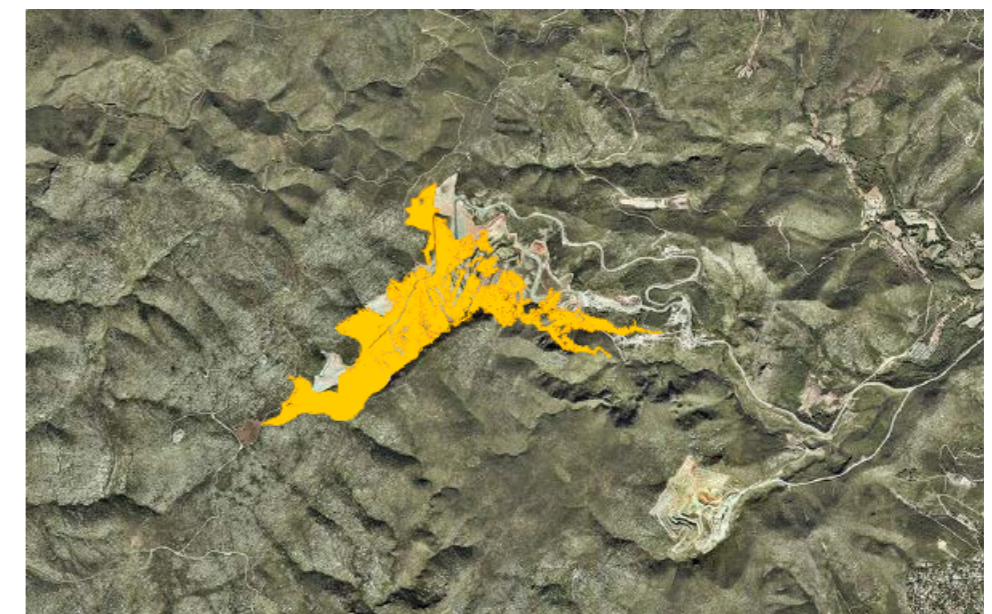


Image 1. 19: Garraf Landfill, 2000.

¹² Jose Cuervo.(2007). El deposit controlat de la Vall d'en Joan. Spain: GG.

Lhasa landfill, China

Lhasa landfill climate is semi-arid monsoon, with a low average temperature of 1.2 to 7.5 °C, annual rainwater 509mm, snow periods 150 days, annual southeaster, Typically there are 3,000 hours of sunshine each year. The site is located on the south of the Tibet plateau, which was officially inaugurated in 2003, includes two phases. The capacity of first phase has been closed in 2015. The capacity of second phase has began into operation in 2015, designed service life of 50 years. However, on the plateau, because of climate and nature environment is too different with general area, which brings many difficulties to the landfill operation. The cold climate not only couldn't keep the temperature of the Leachate biochemical treatment pool stay around 20-30°C, but also directly make the conduit blocked, which make 15 ton/day leachate have to spill back to the landfill area, then the underground soil and underground water polluted by the organic waste, heavy metal and virus. Moreover, facing the rainstorm and windy day, the fragile situation will get worsen, that malodorous gas and leachate will spill to surrounding area and river. (Image 1.20)

In chapter 3, I will do the detail assessment on this site, the detail analysis content could read at [page130](#).

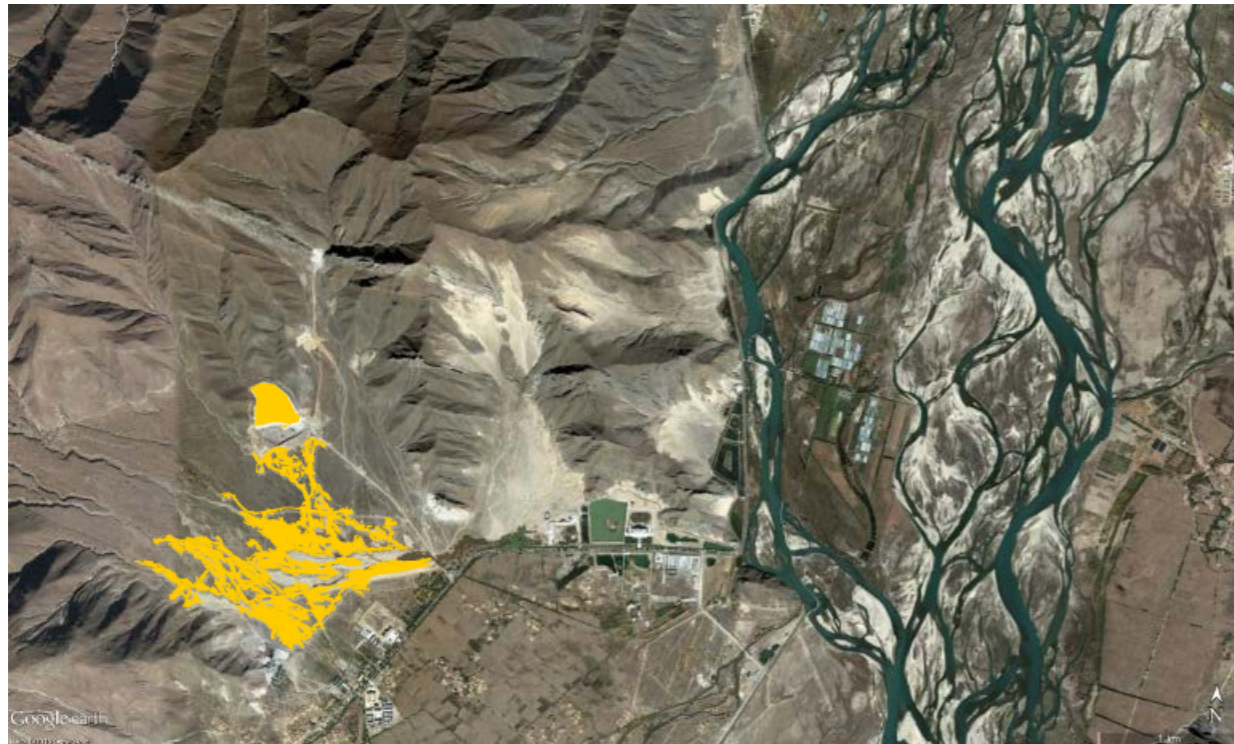


Image 1.20: The Lhasa landfill satellite image, 2005.

Jinkou landfill, China

Jinkou landfill is located in Wuhan city, China. There are 4 areas in this landfill, area 1 is located in the northeast of this site, area is 6.4 ha, thickness of landfill is 13 meters, volume is 83.20 cu.m; area 2 is located in the center of this site, area is 14.9 ha, thickness of landfill is 15 meters, volume is 223.95 cu.m; area 3 is located in the center east of this site, area is 9.77 ha, thickness of landfill is 11 meters, volume is 107.47 cu.m; area 4 is

located in the south of this site, area is 9.76 ha, thickness of landfill is 9 meters, volume is 87.84 cu.m. (Image 1.21, 1.22) This site has been restored, the detail restoration status could read at [page105](#).



Image 1.21: The Jinkou landfill satellite image, 2009.



Image 1.22: The Jinkou landfill, 2014.

Slums disturbance

Mathare, Kenya

Mathare is a collection of slums in Nairobi, Kenya with a population of approximately 500,000 people; the population of Mathare Valley alone, the oldest of the slums that make up Mathare, is 180,000 people. Mathare is the home of football team Mathare United of the MUSA. (Image 1.23)

In 2006, Mathare was damaged by violence between rival gangs the Taliban (not to be confused with the Islamist group of the same name), a Luo group, and the Mungiki, a Kikuyu group. Brewers of an illegal alcoholic drink, asked the Taliban for help after the Mungiki tried to raise their taxes on the drink; since then, fighting between the two has led to the burning of hundreds of homes and at least 10 deaths. Police entered the slum on November 7th 2006 and the General Service Unit arrived a day later. However, many residents who fled are still afraid to return. On June 5, 2007, the Mungiki murdered two

police officers in Mathare; the same night, police retaliated by killing 22 people and detaining around 100. Following the controversial presidential elections that took place on December 27th 2007, gangs of Kikuyu and Luo youth engaged in violent fights and burned more than 100 homes.¹³ All these also are happening in the Bossaso slum. (Image 1.24)

Sêrtar, China

Sêrtar County is a county of Sichuan Province, China. Sêrtar is at an altitude of around 4,100 meters above sea level. It is home to the Larung Gar Buddhist Institute, the largest Tibetan Buddhist institute in the world. As many of the houses in Larung Gar are made of wood, they present a constant fire hazard. On the evening of 10 January 2014, a fire broke out in Larung Gar, burning down more than a dozen structures. Furthermore, local houses are located in the high-density and disrepair environment, which bring the big potential living sewage problem to whole Sertar town. (Image 1.25)



Image 1. 23: The Mathare Valley slum, Allia.C, 2009. Image 1. 24: The Bossaso slum, Daily Mail, 2014.



Image 1.25: Sêrtar, Tugo Cheng, 2016.

¹³Mathare. (July 6, 2006). Retrieved April 22, 2015 from Wikipedia, the free encyclopedia: <https://en.wikipedia.org/wiki/Mathare>

Turó de la Rovira hill, Spain

During the Spanish Civil War, the fascist Italian Legionary Air Force used Barcelona as its first testing ground in the brutal tactic of “carpet bombing” which eventually became routine practice in the Second World War. Eight hundred people died in the indiscriminate attack, more than a thousand were wounded and about fifty buildings were destroyed. As its only defence the city had an extensive network of underground air raid shelters constructed by the population, and a system of anti-aircraft gun emplacements that were installed by the Republican Government. The first of these was located on the top of the Turó de la Rovira which, with a height of 262 meters, is the highest peak in Barcelona’s urban fabric.

The military infrastructure, consisting of seven circular gun platforms, a rectangular platform for the military command personnel and shelters for the troops, was abandoned after the war ended. In the early post-war period the remains were used to construct a squatter settlement known as “Els Canons” (The Guns). Over decades of large-scale immigration of workers from other parts of Spain, and owing to lack of housing, Els Canons ended up with more than a hundred self-built houses. If their inhabitants had few material resources, their resourcefulness was great and they were well organized, struggling for better accommodation in the future while, at the same time, equipping and improving their everyday living space as best they could. (Image 1.25)

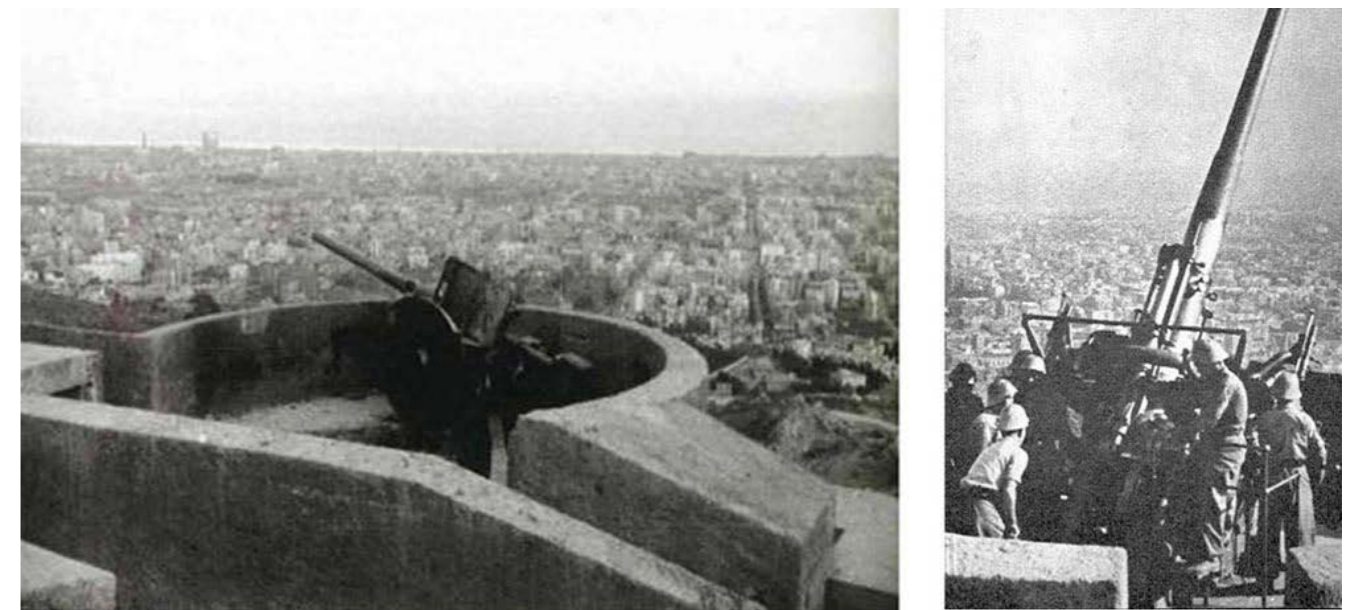


Image 1.25: Turó de la Rovira hill as forts, 1937.

The last of these shacks were demolished shortly before the 1992 Olympic Games, leaving behind on the hill’s stony ground tiled floors, fragments of stairs and remnants of masonry walls. Over the next twenty years the hilltop, marked by the overlapping of the significant fragments of history it had accumulated, surrendered its land to clumps of shrubs, rubbish dumping, graffiti and a lookout for the few people who knew the secret of its privileged

views over the Carmel neighborhood in the north and, in the opposite direction, the plain of Barcelona with the sea in the background.¹⁴(Image 1.26, 1.27) This site has been restored, the detail restoration status could read at [page106](#).

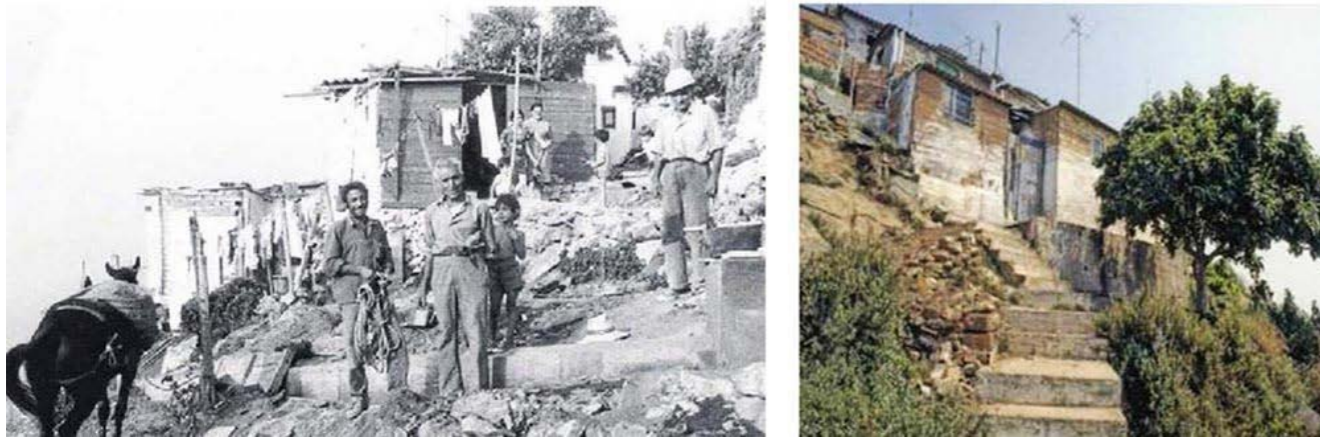


Image 1.26: Turó de la Rovira slum, 1960.



Image 1.27: Deserted Turó de la Rovira hill, Aniol, 2008.

1.1.3 The fragmented path under the nature disaster disturbance

Drought disturbance

Owens Lake, America

This particular lake was not drained by California's drought, the worst on record here. Owens Lake was drained between 1913 and 1924, the first years of operation of the Los Angeles Aqueduct, the 233-mile feat of hydraulic engineering that lined Santa Monica Boulevard with palms, transformed the arid San Fernando Valley into orange groves, and

grew Los Angeles from a city of 300,000 to one of 4 million. "Either you bring the water to L.A. or you bring L.A. to the water," John Huston's character tells Jack Nicholson's character in Chinatown, Robert Towne's noir masterpiece inspired by the Owens Valley water wars. William Mulholland, the engineer on whom Huston's character is in part based, brought the water to L.A., and the rest is history. (Image 1.28)



Image 1.28: The Los Angeles Aqueduct opens with 40,000 Angelenos in attendance, 1913.

Today, Owens Lake is a mostly dry lake in the Owens Valley on the eastern side of the Sierra Nevada in Inyo County, California. It is about 5 miles (8.0 km) south of Lone Pine, California. Unlike most dry lakes in the Basin and Range Province that have been dry for thousands of years, Owens held significant water until 1913, when much of the Owens River was diverted into the Los Angeles Aqueduct, causing Owens Lake to desiccate by 1926. Today, some of the flow of the river has been restored, and the lake now contains some water. Nevertheless, as of 2013, it is the largest single source of dust pollution in the United States.¹⁵(Image 1.29)

The Owens lake bed lies between the Sierra Nevada to the west and the Inyo Mountains to the east. Spanning 110 square miles, the bed is vast enough that, observed from a helicopter, you cannot make out its shape. (In satellite images, its form looks something like the outline of South America, if South America were melting in the desert heat.) As you fly clockwise around the perimeter, a grid of sorts begins in the north, an ad hoc

¹⁴Arrangement of the summit of the Turó de la Rovira hill. (April 6, 2011). Retrieved April 22, 2015 from Public space: <http://www.publicspace.org/en/works/g320-arranjament-dels-cims-del-turo-de-la-rovira/prize:2012>

¹⁵Owens_Lake. (June 6, 2013). Retrieved April 22, 2016 from Wikipedia, the free encyclopedia:

mosaic that runs the eastern length of the bed and wraps around its southern end. Many of the mosaic pieces are trapezoids, and most are gray plains of dried, cracked earth.¹⁶ The state's record drought and more efficient irrigation methods have cut that flow of water, exposing the playa, or lake bed, and putting air quality, wildlife, and crops in jeopardy, that is also a key stopover on the Flyway for migrating birds in need of wet habitats, which are scarce. Shrinking lakes will form the dust storms, the increased salinity left by the evaporating water also makes it hard for fish to thrive. "As salinity goes up, the fish won't reproduce, and so there will just be older fish left that will eventually die off, and this in turn is going to hurt all the fish-eating birds," ecologist Wilcox said.¹⁷ (Image 1.30)

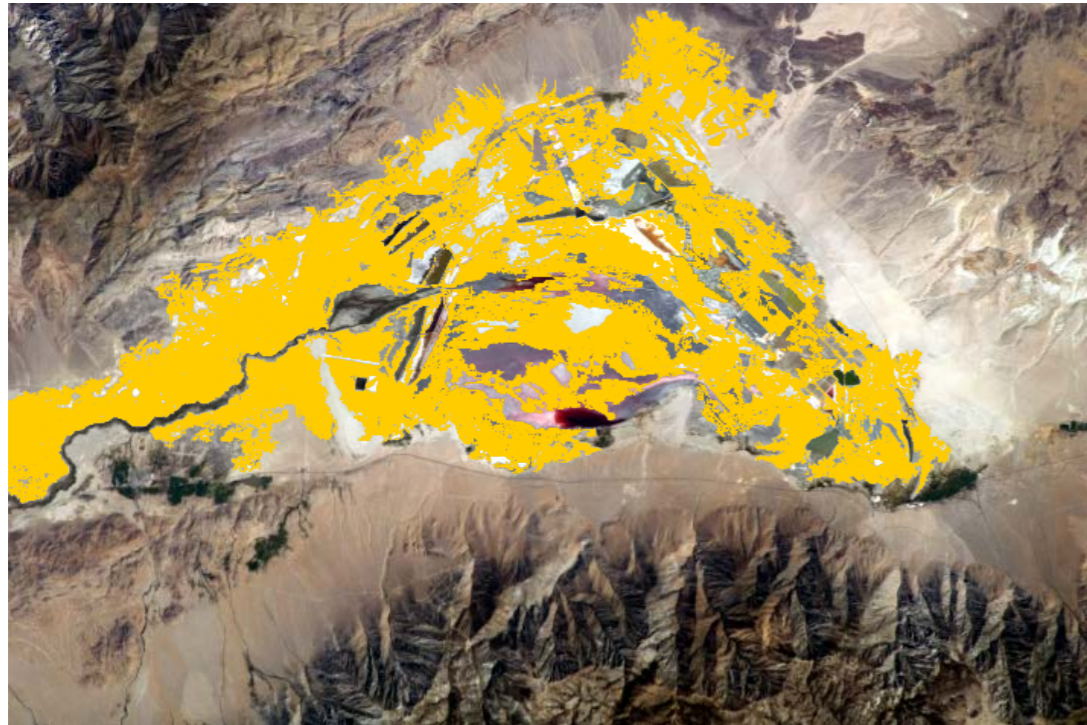


Image 1.29: This astronaut photograph highlights the mostly dry bed of Owens Lake, Nasa, 2011.



Image 1.30: Bacteria turns the brine pool red in the dried Owens lake bed, STEINMETZ. G, 2015.

¹⁶Where Chinatown Began. (October 1st, 2015). Retrieved April 22, 2016 from Vogue: <http://www.vogue.com/projects/13353964/california-drought-owens-lake/>

¹⁷Padma Nagappan. (Nov 8, 2014). Retrieved April 22, 2016 from Takepart: <http://www.takepart.com/article/2014/11/06/california-farmers-are-saving-water-and-thats-bad-wildlife>

Aral Sea

The incredible shrinking lake: In just a few decades, the Aral Sea in Kazakhstan has dried up drastically. It used to be the fourth largest lake in the world, but has been shrinking ever since the former Soviet Union started diverting water from it in 1960 for agricultural purposes. The black outline on both images shows the lake's approximate shores in 1960.¹⁸ (Image 1.31)

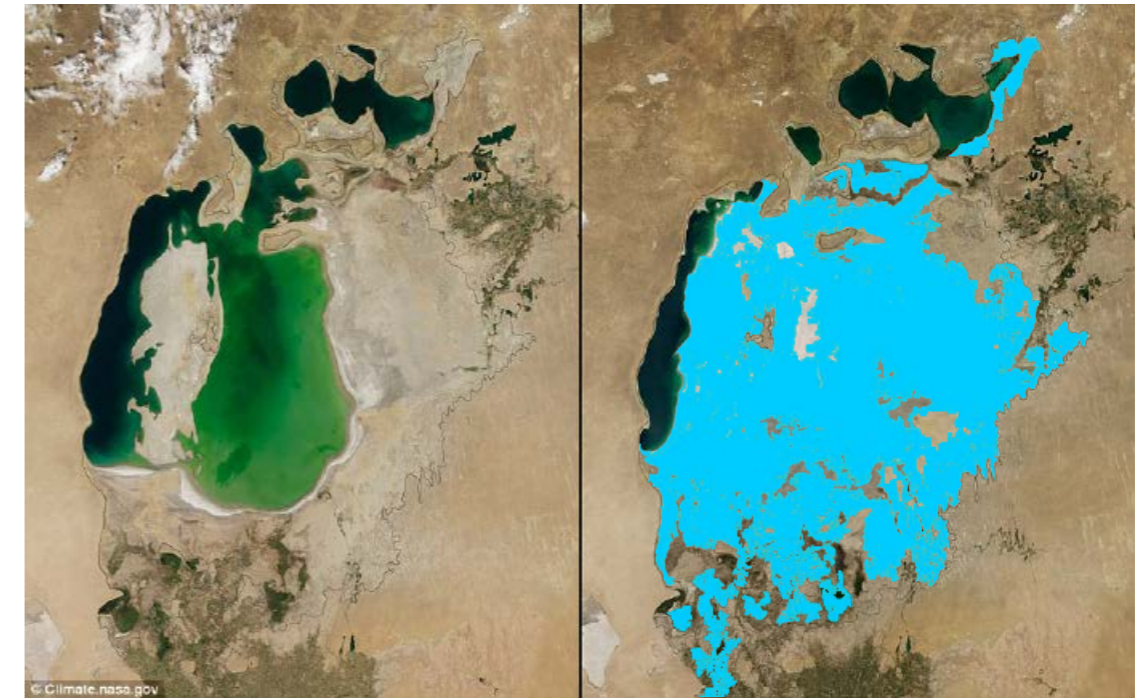


Image 1.31: The shrinking Aral Sea satellite images left, 1980 and right, 2010.

Earthquake disturbance

512 Sichuan big earthquake, China

The 512 Sichuan big earthquake, measured at 8.0 Ms and 7.9 Mw, and occurred at 02:28:01 PM China Standard Time at epicenter (06:28:01 UTC) on May 12 in Sichuan province, killed 69,197 people and left 18,222 missing. It was the deadliest earthquake to hit China since the 1976 Tangshan earthquake. The Beichuan town hardest hit by the earthquake, almost all the city area was destroyed. (Image 1.32) This site has been restored, the detail restoration status could read at [page172](#).

Belice earthquake, Italy

The 1968 Belice earthquake sequence took place in Sicily between 14 and 15 January. The largest shock measured 5.5 on the moment magnitude scale, with five others of magnitude 5+. The maximum perceived intensity was X (Extreme) on the Mercalli intensity scale. The earthquake sequence, centred between the towns of Gibellina, Salaparuta and Poggioreale, killed at least 231 people, possibly more than 400, with between 632 and about 1,000 injured and left 100,000 homeless. It is known in Italy as Terremoto del Belice.¹⁹ (Image 1.33) This site has been restored, the detail restoration status could read at [page170](#).

¹⁸ The devastating effect humans are having on the planet laid bare by these stunning now and then pictures. (March 16, 2015). Retrieved April 22, 2016 from Dailymail: <http://www.dailymail.co.uk/news/article-2996485/The-devastating-effect-humans-having-planet-laid-bare-stunning-pictures.html#ixzz3UXRPxRaA>



Image 1.32: The broken Beichuan city after the 512 Sichuan big earthquake, Sun Liang, 2008.



Image 1.33: Belice earthquake, 1968.

Avalanche disturbance

Iceland avalanche

Longyearbyen avalanche

The entrance tunnel to the worldwide gene bank Svalbard Global Seed Vault (SGSV) near Longyearbyen on Spitsbergen, Norway, On Dec. 19, 2015 11:46 am, The avalanche tumbled down Saturday about 11 a.m. from Sukkertoppen Mountain into Longyearbyen, the main settlement on Svalbard, shoving houses off their foundations, flipping cars and burying people under meters (yards) of snow. (Image 1.34)

¹⁹ 1968 Belice earthquake. (Aril 14, 2015). Retrieved April 22, 2016 from Wikipedia: https://en.wikipedia.org/wiki/1968_Belice_earthquake

Sudavik avalanche

Happened January 16th, 14 people, 8 children and 6 adults, died in the avalanche that fell on Sudavik on the Monday morning, January 16th 1995. The avalanche in Sudavik is the most destructive one in Iceland since 1919, when 18 people died in the avalanche in Siglufjordur. It was surprising how far the avalanche fell. The avalanche was a dry loose snow avalanche when it started and the landscape couldn't do anything to slow it down there is a wet slab avalanche. The weather at this time was unusual. Stiff northwest wind with a lot of precipitation which was the cause of a lot of snow gathering together very fast up in the mountain above the town. In October 1995 an avalanche hit the village again, destroying 29 homes and killing 20 people.²⁰ (Image 1.35, 1.36) This site has been restored, the detail restoration status could be read at [page 110](#).



Image 1.34: Rescue after avalanche in Longyearbyen, 2015.



Image 1.35: Avalanche monitoring for Flateyri, 2014.



Image 1.35: Rescue team workers, Rax. Ragnar, 1995.

²⁰ Flateyri. (August 14, 1999). Retrieved April 22, 2016 from Wikipedia: <https://en.wikipedia.org/wiki/Flateyri>

1.1.4 The fragmented pacth under humanity damage disturbance

Terrorist attack disturbance

Paris Terrorist attack, France

On the evening of 13 November 2015, a series of coordinated terrorist attacks—consisting of mass shootings, suicide bombings, and hostage-taking—occurred in Paris, France, and Saint-Denis, one of its northern suburbs. Beginning at 21:16 CET, six mass shootings in central Paris and three separate suicide bombings near the Stade de France occurred. The deadliest attack was at the Bataclan theatre, where attackers took hostages and engaged in a stand-off with police which ended at 00:58 on 14 November. The Islamic State of Iraq and the Levant (ISIL) claimed responsibility for the attacks. 129 victims were killed, 89 of them at the Bataclan theatre. A further 415 were admitted to hospital with injuries sustained in the attacks, including 80 people described as being seriously injured.²¹ (Image 1.37)

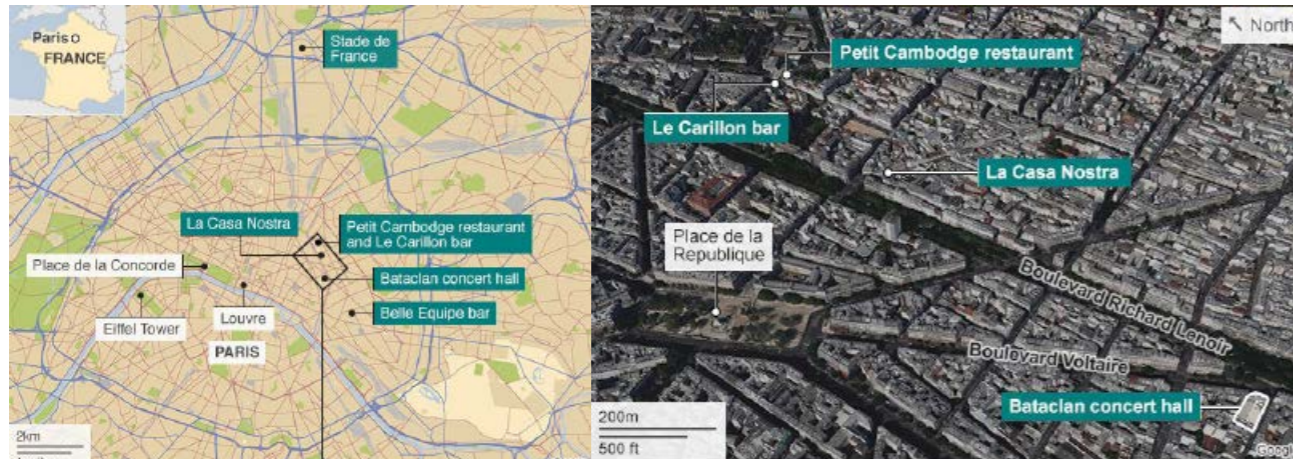


Image 1.37: These points are the Paris Terrorist attack points, BBC, 2015.

911terrorist attack, America

The September 11 attacks (also referred to as September 11, September 11th, or 9/11) were a series of four coordinated terrorist attacks by the Islamic terrorist group al-Qaeda on the United States on the morning of Tuesday, September 11, 2001. The attacks consisted of suicide attacks used to target symbolic U.S. landmarks. Four passenger airliners—which all departed from airports on the U.S. East Coast bound for California—were hijacked by 19 al-Qaeda terrorists to be flown into buildings. Two of the planes, American Airlines Flight 11 and United Airlines Flight 175, were crashed into the North and South towers, respectively, of the World Trade Center complex in New York City. Within an hour and 42 minutes, both 110-story towers collapsed, with debris and the resulting fires causing partial or complete collapse of all other buildings in the World Trade Center complex, including the 47-story 7 World Trade Center tower, as well as significant damage to ten other large surrounding structures. A third plane, American Airlines Flight 77, was crashed into the Pentagon (the headquarters of the United States Department of Defense)

²¹ November 2015 Paris attacks. (Nov 14, 2015). Retrieved April 22, 2016 from Wikipedia: https://en.wikipedia.org/wiki/November_2015_Paris_attacks

in Arlington County, Virginia, leading to a partial collapse in the Pentagon's western side. The fourth plane, United Airlines Flight 93, initially was steered toward Washington, D.C., but crashed into a field near Shank, Pennsylvania, after its passengers tried to overcome the hijackers. In total, the attacks claimed the lives of 2,996 people (including the 19 hijackers) and caused at least \$10 billion in identify and infrastructure damage and \$3 trillion in total costs. It was the deadliest incident for firefighters and law enforcement officers in the history of the United States, with 343 and 72 killed respectively.²² (Image 1.38, 1.39) This site has been restored, the detail restoration status could read at [page113](#).



Image 1.38: 911terrorist attack satellite images before (left, 2001) and after (right, 2001) .



Image 1.39: The plane was hitting the World Trade Center, Eyes open report, 2001.

²² September 11 attacks. (Nov 9, 2001). Retrieved April 22, 2016 from Wikipedia: https://en.wikipedia.org/wiki/September_11_attacks

War disturbance

Buddhas of Bamiyan destroyed

Buddhas of Bamiyan were constructed in the sixth century, at a time when the area was a site of pilgrimage and learning for Buddhists. Bamiyan lies on the Silk Road, which runs through the Hindu Kush mountain region, in the Bamiyan Valley. The Silk Road has been historically a caravan route linking the markets of China with those of the Western world. It was the site of several Buddhist monasteries, and a thriving center for religion, philosophy, and art. Monks at the monasteries lived as hermits in small caves carved into the side of the Bamiyan cliffs. Most of these monks embellished their caves with religious statuary and elaborate, brightly colored frescoes. It was a Buddhist religious site from the 2nd century up to the time of the Islamic invasion in the later half of the 7th century. Until it was completely conquered by the Muslim Saffarids in the 9th century, Bamiyan shared the culture of Gandhara. The two most prominent statues were the giant standing Buddhas Vairocana and Sakyamuni, identified by the different mudras performed. The Buddha popularly called "Solsol" measures 53 meters tall, and "Shahmama" 35 meters—the niches in which the figures stand are 58 and 38 meters from bottom to top. (Image 1.40)

Both Buddhas were carved out of sandstone cliffs and stood at well over 100 feet, and at one point painted and gilded. They managed to withstand the introduction of Islam to the region and the armies of Genghis Khan, but were unable to survive past the first year of the 21st century. In March 2001 the Taliban destroyed huge ancient statues of Buddha in Afghanistan. The statues were carved into the cliffs above the Bamiyan valley. Sayid Mirza Hossein, a local farmer, was taken prisoner by the Taliban and forced to pack explosives around the ancient Buddhas. He told Witness what it felt like to destroy something that he had seen every day of his life.²³ (Image 1.41, 1.42) This site has been restored, the detail restoration status could read at [page114](#).



Image 1.41: Destruction of the Buddhas of Bamiyan by the Taliban, CNN, 2001.



Image 1.42:
The Buddhas of Bamiyan are perhaps the latest example of erasing the past. The 53 m tall statue along with others was dynamited by the Taliban in 2001.

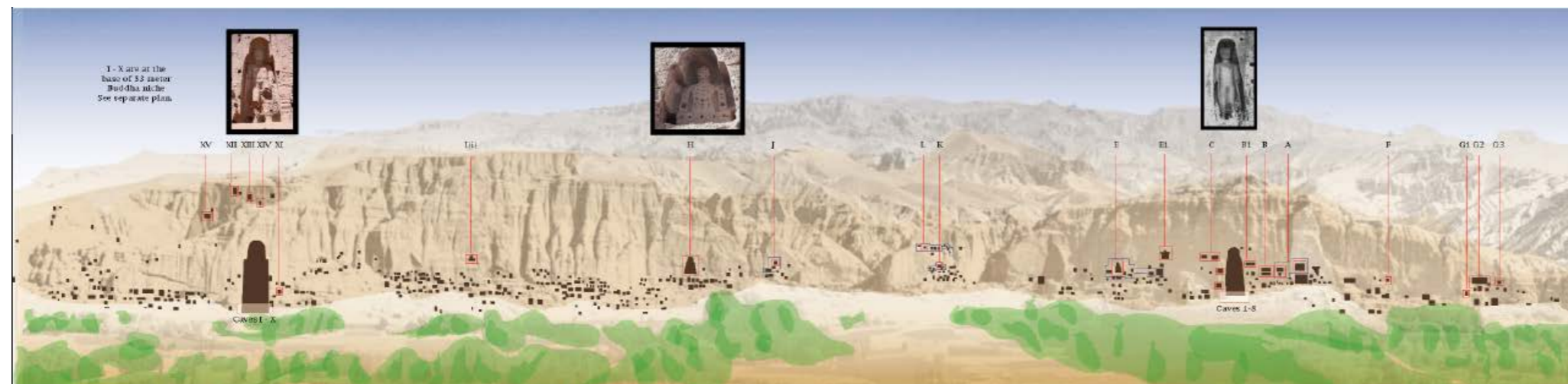


Image 1.40: Numbering and lettering system from Goddard, Goddard, and Hackin in *Les Antiqués Bouddhiques de Bamiyan* (1928); Zemaryalai Tarzi, *L'Architecture et le Décor Rupestre des Grottes De Bamiyan* (1977).

²³ The Buddhas of Bamiyan. (March 3, 2001). Retrieved April 22, 2016 from BBC: <http://www.bbc.co.uk/programmes/p03khlwf>

1.2 The fragmented corridor

Corridor Identify

The corridor has strong effect on the connectivity of landscape ecology structure, whose three basic structures are line corridor, strip corridor and stream corridor. The use of corridors for transportation, protection, resources, and aesthetics permeates nearly every landscape in one way or another. Original nature corridor is the band of vegetation along a stream that differs from the surrounding matrix, They control water and mineral nutrient runoff, thus reducing flooding, siltation, and soil fertility loss.²⁴ However, human just keeping using them, no protecting. We in the view of line, strip and stream to discover the fragmented corridors. Because of cement pavement, there are only unitary plants, poor seepage ability water and soil on the destroyed spillway, which form the fragmented corridor in city area, like urban flooding and traffic link. However, most of the fragmented corridor is distributed in the nature area, lead to the animals and nature environment become the biggest victim. Such as dam, railway, hunting, etc destroyed the river corridor, forest corridor, animal migration corridor. Human disturbances destroy the corridors' structure, plowing, cutting, grazing, building power line, gas pipeline , railroads, highways, the ruts of logging road and canals, after that, human will replant vegetation along these disturbed area, finally, the regenerated corridor formed, where soil loss by wind faster, soil nutrient loss more, erosion by water stronger, which make the environment resource corridors far away. Human disturbances corridors direct focus on economic benefit of efficiently, which make the corridor straighter, the distance shorter and generally, the movement between two points faster in the landscape. Following typical cases will show different types of fragmented corridors under the disturbance of resources over-exploited, city over-expansion, frequent nature disaster and humanity damage.

1.2.1 The fragmented corridor under the resources over-exploited disturbance

Dam disturbance

Dams is a monumental presence on the world landscape. They divert and restrain mighty rivers that have run for millennia. They impound vast artificial lakes. Water from dams has turned deserts into orchards, slaked the thirst of millions of metropolitan citizens, and powered wartime production from the Southeast to the Northwest; but dams have also prevented salmon from spawning, flooded forests and fields, displaced populations, and required graves to be exhumed. In social terms, dams have always held the promise of using technology to harness nature for the benefit of people. Yet today, dams are a much-maligned, even vilified, presence in the world's landscapes. They are criticized as destroyers of animal habitats, usurpers of native lands, boondoggles for land speculators,

²⁴ RICHARD, T. y Forman, M. (1986). Landscape Ecology. America: Wiley, p.131.

or subsidies for wealthy farmers. The similar site has been restored, the detail restoration status could read at [page118](#).

Hoover Dam, America (Image 1.43, 1.44)

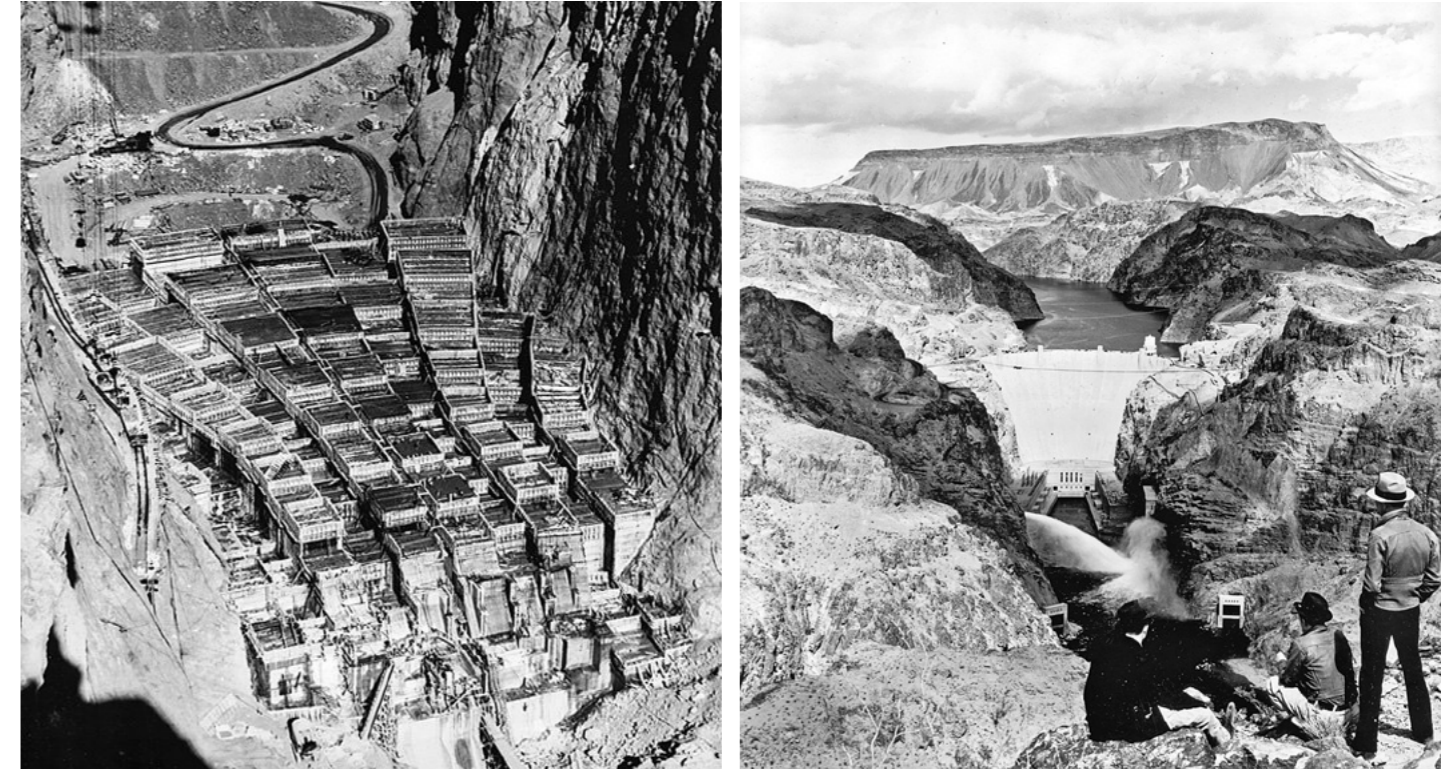


Image 1.43: Hoover (Boulder) Dam Clark County, Nevada, and Mohave County, Arizona, Colorado River, 1930 – 1936, Ben D. Glaha, 1938.



Image 1.44: New bridge and highway at Hoover Dam, Doc Searls, 2012.

Porto Primavera Dam, Brazil

Brazil's Porto Primavera Dam sits on the Paraná River, 28 kilometers (17 miles) upstream from the confluence of the Paranapanema and Paraná Rivers. Constructed to provide hydroelectricity, this dam created the Porto Primavera Reservoir, which was filled in two stages in December 1998 and March 2001.

NASA's Landsat satellite captured these images before and after the dam began filling

Porto Primavera Reservoir. Landsat 5 acquired the top image on March 14, 1987, and Landsat 7 acquired the bottom image on May 12, 2000. The top image shows the Paraná River flowing unimpeded through the incomplete dam, which cuts partway across the river from the north. In this image, the relatively shallow river allows numerous islets to poke above the water's surface. The bottom image shows the reservoir created by the dam. In this image, the reservoir covers a much wider area, and many of the islets that had been visible in the top image no longer appear. In 2006, a study of the effects of the Porto Primavera Dam indicated that it had affected fish reproduction downstream. Porto Primavera Reservoir also experienced an infestation of aquatic weeds. Lars Anderson, who led the study, described this species as one of the world's worst aquatic weeds. It can interfere with hydropower production and the storage and delivery of irrigation and drinking water. ²⁵(Image 1.45)



March 14, 1987



May 12, 2000

Image 1.45: Satellite images Top, 1987 and bottom, 2000 showing before and after the Porto Primavera Dam began filling Porto Primavera Reservoir.

²⁵ Sanches, P.V., Nakatani, E., Bialetzki, A., Baumgartner, G., Gomes, L.C., Luiz, E.A. (2006). Flow regulation by dams affecting ichthyoplankton: the case of the Porto Primavera Dam, Paraná River, Brazil. *River Research and Applications*. 22, 555-565.

Min river cascade hydroelectric station, China

Upper reaches of the min River is one of the ten Center for biological diversity in the world, called green zoology barriers, Natural reservoir. Recent 20 years, many cascade hydroelectric stations were disorderly built in the Min river, mountain was largely excavated, made the mountain lost its natural water storage capacity, caused the serious mountain hazard of soil erosion, debris flow and drought. If these disasters happen on this area, these dams will magnify the impact of disasters. Furthermore, the Min river is cut off by more than 20 cascade hydroelectric stations, which have damaged the reproduction environment of aquatic animal and plant. Min river corridor ecosystem and the aquatic animal migration corridor has been damaged, the fragmented drought valley corridor has formed. (Image 1.46, 1.47, 1.48)

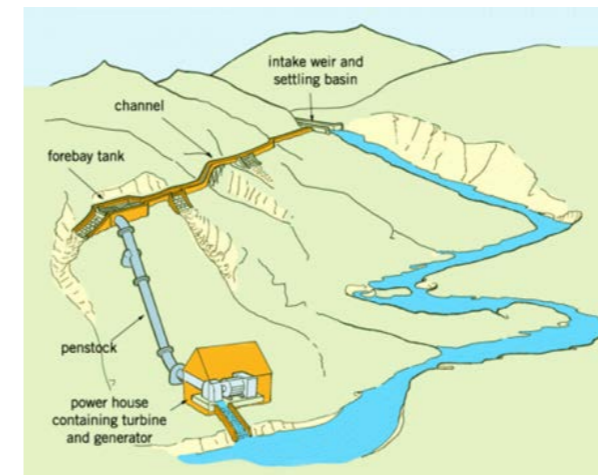


Image 1.46: Cascade hydroelectric station structure explain.



1.47: There are many landslid besides the Min river vally, caused by the Cascade hydroelectric station.



Image 1.48: One cascade hydroelectric station on the Minriver, the satellite images before (left, 2008) and after (right, 2014) the station built.

Samarco dam burst, Brazil

On November 5, 2015, two dams collapsed in southeastern Brazil, sending a torrent of mining sludge through the village of Bento Rodrigues. The muddy floodwaters from an iron ore mining operation destroyed hundreds of homes, killed some residents, and left others missing. As of November 12, 2015, rescuers had recovered the bodies of nine people, according to ABC News; 19 people were still missing.

The Wall Street Journal reported that 60 million cubic meters of wastewater were unleashed, with most of it affecting Bento Rodrigues. The village is located close to the breach, and sits in a river valley just below one of the dams.

The effects of the flooding were felt far beyond Bento Rodrigues. The image shows multiple rivers, far from the village, that remained swollen with wastewater and mud. East of this image, in Barra Longa—a village about 80 kilometers (50 miles) from the dams—the river surged as much as 15 meters and flooded homes, according to Reuters. As health officials conducted tests, cities as far as 300 kilometers (200 miles) downstream lost access to drinking water.²⁶(Image 1.49, 1.50, 1.51)

Seventeen days later, the flood water and mud reached the Atlantic Ocean. Contaminated water continued to flow into the ocean on November 30, 2015, when the Operational Land Imager (OLI) on Landsat 8 captured this natural-color image. The contaminated water contains high levels of mercury, arsenic, chromium, and manganese.²⁷ (Image 1.52, 1.53)

Image 1.49:

Samarco dam catastrophically failed in november. a view from above the dam after the failure, Ricardo Moraes / Reuters, 2015.



Image 1.50:

The school in Bento Rodrigues, Brazil, which was destroyed after the breaking of Samarco dam. Ricardo Moraes / Reuters, 2015.



Image 1.51: The Operational Land Imager (OLI) on Landsat 8 captured these natural-color views of the village and the surrounding region. The top image shows the area on October 11, 2015; the second image shows the area on November 12, after the catastrophe.



Image 1.52:

Contaminated water continued to flow into the ocean on November 30, 2015, Ricardo Moraes / Reuters.



Image 1.53: Landsat 8 captured this natural-color image show the Contaminated water enter the ocean, on November 30, 2015.

²⁶ Flooding in Brazil After Dam Breach(November 5, 2015). Retrieved April 22, 2016 from Nasa: <http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=86990>

²⁷ Contaminated Rio Doce Water Flows into the Atlantic (November 5, 2015). Retrieved April 22, 2016 from Nasa: <http://www.earthobservatory.nasa.gov/NaturalHazards/view.php?id=87083>

Motor-pumped wells disturbance

Karez, China

Ancient Irrigation System in Xinjiang May Disappear in 25 Years. The history of the karez, mainly used in the Hami and Turpan areas in Xinjiang, where it is hot and dry, dates back to the Han Dynasty (206 B.C. - 220 A.D.). It is considered one of the three great projects in ancient China, along with the Great Wall and the Beijing-Hangzhou Grand Canal. As an irrigation system using underground water, the karez consists of four parts: a hole as deep as 50 to 60 meters, an underground canal, an above-ground canal and a small reservoir. They have many advantages, such as little evaporation from season to season and little percolation. A karez can provide a stable water supply that does not consume energy or cause pollution. Wandering underground over 5,000 kilometers, the karez has also been called "the underground Great Wall."²⁸(Image 1.54)

Since 1970s, because of the motor-pumped wells increasing, the waterhead of the Karez is cut off, such as a 2,000-year-old karez irrigation system, which is still in use in northwest China's Xinjiang Uygur Autonomous Region, has reduced from 1,784 to 614 during the past half century, according to local water resources department.

"Declining groundwater levels mainly caused by the sharp rise of motor-pumped wells should be blamed for the ongoing disappearance of the ancient irrigation wells." said Wfuer, general secretary of the Xinjiang Karez Research Association. Since the 1950's, 1170 karezs have dried up with annual water provision amount decreased by 381,4 million cubic meters. As a result, some 190,500mu (12,700 hectares) cannot get irrigation from the ancient water system, said Wfuer. Seeing 23 karezs disappear every year, the great irrigation work invented by the ancient local people will die out in 20 to 25 years without effective protection, said Wfuer. (Image 1.55)

Image 1.54: Karez in Xinjiang province, China.

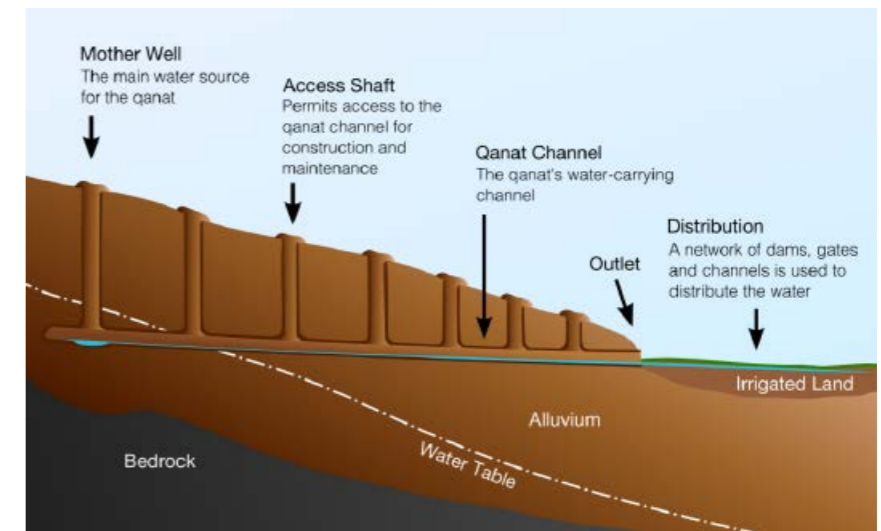


Image 1.55: Karez system explain, Marla Odom.

1.2.2 The fragmented corridor under city over-expansion disturbance

Railway disturbance

Qinghai-Tibet railway

The Qinghai-Tibet railway is a high-elevation railway that connects Xining, Qinghai Province, to Lhasa, Tibet Autonomous Region, in the People's Republic of China. The line includes the Tanggula Pass, which, at 5,072 m (16,640 feet) above sea level, is the world's highest railway. Tanggula railway station at 5,068 m (16,627 feet) 33°00'18.50"N 91°38'57.70"E is the world's highest railway station. Chinese experts have been worried about the impact of the new railroad on the pristine but fragile high-altitude environment of the Qinghai-Tibetan Plateau. An open two-lane highway already exists from Golmud to Lhasa, but environmentalists worry that a railway will bring in larger numbers of workers and visitors, both in the short term and long term, in turn increasing pressure on local wildlife and plant life. although the railway has built 33 underpasses for wildlife migration, which needed assessment whether the wildlife could adapt to the new migration corridor.²⁹(Image 1.56)



Image 1.56: Qinghai-Tibet railway, Reurink, J, 2008.

²⁸ Kang, S., Su, X., Tong, L., Zhang, J., Zhang, L., & Davies. (2008). A warning from an ancient oasis: intensive human activities are leading to potential ecological and social catastrophe. *The International Journal of Sustainable Development & World Ecology*, 15(5), 440-447.

²⁹ Baofa, Y., Huyin, H., Yili, Z., Le, Z., & Wanhong, W. (2006). Influence of the Qinghai-Tibetan railway and highway on the activities of wild animals. *Acta Ecologica Sinica*, 26(12), 3917-3923

La petite ceinture, France

As the famous French cartoons "The Triplets of Belleville" shows the Old Paris resident had been troubled heavily by the city railway. (Image 1.56) This railway is La petite ceinture.

La petite ceinture — the little belt — is an abandoned railway line, 32 km long, that circles Paris. Built in stages from 1852 to 1900, the line connected the main stations of the city's five major railway companies. It closed to passenger traffic in 1934, facing increasing competition from the newly opened Métro; meanwhile freight traffic declined over the years, and by the mid-1980s the line was abandoned. In 1996, it has been photographic playground. walkers, artists, lovers, residents were enthralled by the mystery of its tunnels and fortified territories, by the smell of rust, tar and wood, and by the sense of freedom. Today some areas are used to store equipment for the Paris tramway. Others are slated to become part of a natural green belt. For decades the owner of the tracks (the Réseau Ferré de France) and the city government could not agree on a future for this unique place, but a lack of buildable space in Paris — and the example of projects like New York's High Line and indeed the local Promenade plantée — has accelerated plans for its redevelopment. Residents can only hope that future plans respect the spirit of this place, the last great wasteland in Paris. 30(Image 1.57)



Image 1.56: The image in the cartoons "The Triplets of Belleville" show the very bad living situation in Paris troubled by the railway.



Image 1.57: La petite ceinture is still located in Paris city main area.

The West Side Line, America

The West Side Line, also called the West Side Freight Line, is a railroad line on the west side of the New York City borough of Manhattan. North of Penn Station, from 34th Street, the line is used by Amtrak passenger service heading north via Albany to Toronto; Montreal; Niagara Falls; Rutland, Vermont; and Chicago. South of Penn Station.³¹ For safety, the railroads hired men called the "West Side Cowboys" to ride horses and wave flags in front of the trains. However, so many accidents occurred between freight trains and other traffic that Tenth Avenue became known as "Death Avenue".³²(Image 1.58, 1.59) A 1.45-mile (2.33 km) elevated section of the line abandoned since 1980 (popularly known as the High Line) has been transformed into an elevated park. The south section of the park from Gansevoort Street to 20th Street opened in 2009 and the second section up to 30th Street opened in 2011. This site has been restored, the detail restoration status could read at [page122](#).



Image 1.58: View north from West 17th Street, 1934.



Image 1.59: Bell Laboratories, now Westbeth Artists housing, corner of Bethune and Washington streets, 1934.

Highways disturbance

Trinitat Vella highways, Spain

Barcelona is sited on a terrain that is physically characterized by its natural limits. To the east there is the River Besós and to the west the River Llobregat, and for centuries these were the natural access routes to the city; to the north there is the Collserola chain of hills, and the plain of Barcelona is in the centre. This large plain descends to the sea with small interruptions formed by the foothills of the Collserola chain and on the coast. This plain shows an abrupt drop, to the east and to the west, when it reaches the platforms formed by the rivers. This abrupt drop corresponds to the original topography of the area

³⁰ Jorion, T. (2012). The Forgotten Line. Places Journal. Retrieved April 22, 2016 from: <https://placesjournal.org/article/the-forgotten-line/>

³¹ West Side Line (NYCRR)(April 6, 2014). Retrieved April 22, 2016 from Wikipedia: [https://en.wikipedia.org/wiki/West_Side_Line_\(NYCRR\)](https://en.wikipedia.org/wiki/West_Side_Line_(NYCRR))

³² High Line (New York City)(August 6, 2015). Retrieved April 22, 2016 from Wikipedia: [https://en.wikipedia.org/wiki/High_Line_\(New_York_City\)](https://en.wikipedia.org/wiki/High_Line_(New_York_City))

where the park is sited. As the city has grown it has filled the plain and reached its natural boundaries, and the access routes to the city, which have been a problem for decades, have become a major problem. There was no physical space to resolve the problems derived from current communication needs and from the size of the infrastructures they needed.

Located on the Cerro de la Trinidad, the neighborhood of Trinitat Vella was crossing highways for many years. It is with the impact of large infrastructure road of the Nineties, which was defined by its borders: The Round Dalt, Meridiana Avenue, train tracks and highways in and out. The first settlers of the Trinitat Vella, settled around the years twenty and thirty and began to occupy the land adjacent to the road de Ribes using them as second homes. Trinitat Vella was in the years fifty-one land of welcome for a significant number of immigrants the rest of the state and from the eighties. And, according socio economic indicators of the year 20128, 33% of the population Trinitat Vella is foreign, mainly from the Islamic Republic

Pakistan, Morocco and Ecuador. Before being the current quarter, the Trinitat was one end of the city, also known as Coll de Finestrelles, the Municipality of Sant Andreu de Palomar, independent from Barcelona until 1897. Trinitat was a sparsely populated rural area dating from 1920, year in which the bottom of the Trinitat began to urbanize and absorb the arrival of immigrant workers attracted by the great works of the capital. He born as a small suburb made up of cottages and small industries in the early fifties largely disappear to make way housing blocks and a women's prison. A few years later, the policy of expansion of new roads He separated the Trinitat in two neighborhoods: the Trinitat Nova and Trinitat Vella, division currently persists. North railway disappeared in 1960, giving place the line of high speed train (AVE). A year later he opened the extension of the Meridiana Avenue.

It was not until 1983 that the metro station L1 Trinitat Vella line was connection with the city. A few years later they are beginning the works for what would be the Nus of the Trinitat, work should be completed by 1992, on the occasion of the Olympic Games. "There is no doubt that this is one of the most chaotic areas of Barcelona, is some highways and railroad tracks that divide the neighborhood in isolated areas and make it difficult to stay."³³

Emblematic building: Nus de la Trinitat highway surrounded by arms on three levels, the market of Montserrat, the field of C.F. Montañesa, cinemas and Favencia trinities, School Cardenal Cisneros, workshops subway, the "ghost blog," the cross of the Trinity ... New towers are gone. Guess even the old ravines. (Image 1.60) This site has been restored, the detail restoration status could read at [page125](#).

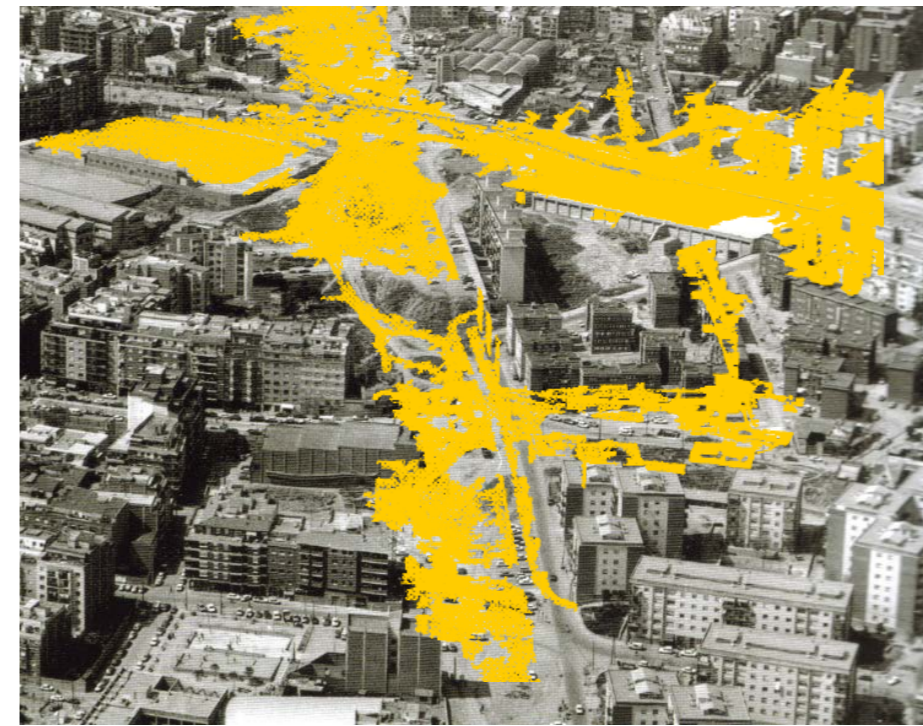


Image 1.60:

In 1979, the emblematic buildings: the market of Montserrat, the field of C.F. Montañesa, cinemas and Favencia trinities, School Cardenal Cisneros, workshops subway, the "ghost blog," the cross of the Trinity.

