

Sky Islands

A past time travel at the Andes Mountains

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Introduction

Billions of years of evolution on the Earth have been drastically devastated at the fastest rate in a mere one hundred years after industrialization. It is no secret to anyone that currently the alarms of climate change or global warming caused by the human species are affecting life on Earth and it is already a fact that the human footprint is now part of the ice records of the Antarctic Pole, but even in many lakes, lagoons, and rivers around the planet that act as deposits of history on Earth. Sky Islands: a past time travel at the Andes mountains represents the history of the evolution of the Andes in about last one million years and its objective is to recover the Earth's memory and make it known. Maybe those who know it, will find the reason and feel the need to protect it in a way to start changing the history of the future of the Andean Páramos and forests but also extended to the ecosystems in the whole Earth.

Sky Islands: a past time travel at the Andes mountains is also an exploration of how to display scientific information using digital art, photography, 3D animation, and data visualization as contemporary tools to imagine ecosystems in the past. The challenge is to find a pathway of telling the dynamic history of the Páramos of the Northern Andes Mountains of South America in a visual and revealing form. This project is a science, art, and technology convergence, integrated into an innovative education model that explores theories from different disciplines with the aim to engage scholars, politicians and general audiences. The purpose is to make them understand the importance of these natural evolutionary processes that at least one millions of years in the Northern Andes, for our current understanding. In more detail, this project will envision how the shifting elevational distributions of the Andean ecosystems was caused by cold and warm conditions driven by long-term climate cycles, called the Milankovitch cycles (Muller et al. 1997) and how the diversification of species increased exponentially as a result of these cycles, but emphatically how these ecosystems which process of evolution that spent millions of years is being deteriorated in just hundred years of devastating human activity.

For this time travel, I am supported by a group of researchers of the University of Amsterdam (UvA) and collaborators that have been studying for more than five decades long-term climate dynamics and the evolution of ecosystems in Northern Andes of South America. Their studies have been focused on understanding vegetation dynamics in the present and past times (see studies from A. Cleef, T. van der Hammen, H. Hooghiemstra and co-workers). After 50 years of studying pollen fossil, aging materials, sedimentation rates, current species of plants, different type of ecosystems and its geographical distribution (among others), they found unique lakes with long fossil pollen and sediment records covering 2.4

million years of history of the Andes Mountains (Hooghiemstra 1984; Bogotá et al., 2011; Groot et al., 2011; Torres et al., 2005, 2013).

But they also found a pathway to make spatial reconstructions through time to generate the most recent explanation of why these unique mountains top ecosystem, represents the highest species diversification between the mountains around the world (Van der Hammen, 1974; Flantua et al., 2014; Flantua & Hooghiemstra, 2017).

Finally, this paper contains five parts, the first describes the geographical and ecological context of the Andes Mountains with a special focus in the Northern Andes and Páramos ecosystems. Then, a travel in time through the Earth's cycles in a timeline of the last 2.4 million years that includes climate change in large scales and its consequences. I will give a background of the ecological crises we are testifying and the negative effects in the modern human. Next an overview of a travel between Science, Arts and Technology as my personal experience of working in both science and arts and how the final piece took shape.

Part one

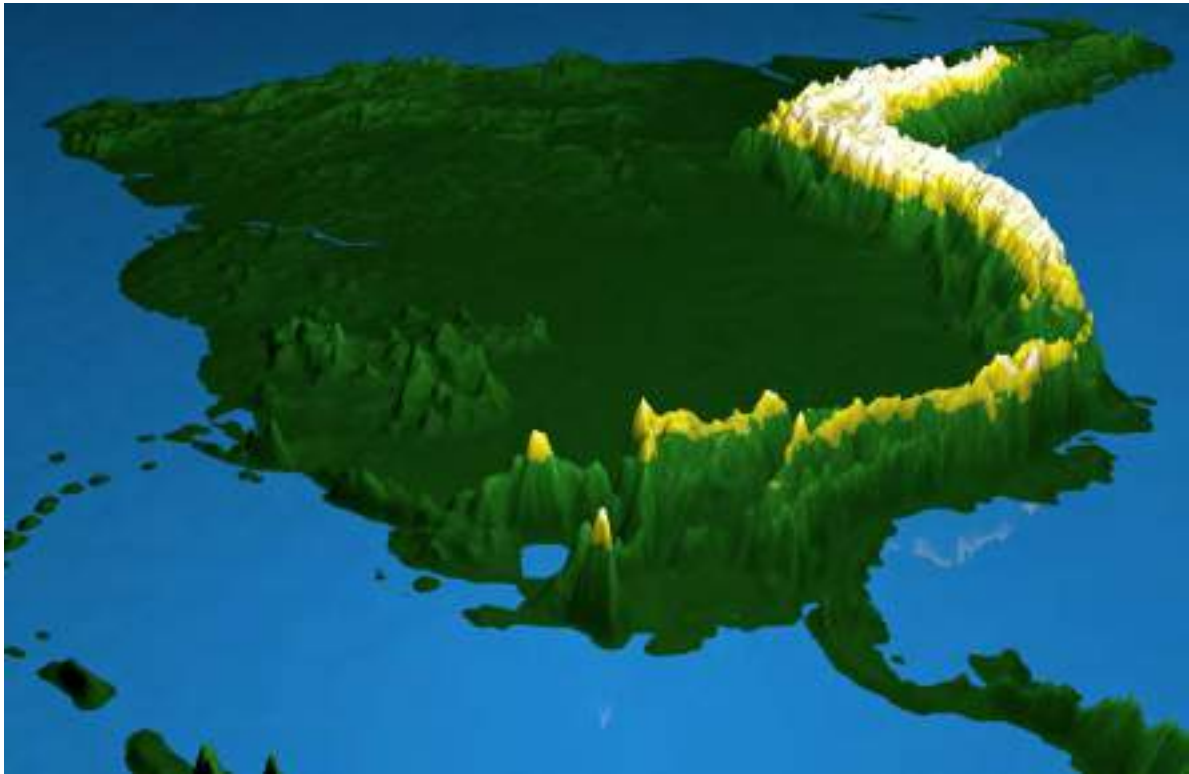
Andes mountains and Páramos



The Andes is a Castilian Aymara name that means "mountain that lights up". This name derives from the Aymara terms Qhantir Qullu Qullu used by the Qulläna people to express what happens in the high mountains that, at sunrise, are the first to be illuminated, and the sunset of the sun, the last to receive their rays. The Spanish, unable to pronounce "Qhantir", had just written down "Anti" and then, as it was about several mountains, he pluralized the term "Antis". Today it survives without having any meaning in the Spanish language.

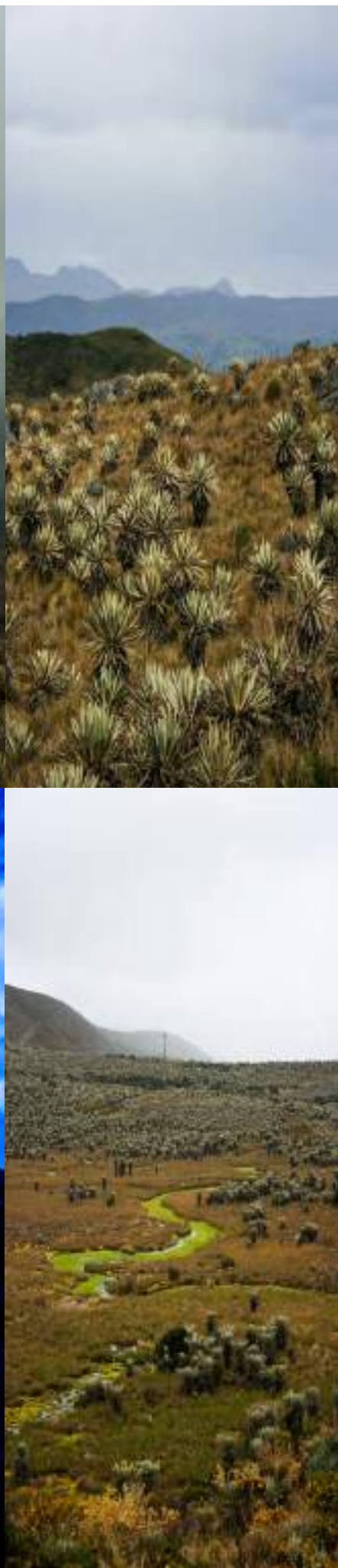
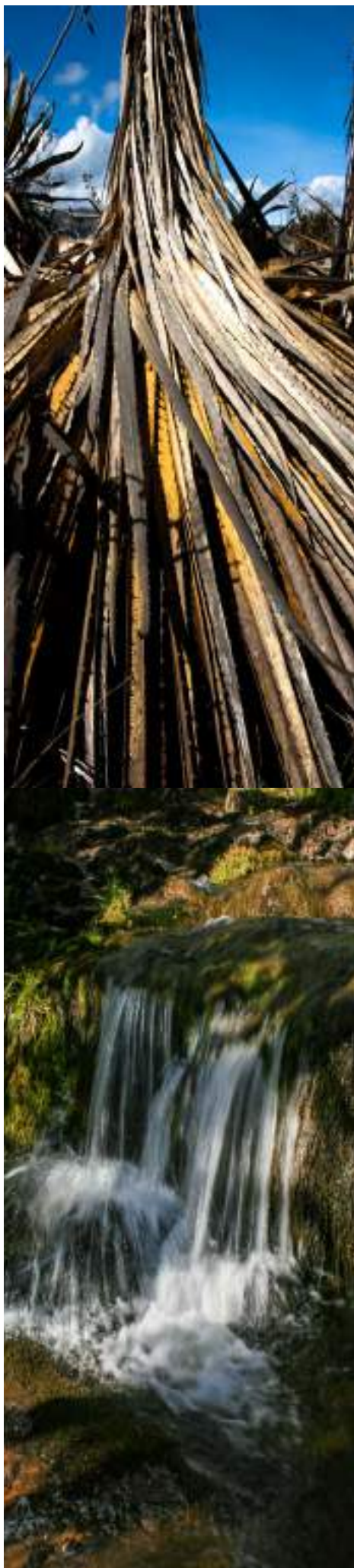
It is also said that word Andes comes from Quechua Anti. According to "The Real Commentaries of the Incas" (1609) written by the Inca Garcilaso de la Vega (1539-1616): The Inca Kings divided their empire into four parts that they called Tihuantin-Suyu, which means "The four parts of the World", according to the four main parts of the sky, east, west, north, and south. They put the eastern part of Antisuyu, by a province called Anti that is to the east; which also they call Anti to all mountain range of Sierra Nevada that passes to the east of Peru.