Highway in national park

Road kill is not simply "bad luck" or an unfortunate consequence of driving, but an avoidable cost and a preventable loss. We know there are solutions that work; what we need is political will and social awareness to implement proven solutions in the right places Today, an emerging priority for transportation and natural resource agencies is to make highways safer for both drivers and wildlife. One of the proven solutions is to build wildlife crossing structures. Providing crossing infrastructure at key points along transportation corridors is known to improve safety, reconnect habitats and restore wildlife movement.³⁴

(Image 1.61) The similar site has been restored, the detail restoration status could read at [page127](#).



Image 1.61: Disturbing accidents, such as this collision with a bear on the I-70 near Eagle, Colorado, occur on North American roadways every year, Shane Macomber, Vail Daily.

³³ Orendain Almada, F. (2014). El Parc de La Trinitat: La Puerta Norte de Barcelona. Retrieved April 22, 2016 from Dspace: http://diposit.ub.edu/dspace/bitstream/2445/56295/2/Orendai%20Almada%20F%C3%A1tima_01.pdf

³⁴ WHY ARE ANIMALS DYING ON OUR ROADS. (Nov 9, 2014). Retrieved April 22, 2016 from Arc: <http://arc-solutions.org/new-thinking/>

Tea Horse Road abandon, China

The ancient commercial passage, dubbed the "Ancient Tea-Horse Road", first appeared during the Tang Dynasty (618-907), and lasted until the 1960s when Tibetan highways were constructed. Meanwhile, the road also promoted exchanges in culture, religion and ethnic migration, resembling the refulgence of the Silk Road . The road stretched across more than 4,000 kilometers mainly in Southwest China's Sichuan and Yunnan provinces and the Tibetan Autonomous Region. Just as the Silk Road, the Ancient Tea-Horse Road disappeared with the dawn of modern civilization, but both routes have played very important roles in the development of China. Different Chinese ethnic cultures, such as the Dai , Yi , Han , Bai , Naxi and Tibetans, have met, fused and developed along the historic road. The road ran across the Hengduan Mountains and the Qinghai-Tibet Plateau -- an area of the most complicated geological conditions and most diversified organisms. Besides its cultural and historic value, the road was also highly appreciated by adventurers and scientists.³⁵ Because of buidling railway, high way and tunnel, the ancient tea route has become a deserted road, which leads its historic culture value, ethnic value, religion value and environment diversified value disappear. This precious culture landscape corridor is disappearing. (Image 1.62, 1.63, 1.64)

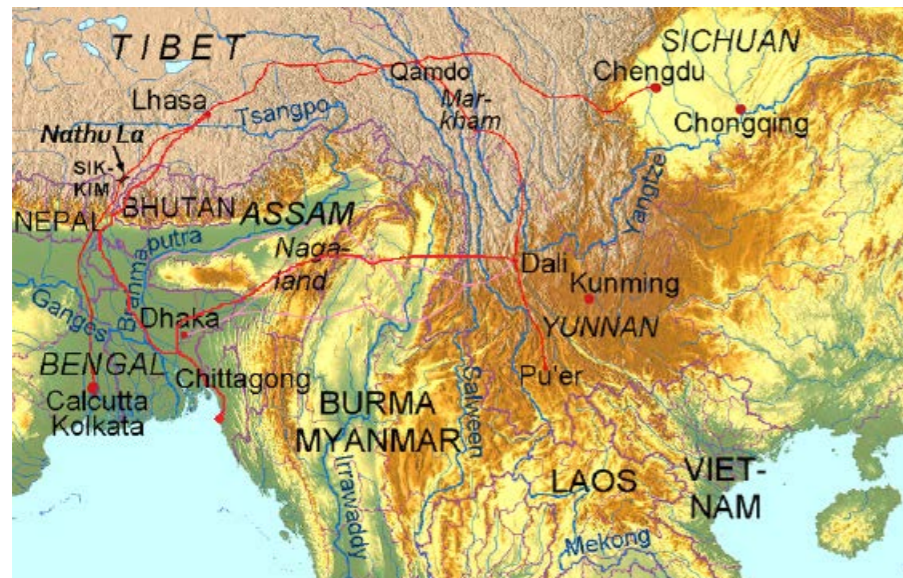


Image 1.62: The Tea-Horse-Road, one of the ancient Tea routes, with variants itself, Yerius J.

Coastline tourism development disturbance

Club Med, Spain

In 1961, on the eastern tip of Iberia Peninsula, Cap de Creus, one the windiest and most northern exposed corner of our geography, Club Med constructed a privative holiday village with 430 buildings to receive around 900 visitors 3 months a year. The urbanization project is considered as one of the most notorious examples of modern movement settlement on the Mediterranean coast.(Image 1.65, 1.66) This site has been restored, the detail restoration status could read at [page129](#).

³⁵ LIU, J. F., ZHANG, J., & WANG, G. Y. (2008). Study on Tourism Development Strategies of the " Ancient Tea Horse Road " in Yunnan Based on " Point-Axis System " Theory [J]. Journal of Guilin Institute of Tourism, 1, 024.



Image 1.64: Markam County on the Tea Horse Road ,Tibet, Reurinkjan, 2006.



Image 1.63: Men Laden With Tea, Sichuan, China, Ernest H. Wilson, 1908.



Image 1.65: Club Med built on the Cap de Creus, Ciprian. D, 1980.

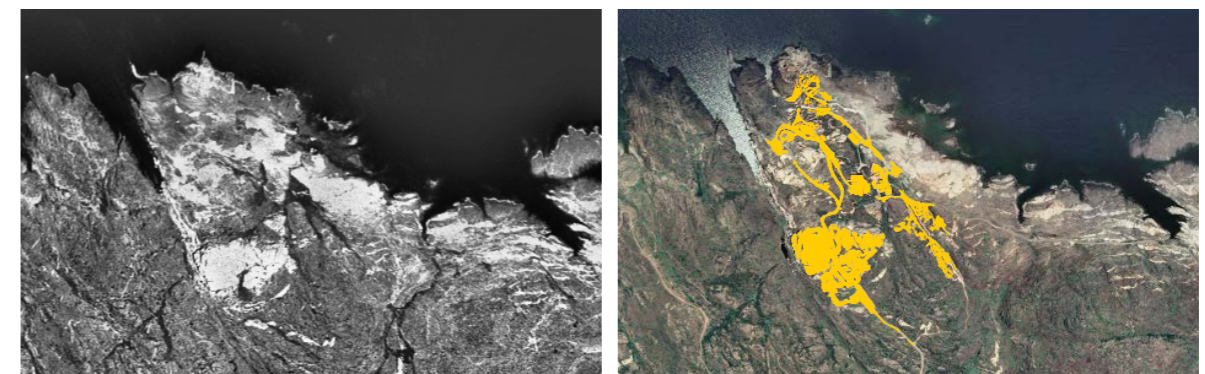


Image 1.66: Cap de Creus satellite images before (left, 1956) and after (right, 2008) built Club Med June.

Orongo Bay, New Zealand

The Orongo bay Conservation Master Plan for a 3,000-acre sheep farm in New Zealand establishes a vision for the extensive regeneration of a devastated ecology while expanding agricultural production and revealing a cultural landscape rich in history.

In 2003, Orongo bay was a typical sheep farm on the East Coast of New Zealand's North Island. Grazing sheep and livestock was tough due to the brutal salt spray and erosion on the exposed slopes. The station's only notoriety came from the prominent cliffs on its northern peninsula—Te Kuri a Paoa, also called Young Nick's Head. Marine farming is a major industry for Northland, and over half New Zealand's oyster exports are produced by marine farms in the north. This government-run oyster farm at Orongo Bay in the Bay of Islands was photographed in 1978, soon after the introduction of Pacific oysters had invigorated the marine farming industry.³⁶ (Image 1.67)

The ecology of Orongo bay, like that of much of New Zealand, has been under assault ever since the arrival of mankind in the 13th century. Lush, temperate rain forest covered the North Island and teemed with a rich diversity of birds, amphibians, and invertebrates. Early Maori settlers cut much of the forest for fire, shelter, and agriculture. The later arrival of English colonists brought further destruction of the forests for lumber and grazing while introducing mice, cats, weasels, rabbits, and other alien mammals that quickly decimated native bird and amphibian populations. (Image 1. 68) This site has been restored, the detail restoration status could read at [page130](#).



Image 1.67: Oyster farm on the Orongo bay, 1978.



Image 1.68: Local famers was mining in the small mountain which rises to 180 meters above Orongo Bay, 1874.

The Seafront of the Albufera, Spain

La Dehesa de El Saler is the natural seashore formation that separates the Albufera of Valencia from the sea. The Buhaira eco-system, as rich as it is endangered, has fallen victim to an urban and industrial growth which is as intense as it is badly planned. The tourism development plans of the Franco era began to develop the Lluent sandbar shore in the 1960s. Over a million square metres of tower blocks lining the sea edge were planned. Democracy brought the creation and delimitation of the Albufera Nature Reserve and halted the urbanisation that was destroying the natural environment. However, part of

³⁶ Orange, C. (2002). Northland region. the Encyclopedia of New Zealand, Retrieved April 22, 2016 from: <http://www.teara.govt.nz/en/northland-region/page-10>

the damage had already been done. The beach was starting to shrink due to erosion, the dunes were razed to the ground, the wetlands had silted up, the marshes were trampled and the pinewood, left unprotected, was shrinking fast, while the immense layout of the development, known to the locals as the 'airport', had a crowning touch: a seafront promenade which (unusually) rose above the line of the horizon, hiding the sea from sight. All in all, a total disaster.³⁷ (Image 1. 69, 1.70) This site has been restored, the detail restoration status could read at [page132](#).



Image 1. 69: Construction on the promenade beach, LLORET, 1970.

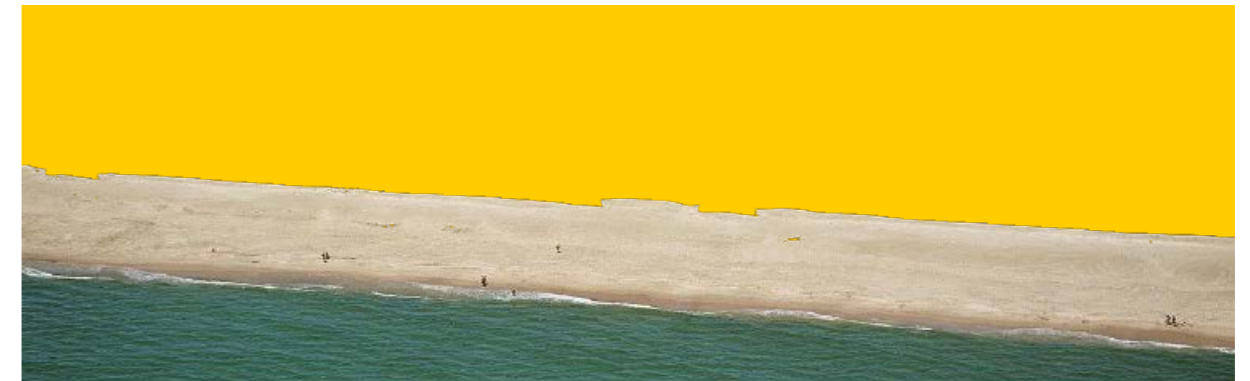


Image 1. 70: Over - exploitation of empty villa on the Saler beach, 1977.

Channel disturbance

Nicaragua Canal, Nicaragua

Hundreds of villages will have to be evacuated and the indigenous inhabitants relocated. Archaeological sites along the route of the canal will be in danger too. The port infrastructure along Nicaragua's Pacific coast would threaten mangrove swamps and sea turtle nesting beaches. The fate of the 3,170-square-mile lake was the main focus of a November meeting in Managua of 15 scientists, including representatives of several academies of science from around the Americas. Researchers were concerned that the lake dredging and the planned 25 daily crossings of huge ships would compromise the lake's water quality, as could potential fuel spills.³⁸ The route will impact part of the Cerro Silva Nature Reserve and the Indio Maiz biological reserve, both of which form part of the

³⁷de la Reguera, A. F. (2001). Ordenación del frente litoral de la Albufera sector Dehesa del Saler, Valencia. Via arquitectura, (10), 76.

Mesoamerican Biological Corridor (CBM), where there are endangered species like scarlet and great green macaws, golden eagles, tapirs, jaguars, spider monkeys, anteaters and black lizards. Studies by the Cocibolca Group say that dredging with heavy machinery, the construction of ports, the removal of thousands of tons of sediment from the lake bottom, and the use of explosives to blast through rock would have an impact on the habitat of sea turtles that nest on Nicaragua's southwest Pacific coast. (Image 1. 71, 1.72)

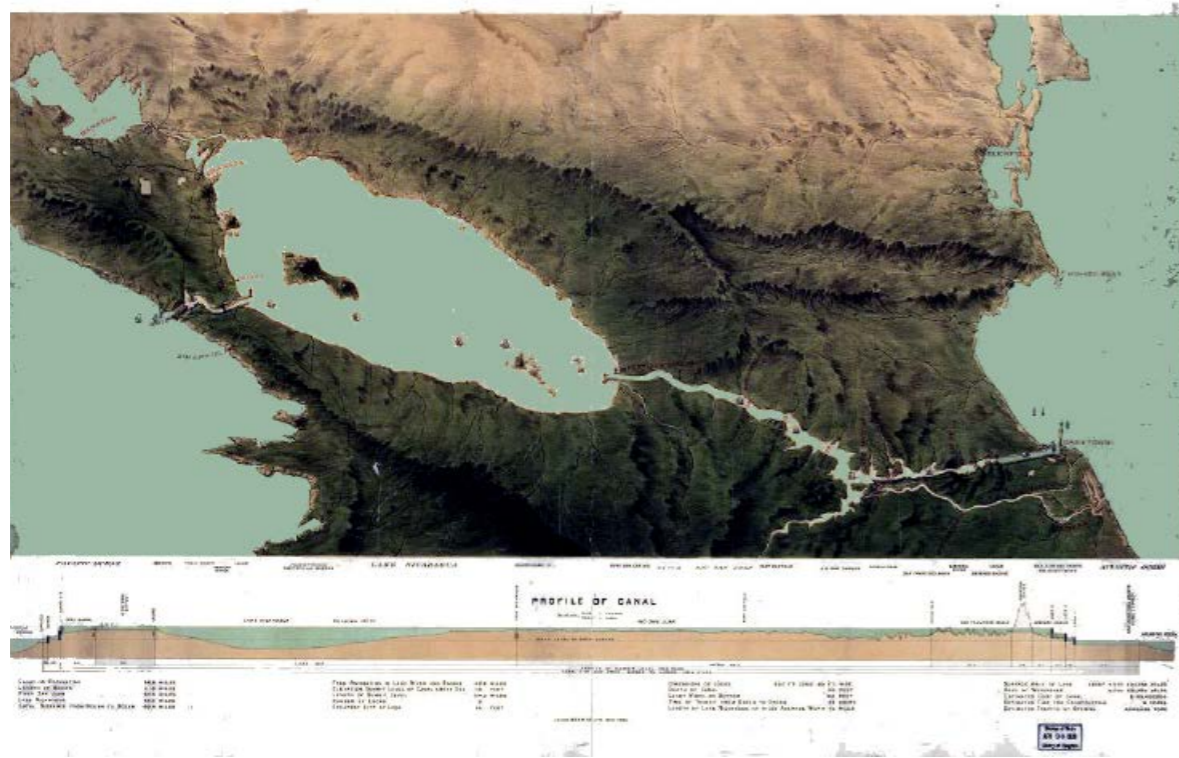


Image 1. 71: A plan map for Nicaraguan Canal, 1870s.



Image 1. 72: The transportation on the Nicaragua Canal, 2010.

Ocean shipping lane, between Sri Lanka and Singapore

The map above is based on OMI measurements acquired between 2005 and 2012. The NO₂ signal is most prominent in an Indian Ocean shipping lane between Sri Lanka and Singapore, appearing as a distinct orange line against (lighter) background levels of NO₂. Other shipping lanes that run through the Gulf of Aden, the Red Sea, and the Mediterranean Sea also show elevated NO₂ levels, as do routes from Singapore to points in China. These aren't the only busy shipping lanes in the world, but they are the most apparent because ship traffic is concentrated along narrow, well-established lanes. For more than a decade, scientists have observed "ship tracks" in natural-color satellite imagery of the ocean. These bright, linear trails amidst the cloud layers are created by particles and gases from ships.³⁹(Image 1. 73)

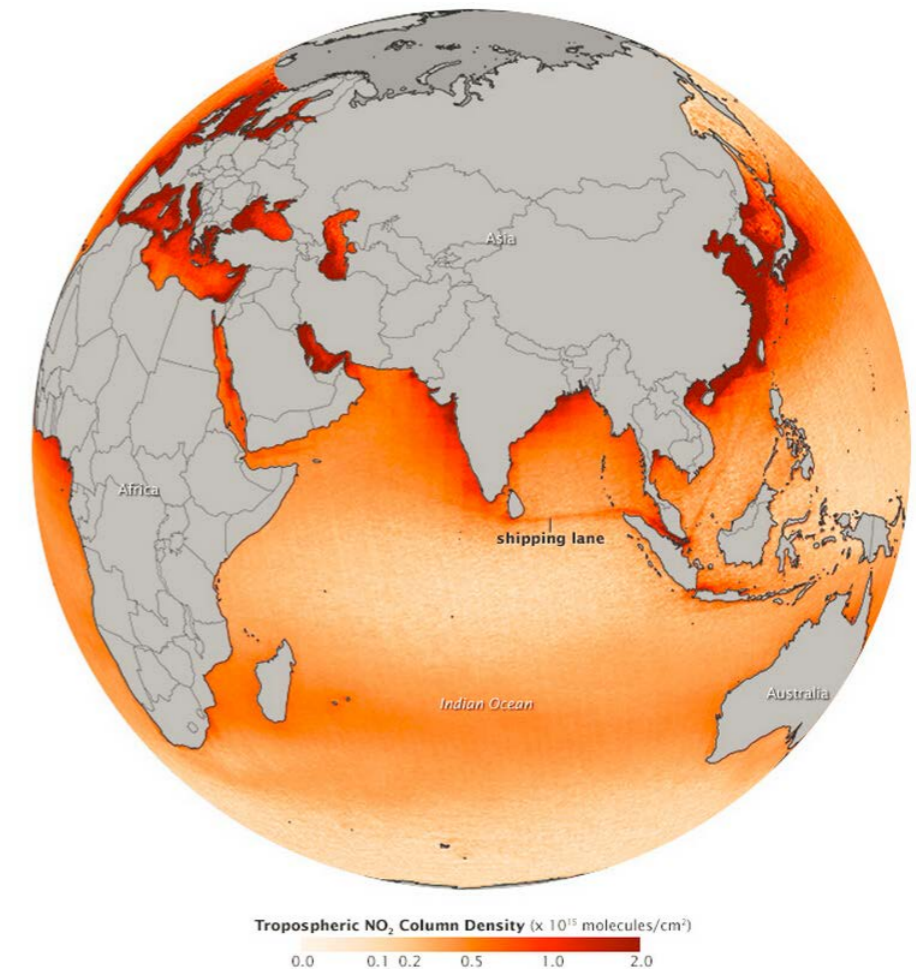


Image 1.73: The NO₂ signal is most prominent in an Indian Ocean shipping lane between Sri Lanka and Singapore, Nasa, 2012.

Hunting disturbance

Many hunting seasons coincide with migration periods, making this perilous time even more threatening for animals. Illegal hunting and poaching are also a threat at this time, and even legitimate hunters may make mistakes and inadvertently shoot protected animals that they have misidentified. Also seed by bird-dispersed or wind-dispersed, if human destroyed the natural sowing corridor, the number of vegetation will reduce.

³⁸ Huete-Perez, J. A., Meyer, A., & Alvarez, P. J. (2015). Rethink the Nicaragua canal. *Science*, 347(6220), 355-355.

³⁹ Ruyter de Wildt, M., H. Eskes, and K. F. Boersma (2012, Jan. 5) The global economic cycle and satellite-derived NO₂ trends over shipping lanes. *Geophysical Research Letters*.

Whaling, Japan

Japan's whaling fleet set sail for the Antarctic despite international pressure to end its annual hunts. The Japanese fisheries agency said the fleet would conduct "lethal research", despite a UN court ruling last year that the hunts were a cover for commercial whaling and have no proven scientific merit. It called for the hunts to be stopped immediately. A mother ship and three other vessels, along with 160 crew, plan to kill 333 minke whales a year in the Antarctic for the next 12 years.⁴⁰ (Image 1. 74)



Image 1. 74: Japan's whaling fleet is shooting the whales in the Antarctic, 2015.

Whaling, Faroese

Also most Faroese still carry out the whale hunt annually since they consider it an important part of their tradition. It is the fifth slaughter of the season on the Faroes, which has seen 490 pilot whales killed on the archipelago since June. (Image 1. 75)



Image 1. 75: This was horrifying hunt whales on a beach in the Faroe Islands, 2015.

⁴⁰ Japan's whaling fleets steam out to fight Western culinary imperialism. (Dec 5, 2015). Retrieved April 22, 2016 from The economist: <http://www.economist.com/news/asia/21679603-japan-returns-southern-ocean-japans-whaling-fleets-steam-out-fight-western-culinary>

Pesticide disturbance

Coast, Hongkong

Fertilizer runoff creates eutrophication that flourishes algal bloom (rapid increase or accumulation in the population of algae in aquatic systems) which depletes the oxygen content in the water that affects marine life. There are many fluorescence of algae along the coast of Hongkong, which caused by the pesticide pollution. The pesticide stay in the algae, the food chain will bring the toxin pollution into the human and animal. As 70% of the earth is covered with water, people actually assumed that all pollutants would be diluted and get disappeared. But in reality, they have not disappeared and their effects can be easily seen as they have entered the food chain. People get contaminated easily by eating contaminated seafood that can cause serious health problems, from cancer to damage to immune system. (Image 1. 76)



Image 1. 76: The glow from a Noctiluca scintillans algal bloom along the seashore in Hong Kong, 2015.

1.2.3 The fragmented corridor under the nature disaster disturbance

Climate changing altitudinal migration disturbance

Altitudinal migration is a short-distance animal migration from lower altitudes to higher altitudes and back. It is commonly thought to happen in response to climate and food availability changes as well as increasingly due to anthropogenic influence. These migrations can occur both during reproductive and non-reproductive seasons. Altitudinal avian migration is common, and can also be found in other vertebrates, and can be seen in some invertebrates. Climate change could be causing migration patterns to shift into an earlier time frame, coinciding with an earlier start of the growing period. This means that migratory species may leave lower altitudes for higher-altitude breeding sites while those breeding sites still lack the necessary resources. Some species that have shorter

migratory paths may be able to return to the lower elevations and wait, but run the risk of running out of the resources in that lower altitude, such as food and cover, that may only be available for a short, set period of time. Furthermore, climate change may cause seasonal storms and rainfall patterns to change, shifting the timing and/or need for altitudinal migration in the future by shifting availability of resources, which is believed to be a driving cause of altitudinal migration.⁴¹ The upward shift of species caused by climate change also holds the potential to cause both mountaintop extinction and lowland biotic attrition. This is because the lowland tropics lack species that can cope with increasing temperatures. Such as bighorn sheep migrate between high mountains, where they are safer from predators, and valleys where there is more food in winter. Because of the climate warming, the snow on the high mountain decreased, bighorn sheep have to change its migration way. (Image 1. 77) According to IMARPE, the deaths of sea lions and dolphins are due indirectly to the phenomenon of El Niño. A total of 230 marine animals, including sea lions and dolphins were found dead on the coast of Lambayeque in the last 20 days, according to the the head of Instituto del Mar del Peru (IMARPE), Jaime de la Cruz. He said that specimens were dying or decaying. He said the mammals were found during several trips from the beach district of Sea Chérrepe to Mórrope. He said they will analyze samples from the animals to determine the real causes of mass death. However, he said that the deaths, especially of sea lions, "should indirectly be connected to this winters El Niño" and could be due to starvation." 80% of dead species are sea lions, which have had to migrate to deeper cold waters for fish. (Image 1. 78)



Image 1.77:
Bighorn sheep in front of Mount Wilbur in Glacier National Park, Kim Keating, 2009.

Image 1.78:
Tens of thousands of walrus were beached on the northwest of Alaska beach, Gary Braasch, 2015.

⁴¹ Altitudinal migration. (2014). Retrieved April 22, 2016 from Wikipedia: https://en.wikipedia.org/wiki/Altitudinal_migration

Tsunami disturbance

2004 tsunami, Indian Ocean

Nearly three weeks after an earthquake triggered the deadly Indian Ocean tsunami on December 26, 2004, satellite analysis continues to illustrate the magnitude of the disaster. This pair of ASTER images contrasts before and after views of a portion of the western coastline of Thailand in the Phang-Nga province, about 50 kilometers north of the island of Phuket. In these images, vegetation is dark red, while bare earth is grey. On December 31, five days after the waves swept ashore, large sections of the shoreline are grey, stripped of vegetation or covered in mud and sand. Water has broken through several places along the northern beach. Tiny fingers of blue water slice into the land where no inlet existed in the image on the right. vegetation patterns may have altered the type of damage the wave created when it came ashore. The forested cape appears to be untouched, possibly because the trees served as a break. The developed beach land probably had less dense vegetation to cushion the wave's impact.⁴² During the devastating 2004 Indian Ocean tsunami, more than 200,000 people lost their lives. Some coastal communities were shielded from the waves' destruction by mangrove forests, which motivated efforts to protect and restore them. (Image 1. 79) This site has been restored, the detail restoration status could read at [page137](#).

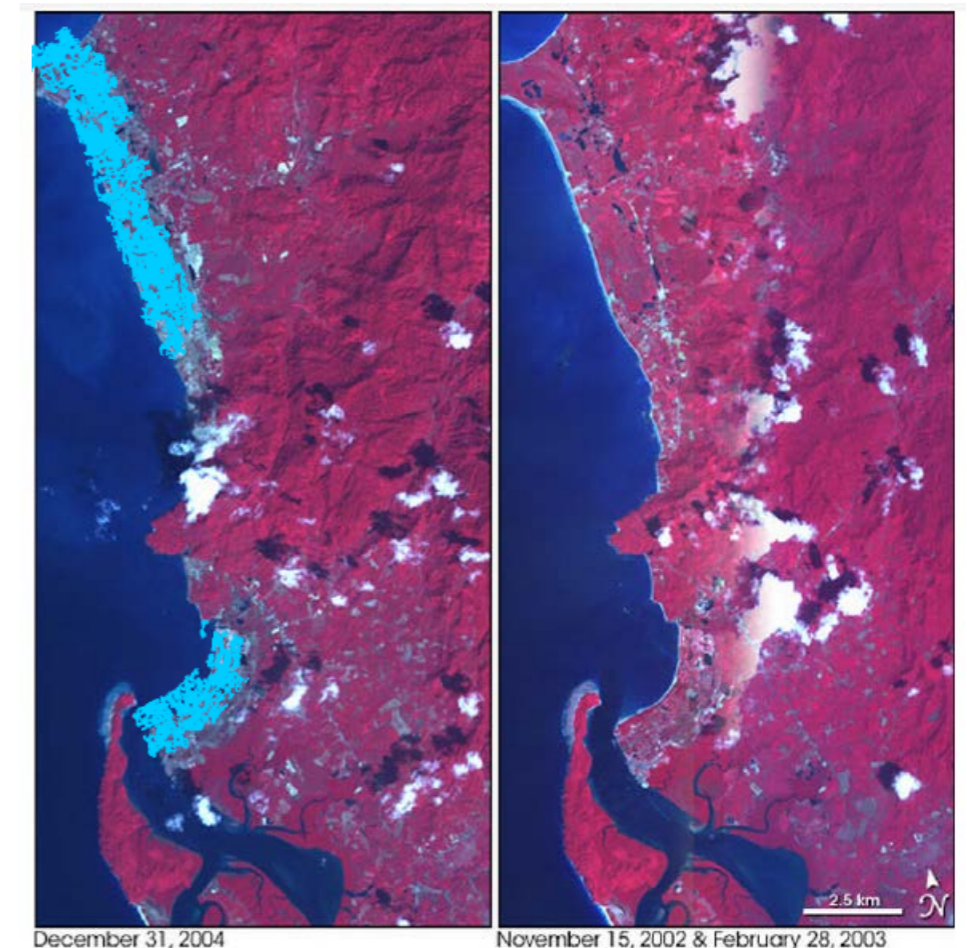


Image 1.79: 2004 tsunami satellite images before (right, Feb, 2003) and after (left, Dec , 2004) tsunami.

⁴²Tsunami Damage in Thailand. (January 16, 2005). Retrieved April 22, 2016 from NASA: <http://earthobservatory.nasa.gov/IOTD/view.php?id=5168>

1.3 The fragmented matrix

Matrix Identify

The matrix is the most extensive types of landscape elements. Of these, the matrix is the most extensive and most connected landscape element type, and therefore plays the dominant role in the functioning of the landscape (i.e. the flows of energy, materials, and species).⁴³ The extensive, relatively homogeneous landscape element that encloses scattered distinct patches of a different type illustrates the fact that the matrix has special properties and is conceptually different from a patch.

We could find many quite diverse areas of human knowledge to define a matrix. There are three important criteria to discover and define the matrix, also goes for fragmented matrix. Matrix area mainly shows two characteristics, one is its flowability, another is its generality. The most extensive element type also often controls flows in the landscape. For example, heat from a desert matrix sweep through villages and croplands; oil spills into the ocean, nuclear leakage into the ocean and air. In fact, the oasis effect refers to desiccation of an area due to advection, and advection is the horizontal movement of heat energy between two areas, such as the urban heat island. And so we adopt relative area as the first criterion for defining a matrix: generally, the area of the matrix exceeds the total area of any other landscape element type present. If a type of landscape element covers more than 50% of a landscape, it is very likely to be the matrix, this is another characteristic of matrix, the generality. Landscapes differ in how evenly distributed through space the various landscape elements are. This spatial evenness or unevenness is easily determined by various methods that suggest that the area of the matrix is usually not a sufficient sole criterion in recognizing a matrix, we must remember also the uneven distribution of the matrix across the landscape, such as fog or light or flood swallows city, and war or avalanche damages city.

Besides, to describe this identify of the matrix in a precise manner, it is convenient to use the mathematical concept of connectivity. That is, a space is completely connected if it is not divided into two open whole. A high level of connectivity in a landscape element type has several consequences.

1. The element may function as a physical barrier separating the other elements. Hence, a wind-break or fire-break may be an effective physical, chemical, and biological barrier between two landscape elements.
2. When the connectivity takes the form of an intersecting of thin, elongated strips, the element may function as a series of corridors facilitating both migration and gene exchange among species. The spatial and mathematical basis for analysis movement along interlocking corridors is familiar in transportation theory and in the geography of movement.
3. The element may encircle other landscape elements to create isolated biological

⁴³RICHARD, T. y Forman, M. (1986). Landscape Ecology. America: Wiley, p.159.

"islands". Thus, livestock in separated fields may eye each other without mixing genes, and populations of mice, butterflies, and clover may become genetically different when separated within a landscape.

However, the disturbance of resources over-exploited, city over-expansion, frequent nature disaster and humanity damage have destroyed the connectivity. In most cases, because of human disturbance, matrix couldn't own all these characteristics. Many sites have been damaged into unexpected fragmented matrix. The following content will let us know more about today the fragmented matrix.

1.3.1 The fragmented matrix under the resource exploitation disturbance

Ocean pollution disturbance

The ocean pollution includes many situations:

The biggest source of pollution in the ocean is directly from land based sources, such as oil, Plastic, Fertilizer, radioactive waste from nuclear reactors, septic tanks, farms, ranches, motor vehicles, among larger sources. Three hundred thousand dolphins and porpoises die each year as a result of becoming entangled in discarded fishing nets, among other items.

Oil spills, America

Oil is the fastest source of deterioration to the ocean, being far more harmful than trash and waste. Oil spills suffocate marine life to death, and leads to behavioral changes and a breakdown in thermal insulation to those that do survive. It essentially changes the entire ecosystem of an affected area, such as a long coastline or deep ocean.

The Gulf oil spill is recognized as the worst oil spill in U.S. history. Within days of the April 20, 2010 explosion and sinking of the Deepwater Horizon oil rig in the Gulf of Mexico that killed 11 people, underwater cameras revealed the BP pipe was leaking oil and gas on the ocean floor about 42 miles off the coast of Louisiana. By the time the well was capped on July 15, 2010 (87 days later), an estimated 3.19 million barrels of oil had leaked into the Gulf. Over the course of 87 days, the damaged Macondo wellhead, located around 5,000 feet beneath the ocean's surface, leaked an estimated 3.19 million barrels (over 130 million gallons) of oil into the Gulf of Mexico—making the spill the largest accidental ocean spill in history. As much as 20 percent of the spilled oil may have ended up on top of and in the seafloor, damaging deep sea corals and potentially damaging other ecosystems that are unseen at the surface. (Image 1. 80) Nearly a month after a deadly explosion at the Deepwater Horizon oil rig, the damaged well on the bottom of the Gulf of Mexico continued to spill oil. southeast.⁴⁴ (Image 1. 81)

Some oil sunk to the seafloor by gluing together falling particles in the water such as bacteria and phytoplankton to form marine snow. As much as 20 percent of the spilled oil may have ended up on top of and in the seafloor, damaging deep sea corals and potentially damaging other ecosystems that are unseen at the surface. There were some

⁴⁴ Oil Slick in the Gulf of Mexico. (May 19, 2010). Retrieved April 22, 2016 from NASA: <http://earthobservatory.nasa.gov/IOTD/view.php?id=44006>

immediate impacts to the animals of the Gulf of Mexico that could be seen with the naked eye: pelicans black with oil, fish belly-up in brown sludge, smothered turtles washed up on beaches. Strandings of both dolphins and sea turtles increased significantly in the years following the spill. (Image 1. 82, 1.83)

Invertebrates in the Gulf were hard hit by the Deepwater Horizon spill—both in coastal areas and in the deep. Seabird losses may have numbered in the hundreds of thousands, but reliable estimates are hard to come by. Much of this area has been cleaned, but eroded shorelines are taking longer to recover and erosion rates have accelerated in these areas. This site has been restored, the detail restoration status could read at [page142](#).

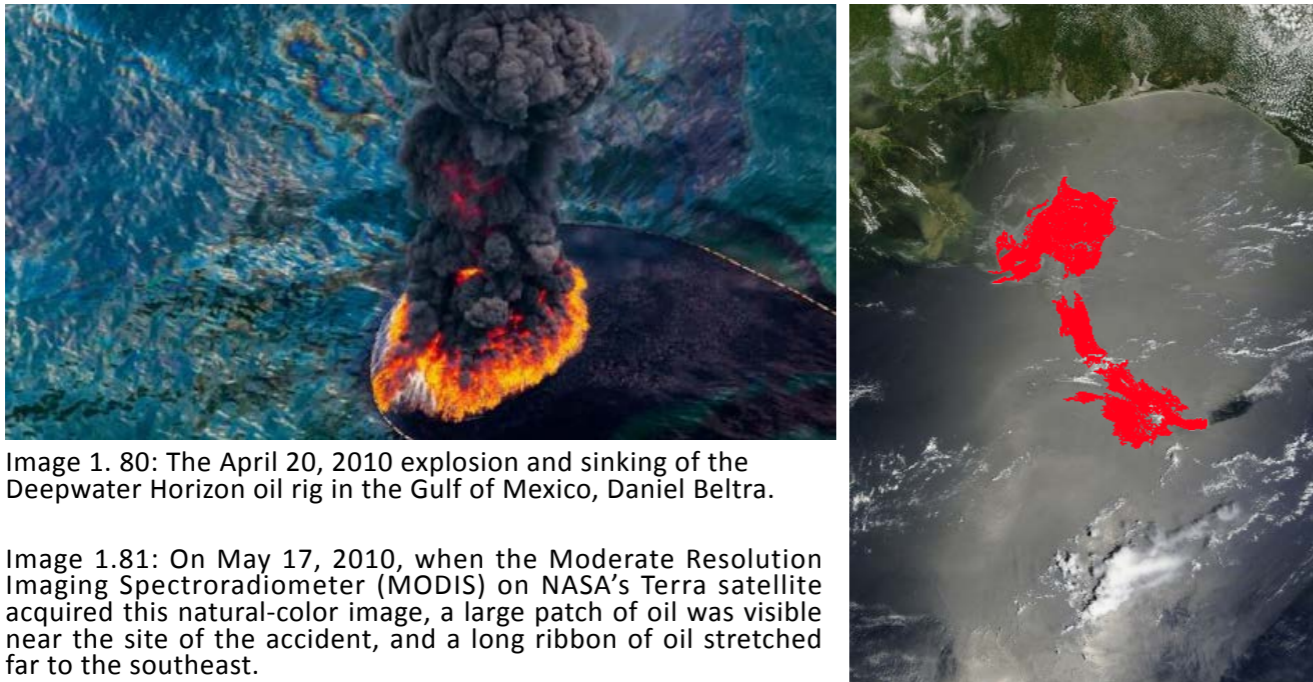


Image 1. 80: The April 20, 2010 explosion and sinking of the Deepwater Horizon oil rig in the Gulf of Mexico, Daniel Beltra.

Image 1.81: On May 17, 2010, when the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite acquired this natural-color image, a large patch of oil was visible near the site of the accident, and a long ribbon of oil stretched far to the southeast.

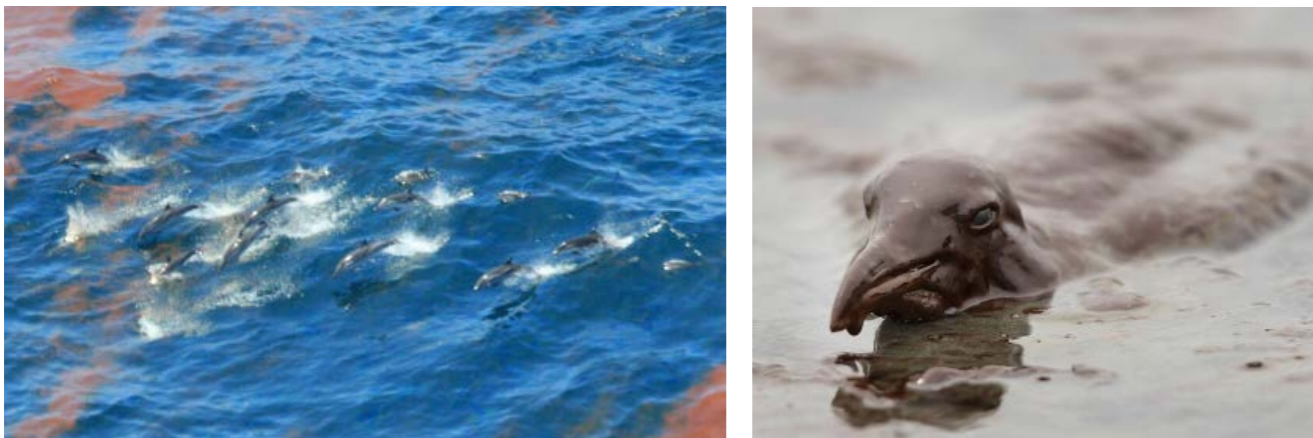


Image 1. 82: Striped dolphins swim among emulsified oil patches on April 29, 2010 in the Gulf of Mexico, a few days after the Deepwater Horizon oil spill, NOAA.

Image 1. 83: July, 3th, 2010, the Gulf oil spill has influenced all the ecosystem in the Mexico bay, in the image one seagull sink into the oil.

Hydraulic fracturing disturbance

It goes by a number of names - 'hydraulic fracturing', 'shale gas extraction', 'hydrofracturing' or 'hydrofracking. But what exactly is fracking, and why has it become such an environmental hot potato? Hydraulic fracturing is the name given to a way of squeezing gas and oil out of tight rock reservoirs, places where these hydrocarbons just won't flow out naturally. It gets pooled in deeply-buried reservoirs - sponge-like rocks where it has been trapped, unable to move any further. Down there it is also under a lot pressure. Simply drill a well into these conventional reservoir rocks, and that pressure drives out the fossil fuels, into the well and so up to surface - such wells are understandably called 'gushers'. Although the controversy with fracking, and shale gas, is new, the technology is quite old. The number of environmental problems for locals has multiplied worryingly, pushing the United States' EPA into conducting a thorough review of the whole industry.⁴⁵ Problems reported include Hydraulic fracturing draws water from local resources, so it can affect water availability, agricultural practices, and the behavior of waterways and the wildlife that depend on them. These effects are amplified in drought-prone regions. Hydraulic fracturing has also caused concern over potential contamination of drinking water by wastewater and fluids that can flow back to the surface after injection. Although wastewater is often disposed of in deep wells, this practice has become more contentious after being tied to induced seismicity in some areas; and even earthquakes.⁴⁶ (Image 1. 84, 1.85)

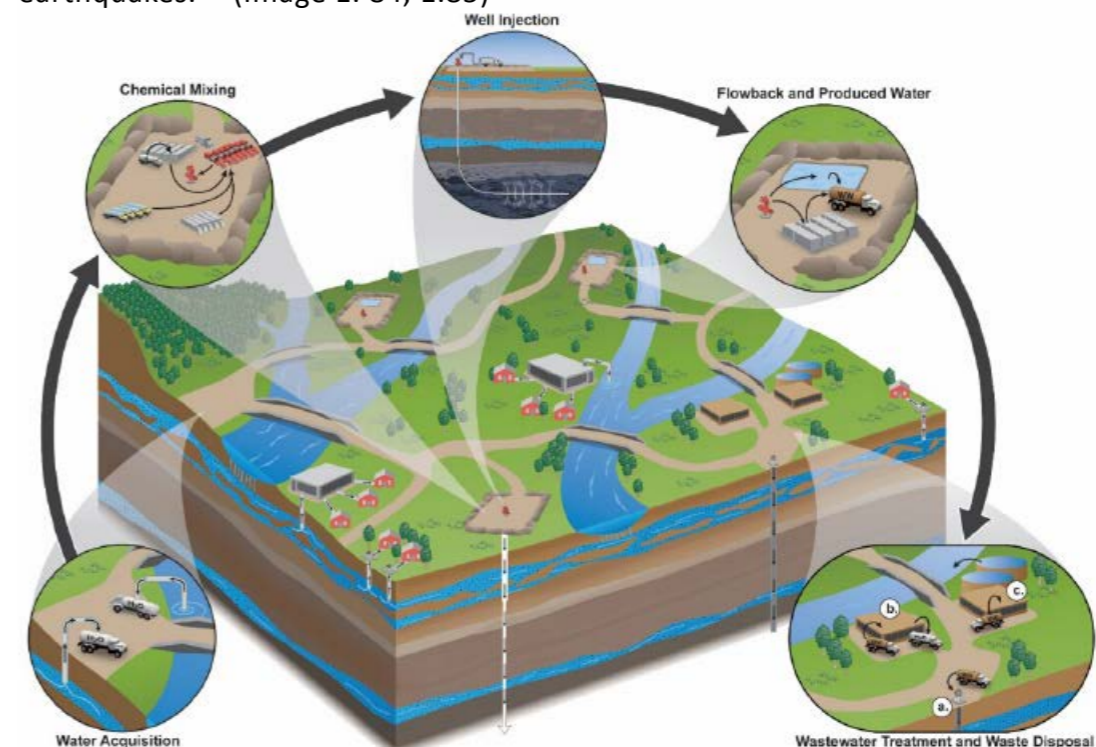


Image 1. 84: The stages of the hydraulic fracturing water cycle. Shown here is a generalized landscape depicting the activities of the hydraulic fracturing water cycle and their relationship to each other, as well as their relationship to drinking water resources. Arrows depict the movement of water and chemicals. Specific activities in the "Wastewater Treatment and Waste Disposal" inset are (a) underground injection control (UIC) well disposal, (b) wastewater treatment and reuse, and (c) wastewater treatment and discharge at a centralized waste treatment (CWT) facility, EPA, 2015.

⁴⁵ Martin Leggett. (July 16, 2011). Hydraulic fracturing and shale gas. Retrieved April 22, 2016 from Earthtimes: <http://www.earthtimes.org/encyclopaedia/environmental-issues/hydraulic-fracturing-shale-gas/#OG4FCfDbyXcH4ZHc.99>

⁴⁶ Briskin, J. (2014). Potential impacts of hydraulic fracturing for oil and gas on drinking water resources. *Ground water*, 53(1), 19-21.

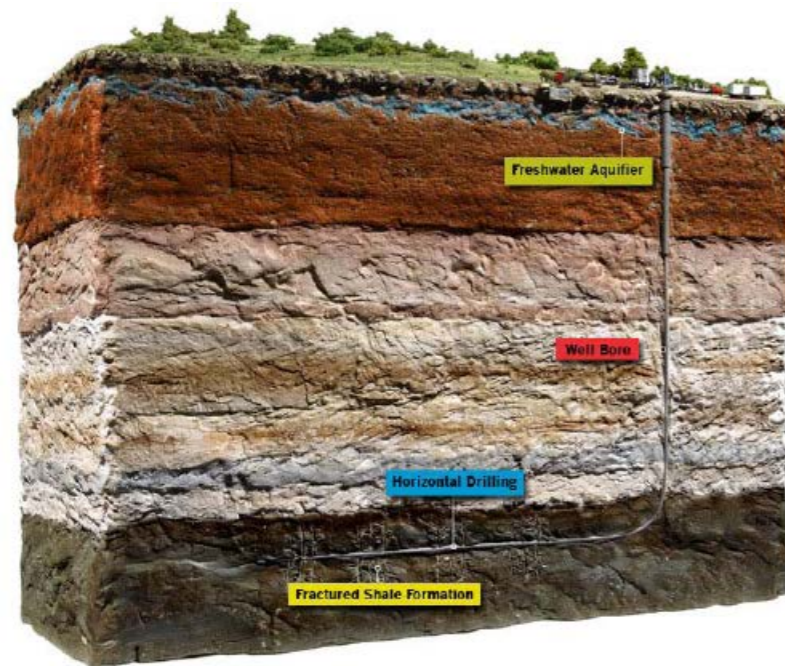


Image 1. 85: The hydraulic fracturing system underground.



Image 1. 87: Resident Canada geese inhabit impacted portion of Yellowstone River July 9, 2011.

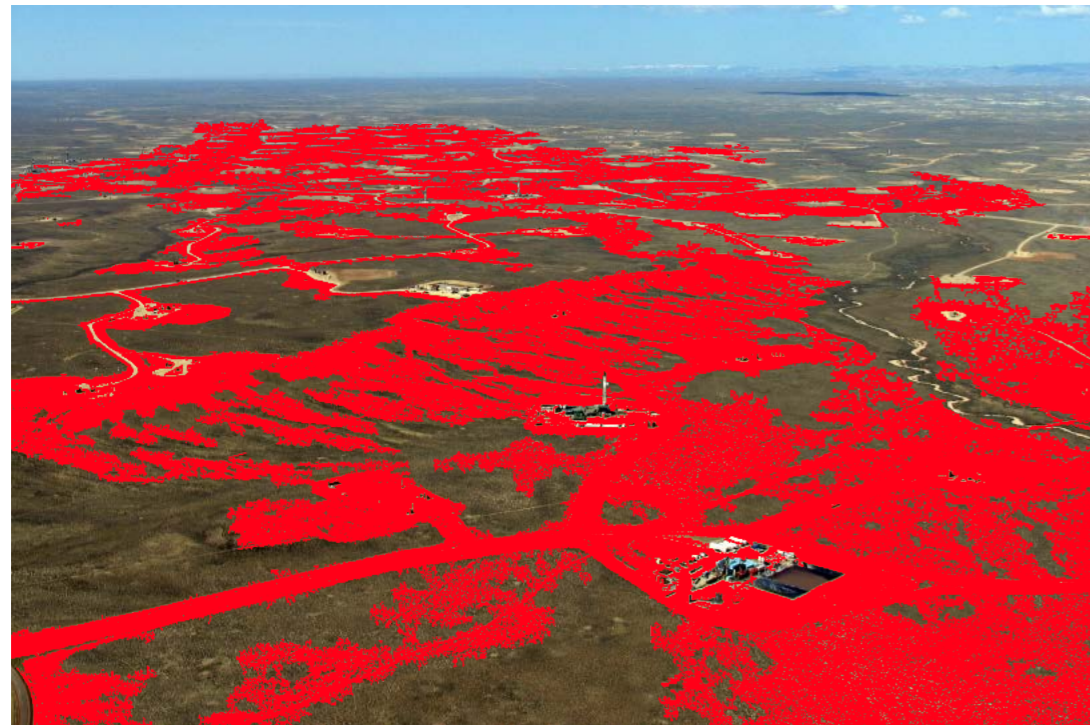


Image 1. 86: Oblique low-altitude aerial photo of wellpads, access roads, pipeline corridors and other natural-gas infrastructure in the Jonah Field of western Wyoming's upper Green River valley, SkyTruth, 2006.

ExxonMobil pipeline rupture spilled into the Yellowstone River, Canada

An ExxonMobil pipeline rupture spilled 42,000 gallons of oil into the Yellowstone River, near Billings, MT. In the aftermath of the spill, ExxonMobil has disclosed that the pipeline has been transporting tar sands oil from Alberta, Canada, which is a low grade, more toxic and corrosive type of oil. Regulators had not been informed that the pipeline was carrying tar sands oil and the disclosure was a result of the spill.⁴⁷ (Image 1. 87)

1.3.2 The fragmented matrix under the city over-expansion disturbance

Air pollution disturbance

Fog, Beijing

The prime candidates are carbon dioxide, ozone and methane, although the latter is not sourced by humans, but instead lies beneath oceans as a rather benign, but massive threat. Global warming of course is the main threat from CO₂ build-up, as well as methane and several others. Pollution from carbon dioxide results from cars and other vehicles (hence the proscribing of high emissions), fossil fuel burning (largely in power stations) and from respiration, particularly bacterial. By far the major cause currently is Chinese, Indian and US power stations. Acid rain was caused by SO₂ Buildings, lakes and trees, along with fish suffering from watery derivatives, were the main victims of a severe acidic reaction. Nitrogen dioxide has a similar history to SO₂, as it also results from combustion. Cars emit a lot of NO₂, along with the infamous carbon monoxide. Heavy metals have been carried by airborne pollution. Photosynthesis is a feature process of all of our green plants we don't eat without photosynthesis.⁴⁸

Residents of Beijing and many other cities in China were warned to stay inside in mid-January 2013 as the nation faced one of the worst periods of air quality in recent history. The Chinese government ordered factories to scale back emissions, while hospitals saw spikes of more than 20 to 30 percent in patients complaining of respiratory issues, according to news reports.

⁴⁷Hoffman, J. (2012). Potential Health and Environmental Effects of Hydrofracking in the Williston Basin, Montana. *Geology and Human Health*.

The Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite acquired these natural-color images of northeastern China on January 14 (top) and January 3, 2013. The top image shows extensive haze, low clouds, and fog over the region. The brightest areas tend to be clouds or fog, which have a tinge of gray or yellow from the air pollution. Other cloud-free areas have a pall of gray and brown smog that mostly blots out the cities below. In areas where the ground is visible, some of the landscape is covered with lingering snow from storms in recent weeks. At the time that the January 14 image was taken by satellite, ground-based sensors at the U.S. Embassy in Beijing reported PM_{2.5} measurements of 291 micrograms per cubic meter of air. Fine, airborne particulate matter (PM) that is smaller than 2.5 microns (about one thirtieth the width of a human hair) is considered dangerous because it is small enough to enter the passages of the human lungs. Most PM_{2.5} aerosol particles come from the burning of fossil fuels and biomass (wood fires and agricultural burning). The World Health Organization considers PM_{2.5} to be safe when it is below 25. Also at the time of the image, the air quality index (AQI) in Beijing was 341. An AQI above 300 is considered hazardous to all humans, not just those with heart or lung ailments. AQI below 50 is considered good. On January 12, the peak of the current air crisis, AQI was 775 the U.S. Embassy Beijing Air Quality Monitor—off the U.S. Environmental Protection Agency scale—and PM_{2.5} was 886 micrograms per cubic meter.⁴⁹(Image 1. 88, 1.89)



Image 1. 88: January, 23, 2013—Beijing suffered fog, the LED screen was showing the blue sky and green mountain video on the Tian'anmen Square.



Image 1. 89: Beijing satellite images before (top, January, 3, 2013) and after (middle, January, 14, 2013) fog, Nasa. The fog enter into Beijing on November 30, 2015, Nasa(bottom).

⁴⁸Dave Armstrong. (Mar 12, 2012). Air Pollution. Retrieved April 22, 2016 from Earthtimes: <http://www.earthtimes.org/encyclopaedia/environmental-issues/air-pollution/>

⁴⁹Air Quality Suffering in China. (Jan 15, 2013). Retrieved April 22, 2016 from NASA: <http://earthobservatory.nasa.gov/IOTD/view.php?id=80152>

Urban heat island disturbance

An urban heat island (UHI) is a city or metropolitan area that is significantly warmer than its surrounding rural areas due to human activities. The phenomenon was first investigated and described by Luke Howard in the 1810s, although he was not the one to name the phenomenon. The temperature difference usually is larger at night than during the day, and is most apparent when winds are weak. UHI is most noticeable during the summer and winter. The main cause of the urban heat island effect is from the modification of land surfaces. Waste heat generated by energy usage is a secondary contributor. As a population center grows, it tends to expand its area and increase its average temperature. The less-used term heat island refers to any area, populated or not, which is consistently hotter than the surrounding area. There are several causes of an urban heat island (UHI); for example, dark surfaces absorb significantly more solar radiation, which causes urban concentrations of roads and buildings to heat more than suburban and rural areas during the day; materials commonly used in urban areas for pavement and roofs, such as concrete and asphalt, have significantly different thermal bulk properties (including heat capacity and thermal conductivity) and surface radiative properties (albedo and emissivity) than the surrounding rural areas. This causes a change in the energy budget of the urban area, often leading to higher temperatures than surrounding rural areas. Another major reason is the lack of evapotranspiration (for example, through lack of vegetation) in urban areas. With a decreased amount of vegetation and wetland, cities also lose the shade and cooling effect of trees, and the removal of carbon dioxide.⁵¹

Hong Kong, China

Hong Kong is always facing the problem of the Shortage of land, includes not only the high price problem, but also the limited cemetery land. Many Hong Kong person need to wait 5 years for an Ashes palce, which leads many cemetery is besides by the football field, residential area. (Image 1. 91)

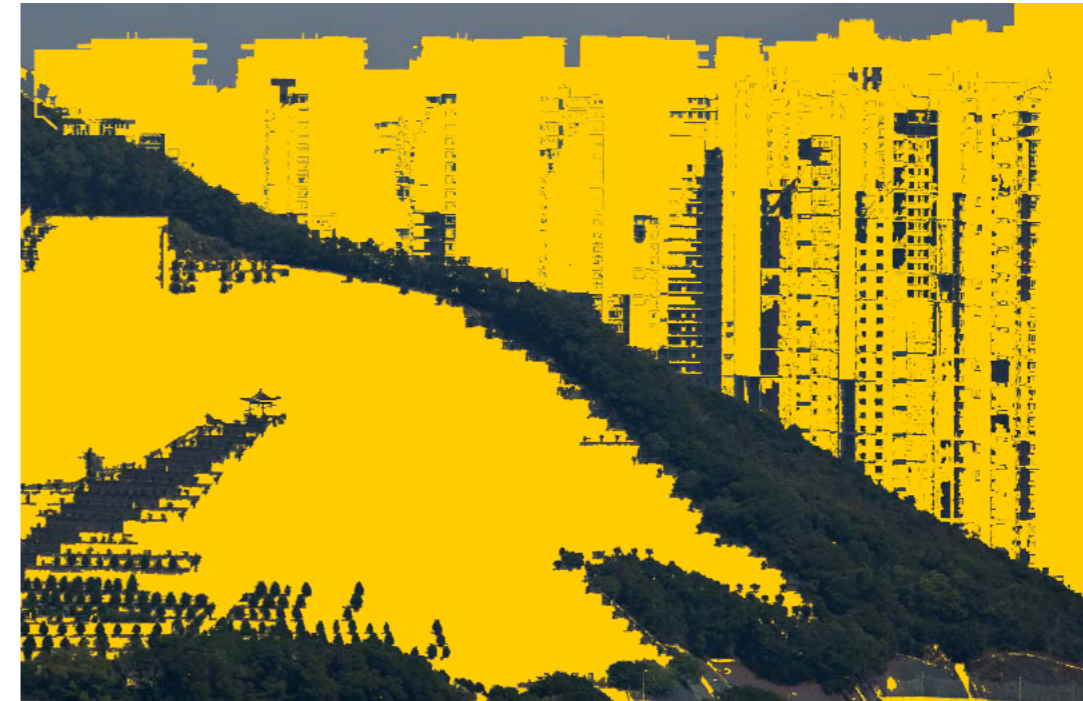


Image 1. 91:
Photo is of a high-rise residential building in front of the hillside cemetery covered verbose, Kin Cheung, 2015.

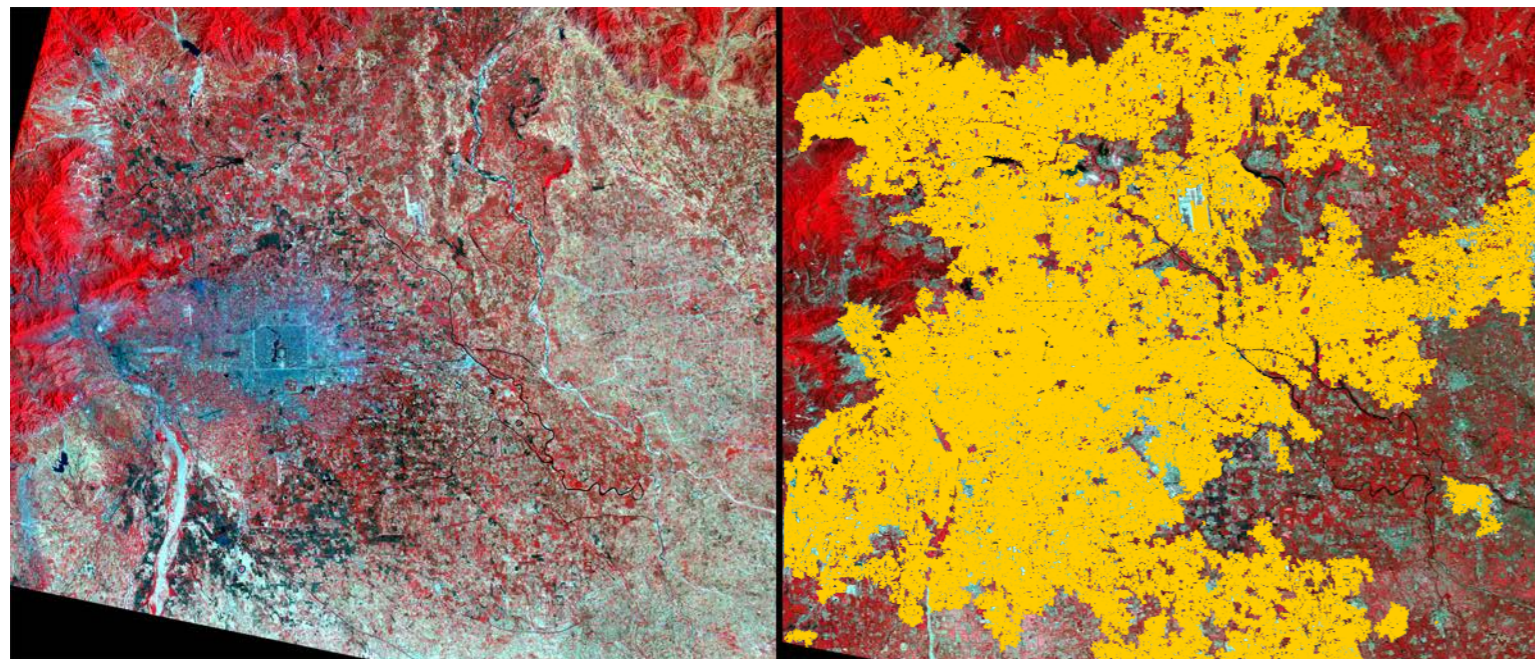


Image 1. 90: Beijing, China has been growing rapidly since the 1970s. The blue tones above represent buildings and pavement, while red tones signify agricultural vegetation. The city on the left in 1977 and on the right in 2011 .

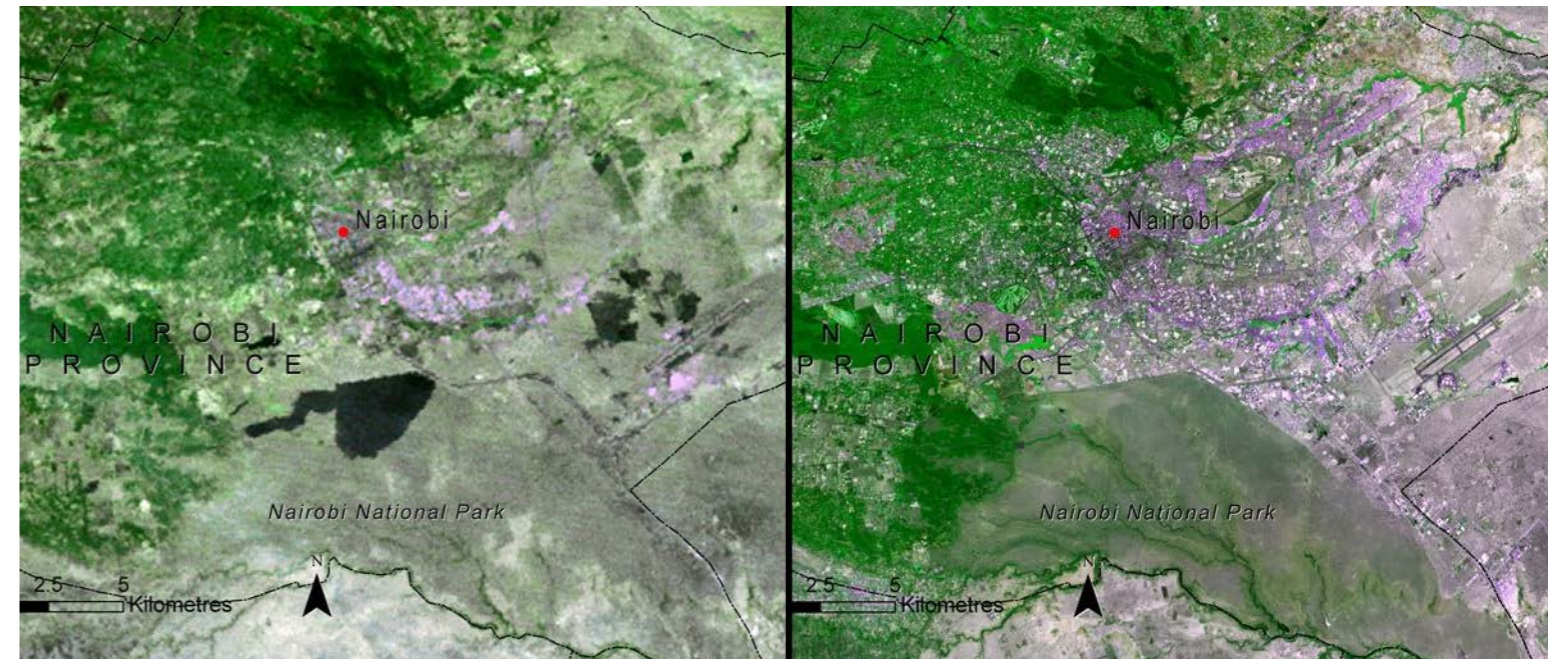


Image 1. 92: Nairobi, Kenya was only founded in 1906 but it has quickly grown to be a booming metropolis. The above satellite images shows the city in 1976 on the left and in 2005 on the right.

⁵¹DAILYMAIL.COM. (March 16, 2015). The devastating effect humans are having on the planet laid bare by these stunning now and then pictures. Retrieved April 22, 2016 from Dailymail: <http://www.dailymail.co.uk/news/article-2996485/The-devastating-effect-humans-having-planet-laid-bare-stunning-pictures.html#ixzz3UXRPxRaA>



Image 1. 93: Nairobi is besides the national park, however, the city not stop the expanding for protecting animals in this national area.

Light pollution disturbance

Light pollution, also known as photo pollution or luminous pollution, is excessive, misdirected, or obtrusive artificial light. Pollution is the adding-of/added light itself, in analogy to added sound, carbon dioxide, etc. Adverse consequences are multiple; some of them may not be known yet. Scientific definitions thus include the following:

- Degradation of photic habitat by artificial light.
- Alteration of natural light levels in the outdoor environment owing to artificial light sources.
- Light pollution is the alteration of light levels in the outdoor environment (from those present naturally) due to man-made sources of light. Indoor light pollution is such alteration of light levels in the indoor environment due to sources of light, which compromises human health.

- Light pollution is the introduction by humans, directly or indirectly, of artificial light into the environment.

The first three of the above four scientific definitions describe the state of the environment. The fourth (and newest) one describes the process of polluting by light.

Light pollution competes with starlight in the night sky for urban residents, interferes with astronomical observatories, and, like any other form of pollution, disrupts ecosystems and has adverse health effects. Light pollution can be divided into two main types:

- Unpleasant light that intrudes on an otherwise natural or low-light setting
- Excessive light (generally indoors) that leads to discomfort and adverse health effects

Light pollution is a side effect of industrial civilization. Its sources include building exterior and interior lighting, advertising, commercial properties, offices, factories, streetlights, and illuminated sporting venues. It is most severe in highly industrialized, densely populated areas of North America, Europe, and Japan and in major cities in the Middle East and North Africa like Tehran and Cairo, but even relatively small amounts of light can be noticed and create problems. Since the early 1980s, a global dark-sky movement has emerged, with concerned people campaigning to reduce the amount of light pollution. The International Dark-Sky Association (IDA) is one non-profit advocacy group involved in this movement.⁵²

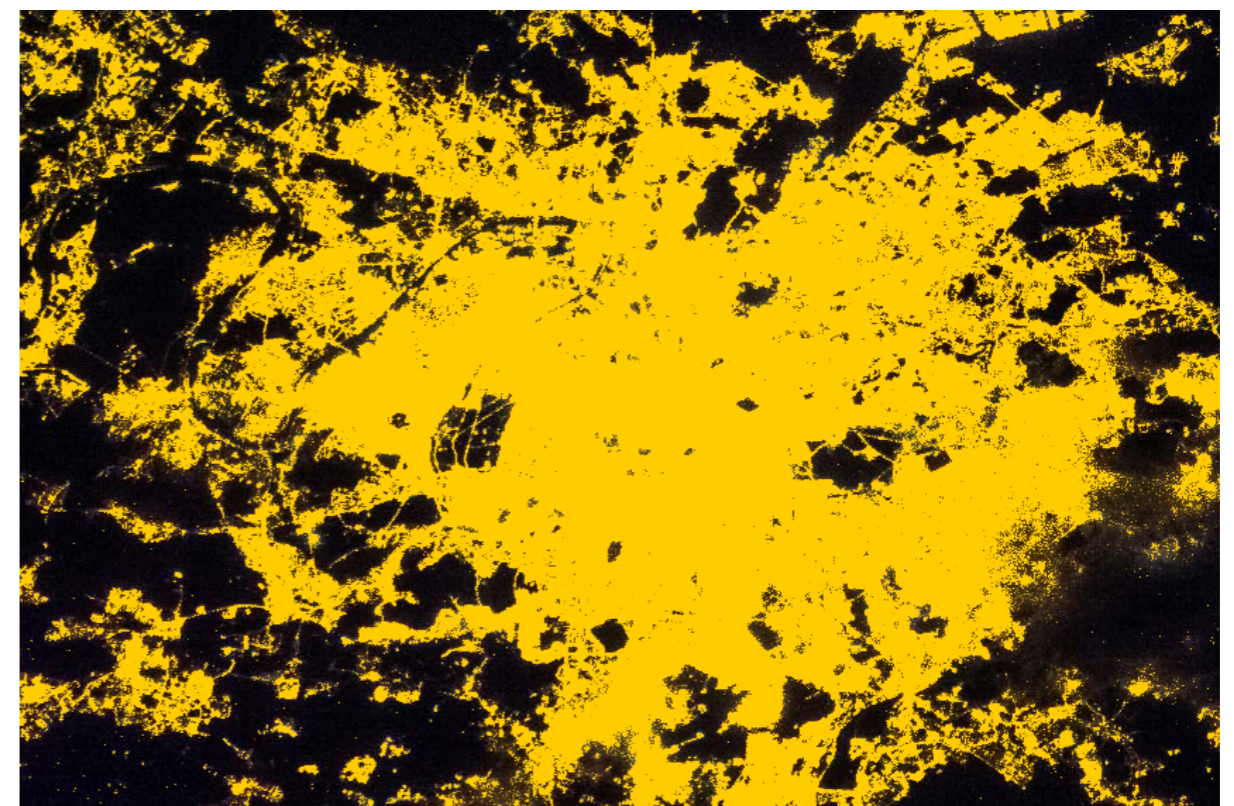


Image 1. 94: Satellite view of Paris at night, Nasa, 2013.

⁵² Light pollution. (2015). Retrieved April 22, 2016 from Wikipedia: https://en.wikipedia.org/wiki/Light_pollution

Teid, Spain(Image 1. 95) This site has been restored, the detail restoration status could read at [page165](#).



Image 1. 95: The Teid island at night, Ansgar Hillebrand, 2015.

Highway and optical cable disturbance

The Nazca Lines

The Nazca Lines are a series of ancient geoglyphs located in the Nazca Desert [citation needed] in southern Peru. They were designated as a UNESCO World Heritage Site in 1994. The high, arid plateau stretches more than 80 km (50 mi) between the towns of Nazca and Palpa on the Pampas de Jumana about 400 km south of Lima. Although some local geoglyphs resemble Paracas motifs, scholars believe the Nazca Lines were created by the Nazca culture between 500 BCE and 500 CE. The hundreds of individual figures range in complexity from simple lines to stylized hummingbirds, spiders, monkeys, fish, sharks, orcas, and lizards. Due to its isolation and to the dry, windless, and stable climate of the plateau, the lines have mostly been naturally preserved.⁵³ (Image 1. 96)

German scholar Maria Reiche developed her theory using her background as a mathematician and her total immersion in Andean culture and history which gave her an undeniable advantage. In 1949 Maria Reich published her book *The Secret of the Pampas* and with it she let the whole world know about the enigmatic Nazca Lines. Maria Reiche died in 1998 after contributing 40 years of her life to the study and conservation of the lines. She traveled lobby for protecting the Nazca Lines, fanally, died and was buried in there. Because of her great efforts, the Nazca Lines was listed into the World Heritage list in 1995. Nazca's Favorite Daughter. However, the city development and highway and optical cable building caused damages on the Nazca Lines. (Image 1. 97)

⁵³Nazca Lines. (Agust 9, 2014). Retrieved April 22, 2016 from Wikipedia: https://en.wikipedia.org/wiki/Nazca_Lines#cite_note-21

In 2015, Digital Globe image showing an area within the site traversed by dirt roads, power lines and geoglyphs. This image shows three unpaved roads within the protected portion of the Nazca World Heritage Site that have been disturbed, probably due to vehicular traffic, plus evidence of erosion along what is usually a dry creek bed in the center middle of the image.⁵⁴ (Image 1. 98)

In a December 2014 publicity stunt, Greenpeace placed a series of large cloth letters visible from the air reading "Time for change! The future is renewable GREENPEACE" in the area adjacent to "The Hummingbird", leaving footprints in the ground in the area around the lines. The incident drew strong criticism and a lawsuit from Peru's government.⁵⁵ (Image 1. 99)



Image 1. 96: One image of Nazca Lines seems astronaut.

Image 1. 97: The lizard was one of the largest figures but the construction of the Pan American highway sliced the figure in two.

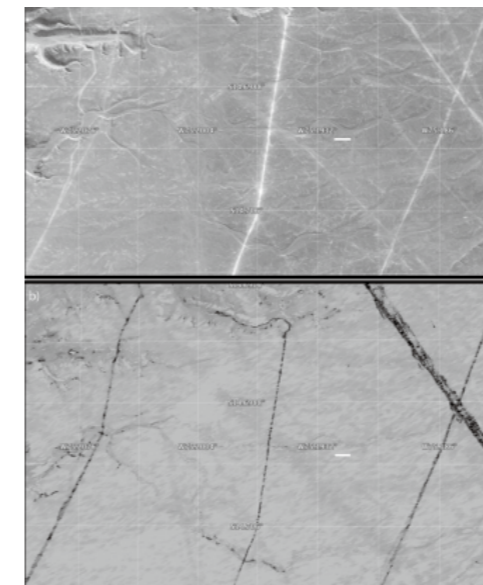


Image 1. 98: Digital Globe image showing an area within the site traversed by dirt roads, power lines and geoglyphs, Nasa, 2015.



Image 1. 99: Greenpeace's 'time for change' message next to the hummingbird geoglyph in Nazca, Thomas Reinecke, 2014.

⁵⁴Disturbance on Dirt Roads Crossing Peru's Nazca World Heritage Site seen by NASA's UAVSAR. (Jan 5, 2016). Retrieved April 22, 2016 from NASA: <http://www.jpl.nasa.gov/spaceimages/details.php?id=PIA20378>

⁵⁵Greenpeace apologises to people of Peru over Nazca lines stunt. (Dec 11, 2014). Retrieved April 22, 2016 from The Guardian: <http://www.theguardian.com/environment/2014/dec/10/peru-press-charges-greenpeace-nazca-lines-stunt>

1.3.3 The fragmented matrix under the nature disaster disturbance

Desertification disturbance

Based on data of soil and vegetation conditions, the figure is about 43%. The difference (9.1 million km² or more than the area of Brazil) represents desertification caused by humans. Huge areas of the United States, Africa, the Middle, East, Australia, and Central and South America are currently undergoing this process. As long as the degraded areas are isolated patches easily reconquered by grasses, the matrix is green. The most widespread cause of desertification is overgrazing. When native plant cover decreases, native animals decrease, new or noxious plants first spread and then decrease, bare soil increases, water and wind erosion increases, and finally eroded sediments build up elsewhere on land and in streams. Once barren land is interconnected, enclosed green patches are likely to succumb to the process, because of both heavy human or animal pressure on the remaining green spots and pervasive flows of heat and sediments from the surrounding bare areas.

Matrix as one element of the landscape structure has been destroyed heavily. Huge sandstorm, desertified coming. Field in the plain is too heavily cultivated, a few pastures are overgrazed, some streams now dry out at times. In short, the changes in the land depend greatly on the three characters of a matrix: relative area of landscape element types, level of connectivity present, and degree of control over landscape dynamics.⁵⁶

Severe drought in Somalia, Kenya, and southern Ethiopia.

In late 2010, a strong La Niña cooled surface waters in the central and eastern Pacific Ocean, while allowing warmer water to build in the western Pacific. Drought over most of East Africa and floods and lush vegetation in Australia and other parts of Southeast Asia. La Niña is a weather phenomenon that is part of a global natural cycle of climate known as El Niño - Southern Oscillation (ENSO). This global cycle has two ends : a warm phase known as El Niño and a cold phase known as La Niña precisely. The National Oceanic and Atmospheric Administration (NOAA) has warned that the ongoing El Niño episode could rival the strongest El Niños on record (1982-83, 1997-98) and is nearly certain to last into the Northern Hemisphere spring of 2016. combined with changes in sea surface temperatures and shifts in rainfall patterns during El Niño, often have negative impacts on the environment. El Niño episodes typically disrupt harvesting seasons, whether that means flooding farmland in South Africa or extreme drought in Australia. Over time, erratic rainfall, flooding and drought have all contributed to massive crop failures in Africa, particularly affected sub-Saharan regions. During an El Niño event, coral reacts to this shift in ocean temperature by expelling the symbiotic algae that lives within its tissues. Once the algae is expelled, the coral is bleached and vulnerable to other harsh marine conditions. ⁵⁷ (Image 1. 100, 1.101) This site has been restored, the detail restoration status could read at [page107](#).

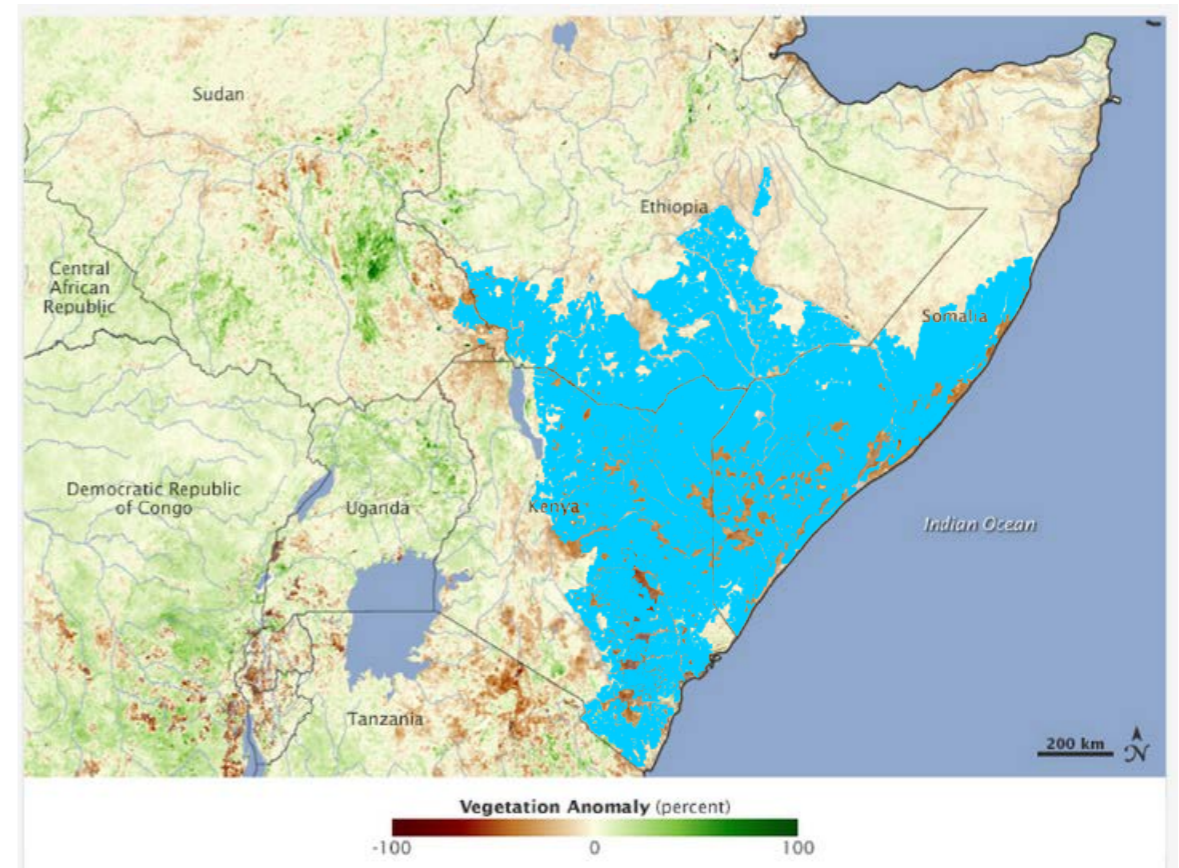


Image 1. 100: This image, from France's SPOT satellite, shows severe drought in Somalia, Kenya, and southern Ethiopia, 2010.



Image 1. 101: The search for water has been the life-sustaining quest for all beings. This photograph depicts the convergence of two groups – the Maasai herders with their cattle and a herd of elephant – on a common watering hole, Amboseli, Kenya, Marie Wilkinson & Cyril Christo , 2007.

⁵⁶RICHARD,T. y Forman, M. (1986). Landscape Ecology. America: Wiley, p.167.

⁵⁷Anyamba, A., Tucker, C.J., Mahoney, R. (2002). El Niño to La Niña vegetation response patterns over East and Southern Africa during 1997-2000 period. Journal of Climate, 15, 3096-3103.

Glacial retreat disturbance

It's the world's highest tropical glacial field and scientists predict it will be gone within 40 years. In the process, it is likely to deliver water shortages and catastrophic floods to towns in the Peruvian Andes. More than 2,500 glaciers slice through the mountain peaks of Peru. Around 660 of them lie in the country's highest mountain range, the UNESCO listed Cordillera Blanca. The United Nations body warns the glacial retreat threatens the livelihoods of 2 million people, living in the valleys below and the desert coastal cities that rely on the glaciers' water."In the last 40 years the glaciers have retreated at least 34 per cent," Huaraz based Glaciologist and Civil Engineer Cesar Portocarrero said.

Flood and avalanches in the Río Santa valley, Perú

Since 1702, more than 22 catastrophic events have resulted from ice avalanches that have caused outburst floods from glacier lakes. The floods, known in Perú as aluviónes, come with little or no warning and are composed of liquid mud that generally transports large rock boulders and blocks of ice. The floods have destroyed a number of towns, and many lives have been lost. One of the hardest hit areas has been the Río Santa valley in northern Perú. Of these catastrophes, the most serious were the aluviónes that destroyed part of the city of Huaraz in 1725 and 1941, as well as the aluvi3n that resulted from the failure of Lago Jancarurish in 1950. In addition, two destructive, high-speed avalanches from the summit area of Huascarán Norte (6,655 m asl) in 1962 and 1970 destroyed several villages and caused the deaths of more than 25,000 inhabitants. Reports of these catastrophic glacier-related events include those by Morales Arnao, B. (1966, 1971), Chiglino (1950, 1971), Lliboutry (1975), Plafker and Ericksen (1978), and Hofmann and others (1983).⁵⁸

(Image 1. 102, 1.103, 1.104)

A chunk of glacier was threatening to fall into an Andean lake and cause major flooding in a Peruvian city of 60,000. A fissure has appeared in the glacier that feeds the Lake Palcacocha near the city of Huaraz, 270 km north of Lima. If the piece breaks off, ensuing floods would take 15 minutes to reach the city. In 1941, the lake overflowed and caused massive destruction, killing 7,000 people. The city can be seen in the left-center part of the image. Lake Palcacocha is in the upper right corner of the image at the head of a valley, below the snow and glacier cap. The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) instrument, aboard NASA's Terra satellite, is being tasked to obtain current images of the glacier to help monitor the situation.⁵⁹ Mr Portocarrero said climate change made glacial avalanches and floods more frequent, increasing the dangers for the provincial capital of Huaraz and its population of 120,000 people. "Laguna Pallqaqucha [a glacial lake] is currently 34 times its normal volume," he said. "If it bursts, 18 million cubic metres of water and debris will flood Huaraz. "There are 10 to 14 dangerous lakes [across the region]. We need early warning systems, starting in Huaraz." Despite the city being flooded by the same lake in 1941 and an avalanche destroying the nearby town of Yungay in 1970, monitoring systems are not in place to alert the region's towns of pending disaster.⁶⁰



Image 1. 103: The city of Huaraz showing extensive white flood of 1941. On the right, the old part of the city remained intact, Arnold Heim, 1947.

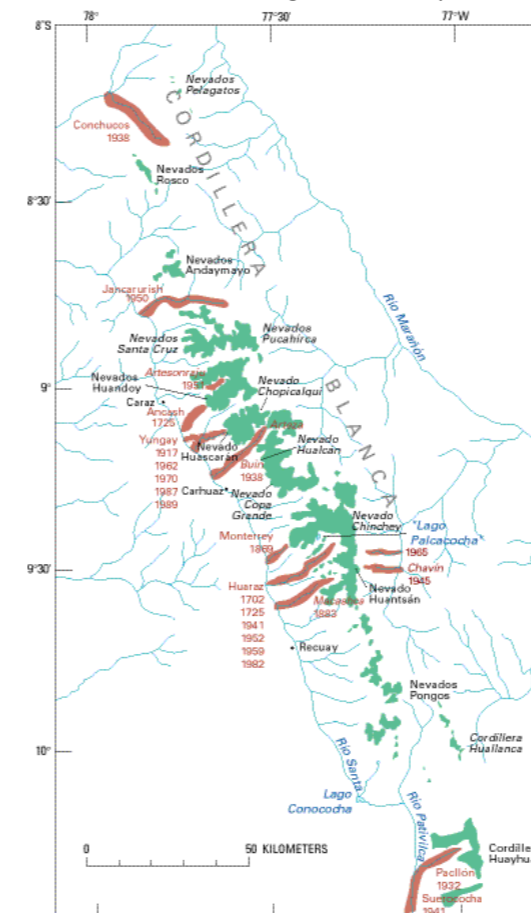


Image 1. 102: The locations of the many natural disasters, glaciological in origin, that have caused deaths or identify damage in the Río Santa valley of Perú since 1702.

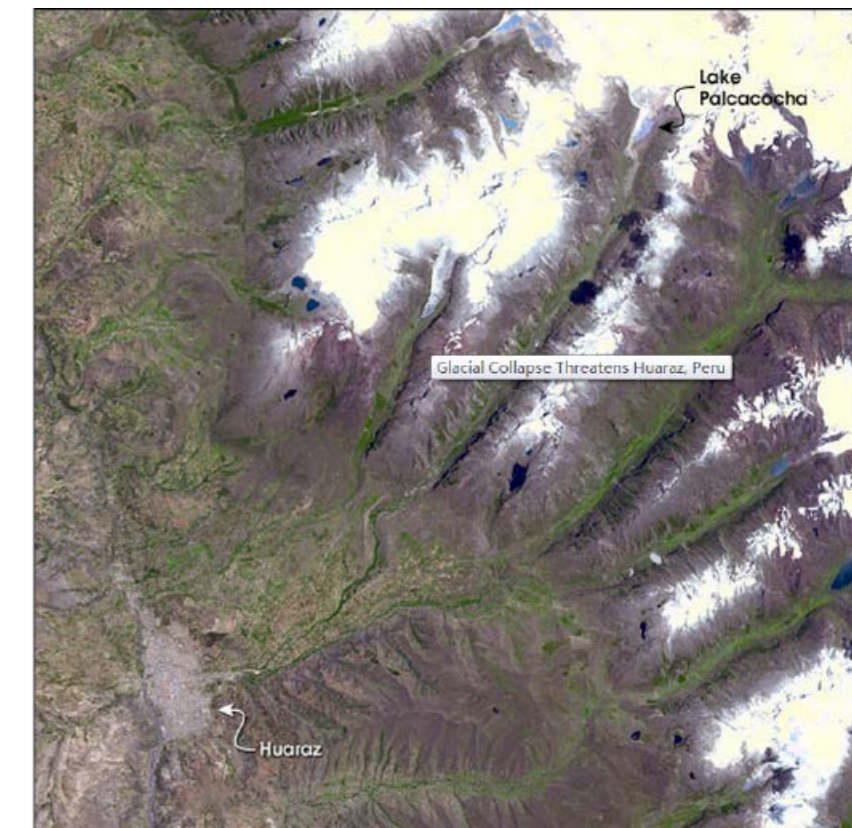


Image 1. 104: Huaraz satellite image. By the climate become warm, the city of Huaraz still face the potential danger of avalanches and flood, Nasa, 2001.

⁵⁸Glacier Hazards. Retrieved April 22, 2016 from USGS: <http://pubs.usgs.gov/pp/p1386i/peru/hazards.html>

⁵⁹Glacial Collapse Threatens Huaraz, Peru. (April 4, 2003). Retrieved April 22, 2016 from NASA: <http://earthobservatory.nasa.gov/IOTD/view.php?id=3343>

⁶⁰World's highest glaciers, in Peruvian Andes, may disappear within 40 years. (Nov 5, 2015). Retrieved April 22, 2016 from ABC: <http://www.abc.net.au/news/2015-11-05/perus-highest-disappearing-glaciers-climate-change/6915668>

Lewis Glacier, Canada

Lake Louise, named Lake of the Little Fishes by the Stoney Nakota First Nations people, is a glacial lake within Banff National Park in Alberta, Canada. The Lewis Glacier is around this lake. The Lewis Glacier is receding. (Image 1. 105)



Image 1. 105: This image was taken in 2014, we could see that, in 1987, the snow line of the Lewis Glacier is on the fire line. However, till 2014, the snow line has receded 120 meters.

Flood disturbance

Hurricane Katrina, America

Above the page 13343 explained the the Gulf of Mexico, then almost miraculously, 10 years before this event, at the same area, Hurricane Katrina caused the historical Disaster, Hurricanes, dam break, flood killed almost 1800 life. This disaster not mainly caused by the Hurricane Katrina, the main reason is channel change of the Mississippi River and wetland reduce both decrease the Anti-disaster ability.

Landscapes respond to constraint by moving differently, often arriving at surprising and undesirable manifestations. Mississippi Floods leaves us with a lingering question: what is the new migratory syndrome of the river and its watershed? What was once a highly dynamic and variable natural system became, in a few decades in the mid 20th century, one of the world's most complex feats of engineering. The single-minded pursuit of flood

protection and efficient navigation transformed as well how the river was perceived by the generations that followed. (Image 1. 106) Without the continual replenishment of sediment from the Mississippi River, the Louisiana Delta has since 1930 lost 2,300 square miles of wetlands due to the combined effects of levee construction, land subsidence, storm damage, canal dredging and hydrocarbon extraction.⁶² (Image 1. 107)

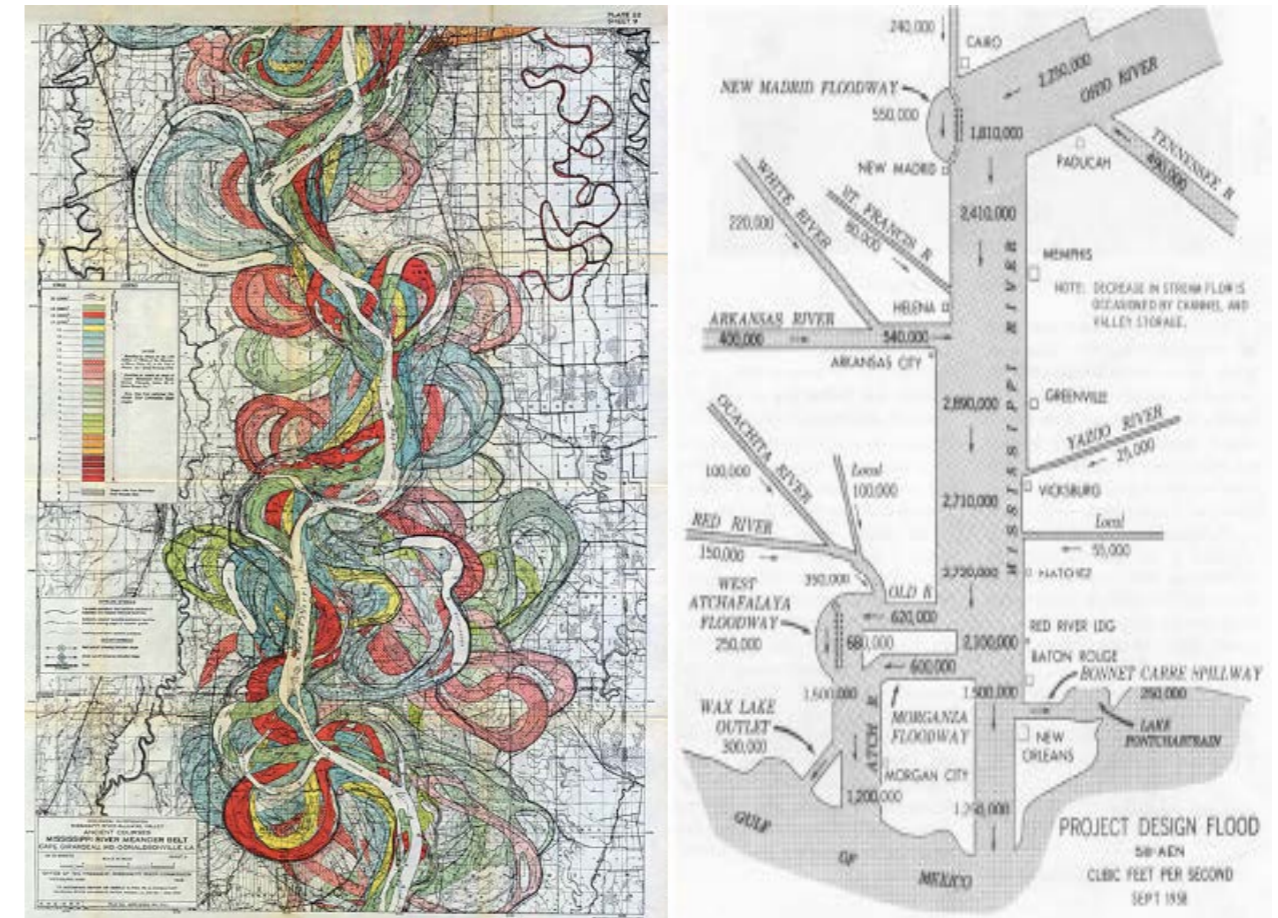


Image 1. 106: Left: Map of ancient courses of the Mississippi River, Cape Girardeau, 1944. Right: America's Wetland Resource Center.

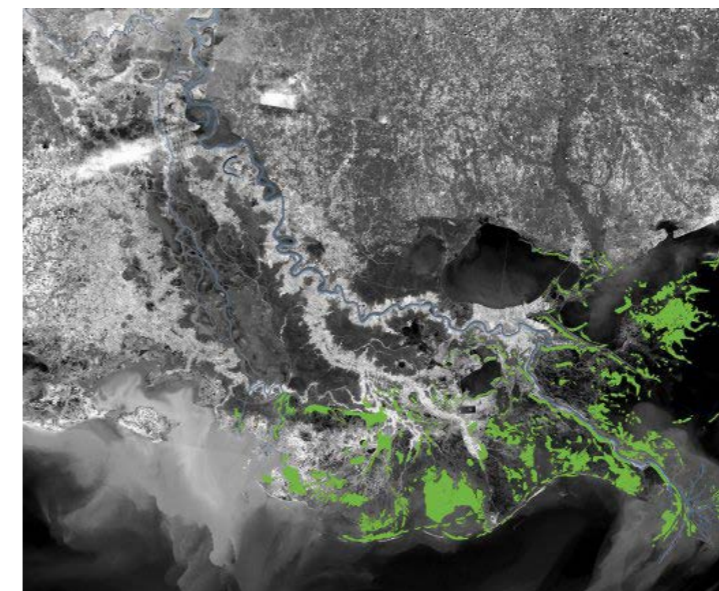


Image 1. 107:

20th century wetland loss, mapping by LSU Coastal Sustainability Studio.

⁶²Mossop, E., & Carney, J. In the Mississippi Delta: Building with Water.

Floodwaters in South Carolina

After record-breaking rains pounded South Carolina in early October 2015, severe floods overwhelmed many parts of the state. More than a dozen dams were breached, entire neighborhoods were swamped, hundreds of roads were made impassable, and more than a dozen people were killed. (Image 1. 108) Flood water covered broad swaths of farmland, forests, and wetlands east of the Congaree River in 2015. Note that the dark areas in the 2014 image are cloud shadows. Meteorologists tracking the event say it was severe enough to be categorized as a “1000-year rain” —meaning there is just a 0.1 percent chance that a rain event so severe can occur in any given year. Meteorologists tracking the event say it was severe enough to be categorized as a “1000-year rain” —meaning there is just a 0.1 percent chance that a rain event so severe can occur in any given year.

Floodwaters have washed out infrastructure in South Carolina, as seen in Columbia on October 5. More than a dozen dams have failed this week in South Carolina amid catastrophic flooding that has destroyed homes and businesses and left more than a dozen people dead. The ultimate cause is too much rainfall over a short period, but the disaster also points to longer-term problems in infrastructure that are putting thousands of people at risk around the world. (Image 1. 109)

Image 1. 108:

On October 8, 2015 (bottom image), the Advanced Land Imager (ALI) on NASA’s Earth Observing-1 (EO-1) satellite observed the flooded interior of South Carolina. For comparison, the second image shows the same area on October 15, 2014, (top image) as observed by the Operational Land Imager (OLI) on Landsat 8.



Floodwaters have washed out infrastructure in South Carolina, as seen in Columbia on October 5. More than a dozen dams have failed this week in South Carolina amid catastrophic flooding that has destroyed homes and businesses and left more than a dozen people dead. The ultimate cause is too much rainfall over a short period, but the disaster also points to longer-term problems in infrastructure that are putting thousands of people at risk around the world. (Image 1. 109)

Ten years after making landfall, scars from Hurricane Katrina still linger. And not just in the blighted houses that mar some neighborhoods. The marshes and swamps that buffer New Orleans from the Gulf of Mexico still show evidence of Katrina’s wrath. The wetlands surrounding Delacroix, a fishing town to the southeast of New Orleans, were some of the hardest hit by the hurricane. This pair of false-color images shows the transformation. The Thematic Mapper on Landsat 5 acquired the top image a week before the storm hit. The Operational Land Imager (OLI) on Landsat 8 acquired the second image in August 2015. With this band combination, normal vegetation appears bright green and flood-damaged vegetation is brown. Water is dark blue. Katrina delivered a massive surge of water that dramatically enlarged lakes, including Lake Lery and Petit Lake. It also scoured new channels and widened canals in ways that eliminated large amounts of marshland. As seen in the 2015 image, flood-damaged vegetation has returned to its normal color, but the enlarged waterways have persisted. Land losses tended to be more severe in freshwater and intermediate marshes closer to the town than in saltwater and brackish marshes closer the Gulf. Freshwater marshes have more pliable soil that is easily washed away. They also tend to support plants with shallower root systems than salt marshes. We could know that the flood influence is a long term damage, which need we to consider how to protect our city to withstand flood before next Hurricane? In order to deal with future potential flood disaster, America government launched a series of restoration action. You could read the detail content at [page 146](#) in the second chapter.



Image 1. 109: Floodwaters have washed out infrastructure in South Carolina, as seen in Columbia on October 5, CHUCK BURTON, 2015.

1.3.4 The fragmented matrix under the humanity damage disturbance

War disturbance

Environmental impact of war mainly includes Unexploded ordnance, Agent Orange, Testing of nuclear armaments, Fossil fuel use, Intentional flooding, etc. The progression of warfare from chemical weapons to nuclear weapons has increasingly created stress on ecosystems and the environment. During World War I, all major belligerents employed the use of weapons of mass destruction (ie, chemical weapons). By the time of war's end, an estimated 1.3 million casualties, including 100,000-260,000 civilians, and unknown numbers of soil erosion, deforestation, and water contamination in areas were caused by chemical weapons. War is hell on earth, of course. You may not be aware of just how toxic and devastating is the footprint that the military-industrial complex leaves behind on Battlefield Earth. Agent Orange, rocket fuel, lead, mercury, petroleum, asbestos, countless carcinogenic solvents. This toxic stew settles into the soil in which we grow our food, seeps down into the water we drink and floats unseen in the air we breathe making us sick — terribly sick — and killing many of us, or leading to birth defects, cancer, miscarriages, and kidney and thyroid disease.⁶³

Atomic bombings of Hiroshima and Nagasaki, Japan

The United States dropped atomic bombs on the Japanese cities of Hiroshima and Nagasaki in August 1945, during the final stage of the Second World War. Within the first two to four months of the bombings, the acute effects of the atomic bombings killed 90,000–146,000 people in Hiroshima and 39,000–80,000 in Nagasaki; roughly half of the deaths in each city occurred on the first day. During the following months, large numbers died from the effect of burns, radiation sickness, and other injuries, compounded by illness and malnutrition. In both cities, most of the dead were civilians, although Hiroshima had a sizable military garrison. The atomic bombings of Hiroshima and Nagasaki was the first and only use of atomic weapons in warfare and it had a devastating effect on the built environment and on human life. The bombs killed as many as 140,000 people in Hiroshima and 80,000 in Nagasaki by the end of 1945, roughly half on the days of the bombings. Amongst these, 15 to 20% died from injuries or illness attributed to radiation poisoning. Since then, more have died from leukemia (231 observed) and solid cancers (334 observed) attributed to exposure to radiation released by the bombs. (Image 1. 110, 1.111)

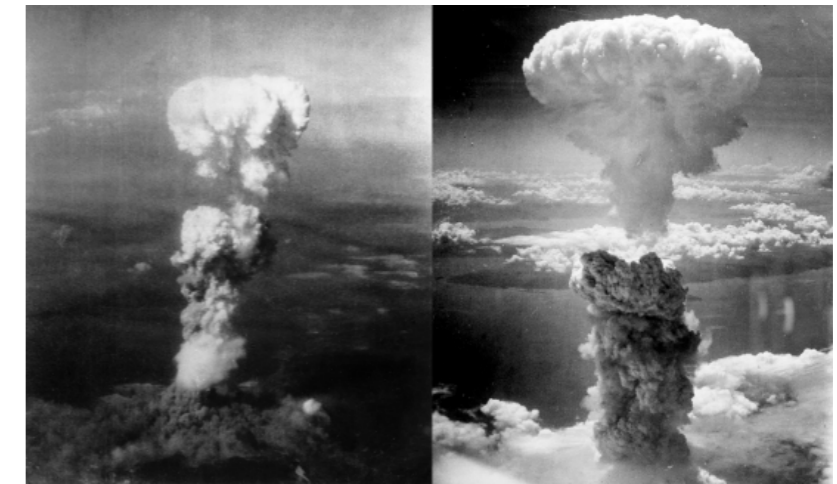


Image 1. 110: Atomic bomb mushroom clouds over Hiroshima (left) and Nagasaki (right), 1945.

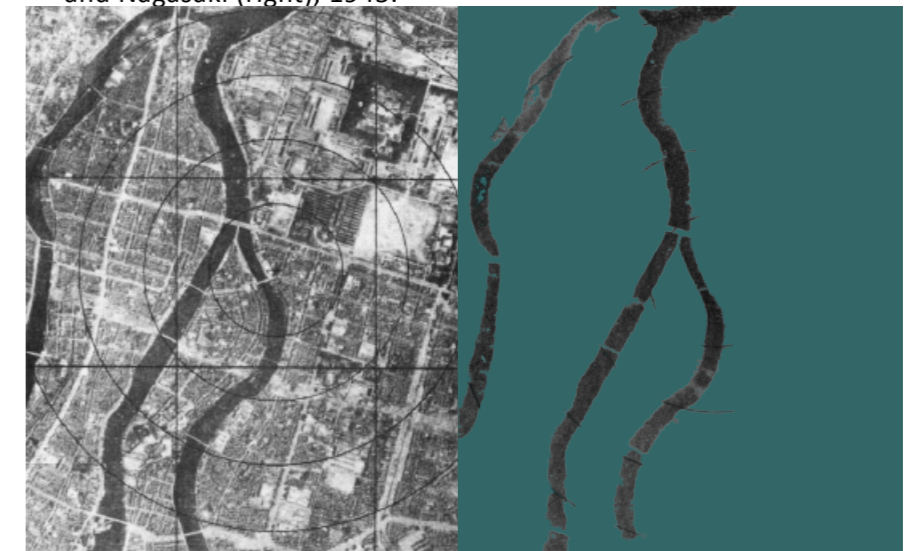


Image 1. 111: Hiroshima before (left) and after (right) the bombing.



Image 1. 112: Nagasaki before (top) and after (bottom) bombing

⁶³ Adas, M. (1995). *The Ecology of War: Environmental Impacts of Weaponry and Warfare*. By Susan D. Lanier-Graham. New York: Walker and Company, 1993. xxx+ 185 pp. Illustrations, glossary, selected bibliography. \$22.95. *Forest & Conservation History*, 39(4), 193-193.

The bombing of Guernica, Spain

The bombing of Guernica (26 April 1937) was an aerial attack on the Basque town of Guernica during the Spanish Civil War. It was carried out at the behest of the Spanish nationalist government by its allies, the German air force's Condor Legion and the Italian Aviazione Legionaria, under the code name Operation Rügen.

The bombing is considered one of the first raids on a defenceless civilian population by a modern air force. The number of victims of the attack is still disputed; the Basque government reported 1,654 people killed, although modern figures suggest between 126 (later revised by the authors of the study to 153) and 400 civilians died. Russian archives reveal 800 deaths on 1 May 1937, but this number may not include victims who later died of their injuries in hospitals or whose bodies were discovered buried in the rubble.⁶⁴ (Image 1. 113, 1.114) This site has been restored, the detail restoration status could read at [page150](#).



Image 1. 113: Guernica booming, 1937.



Image 1. 114: Guernica after booming, 1937.

⁶⁴ La plaza de toros de Badajoz y el bombardeo de Guernica. (Nov 26, 2015). Retrieved April 22, 2016 from Periodistadigital: <http://www.periodistadigital.com/alfonso-rojo/reportero-de-guerra/2015/11/26/badajoz-reportero-guernica-guerra-1936-alfonso-guerra-civil-vasco-rojo-requete-hemingway-yague-mola-franco-goring-steer-hitler-picasso.shtml>

Nuclear accident disturbance

Chernobyl nuclear accident, Russia

The Chernobyl nuclear power plant is located next to the Pripjat River, which feeds into the Dnieper reservoir system, one of the largest surface water systems in Europe, which at the time supplied water to Kiev's 2.4 million residents, and was still in spring flood when the accident occurred. The radioactive contamination of aquatic systems therefore became a major problem in the immediate aftermath of the accident. Bio-accumulation of radioactivity in fish resulted in concentrations (both in western Europe and in the former Soviet Union) that in many cases were significantly above guideline maximum levels for consumption. In the aftermath of the accident, 237 people suffered from acute radiation sickness (ARS), of whom 31 died within the first three months. Most of the victims were fire and rescue workers trying to bring the accident under control, who were not fully aware of how dangerous the exposure to radiation in the smoke was. On the death toll of the accident, the report states that twenty-eight emergency workers ("liquidators") died from acute radiation syndrome including beta burns and 15 patients died from thyroid cancer in the following years, and it roughly estimated that cancer deaths caused by Chernobyl may reach a total of about 4000 among the 5 million persons residing in the contaminated areas. The 1986 explosion of a nuclear generator in Chernobyl (Ukraine) created a large radioactive cloud which polluted existing water supplies and produced contaminated rain in nearby countries. The radiations which are harmful influence nature and occur in the coastal areas. The fishes and water polluted by the radiation. Nuclear radiation can contaminate soil, leading to plants which contain radiation and pose a health threat to individuals.

After the disaster, four square kilometers of pine forest directly downwind of the reactor turned reddish-brown and died, earning the name of the "Red Forest". Some animals in the worst-hit areas also died or stopped reproducing. (Image 1. 115, 1.116) The Chernobyl disaster was the worst nuclear power plant accident in history in terms of cost and casualties. It is one of only two classified as a level 7 event (the maximum classification) on the International Nuclear Event Scale, the other being the Fukushima Daiichi nuclear disaster in 2011.

Image 1. 115:

Aerial view of the damaged core on 3 May 1986. Roof of the turbine hall is damaged (image center). Roof of the adjacent reactor 3 (image lower left) shows minor fire damage.



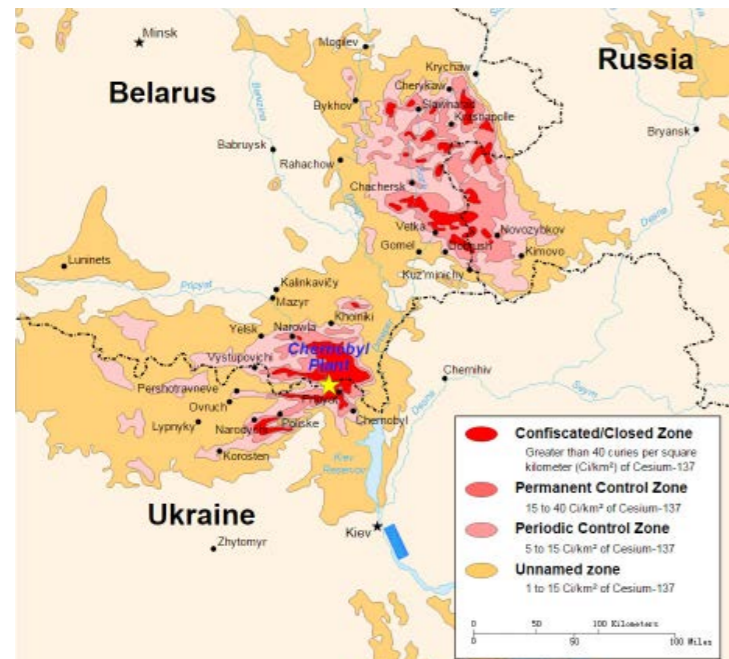


Image 1. 116: Map of radiation levels around Chernobyl, CIA Factbook, 1996.

Four nuclear bombs in the village of Palomares, Spain

On a sunny morning in 1966 two US Air Force planes collided and dropped four nuclear bombs near the village of Palomares in southern Spain. There was no nuclear blast, but plutonium was scattered over a wide area - and Spain is now asking the US to finish the clean-up. The two that fell to earth unsupported by parachutes blew apart on impact, scattering highly toxic, radioactive plutonium dust - a major hazard to anyone who might inhale it. Actually, just how much plutonium is still out there is hard to determine, because the US has never said how much the bombs were carrying to begin with. But Spanish investigator Carlos Sancho estimates that between 15 and 25 pounds (7 and 11kg) of the material ended up in the soil. In Palomares itself, the US and Spain agreed to fund yearly health-checks on residents, and to monitor the soil, the water, the air, and local crops. (Image 1. 117)



Image 1. 117: Map of radiation levels around Palomares, 1966.

1.4 conclusion

The above discussion introduces information regarding the status of the fragmented landscape structures, in summary:

1) Chapter 1 analyses the fragmentation of landscape structures under different conditions of disturbance, which shows that fragmentation becomes progressively more severe until it is found to occur universally.

2) In Chapter 1, the analysis of the fragmented patch, corridor and matrix focuses on visually fragmented structures. However, most of the consequences of these visually fragmented structures are non-visual, influencing other structures, such as patches from the nuclearleakagewhichlead to a fragmented soil matrix; the patch caused by terrorist activity causes the fragmented global matrix of fear in people. Therefore, these two points influence the way people think and must therefore be taken care of carefully. In Chapter 2, we discuss the effect of restoration projects on fragmented thought. Another consideration is that this fragmentation situation is caused by the comprehensive fragmentation of the structural network, which therefore requires a comprehensive assessment. In Chapter 3, an assessment of environmental disruption to both visual and non-visual fragmentation structures is discussed.

3) The case studies in this chapter compare the conditions before and after fragmentation, and show that the surrounding environment is also changing in each example. This surrounding environment requires further assessment and analysis in the following chapters. Therefore, in the Chapter 3,an assessment is made not only of the site, but also of the surrounding environment.

4) In chapter 1, we find that there are different elements influencing the different fragmented structures, such as the temperature, which is very important for the analysis of the fragmented animal migration corridors; hydrology is very important for the analysis of the fragmented flood matrix; vegetation is very important for the analysis of the fragmented landfill patch. So it is necessary to understand the different fragmented landscape structures identified in this chapter, which will enable the correct choice of the correct environmental index to be made relating to the different fragmented structure assessments in Chapter 3.



Image 1.118:
The typical fragmented landscape case
in the world under different type of disturbance.

- The fragmented landscape structure under the resources over-exploited disturbance
- The fragmented landscape structure under city over-expansion disturbance
- The fragmented landscape structure under the nature disaster disturbance
- The fragmented landscape structure under humanity damage disturbance

Chapter 2. The fragmented landscape structure restoration

The fragmented landscape structure Restoration

THE FRAGMENTED PATCH Restoration

under the resources over-exploited disturbance

THE **Restored** FRAGMENTED PATCH

Mine exploitation restoration



Un-restored: Solar energy exploitation disturbance

THE FRAGMENTED CORRIDOR Restoration

THE **Restored** FRAGMENTED CORRIDOR

Dam restoration
Agriculture restoration



THE FRAGMENTED MATRIX Restoration

THE **Restored** FRAGMENTED MATRIX

Ocean pollution restoration




Un-restored: Motor-pumped wells disturbance Hydraulic fracturing disturbance

THE FRAGMENTED THOUGHT Restoration

THE **Restored** FRAGMENTED THOUGHT

Mine and Quarry restoration



under city over-expansion disturbance

THE **Restored** FRAGMENTED PATCH

Landfill restoration
Slums restoration



Un-restored: Channel disturbance Pesticide disturbance

THE **Restored** FRAGMENTED CORRIDOR

Railway restoration
Highways restoration
Coastline restoration
Hunting restoration



Un-restored: Channel disturbance Pesticide disturbance

THE **Restored** FRAGMENTED MATRIX

Wetland and flood restoration
light pollution restoration
Desertification restoration



Un-restored: Air pollution disturbance Urban heat island disturbance
Glacial retreat disturbance Flood disturbance

THE **Restored** FRAGMENTED THOUGHT

Landfill restoration
Abandoned suburbs area restoration
Humanity restoration
Light pollution restoration



under the nature disaster disturbance

THE **Restored** FRAGMENTED

Drought restoration
Avalanche restoration
Earthquake restoration



Un-restored: Climate changing altitudinal migration disturbance

THE **Restored** FRAGMENTED CORRIDOR


Flood restoration
Tsunami restoration



Un-restored: Climate changing altitudinal migration disturbance

THE **Restored** FRAGMENTED MATRIX

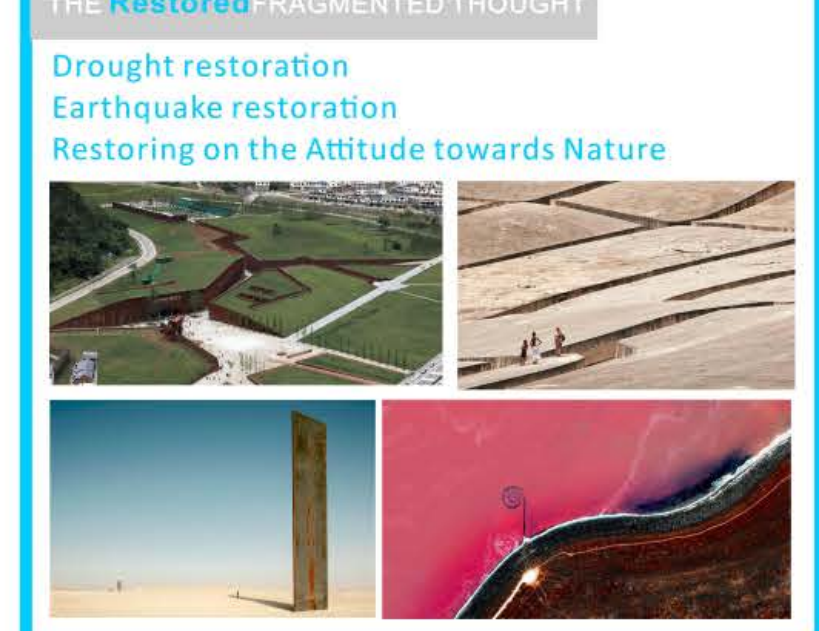
Plant species protection
Wind erosion restoration



Un-restored: Desertification disturbance
Glacial retreat disturbance

THE **Restored** FRAGMENTED THOUGHT

Drought restoration
Earthquake restoration
Restoring on the Attitude towards Nature



under humanity damage disturbance

THE **Restored** FRAGMENTED PATCH

Terrorist attack restoration
War restoration



THE **Restored** FRAGMENTED CORRIDOR

THE **Restored** FRAGMENTED MATRIX

War restoration



Un-restored: Nuclear accident disturbance

THE **Restored** FRAGMENTED THOUGHT

Image 2.1 :
The typical fragmented landscape restoration case in the world under different type of disturbance.

- The fragmented landscape structure restoration under the resources over-exploited disturbance
- The fragmented landscape structure restoration under city over-expansion disturbance
- The fragmented landscape structure restoration under the nature disaster disturbance
- The fragmented landscape structure restoration under humanity damage disturbance

2.The fragmented landscape structure restoration

Chapter 1 has shown the severe global fragmentation of landscape structures caused by different disturbance conditions which have fragmented patch, corridor, matrix and human perception. In Chapter 2, several typical restoration projects are discussed which respond to various fragile landscape structures disturbed by over-exploitation, urban growth and the growing frequency of natural disasters, all factors which contribute to world-wide environmental damage. These restoration projects cover mine exploitation restoration, dam restoration, ocean pollution restoration, agriculture, flood, wetland restoration, landfill restoration, slums restoration, railway restoration, highways restoration, coastline restoration, hunting restoration, humanity restoration, drought restoration, avalanche restoration, flood restoration, tsunami restoration, earthquake restoration, plant species protection, wind erosion restoration, attitude towards nature restoration, terrorist attack restoration and war restoration, which are located in America, Canada, China, Spain, Kenya, Italy, Iceland, France, Afghanistan, New Zealand, Indian Ocean. Also some difficult areas haven't been any restored, such as solar energy exploitation disturbance, motor-pumped wells disturbance, hydraulic fracturing disturbance, channel disturbance, pesticide disturbance, air pollution disturbance, urban heat island disturbance and nuclear accident disturbance, which are located in Brasil, Honduras, Sumatra, Nicaragua, Singapore, Japan, Faroese, Peru and Russia. (Image 2.2)

This research finds that a variety of conditions - different sites, different fragmented structures and different degrees and types of disturbance - lead to a number of restoration responses which generally fall into two broad categories: First, those that attempt to adapt to and engage with the resilience of rapidly changing landscapes (modern advanced restoration), and include Social Cognition (the process of acquiring knowledge through thought, experience and the senses as demonstrated by ancient preserved cultures and modern artistic expression); Second, those that seek to counter or reverse the processes of global warming and natural disasters through deliberate, large-scale interventions (geological engineering). (Image 2.1)



image 2.2: The typical fragmented landscape restoration case in the world.

2.1 The fragmented patch restoration

2.1.1 The fragmented patch restoration under the resource over- exploitation

Mine exploitation restoration

Chambers Bay, America

Chambers Bay is a public golf course in the northwest United States , located in University Place, Washington. Fearing developers would encroach on their plant, the county decided to buy the remaining 600 acres for \$40 million, financed by the taxpayers of Pierce County. In just over a decade, community leaders and citizens turned the barren mine into a public park complete with trails, meadows, picnic areas, a rehabilitated marine shoreline, and, not least, a world class municipal golf course. In order to minimize the use of chemicals and herbicides on the grounds and landscaping, in 2006 the county began to manufacture its own fertilizer out of biosolids (aka poop) from the wastewater treatment plant. The product, dubbed SoundGRO, has been awarded the highest standard by the EPA. They didn't stop there. The plant's gas byproduct is being used to power the treatment plant itself, and the county has begun an effort to irrigate the grounds with reclaimed wastewater that would otherwise flow into the Puget Sound. Using reclaimed wastewater will also minimize the use of potable water from drought-stricken Washington state's water reserves. By next year, the course will not use a single drop of municipal water.⁶⁵

In an effort to revive the ecosystems destroyed by mining, the park cleaned up leftover industrial waste and restored wildlife habitats. The course has at least two eagles' nests, as well as hawks, osprey, fox, beaver, coyote, and deer. At the marine shoreline, closed to the public for a century, two creosote docks, used to load barges with sand and gravel from the mine, were taken out, allowing the area's many different species of salmon to return to Chambers Bay.⁶⁶ However, this project maybe is a test of restoration, the effect still needed be questionable. (Image 2.4, 2.5)



The current site of Chambers Bay golf course used to be a gravel mine, Pierce County, 1940.

⁶⁵ Chambers Bay. (Dec 21, 2015). Retrieved April 22, 2016 from Wikipedia: https://en.wikipedia.org/wiki/Chambers_Bay#cite_note-cbgcot-2

⁶⁶ The Best Golfers in the World Are Playing on a Poop-Watered Course. (June 20, 2015). Retrieved April 22, 2016 from Motherjones: <http://www.motherjones.com/environment/2015/06/best-golfers-world-are-playing-golf-course-powered-poop>

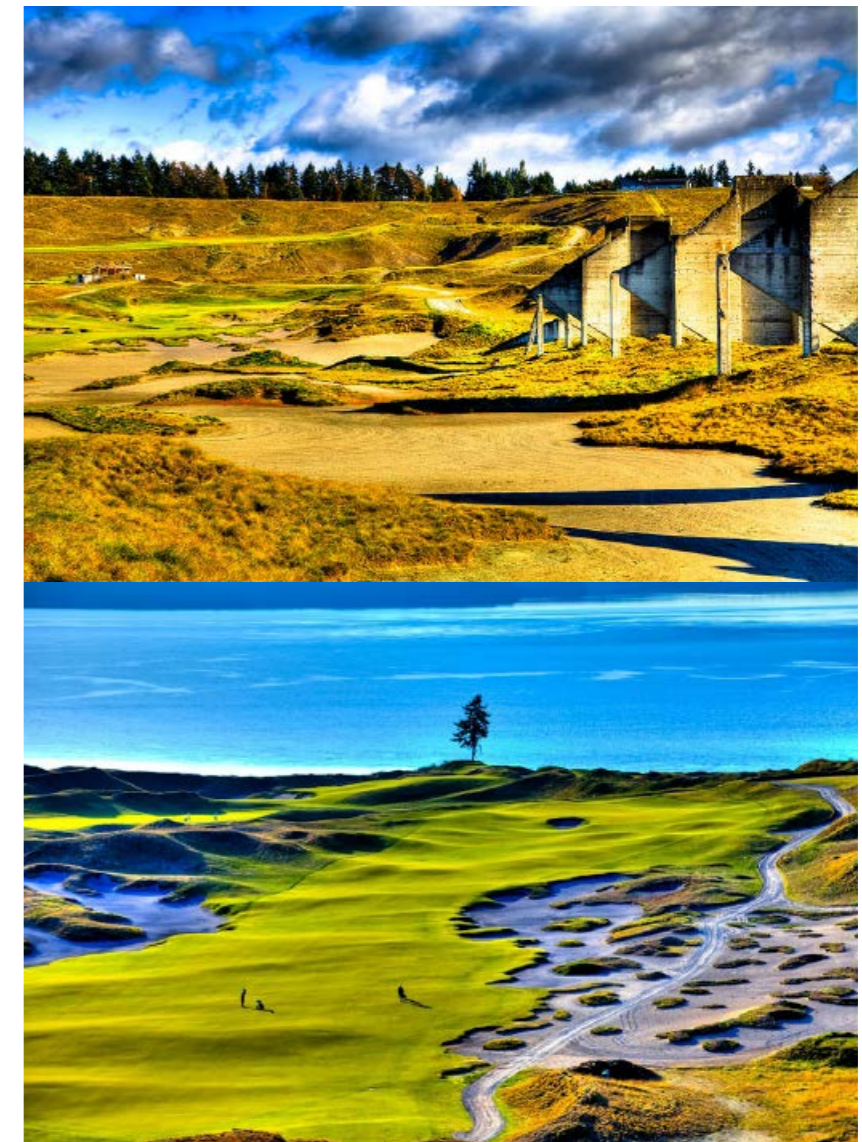


Image 2.4: Chambers Bay golf site, Patterson. D, 2015.



Image 2.5: Jordan Spieth watches his tee shot on the 10th hole during the second round of the U.S. Open golf tournament at Chambers Bay on June 19, 2015 in University Place, Wash, Charlie Riedel.

Flambeau Mine, America

The 181-acre mining site was located about one mile south of Ladysmith and bounded to the east by State Highway 27 and to the west by the Flambeau River. Prior to construction of the mining facility, the site consisted of active agricultural lands, old farm fields and forested areas. Several intermittent streams flowed through the site to the Flambeau River, and about eight acres of wetlands were located within the project boundary.