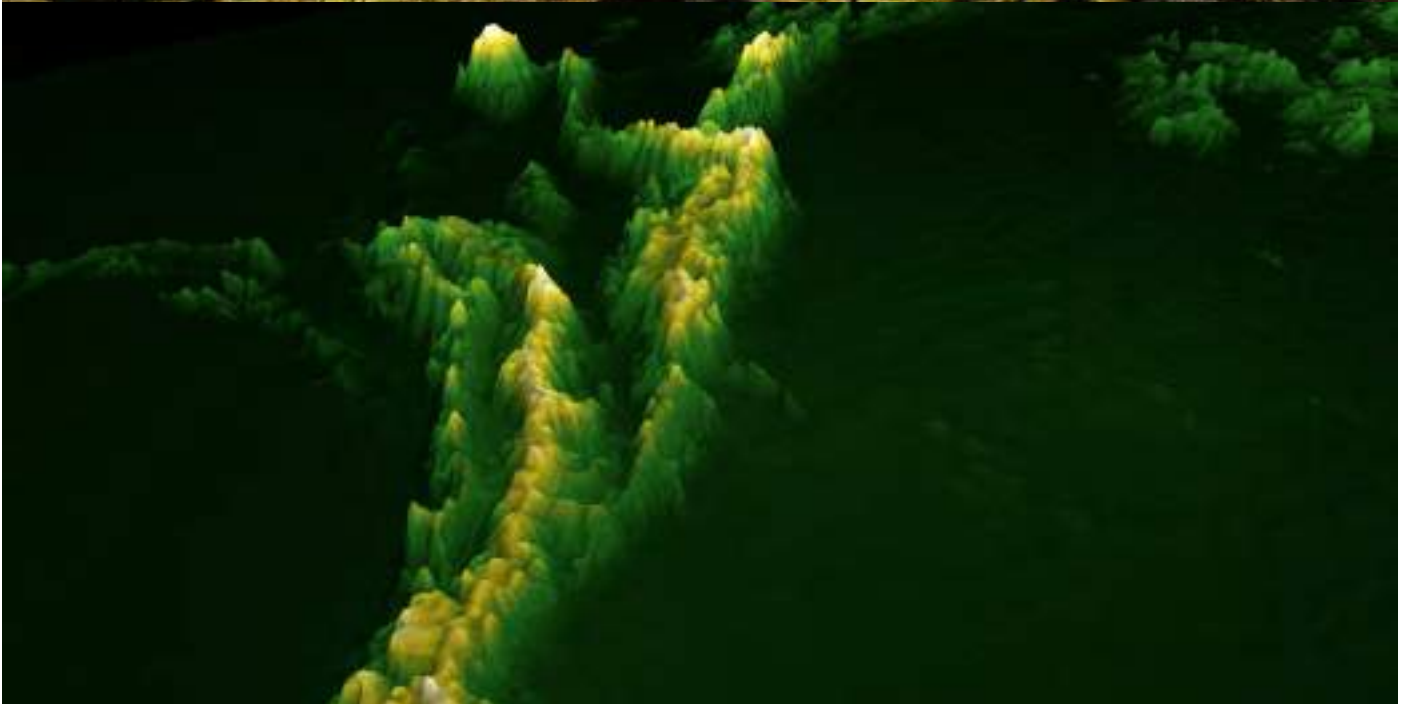
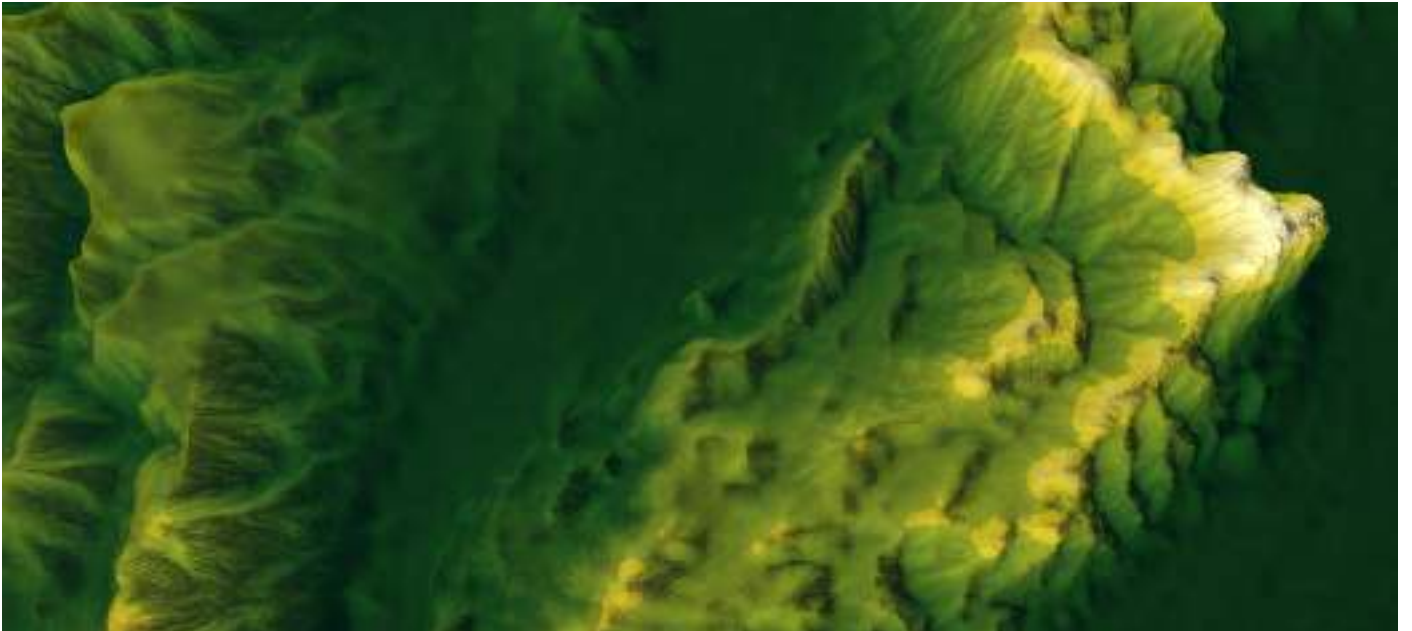
The Andes mountains emerge in South America as the longest in the Earth, and the major mountain system running the length of the Pacific coast from Argentina, Chile, Perú, Colombia, Ecuador to Venezuela. By a range of about 7.000 km from the sea level to the highest peak which rises to a height of 6.960 meters, called Aconcagua. The majesty of Andes reflects the snow in the summit and its streams and pathways in the boundary of abysses lead down to the valleys and canyons to become the giant rivers which waters run to flows into the Pacific and Atlantic oceans. These astonishing mountains harbor the riches assemblage of plants and animals in the Neotropics and perhaps in the world.



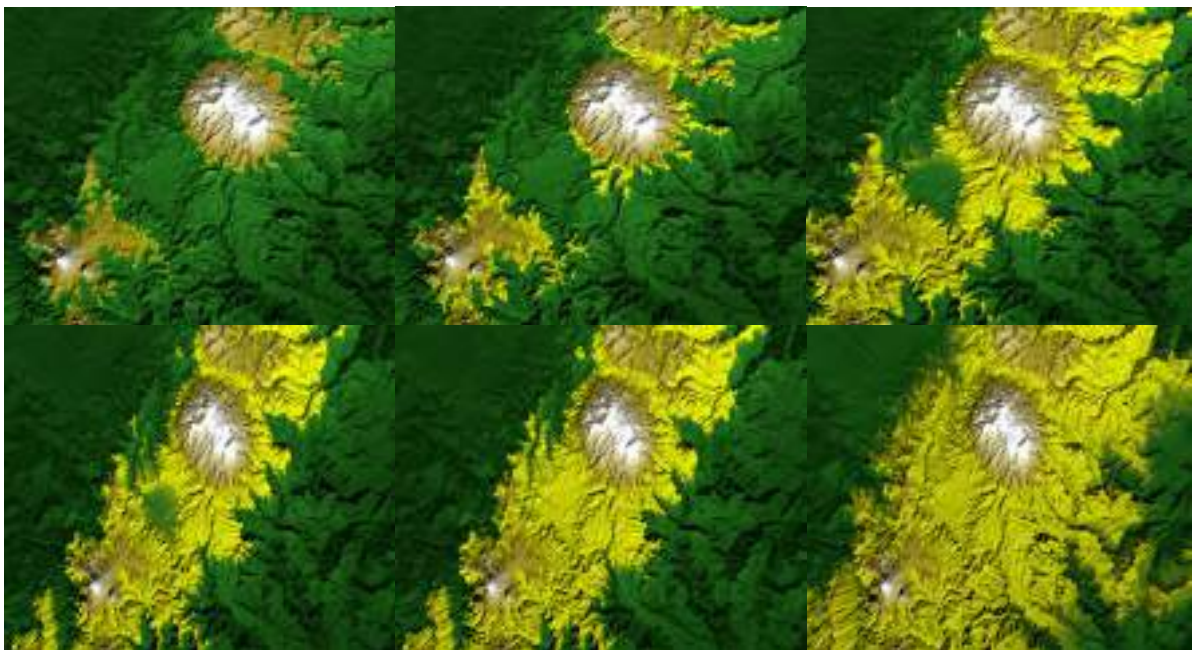
To conceive an image of the Northern Andean ecosystems from the highest to the bottom, there is a perennial white snow line in the highest peak which distribution goes from 7.000 and 5.000 meters above the sea level. Then, under the white snow peaks the amazing yellow and green Páramos ecosystems, with small but warrior plants unfold from 5.000 to 3.000 meters. If we continue walking downwards, the Andean Forest will take the scene with different structures and species composition of colorful trees, lianas, epiphytes and fauna which beauty's cloaked in foggy mist. Afterward, under 1.000 meters downwards, a tropical jungle extends its roots to the sea level where the Pacific and the Atlantic oceans hit the mountains or where the Amazon Jungles and Eastern plains will continue to meet the other side of South America (see photos of Andes, Páramos and its plants in this part).







In the present day, the Páramos resemble a refuge of species and ecological unique assemble and diversification, an archipelago of isolated islands or Sky islands. However, in the past, they dominated large surface areas throughout the northern Andes. Driven by large scale cycles of climate change, the sky islands shifted altitudinally along the mountain slopes, influenced also by the topography that causes a complex spatial mosaic of fragmented (small) and connected (large) Páramo areas. During cold conditions, the low elevational position of the páramos cause the many isolated Páramo islands to fuse, while during warmer conditions the páramos formed isolated archipelagos, as a long connectivity-disconnectivity dance or a mechanism described as the flickering connectivity system (Flantua & Hooghiemstra, 2017). For Páramos, the glacial-interglacial cycles drive fauna and flora species rhythmically along the slopes, opening temporary dispersal pathways or dividing populations of plants and animals into isolated remnants. This opportunity of connection and disconnection of plants and animal's populations created the flickering connectivity system that created the impulse for species to evolve or disappear (see animated images of flickering in different periods of time).



Today, we have the privilege to witness the existence of Páramos, not only because they are ancestral sacred places for the first aboriginal humans, and because to stand up on their land creates a peaceful sense of being part of the nature and planet, but also because they act as a sponge absorbing moisture from rain and fog for subsequent use by plants, animals, and humans. Páramo is the mother that gives birth to the water that runs downwards and maintains the life in the Andean mountains and the Earth, for water being the essential constituent that sustains and reproduces life on this planet.



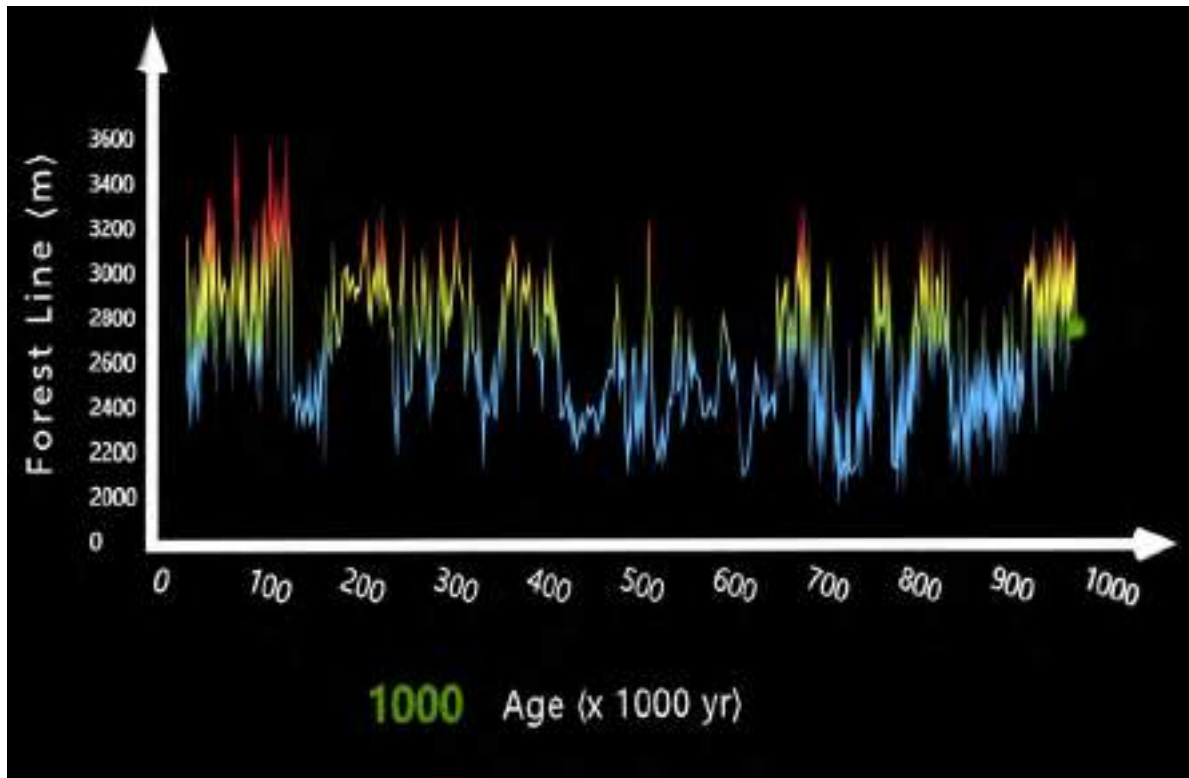
Part two

Earth Cycles: from Pleistocene to Anthropocene



The Earth is an alive organism that has been walking around the sun closer or further, grading the axes up and down and experiencing different glacial and interglacial periods of climate that have left a signature of CO₂, water, plants and animal fossil prints, amongst others. As well, the modern human history has their own record already written on the Earth's surface. The Earth is 4.54 billion (4'500.000.000) years old, since then she has been evolving and many changes on her surface and oceans have been sculpting to create the current shape she has. Her surfaces have hosted different climates, landscapes, species of plants and animals and other life forms. Between all of these species, we the "homo sapiens" are one of the most successful species with a history of just about 200.000 years, but our last civilization has emerged from industrialization to be almost completely separated from the natural systems of the planet in a mere hundred years.

The history of cycles on Earth have been written on the soils, they are as layers that we can see in a profile of sediments, in a wall of a naked mountain, in an ocean's cliff or they can be drilled from ice deposits, lakes or in a river's wall. That is the path that geologists, paleoclimatologists or paleoecologists use to find signals of past times and recreate the history on the Earth and its movements of transformation. I will briefly talk about the last period of time called the Quaternary and the newborn Anthropocene to contextualize the Sky islands story.

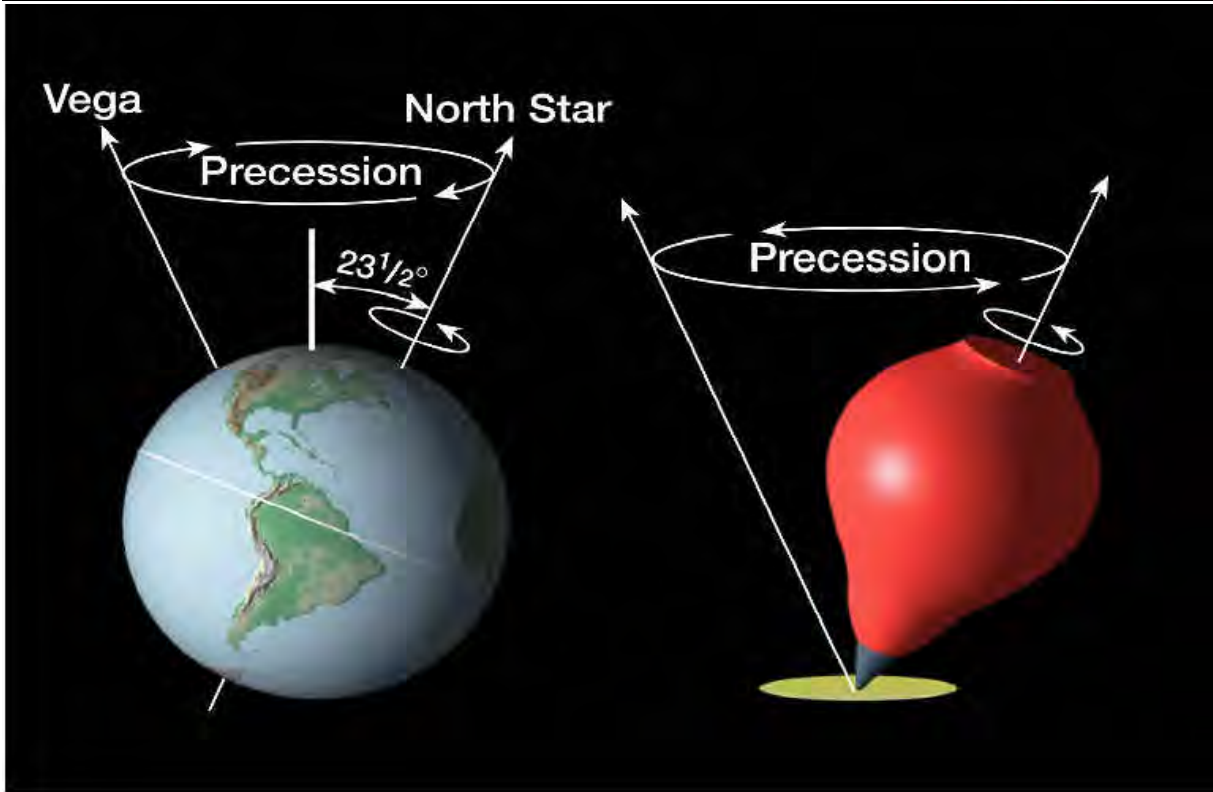
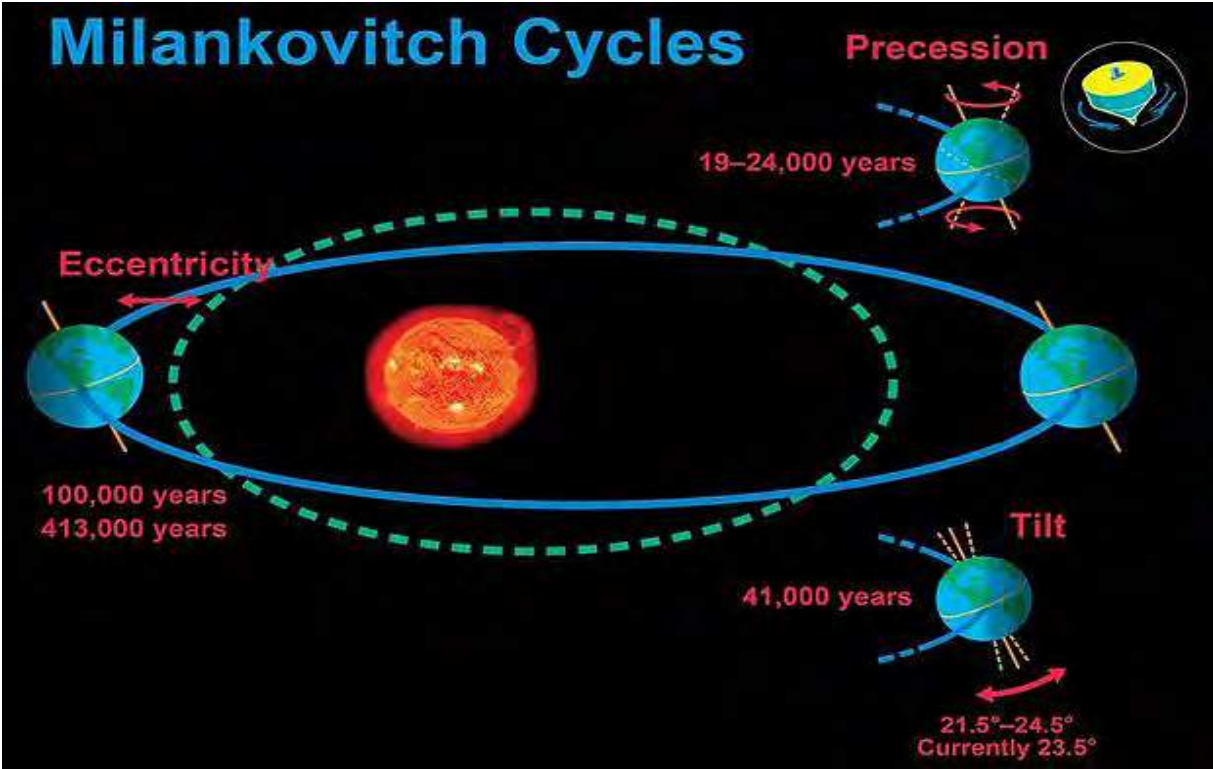