During the active mining period, Kennecott employed approximately 70 employees, most of whom were from the Rusk County area. Throughout the life of the Flambeau Mine, an extensive environmental monitoring program was conducted to ascertain the extent of environmental impacts from the project and to determine if the project was complying with all applicable statutory, rule and permit requirements. As specified in various permits, the Flambeau Mining Company was required to regularly monitor a number of groundwater factors, including groundwater levels, groundwater quality, air quality, surface water quality, wastewater effluent quality and flow, mine inflow, wetlands, aquatic ecology, stockpile leachate quality and meteorology.⁶⁷ (Image 2.6, 2.7)



Image 2.7: Flambeau Mine Site: b) during mining (1996), and c) after mining (2002)

2.1.2 The fragmented patch restoration under the city over-expansion

Landfill restoration

Garraf landfill, Spain

The Garraf waste dump was opened in 1974 in a valley in the limestone massif of Garraf, in the natural park of the same name. The restoration project defines a pattern of topographic configuration with terraces, side slopes, drainage system of internal fluids (separated of the external drainage net), biogas extraction net, pathways and plantation by phases.

The whole restoration project goal is that Garraf Park absorbs the dump by using the local forest tissue and supporting the establishment of primary ecosystems and its development and succession which thought the time will turn to adapted situations to the site environment. The plantation process is being done through strong local species with a

few pouring demand and already adapted to the place environment. The vegetal structure planned with different local sorts of shrubs and trees organizes the plantation project.

Infilling began at the lowest point. Shrubs and trees were eliminated, the site was waterproofed with clayey soils, a drainage system was installed for the leachate and work began on the superposition of layers of waste matter, alternating with shallow layers of earth. As the bottom of the valley was filled in, the waterproofing was extended. The landfill now occupies 70 hectares with a depth of waste matter of over 80 meters at some points.

From 2000 to 2008, starting on restoring eco-park 1,2,3, On 31 December 2006 the Garraf controlled landfill site was completely closed. In 2007, eco-park 4 began to be restored up to now. However, at the same time the eco-park 4 was still depositing remaining wastes until 2009, where 350,000 ton waste were treated at there. At the start of the restoration project, a layer of earth covered the latest deposit of refuse. A large concrete ditch separates virgin land from the operational waste dump and channels drain runoff from the mountainside. Semi-clean waters and runoff water from the working area accumulate in a reservoir, where they are treated. The restoration process began at the lowest levels while the waste tip is still in use higher up. A new and completely different system was superposed on the existing one, and the two will coexist until the dump is closed. Restoration will only be complete three years after closure.

Earthwork : The construction of terraces at the waste dump was determined by the need to contain rubble; this criterion is imposed on working waste dumps to ensure the stability of the great mass of accumulated waste. Due to the configuration of the subsoil, excavation is not possible in this process. The only way of forming terraces is by importing material. The site's steep slopes called for the construction of retaining walls more than 10 meters high, requiring a great deal of imported earth (465,000 m³ for the first 20 hectares).

Soil : The determining element in farming is the soil. The new earth was imported over two periods. The first served to build the basic structure of terraces and fill in the space between the retaining walls. The second was used to form a layer of fertile land for the introduction of vegetation. Between the two were laid layers of sand, geotextile, waterproof lining and a second layer of sand to separate the waste dump from new soil. The heterogeneous, inert soil had to be made fertile and suitable for planting with a crop that would grow down into the layers formed by the passage of machinery, removing stones and breaking up the terrain to make it uniform and produce the finished profile. Then manure was applied to specific planted areas (slopes and rows of trees) and plant compost to the terraces to improve the structure and texture of the soil. Crop rotation based on leguminous plants was also established on the terraces in order to improve soil fertility.

Vegetation: Three types of plants were employed in the restoration of the waste dump: rows of pine trees lining the drainage channels and paths, an assortment of shrubs on

⁶⁷Reclaimed Flambeau Mine. (Nov 13, 2013). Retrieved April 22, 2016 from Dnr: <http://dnr.wi.gov/topic/mines/flambeau.html>

the slopes and leguminous crops on the terraces. The planting of pine trees and shrubs represents a major investment per square meter of restored land. The introduction of leguminous crops, conversely, is low in cost per square meter but requires a much longer management period (two to three years). These crops may be native species of the Garraf (planted very densely on the land adjacent to the park) or the agricultural species that are sown on the other plots.

Management: Farming operations are linked to production cycles and are at the mercy of unpredictable factors such as the appearance of pests, diseases or unexpected changes in the weather. This forces farmers to adapt management tasks and be constantly alert to crop development. Some interventions are preventive, others curative. The ultimate aim is to bring about the implantation of species that are native to the Garraf, whether by means of direct introduction on the slopes (planting, irrigation and weeding) or by providing the conditions conducive to natural propagation on the terraces. The latter case calls for observation of the growth of invasive species. Pioneering or excessively invasive species will be eliminated and the most suitable plants will be selected. In addition to farming, the project also takes into account the various spontaneous natural processes.⁶⁸ (Image 2.8)

Image 2.8:

Garraf landfill restoration process site view: from 2004 to 2012, BATLLE I ROIG Arquitectes.



2004



2008



2012



2012

⁶⁸Batlle, E. (2011). El jardín de la metrópoli: del paisaje romántico al espacio libre para una ciudad sostenible. GG.

Jinkou landfill, China

According to the survey, since 2005, shut down jinkou landfill, its total area is about 410,000 square meters, which has been closed for more than 10 years, pollution levels have been significantly reduced, and is in a stable state, anaerobic treatment, directly cover geomembrane and soil, and join the plant trees and repair. Another area of 213300 square meters has been closed 7 years, still unstable, trash in the ground to rot, degradation, often overflowing with biogas, better applied the aerobic treatment restoration. (Image 2.9)



Image 2.9: Jinkou landfill Site: top image (before restoration, 2014), bottom image (after restoration, 2015)

Slums restoration

Turó de la Rovira hill, Spain

Eventually, at the initiative of the District of Horta Guinardó municipal administration and the Agència de Carmel (Carmel Neighbourhood Agency) and on the basis of a conceptual blueprint designed by the MUHBA (History of the City Museum of Barcelona), a project of renovation and landscaping of the site was embarked upon with a view to creating a History of the City Museum heritage site in the Tres Turons (Three Hills) Park. This was to be a space conserving history and in memory of a recent and highly relevant past with a lookout that would be accessible to the general public. The intervention aimed to minimise the impact on the existing features of the hilltop while bringing out its different layers of meaning. This archaeological space, combining relics of war and of twentieth-century informal urban growth, is now a unique case in the entire urban heritage and museum patrimony of the great European cities.

The intervention took as its starting point the awareness that this was a dynamic site, which was confirmed as the processes of cleaning up and clearing away of brushwood revealed new aspects of the idiosyncrasy of the place. Its steep slopes complicated the tasks involved in work that aimed to protect, consolidate and respect fragile, valuable ruins. Basic construction materials and rusting metal were used in the incorporation of new elements, which was reduced to an essential minimum. Fine handrails protect stairs and balconies and indicate possible routes to the visitor. The only added paving, consisting of a stretch of concrete of deactivated surfaces revealing granulates in relief, is respectfully separated from the platforms of the anti-aircraft gun emplacement, although it links them with a path leading to the access road.

The slopes of the hill have been reforested with different species of Mediterranean pines, concentrated at the lower levels so as not to interfere with the views from the lookout. On the northern side, which overlooks Carmel there is also vegetation adapted to a certain degree of humidity, including carob, fig and olive trees. On the southern slope, facing the sea there are large numbers of prickly pears and Aleppo pines.⁶⁹(Image 2.10)



Image 2.10: Turó de la Rovira hill title: top image (before restoration, 2008), bottom image (after restoration, 2012)

⁶⁹ Arrangement of the summit of the Turó de la Rovira hill. (April 6, 2011). Retrieved April 22, 2015 from Public space: <http://www.publicspace.org/en/works/g320-arranjament-dels-cims-del-turo-de-la-rovira/prize:2012>

2.1.3 The fragmented patch restoration under the nature disaster

Drought restoration

Sidi-Toui National Park, Tunisia

Sidi Toui National Park was established in 1993, and as the native vegetation returned, so did a number of bird species. In 1999, local authorities introduced a small population of Scimitar-horned oryx. Prior to the park's establishment, this and several other antelope and gazelle species had been driven nearly to extinction by habitat loss.⁷⁰(Image 2.11)

The 1987 image shows a region pushed toward desertification by the combined pressures of drought, agriculture, and overgrazing. In the 1999 image, the area's native vegetation had begun to return inside the park's protected borders. The park's area is easily discerned by the revived grassland, which appears as a deep shade of brown. The grassland's brownish hue results partly from dry wintertime conditions, and partly from the region's overall aridity.⁷¹(Image 2.12)



Image 2.11: In Sidi-Toui National Park, 24 hours after calving adult female 'Salwa' (left) who left her herd to give birth, is chased by territorial male 'Mustapha' (right) who is attempting to prevent her from leaving his territory, November 2011.



Image 2.12: Sidi-Toui National Park satellite images: top image (after restoration, 1999), bottom image (before restoration, 1987)

⁷⁰ Sidi Toui National Park, Tunisia. . (Nov 2, 2008). Retrieved April 22, 2016 from Nasa: <http://earthobservatory.nasa.gov/IOTD/view.php?id=35741>

⁷¹ Molcanova, R., & Wachter, T. (2008). Scimitar-horned Oryx Behaviour and the Influence of Management in a Fenced Protected Area: Sidi-Toui National Park, Tunisia. Al Ain Wildlife Park & Resort, United Arab Emirates, 29 th April–2 nd May 2008, 27.

Drylands, Lisbon

Drylands (An Open Ideas Competition for Retrofitting the American West) WATER SENSITIVE LAND MARK The current situation of water scarcity in many countries worldwide, as well as the physical history and his testimonies provide us important clues to the development of the proposal. The argument of the project focuses on the idea of an infrastructure ecological, environmental and community capacity to balance effective solutions for the management of water resource but also to rehabilitate our cities in order to promote new dynamics of collective participation and increased use of public space. Their main goal was to achieve a reinterpretation of a collection of ancient models of water retaining systems, as exemplified by the step well infrastructure, mainly existing in India - recreating a sustainable, dynamic and adaptable system to support human activity and community life.

The project combines 4 key strategies: Water strategy - as a vast network of commitments between collecting, storing, treating, reusing and recharging. Green strategy - to produce diversification biodiversity but also to promote an effective Carbon Water sink net taking advantage of the plantation landscape design and management and providing the use of native plant communities like forest woodland patches and under story vegetation. Program strategy - as a vast network of facilities capable of promoting additional public participation and interaction dynamics, introducing important new lifestyles and renewed collective conscience. Adaptation of the model - as an open model able to be replicated and dimensionally adapted to the scale of the city but also to the scale of the territory.

(Image 2.13)

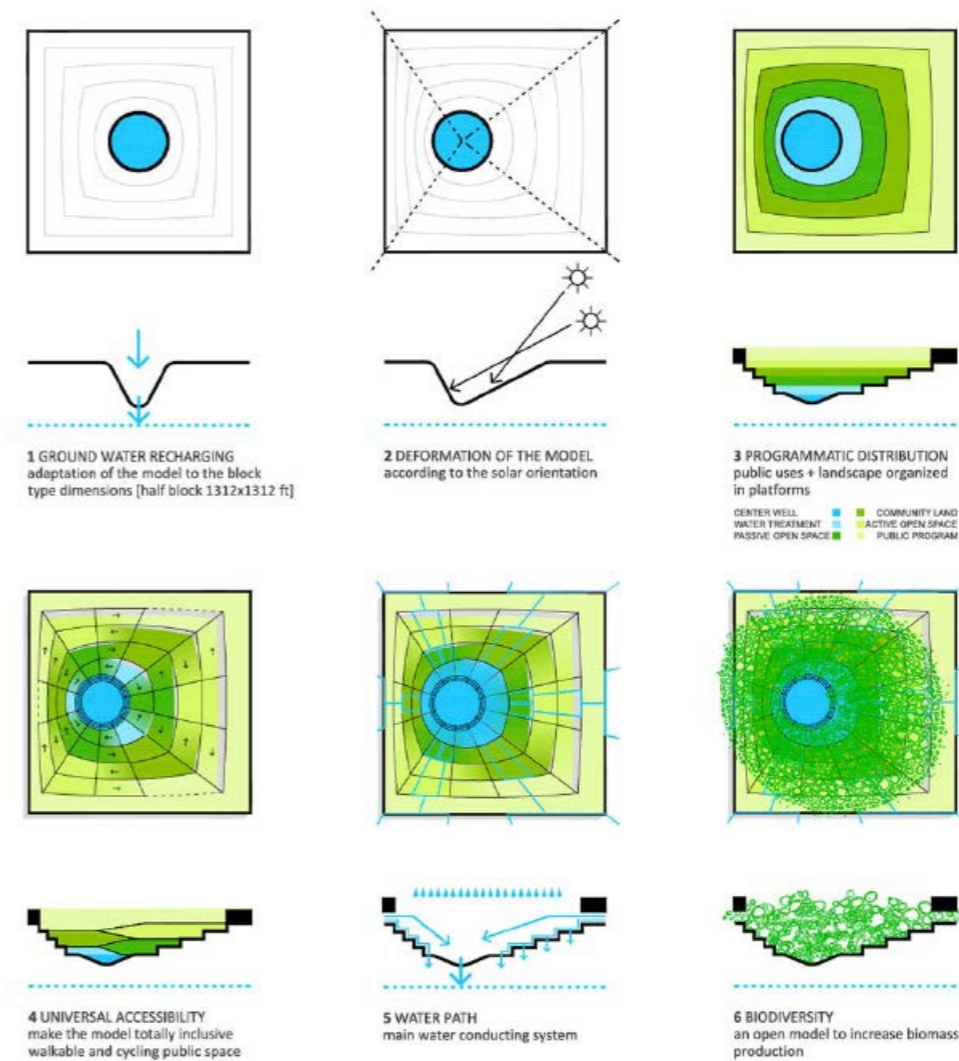


Image 2.13: Dry land idea system explain, Atelier Data, 2012.

Avalanche restoration

Iceland Several Icelandic towns and villages at the Westfjords, the Eastfjords and in north Iceland are located at the foot of high mountains and thus face the threat of avalanches. Landslides also occur, but more rarely. After a few fatal avalanches in 1995, a national research program was launched to investigate the avalanche hazard of certain areas of Iceland, resulting in law amendments on monitoring avalanches and landslides.

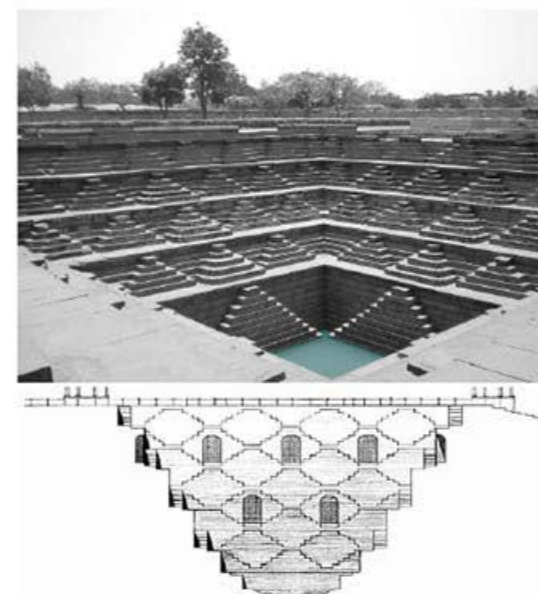
Two projects have already been completed, a few are under way, and others are still at the plan fling stage. All involves structures that constitute a major intervention in the landscape and the mediate natural surroundings of the respect towns. How do the anti-avalanche structures work? This is best answered by citing two major avalanches at Flateyri, which were kept away from the village by defence walls. Moreover, in 1998/1999, a large avalanche was deflected at Siglufjordur by a diversion wali that was not even complete. This incident certainly proved the worth of the structure.

Flateyri village, Iceland

This is done using angled walls and one of the most successful examples can be found at flateyri in iceland (see above) where a triangular deflecting dam can be clearly seen above the village. the dam was built following a fatal avalanche in 1995 and since its construction the dam has successfully diverted at least 2 more large avalanches. (Image 2.14)



SURVEY OF WATERSHED OF FRESNO CITY
current network of existing pockets of water, responsible for storm water collection and recharging of the groundwater level



STEP WELL EXAMPLE . INDIA
historical and cultural infrastructure model for water collecting



Image 2.14: Aerial views of Flateyri since the dam has been installed. Over Flateyri and proposed protection measures are in the foreground: top image is in winter, bottom image is in summer, Mats Wibe Lund, 2000.

Sigluffjordur village, Iceland

Avalanche defence structures at Sigluffjordur. This town is located at a narrow fjord surrounded by 1,000-metre-high mountains on the northern coast. It originally developed on a small peninsula reaching out into the fjord, but later began to spread up the mountain and along the shore. Since 1836, a total of 46 avalanches have fallen on the southern part of the town, and some of the buildings have had to be permanently evacuated, making them almost worthless to the owners; moreover, whole sections of the town, Sigluffjordur is suffering serious threat from avalanches. In response, it has now been divided into seven hazard areas, and preventive measures are being planned for five. Landscape architects of Laidslag Ltd. were involved from the very start and throughout all of the phases of the project. The avalanche works chosen for the southern part of the town

consist of two diver Sioi structures to deflect avalanches from the Populated area. The smaller wall, which is 200 metres long and 14 to 16 metres high, is located at 75 metres up the side of the mountain, and is not as visible as the larger wall. This is 700 metres long and 18 metres high, and reaches up the mountain from the 20-metre contour line to the 180-metre one. The soil required for the structures was obtained by excavating 6 to 12 metres deep into the earth, thereby forming a deep channel with the additional purpose of catching and directing avalanches. The inclination of the upper side of these structures (i.e. the one facing the brunt of avalanches) is 1:1.4, whereas the lower side, which looks downwards onto the town, varies between 1:1.4 and 1:2.5. To prevent the diversion walls from being too dominant in effect, their width has been varied, thus creating an organic shape on the lower, more visible side in contrast to the steep inclination at the top. The lowest part of each structure has the form of a sloping bastion crowned by a public viewpoint, thus creating an architectural impression. A small cheerful stream forms a round pond at the foot of the bastion, where the channel stops. Emphasis has been placed on cultivating the area to fight soil. The sowing of grass began at the lower levels of the structures in July 1999, and the greening of the whole area, a total of 30 hectares, is due for completion this year. Trees and bushes have also been planted. The avalanche defence structures also act as part of a recreational facility teaching up the mountain above the town, as their top areas are a route for hikers going up to the mountain and are already popular as such. In other words, the town's population has accepted the defence structures as a part of the local landscape. Many mediaeval towns walls built round them to defend them from outside attack, and it is in similar fashion that the avalanche defence structures of Sigluffjordur protect the community from the threat of avalanches. Two baffle structures at Sigluff are to deflect avalanches into unpopulated areas in future. As such they are part of a local recreation area, being incorporated into hiking paths leading into the mountains, and featuring viewing bastions on their lower sides. The planners placed a great deal of emphasis on the design of the defence works, shaping them organically on the lower side to make them less merge them into the landscape. Importance was attached to greening the site, which was started out by sowing grass. Trees and bushes are planted this year.⁷² (Image 2.15)

As a consequence, the avalanche threat has now been mapped, and measures have been launched in areas deemed at most risk. The project groups involved are made up of civil engineers, geotectonic specialists, meteorologists and avalanche specialists, and the authorities recently also realized that the participation of landscape architects is essential. The projects are executed in two stages: a preparatory phase. The landscape architects play an advisory role in the formulation and planning work to minimize environmental impact and take local conditions and landscape

elements into consideration. Phasis is placed on a detailed project illustration as a basis for environmental assessment and to provide orientation to the population at each location. (image 2.16)

⁷²Vilhjalmsson. (2001). Avalanche defence structures in Iceland, *Topos*, 36, 42-47.

Image 2.15:

Views of Siglujjördur since the dam has been installed: top image is in summer, bottom image is in winter, 2000.



Image 2.16:

Steel supporting structures.



2.1.4 The fragmented patch restoration under the humanity damage

Terrorist attack restoration

NATIONAL 9/11 MEMORIAL

The National September 11 Memorial & Museum (known separately as the 9/11 Memorial and 9/11 Memorial Museum) are the principal memorial and museum, respectively. They commemorate the September 11, 2001, attacks, which killed 2,977 victims, and the World Trade Center bombing of 1993, which killed six. The memorial is located at the World Trade Center site, the former location of the Twin Towers, which were destroyed during the September 11 attacks. It is operated by a non-profit corporation whose mission is to raise funds for, program, own, and operate the memorial and museum at the World Trade Center site.

In January 2004, Reflecting Absence, by architect Michael Arad and landscape architect Peter Walker, was selected from 5,201 entries from 63 countries as the winner of the LMDC's design competition. Two 1-acre (4,000 m²) pools with the largest man-made waterfalls in the United States comprise the footprints of the Twin Towers, symbolizing the loss of life and the physical void left by the attacks. The waterfalls are intended to mute the sounds of the city, making the site a contemplative sanctuary. Landscape architect Peter Walker planted many parts of the memorial with white oaks. Almost 400 sweet gum and swamp white oak trees fill the remaining 6 acres (24,000 m²) of the Memorial Plaza, enhancing the site's reflective nature.

Pedestrian simulations tested the memorial's design. The pedestrian-modeling program Legion was used to simulate visitor utilization of the space, and its design was tweaked to prevent bottlenecks. The fountain was engineered by Delta Fountains.

The names of 2,983 victims are inscribed on 76 bronze plates attached to the parapets of the walls of the memorial pools: 2,977 killed in the September 11 attacks and six killed in the 1993 World Trade Center bombing.⁷³ (Image 2.17, 2.18)

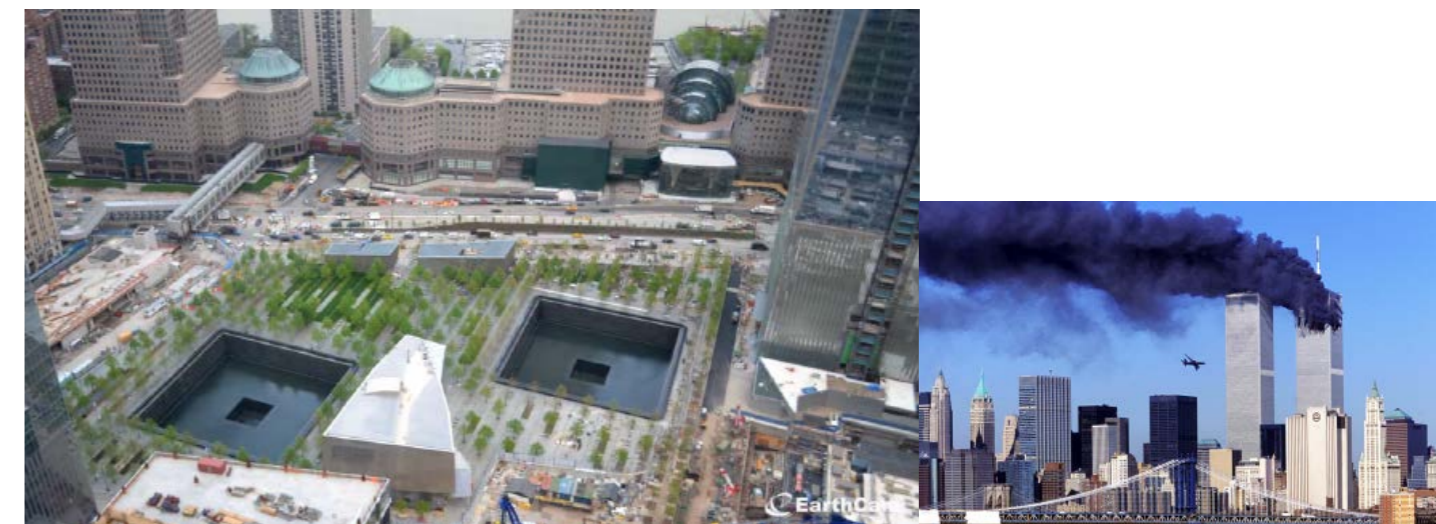


Image 2.17: National September 11 Memorial & Museum : right image (before restoration, 2001), left image (after restoration, 2012), Anthony Domanico.

⁷³National September 11 Memorial & Museum. (Dec 9, 2014). Retrieved April 22, 2016 from Wikipedia: https://en.wikipedia.org/wiki/National_September_11_Memorial_%26_Museum



Image 2.18: Persons come to the North Pool with the 9/11 Museum mourn dead. And Obama Hosts a Moving Dedication at National 9/11 Memorial & Museum, 2014.

War restoration

Buddhas of Bamiyan, Afghanistan

Fourteen years after the Taliban dynamited the world-famous Buddhas of Bamiyan, the giant statues were resurrected with 3D light projection technology in the empty cavities where they once stood in Afghanistan.

The project was undertaken by a Chinese couple who used 3D laser light projection technology to fill the empty cavities in the cliff in the Bamiyan Valley in Hazarajat with Buddha's virtual images, 230 km northwest of Kabul. The couple - Janson Yu and Liyan Hu - were saddened by the destruction of the two statues which were carved during the 6th century and decided to undertake the project. They took permission both from the Afghan government and UNESCO to bring the statues back for one night only in the empty cavities in the cliff. The event on June 7 saw projectors displaying huge holographic statues of the exact size of the precious cultural monuments that were lost, accompanied by music. "The

projections were not widely publicised, but over 150 people came to see the spectacle. Crowds remained well into the night and some people played music while others looked on," a journalist, who witnessed the show, was quoted as saying by The Atlantic.⁷⁴ (Image 2.19, 2.20)

Ur ancient city, Nasiriyah "On the road" team also applied the most advanced 3D laser range finder scanner in the world did an all-round 3D scanning on Ur ancient city in Nasiriyah, finally, collect point cloud to build Ur ancient city modeling successfully. This team send the visualization document to Iraq museum, which could offer the offspring and researchers the original history materials, in case of the ur ancient city will be damaged by the extremist organization, Islamic state in the future. (Image 2.21)



Image 2.19: They used the projections to fill the 175 feet hole left behind after the statue was destroyed. More than 150 people went to watch the light show and danced in front of the holographic statue well into the night, 2015.



Image 2.20: The project is realised by Zhang Xinyu (right) and Liang Hong (left), both passionate travellers, 2015.



Image 2.21: 3D scanning modeling of the Ur ancient city, 2015.

⁷⁴World-Famous Buddhas of Bamiyan Resurrected in Afghanistan. . (June 15, 2015). Retrieved April 22, 2016 from Ndtv: <http://www.ndtv.com/world-news/world-famous-buddhas-of-bamiyan-resurrect-in-afghanistan-771524>

The USS Arizona Memorial, Hawaii

The USS Arizona Memorial, located at Pearl Harbor in Honolulu, Hawaii, marks the resting place of 1,102 of the 1,177 sailors and Marines killed on USS Arizona (BB-39) during the Japanese surprise attack on Pearl Harbor on 7 December 1941 and commemorates the events of that day. The attack on Pearl Harbor and the island of O'ahu was the action that led to the United States' direct involvement in World War II.

The memorial, built in 1962, is visited by more than two million people annually. Accessible only by boat, it straddles the sunken hull of the battleship without touching it. The national memorial was designed by Honolulu architect Alfred Preis who had been detained at Sand Island at the start of the war as an enemy of the country because of his Austrian birth. The United States Navy specified that the memorial be in the form of a bridge floating above the ship and accommodating 200 people.

The 184-foot (56 m)-long structure has two peaks at each end connected by a sag in the center of the structure. It represents the height of American pride before the war, the sudden depression of a nation after the attack and the rise of American power to new heights after the war. Critics initially called the design a "squashed milk carton".

The architecture of the USS Arizona Memorial is explained by Preis as, "Wherein the structure sags in the center but stands strong and vigorous at the ends, expresses initial defeat and ultimate victory ... The overall effect is one of serenity. Overtones of sadness have been omitted to permit the individual to contemplate his own personal responses ... his innermost feelings."⁷⁵ (Image 2.22, 2.23)



Image 2.22: Bird view of the USS Arizona Memorial, 2010. Image 2.23: the internal USS Arizona Memorial, 2010.

⁷⁵USS Arizona Memorial. . (Nov 24, 2015). Retrieved April 22, 2016 from Wikipedia: https://en.wikipedia.org/wiki/USS_Arizona_Memorial

2.2 The fragmented corridor restoration

2.2.1 The fragmented corridor restoration under the resource over-exploited

Dam restoration

Geesthacht Fish Pass, Germany

The fish pass is located 142 km upstream from the mouth of the Elbe River at the Geesthacht weir where the Elbe has a mean flow of 728 m³/s. The flow regulation weir creates an impoundment of 31.4 km long. A vertical-slot fish pass was built to ensure access to reproduction habitats for Atlantic salmon, sea trout and Atlantic sturgeon to in the upper reaches of the Elbe. A focus was given to the restoration of sturgeon populations that were already extinct in the Elbe River. The Elbe sturgeon can reach a length of 3 m and weigh 130 kg, thus serving as a comparison to the large fish species of the Mekong River. The fish pass dimensions are designed according to the size of this species.

The fish pass is 550 m long and covers a height difference of up to 4 m. Fish are directed towards the entry of the fish pass by five gutters in the weir. The attraction flow helps the fish find the entrance which is located directly at the bottom of the weir. The fish pass consists of 45 large pools (length = 9 m, width = 16 m, minimum depth = 1.75 m) with head differences of < 10 cm. The pools are connected by two slots with a width of 1.2 m each. Within the fish pass, six additional flow inlets are regulated by float controls to ensure sufficient attraction flow. The maximum flow of the fish pass is 15 m³ /s which represents 2% of the mean flow of the Elbe. Monitoring in the first 12 months after completion (2010) shows passage of more than 300,000 individuals out of 43 fish species. Successful passage of small-sized fish species, including the threespined stickleback (*Gasterosteus aculeatus*, > 100,000 individuals), large-sized diadromous fish, including the Atlantic salmon and sea trout, and potamodromous species, including the European catfish and sander, proves that the fish pass is not size- and species-selective. Therefore, the fish pass is rated as fully functional. By January 2012, a total of 500,000 individuals had passed the fish pass with daily peaks of 25,000 individuals, including a 3 m long sturgeon.⁷⁶

Because biologists and ecologists have been camping at the top of the dam from the opening of the ladder, to count, identify, weigh and measure the fish as they passed, to put them back in the higher waters to they could continue their journey to the perpetuation of the species.

And they have demonstrated the effectiveness of this type of infrastructure, although only Vattenfall agreed to build the ladder as a precondition for the construction of the power plant near Hamburg-Moorburg. (Image 2.24, 2.25)

⁷⁶Nam, C. L. P. T. V. (2015). Review of Existing Research on Fish Passage through Large Dams and its Applicability to Mekong Mainstream Dams. MRC Technical Paper. 48.



Image 2.24: Bird view of Geesthacht weir Fish Pass, 2013.



Image 2.25: The fish pass the fish ladder. Biologists, in his account, estimated that there were days that reached up to 25,000 daily fish; and this past week told their "fish one million" a lota 50 cm long weighing 972 grams in scale, 2013.

Elwha Dam and Glines Canyon Dam, America

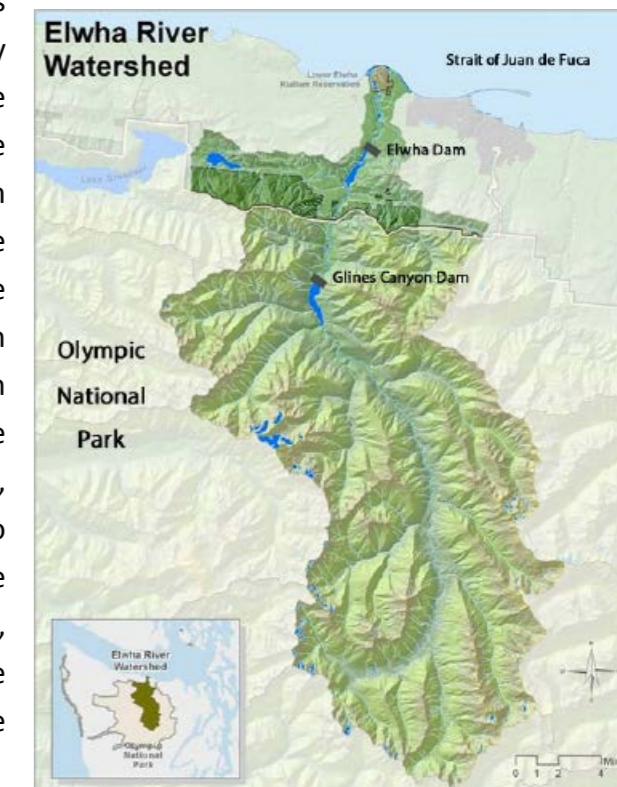
From his first day in office, President Obama has linked our economic recovery with a clean energy and more sustainable use of our resources. One of his first acts in office was to sign a Recovery Act that included \$80 billion in clean energy investments that will help double America's renewable energy-generating capacity in three years, while creating thousands of good jobs. This Recovery Act funding also included \$167 billion for the National Oceanic and Atmospheric Administration or NOAA, to award grants for coastal restoration. Out of more than 800 applications, NOAA chose the fifty most promising projects from across the country that held the most potential to immediately impact the environment and help our economy. Nationwide, this money will go towards: Restoring more than 8,900 acres of habitat. Removing obsolete and unsafe dams around 700 stream miles so fish can better migrate and spawn; and Creating the equivalent of more than 250 full-time jobs, and potentially 1,000 full-time jobs once all 50 projects are complete.

The Elwha Ecosystem Restoration Project is a 21st-century project of the U.S. National Park Service to remove two dams on the Elwha River on the Olympic Peninsula in Washington state, and restore the river to a natural state. It is the largest dam removal project in history. The removal of the first of the two dams, the Elwha Dam, began in September 2011 and was completed ahead of schedule in March 2012. Removal of the second dam, the Glines Canyon Dam, was completed on August 26, 2014.

Elwha Dam was built privately from 1910 to 1912 by Thomas Aldwell, who owned land in the area. This resulted in blocking passage of migrating fish, limiting them to the lower 4.9 miles (7.9 km) of river below the dam. Olympic National Park was established by the federal government in 1938 during the Great Depression. The national park, tasked with preserving natural ecosystems, had a man-made system within its boundaries that was known to disrupt major portions of the ecology. (Image 2.26) Final congressional approval of the dam removal project was expressed in the Elwha River Ecosystem and Fisheries Restoration Act of 1992, which authorized the Secretary of the Interior to acquire and remove two dams on the river and restore the ecosystem and native anadromous fisheries. Until removal, the dams had been operated by the Bureau of Reclamation, with National Park Service oversight. When the federal government purchased the dams in 2000, it freed the James River Corporation from any further liability related to the damage caused by the dams in the past or potentially in the future. After the 1992 Elwha River Ecosystem and Fisheries Restoration Act was passed, a number of alternatives for restoration were explored by the Department of the Interior. The Final Programmatic EIS (Environmental impact statement), released in June 1995, concluded that the only way to fully restore the river was to remove both dams. The Final Implementation EIS, released in November 1996, concluded that sediment that had accumulated in the two reservoirs should be allowed to erode and disperse naturally downstream.⁷⁷ (Image 2.27, 2.28)

Image 2.26:

The Elwha Dam was located five river miles from the Strait of Juan de Fuca, in Olympic National Park. The remains of the Glines Canyon Dam are eight miles upstream, Elwha River Restoration Project, 2013.



⁷⁷Fraser, C. . (Oct 14, 2013). Retrieved April 22, 2016 from Yale: http://e360.yale.edu/feature/the_ambitious_restoration_of_an_undammed_western_river/2701/

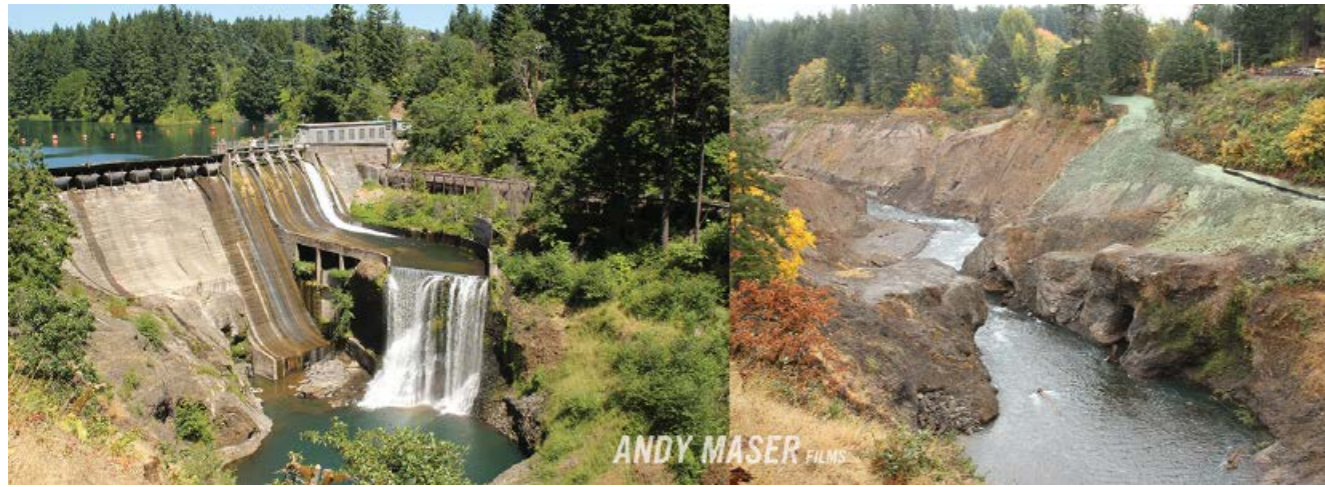


Image 2.27: The Elwha Dam site – before and after removal, 2011.



Image 2.28: The 210' concrete curtain of Glines Canyon Dam, Washington. Images of the dam's current state and rendering of post-dam removal, USA National Park Service, 2014.

2012 summer Chinook and other salmon species spawned in tributaries that had been blocked for a century. Meanwhile, more than 24 million³ of clay, silt, sand, gravel, and cobble that had built up behind the dams began to flow. This sediment, especially the gravel, is necessary for the restoration of fish spawning habitat, and downstream beaches and stream beds long starved of gravel, sand, and silt will ultimately be bolstered by its return. But in the short term, excess turbidity remains the biggest concern for the watershed's human and animal residents during the next 3–10 years. Dramatic increases in turbidity are expected to kill fish and diminish spawning success⁷ as well as affect water for drinking, hatcheries, and a paper mill. Negotiating how to mitigate these concerns took decades—and a lot of money.

Tearing down dams releases mass quantities of pent-up sediment and, in some cases, contaminants in the short term, but it restores ecosystems in the long term. As the fish begin returning to the Elwha River, the biggest dam removal in history is being touted as a model for future dam breaches.⁷⁸

“Things are happening on a daily basis,” says Pess. “Numerous fish have spawned above

⁷⁸ Nicole, W. (2012). Lessons of the Elwha River: managing health hazards during dam removal. *Environmental health perspectives*, 120(11), a430.

the dam now.” This year, Chinook, pink, and coho salmon plus steelhead have spawned in river reaches previously blocked. The river ecosystem is undergoing a dramatic transformation and is a living laboratory for scientists. The people of the Lower Elwha Klallam Tribe have voluntarily relinquished their rights to fish for five years, but in a few years they expect to see increased salmon runs in their historic fishing ground, as will recreational fishers. Most of the environmental contaminants from the dams will have been remediated and removed by then as well. Yet with the biggest sediment slugs still to come, the salient question for the restoration project is to quantify the impacts of these heavy sediment loads on spawning and rearing salmon. (Image 2.29, 2.30)

Workers are planting hundreds of thousands of native seeds and seedlings to restore the landscape now exposed to the elements. Now that Elwha River flow has been restored along its entire length, salmon are exploring the river habitat along its entire length, and the first salmon fry have been already been seen in the waters above the site of the Elwha dam. As the salmon population is restored in the next few decades, it is expected that other native species will also return to the area, such as eagles and bears, which depend on the salmon spawning run as a rich food source. (Image 2.31, 2.32)

Image 2.29:

The two photos compare the river channel at the site of present day Lake Mills before and after dam construction. The photo on the left was taken prior to 1927 when construction of Glines Canyon Dam began. The photo on the right shows the current river channel with Lake Mills Reservoir filled behind the dam, National park service.



Image 2.30:

Brian Cluer of NOAA Fisheries took this photo on November 6, 2012, about 1000 feet upstream from Glines Canyon Dam. Once 210 feet tall, only about 65 feet of the dam is left as demolition continues, The dam should be completely gone by May, Lynda Mapes, 2012.





Image 2.31: Elwha River residents haven't seen a salmon spawning run like this in over one hundred years, Salmon spawning habitat requires regular flow and low turbidity, flickr.com/toddbarden, 2014.



Image 2.32: A river otter looks on as crews work nearby, Kim Sager-Fradkin, 2014.

2.2.2 The fragmented corridor restoration under the city over-expansion

Railway restoration

High Line Park, America

High Line Park expands along abandoned elevated railway Vadis in New York C139. An Ingenious roof garden forms a promenade about ten meters above street level, both public attraction and business card for the landscape architecture profession worldwide. The collaborative effort to transform the High Line, an industrial artifact, into a public park, has been a remarkable achievement of public entities and private citizens devoted to a cause and a vision. Varieties of vegetation types, from wetland to dry meadows, wetland and woodland to pen beds, meshes with the topography, which is despite the unified design of the concrete planks. (Image 2.33)



Image 2.33:

High line park site: top image (before restoration, 1934), bottom image (after restoration, 2013)

Highways restoration

Trinitat cloverleaf park, Spain

The Trinitat area is sited on the space occupied by a former meander in the River Besós, from which the river was withdrawn when the riverbed was redefined. The site is formed by soil derived from alluvial deposits on top of harder bedrock that the river skirted. This harder bedrock comes to the surface at the edges of the park, in the districts of Trinitat Vella and Sant Andreu. The division between the two geological zones is significant, with a drop of nine metres between the shelf the district is sited on and the platform of sediments formed by the river.

The site where the park is located was previously occupied by allotments and the sidings yard of Sant Andreu railway station, and these were the last free spaces in the area, which has traditionally been the northern access to Barcelona. This was the reason it was chosen as the location for the future cloverleaf for road access to the city. In addition to

the railway line running on the original lower elevation of the terrain, there is now an underground railway line, or metro, the vault of which breaks through to the surface in some places, as well as the new road infrastructures.

The Trinitat cloverleaf resolves the crossing and intersection of the city's new outer ringroad and the motorways leading to the north and east. The complexity of the layout gives rise to a superposition of structures that increases the original nine metres of drop to fifteen, now that the road intersections are finished, and this introduces a new topographic element and a new relationship between the park and the city. As a result, the park area is sunken, not only with respect to the city, but also with respect to the new roads. The same problem of lack of physical space for infrastructure meant that it was also necessary to use the park's intended site for all the transformer stations of the electricity companies supplying the city, whose access is by means of high voltage pylons located along the course of the river. These pylons crossing the park mean the scale of the elements making up the park's new topography is even more gigantic.

The aims of the project are to solve the problems arising from the situation described above:

to improve access to the interior of the park, to reduce the environmental impact, both visual and acoustic, of the new roads on the district and park, to solve the gigantic scale of the highways and the road infrastructures, to upgrade the edges of the district, to provide extensive facilities and to make the area into a sign of, and an expression of, the entrance to the city.

The project is based on a general assessment of the surroundings that led us to think that the treatment of the cloverleaf and the motorway connections should not be considered as the sum of many different solutions, but as a single coherent project, in which vegetation, hydraulics, topography, facilities and public spaces are governed by the idea of a single route. Like the water, the wind and the electric supply lines, the elements that make up the project follow the riverbed. They are grouped in linear blocks and this is how the vegetation acquires sufficient scale to balance the roads. The public spaces, facilities and the water are all in continuous lines that cross the area of the project.

The use of vegetation as a means of modifying the scale of the site is reinforced by basing the topography around a single formal effect: a hill, in the shape of a spherical skull cap, rising from the lowest elevation of the site almost to the level of the motorways. The lines of vegetation that follow the riverside cross the hill giving rise to an accentuated formal effect that creates the overall image of the park. The stepped section of the promenade arranges the topography of the project into two clearly differentiated levels. The lower level, slightly higher than the original elevation of the site, corresponds to the access from the exterior under the motorways, and to the level of the metro which surfaces at one of the park's edges. Both are treated as patios and are connected to the lower promenade by means of two passages under two pedestrian bridges that confer continuity on the upper promenade. The lowest elevation of the park corresponds to the lake by the side

of the lower passage. The upper level corresponds to the elevation of the access from the district; this access is possible because part of the motorway is covered.

After passing the metro and the theatre, the promenade reaches the side of the plaza that covers the motorways and allows access from the district. At this point the promenade gathers together the rest of the park's facilities; a children's playground, tennis courts and other sports facilities, a pelota court, changing rooms and storerooms. The pelota court is sunken to hide the nine metre wall, whose base is at the original elevation of the site. The pelota court and the sports tracks are at a different level to the promenade and this is resolved by a similar treatment to that of the other lower areas: a patio in blue. The changing rooms, like the bar on the terrace, serve to mark the end of the promenade. The roof is accessible, giving a view of how the planted strips into the park.⁷⁹(Image 2.34)



Image 2.34: Trinitat cloverleaf park site: top image (before restoration, 1979), bottom image (after restoration, 2014)

⁷⁹ Orendain Almada, F. (2014). El Parc de La Trinitat: La Puerta Norte de Barcelona. Retrieved April 22, 2016 from Diposit: http://diposit.ub.edu/dspace/bitstream/2445/56295/2/Orendai%20Almada%20F%C3%A1tima_01.pdf

Crossing structures in the wildlife area

Crossing structures include underpasses and overpasses, both of which have been constructed in a variety of sizes and designs. One way to minimize human-wildlife conflict is to construct wildlife crossings such as bridges and underpasses that allow animals to cross human-made barriers safely. The first wildlife crossings were constructed in France during the 1950s. Since then, several European countries including the Netherlands, Switzerland, Germany, and France have been using various crossing structures to reduce the conflict between wildlife and roads. (Image 2.35) These landforms have always been important habitat and migration corridors, and they are becoming even more essential. Although wildlife underpasses are less costly to build and more commonly used by a diversity of species, wildlife overpasses are preferred by certain wide-roaming and iconic species-at-risk, such as grizzly bears. Overpass structures are also more visible and noteworthy to motorists.⁸⁰



Image 2.35:

Wildlife pass in the world. These projects from the top to the bottom are from Netherlands, Belgium, Kenya, America, Austria.



⁸⁰ WHY ARE ANIMALS DYING ON OUR ROADS . (April 23, 2014). Retrieved April 22, 2016 from Arc: <http://arc-solutions.org/new-thinking/>

Trans-Canada Highway in Banff National Park, Canada

Wildlife crossings have also become increasingly common in Canada and the United States. The most recognizable wildlife crossings in the world are found in Banff National Park in Alberta where the national park is bisected by a large commercial road called the Trans-Canada Highway. To reduce to effect of the four lane highway, 24 vegetated overpasses and underpasses were built to ensure habitat connectivity and protect motorists. These passes are used regularly by bears, moose, deer, wolves, elk, and many other species.⁸¹ "The winning design combines complex ecology and engineering with practical intelligence by taking ordinary technology and recasting it in a new way," said Nina-Marie Lister, the ARC competition advisor and professor at Ryerson University in Toronto, Canada. "Using a simple, modular approach to construction, the HNTB+MVVA design deploys familiar, everyday materials with elegance and cost-effectiveness. The jury chose this design because it is not only feasible, but because it has the capacity to transform what we think of as possible – a novel design solution to a growing problem that could serve as a model for the world." Growing scientific research shows the importance of wildlife crossings and their effectiveness at reducing wildlife-vehicle collisions. In Banff National Park in Alberta, Canada, a continuous series of 22 underpasses and two overpasses has resulted in an 80 percent reduction in total wildlife fatalities because wildlife was allowed to roam free uninterrupted of human transportation. As a result, there have been approximately 240,000 crossings (and counting) of 11 species of large mammals, including wolf, grizzly bear, elk, lynx, mountain lion, and moose across these paths.⁸² (Image 2.36) Caught in action by a motion-sensitive camera, a grizzly passes over the Trans-Canada highway on an overpass in Banff National Park. Overpass or underpass - that is the question! There is evidence that certain animals prefer particular types of crossing structures. When given a choice, grizzly bears, moose, elk, wolves and deer almost always use wildlife overpasses.⁸³ (Image 2.37)



⁸¹Bissonette, J. A., & Adair, W. (2008). Restoring habitat permeability to roaded landscapes with isometrically-scaled wildlife crossings. *Biological Conservation*, 141(2), 482-488.

⁸²HNTB+MVVA Win ARC Wildlife Crossing Competition. (Jan 25, 2011). Retrieved April 22, 2016 from Bustler: http://www.bustler.net/index.php/article/hntbmvva_win_arc_wildlife_crossing_competition/

⁸³Wildlife Gallery. (Dec 23, 2012). Retrieved April 22, 2016 from Parks Canada: <http://www.pc.gc.ca/eng/pn-np/ab/banff/plan/transport/tch-rtc/passages-crossings/recherche-research/faune-wildlife.aspx?a=1&photo={FE28106E-BE57-480F-BE9A-764F77D129AC}>
An interwoven visualization platform for assessing the restoration of fragmented landscape structures

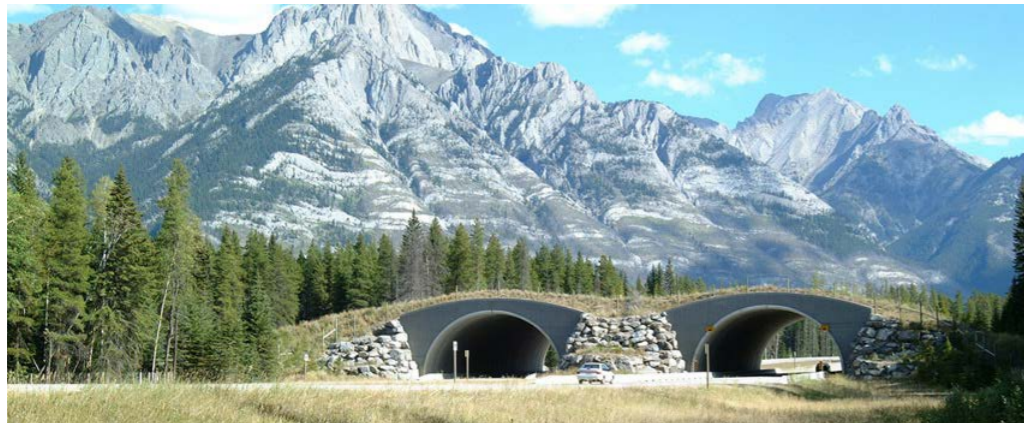


Image 2.36: Banff National Park, Alberta, Canada, is a leader in the design and implementation of wildlife crossing structures in North America. There are more than two dozen crossing structures over the TransCanada Highway through the Banff area, Susan Hagood, 2010.



Image 2.37: Animal crossing structures caught in action by a motion-sensitive camera. In particular, grizzly bear moms are a family affair, more known to use wildlife crossing structures with their cubs following closely behind. Research has shown that these cubs return to use the very same crossing structures as adults.

Coastline restoration

Cap del creus nature park, Spain

With the advent of democracy and the rise of ecological consciousness, Cap de Creus was declared as Natural Park in 1998. The cape, including Club Med surroundings, was classed with the highest figure of land protection for its outstanding geological and botanical values. In the summer of 2003 Club Med ceased activity. In the period, 2008-10, Club Med has been 'deconstructed', its ecological dynamics revived and a network of paths and viewpoints as been 'remade' for its rediscovery, becoming Mediterranean coast biggest restoration project ever. The work distills and enhances the consubstantial values of the site, the diversity of geological formations, the harshness and nakedness of the rock outcrops, the specialization of native vegetation, the wind and the sea magnificence.

Four actions are contemplated in the restoration project:

Earthwork : Selective deconstruction of 430 buildings, equivalent of 1.2 ha of edification and 6 ha of urbanization. 3. Management & recycling of 100% of construction waste, 45.000 m reusing 'in situ' local stone for landfills, and transporting ceramic materials outside for civil works. Ecosystem dynamics revival, remaking the site's topography and drainage systems, to reestablish the original sediment flows and exchanges between land and sea. (Image 2.38)

Vegetation: Removal of Invasive Exotic Flora (IEF), *Carpobrotus edulis* and other 10 species on a surface of 90 ha. IEF once planted in the Club scattered around displacing specialized maritime rocky native communities of EU protected flora.





Image 2.38: Cap del creus site: top image (before restoration, 2008), middle image (construction process), bottom image (after restoration, 2012)

Orongo Bay, New Zealand

Assisted by a talented team of biologists and ecologists, the team saw a unique opportunity for a major wildlife conservation area on the peninsula of Young Nick's Head. Protected by steep cliffs on three sides, the landscape architect orchestrated the installation of a predator-proof fence to create a sanctuary ideal for nesting migratory birds. Existing rodents and pests were eradicated and a dense planting of coastal woodland tree saplings were planted to create habitat. The ultimate goal for the sanctuary is to re-introduce the Tuatara, a highly endangered prehistoric reptile that once inhabited the exposed cliffs of the North Island. The effectiveness of the restoration efforts are supported by a vigilant and aggressive pest control regime. The improved habitat and reduced predation has already attracted new arrivals and nesting including blue penguins, and fluttering shearwaters. An audio system that plays recorded bird calls has attracted the endangered grey-faced petrel to nest and breed, the first success of its kind in the world.

To support the efforts of the Tuatara Preserve, the landscape architect initiated an extensive plan for restoring the adjacent Orongo wetland, a once-vibrant tidal wetland that previous landowners drained for grazing. To provide a diversity of habitat, the master plan proposed the restoration of a saltwater wetland and the construction of a freshwater wetland. A large sinuous earthen embankment divides the watersheds and diverts

rainwater to the inland freshwater wetland. While the saltwater wetland is tidal, the freshwater wetland is designed to accommodate seasonal flooding. A winding ribbon of water flows year-round and the broad flats flood during the wet season. The islands' slopes and sizes are carefully calibrated to provide protective habitat for specific amphibians. Reforestation on the uplands above the wetlands is part of a larger effort that extends southward from the Tuatara Preserve five and one half miles along the coast. These highlands are exposed to battering winds and rain and are slowly eroding into the sea. Reforestation helps stabilize the vulnerable coastline while creating valuable habitat and increased connectivity through wildlife corridors. To date, 500,000 trees have been planted at Orongo bay. the ecological restoration projects are a source of pride for the tribe. The design team worked with the Ngai Tamanuhiri to start a nursery that allows the tribe to supply some of the trees required for the reforestation effort. This provides much needed employment and invites the community to share their wisdom of local plants and participate in the ecological regeneration. (Image 2.39, 2.40)



Image 2.39: Orongo Bay wetland site: top image (before restoration, 2005), the wetland under construction show both the channel retains water throughout the year and the flooded condition during the wet season; bottom image (after restoration, 2010), this conceptual rendering of the completed wetland helps illustrate the scale of the construction and the future wildlife corridors created by the reforested valleys. Nelson Byrd Woltz.



Image 2.40: The 1,640-foot-long Excluder Fence includes a flange at the top to discourage climbing rodents. A below-grade flange repels any attempt to dig under the barrier, Nelson Byrd Woltz, 2010.

The Seafront of the Albufera, Spain

A new start was required, first restoring the generative cross-section of the landscape in its organic unity, indispensable since the degradation of any part of the ecotope endangers the viability of the rest, then recreating the landscape, attempting to make the nature restoration operations compatible with the leisure use of an area under pressure from over a million potential users in the city of Valencia and its metropolitan area. The El Saler motorway and Nazaret-Oliva main road, with junctions at two levels, have nurtured a peripheral strip that includes the racecourse and Stevedores School (both abandoned), the municipal campsite, the sports complex, a golf course and the Parador hotel.

The first step was the general 'decontamination' of the sector covered by the project. Over 400 million pesetas were spent on demolishing the urbanisation works. The next was to design a functional structure that could be superimposed on the natural cross-section of the landscape to be reconstructed. The redesigned access routes became fire breaks for the pinewood and now end at bollards car parks. The length of the shoreline can only be covered on foot. The restored "old Muntanyar road", the Valencia-Sueca bicycle path and the new footpath to the rear of the frontal dune system constitute a network that connects up the shoreline, providing access to the facilities, the lake environments and the restricted pathways to the beach.

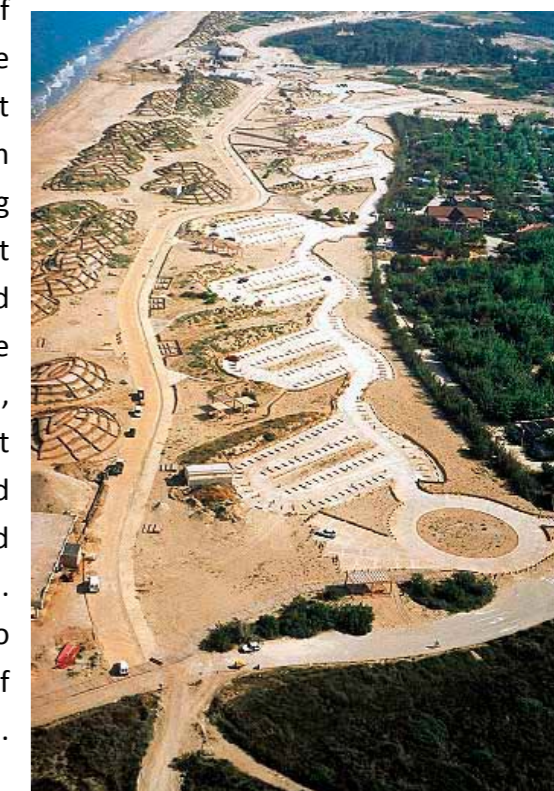
At the same time, remaking the landscape. Geometry, which the ancient Greeks called the Science of Knowledge, provided the answer: the strict lines of the paddy fields, the regular layout of the irrigation canals, the cleanness of the ploughed fields and the filter of the groves are perfectly adapted to the geography of the alluvial shelf. Their deformations, due to atmospheric factors, are casual mutations that give the different spaces of the

rich natural tapestry their character. Equally, the formal result of external factors that act on the medium is visible in the microcosms of the land. Undulations and outcrops, the lines on the elevations, colours and textures: these are the authentic models that can be transferred to a larger scale, to geometries. Volumes, surfaces and defined lines presuppose exact locations, types, the ability to measure, value and build. A basic barchan-type dune module was designed. Combined in a symmetrical chain, facing the prevailing wind, they form an orderly range of crests and hollows: the blow-outs of the frontal system and the sub-dunes. Once the line of dunes had been restored, they were planted and fixed with the help of cane 'hedges'. Their layers contained the seeds of numerous native plant species, distributed according to the face of the dune and their height on it. The wind, the rain and the tides would take care of the rest. The expanse of *Pinus pinea* and *Pinus halepensis* that will restore the missing area of the pinewood down to the shoreline was planted in a geometrical sequence, staggered in 'ripples' for protection against the Gargal wind.

The wetlands of the malladus or grassy hollows, the recuperated lake spaces, are both breeding grounds for birds and barriers that limit access to the wood. They were dredged down to the impermeable grey silt loam layer, except in certain areas where the water table was pierced to obtain a permanent sheet of water. A wooden canopy was placed alongside the section of the path that borders this lake, providing shade and a viewing point over the mallada. The footpath and bicycle path are placed in the lee of the dunes, where the least sand accumulates, along the route marked out by the demolished urbanisation works (but 6 rather than 80 meters wide). The car parks are camouflaged among the windings of the sub-dune system and should in time be integrated among the future trees and the lentisk, myrtle, phillyrea and 'sea juniper' (*Juniperus macrocarpus*) bushes that are colonising the ground. The concrete ship that was saved when the Stevedores School was demolished has been converted into a Nature Reserve Information and Documentation Centre. Beached among the new dunes, it is, in a way, a memorial to the project: a reminder that the destruction of the work of human hands makes way for the original landscape to be built. paradox.⁸⁴ (Image 2.41, 2.42)

Image 2.41, 2.42:

The Seafront of the Albufera site: Top image (before restoration, 1970), bottom image (after restoration, 2000)



⁸⁴De la Reguera, A. F. (2001). Ordenación del frente litoral de la Albufera sector Dehesa del Saler, Valencia. *Via arquitectura*, (10), 76.

Hunting restoration

Protecting the Panda corridor, China

In the Jiuding mountain range, Sichuan province, China, at an elevation of 4,000 meters, an association has spontaneously been formed by the Qiang national farmers. Hunting on the Jiuding Panda migration corridor is forbidden, and so these farmers spend ten days every month walking through the mountains looking for illegal poachers.

Because this association is not a professional outdoor team, these farmers have no professional equipment and must take ropes, baskets and woven bags in order to climb steep slopes, drinking water from melted snow and home brew for the cold, and living in wild caves. However, in the last 20 years, they have demolished ninety thousand hunting traps. As a result, certain endangered species have increased in numbers (Lin musk deer - *moschus chrysogaster*, and "Camel" Sue's gazelle).⁸⁵ (Image 2.43, 2.44)



Image 2.43: The team was removing hunting iron wire, Tengxun news, 2015.



Image 2.44: The wild hard life of old famers for protecting wild animals, Tengcun news, 2015.