The Quaternary

The Quaternary is the more recent period with just about 2.6 million (2'600.000) years ago to the present day that can be separated in two periods: the Pleistocene and the Holocene. The Pleistocene happened between 2.6 million years and 10.000 years before present. It recorded different climate cycles with marked periodicity for glacial (cold ice-age) and interglacial (warm-age), ages that transformed the face of the Earth, causing extinction and speciation (generation of new species), as well as geographical changes in the distribution of plants and animals of which strong evidence can be seen in the Andes ecosystems (Van der Hammen, 1974). The Holocene extended from 10.000 years ago until 1.950 of our days and it is the most recent and modern interglacial. After the Holocene a new period was born, the Anthropocene, that is considered the contemporary geological period in which sediment records are evident since 1950 (Waters et. al, 2016).

The Quaternary and its glacial–interglacial cycles have been engraved in marine and terrestrial paleoclimate and paleoecological records around the world. Projects like EPICA-VOSTOK in Greenland and Antarctica and FUQUENE-FUNZA in Colombia, amongst others, have focused efforts drilling ice and sediment cores to understand local and global climate history. This fossil record show that intensive and long ice-age glacial took place followed by warm short interglacial periods, and the last million years ‘ten’ ice-ages have occurred.

These results confirmed Milankovitch's astronomical theory about cycles of eccentricity (every 100,000 years), obliquity (every 41,000) and precession (every 26,000 years), cycles that caused a repeated variation in the solar radiation reaching the Earth, which strongly influenced climatic patterns around the globe (NOOA 2017; Flantua & Hoghiemstra 2017; Hoogiemstra et.al. 2006; Scientific America 2005; Van der Hammen 1974).



The Anthropocene and Global Warming

As I mentioned before, the Anthropocene is a newborn period that describes how the modern human actions have had a drastic effect on the Earth as for example the current global warming (Crutzen & Stoermer 2000). After many discussions and recent stratigraphically record studied (Waters et. al., 2016), the Anthropocene is described with markers of functional changes in the Earth system, as a functionally and stratigraphically distinct period from the Holocene. The appearance of manufactured materials in sediments, including aluminum, plastics, and concrete, coincides with global spikes in fallout radionuclides and particulates from fossil fuel combustion. Carbon, nitrogen, and phosphorus cycles have been substantially modified over the past century, as well as rates of sea-level rise and the extent of human perturbation of the climate system exceed Late Holocene changes. Some of the most powerful pieces of evidence are biotic changes that include species invasions worldwide and the accelerating rates of plants and animal's extinction. Since 1970, there has already been a 58% overall decline in the numbers of fish, mammals, birds, and reptiles worldwide, according to the WWF's latest bi-annual Living Planet Index, which means that we are already losing species at a rate consistent with a sixth mass extinction event. These combined signals render the Anthropocene stratigraphically distinct from the Holocene and earlier epochs (WWF, 2016).



Furthermore, opposed to changes in climate that may have resulted as part of Earth's natural processes, global warming in the Anthropocene is a result of destroying natural landscapes and ecosystems and releasing ancient stores of carbon. These alterations are causing changes in temperature, sea ice extent and carbon dioxide concentrations that can be quickly visualized in the climate time machine (NASA 2017). The oil extraction, hydroelectric construction, mono-agriculture and modern cities or cement's jungle, can be seen as contributing factors, and a means towards our modern mutant creation.

In this way, global warming is not only a consequence of changes in the Earth's long-range planetary motions but also a result of the land use transformations that we have been strongly accelerating in just a hundred-year post-industrialization. As modern humans, our behaviors and habits have contributed to global warming through the carbon footprints, and this process is alerting us in ways that will make us change our habits to return to a balance with the Earth and to remember our origins as just another species. As Davis et al. (2015) described: Critical Climate Change is oriented, in this general manner, toward the epistemo-political mutations that correspond to the temporalities of terrestrial mutation. As well as I believe that our civilization is crossing the line between the end of one era and the beginning of a new one, so I wonder if perhaps, we are already living the 'Quinary'?, a new geological era after Quaternary starting with the Anthropocene, with our fingerprints already made on the layers of history deposited and eroded for millions of years. For Dickinson (2015), "Anthropocene is both a metaphysical concept and concrete reality: tomorrow's fossil record will reveal one story only, that on the rise and demise of the human race". In this sense, I agree and keep hope as Donna Haraway (2015, 2017) along with others who think the Anthropocene is more a boundary event than an epoch, like the K-Pg boundary between the Cretaceous and the Paleogene. The Anthropocene marks severe discontinuities; what comes after will not be like what came before. Haraway thinks our job is to make the Anthropocene as short/thin as possible and to cultivate with each other in every way imaginable epochs to come that can replenish refuge.



Today the Earth is a refuge, a refugium of refugia

In biology, a refugium (plural: refugia) is a location which supports an isolated or relict population of a once more widespread species. This isolation can be due to climatic changes, geography, or human activities such as deforestation and overhunting. There is evidence that glacial conditions on Earth have prevailed for approximately 80% of the past 2 million years. Biologists have long debated the fate of temperate fauna and flora during these glacial periods and the part played by cold-stage isolation of plant and animal species in determining current patterns of biodiversity. Biogeographers coined the term “refugia” to describe the localities where temperate fauna and flora existed during full-glacial conditions. However, the precise locations of refugia and their impact on the present-day distribution and diversity of species are still under investigation (Willis & Whittaker, 2000). Haffer (1969) described that forest and non-forest biomes on the continents changed continuously in distribution during the geological past, breaking up into isolated blocks and again expanding and join under the varying dry to humid climatic conditions. Then plant and animal communities disrupted and species changed their distributions individualistically during the various climatic phases, which are supported by field data, indicating vegetation changes in Amazonia existed for the Quaternary. Another example of today are Páramos that are acting as islands of refuge, but when the temperature was down Páramos expanded and the refugia were connected (Flantua & Hoghiemstra 2017).

Anna Tsing (2015) suggested the inflection point between the Holocene and the Anthropocene might be the wiping out of most of the refugia from which diverse species assemblages (with or without people) can be reconstituted after major events (like desertification, or clear-cutting, etc.). Tsing argues the Holocene was the long period when refugia, places of refuge, still existed, even abounded, to sustain reworlding in rich cultural and biological diversity as is mentioned above. For Tsing the outrage meriting a name like Anthropocene is about the destruction of places and times of refuge for people and other critters, which means that right now the Earth is full of refugees, human and not, without refuge. So today, any relict of an ecosystem on the Earth is an island, a refuge of refugees, human and not without refuge as Tsing says in wise words.

Part three

Biophilia, Solastalgia and the age of Ecological Crises

Nowadays, we are facing the age of Ecological crises led by current global warming or anthropogenic climate change. The last few years we have been witnessing extreme seasonal weather and an increment of hurricanes and tsunamis, to name just a few of the most evident environmental changes. The Earth clearly has been affected by humans but there is also evidence of how the modern human has been negatively affected by being disconnected from the Earth. We as one more of the species on Earth have forgotten our origin and this forgetfulness has brought negative consequences on our psyches and of course our planet. Here, I will introduce some of the concepts related this dis-connection and the need of being connected or grounded in nature.

In 1984 the American Biologist and Entomologist, Edward Wilson, coined the term Biophilia, a hypothesis about how humankind, as a part of our species evolutionary heritage, has an innate need to be around living things and how we are naturally drawn to those places that in our pre-historic past, have best-facilitated survival. Although, Biophilia was first used in 1973 by the philosopher and social psychoanalyst Erich Fromm, who described it as “the passionate love of life and of all that is alive”, Wilson described and popularized the hypothesis as “the connections that human beings subconsciously seek with the rest of life.” Since then, many other researchers of different disciplines have been using the concept to design urban planning as well as to find psychological health benefits and wellbeing for our society. Thus, Biophilia invites us to incorporate and cultivate a nature connection in urban communities to enhance psychological wellbeing (Cleary et al., 2017).

Solastalgia on the other hand, is a concept developed by the philosopher Glenn Albrecht and first introduced at the Ecohealth Conference in Montreal in May 2003 to give greater meaning and clarity to environmentally induced distress. “As opposed to nostalgia, the melancholy or homesickness experienced by individuals when separated from a loved home, solastalgia is the distress that is produced by environmental change impacting people while they are directly connected to their home environment”. Albrecht explains solastalgia as a combination of the Latin word solascium: comfort, and the Greek word algia: pain. Solastalgia is related to somaterratic illnesses (soma: body, terratic: earth-related) that threaten physical wellbeing and are caused mainly by living in ecosystems that have been destroyed, transformed, and contaminated by pollutants and toxins generated by over-exploitation of natural and conserved ecosystems. The alteration is a consequence of human activity as exploitation and transformation in massive scales because of mining, oil extraction, hydroelectric construction, mono-agriculture, cattle raising and modern-day cities, among others (Albrecht, 2006; 2007).