⁸⁵ Sichuan qiang - old anti - theft in 20 to defend the " panda corridors ". (Dec 17, 2015). Retrieved April 22, 2016 from Xinlang: http://news.qq.com/a/20151217/055997.htm?pgv_ref=aio2015&ptlang=2052#p=9

2.2.3 The fragmented corridor restoration under the nature disaster

Flood restoration

Room for the River , Netherlands

the submerged Somerset levels at the peak of the winter floods that devastated swathes of England and hundreds of broken flood defences have now been repaired thanks to £270m of emergency funding from government. Hard-won reclaimed land – polders – are being given back to rivers and meanders are being cut back into flood plains, all as part of a back-to-nature approach that is reversing centuries of battling against water, in favour of finding ways to live with it. The Netherlands is a land of waterways and a quarter is below sea level, with 60% of its people in flood-risk areas.

There is deep experience of what it takes to deal with flooding, in both financial and human terms. Another 10 farmers and 24 other families are having to make way as the river takes possession of its flood plain once more. The project is the biggest of 34 " Room for the River " (RR) projects across the Netherlands, costing €2.3bn (£1.9bn) and set to finish in 2015. Vic Gremmer, the local residents' spokesman, is staying and moving to a new house. "Being forced to move so other people can keep their feet dry is acceptable," he says. The disruption is enormous: new bridges, roads, pipes and repositioned dykes are all in construction, leaving great muddy tracks across the flat green and blue landscape.⁸⁶

(Image 2.45)



Image 2.45:

Top image: A De Dommel water board project shows how reclaimed land polders are being given back to rivers and meanders are cut into flood plains, as part of Netherland's back-to-nature approach. Bottom image: The Noordwaard polder in Werkendam is one of the key areas of the national Room for the River project. Courtesy Werry Crone, 2014.

⁸⁶ Carrington . D. (May 19, 2014). Retrieved April 22, 2016 from Theguardian: <http://www.theguardian.com/environment/2014/may/19/floods-dutch-britain-netherlands-climatechange>

When Gov. Andrew M. Cuomo of New York proposed the other day to spend up to \$400 million to buy and raze homes in the floodplains damaged by Hurricane Sandy, we could thought of Netherlands. New York is not Rotterdam (or Venice or New Orleans, for that matter); it's not mostly below or barely above sea level. But it's not adapted to what seems likely to be increasingly frequent extreme storm surges, either, and the Netherlands has successfully held back the sea for centuries and thrived. After the North Sea flooded in 1953, devastating the southwest of this country and killing 1,835 people in a single night, Dutch officials devised an ingenious network of dams, sluices and barriers called the Deltaworks.

Water management here depends on hard science and meticulous study. Americans throw around phrases like once-in-a-century storm. The Dutch, with a knowledge of water, tides and floods honed by painful experience, can calculate to the centimeter — and the Dutch government legislates accordingly — exactly how high or low to position hundreds of dikes along rivers and other waterways to anticipate storms they estimate will occur once every 25 years, or every 1,000 years, or every 10,000. And now the evidence is leading them to undertake what may seem, at first blush, a counterintuitive approach, a kind of about-face: The Dutch are starting to let the water in. They are contriving to live with nature, rather than fight (what will inevitably be, they have come to realize) a losing battle.

Why? The reality of rising seas and rivers leaves no choice. Sea barriers sufficed half a century ago; but they're disruptive to the ecology and are built only so high, while the waters keep rising.

Polders are reclaimed marshes, floodplains and other low-lying lands, surrounded by dikes. By lowering the dike along the northern edge of the two-square-mile Overdiepse Polder, the Bergse Maas canal will be able to spill in, diminishing the water level in the canal by a foot, enough to spare the 140,000 residents of Den Bosch, upriver, in the event of once-every-25-year floods. By displacing farmers, in other words, residents in that city can breathe a little easier.kryptonite.⁸⁷(Image 2.46)



Image 2.46: Overdiepse Polder, an infrastructure project in the southeastern province of Brabant south of Amsterdam, will have eight elevated farms, CreditDick Sellenraad, 2013.

⁸⁷ Kimmelman, M. (Feb 13, 2013). Going with the flow. Retrieved April 22, 2016 from The New York Times: <http://www.nytimes.com/2013/02/17/arts/design/flood-control-in-the-netherlands-now-allows-sea-water-in.html?pagewanted=all&r=1>

Tsunami restoration

A study of an Indonesian coastline ravaged by the December 2004 tsunami has estimated the buffering capacity of intact mangrove forests, which could protect homes and buildings. Cuddalore District near the southern tip of India gave researchers an excellent opportunity to examine tsunami damage under different circumstances. The area has a fairly straight shoreline, relatively uniform beaches, and a consistent continental slope. What varied along the shoreline was coastal tree vegetation; some areas had trees, others did not. By examining cloud-free satellite images before and after the tsunami, researchers could discern what a difference the coastal trees made. The Landsat 7 satellite acquired this image on October 20, 2000, capturing the vegetation cover and land surface features before the tsunami struck. In this image, blue indicates water and green indicates vegetation. Other types of land cover range in color from brown to pink. Two dense mangrove forests appear near the coast.

Mangrove trees, well adapted to tidal environments along shorelines, lined part—but not all—of the coast of the Cuddalore District, both in 2000 when this image was acquired, and in 2004 when the tsunami struck. After the natural disaster devastated the region, an international team of scientists surveyed the damage. In the fall of 2005, the researchers published their findings in the journal *Science*. They found significantly less damage from the tsunami in areas shielded by mangrove forests. Coastal villages with no protection, the team concluded, were destroyed, while villages protected by mangrove trees survived the tsunami with little or no damage.

Mangroves make up a vital part of civilization's coastal defenses. They reduce storm surge, can even mitigate damage caused by tsunamis. Waves lose strength passing through their dense tangled roots and branches. In less than one human lifetime, some of the planet's richest and most vital coastal habitats could disappear. Sea-level rise is expected to flood and drown the mangrove forests of much of the Indo-Pacific. The scientists found that, in 69 per cent of their examples, the supply of sediment would not keep pace with changes in sea level: that is, by 2070, many forests would be submerged. These would include ecosystems in Thailand, Sumatra, Java, Papua New Guinea and the Solomon Islands.⁸⁸(Image 2.47)

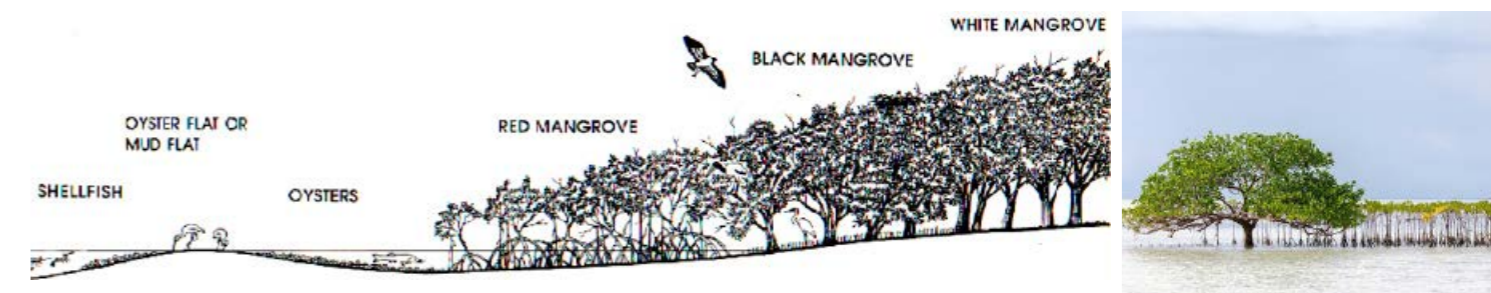


Image 2.47: Mangroves make up a vital part of civilization's coastal defenses. They reduce storm surge, can even mitigate damage caused by tsunamis. Waves lose strength passing through their dense tangled roots and branches. (A joint study by Wetlands International and The Nature Conservancy found that wave heights decrease over 10% with every 100 meters/yards of mangrove forest.)

⁸⁸ Duke, N. C., Meynecke, J. O., Dittmann, S., Ellison, A. M., Anger, K., Berger, U., ... & Koedam, N. (2007). A world without mangroves?. *Science*, 317 (5834), 41-42.

Mangrove regeneration, Philippines

Replanted mangrove trees in Southeast Asia are getting credit for protecting against deadly tsunamis and typhoons such as Haiyan in the Philippines and cutting greenhouse gas emissions. Mangrove regeneration in Northern Samar, about 100 miles (160 kilometers) north of the worst-hit Philippine city of Tacloban, helped minimize damage from the Nov. 8 storm, according to the Trowel Development Foundation, which oversaw the plantings. (Image 2.48)



Image 2.48: People plant mangrove trees in Northern Samar province, the Philippines, Trowel Development Foundation, 2013.

“Nests” proposal for mangroves restoration

Ecological designers have even fashioned modular “nests” for mangroves to restore land lost to sea level rise, unveiled a concept to reduce the impact of rising sea levels in the world's delta regions by introducing a modular structure that will cultivate mangrove forests to form natural dams. (Image 2.49)

After carefully studying the biological qualities of mangroves, the designers found that the salt-tolerant plants act as a natural breakwater against tides, trapping river sediment in their strong roots and helping to prevent ecosystems from washing away. "After having examined the processes of sedimentation, the hydrodynamic characteristics, and the ecological conditions, we concluded that the intentional retention of water-borne alluvium carried in big quantities by the delta rivers could be the key to compensate land loss caused by sea level rise," explain the team in their design report.

The designers propose an structure that can be easily installed beneath the water's surface, providing a modular infrastructure to house growing mangrove plants, which thrive in coastal habitats. "The modules serve as containers and incubators for the young mangrove saplings that, getting stronger with time, will become self-supporting and form a natural dam," said the team. The project is named CALTROPE - a mixture of the words caltrop (a kind of water chestnut) and rope. The first is a reference to the the curving shape of the objects, while the second refers to the lacy appearance of the modules when

combined. Made from a combination of concrete and organic materials, the structures are expected to crumble away after 15 to 20 years. By this point the plants will be strong enough to support themselves and the dissolved material will become part of the sediment. Another benefit of the structure is that it will create new habitats for oysters and prawns. (Image 2.50)

The project was recently named one of three overall winners in a design competition launched by the Jacques Rougerie Foundation, a non-profit organisation focussing on the relationship between architecture and the sea.

The aim of the project is to synthesise and balance the natural dynamics and forces of the delta regions applying an easy-to-install modular structure. CALTROPE is a lace-like structure that is able to catch and collect river sediment with the help of mangrove plants, so integrating natural and architectural elements. Working like a catalyst, it will provoke positive changes at the most critical shoreline points. With this cooperative, participatory and locally supplied work can also reorganise and socialise the local population in a constructive and self-supporting manner.⁸⁹



Image 2.49: Modular “nests” for mangroves modeling, 2012.

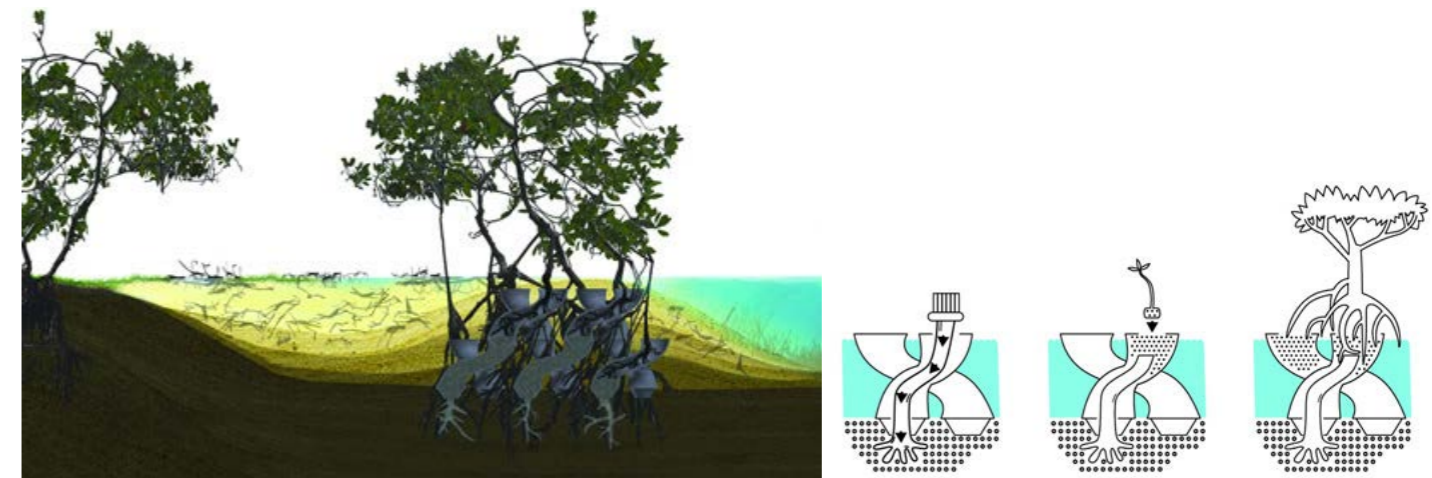


Image 2.50: CALTROPE comes from the words 'caltrop' (water chestnut) and 'rope', 'caltrop' referring to the shape of the object, and 'rope', to the linear, lace-like installation principles, 2012.

⁸⁹ Modular CALTROPE structure reduce impact of rising sea levels by cultivating mangrove forests. (Dec 19, 2013). Retrieved April 22, 2016 from Dezeen:<http://www.dezeen.com/2013/12/19/modular-caltrope-structure-prevents-rising-sea-levels-mangrove-forests/>

2.3 The fragmented matrix restoration

2.3.1 The fragmented matrix restoration under the resource exploitation

Ocean pollution restoration

The Gulf oil spill, America

the Gulf oil spill, when oil spills into the ocean, it is difficult to clean up. When you have 3.19 million barrels to clean up, it is even harder. The USA government takes two solutions. The most basic method of clean up is to control the spread of the oil using physical barriers. Cleanup workers first surround the slick with floating booms to keep it from spreading to harbors, beaches or biologically important areas like marshes. Then they can use different tools to remove the collected oil. Often they will drive skimmers, boats that skim spilled water from the water's surface, through the slick. After most of the oil is removed by skimmers, workers use sorbents to mop up the trace amounts left behind. They come in three main types: natural organic materials like peat moss, straw, hay and sawdust; natural inorganic materials like clay, volcanic ash, sand, or vermiculite; and synthetic sorbents made of materials similar to plastic like polyurethane, polypropylene, and polyethylene. Another option is to speed up the oil's natural biodegradation using dispersants. These slicks can wreak havoc on coastal ecosystems and animals, so cleanup workers use dispersant chemicals that break down the oil into smaller particles that mix with water more easily to prevent them from forming. Dispersants are often used when workers want to stop the slick from spreading to a protected area like a harbor or marsh. This can be a boon for animals found on the surface and coast, such as seabirds, marine mammals and those found in the Gulf's mangroves, because the oil is moved out of their habitat. But dispersants can also enter the food chain and potentially harm wildlife.⁹⁰ (Image 2.51)



Image 2.51: A C-130 Hercules from the Air Force Reserve Command deploys dispersant into the Gulf of Mexico, as part of the Deepwater Horizon/BP oil spill response effort, Tech. Sgt. Adrian Cadiz, 2010.

⁹⁰The Ocean Portal Team . (July 15, 2011). Gulf Oil Spill. Retrieved April 22, 2016 from Ocean portal: <http://ocean.si.edu/gulf-oil-spill>

Agriculture, flood, wetland restoration

Wetlands are water-rich natural areas that occur chiefly along rivers and in deltas. Those are the same places where most urbanisation occurs, however. Urban expansions and the correspondingly lower groundwater levels put pressure on wetlands and wet nature around the world.

By their very nature, wetlands are overflow areas for rivers and as such are natural rainwater buffers. Wet natural areas are of great importance to amphibians and dragonfly species and are a breeding ground for many species of birds.

Recently the possibilities for creating wetlands in and around towns and cities have been given more attention, following the disappearance in recent decades of large stretches of wet nature, and thus also natural buffers, as a result of urban expansions and land drainage. In the USA, for example, wetlands are being created to buffer some of the run-off from precipitation and slow the rate at which it drains away. This is a new approach compared with rapid drainage systems using ditches and pipes. Another benefit of wetlands is that biological pollutants are eliminated by plant life and settle in the sediment, which significantly improves the quality of the run-off.

In some cities, London for example, wetlands serve a function by developing greater biodiversity and natural and pleasant recreation areas for city dwellers. Urban wetlands should be designed in such a way that they allow for the possibility that the water running into them from the urban surroundings is more polluted than in a natural environment. Moreover, recreational uses might conflict with the targeted natural development. Another difference is that urban wetlands are less dynamic than natural wetlands. In natural wetlands, flow patterns change and zones fall dry. In urban wetlands, the process is controlled more by humans, since certain visual qualities and uses are sustained and less dynamism is accepted.

Urban wetlands are capable of purifying urban water efficiently and cheaply. In the USA, conventional wisdom holds that urban wetlands are ten times as cheap as conventional, more high-tech purification plants for purifying urban rainwater run-off. That is one of the principal reasons why natural wetlands in urban areas are protected in the United States. However, the multiple roles that wetlands play for urban systems are so important that more and more new wetlands are being created.

Natural and in particular urban wetlands can play an important role in coastal protection and as protection against river flooding. Sediment settles in natural deltas, offering a natural barrier to protect the hinterland. In areas where space is under less pressure, or in combination with recreational functions, wetlands present an alternative to conventional rainwater processing. Wetlands, even urban wetlands, are important biotopes. Rendering parts of urban wetlands difficult or impossible to access enhances that effect. Urban wetlands can fulfil an important function in improving the quality of surface water and purifying precipitation running off from towns and cities. Processing urban precipitation run-off and surface water in urban wetlands helps in the elimination of phosphates,

nitrites, solid substances and heavy metals. Urban wetlands can be used to maintain or improve the quality of surface water.⁹¹

The Napa Sonoma Marsh, America

Around 1860, the Napa Sonoma Marsh was one of the most productive wetlands of the Pacific Coast, providing habitat for millions of birds. By the mid-1980s, the San Francisco Bay perimeter had lost over 91 percent of its wetlands.⁹² SAN FRANCISCO—Climate change has caused rising tides to pose a threat for the San Francisco Bay Area. As a result, a new report shows that in order to reduce flooding, 54,000 acres of the Bay Area's wetlands will need restoration within the next 15 years. Local politicians and environmental scientists are working together to create a platform advocating a tax measure that will fund the restoration effort. According to biologist Letitia Grenier, if nothing is done, "bigger waves will come in with high tides and storms, and cause more flooding." Grenier says, the wetlands will be gone, and our wildlife will be threatened. According to a study done by the National Academy of Sciences, the 10 hottest years on record have occurred within the last 20 years. As a result, the Pacific Ocean off the coast of California will rise about one foot in the next 20 years, and 2 feet by 2050. Scientists are saying cities like San Francisco, Oakland, and Foster City, will need protective seawall barriers in order to prevent flooding. As more time passes, severe sea level rises will make wetlands restoration more difficult and costly.⁹³

Massive new wetlands restoration began reshape San Francisco Bay since 2001, Napa Sonoma Marsh as one part of this plan. Construction crews and biologists are in the final stretch of a 20-year project to restore 11,250 acres of former industrial salt ponds back to a natural landscape. The first two phases were completed in 2006 and 2007 and now only one remaining phase is left to complete. (Image 2.52)

Phase I - completed in 2006 by the State of California. Involved the opening of 3,000 acres of salt ponds to full tidal action.

Phase II - completed in 2007 by the State of California. Involved the restoration of 1,700 acres to managed ponds to provide waterfowl and shorebird habitat.

Phase III - expected to begin construction. Involves the restoration of the final 1,900 acres. In Napa sonoma marsh, the restoration -- encompassing an area as big as 8,500 football fields -- is also offering a road map for similar projects now underway in the East Bay and Silicon Valley, particularly the massive restoration of 15,100 acres of former Cargill Salt ponds that extend from Hayward to San Jose to Redwood City. The \$10 million pipeline will take up to 550 million gallons a year of treated wastewater to two former salt ponds, where it will dilute a highly saline byproduct of salt-making called bittern, so it can be slowly released to the bay. After the bittern has been diluted, the recycled water will be used for growing grapes in the Carneros region, decreasing farmers' reliance on pumping groundwater. This restoration main Significance: Extensive habitat for endangered species, migratory waterfowl and shorebirds, and fish and other aquatic species, A beneficial use

⁹¹Homes. B. (April 9, 2009). Retrieved April 22, 2016 from Urbangreenbluegrids: <http://www.urbangreenbluegrids.com/measures/urban-wetlands/>

⁹²Napa Sonoma Marsh. (Dec 9, 2009). Retrieved April 22, 2016 from Wikipedia: https://en.wikipedia.org/wiki/Napa_Sonoma_Marsh#cite_note-6

for recycled water, Improved water quality and productivity in the Napa River and San Francisco Bay, and Public open space and recreational opportunities, including fishing, birdwatching, hunting, and environmental education.⁹⁴ (Image 2.53)

As the grapes hang plump on the vines awaiting the autumn harvest, this area along the northern shores of San Francisco Bay is growing a new bounty: huge numbers of egrets, herons, ducks, salmon, Dungeness crabs and other wildlife, all returning to a vast network of newly created marshes and wetlands. The new wetlands not only expand wildlife and public recreation, they also offer a buffer to reduce flooding as sea levels continue to rise because of global warming, scientists say. And unlike other environmental restoration projects -- such as replanting a clear-cut redwood forest, which can take 100 years or more to come to fruition -- the payoff with wetland restoration begins almost immediately. Once earthen levees are breached, bay waters thick with fish, crabs, plant seeds and other life come pouring in, which in turn draw everything from steelhead trout to avocets to snowy egrets looking for a meal. For now, outdoor lovers, fishermen, duck hunters and the project planners are reveling in their newfound creation. Striped bass, endangered shorebirds and even bat rays are back.⁹⁵ (Image 2.53)

⁹³Napa Sonoma Marsh. (Dec 9, 2009). Retrieved April 22, 2016 from Wikipedia: https://en.wikipedia.org/wiki/Napa_Sonoma_Marsh#cite_note-6

⁹⁴Napa Sonoma Marsh Restoration Project. (Dec 19, 2015). Retrieved April 22, 2016 from Napa: <http://www.napa-sonoma-marsh.org/overview.html>

⁹⁵Hollibaugh, J. T. (1996). San Francisco Bay: The Ecosystem. Further investigations into the natural history of San Francisco Bay and delta with reference to the influence of man. American Association for the Advancement of Science.

Image 2.52: The Napa- Sonoma Marsh restoration plan map, Bay area news group, 2013.

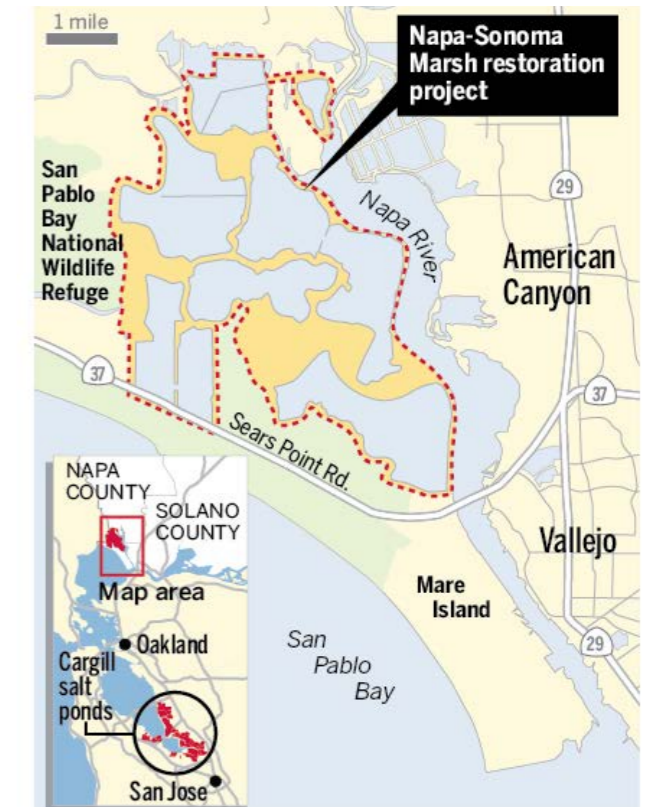
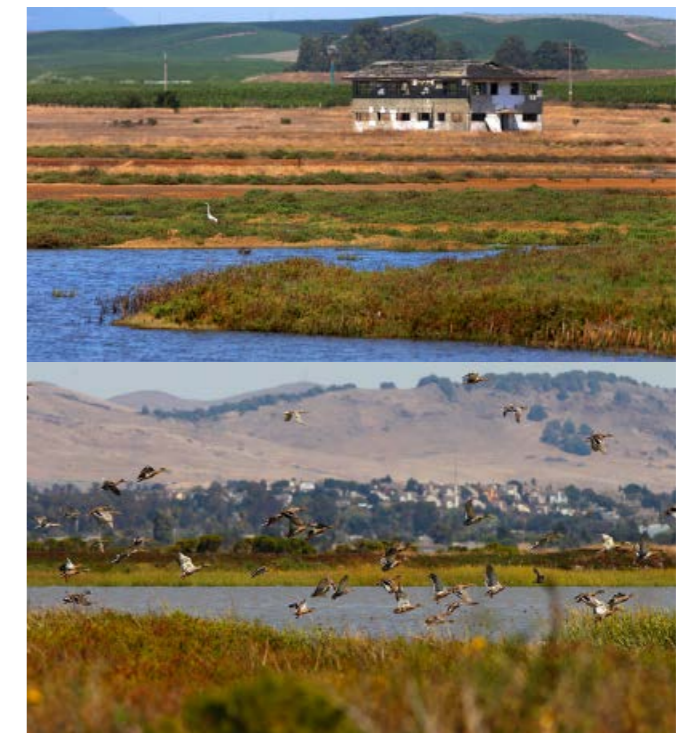


Image 2.53: A group of duck take off from a restored wetland in the Napa-Somoma Marsh State Wildlife Area on Friday in Napa, Calif. About 10,000 acres of former salt ponds are being restored to wetlands in the North Bay, Bay area news group, 2013.



The Bandon marsh, America

After more than 10 years of land acquisition, planning, design and preparation the Ni-les'tun Tidal Marsh Restoration Project at Bandon Marsh National Wildlife Refuge is now under construction and will be completed late this summer. Most of the land in the Ni-les'tun Unit is diked lowland pasture and will eventually be restored to tidal marsh, making history as the largest tidal marsh restoration project ever attempted in Oregon. Other habitats of the Ni-les'tun Unit include intertidal marsh, forested wetlands, grasslands, and upland forest.

Preliminary restoration work began during the summer of 2009 and included obliteration of some of the smaller agricultural drainage ditches. Some of the new tidal channels that will deliver tidal flows to the upper marsh were dug. In 2010 the majority of the tidal channels will be dug, larger drainage ditches will be filled, the dike along the river will be lowered, and tide gates will be removed. This will allow the unimpeded return of the daily tides on this area for the first time in more than a century and plants and animals will start adjusting to the newly restored conditions.⁹⁶ (Image 2.54, 2.55, 2.56) The Ni-les'tun unit is a habitat restoration project which will eventually benefit fish and wildlife. It consists of intertidal and freshwater marsh, and riparian land. It also protects a 4,500 year-old Native American archaeological site of the Coquille Indian Tribe. The Refuge is planning a marsh restoration for this unit where an influx of saltwater and freshwater will allow a revival of mudflats and marsh plants, and interconnecting tidal channels will bisect the wildlife habitat south of the overlook deck. As the land returns to a functioning intertidal marsh, flocks of seasonally driven migratory birds and young fish will use the restored habitat. (Image 2.57) The Landscape infrastructure had been enriched, such as pumps, canals, gates, and levees gives managers the tools to recreate those conditions. They are effectively designing with water to induce migratory processes.

However, December, 2011, the Bandon Marsh National Wildlife Refuge haven't protected this area from flooding. The reason is miscellaneous, maybe this restoration project is too young to stop flood; says even this project isn't at the right restoration direction. Whatever, this site must be re-assessed and keep monitoring. (Image 2.58)



Image 2.54: Bandon Marsh National Wildlife Refuge restoration area, USFWS - Pacific Region, 2011.

⁹⁶Brophy, L. S., & van de Wetering, S. (2012). Ni-les' tun tidal wetland restoration effectiveness monitoring: Baseline: 2010-2011. Green Point Consulting, the Institute for Applied Ecology, and the Confederated Tribes of Siletz Indians.



Image 2.55: A Knife River excavator crushes the Fahys Creek culvert shortly after it was extracted from the dike in the Bandon Marsh restoration , USFWS - Pacific Region, 2011.



Image 2.56: Members of the Coquille Indian Tribe paddle a ceremonial canoe Thursday into the freshly flooded Bandon Marsh. Before the swath of land was diked and drained for farming about 100 years ago, it sustained the Coquilles for centuries, U.S. Fish & Wildlife , 2011.



Image 2.57: As soon as saltwater was allowed to wash across the restored marsh this week, a flock of least sandpipers found a spot to roost there, U.S. Fish & Wildlife , 2010.



Image 2.58: Aerial View of the lower Coquille River Estuary looking southwest as the marshes flood about an hour before high tide November 25, 2011. The parking lot for the Rocky Point Boat Ramp is visible in the lower right corner, U.S. Fish & Wildlife , 2011.

2.3.2 The fragmented matrix restoration under the city over-expansion grow

Landfill and wetland restoration

The Lincoln Park, America

The Lincoln Park design team, made up of primarily CJF and CJR personnel, working for the New Jersey Department of Environmental Protection with the National Oceanic and Atmospheric Administration created a design to return half of this blighted section of Jersey City back to a fully functional tidal marsh. The other half is being developed by the Hudson County Improvement Authority into a nine-hole public golf course. The wetland restoration included clearing illegally-dumped debris, excavation of over 250,000 cubic yards of material to restore the correct marsh elevations, adding 4,000 feet of new inter-tidal channels and connecting the pond to the Hackensack River, which will restore the tidal flushing to the pond.⁹⁷ A large tidal marsh adjacent to Lincoln Park in Jersey City, N.J. had become a landfill without a permit. The wetlands, streams and salt marshes were blighted and full of illegally dumped debris. The area was not a healthy habitat for birds and fish, nor an effective coastline support against future effects of climate change. In 2009, the National Oceanic and Atmospheric Administration received \$167 million from the American Recovery and Reinvestment Act to fund coastal restoration projects. With help from Louis Berger, the New Jersey Department of Environmental Protection applied for funds to restore 42 acres of wetlands at Lincoln Park. The project received \$10.6 million.

Challenge

A tidal marsh needed to be designed that not only fit into the natural landscape but also met the recreational and public space needs of Hudson County. In addition, to satisfy the U.S. Army Corps of Engineers, the marsh design had to incorporate beneficial reuse of dredge material coming from the Hudson River.

Solution

Louis Berger's state of the art design:

Restored over 42 acres of tidal habitats from high marsh to open water and mud flats. Provided beneficial reuse of dredge sands as the planting base of the marsh. Provided for excavation of more than 250,000 cubic yards of illegally dumped materials to restore the correct marsh elevations. Added more than 4,000 feet of new inter-tidal channels. Reconnected a pond to the Hackensack River, restoring tidal flushing to the pond. Provided walking trails and interpretive signs along the perimeter of the marsh. The Lincoln Park Wetland Restoration Project garnered Louis Berger a letter of commendation from the U.S. secretary of commerce, Rebecca Blank, and won a Coastal America Partnership Award, which recognizes outstanding projects that make a significant contribution toward the restoration and protection of the United States' coastal environment. This is the only environmental award of its kind presented by President Obama's administration.⁹⁸

The Lincoln Park restoration project in Jersey City, New Jersey has done something

⁹⁷Gobster, P. H. (2007). Urban park restoration and the. *Nature and Culture*,2(2), 95-114.

⁹⁸Lincoln Park Wetlands Restoration. (Nov 21, 2013). Retrieved April 22, 2016 from Louisberger: <http://www.louisberger.com/our-work/project/lincoln-park-wetlands-restoration-new-jersey-us>

remarkable: turned a once-barren landfill into a functioning wetland, teeming with fish, birds and other wildlife. This project, only a few miles from Manhattan on the banks of the Hackensack River, is an urban oasis for wildlife in an area that used to only be home to trash. And, since it received Recovery Act funding in 2009, this project has supported roughly 100 direct jobs so far. Working with local contractors, we restored tidal waters to the site by excavating dredge and landfill material—40,000 truckloads in total. The contractors capped the former landfill with sand, then recreated contours to the land to restore tidal creeks and wetlands. This has reopened passage for fish to a tidal pond. All told, we created 42 acres of wetland. We also created a half mile walking path to connect the park to the Liberty Water Gap National Trail. Before the restoration, there was little wildlife in the area besides the occasional sea gull. But during recent monitoring, we've spotted 12 species of fish, including alewives and striped bass, using the wetlands for refuge. We also observed more than 50 bird species, including egrets and osprey, and have spotted other wild animals like the mink. The park is now used by boaters, hikers, bikers, and anglers. The project has been in the works for more than 15 years, since New Jersey received Natural Resource Damage Assessment settlements for three large oil spills in nearby waterways. With a \$10 million boost from the Recovery Act, we worked with the New Jersey Department of Environmental Protection and other partners to get the work done. This team is now being recognized for its perseverance and dedication with a Partnership Award from Coastal America.⁹⁹ (Image 2.59)

Image 2.59:

The Lincoln Park Site restoration process: top image (2003), middle image(2010), bottom image show the new Hudson County golf course shows off the west side of Jersey City. (2014)



⁹⁹Landfill Turned Urban Oasis—Wetland Now Home to Fish and Birds. (Nov 21, 2013). Retrieved April 22, 2016 from NOAA: <http://www.habitat.noaa.gov/highlights/landfillturnedurbanoasis.html>

2.3.3 The fragmented matrix restoration under the nature disaster

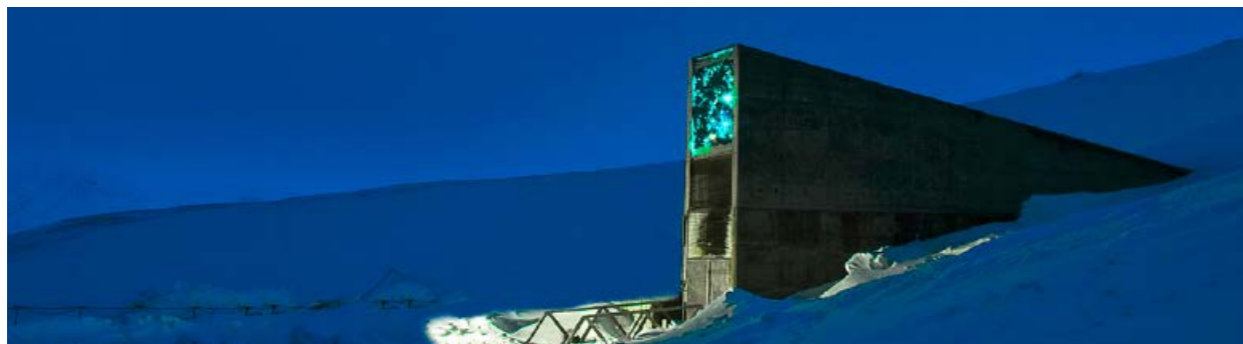
Plant species protection

Svalbard Global Seed Vault, Norway

The Svalbard Global Seed Vault (Norwegian : Svalbard globale frøhvelv) is a secure seed bank on the Norwegian island of Spitsbergen near Longyearbyen in the remote Arctic Svalbard archipelago , about 1,300 kilometers (810 mi) from the North Pole . Conservationist Cary Fowler , in association with the Consultative Group on International Agricultural Research (CGIAR), started the vault to preserve a wide variety of plant seeds that are duplicate samples, or "spare" copies, of seeds held in gene banks worldwide. The seed vault is an attempt to insure against the loss of seeds in other genebanks during large-scale regional or global crises.¹⁰⁰

The Svalbard Global Seed Vault's mission is to provide a safety net against accidental loss of diversity in traditional genebanks. While the popular press has emphasized its possible utility in the event of a major regional or global catastrophe, it will be more frequently accessed when genebanks lose samples due to mismanagement, accident, equipment failures, funding cuts, and natural disasters. These events occur with some regularity. War and civil strife have a history of destroying some genebanks. The national seed bank of the Philippines was damaged by flooding and later destroyed by a fire; the seed banks of Afghanistan and Iraq have been lost completely. According to The Economist, "the Svalbard vault is a backup for the world's 1,750 seed banks, storehouses of agricultural "We hoped that we would never get such a request," said Asmund Asdal, who runs the vault on behalf of the Nordic Genetic Resources Center. "Ideally, all the world's seed gene banks would function normally but of course we are prepared for this."¹⁰¹

Syria's civil war prompted the first withdrawal of seeds from the vault in September, following a request by the International Center for Agricultural Research in Dry Areas (ICARDA). ICARDA moved its headquarters to Beirut from Aleppo in Syria in 2012 because of the conflict.¹⁰² However, on December, 19, 2015, it's ironic that eight people were taken to hospital after the avalanche tumbled down from Sukkertoppen mountain, which very nearby the Svalbard Global Seed Vault.¹⁰³ (Image 2.60)



¹⁰⁰ PANDEY. A . (Sept 15, 2015). Retrieved April 22, 2016 from Ibtimes: <http://www.ibtimes.com/land-degradation-desertification-might-create-50-million-climate-refugees-within-2097242>

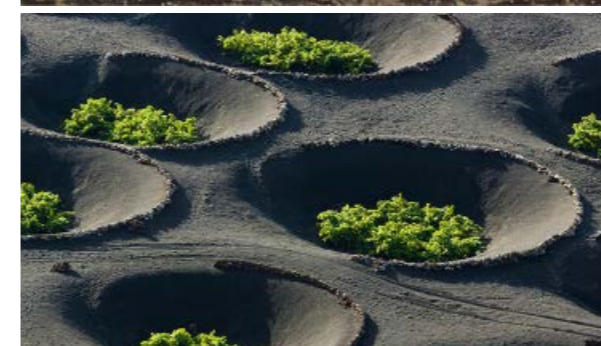
¹⁰¹ Syria War Forces First Withdrawal from Svalbard Global Seed Vault. (Sept 25, 2015). Retrieved April 22, 2016 from Nbcnews: <http://www.nbcnews.com/news/world/syria-war-forces-first-withdrawal-artic-seed-vault-n433471>

¹⁰² FOUICHE. G. (Oct 19, 2015). Domsday Arctic seed vault to receive two deposits in 2016. Retrieved April 22, 2016 from Reuters: <http://www.reuters.com/article/us-environment-doomsday-seeds-idUSKBN0TY0Z820151215>

¹⁰³ Several people missing after avalanche smashes into houses on Arctic island. (Dec 15, 2015). Retrieved April 22, 2016 from Independent: <http://www.independent.ie/world-news/europe/several-people-missing-after-avalanche-smashes-into-houses-on-arctic-island-34301064.html>



Image 2.60: Asmund Asdal Senior Adviser from NordGen inspects seeds in storage at the international gene bank Svalbard Global Seed Vault (SGSV) near Longyearbyen on Spitsbergen, Norway, ANNA FILIPOVA, October 20, 2015.



Wind erosion restoration

La Geria, Spain

La Geria is an area of the island of Lanzarote, Canary Islands (Spain), known for the uniqueness of its volcanic landscape. He was used to the planting of vines for wine production, being abundant the variety Malvasía. Because of windbreaks are required to reduce crop desiccation and soil loss by wing. The vineyards of la gería, lanzarote do wine region, single vines are planted in pits 4–5 m wide and 2–3 m deep, with small stone walls around each pit. The shape of the holes and the additional wall protect crops wind. This agricultural technique is designed to harvest rainfall and overnight dew and to protect the plants from the winds. Furthermore, the vines are planted in cones formed in the lapilli, lava stones known locally, and additionally protected by small dry stone walls. Also they planted fruit as figs, in the same way. This type of planting allows plants to take root more easily in the fertile soil, while the upper layer of lapilli reduces evapotranspiration. (Image 2.61)

Image 2.61: Malvasia grape vines growing in topsoil, covered in lapilli, La Geria, Lanzarote. The low, curved walls protect the vines from the constant, drying wind, Andreas Weibel, 2015.

2.3.4 The fragmented matrix restoration under the humanity damage

War restoration

The bombing of Guernica, Spain

The bombing of Guernica (26 April 1937) was the subject of a famous anti-war painting by Pablo Picasso, which named Guernica, is a mural-sized oil painting on canvas by Spanish artist Pablo Picasso completed by June 1937. The painting, which uses a palette of gray, black, and white, is known as one of the most moving and powerful anti-war paintings in history. Standing at 3.49 meters (11 ft 5 in) tall and 7.76 meters (25 ft 6 in) wide, the large mural shows the suffering of people, animals, and buildings wrenched by violence and chaos.

The painting is believed to be a response to the bombing of Guernica, a Basque Country village in northern Spain, by German and Italian warplanes at the request of the Spanish Nationalists. Upon completion, Guernica was displayed around the world in a brief tour, becoming famous and widely acclaimed, and believed to have helped bring worldwide attention to the Spanish Civil War. Guernica has become a universal and powerful symbol warning humanity against the suffering and devastation of war. Moreover, the fact that there are no obvious references to the specific attack has contributed to making its message universal and timeless. Guernica was moved to its current permanent location in a purpose-built gallery at the Museo Reina Sofía in 1992.¹⁰⁴ (Image 2.62, 2.63)



Image 2.62: Guernica after bombing, 1937



Image 2.63: Guernica is a mural-sized oil painting on canvas by Spanish artist Pablo Picasso completed by June 1937

Basque Government commissioned the sculptor San Sebastian, held on the occasion of the fiftieth anniversary of the bombing, almost not possible because Chillida not consider it appropriate that the site is proposed. The exploration around the symbolic oak Basque freedom led him to a garden, a stone's throw from the Assembly House, which is considered idónea. Our father's house sculptor for its author a great metaphor in concrete. "A metaphor," he explains, "the house, which represents the country, while the bow of a boat and even bow and arrow, trying to pick up the relationship archer aiming his dart. Within it is the symbol of peace, of life, of tolerance, in direct dialogue with the hollow shaft through the main element. "

Although the initiative occurred around monument to commemorate the bombing of the village, the sculptor admits to having thought little in the tragedy. "It's a sad story, but instead of looking back I wanted to look forward," he says. Incorporating Gure Etxea Aitaren a whole than in the past half century has evoked the war barbarism can be used to project its symbolic content to more hopeful, as those who have guided the artist.¹⁰⁵ (Image 2.63)



Image 2.63: Our father's house sculptor, Eduardo Chillida, 1988.

¹⁰⁴Guernica (Picasso). (Nov 9, 2014). Retrieved April 22, 2016 from Wikipedia: [https://en.wikipedia.org/wiki/Guernica_\(Picasso\)](https://en.wikipedia.org/wiki/Guernica_(Picasso))

¹⁰⁵Chillida rinde homenaje al árbol de Guernica. (April 25, 1988). Retrieved April 22, 2016 from Elpais: http://elpais.com/diario/1988/04/25/cultura/577922406_850215.html

Eduardo Chillida's another sculpture named *El Peine del Viento XV*, the work in San Sebastian which is located in weathering seaside, is the most emblematic work of Eduardo Chillida. With a poetic language, it reverses the eternal metaphor for the wind between combing the city. Designed Corten steel to withstand the passage of time and the strong sea erosion and wind, the Wind Comb is presented as a monumental set of three solid steel shapes powerfully clinging to the rocks that open like claws and defy the laws of the nature. The first two, located on the same geological strata, and facing horizontally maintain a constant dialogue, the result of the union of past and present. The third, vertically erect on the horizon, interrogates the unknown future. Three elements mark and limit the place, they built a sacred space that connects the man himself and the cosmos, a place of encounters between humans and nature. (Image 2.64)



Image 2.64: Peine del Viento XV sculptures, Eduardo Chillida, 1976.

Alberto Burri, Italy

Alberto Burri (born 12 March 1915 in Città di Castello, Italy, died 13 February 1995 in Nice, France) was an Italian painter and sculptor. In 1940 he received a degree in medicine from the Università degli Studi di Perugia. He then served in World War II, first as a frontline soldier and then as a physician. His only sibling, Vittorio Burri, also a doctor, was killed on the Russian front. During the North African campaign, British forces captured Burri's unit in La Marsa, Tunisia, in May 1943. After being transferred to different prisoner-of-war camps in North Africa, where he continued to work as a physician to the wounded and sick, he was sent to a prisoner-of-war facility for Italian soldiers in Hereford, Texas. Disaffected by war and by his internment, Burri took up painting in an autodidactic, figurative style and never practiced medicine again. (Image 2.65)

In 1950 BURRI MADE HIS FIRST Sacco (sack) from a cast-off burlap bag mounted on a stretcher. During his time in a Texas prisoner-of-war camp (1943–46), the artist had used found gunnysacks as canvases for figurative paintings. In the Sacchi series, the unpainted

burlap functions as both support and ground. Form, line, color, and tone emerge from the textile's warp and woof, stains, patches, and stitches. Burlap is produced with jute, a coarse fiber related to the finer linen used for artists' canvases. As a result, the worn and tattered material looks like a traumatized version of a traditional canvas. When the Sacchi were first exhibited in Rome in 1952, one critic described them as paintings but "impoverished, rotted, consumed, and already wasted away."

Burlap was ubiquitous on the front lines during World War II, and used for supply sacks, sandbags, and camouflage. The Sacchi, however, respond to the historical context of postwar Italy as an impoverished country dependent on the charity of the United States. A few of the gunnysacks Burri employed had carried foodstuffs from America's Marshall Plan relief effort (1948–53), but most came from the flour mill in his hometown. The worn burlap attests to use by different hands as well as to the artist's own laborious stitching. Lacerated and threadbare, the material evinces anger and shame but also vulnerability and dignity. The Sacchi find their closest parallel in the neorealist cinema of Vittorio De Sica, Roberto Rossellini, and Luchino Visconti, who captured the misery of the time with a similar weave of documentary fact, aesthetic strategy, and humanity. (Image 2.66)

Burri's assemblages relate to the collage practice of Tactilism, which the Futurist F. T. Marinetti promoted after World War I in response to veterans' experiences of blindness and shell shock. Informed by Maria Montessori's methods for educating children in sensory discrimination, Tactilism emphasized the therapeutic role of manipulating materials and "hands that see." Burri handled traumatized bodies as a doctor and understood the reparative force of touch. The powerful effect of the Sacchi results from a similar activation of the tactile sense. They compel the eye and hand to work in tandem as the viewer projects the feeling of the nubby burlap as well as the damage inflicted upon it.



Image 2.65: Italian soldiers during the Italo-Ethiopian War, Amba Aradam, left one is Alberto Burri, Mariella Andreoli, Città di Castello, 1935.



Image 2.66:

Sacco H 8 (Sack H 8), ca. 1953. Burlap, synthetic polymer paint, thread, and Vinavil on black fabric, 86 x 100 cm. Courtesy Galleria Tega, Milan. Photo: Paolo Vandasch and Romina Bettega.

In the mid-1950S BURRI ADOPTED materials essential to the building industry and to Italy's postwar reconstruction. Instead of giving new life to fabric remnants, he repurposed pristine wood veneer, sheet metal, plastic sheeting, and insulation board. He also developed a new process of burning materials, which he called combustion. The Surrealists had invented soot drawing, or fumage, in the 1930s, but Burri was precocious in his mastery of fire as a full-fledged painterly technique. The Legni (woods) are composed of thin laminates, usually of birch or oak, meant to replicate expensive hardwood furniture and wall paneling. With the flame of an oxyacetylene torch, the artist buckled the golden-hued surfaces, painted brooding shadows, and carved jagged-edged holes. The veneer's association with human shelter adds to the searing power of the charred passages. The Legni provoke instinctive reactions to fire: the desire to feel its warmth and ponder the multicolored glow braced by the knowledge that it can cause pain and destruction in a flash.¹⁰⁶ (Image 2.67)



Image 2.67: Legno e bianco 1 (Wood and White 1), 1956. Wood veneer, combustion, acrylic, and Vinavil on canvas, 87.7 x 159 cm. Solomon R. Guggenheim Museum, New York 57.1463. Alberto Burri's main paintings as a selection longterm exhibition in the Guggenheim Museum. Photo: Kristopher McKay.

¹⁰⁶Alberto burri was born on march life. . (Feb 9, 2016). Retrieved April 22, 2016 from Guggenheim: <http://exhibitions.guggenheim.org/burri/art/sacks/grande-sacco-1952>

2.4 The restoration of fragmented structures of thought

The restoration of memory is another kind of invisible landscape restoration. This is invaluable as it belong to Landscape structure of the human spirit restoration for the history culture or nature cognitive. Today, the ancient city of Loulan was eroded by weathering, the Buddhas of Bamiyan were bombed by a terrorist organization, nuclear leakage occurs through disaster or accident, etc. Mankind also faces fickle conditions of nature, frequent war, and depopulation. All of these fragmented structures affect human cognition and the inner spiritual world of man, and yet, all of this fragmented inner spiritual world is concealed behind the visually fragmented structures of patch, corridor and matrix. The principle reasons for this are: human greed over energy, the sense of human superiority, the pursuit of pleasure, etc. Moreover, the occurrence of natural calamities together with man-made has lead mankind to become afraid of nature, of the fragmented environment, and even afraid of implementing certain kinds of restoration. Consequently, the most important restoration of all is to reinstate the concept of nature in human cognition. Before attempting to restore the fragmented landscape structures, perhaps we first need a patch to reflect, a corridor to mourn, and a peaceful matrix to mature the soul. The following section discusses a selection of restoration projects of fragmented thought structures.

2.4.1 The fragmented thought restoration under the resource explotion

Mine and Quarry restoration

Opus 40, America

Opus 40 is a large environmental sculpture in Saugerties, New York, created by sculptor and quarryman Harvey Fite (1903—1976). It comprises a sprawling series of dry-stone ramps, pedestals and platforms covering 6.5 acres (2.6 ha) of a bluestone quarry. Fite, then a professor of sculpture and theater at Bard College, Annandale-on-Hudson, New York, purchased the disused quarry site in 1938, expecting to use it as a source of raw stone for his representational sculpture. Instead, inspired by a season of work restoring Mayan ruins in Honduras, he began creating sculptures for installation in the quarry space itself. Fite died in 1976, in the 37th year of his creation. He died working on it, in a fall. He left some unfinished areas—but, as his stepson, the writer Jonathan Richards, has observed, "Opus 40 is as complete as it ever would have been. It was the product of Fite's ceaseless vision, and could only have been stopped by his death." Brendan Gill, in the March, 1989 edition of *Architectural Digest*, called Opus 40 "one of the largest and most beguiling works of art on the entire continent," and he has also called it "the greatest earthwork sculpture I have ever seen." Though Fite was not associated with the Land Art or Earthworks sculptural movement of the 1970s, he came to be known as a pioneer of that movement,

and was recognized in 1977 by the Hirshhorn Museum of the Smithsonian Institution, in a show entitled "Probing the Earth: Contemporary Land Projects," as a forefather of the earthworks movement.¹⁰⁷(Image 2.68, 2.69)

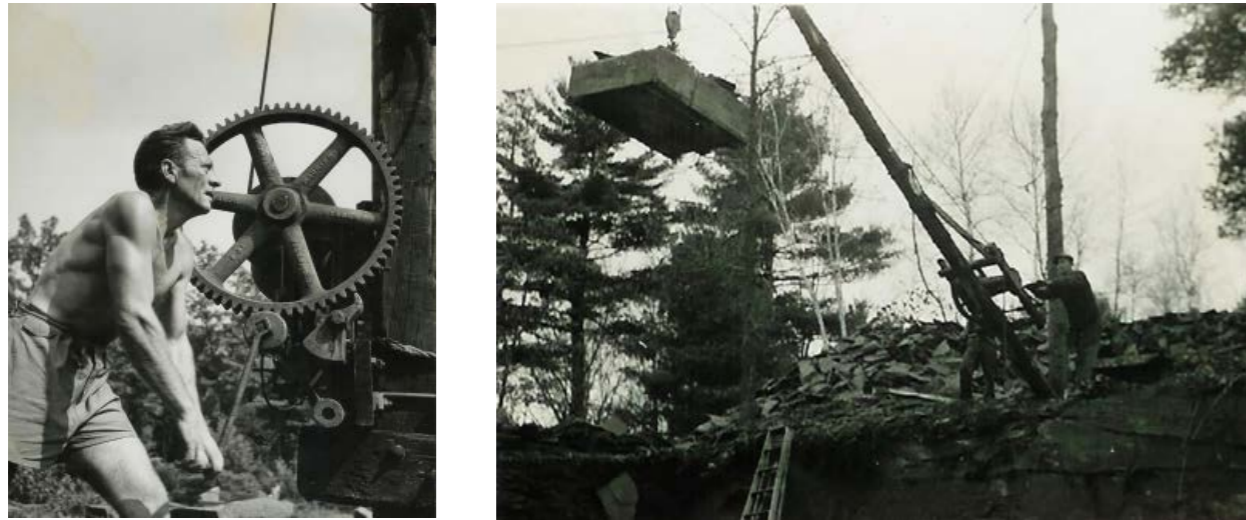


Image 2.68: Harvey Fite worked in the Opus 40 project, 1942.



Image 2.69: A wedding celebrated in the Opus 40 project, CYNTHIA DELCONTE, 2010.

¹⁰⁷Opus 40. (March 19, 2014). Retrieved April 22, 2016 from Wikipedia: https://en.wikipedia.org/wiki/Opus_40

Quarry Garden, China

Renovated from abandoned quarry yard, Quarry Garden has become one new landmark and name card of Shanghai. Its capabilities are fully displayed based on ecological restoration and culture reconstruction strategies. One dangerous inaccessible abandoned land has been built into one attractive tourist resort for visitors approaching natural landscape and experiencing the culture of quarrying industry. And the challenge of constructing dramatic aesthetical space on highly-difficult construction techniques also becomes one highlight of this project.

The quarrying industry has stripped the vegetation cover on the surface layer and altered the landform significantly, causing water and soil loss as well as habitat fragmentation. Given to rare rock ground, the designer takes the "substruction" strategy and attempts to build a new biocoenosis through reshaping the land form and increasing vegetation cover. As for exposed hills and rock walls, the designer manages to respect the trueness of rock-wall landscape, rather than apply the routine wrapping method. Under the premise of effective keep-off for safety consideration, the designer adopts the "subtraction" strategy of no intervention and leaves the rock wall to restore by itself under rain, sunshine and other natural conditions. Designer prof. Zhu want to create natural and cultural experience of oriental style for guiding visitor enjoy the Enlightened by Chinese landscape painting and classical literature, modern design has been applied to this project to interpret the natural landscape culture of the orient as well as the utopianism of China. The oriental tradition is different from the western "static" appreciation ways and emphasizes more on visible and visitable "accessible" landscape experience. Moreover, the "The land of Peach Blossom", a classic literary works considered to describe "the oriental Garden of Eden", has vividly depicted a fishermen's miraculous experience in a Utopia world through a route. As a reflection of oriental natural landscape culture, the designer has copied the scene in the "The land of Peach Blossom" and ensured the visitors to tour and enjoy the landscape through a dramatic route based on the unique land form of the deep pool.¹⁰⁸

(Image 2.70, 2.71)



Image 2.70: Quarry Garden Site: top image (before restoration, 2006), bottom image (after restoration, 2012)

¹⁰⁸Quarry Garden in Shanghai Botanical Garden. . (2012). Retrieved April 22, 2016 from Asla: <https://www.asla.org/2012awards/139.html>



Image 2.71: Visitor step down into the Quarry Garden Site, 2014.

Edward Burtynsky Photographer, world

Insist on not changing, now the nature fragile area is already one kind of landscape. About the nature fragile areas, there are two important points on the restoration system. One is protecting the nature fragile area. No measure or just simple embellish can be taken, because the nature fragile area is already a landscape. For example, the photography related to the earlier industry time has shown the serious shortage of water and vegetation. Also some sculptures appeared which are very suitable for the surrounding. People want to alert humans by silent behavior. Such as the photography named Edward Burtynsky Quarry published by photographer Edward Burtynsky.

Edward Burtynsky, OC (born February 22, 1955) is a Canadian photographer and artist known for his large-format photographs of industrial landscapes. Burtynsky's most famous photographs are sweeping views of landscapes altered by industry: mine tailings, quarries, scrap piles. The grand, awe-inspiring beauty of his images is often in tension with the compromised environments they depict. He has made several excursions to China to photograph that country's industrial emergence, and construction of one of the world's largest engineering projects, the Three Gorges Dam.

On his website, he wrote: Nature transformed through industry is a predominant theme in my work. I set course to intersect with a contemporary view of the great ages of man; from stone, to minerals, oil, transportation, silicon, and so on. To make these ideas visible I search for subjects that are rich in detail and scale yet open in their meaning. Recycling yards, mine tailings, quarries and refineries are all places that are outside of our normal experience, yet we partake of their output on a daily basis. These images are meant as metaphors to the dilemma of our modern existence; they search for a dialogue between attraction and repulsion, seduction and fear. We are drawn by desire - a chance at good living, yet we are consciously or unconsciously aware that the world is suffering for our success. Our dependence on nature to provide the materials for our consumption and our concern for the health of our planet sets us into an uneasy contradiction. For me, these images function as reflecting pools of our times.¹⁰⁹(Image 2.72)

¹⁰⁹ Burtynsky, E. (2011). Edward Burtynsky Quarry. German: Steidl.

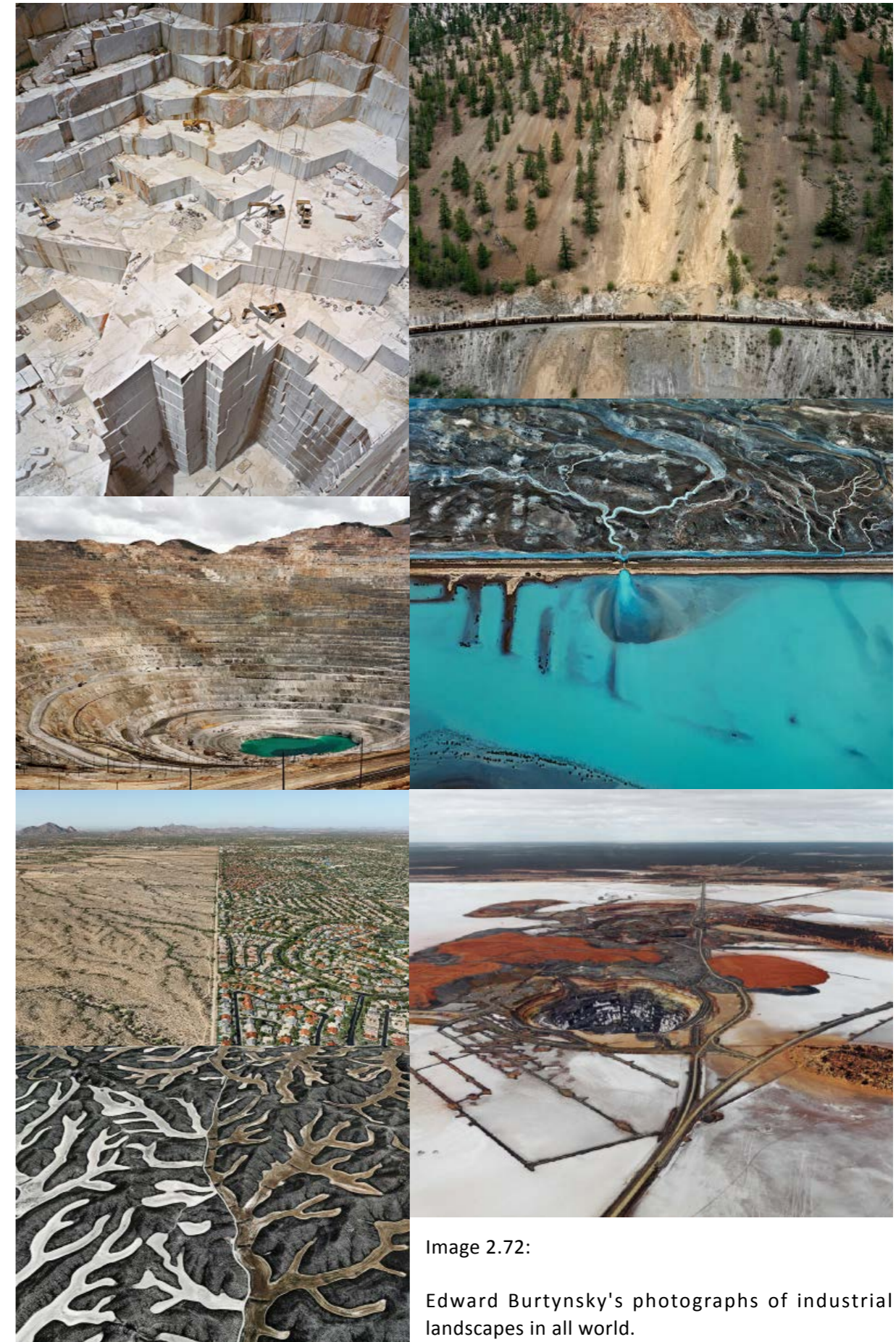


Image 2.72:

Edward Burtynsky's photographs of industrial landscapes in all world.

2.4.2 The fragmented thought restoration under the city grow

Landfill restoration

Amager Resource Center, Denmark

In an industrial area not far from the center of Copenhagen, a giant wedge-shaped edifice is taking shape. When it is finished in 2017, its sharply angled roof will be home to one of the Danish capital's newest and most unusual tourist draws: a ski slope. But the building's name—the Amager Bakke incinerator—exposes it as more than a mere novelty; it's also an ambitious attempt to solve a vexing problem. When it is up and running, the \$650 million piste-topped plant will have the capacity to burn up to 400,000 tons of garbage each year, producing enough heat and electricity for about 150,000 households. The waste-to-energy plant, Amager Resource Center, is located in an industrial area, that throughout the years, has turned into an extreme sport destination for thrill seekers. Different extreme sports activities take place in the raw industrial facilities such as cable wake boarding, go-kart racing, and rock climbing among others. The Amager Resource Center is the most significant landmark in the area and the building is in need of renewal. We propose a new breed of waste-to-energy plant, one that is economically, environmentally, and socially profitable. Instead of considering Amager Resource Center as an isolated object, we mobilize the architecture and intensify the relationship between the building and the city—expanding the existing activities in the area by turning the roof of the new Amager Resource Center into a ski slope for the citizens of Copenhagen.

The new plant established Amager Resource Center as an innovator on an urban scale, redefining the relationship between the waste plant and the city. It will be both iconic and integrated, a destination in itself, and a reflection on the progressive vision of the company. Denmark and other European countries are generating more of their electricity by burning garbage, reducing their energy costs and reliance on fossil fuels while sharply

curbing waste on a crowded continent where landfill space is scarce. In 2011, the most recent year for which statistics are available, there were 454 waste-to-energy plants operating in Europe, burning 78 million tons of garbage and industrial waste, according to the Confederation of European Waste-to-Energy Plants.¹¹⁰ (Image 2.73, 2.74, 2.75)

Image 2.73: Topped with a ski slope, the Amager Bakke waste-to-energy plant will double as a tourist attraction when it opens in Copenhagen in 2017, the Bjarke Ingels Group.



Image 2.74: The plant was designed to belch out a large smoke ring every time a ton of carbon dioxide is released to serve as a reminder of the environmental impact of consumption, the Bjarke Ingels Group.



Image 2.75: A rendering shows the skiers in action, the Bjarke Ingels Group.

Abandoned suburbs area restoration

Tagus Linear Park, Portugal

The Tagus Linear Park (TLP), located in the municipality of Vila Franca de Xira, in the northern outskirts of the Portuguese capital city of Lisbon, is a landscape architecture endeavour that internalizes the shift of values needed to overcome the dangers of our current era. It eschews the enormous risks entailed in “human activities” that are driven by sheer eagerness for growth, without measuring environmental and social impacts. Instead, the TLP was designed with a careful ethical ambition to reshape space through fostering both, social and civic participation as well as through rebalancing the connections between human communities and different land uses in an environmentally-friendly manner.

¹¹⁰European Plants Generate Energy—and Pride—from Waste . (April 4, 2014). Retrieved April 22, 2016 from Dwell: <http://www.dwell.com/green/article/european-plants-generate-energy%E2%80%94and-pride%E2%80%94waste#7>

The Tagus Linear Park combines two different typologies of spaces: A single multifunctional area named 'PRAIA DOS PESCADORES' (FISHERMEN'S BEACH), set by the riverside within a former sand deposit, and 6 km of PEDESTRIAN TRAILS associated with dirt roads, waterlines banks (streams and drainage ditches), which converge to Praia dos Pescadores, coming from urban and natural areas. The connection between the 'beach' and natural areas is made through a 700m long raised wooden path by which a Bird Observatory built from old pallets can be reached.¹¹¹ Everybody could hike, ride, fishing and picnic in here. (Image 2.76)



Image 2.76: The local person do fishing, riding, running and exercise in the Tagus Linear Park, Topiaris landscape architecture, 2013.

¹¹¹Marques. V. S(2014). Four-Dimensional Landscape Architecture. Topos, 89, 68-73.

Humanity restoration

Banyoles old town public space, Spain

Banyoles' old town used to be a deteriorated area in which vehicles and pedestrians cohabitated around a urban system of narrow streets and old sidewalks. The irrigation canals that originally were clean had become part of the sewer system of the city. Around the Central Square there were also sidewalks in which cars parked randomly. The process was to pedestrianize the whole area, removing all the old sidewalks. The new intervention is made with travertine stone. This calcareous stone has always been present in the city's subsoil. All the enigmatic buildings, churches, medieval houses or monuments were also raised with travertine. The departing point is departing point is to cover the Central Square (the most relevant part of the project) using a tessellation of travertine.

The proliferation of this tiling arrives to the streets and minor squares in different phases of the project. On the other hand, the irrigation system is uncovered intermittently across the pedestrian ways. Eventually, it is opened in bigger sections so children can play as if they were in front of a puddle of water. Re-paving the city center defines a new pedestrian area. It corresponds to a part of Banyoles in which the traces of the medieval age are still present. In fact, the urban planning at the historical center shows up as a sequence of squares as 'Plaça dels Turers'. 'Plaça Major' (Central square), 'Plaça dels estudis' (Studies square), 'Plaça de la Font' (Water and water through the old town of Banyoles, giving them back the itineraries they occupied originally. We chose the same material in which all the city center is built. The tiles of travertine stone generate folds in order to form canals or regulation gates. We break the lineality of the pedestrian paths making cuts in their surface so the flow of water can be felt. Certainly, the purpose is to exhaust the possibilities of the material of travertine itself, from the soil to the new paving passing through water. We strongly believe that the old town will now become a sequence of paths in which the inhabitants would have the possibility to enjoy the historical center and its 12th Century architecture. From now on, the pedestrian will always be accompanied by the presence of the water.¹¹² (Image 2.77)



¹¹²Mias Gifre, J. M. (2013). Banyoles: Banyoles old town refurbishment project by Josep Miàs. Spain: Bas López X.



Image 2.77: Open section of canal on one side of a street in Banyoles' old town and detail of the points where a section of a canal widens to form a pool. Like geological accidents that suddenly appear in the urbanised continuity, these irruptions of water in the ground speak of the old swamplands that were dried out to construct the town. Now the water back to the old town, 2008, Mias.

Ella & Pitr, France

Ella & Pitr are poets of street art, graffiti away, their characters remind me of children's stories revisited the taste of the street. They use the space in their own way, regardless of the severity, or the perspective of the viewer. It's their creations that matter and come to life through the energy that infuses their places where they were born, art, brick and wind. (Image 2.78)

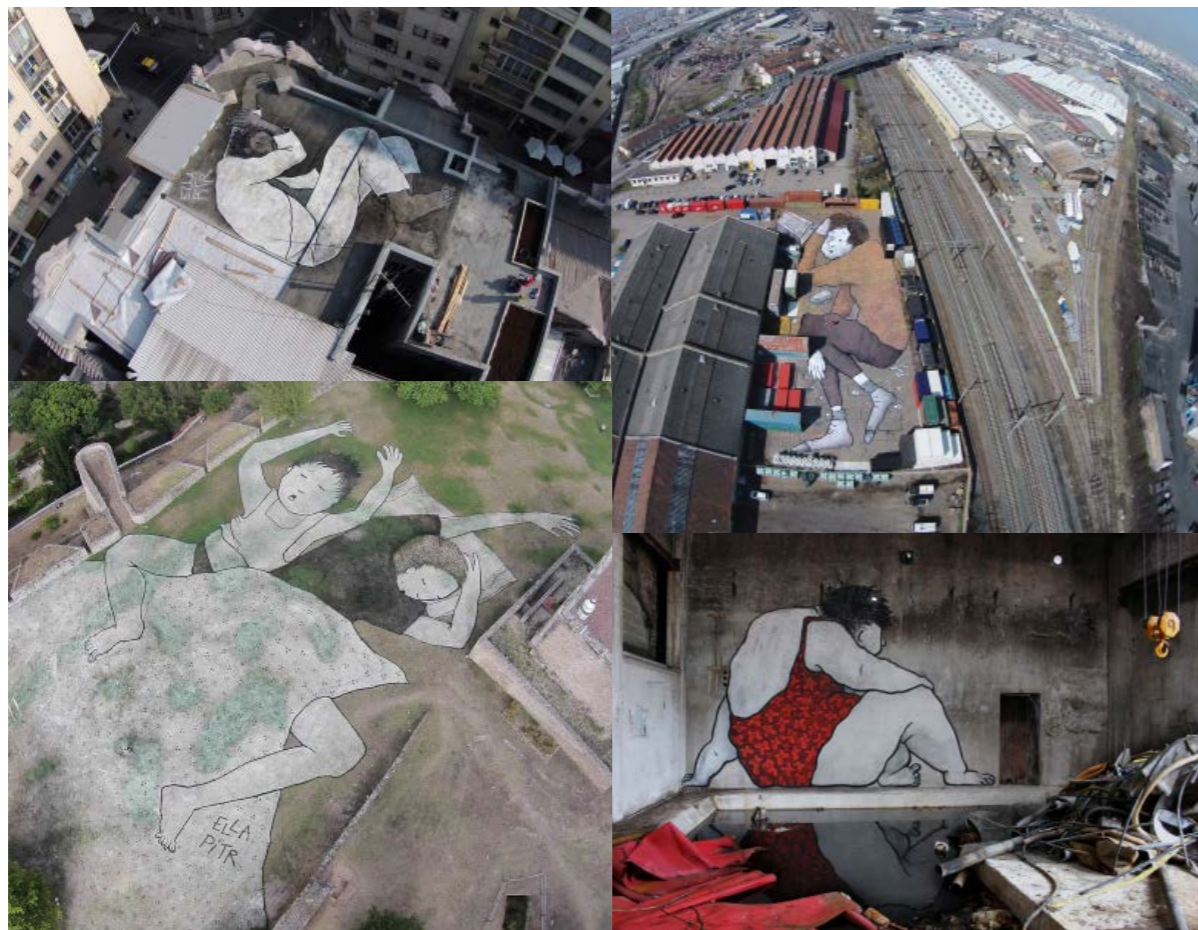


Image 2.78: Ella & Pitr street arts, 2011.

Light pollution restoration

Teide National park, Spain

Although the observatory on the Teide National park has optimal environmental conditions for astronomy with minimal light pollution, and attracts many thousands of astronomers every year, today, light pollution has now begun to influence the island of Tenerife. This trend affects the vision of the stars and must be tackled through everyone saving energy to protect the night sky.

When we fly pass cities using infra-red technology, we find some light and some dark places. Although children may be afraid of the dark, their parents know that much darker, cleaner places, left undisturbed by humans, allow a far brighter vision of the universe. (Image 2.79)

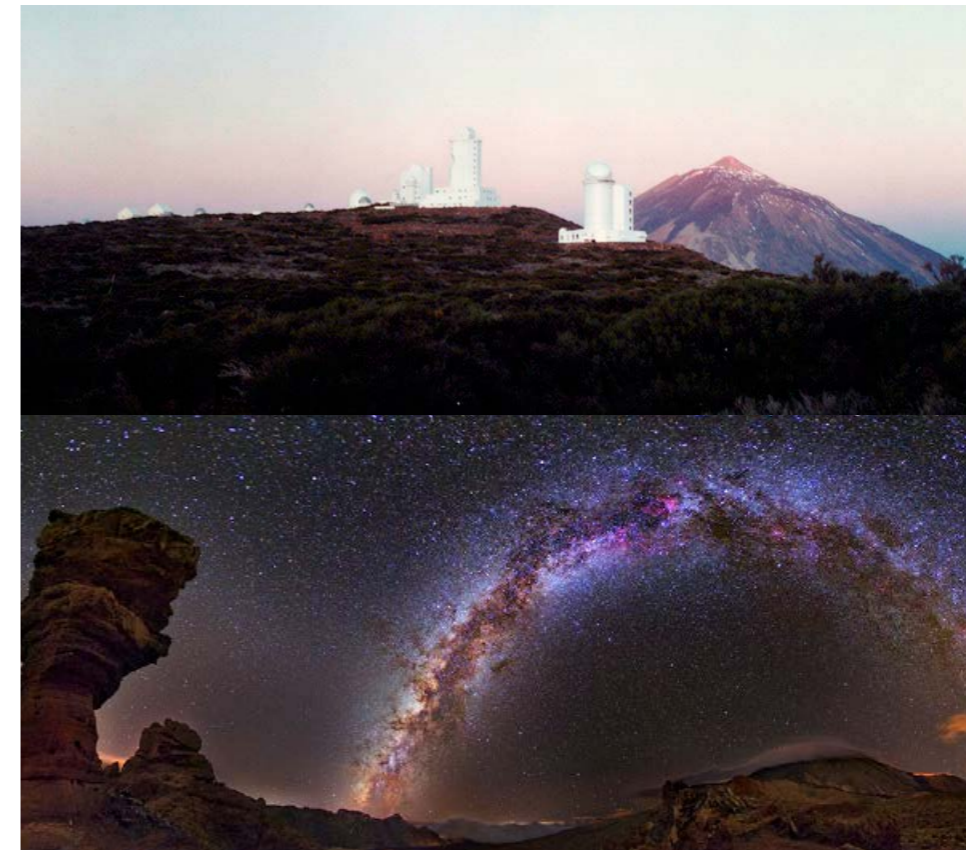


Image 2.79: The observatory on the Teide National park, telescopes, 2012.

Roden Crater, America

Turrell said: "We're not apart from nature so that the hothouse is not unnatural. Someone was talking to me about the difference between natural light and artificial light. Well, there isn't any difference because in light everything reveals what it is. When astronomers look at the stars, the stars reveal themselves in their light. When you do the flame test in chemistry to find out what something is made of, it releases a characteristic light of that material at that temperature. The same is true when we make a light bulb. You heat tungsten and it gives off a particular light. If you heat xenon under high pressure it will give off a characteristic light and so there is no unnatural light – there is only light. I'm

interested in light wherever it comes from. I like gallery light. It is as reverent an object as, say, the sun or the moon. And it is something we've done."¹¹³

James Turrell (born May 6, 1943) is an American artist primarily concerned with light and space. Turrell was a MacArthur Fellow in 1984. Turrell is best known for his work in progress, Roden Crater, a natural cinder cone crater located outside Flagstaff, Arizona that he is turning into a massive naked-eye observatory. Roden Crater is a cinder cone type of volcanic cone from an extinct volcano, with a remaining interior volcanic crater. It is located northeast of the city of Flagstaff in northern Arizona, United States. The artist James Turrell, for his land art project, acquired the 400,000-year-old, 3-mile-wide (4.8 km) crater's land. Turrell has since been transforming the inner cone of the crater into a massive naked-eye observatory, designed specifically for the viewing and experiencing sky-light, solar, and celestial phenomena. The fleeting Winter and Summer solstice events will be highlighted. On the official website, the introduce words were written that: Set in a stage of geologic time, the Roden Crater's chambers and tunnels create a music of the spheres by isolating and intensifying the light of the sun, moon, stars and planets. It invites you to become an active participant in what you see and inspires you to have a deeply personal experience that connects you to the cosmos.¹¹⁴ (Image 2.80, 2.81)



Image 2.80: This aerial photo of the cone gives you an idea of the scale, James Turrell, 2011.



Image 2.81: Turrell began thinking about the project in 1974, and was able to purchase the crater in 1979. His plan for the crater involves twenty "spaces", some with multiple views of the sky, arranged in a progression that culminates in the large central space, Lars Larson DP, 2014.

Crawick Multiverse, Scotland

The Crawick Multiverse was created on a former open-cast coal mine. It is a major land restoration project intended to benefit the communities of upper Nithsdale. Constructed from material found on the site, most spectacularly 2,000 boulders, it conveys cosmological themes galactic mounds, comet collisions, a sun amphitheatre and culminates in a most recent speculation: that we inhabit one of a number of universes, one surprisingly balanced to produce life and mind. As can be seen in the plans on this page, this well-tuned universe is one among over a hundred that are presented as boulders, on the Multiverse spiral. The spiral mound (seen right in the first photo) is at the end of a walk north, and upwards, in an intimate part of the landscape protected by scrub birch. The North-Point sign, and the overall plan, show the North-South Line, and the rhythmical cadence of upright stones (which rise and fall and rise in height) and lead directly to the Omphalos, with its mythic and scientific representations of the centre of the earth. Walking in this project, visitors could feel the honor for the universe. (Image 2.82, 2.83)

¹¹³Whittaker, R. (2005). Greeting the Light: an interview with James Turrell. Works+ Conversations, (2).

¹¹⁴Roden Crater. (1977). Retrieved April 22, 2016 from Jamesturrell: <http://jamesturrell.com/work/roden-crater/>

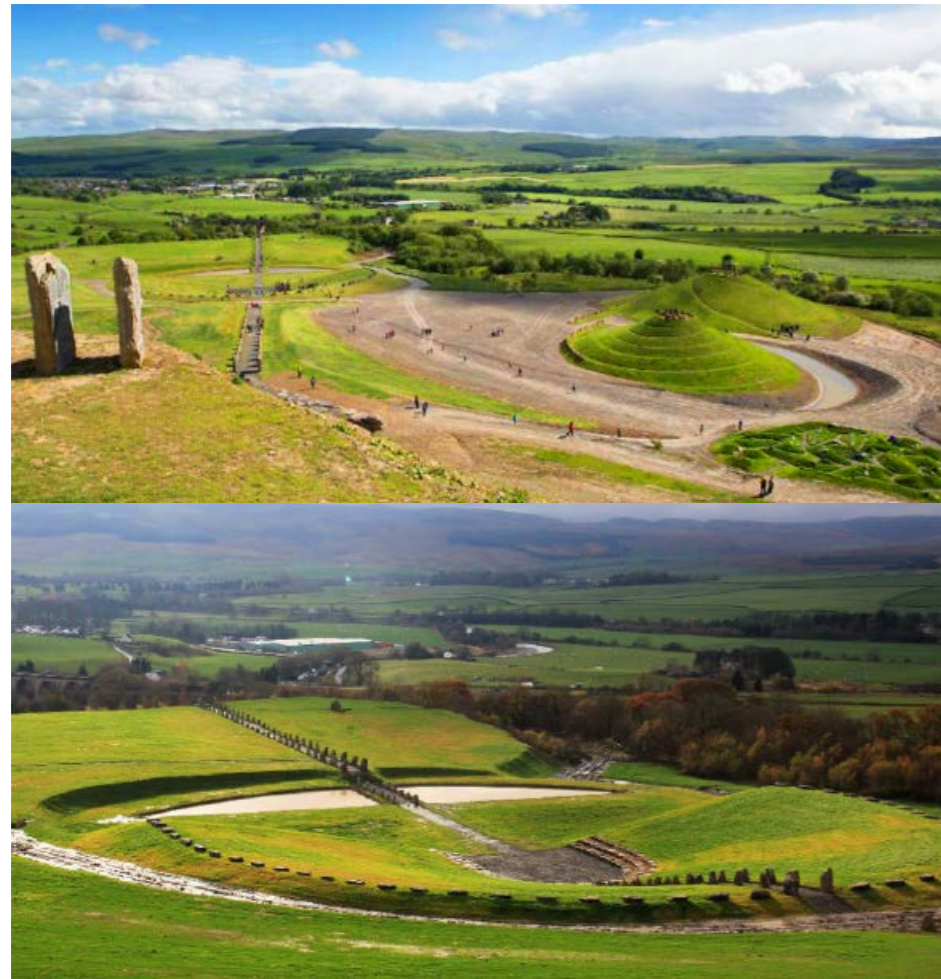


Image 2.82: Visitors is in the Crawick Multiverse project, 2015.



Image 2.83: The opening dance mirrors the north-south line in front of the Crawick Multiverse project, Charles Jencks, 2015.

2.4.3 The fragmented thought restoration under the nature disaster

Drought restoration

Spiral Jetty, America

Spiral Jetty is an earthwork sculpture constructed in April 1970. Built on the northeastern shore of the Great Salt Lake near Rozel Point in Utah entirely of mud, salt crystals, basalt rocks and water, Spiral Jetty forms a 1,500-foot-long (460 m), 15-foot-wide (4.6 m) counterclockwise coil jutting from the shore of the lake. The water level of the lake varies with precipitation in the mountains surrounding the area, revealing the jetty in times of drought and submerging it during times of normal precipitation. The sculpture becomes submerged whenever the level of the Great Salt Lake rises above an elevation of 4,195 feet (1,279 m). At the time of Spiral Jetty's construction, the water level of the lake was unusually low due to drought. Within a few years, the water level returned to a normal level, submerging the jetty for the next three decades. In 2002, the area experienced another drought, lowering the water level in the lake and revealing the jetty for a second time. The jetty remained completely exposed for almost a year. During the spring of 2005, the lake level rose again due to a near-record-setting snowpack in the surrounding mountains, partially submerging the sculpture. In spring 2010, lake levels receded and the sculpture was again walkable and visible. As of late June 2011, runoff from a record snowpack has again completely submerged the Jetty. Current conditions fluctuate, but as of October 2015, the jetty is above water and visible.¹¹⁵ (Image 2.84, 2.85)

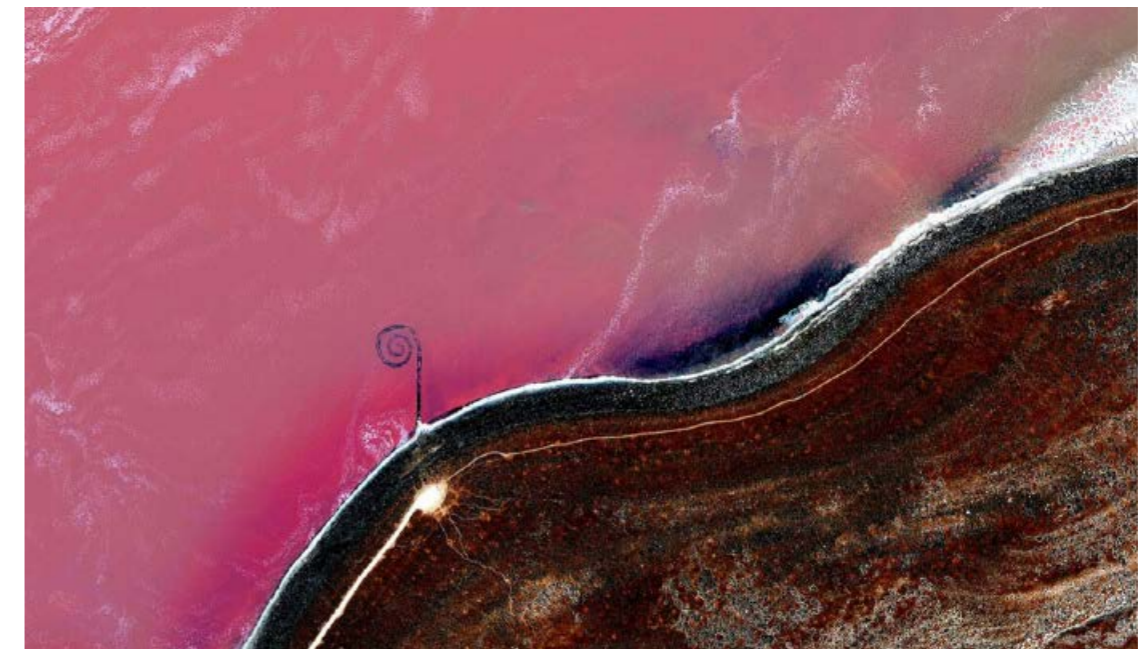


Image 2.84: Spiral Jetty is an earthwork sculpture by Robert Smithson, consisting of a 1,500-foot-long (460 m), 15-foot-wide (4.6 m) counterclockwise coil jutting from the northeastern shore of the Great Salt Lake in Utah, USA. Smithson reportedly chose this sit, Daily Overview, 2015.

¹¹⁵Spiral Jetty. (2015). Retrieved April 22, 2016 from Wikipedia: https://en.wikipedia.org/wiki/Spiral_Jetty



Image 2.84: These three Spiral Jetty Site images show the water level changed, which could help distinguish Great Salt Lake drought level in different season and year.

Earthquake restoration

The Great Cretto Gibellina, Italy

The Grande cretto (Large Cretto , 1985–89) for Gibellina, Sicily, is Burri's monumental work of Land art. It was built to commemorate an earthquake's destruction of the original city of Gibellina, resulted in 1,150 casualties, 98,000 homeless and destroyed six countries in the Belice valley, 14 January 1968. Gibellina has since been rebuilt, about 20 km from

the city's original location.¹¹⁶

The mayor of Gibellina, Ludovico Corrao called many famous artists joined with enthusiasm and generosity for founding of new Gibellina, also included Alberto Burri, but he did not want his work to be done in the new city that was defining. Burri said: "We went to Gibellina with architect Zanmatti, which had been commissioned by the mayor to take care of everything. When I visited the place, in Sicily, the new country had been largely completed, and was full of works. This is not I do nothing for sure, I said right away, ... let's see where the old town. It was almost twenty kilometers. A twisting road, sunburned, winds inland of Trapani to lead us, after kilometers of desolate absence human to a heap of ruins ... As I was really impressed. I was almost crying ... and now I had the idea here is, here I feel that I could do something."¹¹⁷ Fight the wreckage that both are a problem for everyone, the right to arm ourselves, and with the concrete make a huge crack white, so that remains - lasting memory of this event. Done!". Burri transformed the expanse of ruins in an immense tomb. "when you get to Gibellina old, can be seen as a shroud, white, dazzling, thrown on the slope of montagna. It occupies several hectares and is the largest contemporary sculpture in the world. Let me tell you, is more than a sculpture, "it is a sculpted landscape." The project was started in 1984 and completed five years later. The ruins were destroyed by the intervention of the army; gathered with bulldozers, compacted and held together by wire mesh. Above these homogeneous blocks it is dripped liquid cement white. Each slit is 3.2 meters wide, while the blocks are one meter high and about sixty. The layout of blocks and fissures follows largely the urban layout, with streets and blocks. Entering his belly rubble are compacted under a layer of concrete whitewashed thickness of one meter and a half, creating in this monument that has no equal, winding trenches, that respect the old layout of the streets and junctions. Seems to hear them again, the cries of thousands of funeral processions, between the smooth walls, cold, immaculate of the crack.

On the occasion of the centenary of the birth of Burri, 17 October 2015, the Sicilian Region, the City of Gibellina in collaboration with the Fondazione Palazzo Albizzini Collection Burri it decided to complete this great work, unparalleled in the international art scene and to restore dignity to the part already made by 'artist. The Great Cretto Gibellina was officially opened. Exactly thirty years after the start of its implementation (1985), perhaps the most famous work of Alberto Burri has found its completion. (Image 2.86, 2.87)

¹¹⁶Gibellina 1968. (2015). Retrieved April 22, 2016 from. Palinsesti: <http://www.palinsesti.org/2006/grande-cretto>

¹¹⁷Raisi. (Agust, 5, 2010). Grande Cretto – Burri – Gibellina. Retrieved April 22, 2016 from. Blogsicilia: <http://www.blogsicilia.eu/grande-cretto-burri-gibellina/>

Image 2.86:

The Great Cretto Gibellina project plan map (bottom image, 1984) was inspired by Burri's painting Grande bianco (top image, 1971).



Image 2.87: The Great Cretto Gibellina project site images, Rino Palma, 2008.

Beichuan earthquake memorial, China

Beichuan earthquake memorial is located in the qushan county, nearby the Beichuan middle school earthquake site. This memorial links the collapsed building and earth landscape to return the original space, which reflects remembering for the dead. The huge "crack" earth landscape design keeps the sad memorial time and disaster.¹¹⁸

(Image 2.88)



Image 2.88: The aerial photo of the Beichuan earthquake memorial gives you an idea of the crack landscape, 2013.

Restoring on the Attitude towards Nature

"East-West/West-East", Qatar and "Te Tuhirangi Contour", New Zealand

Sculptor placed works in the nature, such as sculptor, The sculptor Richard Serra (born November 2, 1939) is an American minimalist sculptor and video artist known for working with large-scale assemblies of sheet metal. Serra was involved in the Process Art Movement. His two famous landworks "East-West/West-East," and "Te Tuhirangi Contour" reflect his artistic interventions on the land for how to understand nature and respect nature. This breathtaking sculpture "East-West/West-East" in the Brouq nature reserve spans over a kilometer and comprises four steel plates, each over fourteen meters in height. To guarantee perfect alignment, Serra examined the topography of the land and beautifully enhanced the vast, desolate space in the heart of the desert. The result is spectacular and although modern, timeless.¹¹⁹ East-West/ West-East is a sculpture composed by four major steel structures, more than fourteen meters high each, forming a straight line through the desert, exceeding one km, which is completely according to the land topography.

Richard Serra succeeded in raising the public art to another dimension, shaped and interpreted the desert landscape, in a contemporary view but at the same time in a timeless way, trying to reach the land art. (Image 2.89)

¹¹⁸Crack memorial park. . (Dec 23, 2015). Retrieved April 22, 2016 from Mafengwo: <http://www.mafengwo.cn/travel-news/177112.html>

¹¹⁹EAST-WEST / WEST-EAST BY RICHARD SERRA. (Dec 9, 2015). Retrieved April 22, 2016 from Qatar Museum: <http://www.qm.org.qa/en/project/east-west-west-east-richard-serra>



Image 2.89: This aerial photo of the aerial photo of the sculpture "East-West/West-East" gives you an idea of the scale among the nature, land and human, Nelson Garrido, 2015.

"Te Tuhirangi Contour"'s 56 steel plates lean out by 11 degrees from the vertical and trace a single contour line across the land in a way that, in the artist's words, "collects the volume of the land." The work is a hallmark of the strong relationships formed between collector and artist. Serra says of meeting Gibbs, "The first thing he said to me was 'I've just been to Storm King and I want a more significant piece than that. I don't want any wimpy piece in the landscape.'" (Image 2.90)



Image 2.90: Te Tuhirangi Contour lives with the mountain and animal together in the nature, Richard Serra, 1999.

2.5 conclusion

The cases discussed above give the following information about fragmented landscape structures and their restoration status:

1) We find that following restoration, similar types of fragmentation can achieve different conditions, or statuses. These include the restoration of fragmented areas back to their original natural status, or to a new modified status, or others with no restoration but just new status as works of art. These different statuses lead to the discovery of further potential for restoration. The question is which status is the most suitable for each different site? We need to monitor restored sites and make an assessment of the un-restored areas. As a result, rules may appear through experience, or even failure from which to learn for future restoration projects. In the next chapter, the restoration project for the Garraf landfill site is monitored, and an assessment is made of the un-restored Lhasa landfill using visual environmental technology.

2) The New Jersey Department of Environmental Protection project, funded by the American Recovery and Reinvestment Act, restored 42 acres of wetland, stream and salt marsh habitat to the Hackensack River in northeast New Jersey, providing new habitats for several species of birds and fish and providing coastline support against climate change. The tidal marsh, which was originally designed to offset damage from a 1990 oil spill in the Arthur Kill channel, has been incorporated into the 270-acre Lincoln Park in Jersey City and includes walking trails and recreational space. So in this chapter, the restoration projects of the Chambers Bay, the Flambeau Mine, the Gulf oil spill, the Napa Sonoma Marsh, the Bandon marsh, the Lincoln Park are not only the separate structure restoration, Indeed, these restorations form a restoration system, link the patch, corridor and matrix together to restore the ecological connectivity. (Image 2.92)

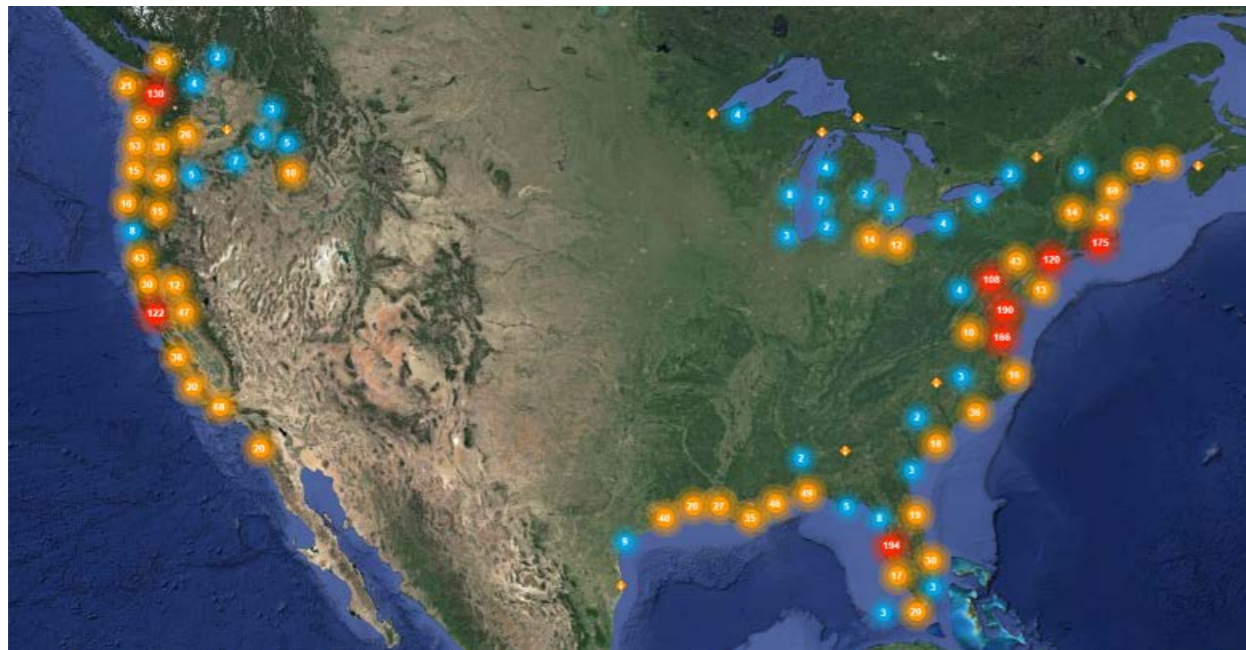


Image 2.92: The habitat restoration project in American, Noaa, 2016.

3) The wildlife corridor restoration reflect the restoration system. Wildlife crossing structures present a timely opportunity to communicate both the problems and the solution to the general public. By making these structures visible, people can experience first-hand—and identify with—engineered landscape designs that create safer roads. At the same time, wildlife crossing solutions have the dual benefit of improving motorist safety and protecting wildlife populations. Eventually, with many crossing structures in place, we can begin to reconnect our landscapes and ultimately restore the important functions of wild ecosystems. However, there are two facts, that the shortest human made corridor is not always the best corridor and climate change heavily. “The shortest path is not always the best path,” said researcher Sadie Ryan, an ecologist at the State University of New York in Syracuse. “Connectivity is not always just a straight line of greenway that you can identify from an airplane.” This kind human made wild corridor couldn't really realise the ecosystem true connectivity, which just avoids to the high line threaten, not focus on the animal real migration ecosystem. “Landscape connectivity is as diverse as the animals that live in it,” said lead author Deborah Rudnick, an environmental scientist with Integral Consulting Inc, in Seattle, WA. On the ground, managers need to address the biology of their focal species, understanding behavior, genetics, adaptation, and habitat. They have to scale up observational and experimental data to predict interactions with other wildlife and physical features of the landscape, layering on the possibility of climate changing, waterways shifting, and human life encroaching. Connections can be conduits, or more complex extensions of habitat, looking more like a web than a greenbelt. The need to move is most obvious for migratory animals and the large animals that need big tracts of territory. Most of us are aware of large and charismatic animals like deer, bear, or coyotes. But plants, and smaller, less itinerant animals, also benefit from connections to wider spaces.

Climate change has made build or restore the ecosystem connectivity more difficult. Climate change, and wildlife’s response to climate change, is not a linear process. We can’t expect all species simply to move to colder climes, nor expect ecological communities to move as complete units, said Ryan and Rudnick. Species have independent capacities to adapt and move, decoupled from the ecological relationships of predator to prey, pollinator to flower, or grazer to ground cover.¹²⁰

Such as only 40km far from the over pass corridor in Banff National Park, the Louise Glacier recession is happening, which mentioned in the fragmented of matrix in nature area part of chapter one. The mornitoring on the change of animal migration route and environment caused by the climate is more science and suitable for the ecosystem, which could bring big help on the corridor restoration. Moreover, in the next chapter, the environmental assessment must be comprehensive and systematical, not only a simply separate structure analysis.

¹²⁰Lester. L. (Octorb 19, 2012). The latest installment in ESA’s Issues in Ecology series takes on models and methods for reconnecting wildlife habitat in restoration and conservation planning and management. Retrieved April 22, 2016 from Esa: <http://www.esa.org/esablog/research/landscape-connectivity-corridors-and-more-in-issues-in-ecology-16/>

4) The Chambers Bay mine restoration scheme has used a large amount of water, chemicals and herbicides on this Golf area. The restoration of the Gulf oil spill applied chemical dispersants which then entered the food chain and potentially harmed wildlife. After the Bandon Marsh was restored, this site still failed to have adequate flood defences. Possibly the restoration project came too late, but equally, many other urgent projects such as this lack adequate scientific guidance. However, no matter how hard we try to fix them in place, landscapes never stop evolving, which means we need pay greater attention to monitoring over the long term. Therefore, to begin with, assessment is more significant than restoration. In Chapter 3, the assessment of Garraf landfill site covers a 20 year period of restoration.

Many geo-engineerings flip the wager and attempts to alter the very trajectories of climate change at a global scale. In this category, we have carbon markets and forestry protocols, as well as more radical techniques such as dumping vast quantities of iron or lime into the ocean to increase marine photosynthesis. Carbon sequestration is landscape migration on the most abstract, deliberate, and grandest scale — a global return migration of elemental material. Other geo-engineering schemes, such as solar radiation management techniques, like cloud whitening or stratospheric aerosol spraying, seek to minimize symptoms of global warming rather than address its root causes. Ironically, We could find more serious fragmentation is going on around restoration sites. Such as the avalanche happened besides the Svalbard Global Seed Vault. (image 2.93) The melting Lewis Glacier is in the Banff National Park, where has built the wildlife crossings for wild migration corridor restoration.(image 2.94) America government is still restoring and dredging for the big Mississippi river flood, however, at the same time, oil spilling disaster happened in the Mexico bay, which is at the estuary of Mississippi river. One of the many deadly tornadoes that struck the U.S. Southeast in late April 2011 was the Cordova tornado that cut a southwest-northeast track through Alabama. Lasting longer than two hours, the tornado formed on the afternoon of April 27, 2011. It left a path of damage 123 miles (198 kilometers) long and 0.75 miles (1.2 kilometers) wide in places, the U.S. National Weather Service reported. Gas wells dot the mostly green landscape, but the tornado track is a long gash of brown. The Cordova tornado apparently stripped away vegetation.¹²¹ (Image 2.96) The blankets, he told AFP during interviews in August, reduce the ice melt by as much as 70 per cent, explaining why the covered cave towers far above the nearby centre of the glacier tongue, which slopes lazily into a pine-green lake. they are a very temporary fix. "It has been heartbreaking to see the glacier shrink, and today it is really painful to see it covered in blankets, to see this vain battle to save a dying mountain," he told AFP.¹²²(Image 2.97) Tecumseh Abandoned Mine Land Reclamation Project get the Engineering Excellence Grand Project Award, This very complex project included reclamation of extensive areas of toxic coal mine refuse, a large impoundment of extremely acidic water, and a continuous discharge of acid mine drainage (AMD) consisting of highly concentrated sulfuric acid from the large area of coal refuse. This drainage discharged directly into Barren Fork

¹²¹Tornado Damage near Berry, Alabama. (May 13, 2011). Retrieved April 22, 2016 from Nasa: <http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=50594>

¹²²Blankets cover Switzerland's Rhone Glacier in vain effort to slow the melting of ice. (Dec 12, 2010). Retrieved April 22, 2016 from Straitstimes: <http://www.straitstimes.com/world/europe/blankets-cover-switzerlands-rhone-glacier-in-vain-effort-to-slow-the-melting-of-ice>

Creek resulting in fish kills for miles downstream for many years. Reclamation included installation of a large anoxic limestone drain system and development of a huge wetland.¹²³ (Image 2.98)However, everyone could easily find this restoration is fooling for everyone. The mine company has been exploiting much lager area since 2012. (Image 2.98) All these ironic events seem to show that humankind has not had enough time to face disaster. A highly efficient environmental assessment platform is urgently needed, which leads to the conclusion that it is essential to build this visual platform to defend the environment from terrible disasters of both human and natural origins. In Chapter 3, an environmental assessment is conducted for the un-restored Lhasa landfill site.

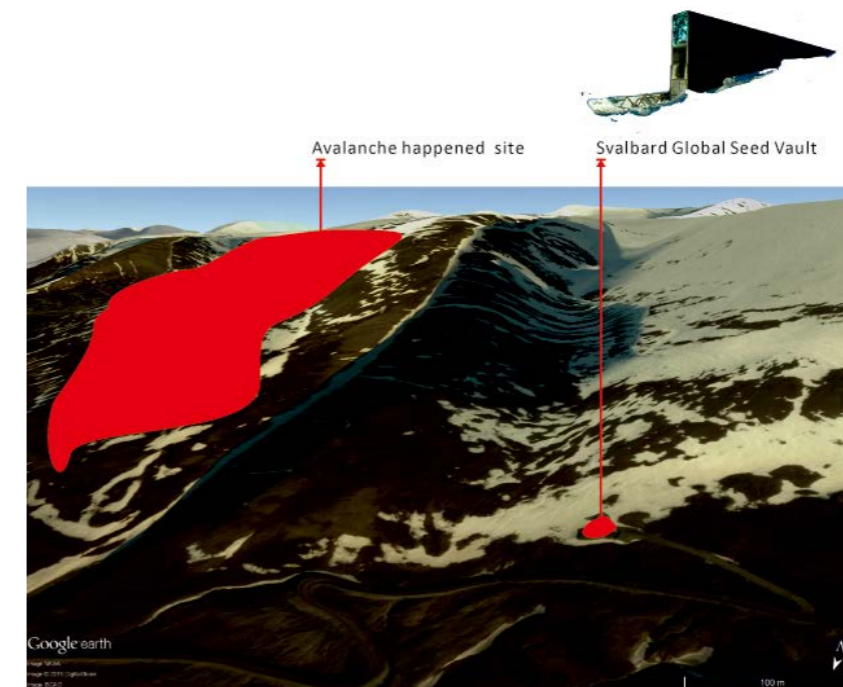


Image 2. 93:

The avalanche happened besides the Svalbard Global Seed Vault, 2015.



image 2.94:

The melting Lewis Glacier is in the Banff National Park, where has built the wildlife crossings for wild migration corridor restoration.

¹²³TECUMSEH ABANDONED MINE LAND RECLAMATION PROJECT. (April 2, 2010). Retrieved April 22, 2016 from Gov: <http://www.in.gov/dnr/reclamation/3507.htm>

**Chapter 3. Weaving the platform of visualization for
assessing the frag-mented landscape structure restoration**

3. Weaving the platform of visualization for assessing the frag-mented landscape structure restoration

In chapter 2, we know that, the process of landscape restoration in highly polluted areas is influenced by complex interactions between hydrology, vegetation and surface temperature; these are interconnected through the comprehensive medium of the landscape structure which is made up of patches, corridors and matrices. In this study, we research the landscape structure using an environmental monitoring model, configured with high real-time visualization, to assess the process of controlling pollution and surface soil restoration in the fragmented site. Using a unique visual environmental impact assessment platform, we evaluate a simulation from July 1999 to July 2014, and conclude that, at 5m X 5m resolution from the Unmanned Aerial Vehicle (UAV), and 30 m X 30 m resolution from the Landsat satellite (combining GIS, ENVI, Rhino and Grasshopper software), the model captures the main features of observed surface temperature, vegetation and the hydrology variation in the landfill site. The finer visual representation of the complex surface temperature, vegetation variables and explicit hydrology simulation at different resolutions, significantly improves the efficient and comprehensive assessment of the landfill restoration process, in particular in the visualization analysis of the structure of the damaged landscape eco-system. The change in the structure of this fragmented landscape eco-system during the restoration process is noteworthy; the growth of the vegetation patch and the trend of the surface temperature matrix for each succeeding year are included in the new hydrology corridor.

Weaving means the accurate and comprehensive analysis of the fragmented landscape structure. We can apply a flowchart to explain this process of weaving the fragmented landscape structure, in order to make a visualization of the environmental impact assessment (Image 3.2).

3.1 Area study to ensure the observational environmental index

First, I will refer to the Barcelona Garraf landfill project to explain the visual environmental impact assessment platform. We start by considering what kind of environmental index can mainly reflect the fragmented patch, corridor and matrix in the Barcelona Garraf landfill. Garraf landfill slopes from a height of 500 m to a base of 200m high, and is located on the northeast coast of the Iberian Peninsula, facing the Mediterranean 3 kilometers away and 10 kilometers from the Barcelona megalopolis and the Llobregat river. Garraf landfill has a Mediterranean climate, with mild, humid winters and warm, dry summers and annual moderate rainfall of 640mm (Image 3.3). All the fundamental

geographic information shows that the terrain "drops". As the rain falls into this area, it causes leachate spill, forming a fragmented pollution corridor.

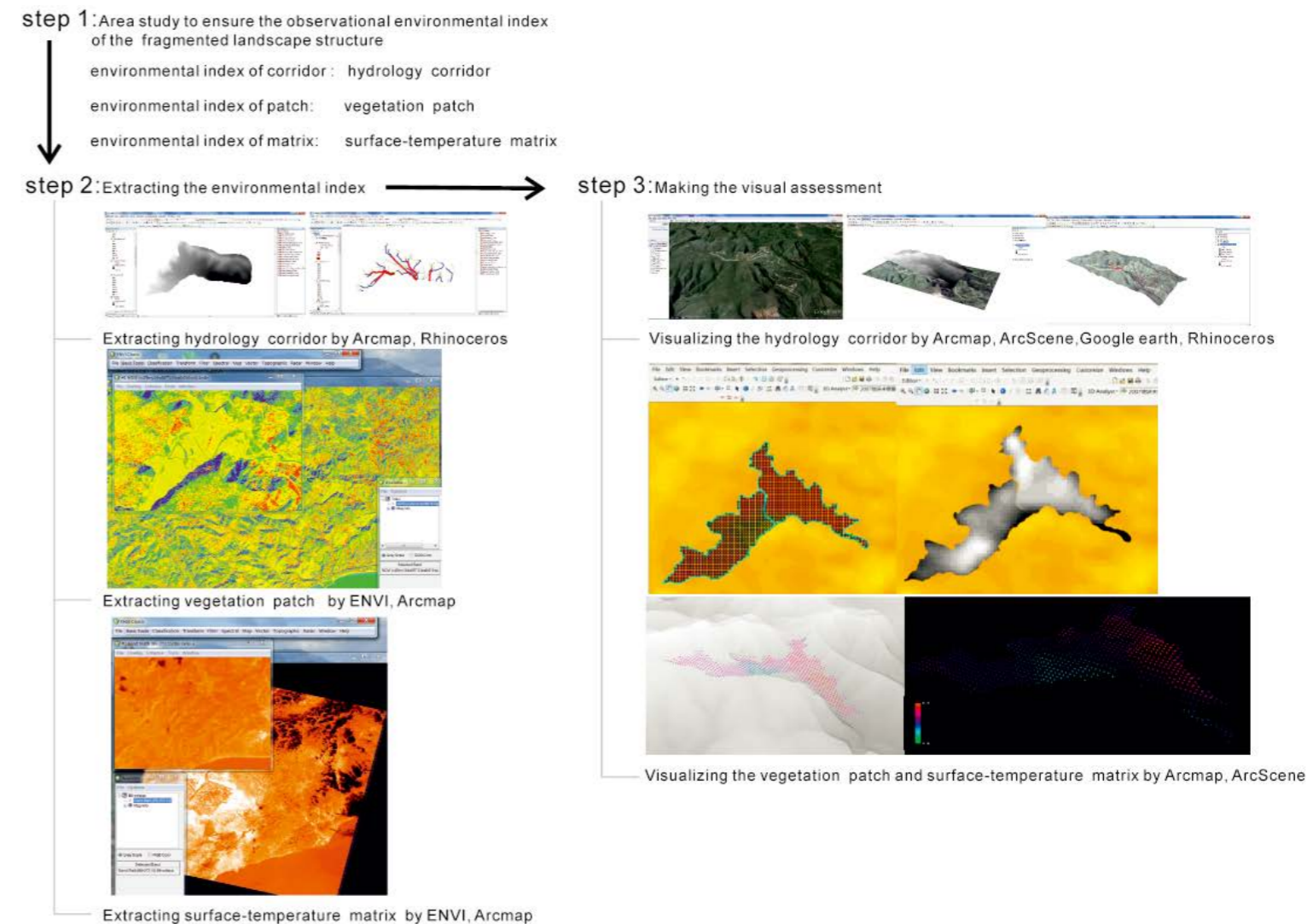


Image 3.2: The process of the visualization environmental impact assessment

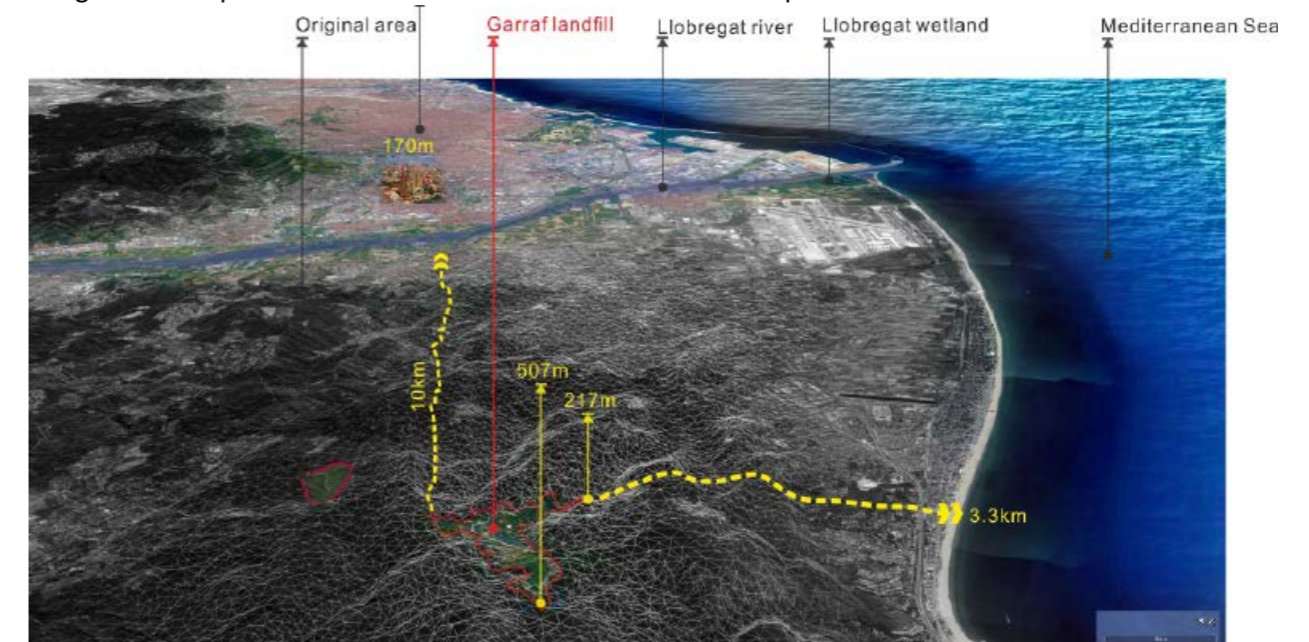


Image 3.3: The fundamental geographic informations around Garraf landfill, Liyuan Qian, 2016.

In 1972, Barcelona City Council published a public call for tenders for the management of a new controlled landfill site located in the Garraf massif. The groundwork started at the end of 1973. The Garraf controlled landfill site was officially inaugurated, and the first waste was deposited in 1974 and the recovery plants came into service. The volume accumulated during the thirty two years of life of the garraf controlled landfill site is 26,676,000 tonnes from 1974 to 2006. In some parts of the valley, the elevation of the deposited waste has reached 80 meters depth in the central area. The year during which the most waste was dumped was 1992.

From 2000 to 2006, work started on restoring eco-park 1,2,3. On 31 December 2006 the Garraf controlled landfill site was completely closed. In 2007, eco-park 4 began to be restored which continues to the present. However, at the same time eco-park 4 was still depositing remaining waste until 2009, when 350,000 tonnes of waste was treated there(Image 3.4, 3.5). There is rubbish 80m deep in Garraf landfill, which has caused heavy erosion and pollution of the soil and vegetation.¹²⁴ However the Garraf landfill has abundant annual sunshine which leads to high surface soil and air temperatures creating fires. The high surface temperature areas formed are in the fragmented matrix and patch. Moreover, this fragmented hydrology corridor, vegetation patch and surface temperature matrix are the main factors which form the fragmented environmental index.

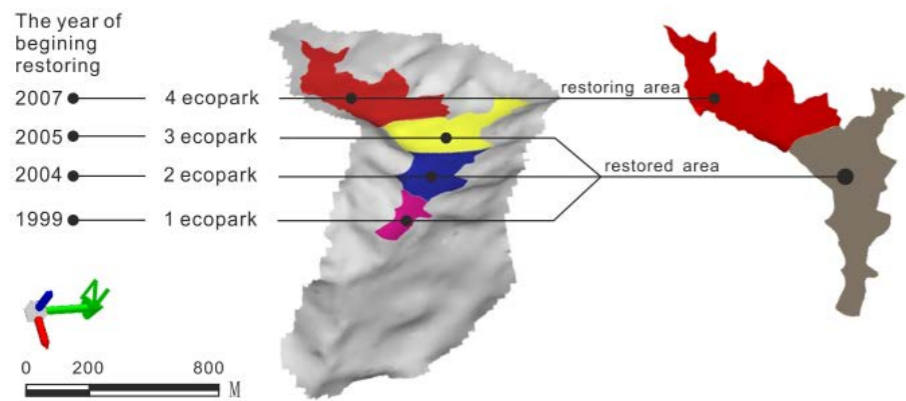


Image 3.4: The distribution of Garraf landfill with the restoration situation



Image 3.5: Fotos of Garraf landfill in 2004, 2008, 2012, 2014

¹²⁴Enric Batlle. (2011). El jardí de la metròpoli. Del paisatge romàntic al espai lliure para una ciutat sostenible. Spain:GG, p.91-93.

3. 2 Extracting and visualizing the environmental index

3.2.1 Extracting and visualizing the fragmented hydrology corridor

The Arcmap software deals with the DEM document to extract the hydrology. (Image 3.6) Then the arcmap geographically corrects the satellite image from google earth.(Image 3.7) The Arcscene imports the satellite image to match the DEM surface 3D modeling. (Image 3.8)Finally, the arc scene imports the hydrology onto the 3D modelincorporating the frag-mented hydrology corridor. (Image 3.9)

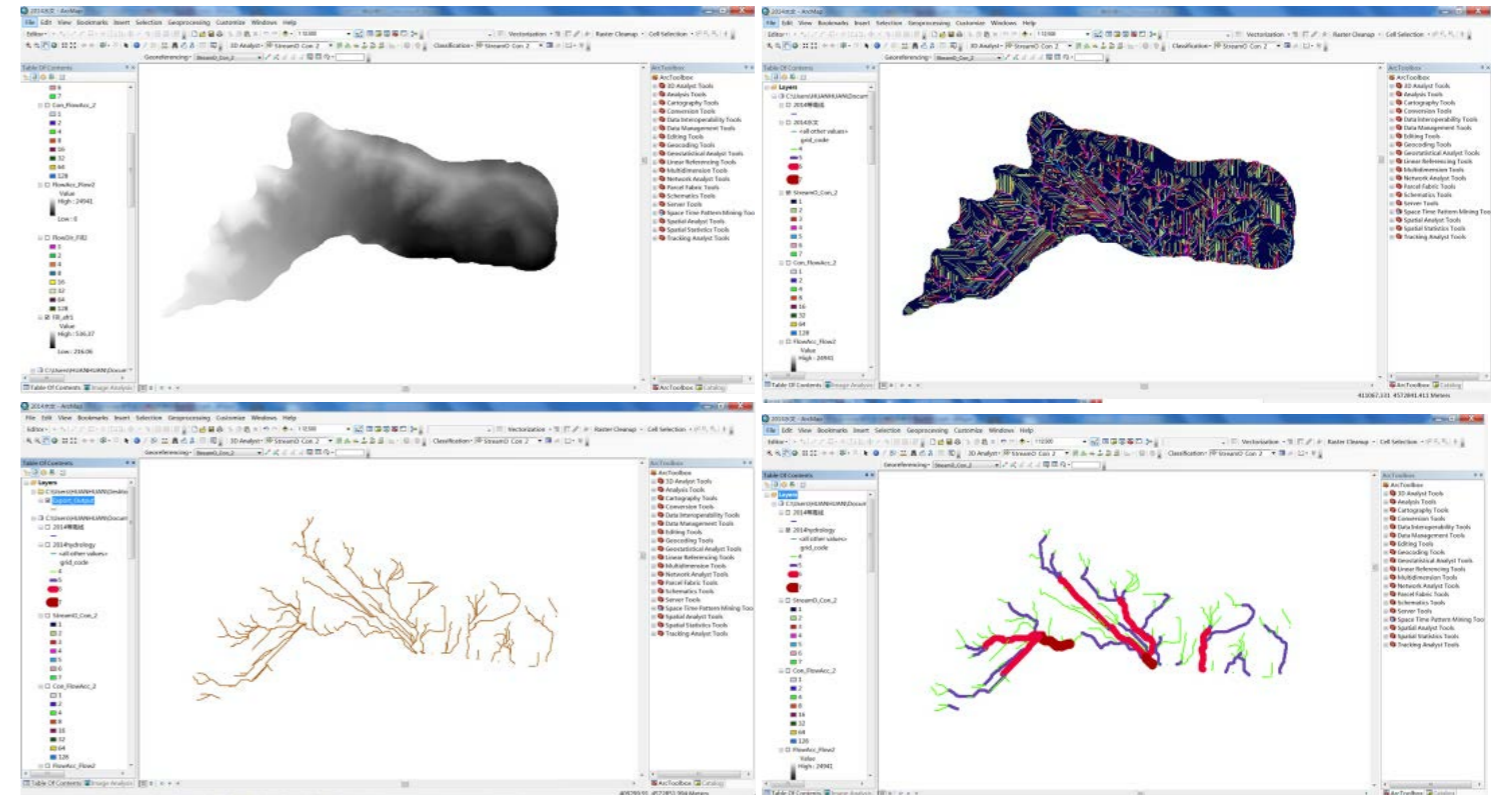


Image 3.6The Arcmap software deals with the DEM document to extract the hydrology.

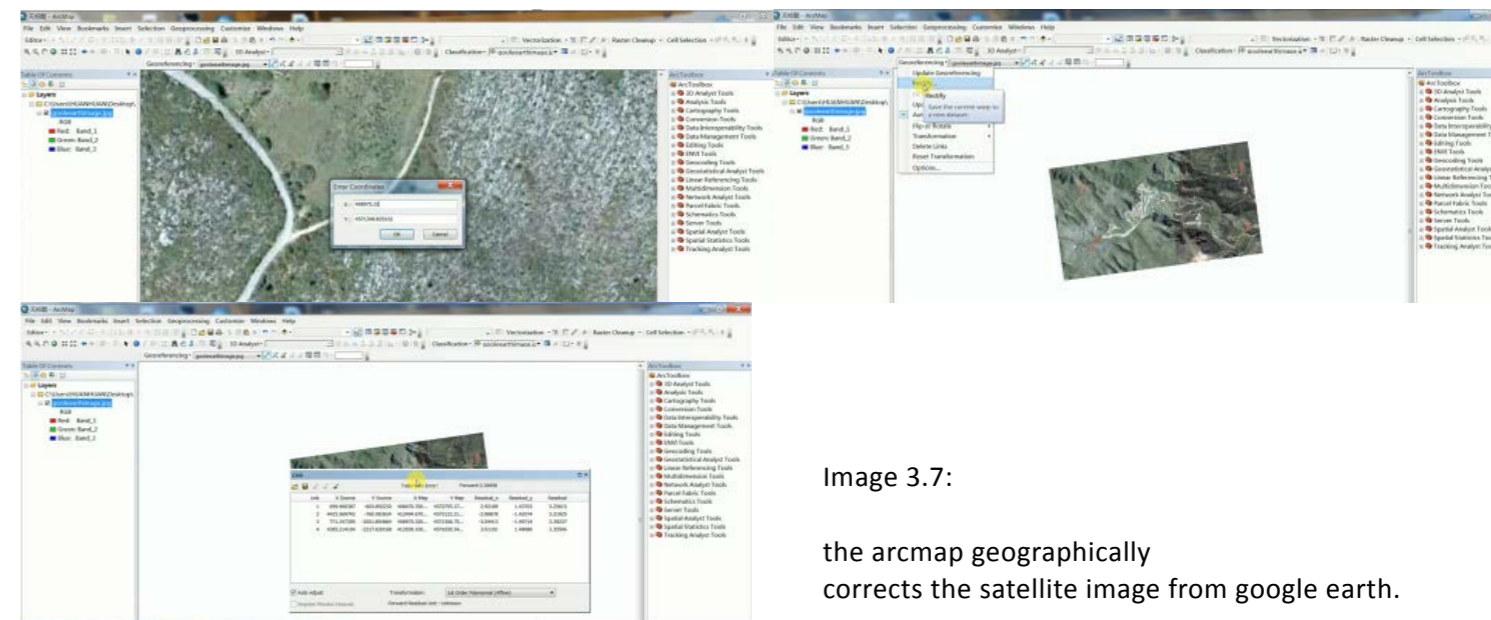


Image 3.7: the arcmap geographically corrects the satellite image from google earth.