As a new concept Albrecht says: “I found that many traditional cultures and their indigenous languages have words for home-heart-environment relationships, however, it is interesting to note that modern English has very few. I created the concept of ‘solastalgia’ to fill this void and to give expression in the English language to a fundamentally important relationship between people, communities and their home environment. I also feel that we need many more new concepts that recapture the closeness that human animals have with their support environment or habitat”.

Albrecht (2007) based on his research on mining and drought also defined “psychoterratic illness” as an Earth-related mental illness where people’s mental wellbeing (psyche) is threatened by the severing of healthy links between themselves and their home/territory. Likewise, psychoterratic illness has been also named by many other psychologists working on this subject after Albrecht like “Nature Deficit Disorder, Ecoanxiety and Ecoparalysis”. For this reason, this age is recognized as the age of ecological crises (Smith 2010) and it is why the realm of the ‘psychoterratic’ or positive and negative relationships between human mental health and the earth has to be re-created in the twenty-first century” (Albrecht 2016).

Kim Donehower (2009) writes about migration and cultural and identity loss, he explains: “solastalgia captures the interrelationship between environmental degradation and the disruption of families and communities. The resulting symptoms of this human distress of dislocation and habitat destruction are –depression, alcohol and drug abuse, high rates of suicide, diabetes, and heart disease; and the breakdown of family and community culture- coupled with ecological distress are embraced in the notion of solastalgia or Earth’s nostalgia”.

The age of ecological crises is also related to the current global warming. Which is not a consequence of changes in the sun’s activity and Earth cycles at galaxy scales, it is a consequence of the transformation of land use that we have been accelerating for the last hundred years after industrialization and overpopulation. As modern humans, our behavior and habit have contributed massively to global warming. Global warming is not only alerting us to the fact that we must change our habits to re-establish balance with the Earth but also remember our origins.

In fact, there is a recent report by the American Psychological Association (APA) entitled “Psychology and Global Climate Change: Addressing a Multi-Faceted Phenomenon and Set of Challenges,” the aim of which is to examine the role of psychology in understanding and addressing global climate change, including efforts to adapt to and mitigate climate change. In that paper researchers describe the contributions of psychological research to an understanding of psychological dimensions of global climate change, provide research recommendations, and propose policies for APA to assist psychologists’ engagement with this issue (Swim et al., 6).

For me, this means that the psychological community is now aware of the consequences of global warming for the human psyche and of the vital role of the environment for a healthy life as its role in helping people to deal with this crisis.

“Ecopsychology” appeared in the same way and is defined by John Davis (2006) as the story of “the home of the soul”. It is concerned with healing the relationship between the human soul and the “soul of the world” -Anima Mundi-. It acts as a bridge between the fields of ecology and psychology to address the psychological and spiritual roots of the ecological and human crisis that we are experiencing. During the past approximately sixty years, the focus of psychiatry’s attention has gradually become enlarged, from an early preoccupation with intra-psychic [interior] processes to include interpersonal and broad sociological-anthropological factors. It would seem that a natural next phase would consist of broadening our focus still further, to include man’s relationship with his nonhuman environment.” Four decades later, this next phase in the broadening of psychologies’ focus—call it “ecopsychology” has finally begun to take shape.

So is solastalgia an old and big trauma?

In our society, everybody has at least one trauma. “The notion of trauma has confronted us not only with a simple pathology but also with a fundamental enigma concerning the psyche’s relation to reality. In its general definition, trauma is described as the response to an unexpected or overwhelming violent event or events that are not fully grasped as they occur but return later in repeated flashbacks, nightmares and other repetitive phenomena” (Caruth, 1995).

I truly believe that trauma creates a physiological route in our bodies, as a result of experiences that we have had in our life or perhaps patterns transmitted by our ancestors like a genealogical tree. Then, a physiological route is created like a pattern in the nervous system and stored as genetic information and thus transmitted from generation to generation. This means that every human being has the whole human history in their cells; one collective and common history, and one personal. In this way, if genes with DNA and RNA are the best archive or database that exists since the beginning of time, can you imagine all the collective traumas we experienced as humanity, after all this war, repression, and loss of the natural environment? Trauma generates pain, pain generates physiological paths or patterns, and as a consequence we use drugs, alcohol or chemical medication that create addiction but help us to forget the pain. This is how Western psychiatry and modern medicine resolve the big problem, and how modern society is hiding a huge and ancestral pain: Solastalgia, the pain for a lost home and the nostalgia and melancholy for the peace instilled by living in a natural or aboriginal family and community surrounded by wilderness.

This hypothesis is not far from what studies in epigenetics have found. There is evidence that trauma can be transferred to the genes and then to the next generation and it is known as epigenetic inheritance. Epigenetic is the study of physiological, genetic, environmental, and developmental mechanisms of behavior in human and nonhuman animals. Investigations typically focus at the level of chemical changes, gene expression, and biological processes that underlie normal and abnormal behavior related to substance use, psychiatric illness, learning/memory, neurodevelopment, parenting, stress, and neurodegenerative disorders (Franklin et al. 2010; Lester et.al., 2011; Bagot et. al. 2014; Davos J. 2016; Toepfer et al. 2017). This idea is controversial, as scientific convention states that genes contained in DNA are the only way to transmit biological information between generations. However, our genes are modified by the environment all the time, through chemical tags that attach themselves to our DNA, switching genes on and off. These recent studies in epigenetics suggested that some of these tags might somehow be passed through generations, meaning our environment could have an impact on our children's health. Also, is good news to know that if our epigenetic structure can become relatively jumbled due to challenging and painful environmental factors, they may also become more aligned as we make healthier decisions about exposing ourselves to less environmental contaminants and, if possible, less emotional contaminants, like stress and trauma (Davis, 2016).

In this way, somehow our hurts or pains are coming from ancestral memories. We lost our connection with the Earth, with "Mother Earth," something referred to by many aborigines or native cultures around the world like Hopis from North America, or Mapuches and Koguis from South America or aborigines from Australia and New Zealand, amongst others. How many thousands of years of Solastalgia have we have been experiencing? These folks still perceive and feel Earth as a Mother and Goddess, as a live spirit with emotions and perceptions. For those native and original cultures still with ancestral memories, "She, the Earth" is a common personification of nature that focuses on the life giving and nurturing aspects of nature by embodying them in the form of a mother. For instance, in the Inca mythology, "Mama Pacha" or "Pachamama" is a fertility goddess who presides over planting and harvesting and causes earthquakes. There are many images of women representing Mother Earth or Mother Nature, and they are timeless. In prehistoric times, goddesses were worshipped for their association with fertility, fecundity, and agricultural bounty. Priestesses held dominion over aspects of Incan, Algonquian, Assyrian, Babylonian, Slavonic, Germanic, Roman, Greek, Indian, and Iroquoian religions in the millennia prior to the inception of patriarchal religions.

Solastalgia as a concept was coined after treating a current aboriginal Australian community that is suffering distress after scarcely 20 years of experiencing destruction of their territory or land because of mining, then thinking about our genealogical tree and assuming that we are connected with our ancestors through the genes and many generations of DNA replication and information, it follows that every person on this planet is suffering from Solastalgia.

After many generations, or at least the last hundred years after industrialization, we are still not more consciously connected with “our house”, and when I say “our house” I refer specifically to our planet, our Earth.

The Earth is the only house we have, and I feel sadness every day and a pain in my heart, when observing all the destruction we have created to the original paradise that this planet was some time ago. The last generations have forgotten how to respect and feel gratitude and love for being part of the same ecosystem, it is like an organelle inside the cell forgetting that it is part of the cell or an organ forgetting that it is part of the body. It is because we forget that we are the children of the Earth and the Earth is the big mother who feeds not only our bodies but also our souls.

Are we artists able to create healing experiences in order to help the future generations to cure solastalgia?

Recapping Dewey (1934): “An experience” is one in which the material of experience is fulfilled or consummated, as for example when a problem is solved, or a game is played to its conclusion. For Dewey “life is a collection of histories, each with their own plots, inceptions, conclusions, movements, and rhythms. Each has a unique pervading quality”.

So I wonder if an experience is deeply connected with the complete body, that includes cells and organs directed by the brain and nervous system as the director of an orchestra; if it is always heading for the emotions, because an individual’s state of mind is interacting with biochemical (internal) and environmental (external) influences; if it is associated with mood, temperament, personality, disposition, and motivation, are we then able, after several experiences, to change genetic patterns and create new behaviors that may be inherited by the next generation? Could we change our genetic patterns if we change our behaviors now? Can we create a new legacy for future generations: people who feel love for the Earth and are at peace living on a beautiful planet? Could we change the future of the planet if we collaborate to change the environment, similarly to how a cell changes physiological paths to create immune defenses in order to protect the organs and the whole body? Finally, how can we, as artists, create emotions through an artistic experience that can change our perception of the environment and the Earth?

Many of these questions I feel can be answered in the essence of Albrecht when he coined the other term “Soliphilia”, meaning the solidarity needed between all of us and the need to be responsible for a place and the unity of interrelated interest within it. Solastalgia will be overcome only when sufficient numbers of us act in solidarity to defeat the forces of desolation (Albrecht 2010). Or, as Albert Schweitzer said, “ethics is nothing else than reverence for life.” In all aspects of life - social, cultural, psychological, political, scientific and economic – we as humans need to redirect our energy and intelligence to an ethically inspired, urgent, practical response to overcoming the causes of solastalgia (Albrecht 2007).

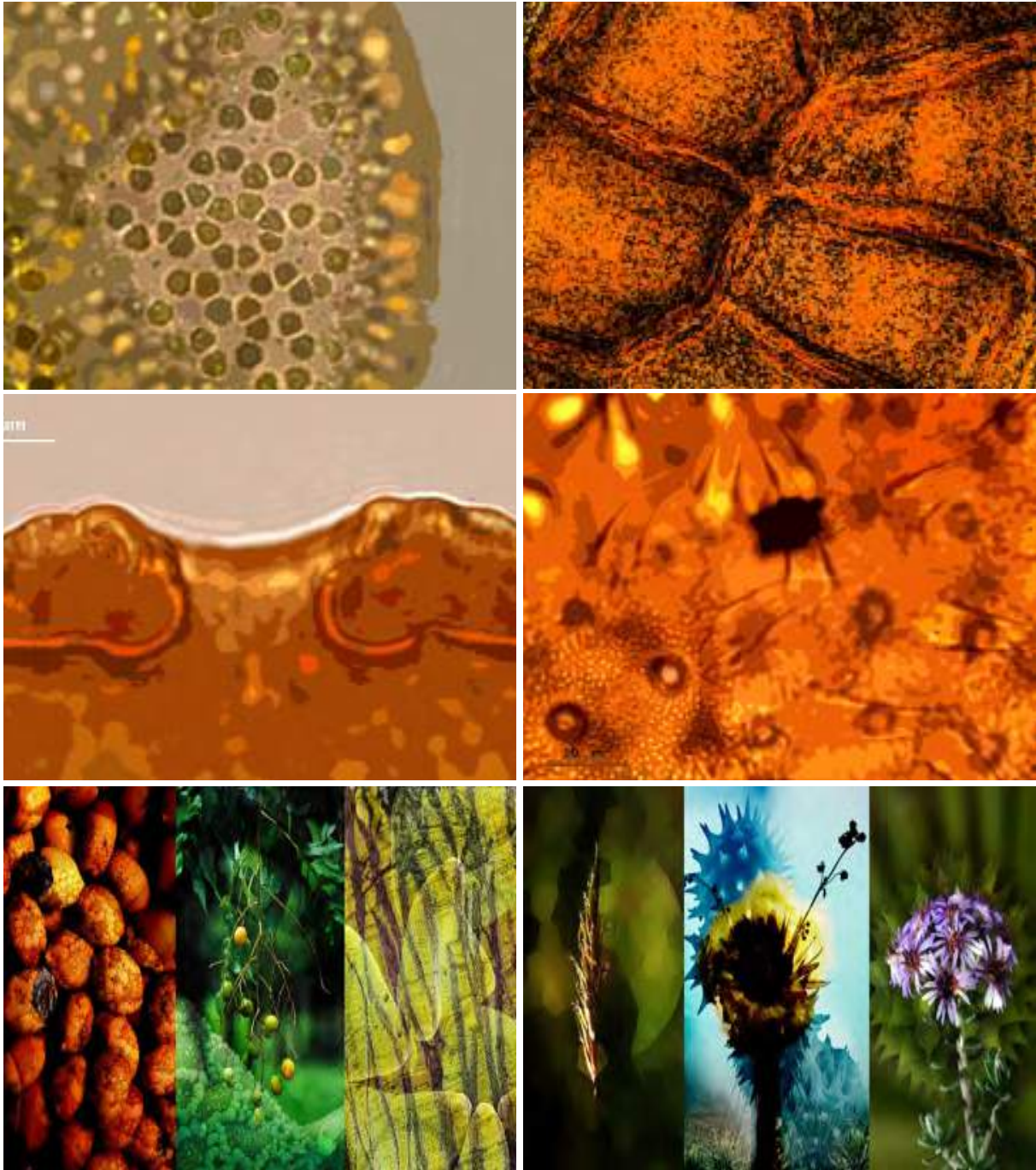
Part four ***Augmenting realities of the invisible Worlds: a travel between Science and Arts***

Micronaut

The first time I placed my eyes between a tube of two lenses it was in a cell biology class, by then I discovered the invisible worlds living under my skin, traveling through my blood currents and inhabiting my body in a way I never expected to see. I saw abstract pictures which triggered my imagination for revealing existing worlds inside of any living and no living organisms. Later, my curiosity drove me to explore neurobiology and peripheral nervous systems cells to understand how the sciatic nerve recover the path in order to repair it when it is broken. Later on, during Geography, Geology and Botany classes, I was astonished by theories about how the Landscapes and Ecosystems changed through time as a consequence of climatic changes lead by galactic cycles around the sun but also because changes in the Earth's angle. Then, the idea of discovering which plants and ecosystems happened during these cycles of time and climate was the most exciting part to me. I realized the hidden power of studying the layers of pollen fossil trapped and conserved under specific conditions of lakes, marshes, swamps, bogs, rivers and oceanic's sediments have.

I spent hours that became years seated in a special chair and watching through these two lenses. I chose the path of predicting lost ecosystems, traces of climate change, ecosystems of past times, dreaming with plants and landscapes of remote times, and it was when my travels in time and space started to go thousands of years before the present. Travels I had the opportunity to do over the Amazon Jungles and rivers, over the Andean Cordillera's ecosystems, but also my curiosity grow up further to understand dry forests, savannas, and deserts or just to continue exploring with my imagination the nature on Earth.

Researching and exploring microstructures, cells, organelles dyed with different color markers as blue or pink made me feel as a 'micronaut' or microworlds's traveler, there you have to push your mind and imagination to improve the knowledge in Science theories. But at the same time, traveling in the glass slide from one side to the other, playing with the contrasting light, objective lenses for magnification, coarse and fine focus as a ship driver, I found the abstract art of the structures which give a shape to pollen grains, trees, roots, leafs, insects and all the incredible micro-architecture of nature where deep sense of harmony, aesthetic and art is imprinted. That's why centuries after its invention, the microscope continues to prove that it is not only crucial to science but can also produce works of art and outreach (Schneibel, 2016).

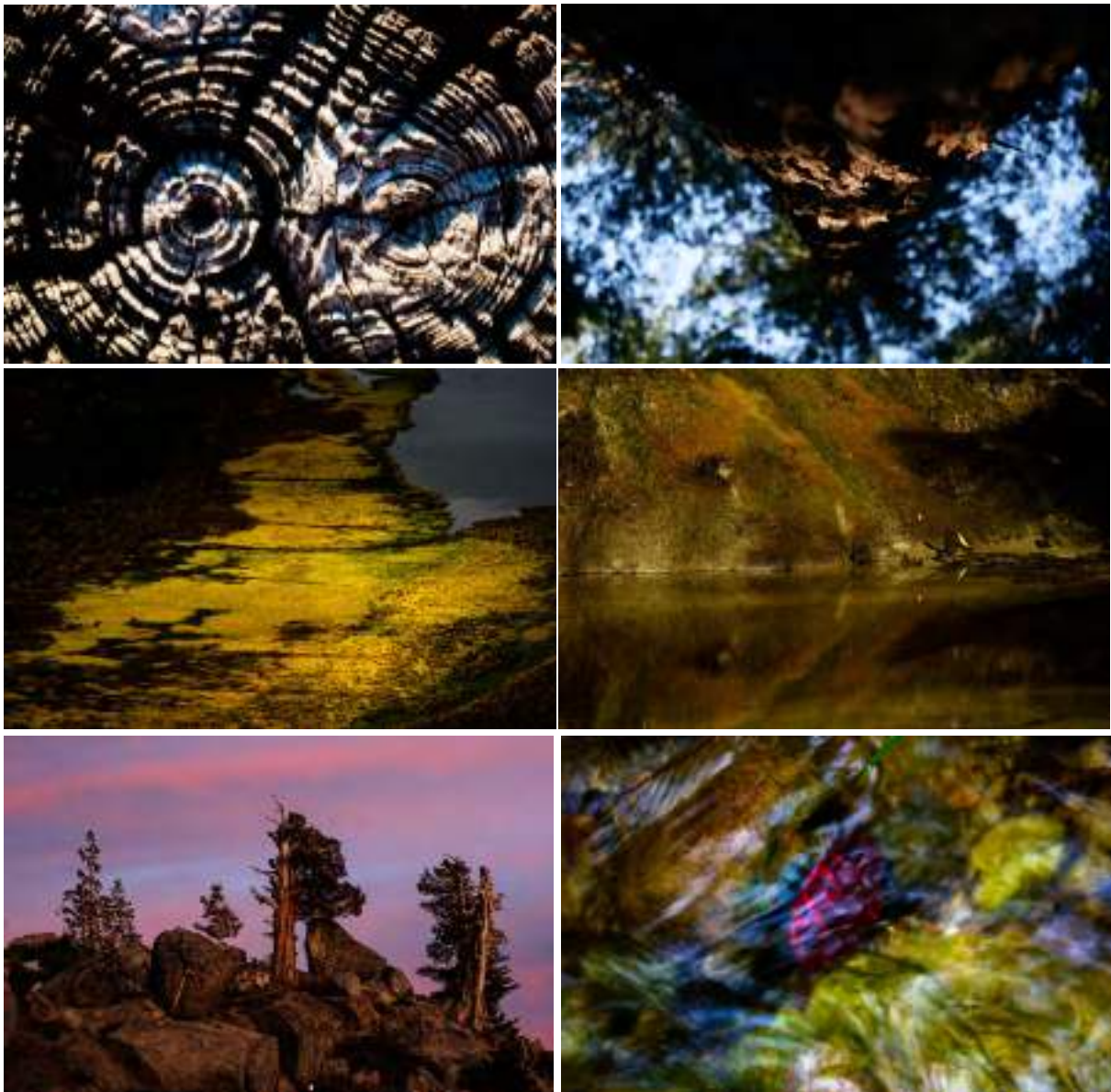


I discover more micronauts feeling the same from different science branches and definitely using a supreme electronic microscope to present amazing images where millions of augmentations are needed (Stone, A. 2014; Schneibel, A. 2016; Greenberg, G. 2017; Oeggerli, M. 2017).

The microscope was my first media object to explore hidden worlds living under the skin, under the soils, under the water and inside of any living and apparently non-living organisms. Beyond imaginable, invisible worlds came up visible to my eyes as the augmented reality of nowadays, as micro-worlds that reveal macro-worlds from other times. Since then, I never stopped to observe nature (see photos above as micronauta).

Macronaut

The analog and digital camera were my second media object and partner for years as a biology student and then as a researcher, or just as a traveler and explorer of wild nature. My work as botanist, palynologist (taxonomist of pollen), or paleoecologist (reconstructing past ecosystems using pollen fossil as a proxy) for different government and academic-based interdisciplinary research teams that investigate plant communities at different temporal and spatial scales in the Colombian Andes and Amazonian regions, allowed me to gain an understanding of landscapes, ecosystems, plants and climate change in the present and past times. But also allow me to travel and express through the use of different lens and camera my feelings about wild, nature, landscapes, plants, animals and bring them into a film of fantasy world. To my eyes hidden worlds appeared while I was an observer, a researcher of plants and flora, I felt then as a macronaut sightseeing into the wild to create through the lens or an eyewitness of what I was witnessing (see photos as macronauta).