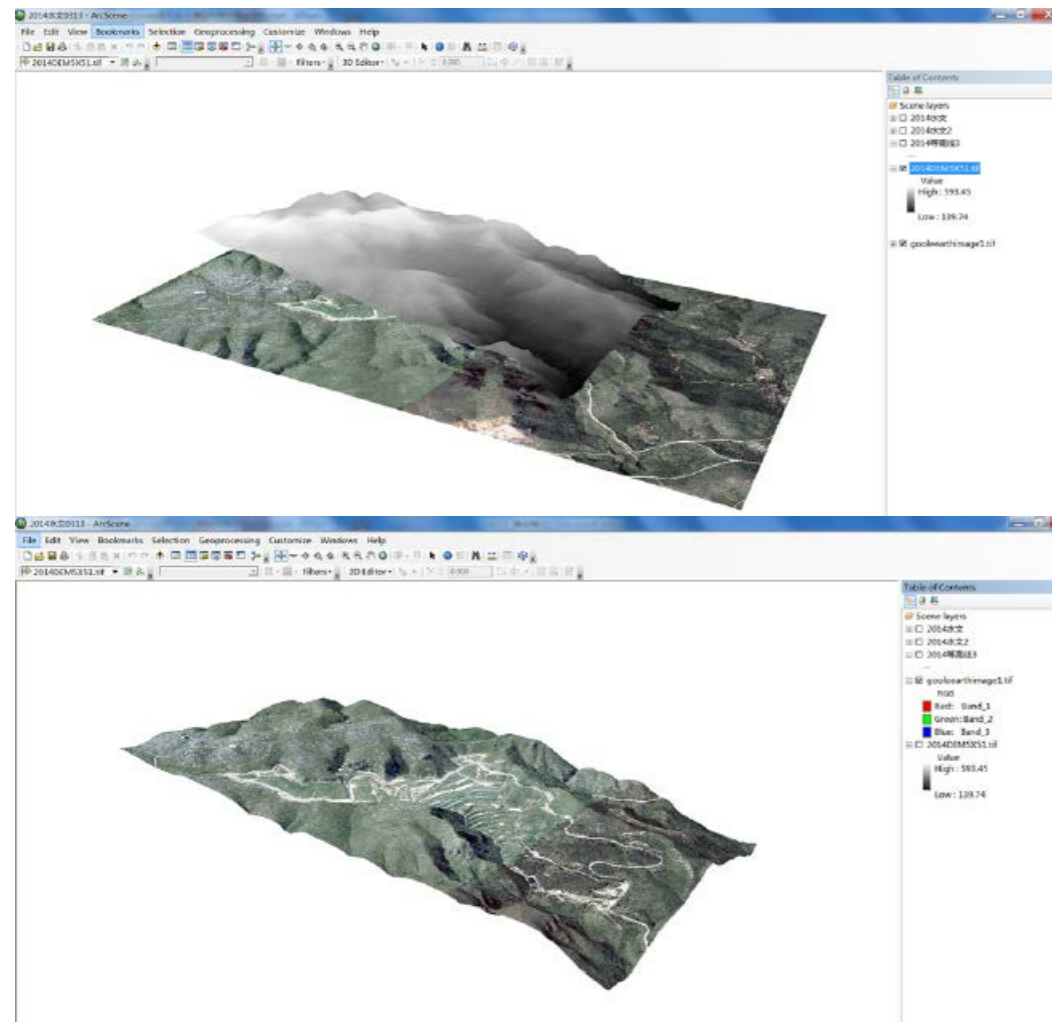


Image 3.8: the satellite image is inserted into the Arcscene to match the DEM 3D topography modeling

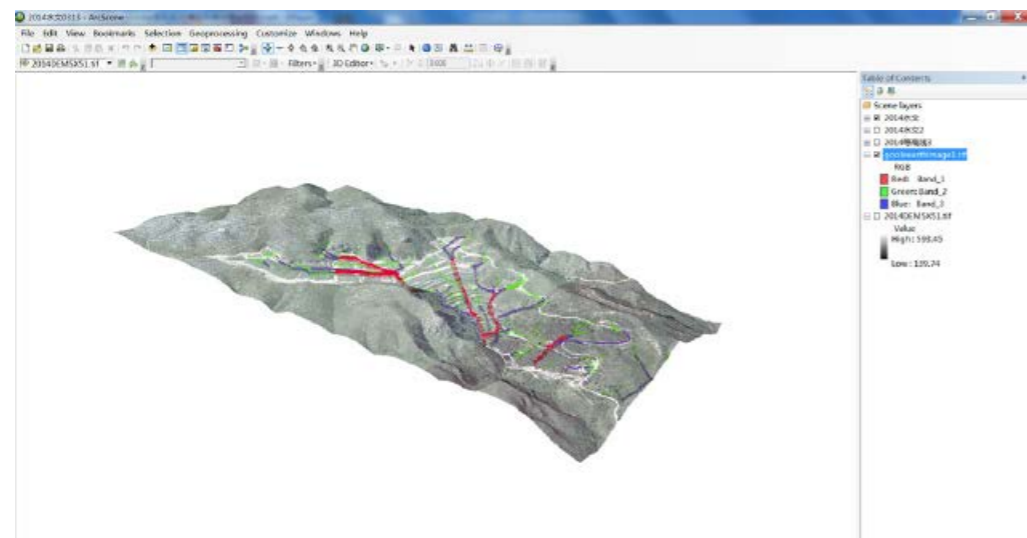


Image 3.9: the arc scene imports the hydrology onto the 3D model incorporating the fragmented hydrology corridor

3.2.2 Extracting and visualizing fragmented surface temperature matrix and fragmented vegetation NDVI patch

While extracting and visualizing the fragmented surface temperature matrix and fragmented vegetation NDVI patch, we faced the difficulty of research site scale and resolution which are too small to visualize. First, we applied the ENVI Arcmap software to deal with the document of 1999 Landsat7 band 6B and 1996 Landsat5 band4 and 3. Finally, we extracted the fragmented surface temperature matrix for 1999 and fragmented vegetation NDVI patch for 1996. Then we applied the Arcmap to transform the low-resolution raster document to the vector document, and then combined ArcScene, ENVI software to successfully extract the visual fragmented landscape structure from these low-resolution raster foundation models of surface temperature and vegetation to make these visualization models. The image shows the process of plotting the fragmented temperature matrix in 1996. (Image 3.10, 3.11)

3.3 Assessment

The environmental assessment step shows how this platform monitors and forecasts each stage of the restoration of the fragmented landscape structure. We continue with the assessment of the Barcelona Garraf landfill to explain this visual environmental impact assessment platform.

3.3.1 Visual fragmented hydrology assessment from 1999 to 2014

After extracting and visualizing the fragmented hydrology corridor of Garraf landfill in the years from 1999 to 2014, we were able to confirm the original fragmented hydrology corridor and the restored hydrology corridor. (Image 3.12)

In 2014, the restoration team built two rainwater storage pools on the two watersheds along the fragmented hydrology corridor at the middle of site, which collect the clean rainwater. The restoration team also built a waterproof discharge canal surrounding the site border, to prevent not only the leachate spilling to surrounding natural area, but also the clear rainwater flowing along the land slope into the polluted area. There is a watershed in the fragmented hydrology corridor at the lowest spot, where team built a big leachate treatment pool to collect the leachate underground water (Image 3.13). We find that these changes avoid most of the leachate spills and rainwater re-pollution, and have successfully contributed to the restoration of the most fragmented part of the hydrology corridor.

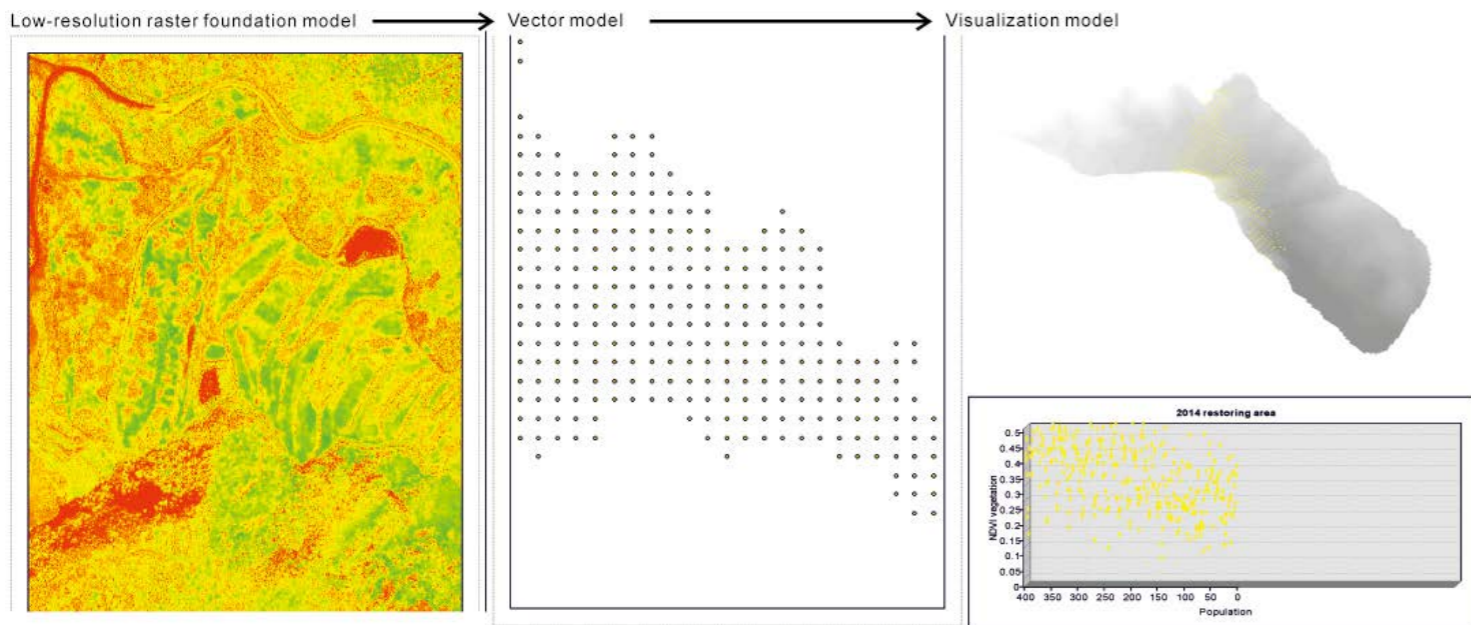


Image 3.10: The process of visualizing the low-resolution raster foundation model

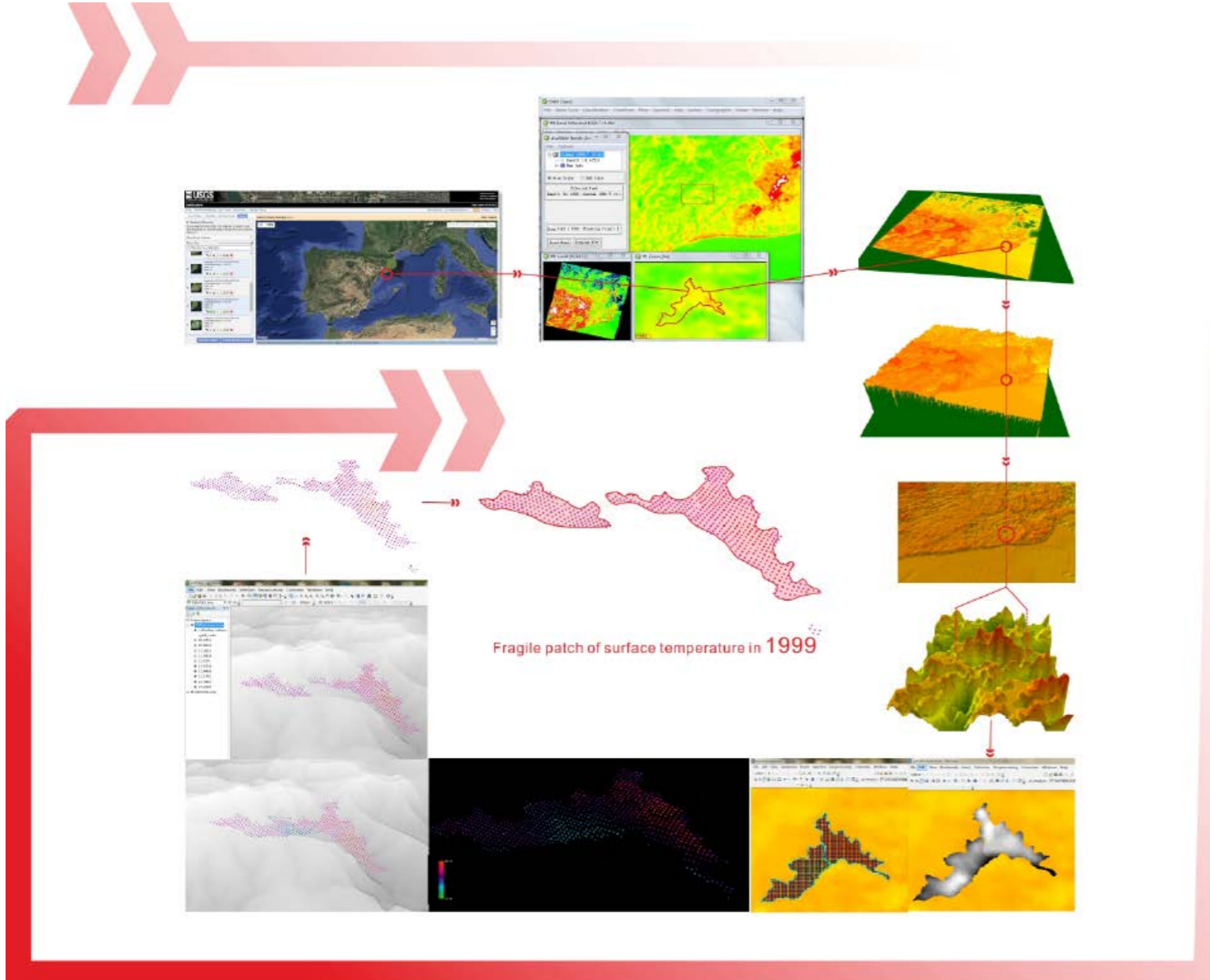


Image 3.11: The process of accurately plotting the fragmented surface temperature matrix in 1999.

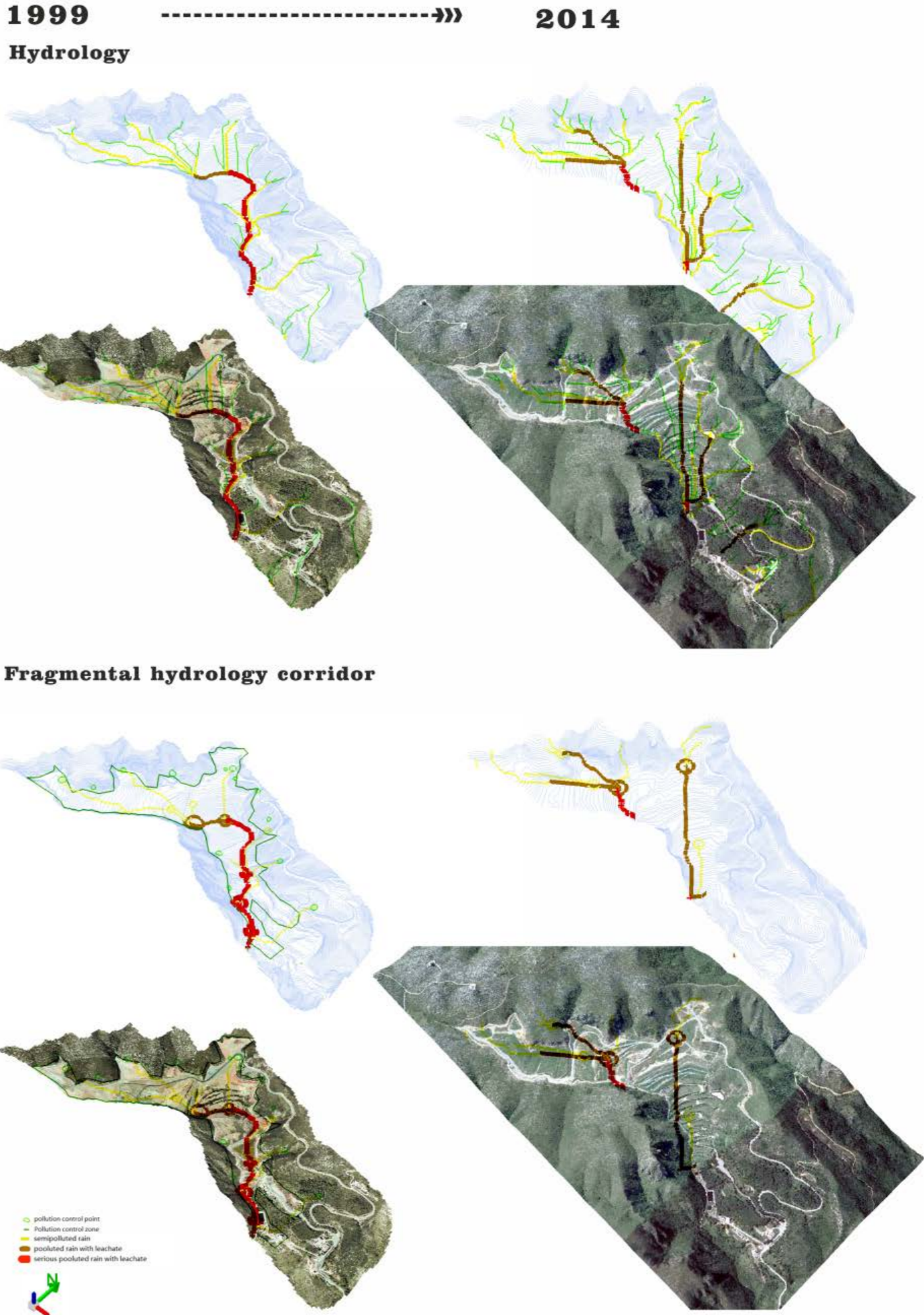
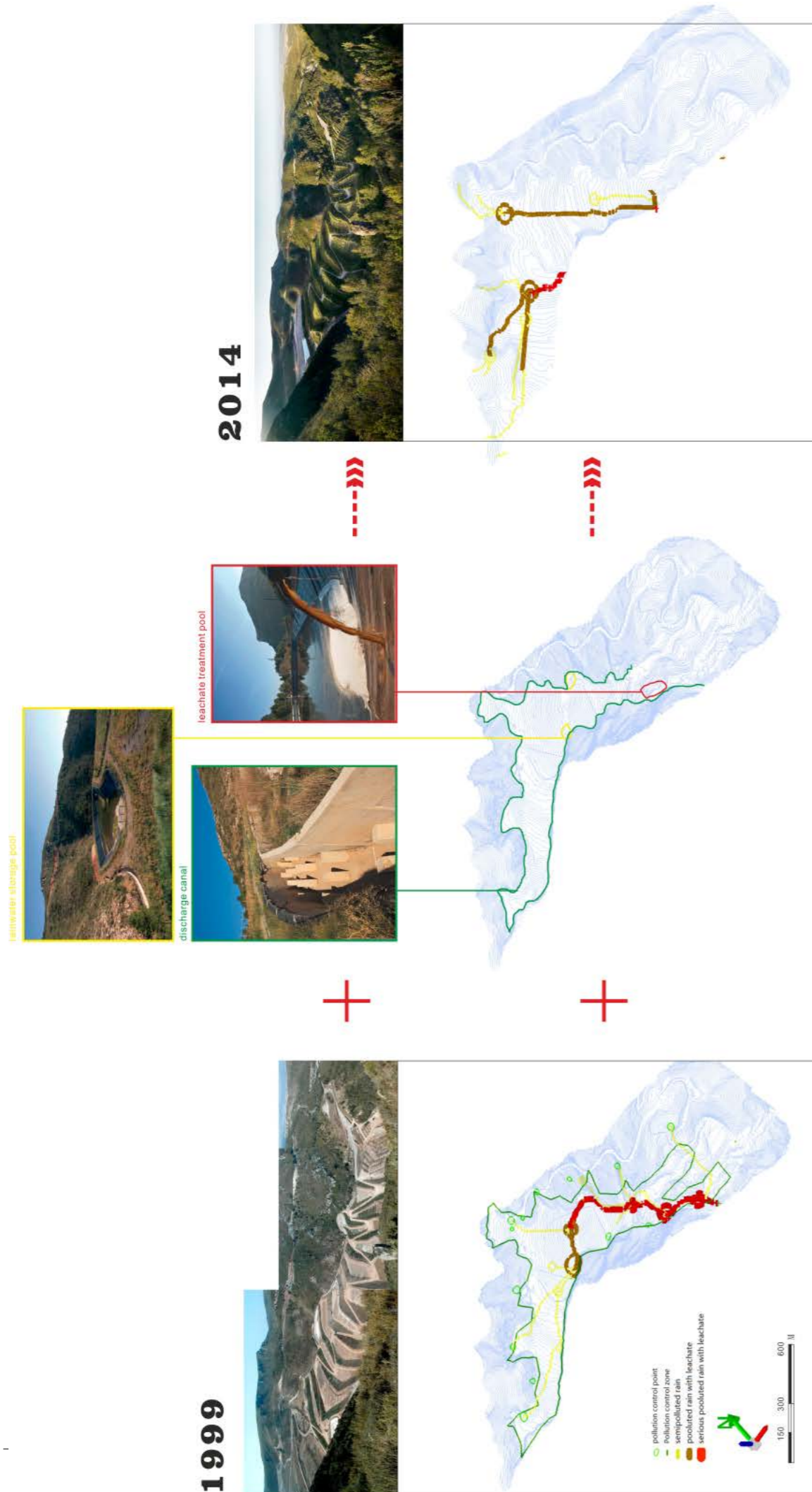


Image 3.12: The process of plotting fragmented hydrology corridor from the hydrology between 1999 and 2014, based on the direction of the rainwater and leachate spill flow

Image 3.13: The process of assessment of the fragmented hydrology corridor of the Garraf landfill from 1999 to 2014, with images of restoration on the fragmented hydrology corridor before 2014, include two rainwater storage pools, a waterproof discharge canal and a leachate treatment pool.



3.3.2 Visual fragmented surface temperature matrix assessment from 1999 to 2014

After measuring and plotting the surface temperature matrix for the Garraf landfill in the years 1999, 2007 and 2014, we could illustrate the original fragmented surface temperature matrix and the restored surface temperature matrix. Comparing the surface temperature matrix modelling in ecoparks 1,2 and 3 with the original natural area beside this landfill for July 1999, 2007 and 2014: the surface temperature of the original natural area (green) is still lower than eco-park1,2 and 3(yellow); however, the temperature difference between these two areas becomes smaller, and the surface temperature of ecoparks1,2 and 3becomes lower than the area eco-park 4 (red) still being restored. The 15 year surface temperature assessment shows the fragmented surface temperature matrix of the restored area eco-parks1to3 get steady restoration, that has no rebound phenomenon. (Image 3.14)

3.3.3 Visual fragmented vegetation patch assessment from 1996 to 2014

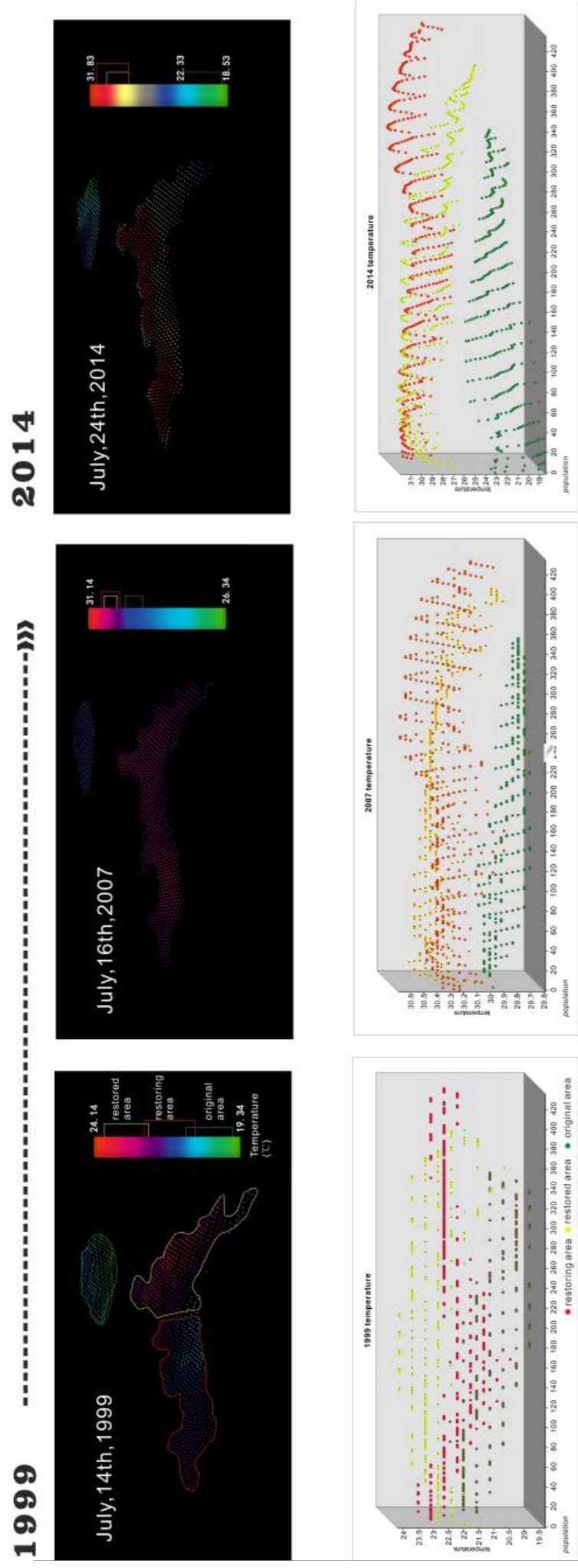
Like the surface temperature assessment, we now compare the vegetation patch modelling in ecoparks 1,2 and 3, with the original natural area for July 1996 and 2014: the vegetation NDVI of the original natural area (green) is still lower than eco-parks1,2 and 3(yellow). However, the vegetation NDVI difference between these two areas obviously become much smaller, and moreover, the vegetation NDVI of almost eco-park1,2 and 3 (yellow) being restored is higher than 0. The vegetation NDVI assessment of this 15 year period shows that the fragmented vegetation patch of the restored area the eco-parks gets the steady and appropriate restoration (Image 3.15).

3.3.4 Weaving the visual fragmented environmental assessment from 1996 to 2014

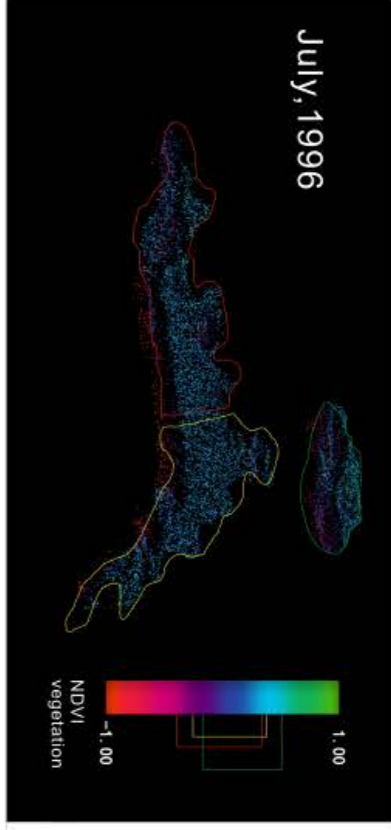
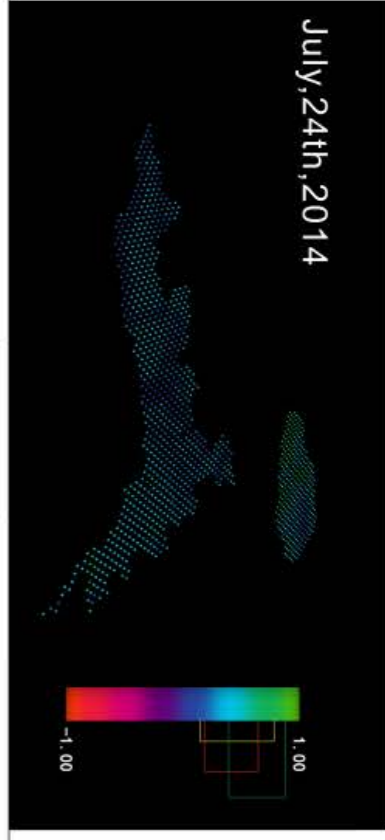
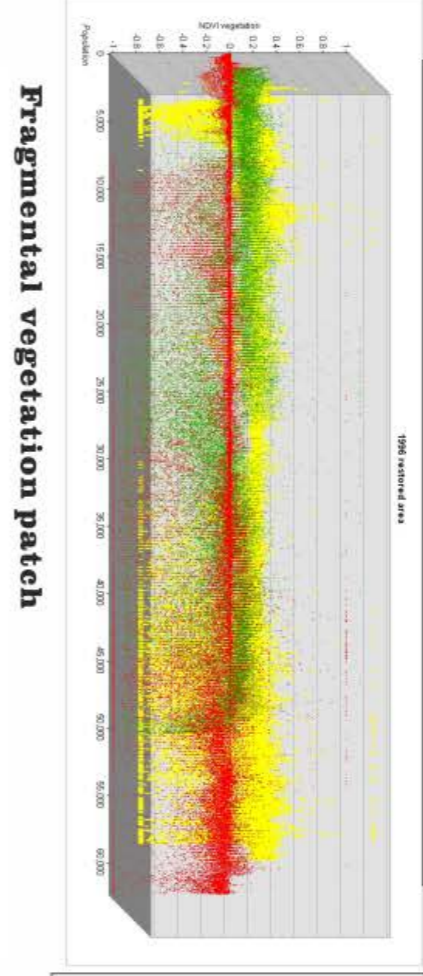
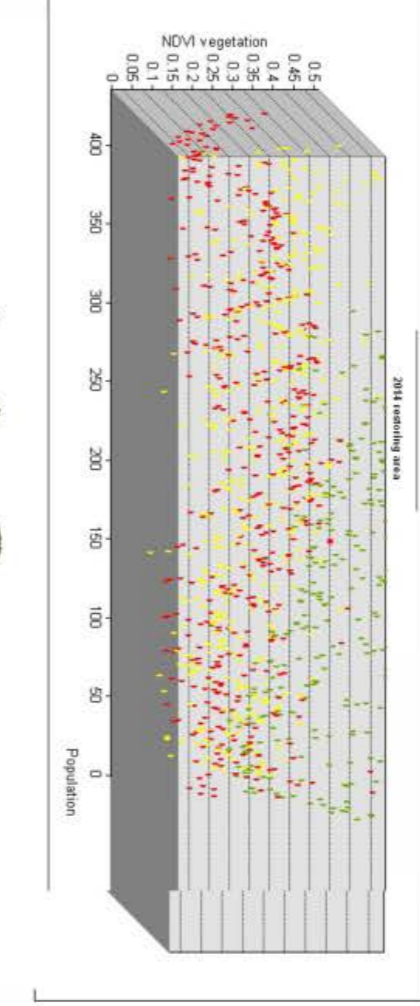
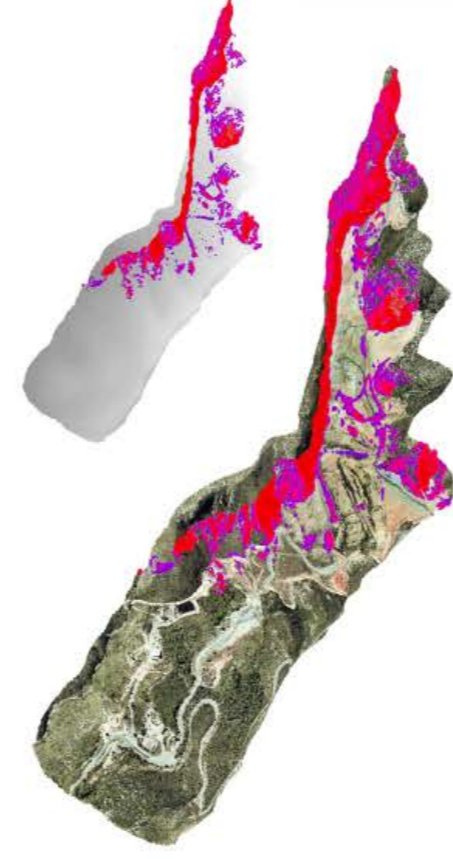
Now if we combine together the fragmented hydrology corridor, the fragmented surface temperature matrix and the fragmented vegetation patch in Garraf , which forms the Garraf landfill fragmented landscape structure, we can directly and scientifically see and measure the comprehensive fragmented environmental situation before restoration in 2000 (Image 3.16).

Throughout the 15 years restoration process of eco-parks 1,2 and 3, , the area of ecopark 4 has been and is still being restored. If we do the environment assessment to ensure whether the fragmented landscape structure of garraf landfill in 2014 has become better, by comparing the changing landscape structure in the restored area of eco-park 1,2 and 3, with the original natural area alongside this landfill, we will discover the restoration effect during these 15 years. (Image 3.17)

Image 3.14: The process of assessing the fragmented temperature matrix of the Garraf landfill from 1999 to 2014, based on the comparison among surface temperature differences of the restored area (yellow line polygon and points), the areas being restored (red line polygon and points), and original natural area (green line polygon and points) for the years 1999, 2007 and 2014.



Fragmental temperature matrix



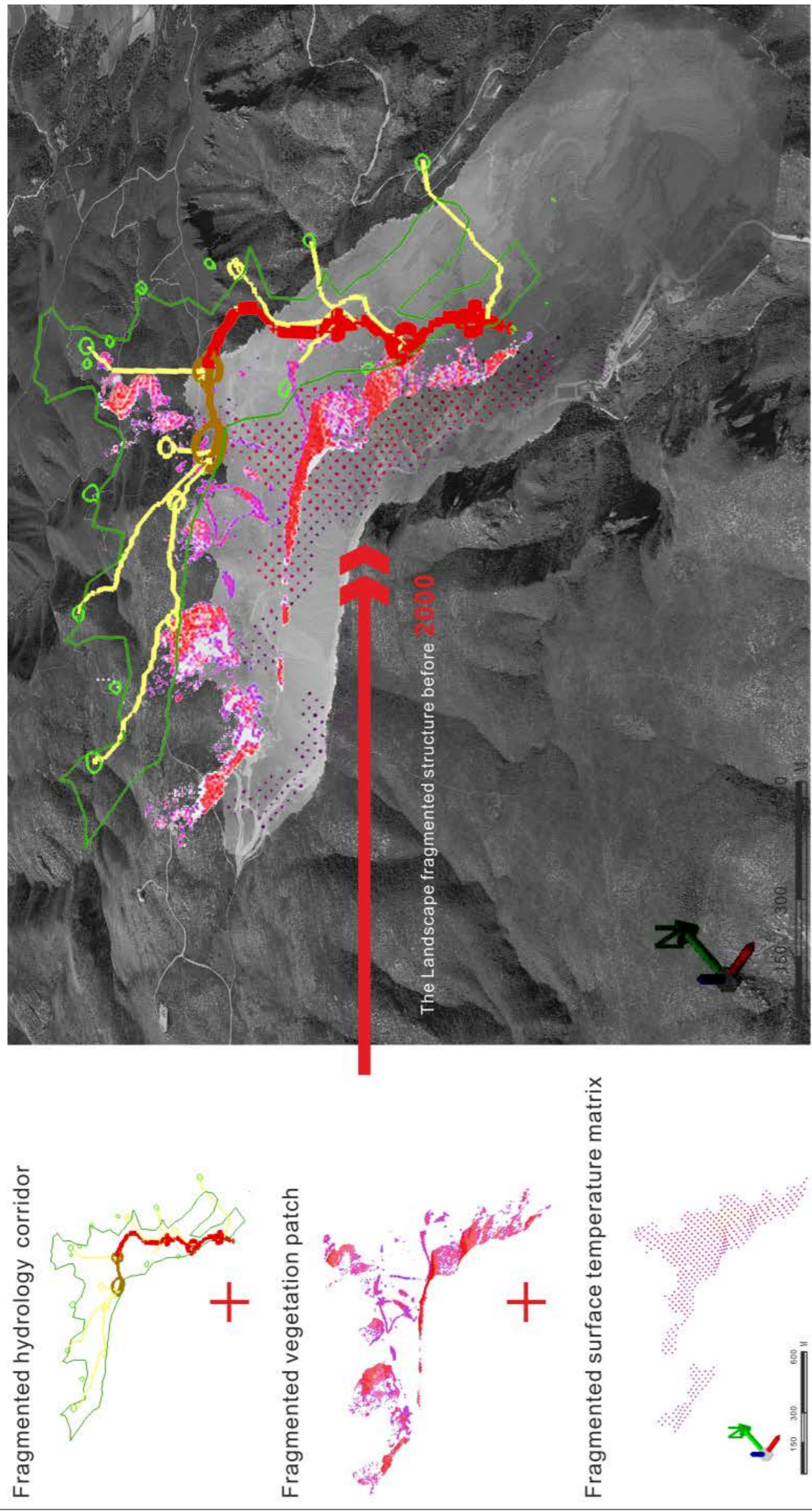
1999

2007

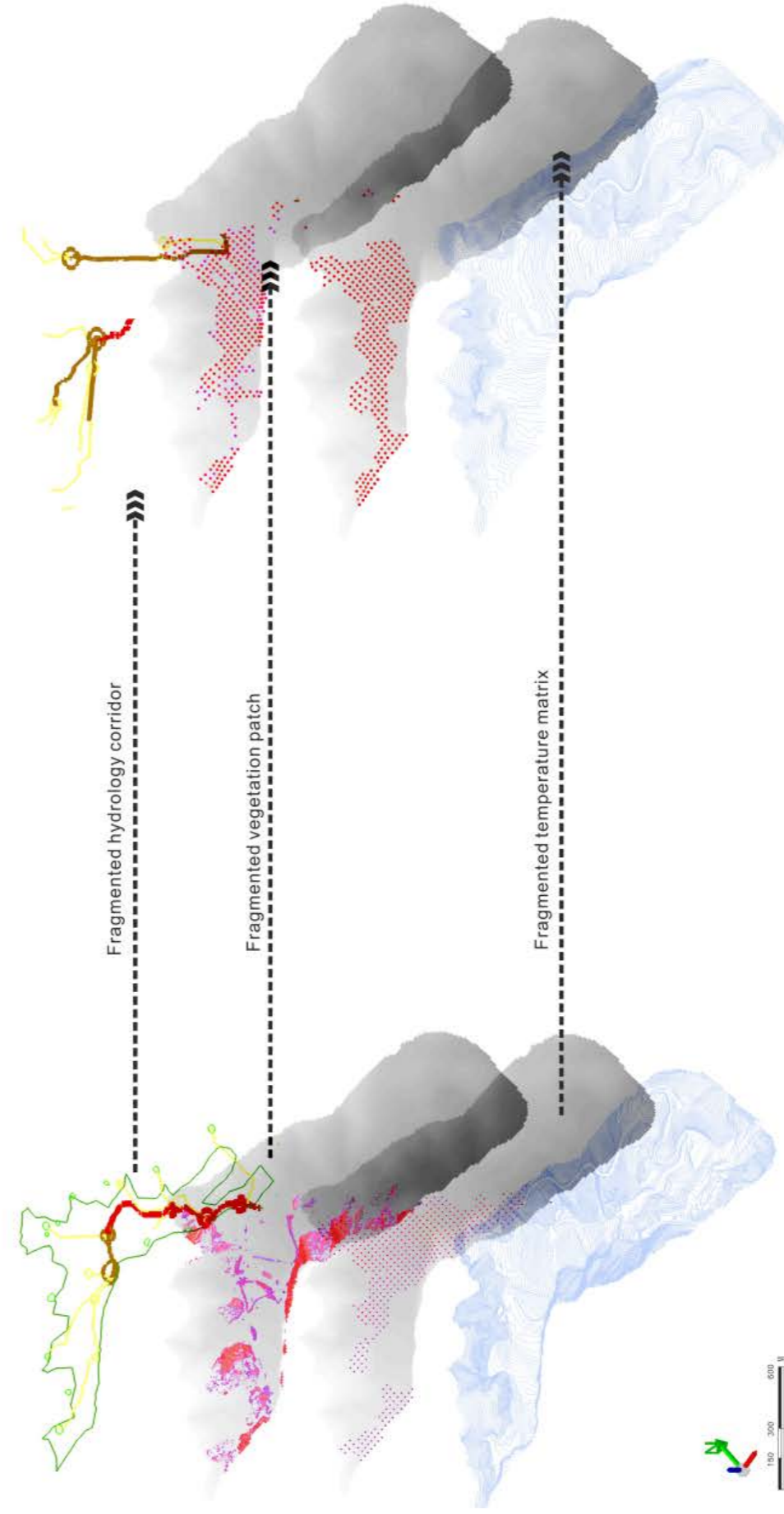
2014

Image 3.15: The process of assessing the fragmented vegetation patch of the Garraf landfill from 1996 to 2014, based on the comparison among vegetation differences of the restored area (yellow line polygon and points), the area being restored (red line polygon and points) and original natural area (green line polygon and points) in 1996 and 2014.

Image 3.16: The Garraf landfill fragmented landscape structure before 2000, combined with the fragmented hydrology corridor, fragmented surface temperature matrix and the fragmented vegetation patch.



15 years environmental assessment for the fragmented landscape structure in Garraf landfill



The Landscape fragmented structure before 2000 **The Landscape fragmented structure in 2014**

Image 3.17: The fragmented landscape structure comparison between 2000 and 2014, including the fragmented hydrology corridor, the fragmented surface temperature matrix and the fragmented vegetation patch.

Through nearly 15 years of restoration, the visual assessment shows the good changing trend of the fragmented hydrology corridor, the fragmented surface temperature matrix and the fragmented vegetation patch in the Garraf landfill. It is well known that restoration is a long process, and furthermore, the current volatile climate increasingly leads the environmental parameters to become more volatile, which requires more types environmental parameters join our assessment. So now we still don't know whether there has been completely successfully restored, we need to not only analysis more types of environmental parameters such as the quality of the underground soil, underground water and air; but also to still monitor the rest, and the new fragmented landscape structure observed in 2014. This new fragmented landscape structure forecasts the future environmental trend that will help the restoration team monitor the environmental restoration process.

3.4 Monitoring the un-restored area--Tibet Lhasa landfill

More fragmented original area is more easily to be damaged, so the fragmented original area is more sensitive to the environmental fragmentation, which will lead the environmental defensive ability become more recognizable, that will bring the help for assess out the most fragmented area and landscape structure. To be precise, the environmental assessment in fragmented original area will help us build the more exact and efficient, even more in line with the ability of the natural self-healing environmental assessment platform. Accordingly, we do the visual environmental impact assessment (EIA) platform for the operating Lhasa landfill, which is located in plateau original area.

3.4.1 Area study to ensure the observational environmental index

Lhasa landfill climate is semi-arid monsoon, with a low average temperature of 1.2 to 7.5 °C, annual rainwater 509mm, snow periods 150 days, annual southeaster, Typically there are 3,000 hours of sunshine each year. The site is located on the south of the Tibet plateau, which was officially inaugurated in 2003, includes two phases. The capacity of first phase is 1,902,800 ton, 172~411t/d, that has been closed in 2015. The capacity of second phase is 9,078,100 ton, 350t/d, which has began into operation in 2015, designed service life of 50 years.

Lhasa landfill is topped 3735 m high, ended 3680m high, terrain forms a slow slope from Northwest to Southeast, 550 meters away from the Niesdang village primary school, 3.4km away from the Lhasa river upstream, 14.2 km away from the Lhasa urban area. Moreover, there is a seasonal river named Nipugou river is located upper reaches of this site, in summer, this river will through there into Lhasa river. The underground water depth 3-6m (Image 3.18).

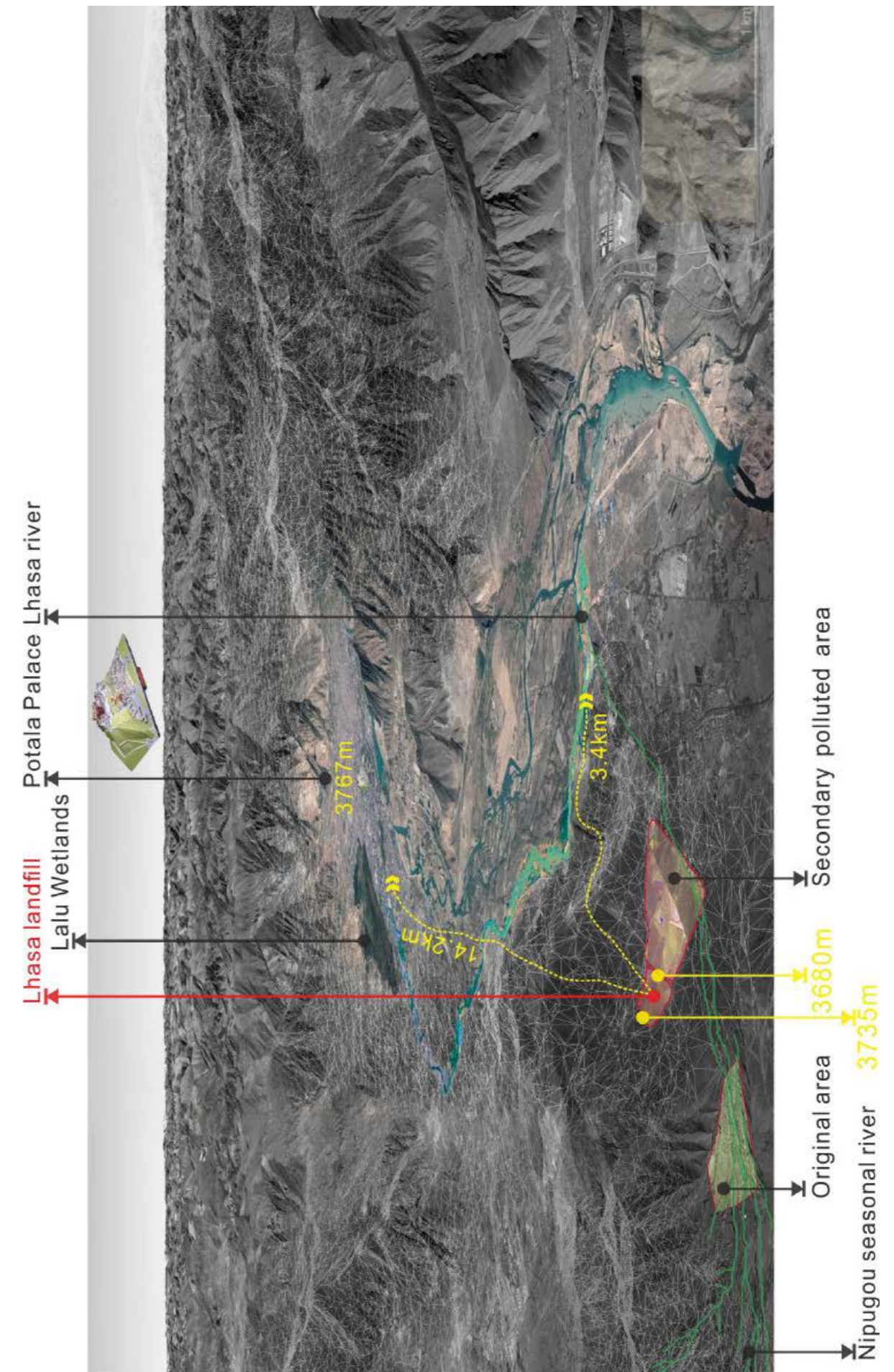


Image 3.18: The fundamental geographic informations around Lhasa landfill

However, on the plateau, because of climate and nature environment is too different with general area, which brings many difficulties to the landfill operation. The cold climate not only couldn't keep the temperature of the Leachate biochemical treatment pool stay around 20-30 °C , but also directly make the conduit blocked, which make 15 ton/day leachate have to spill back to the landfill area, then the underground soil and underground water polluted by the organic waste, heavy metal and virus. Facing the rainstorm and windy day, the fragmented situation will get worsen, that malodorous gas (CH₄, NH₃, H₂S, etc) and leachate will spill to surrounding area and river (Image 3.19).

Moreover, the fragmented hydrology corridor, fragmented surface temperature matrix and fragmented vegetation patch are the main fragmented environmental index. Extracting and visualizing environmental index in Lhasa landfill will apply the same methods as the Garraf landfill.

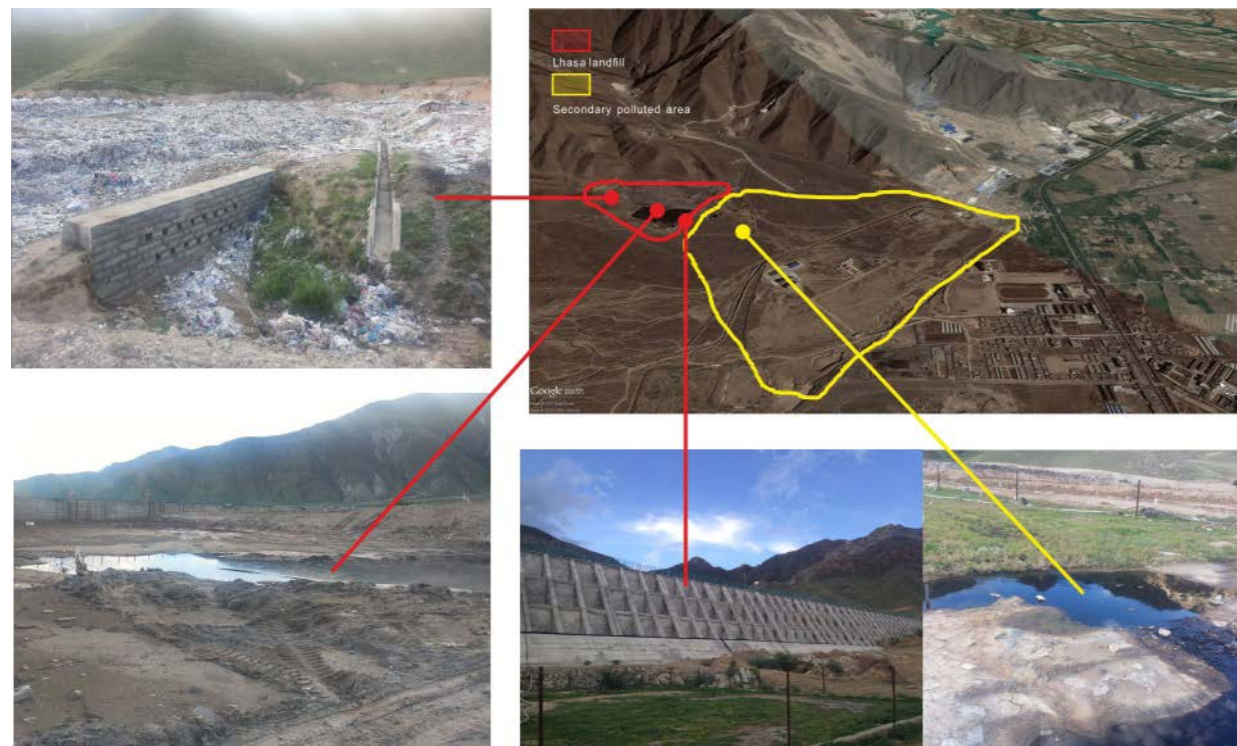


Image 3.19: Fotos of leachate spill in the Lhasa landfill in 2014.

3.4.2 Visual fragmented hydrology assessment in 2014

After exacting and visualizing the fragmented hydrology corridor of Lhasa landfill in the 2014, we could ensure the fragmented hydrology corridor. (Image 3.20). Combining with the worsen situation and the geographic information, we could image that the rain and snow will follow the terrain down to the low land caused leachate spill, which will pollute the seasonal river Nipugou river, Lhasa river and the surrounding area, that the hydrology in Lhasa landfill formed fragmented pollution corridor. Following the fragmented hydrology corridor assessment, the fragmented structure outline and trend almost form, that the worst polluted area is around the fragmented corridor.

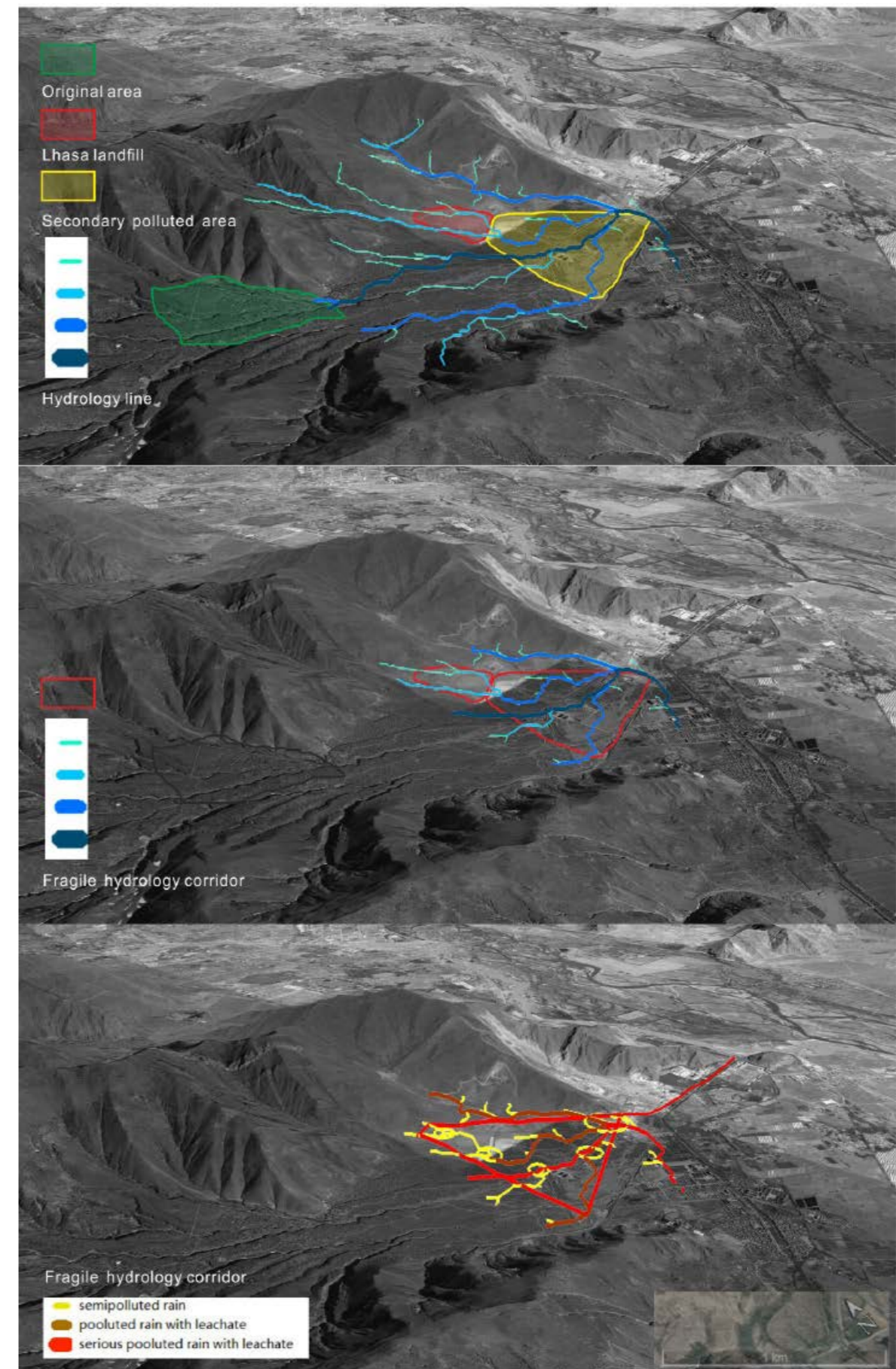


Image 3.20: The process of exacting fragmented hydrology corridor from the hydrology in 2014, based on the rainwater and leachate spill flow direction along the hydrology

3.4.3 Visual fragmented surface temperature matrix and vegetation patch as-sessment from 2001 to 2014

Lhasa landfill has low temperature in winter, so waste will be unfreeze in summer, combined its annual abundant sunshine and wind, which make its annual worst pollution in every summer. The high surface temperature areas formed the fragmented matrix and patch, so we apply the ENVI, Arcmap, ArcScene, Rhino and Grasshopper software to deal with the document of May, 24th, 2014 Landsat8 band 4,5,10. Finally, extracting the fragmented surface temperature matrix and fragmented vegetation NDVI patch in 2014 (Image 3.21). We also will apply the same solution with Barcelona Garraf landfill assessment to deal the difficulties of resolution and visualization.

After extracting the landscape fragmented structure in 2014, we could find the focus of the worst fragmented areas are located in the Lhasa landfill and secondary polluted area. Then we do a more detailed analysis in the worst fragmented areas, that comparing the 2001 environmental situation with 2014. In 2001, there was no Lhasa landfill in the red line polygon, its surface temperature and vegetation index very closed to the original area (green line polygon), moreover, the surface temperature and vegetation index in yellow line polygon were lower than red line polygon. However, after Lhasa landfill built in 2003 till 2014, there happened big change, not only the Lhasa landfill makes the red polygon area stay in the much higher temperature and less vegetation than original area (green line polygon), but also the more terrible pollution influences on the secondary polluted area (yellow line polygon), its environmental situation is worse than Lhasa landfill area (red line polygon) (Image 3. 22). All these assessment on the fragmented landscape structure could help us foresee the future fragmented trend, that the Lhasa landfill will bring the worse pollution to broader surrounding area.

3.4.4 Weaving the visual fragmented environmental assessment in 2014

The plateau case analysis let us realize the surrounding areas could be worse than the source of fragmentation, even in the more fragmented original area will be more easily and quickly polluted, because of its single ecological chain. So the defense is so necessary for Lhasa landfill and its surrounding area. And therefore, we combine the fragmented hydrology corridor, fragmented surface temperature matrix and fragmented vegetation patch in Lhasa landfill 2014 together, which forms visual environmental impact assessment (Image 3. 23). This assessment could not only offer the guide for the restoration after the landfill closed in the future, but also forecast the comprehensive and science future fragmented trend for the local department of environment to in advance defend the fragmented trend and restore the landscape fragmented structure.