Crossing the Science-Art's frontier

I think Arts is a way to transform or create a language of emotions, it is a medium to express feelings, imaginations, perceptions, visions, dreams, believing. I consider Art as able to cross any branch of knowledge and give them a new shape of expression. On the other hand, Science is a way to understand and answer questions about life through observation and experimentation. For me, Science is a tool to explore the meaning of life on Earth but is incomplete to express my imagination and feelings about the life on Earth, and the strength of Arts gave me the freedom I want to express my feelings and visions about this knowledge. I feel more complete with the inter-connection between Arts, Earth's Science, Psychology, Philosophy, Indigenous Ancestral Knowledge, and Technology to express my understanding of life and concerns about the Earth.

That is why I experience the objectivity of science, the subjectivity of arts and follow my intuitions and perceptions to integrate both branches. I started as spontaneous photographer of nature but also, I had the opportunity to explore Arts in the academy for first time, as part of The Force Majeure project, Sierra Nevada: an adaptation, under one of my close conceptual Artist inspirers and advisers, Newton & Helen Mayer Harrison in Santa Cruz, California (The Harrisons, 2017). This, experience help me to me to give the first step and cross the line between Science and Arts in a way to find the integration of both or just the beginning to develop my own vision.

Those years, I discovered a conceptual movement of artists exploring the metaphorical language of Planet Earth and its science. From a cosmic concept (cosmology of Ptolemy) and a terrestrial horizon (the experience of it having been altered by the discovery of the hugeness of planetary areas and the rotundity of Earth (Knebusch, 2004). A movement that started in the 1970's like "Environmental Art", which expression coined as an umbrella term to encompass Eco-Art/Ecological Art, Ecoventions, Land Art, Earth Art, Earthworks, and Art in Nature (Bower, 2010). A movement call now 'Art in the Anthropocene" (Anthropocene Agents, 2017; Dickinson, 2015; Alonso, 2015; Bourriaud, 2014). Some of these artists have been inspiring me to engage audiences, with the aim to create consciousness about the climate change, or reclaiming land and water damage, or regarding the restoration of ecosystems or protection of watersheds underuse of models for sustainable restoration. I found them as an inspiration because I feel the same need to contribute to environmental education and to plant seeds of consciousness to treat our planet with love and respect.

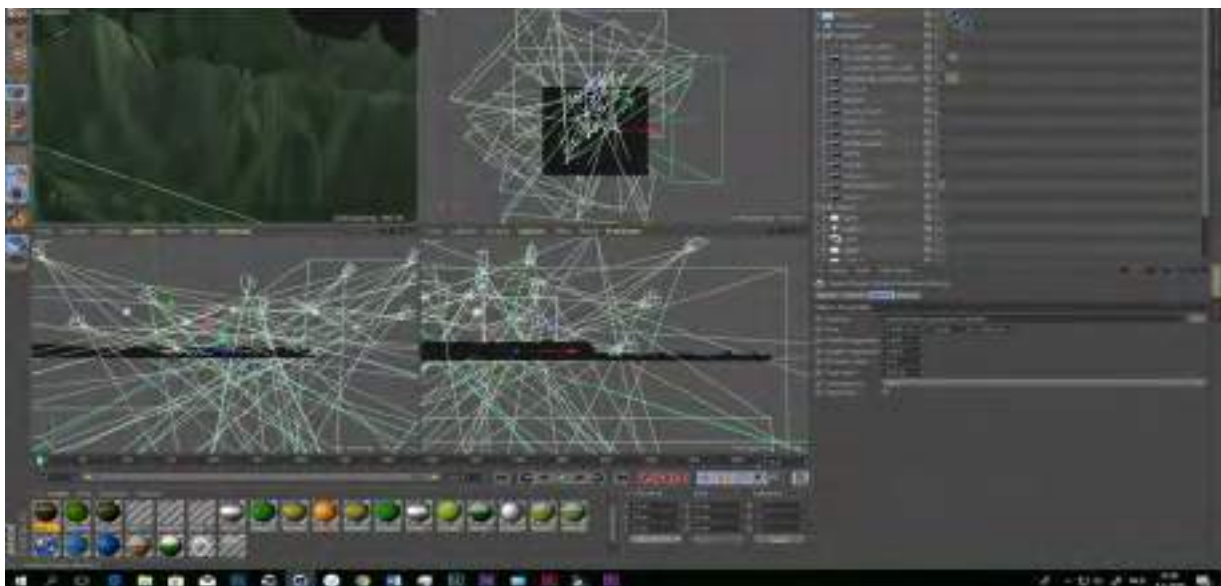
Part five

Sky Islands as an Art-Science-Technology Exploration

Cinematic fantasies or the good Engineer

I experience Science and Arts overlapping each other, as Francoeur (1997) said: Science and Arts give shape to a new creation that enlightens insights triggers our imagination and helps to put ideas in a new perspective. Especially subjects that are complex in multiple dimensions can highly benefit from the integration between theoretical knowledge and modeling with simulations and scientific visualization, shaping our sensory experience on something that by definition can neither be touched nor seen. For example, Iwasa (2014) is a molecular biologist who assures that animations are very useful for communicating an idea and also very beneficial for exploring a hypothesis in Science, her experience with the process of creating an animation is that can act as a catalyst that allowed researchers to crystallize and refine their own ideas. My experience working as biologist and artist have been complex for different reasons.

After more than a year working with Cinema 4D, I discovered that my cinematic fantasies become more an exploration of commands and understanding of a big database, that in different recipes will create ideal worlds of animation. I have been struggling with the technology as a computer motion engineer and the scientific precision need by my collaborators in science against a natural and hearth's impulse of freedom. Sometimes I just want to follow my intuitions of playing with a new tool and create images that inspire me or reflect a metaphor, further than designing an explanation. Sometimes I want to create scenarios that are not interesting for my collaborators in science and their interest as visual theory's explanation, sometimes I am dreaming to create a project where one scene will take years of working or numerous people working on that. (see photo of making the Andes in cinema 4D).



Sky Islands Installation and Past Renders

Exploring different New Media Art tools help me to generate new exhibitions about my dreams about Nature and give me an opportunity to express somehow my concerns about the present and the future Planet Earth.

Sky Islands: a past time travel in the Andes mountains somehow is a continuation of Verde Oscuro, Lluvia de Pollen, Fluctuations, and Naturalmente. Projects, I produced before and are interlaced as explorations of past, present and future ecosystems on the Earth.

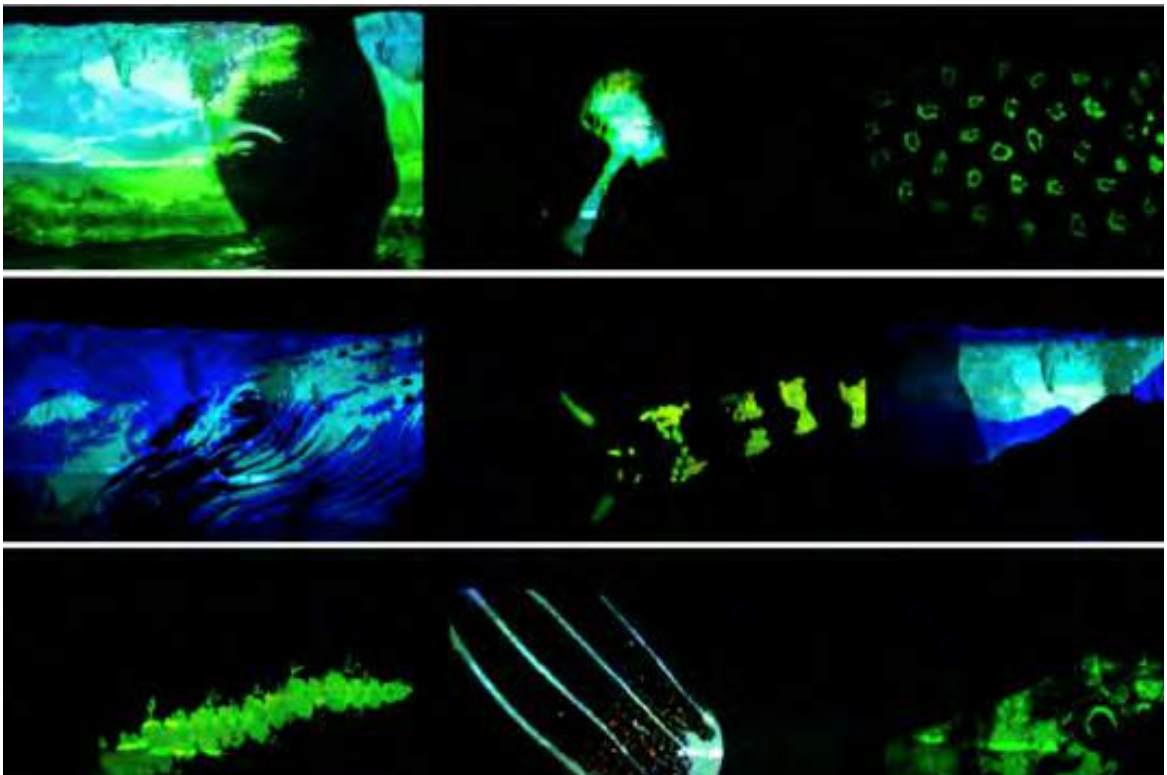
Verde Oscuro (2013) was a video mapping projection, a metaphor about the ecological history of three eras: the past, the present and the future of place a building occupies today in Santa Cruz, California (see photos).



Lluvia de Polen (2011) was a wooden structure shaped beehive cell that evokes the earth and sphere-shaped pendulum hints pollen and pollen rain that takes place on Earth at all times, integrated with photography of different Andean Mountains Ecosystems of Colombia (see photos).



Fluctuations (2014), was video mapping projection, an allegory symbolizing the Ecosystems that occur over a sea's cliff during different periods of time before today (see photos).



and *Naturalmente* (2017) was a video mapping projection on a balloon, a metaphor about the Earth. It was about the happiness concept in a sense of well-being and connectedness between different species of animals and the environment (see photo).