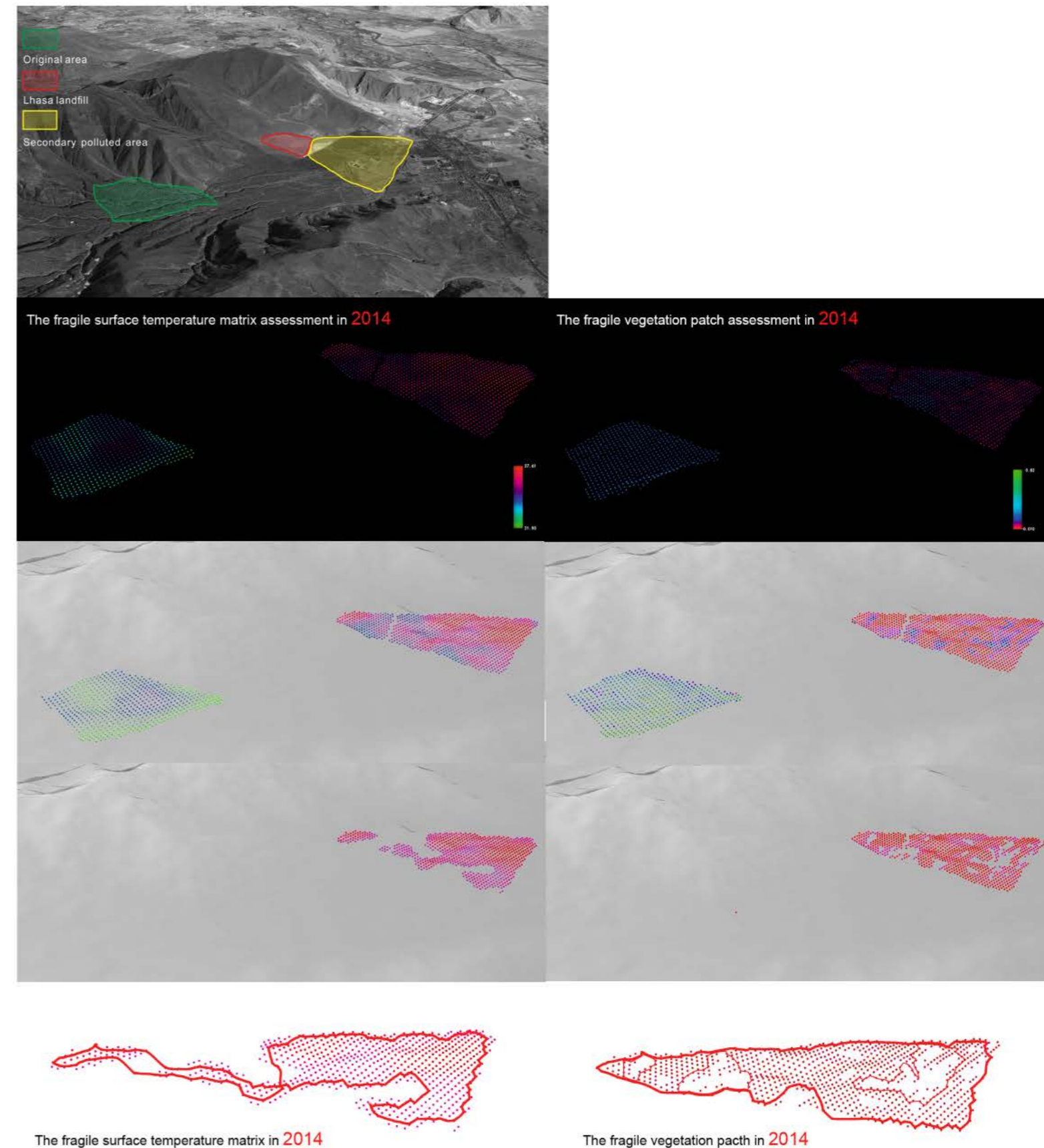


Image 3.21: The process of exacting fragmented surface temperature matrix and fragmented fragmented vegetation NDVI patch in 2014 by ENVI, Arcmap, ArcScene, Rhino and Grasshopper software

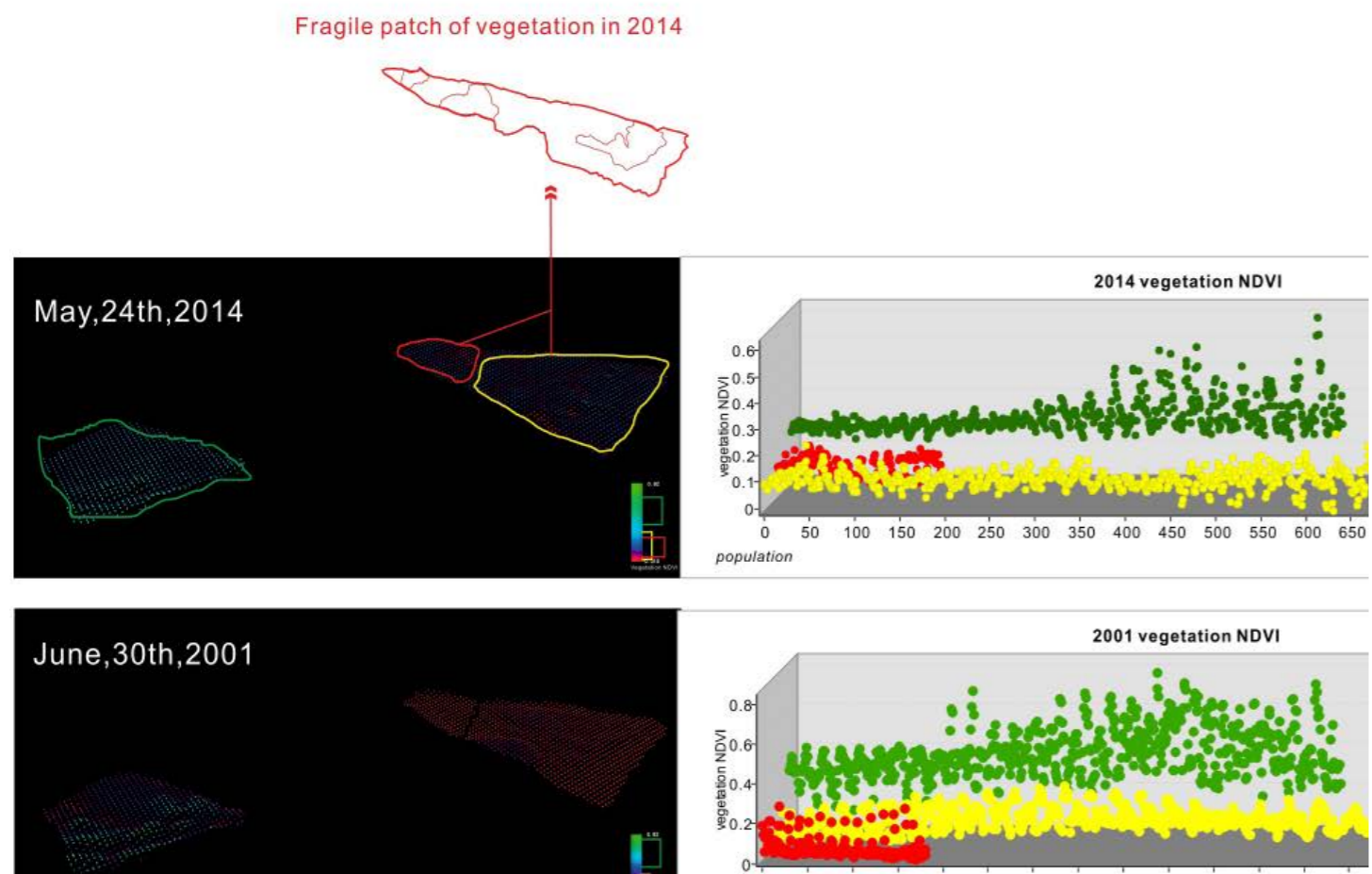
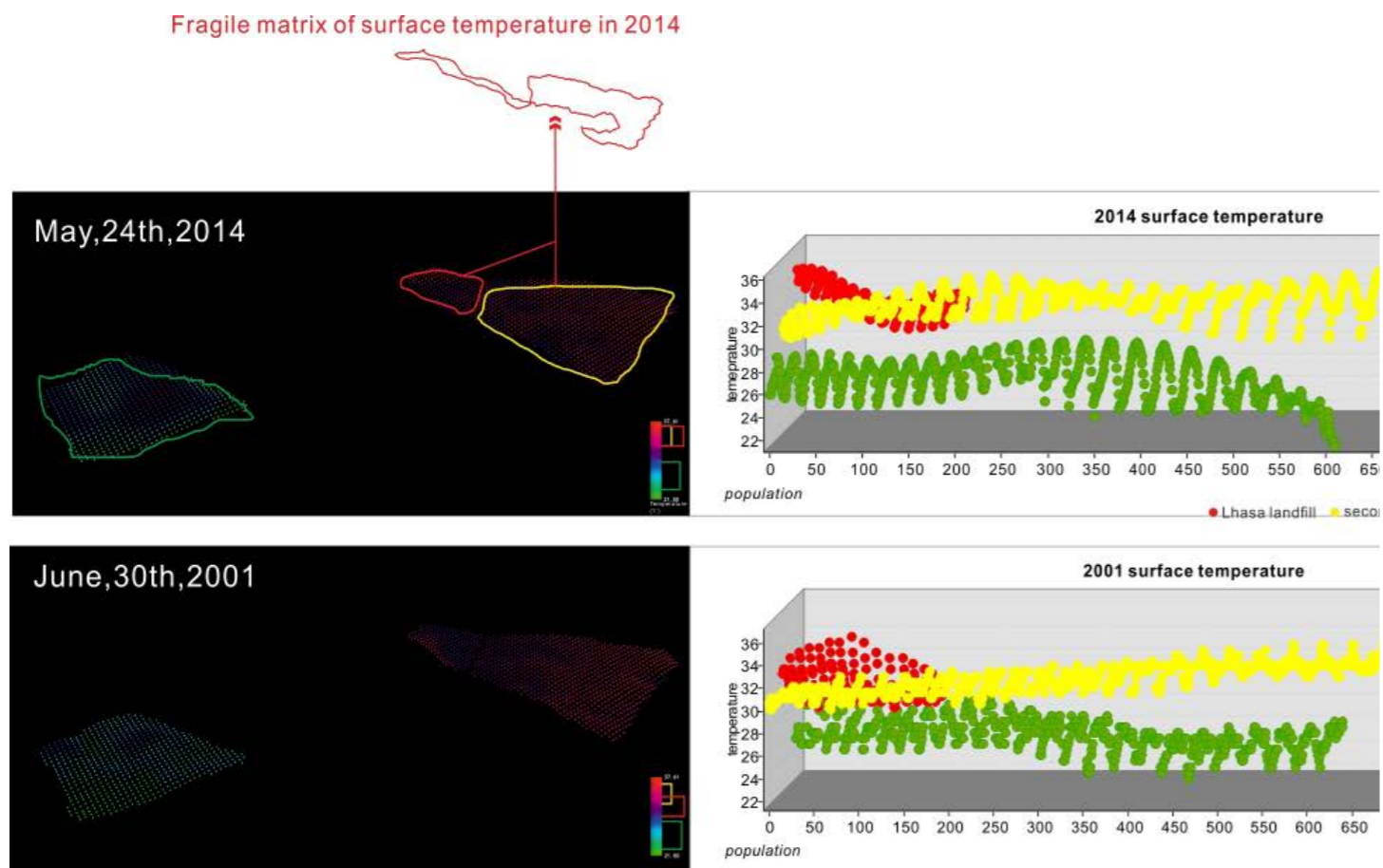


Image 3. 22: The comparition among surface temperature and vegetation different of Lhasa landfill (red line polygon and points), secondary polluted area (yellow line polygon and points)and original natural area (green line polygon and points) in 2014 and 2001.

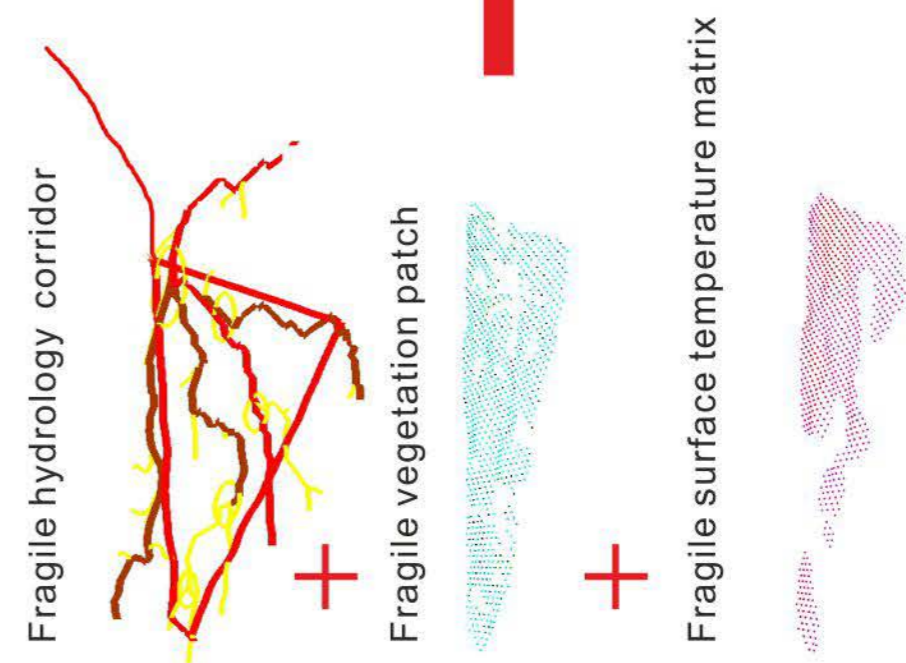
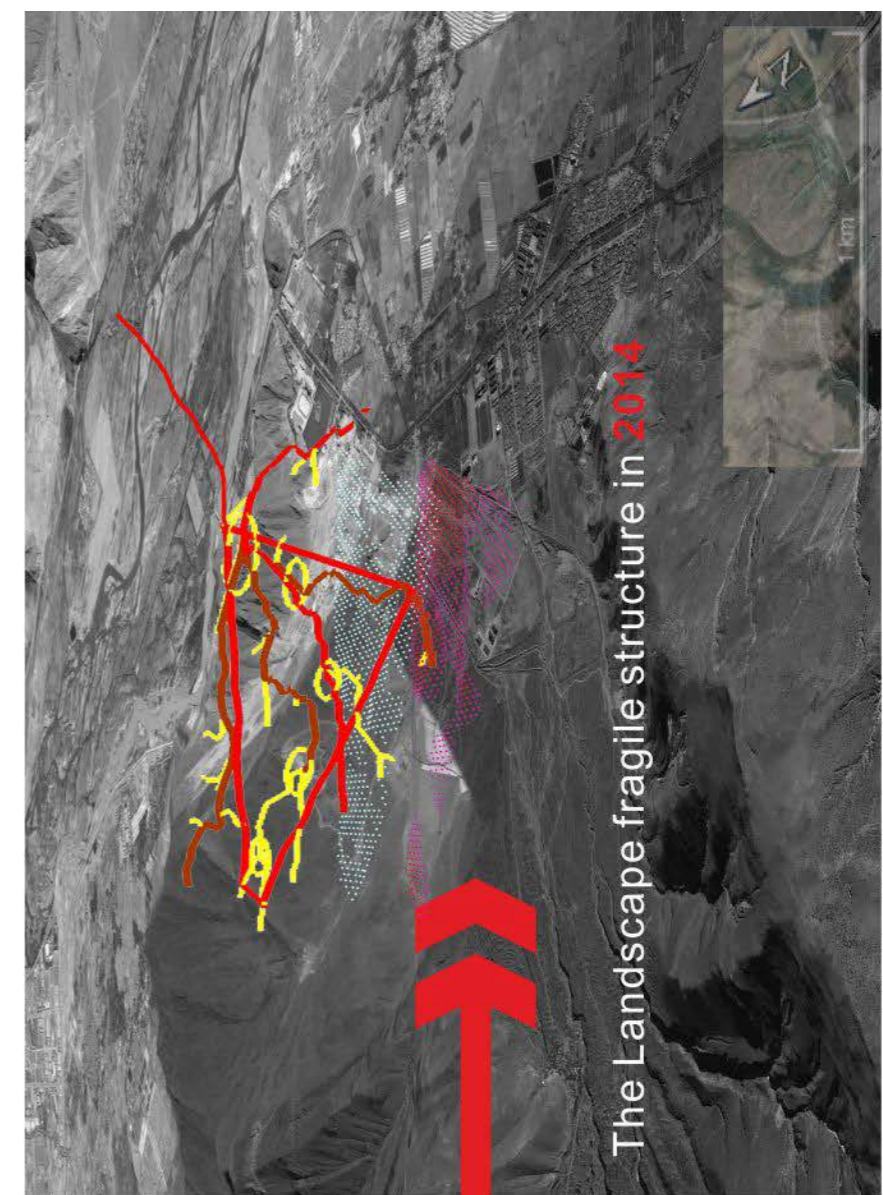


Image 3. 23: The Lhasa landfill fragmented landscape structure in 2014, combine the fragmented hydrology corridor, fragmented surface temperature matrix and fragmented vegetation patch together, forecast the future fragmented trend

3.5 Conclusion

The visual environmental assessment of the impact on the restoration process of the Barcelona Garraf landfill realizes assessing , which has monitored the effect of the restoration on the fragmented landscape structure, has been made. The Lhasa landfill assessment makes another contribution to the forecast and defense of this fragmentation trend within the fragmented area. Meanwhile however, the visual environmental impact assessment platform of both the coastal Barcelona Garraf landfill and the Lhasa plateau landfill, shows the stability and plasticity under different geographical backgrounds and environmental parameters. How-ever, climate change tells us that this is not enough, and that the ecosystem depends upon animals, and animal migration patens depend on the climate; the underground water depend on the rain, river and snow, and all these depend on the climate.

To face this difficulty, we need to add more types of environmental parameters - such as underground water soil conditions, air quality, animal migration, the influence of wind, light and noise, etc- which will help us detect a more realistic and comprehensive platform. Climate change leads our future research into this field of the fragmented area, which will not only be limited to the polluted area, but also expanded to the possibility of future natural disaster, which means we need more efficient visualization technology. Such parameters as the food chain and migration chain could guide us to find an ecological cycle principle. During these years, thanks to miniaturized transmitters which are becoming lighter and lighter (some weighing less than 5 grams), and to the sensitivity of receivers on satellites which can record very low-powered transmissions (150 mW), it has now become possible to track and locate new species, whose migratory behavior has not yet been discovered or determined. (Image 3. 24)^{125 126 127}

This composite image of southern Africa and the surrounding oceans was cap-tured by six orbits of the NASA/NOAA Suomi National Polar-orbiting Partnership spacecraft on April 9, 2015, by the Visible Infrared Imaging Radiometer Suite (VIIRS) instrument. Tropical Cyclone Joalane can be seen over the Indian Ocean. Winds, tides and density differences constantly stir the oceans while phytoplankton continually grows and dies. Orbiting radiometers such as VIIRS allows scientists to track this variability over time and contribute to a better understanding of ocean processes that are beneficial to human survival on Earth.¹²⁸ (Image 3. 25) In this exploratory way, we will try to find an appropriate dynamic simulation technique.

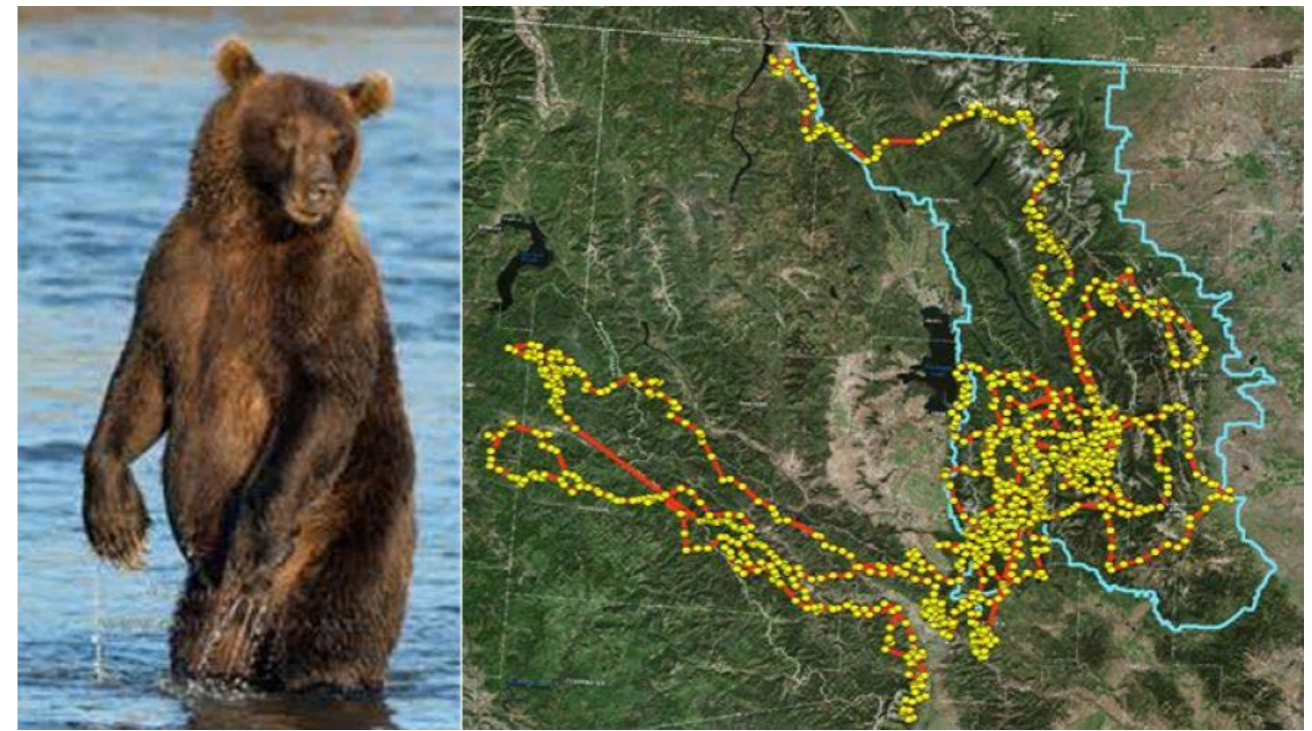


Image 3. 24: Bear tracks: Data shows the grizzly's 'bizarre' 2,800-mile trek across backyards, main streets and highways, Perry Chiaramonte, 2014.

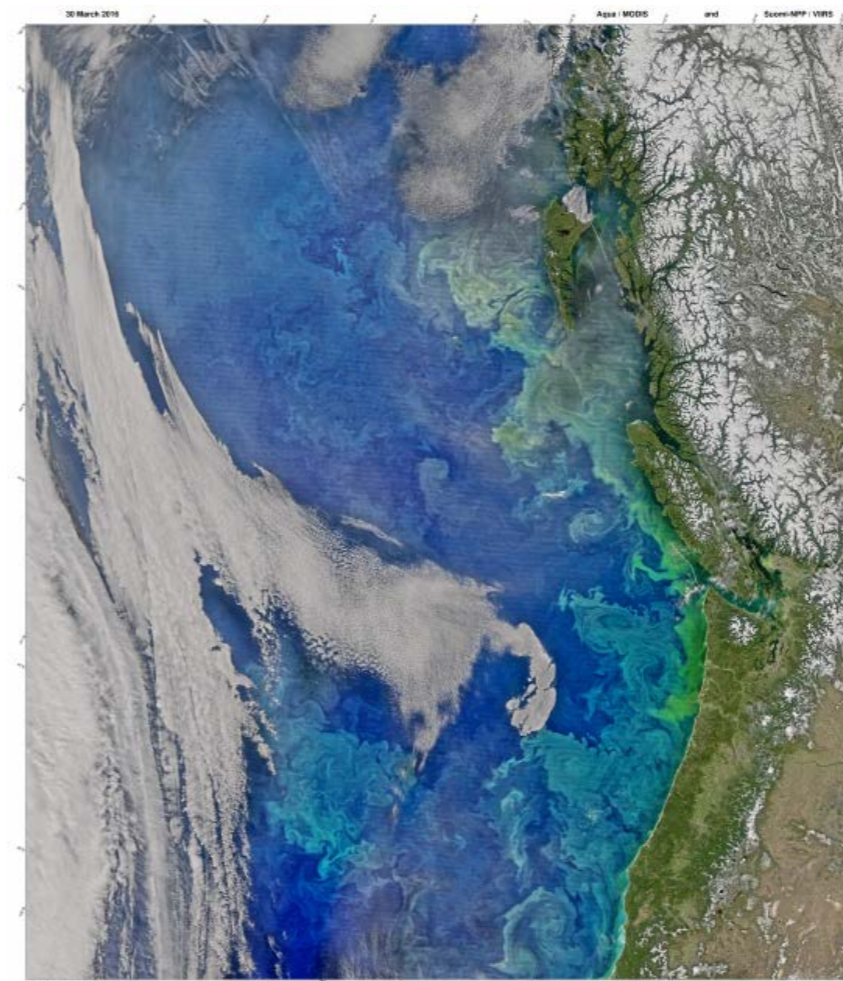


Image 3. 25: Iron rich waters around the Kerguelen Islands support spring phyto-plankton blooms which are often hidden from the satellite view by cloud cover. November 21, 2015 was a sunny day in the region, however, as can be seen in the above VIIRS image, OceanColor, 2016.

¹²⁵ Kays, R., Crofoot, M. C., Jetz, W., & Wikelski, M. (2015). Terrestrial animal tracking as an eye on life and planet. *Science*, 348(6240), aaa2478.

¹²⁶ Morelle, R. (June 7, 2007). Argos: Keeping track of the planet. Retrieved April 22, 2016 from Bbc: <http://news.bbc.co.uk/2/hi/science/nature/6701221.stm>

¹²⁷ Hoare, B. (2009). *Animal migration: remarkable journeys in the wild*. America: Univ of California Press.

Chapter 4. Conclusion

4. Conclusion

While writing Chapter 1 (the fragmented landscape structure), almost every day, I would find new and worsening fragmented cases appearing, causing me great concern over their growing number. I encouraged myself to remain calm, and to examine each case in detail. There is an old saying in China - 'every invalid is a doctor'. When I reached Chapter 2, the following headlines of more new restoration projects gave me greater optimism:- the Americans getting initial results from the national seaside wetland restoration plan after suffering years of hurricane and flood damage; Canada building the crossway for animal migration; the Netherlands setting aside space for flooding; Iceland building the landscape defence wall against avalanches, and many other memorial landscapes which illustrate humanity's correct-minded attitude towards nature.

However, the pessimistic situation is that many landscape restoration projects lack scientific assessment, leading to no improvement in the fragmented situation. When I began to write Chapter 3, I was pleased that through my contribution I could take some action to assist the fragmented situation. The visual environmental assessment platform could not only save time and increase efficiency, but also offer suggestions for the restoration of these essential fragmented cases. I am also motivated by the fact that there is great potential for improving the accuracy of the environmental impact assessment platform in restoration by using high-visualization models to develop such studies in the future. This research not only restores the fragmented environment, but also provides refuge for human, animal and plant species. In one sense, my thesis seems to be a 'dream-catcher' - I understand the earth and I want to help solve her problems, which are of great significance in my life.

Beyond this thesis, there are still many defects of data and technologies which urgently need to be solved. Through detached but detailed observation suggests that this visual environmental assessment seems to open a new windows of opportunity for experts. This research offers only an initial platform, and we need to keep on exploring more scientific and appropriate ways to restore the self-healing ability nature using this platform. No matter how far in front of us, we shouldn't forget the original source, that maybe the best way is hidden in the natural virgin landscape, in the distant universe or in the past. In the following part, we will discuss the possibilities for the restoration of the future landscape.

4.1 Future landscapes restoration are viewed in the virgin land

Virgin landscapes are usually found in plateau, in Africa deserts, uninhabited islands, and the polar regions, places too remote for humans to reach. In these virgin landscapes, changes to the ecosystem are easily amplified, which can forecast disaster trends, bringing important assistance for the prevention of such occurrences in the future. The original

landscape structure may guide us to find unexpected ways to restore, and moreover, this original unassisted restoration capability may help for future landscape restoration.

"Restoration" in many cases means ecosystem development organized and assisted by humans. Also without any human management, however, sometimes ecosystems are set back to an earlier stage of development or into a quite new constellation of environmental factors and of species. After such "disturbances" the ecosystem spontaneously and without any input of man starts to develop back to a stage, which may be similar to the stage before disturbance or impact, respectively. For example during a storm event, coniferous trees may be thrown down, and the structure of the stand will change totally; but some decades later it may again be a coniferous forest. After a mudflow, even soil material and soil structure may be completely different than before the event, but (depending on the general climate conditions) a new forest will emerge after a while. While most of the formerly managed forest stands, released to a free succession, will develop to a stage of increased naturalness, seminatural grasslands or arable field ecosystems will totally disappear after the abandonment of human impact. Not in each case "assisted development" is needed – in several cases the restoration work can be done by nature itself. Nevertheless for landscape planning a good knowledge of the involved ecosystem processes is important to decide, where and when such unassisted restoration may lead to which kind of ecosystems, and which time span may be involved. Below sites from some kind of terrestrial ecosystems all over the world.¹²⁹

Africa is the last region of clean land left on earth. There is strong natural power in this land. Its north is covered by vast deserts, and west is covered by rainforest. The most fertile savannah stretches for thousands of miles from west to south. The most wonderful story of wild animals and plants takes place on this land. There are thousands of mysterious circles on its southwest corner, in the most inaccessible Kalahari Desert. The shape of these circles never change or move. Amazingly, although it never rains there, water is always hidden deep beneath the ground. (Image 4.1, 4.2, 4.3)



Image 4.1: The satellite image shows the circles are concentrated within a 1,800km-long strip of land, Stephan Getzin, 2014.

¹²⁹Fischer. A. (2016)Unassisted restoration: pitfalls and progress(OpenS). Ser conference.



Image 4.2: The circles appear to be regularly spaced, Inside a fairy circle, nothing seems to grow, Stephan Getzin, 2014.



Image 4.3:

Adansonia digitata (baobab) is the most widespread of the *Adansonia* species, and is native to the African continent. The long-lived pachycauls are typically found in dry, hot savannas of sub-Saharan Africa, where they dominate the landscape, and reveal the presence of a watercourse from afar. Their growth rate is determined by ground water or rainfall, and their maximum age, which is subject to much conjecture, seems to be in the order of 1,500 years. continent.

There is biggest lava lake in the Nyiragongo Volcano. The lava eruptions from 15 km below the surface, which is continue changing the topography of the eastern Africa. All seem restless and ruthless, however, it births the colorful life. The land is covered by the rich volcanic soil, which builds the ideal condition for the grass, the grass attract large number of wildlife group, such as gnu. (Image 4.4, 4.5)



Image 4.4: The view from the volcano rim, 11,380 feet above the ground. At 1,300 feet deep, the lava lake has created one of the wonders of the African continent. Even though the lava lake often overflows, the seven members of the expedition yearn to walk its shores, Wild Wonders of Europe, 2011.



Image 4.5: This the season of the Great Migration of East Africa.

The Rwenzori Mountains of equatorial East Africa are widely known to be the legendary “Mountains of the Moon” described by Ptolemy in 150 A.D. as ‘the Mountains of Moon whose snows feed the lakes, sources of the Nile’. Indeed, snow and ice on these glaciated mountains that straddle the border between the Democratic Republic of Congo (DRC) and Uganda supply water to lakes that are a source of the White Nile as it flows north from Uganda into the Sudan. The mountains are also a hotspot of biodiversity featuring rare Afro-alpine fauna and flora. The last mountain gorilla is in there. Uganda’s forest now is few left, most tourist attraction, and indeed one of the world’s most remarkable

wild life encounters, is tracking the rare mountain gorilla in the remote forests of south – western Uganda. These magnificent animals which are found only in the forests of Bwindi impenetrable and the virunga volcanoes, number less than 800, over half of them in Uganda.¹³⁰(Image 4.6, 4.7)



Image 4.6: Speke Glacier in the Rwenzori Mountains with distinctive Afroalpine vegetation, Tree Senecio, in the foreground, Richard Taylor, 2014.



Image 4.7: Mountain gorilla live in Uganda forest, many foreigners would like going into see them, 2015.

¹³⁰Glaciers Recede in East Africa's "Mountains of the Moon". (Octor. 9, 2015). Retrieved April 22, 2016 from Glacierhub: <http://glacierhub.org/2014/10/09/glaciers-recede-in-east-africas-mountains-of-the-moon/>

The more danger place in Africa is Bogoria lake. The lake waters contain large concentrations, which are high deleterious caused by the tephra. the lake is highly productive with abundant cyanobacteria (*Arthrospira fusiformis*) that feed the flamingoes, but few other organisms inhabit the lake eg the monogonont rotifer species *Brachionus*. (Image 4.8)



Image 4.8: The water with tephra flow into the Lake Bogoria, which is highly productive with abundant cyanobacteria that feed the flamingoes the Franco Cappellari, 2015.

The Congo rainforest is located in the middle of Africa. There are 500 square kilometers of rainforest. After raining, all the water follows the Congo river channel to the west. When passing a plateau in the middle of Africa, the amazing Zongo Waterfalls are formed. All these feed the most original forest in the world. (Image 4.9)

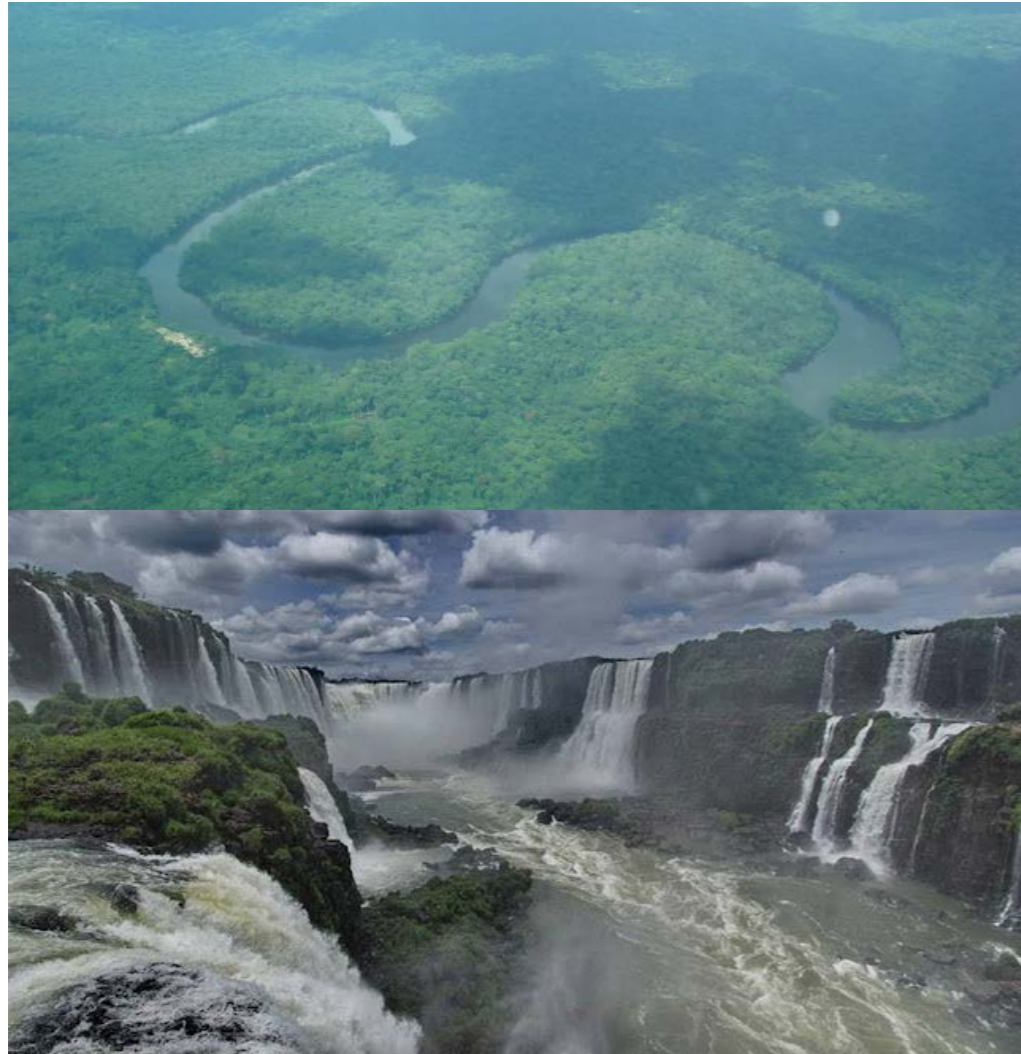


Image 4.9: The Congo river channel finally forms the Zongo Waterfalls.

On the Tibetan Plateau, known in China as the Yarlung Tsangpo River—flow from Tibet's Himalaya mountain range into India. The Tibetan Plateau's lockbox of snow and glacial ice supplies freshwater to nearly a third of the world's people. (Image 4.10) On the Iceland, mostly plateau interspersed with mountain peaks, icefields. Colourful rhyolite mountains Landmannalaugar in Fjallabak Nature Reserve, Highland of Iceland, at the edge of Laughraun lava field that was formed in an eruption year 1477. (Image 4.11, 4.12, 4.13, 4.14, 4.15) There are still original vegetation structures on some uninhabited islands. Such as the small mangrove island in Fiji. Socotra is considered the jewel of biodiversity in the Arabian Sea. One of the most striking of Socotra's plants is the dragon's blood tree (*Dracaena cinnabari*), which is a strange-looking, umbrella-shaped tree. These trees are found nowhere else on earth and many are estimated to be over 800-years-old. (Image 4.16)

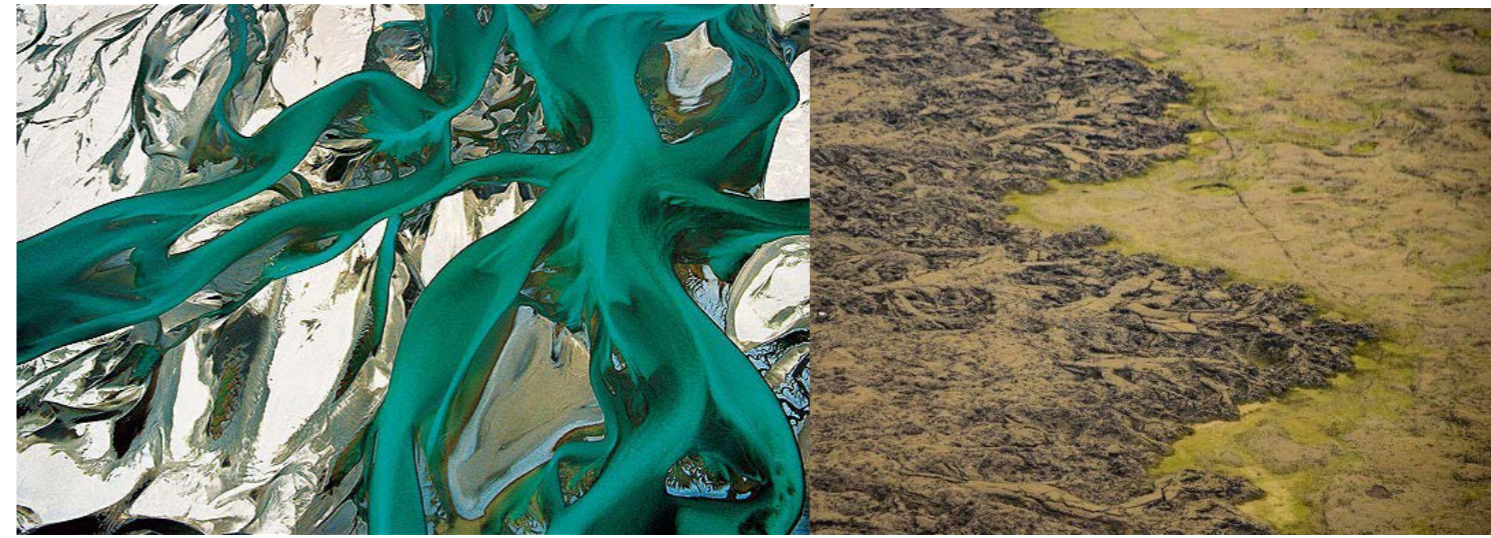


Image 4.10: Ribbonlike branches of the Brahmaputra River, 2012.

Image 4.12: Patterns of a lava field in South Iceland, Aya O, 2015.



Image 4.11: Landmannalaugar colorful mountains in Iceland, Christian Aslund, 2015.



Image 4.13: These steaming geothermal currents are found in Kerlingarfjöll, a mountain range located in the central highlands of Iceland, Shutterstock, 2014.

Image 4.14: A seasonal view of southern Iceland. Bartnikas explains that as glaciers melt in the summertime, rivers start their currents among fractures in the lava fields, Stas Bartnikas, 2015.



Image 4.15: Aerial view of a mangrove island in Fiji, Stuart Chape, 2015.



Image 4.16: Dragon's Blood Trees on the Socotra Island, Rod Waddington, 2014.

All these original landscape structures are examples of the natural restoration ability of original unassisted landscape. We can see the huge eco-cycling power exist in these original corridors, patches and matrices. In the future we need to find out how these restoration principles, and power which drives them function.

4.2 Future landscapes restoration are viewed in the universe

What will the earth become in the future? The question not only children ask, but also everyone wants to know. As the beginning of the film "Mad Max: Fury Road" said, my name is Max, my world is fire and blood. Why are you hurting these people, It's the oil, stupid. Oil wars. We are killing for the guzzoline. The world is actually running out of water. Now there is the water war. To the terminal freak-out point. Mankind has gone rogue, terrorizing itself. Thermonuclear skirmish. The earth is sour. Our bones are poisoned. We have become half-life. As the world fell, each of us, in our own way, was broken. It was hard to know who was more crazy...me or everyone else. (Image 4.17)

The earth may never become an extreme like the Moon or Mars, however, these will always be a warning to humans; maybe someday the earth, Mars and the Moon will be no different. New findings from NASA's Mars Reconnaissance Orbiter (MRO) provide the strongest evidence yet that liquid water flows intermittently on present-day Mars. The below was produced by first creating a 3-D computer model (a digital terrain map) of the area based on stereo information from two HiRISE observations, and then draping a false-color image over the land-shape model. Dark, narrow streaks on Martian slopes such as these at Hale Crater are inferred to be formed by seasonal flow of water on contemporary Mars. The streaks are roughly the length of a football field. The imaging and topographical information in this processed, false-color view come from the High Resolution Imaging Science Experiment (HiRISE) camera on NASA's Mars Reconnaissance Orbiter. These dark features on the slopes are called "recurring slope lineae" or RSL. Planetary scientists using observations with the Compact Reconnaissance Imaging Spectrometer on the same orbiter detected hydrated salts on these slopes at Hale Crater, corroborating the hypothesis that the streaks are formed by briny liquid water.¹³¹(Image 4.18)



Image 4.17: The first scene in the film of Mad Max: Fury Road.

¹³¹Greicius.T.(Sept.28, 2015). Recurring 'Lineae' on Slopes at Hale Crater. Retrieved April 22, 2016 from Nasa: <http://www.nasa.gov/image-feature/jpl/pia19916/recurring-lineae-on-slopes-at-hale-crater-mars>

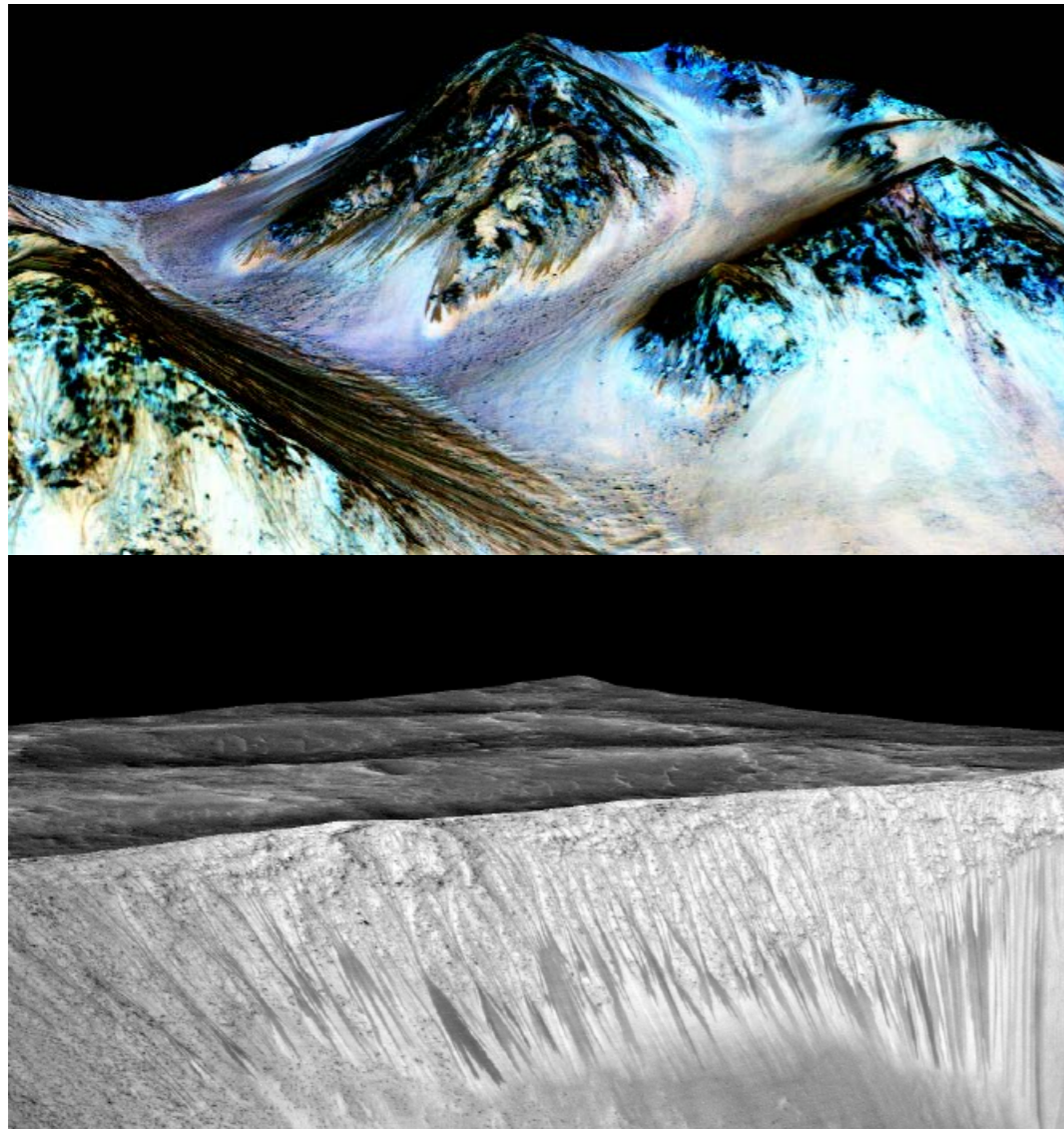


Image 4.18: Recurring "Lineae" on Slopes at Horowitz Crater, Nasa, 2015.

This is an exciting time for humanity, which is now at a point to confirm if life exists on Mars. Another way to think about this is whether research into Mars' present state could help us find out what is necessary for life on earth in its initial or final state; this will help to find the right way to view landscape restoration so that we can achieve at least two important goals; first, that we pay more attention during to the most essential matters of landscape restoration, and the elements of life in the environment at the initial stage of the earth's existence.

As the radar studies with the SHallow RADar (SHARAD) on the Mars Reconnaissance Orbiter showed that Lobate Debris Aprons (LDA) and Lineated Valley Fill (LVF) contain pure water ice covered with a thin layer of rocks that insulated the ice. Ice was found both in the southern hemisphere and in the northern hemisphere. Researchers at the Niels Bohr Institute combined radar observations with ice flow modelling to say that ice in all of the Martian glaciers is equivalent to what could cover the entire surface of Mars with 1.1 meters of ice. The fact that the ice is still there and has not evaporated out into space suggests that a thick layer of dust is protecting the ice. The current atmospheric pressure

on Mars is so low that any water ice simply evaporates.¹³² (Image 4.19)

And secondly, that we can learn what the difference will be after the landscape structure has been completely broken, as shown below in the image of Gullfoss waterfall in Iceland, where we can imagine how this site without water, would be very similar to Mars. The Gullfoss waterfall is located in the canyon between the North American and Eurasian Plates can be clearly seen in the cracks or faults which traverse the region. (Image 4.20)

Las Rio Tinto mines are among the most oldest in the world and contain the bulk of known copper pyrites. The river's name comes from its reddish ocher passing on the banks. These colors are due to the high, since the dawn of history, ferruginous salts and ferric sulfates, and the scarcity of oxygen, give a very acidic pH. Rio Tinto is a unique place in the world, both for its chromatic beauty as for its exceptional environmental conditions. Its waters have little oxygen and harbor significant biodiversity of microscopic organisms whose presence has attracted NASA scientists investigating the ecosystem, due to its similarities to Mars.¹³³ Its red waters are characterized by a PH between 1.7 and 2.5 (very acidic), with high content of heavy metals mainly iron , copper , cadmium , manganese, etc. , but with oxygen , since the organisms that exist in the river they are mostly photosynthetic . These organisms adapted to extreme habitats are acidophilus and feed only on minerals ; are both procariotascomo eukaryotes , including between second some species of fungi

Image 4.19:

Martian glacier as seen by HiRISE. Glacier is moving down valley, then spreading out on plain. Evidence for flow comes from the many lines on surface. The rimming ridges at the end of the glacier are probably moraines. Location is in Protonilus Mensae in Ismenius Lacus quadrangle, Nasa, 2010.

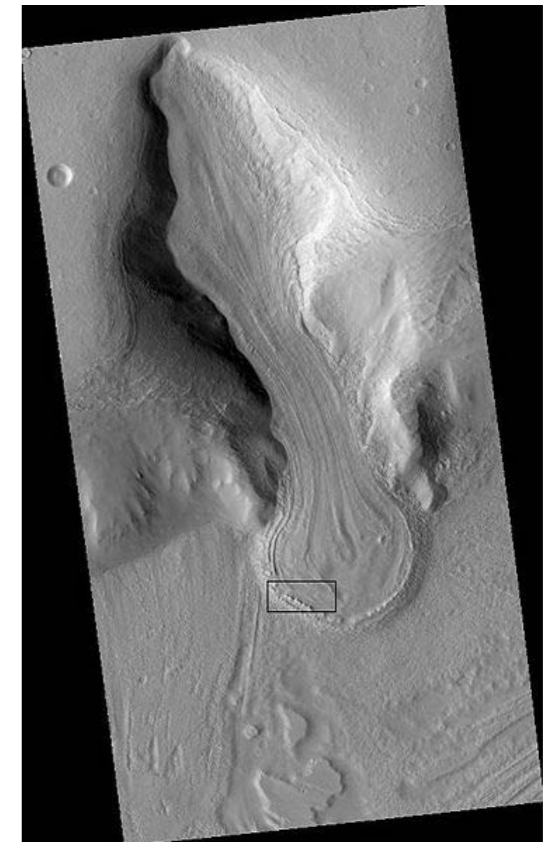


Image 4.20: Gullfoss waterfall.



¹³²Glaciers on Mars. (Dec 19, 2015). Retrieved April 22, 2016 from Wikipedia: https://en.wikipedia.org/wiki/Glaciers_on_Mars
¹³³ADDRESSING CLIMATE CHANGE LEGACY—LUCIE FOUNDATION CURATES PHOTOGRAPHY EXHIBITION HIGHLIGHTING GLOBAL CLIMATE CHANGE. (2015). Retrieved April 22, 2016 from Luciefoundation: <http://www.luciefoundation.org/programs/cop21/>
 An interwoven visualization platform for assessing the restoration of fragmented landscape structures

and algae endemic river . Therefore , NASA chose him as habitats to study their possible similarity to the atmosphere of the planet Mars. An experiment involving the Superior Council for Scientific Research , and developed in the Rio Tinto , has confirmed the possibility that certain types of organisms can survive under restrictive conditions on the planet Mars. Marte.¹³³(Image 4.21, 4.22)

NASA's most iconic Earthrise photo was taken by the crew of the Apollo 8 mission as the spacecraft entered lunar orbit on Christmas Eve Dec. 24, 1968. That evening, the astronauts -- Commander Frank Borman, Command Module Pilot Jim Lovell, and Lunar Module Pilot William Anders -- held a live broadcast from lunar orbit, in which they showed pictures of the Earth and moon as seen from their spacecraft. Said Lovell, "The vast loneliness is awe-inspiring and it makes you realize just what you have back there on Earth." (Image 4.23) "The image is simply stunning," said Noah Petro, Deputy Project Scientist for LRO at NASA's Goddard Space Flight Center in Greenbelt, Maryland. "The image of the Earth evokes the famous 'Blue Marble' image taken by Astronaut Harrison Schmitt during Apollo 17, 43 years ago, which also showed Africa prominently in the picture."

In this composite image we see Earth appear to rise over the lunar horizon from the viewpoint of the spacecraft, with the center of the Earth just off the coast of Liberia (at 4.04 degrees North, 12.44 degrees West). The large tan area in the upper right is the Sahara Desert, and just beyond is Saudi Arabia. The Atlantic and Pacific coasts of South America are visible to the left. On the moon, we get a glimpse of the crater Compton, which is located just beyond the eastern limb of the moon, on the lunar farside. (Image 4.24)



Image 4.21: Las Rio Tinto mines.

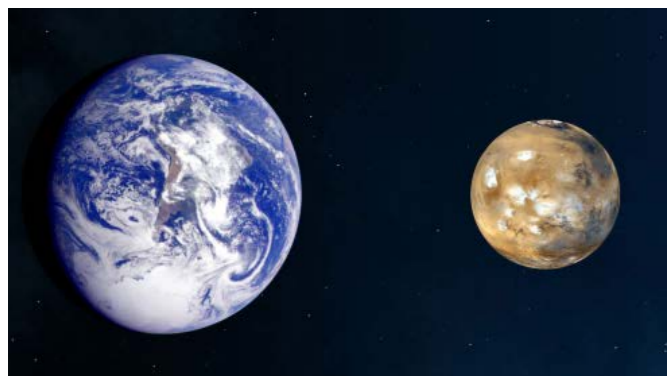


Image 4.22: Learn about the similarities and differences between Mars and Earth, we could imagine the Mars would become the best real visualization for future fragmented earth, Nasa.



Image 4.23: Apollo 8 gave us the first color view of Earthrise from the vicinity of the Moon, Commander Frank Borman, 1968.



Image 4.24: Recently a unique view of Earth was captured from the spacecraft's vantage point in orbit around the moon, NASA's Lunar Reconnaissance Orbiter (LRO), 2015.

Comparison of these two images both of the earth's development, show that there are very big changes in the earth's evolution during the past 43 years. This may be difficult to perceive visually, however, time is the best witness - humanity is damaging this beautiful earth.¹³⁴ What is the most despairing moment of the future? The similarity between environmental conditions and geological Teide National Park and the planet Mars have turned this spot volcanic reference point for studies related to the red planet. We could stand on the island of Tenerife to image this future moment; that many years later, the earth may become very similar to the Moon or Mars, as seen by a human standing on the earth watching the moon rise. Maybe there are many answers hiding in the Universe. (Image 4.25)



Image 4.25: Moon Rising Over Mount Teide seems as on the Moon or Mars see the earthrise, James Hastie, 2012.

¹³³Río Tinto. (Feb 19, 2010). Retrieved April 22, 2016 from Wikipedia: https://es.wikipedia.org/wiki/R%C3%ADo_Tinto

¹³⁴Earthrise Revisited. (May 28, 2015). Retrieved April 22, 2016 from Apollo flight journal: <http://earthobservatory.nasa.gov/IOTD/view.php?id=82693>

4.3 Future landscapes restoration are viewed in the past

Chapter 2 mentioned a restoration artist named Alberto Burri. His late works revisit the geometric and biomorphic motifs and pitch-black colour of the Catrami, affirming Burri's retrospective view of his career: "My last picture is the same as the first."¹³⁵ The ancient past could always awake our forgotten beliefs, principles and thought. Maybe some truth is hidden in the past. However, humanity is a greedy and forgetful species, who has lost precious memory.

As the chapter 1, we know that many fragmented cases in the world, Ivanpah Solar Electric Generating System, Bingham Canyon Mine, the polluted Napa Sonoma Marsh, Honduras Shrimp aquaculture, Sumatra burning lowland forests, Barcelona Garraf Landfill, Lhasa landfill, Mathare slum, drought Owens Lake, China 512 big earthquake, Italy Belice earthquake, iceland avalanche, Paris Terrorist attack, 911 Terrorist attack, bombing Buddhas of Bamiyan, Hoover Dam, Brazil Porto Primavera Dam break, America West Side Line, China ancient tea route abandon, etc. However, among most of these fragmented sites, we could only find few old images. (Image 4.26)

All these images of the past bring us many original environmental concepts which may be of great help for us to find the right direction for restoration in the future. The past will always be a source of precious enlightenment.

4.4 The end

One article named "Landscape Migration Environmental design in the Anthropocene". Human-induced climate change as accelerated landscape migration. The movement of carbon induces a cascade of attendant motions, leading to rapid landscape change at scales we can perceive and experience. Every decade, biomes migrate approximately 3.8 miles toward the earth's poles; spring events, such as the flowering of fruit trees, occur 2.5 days earlier. Water melting near the poles redistributes itself throughout the oceans. Rising seas and powerful storms transform and relocate coastlines. The writer Brett Milligan mentioned one word "landscape migration". Looking back, are animals, humankind and its culture actually on the same migration trip in unison with the landscape? ¹³⁶ I should perhaps give this part another more suitable name: the escape road.

I arrived along with my husband and mother at the Segantini Museum on the Swiss Italian border in the summer of 2015. When I saw the great Alpine painter Giovanni Segantini's Alpine Triptych (Life – Nature – Death), I decided that my thesis would end with these three paintings.(Image 4.27) The program of the Alpine Triptych is devoted to the cycle of life. Just as the destination of every trip is actually home, once you leave home, you are on the way back. Wishing for the grand and lengthy escape trip of earth which can be thought of as Samsara - the cycle of death and rebirth to which life in the material world is bound, takes place as the seasons alternate by turns through the long winter, followed by the step into spring. As long as we hold this belief, tomorrow is another day.

¹³⁵CELLOTEX / FIBERBOARD. (1975). Retrieved April 22, 2016 from Guggenheim: <http://exhibitions.guggenheim.org/burri/art/fiberboard/grande-nero-cellogex-m-1-1975>
¹³⁶ Milligan, B. (2015). Landscape Migration. Places Journal.

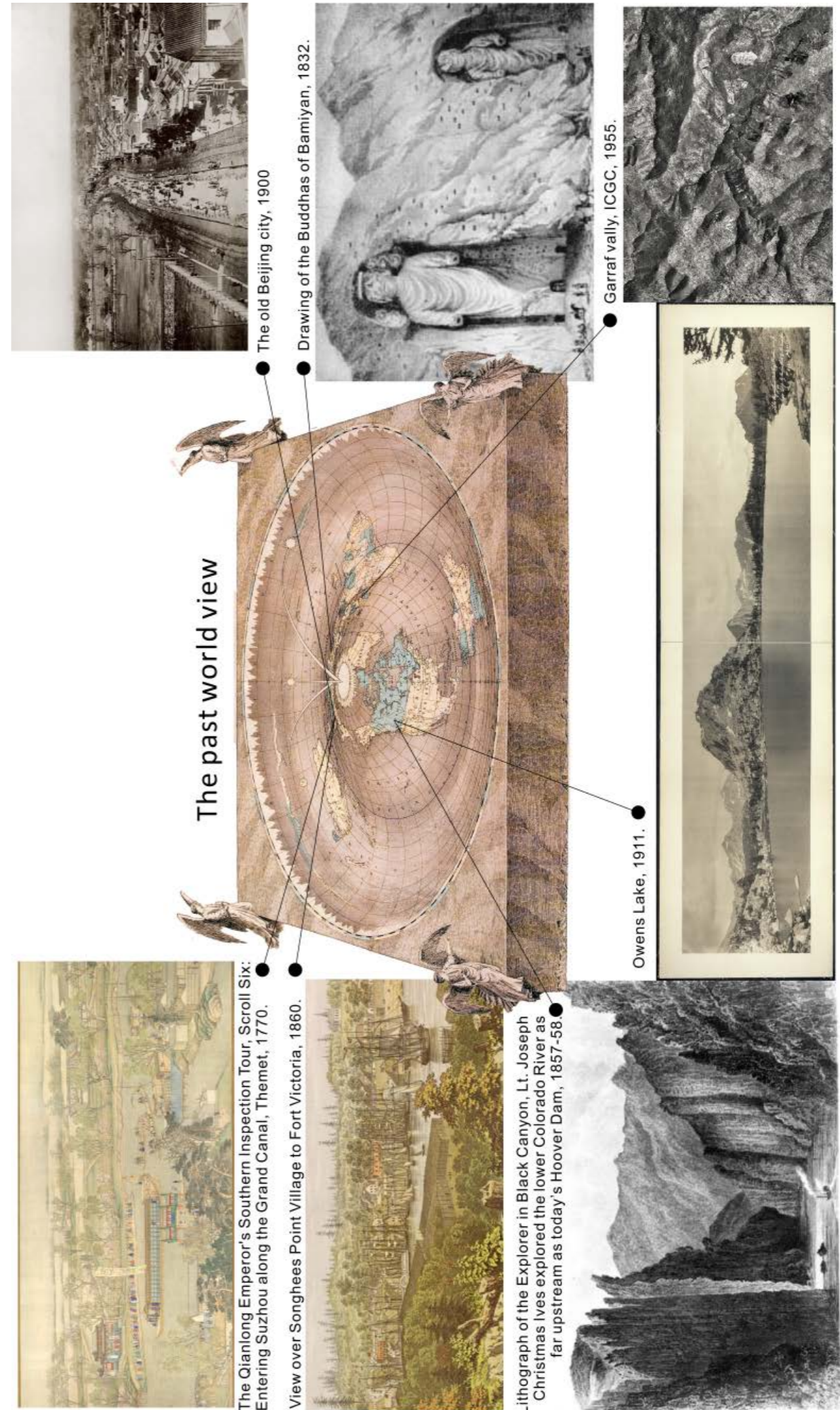


Image 4.26: The past world view.

Image 4.27: Alpine Triptych, Giovanni Segantini, 1899.

It begins with Life, depicted from Soglio with a view of the Bergell mountains. The time is late afternoon. The sun shines on the peaks of the Sciora Group, while the moon is already reflected in the small pond. A woman has led her cow – both are mothers – to the trough. A fir, a tree of life, connects her figure with the horizon and firmament. The cycle of day and night, morning and evening, birth and death determines human lives.

Life, 1898-1899



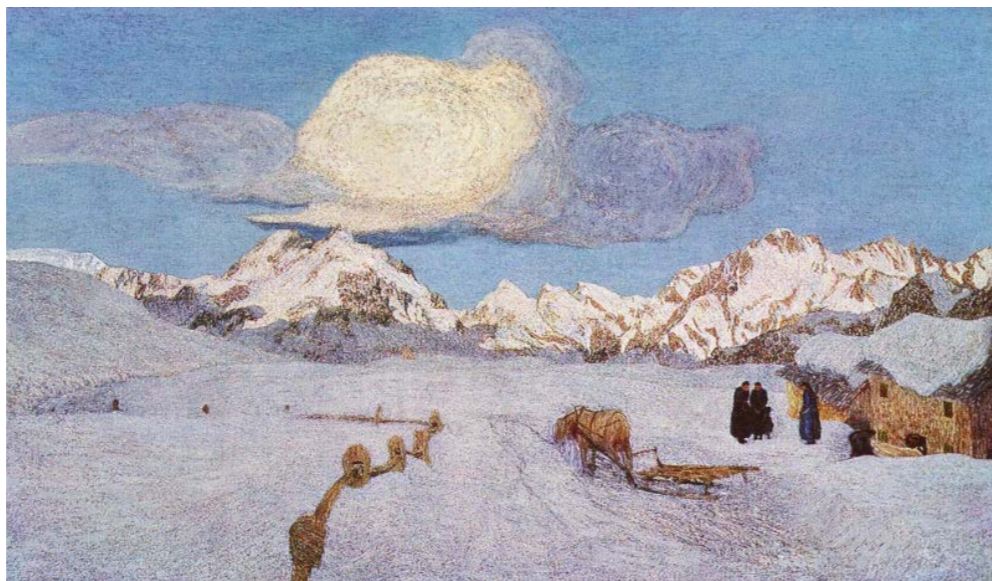
Nature, 1898-1899

As in the first section, in the middle section, Nature, the sun is setting and its last rays form a circular halo. The sky occupies nearly two thirds of the picture. In the foreground, two farm people quietly lead their animals home. The viewer's eye is drawn over St. Moritz and the Upper Engadine lake district in the direction of Maloja. The fact that human life is a mere episode and only the mountains and meadows, sun and moon, earth and water, trees and clouds will survive, becomes clear at the latest in the third painting, Death.



Death, 1898-99

Death comes in the early morning. A short distance outside Maloja, in the background the Bergell mountains just illuminated by the sun, a dead girl is being carried out of a cabin as a horsedrawn sleigh waits. The mourners are as silent as the frozen snow. In the sky, by contrast, a pantheistic cloud gathers, recalling an image of God or an angel towering over the scene. This is where the paths of men lead, in the direction indicated by a hedge and snowy path.



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