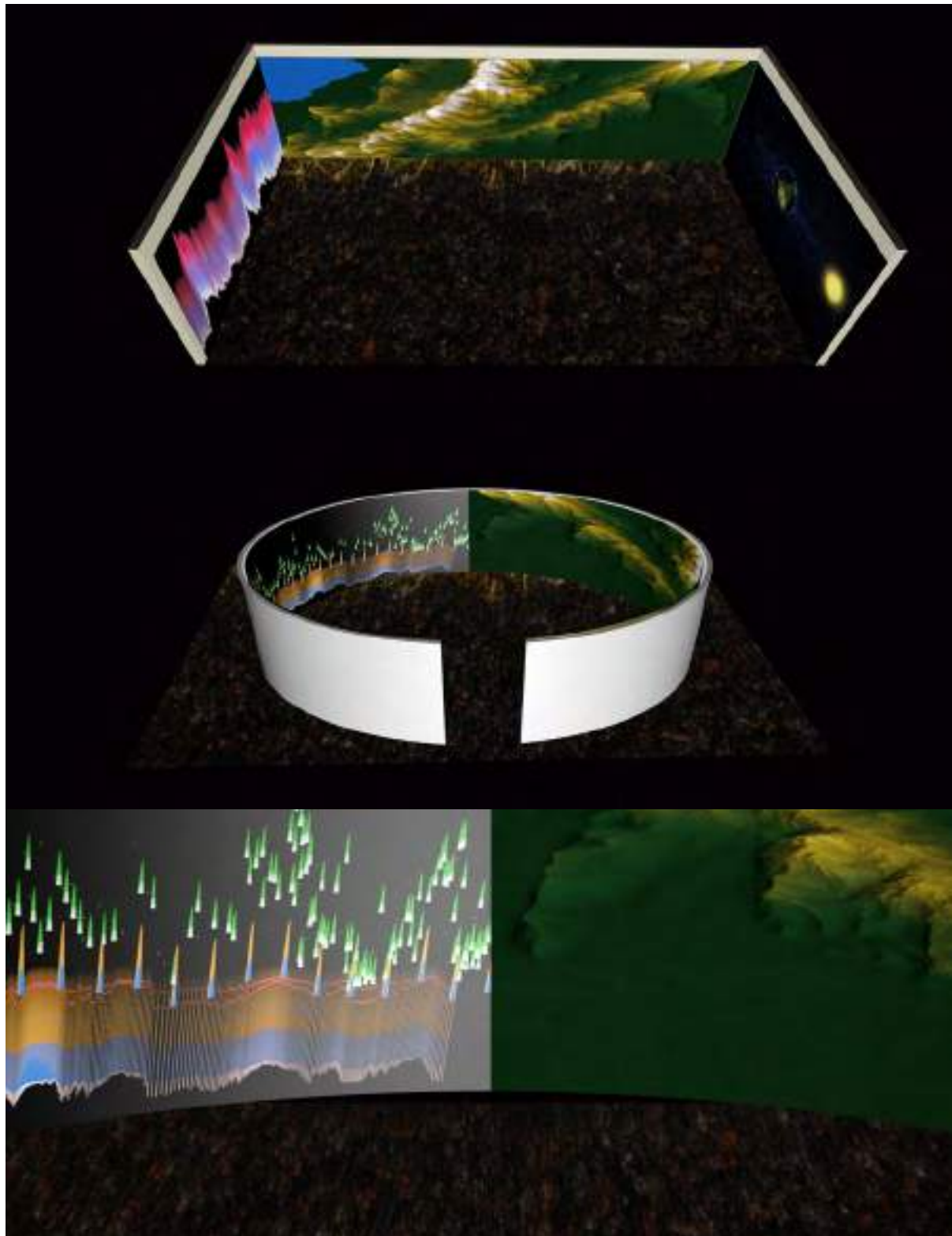
These works triggered my interest in exploring further 3D animation and data visualization as a contemporary tool to imagine ecosystems in time and space. I feel that visual art communication is a powerful instrument to create awareness about the importance of ecosystems, biodiversity, and wildlife (Giraldo, 2018).

Today, *Sky Islands* is taking a shape, it will be the result after exploring two different types of engaging audiences. The first will be a short five minutes movie directed to a group of scholars interested in learning the result of more than five decades of theories and research in paleoecological and biogeographical reconstruction of Andes Mountains in the past. This audience will be able to read and understand easy the language and terminology used in science and will be educated in an easy and visual way. This movie will be available through the social media, websites and will be used in presentations for Sciences Earth Congresses and Sciences class (see apendix I and II for the script process of transformation).

The second one, it will be an installation of immersive 360-degree screen, or multiple screens. The display will contain three types of screens. First one: with scenes of the galactic cycles outside of the Earth. Second one: the process (Flickering Connectivity System) happening in the Andes mountains as a mirroring or a reflection of the Sun-Earth cycles, and third one: scenes of a clock's time based on ice and pollen data-records (see photos next page).

This exploration will be directed to general audiences interested in Science, Arts, the history of Andes Mountains as an example of the history on the Planet Earth. I will use much larger spaces, where viewers will be able to have a physical experience, and an impression or feeling of the artwork more directly. I will use also natural components as symbolic elements of the Earth.

Today, Sky Islands is just a result for a long-term project which final shape will have new scenarios as closer scenes with plants and animals of the past times in the Andes mountains.



Conclusion

Sky Islands: a past time travel at the Andes mountains is not more than the result of a wish I dreamt many years ago when I was part of a group of researchers and traveler of the past times. Watching the hidden worlds living under the soils, under the water and inside of any living and apparently no living organisms with microscopes but also traveling for new research adventures in the forest and mountains with my camera as a witness. Since then, I saw beyond imaginable, invisible worlds that came up visible to my eyes as the augmented realities. Micro-worlds that revealed macro-worlds from other times.

Sky Islands would be outlined as an exploration of the Earth as a visual concept, with the aim to tell the last chapter of Earth's history, where global conditions affected the Andes mountains to create a unique species diversification in the Páramo's ecosystem. One of the hotspots of diversity on our Planet. This visualization, not only opens a door to travel in a time machine, from the Latest Pliocene to the Anthropocene as a first step toward opening minds and creating awareness, but also to implant a concern and post a question about how we can change the future and our relationship with the Andes and finally with the Earth in a way to mend the disaster our modern human species have been creating.

Sky Islands as 3D animation is not only an approach to visualize science's theory as a tool for scholars conceive the last million years of evolution at Páramos Ecosystems in the Andes Mountains, but also to engage politicians, kids, families and general audiences as they are current and new generations of Andean people to understand why the importance of treating the Páramos with love and respect. For this reason, collaborations between Science and Arts should continue for their immense importance to create flexible ways of learning and sharing knowledge.

To finish, the question about how can we, as artists, create emotions through an artistic experience that can change our perception of the environment and the Earth, is still looking for answers. The path will be exploring how Art installations can create the experience I want to transfer my emotions about the Earth to those whose memory is lost in the modern times.

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Appendix

TOTAL (seconds)	DESCRIPTION	ANIMATION	COMMENTS
5	Background music - background image appearing	Show a background image	
5	Title: 3D visualization of the ice age in the Andes	Show title	
5	Introduce biodiversity "Global biodiversity is unevenly distributed around the world"	Global biodiversity map	1.
10	Introduce biodiversity in and around mountains 1. Especially areas in and around mountains concentrate biodiversity 2. Tropical mountain regions with rich biodiversity are the Northern Andes, African rift valley and the Hengduan Mountains towards the east of the Himalaya.	Exaggerate mountains in global biodiversity map. Show the mountains of the tropical regions	2.
15	Introduce the Northern Andes The Northern Andes is a relatively "young" mountains with uplifts starting 10 million years up to the recent past It has a complex topographic setting of different parallel running mountain ranges called 'Cordilleras'	Zoom into the Northern Andes to show its complex topography.	3.
10	Introduce the páramos 1. The Northern Andes is home to the richest alpine ecosystem in the world, called the páramos.	Show the current distribution of the páramos in the map of the Northern Andes	4.Map?
20	Introduce the vegetation of the páramos 1. The páramos is a treeless high-elevation shrub- and grassland vegetation belt restricted to the Andes. 2. A rich plant diversity is found, including Lupinus, Hypericum, Bartsia and Puya. 3. Most striking are giant rosettes with a woody stem, the "frailejónes" (Espeletia, Asteraceae).	Show pictures of the páramo landscape and selected plants: Lupinus, Hypericum, Bartsia, Puya. Show the Espeletiina	5.
20	Introduce the hypothesis 1. The páramos have been named the "world's fastest evolving and coolest biodiversity hotspot" 2. Phylogenetic studies show that the páramos harbor a high concentration of rapidly diversifying lineages 3. These are called "radiations" and occurred especially in the recent past namely the last 3 million	Show a very simplistic animation of a phylogenetic tree that quickly "ramifies"	6.

	<p>years.</p> <p>4. So what could have driven these radiations in the Northern Andes?</p>		
20	<p>Introduce the concept of a different páramo extent in the past What we know is that the páramos have had a very dynamic history. The current distribution of the páramos is restricted to numerous “islands” on mountain tops forming an archipelago of “páramo sky islands” Early studies in the 70’s hypothesized that Pleistocene ice ages caused the páramos to be much larger.</p>	<p>Show again the current distribution of páramos on mountain tops</p>	7.
15	<p>Introduce the effect of climate fluctuations 1. Cold periods during Pleistocene climate fluctuations caused the páramo to move downslope. 2. As a result, many páramos were connected in the past forming vast areas throughout the Northern Andes. 3. Until now, most páramo reconstructions only go 21.000 years back into time, the period called the Last Glacial Maximum.</p>	<p>Zoom into the Puracé. Show the changing páramos extent</p>	8.
15	<p>Introduce long fossil pollen records 1. Thanks to a 540 m long fossil pollen record retrieved from a deep lake basin in Colombia... 2. We can now reconstruct the dynamic history of the páramo over a period of 1 million years. 3. Fossil pollen records provide insights into past vegetation and climate conditions</p>	<p>Shown the Northern Andes and the location of Funza record Show a fossil pollen record “appear” from the Bogotá basin</p>	9. Show pollen grains?
30	<p>Spatial reconstructions of the páramos The páramos show a complex pattern of isolated and connected islands changing through time During cold periods, it expanded extensively forming large areas of connected páramo During warm periods, numerous páramo islands formed and in some regions connected into archipelagos.</p>	<p>Show the 12 maps with 12 UFL positions here show also the oblique distribution areas of páramo. Bring the 12 settings in a movie & a running dot along the pollen record is indicating (a) time and (b) showing cold max-glacial < - > cool</p>	10. Figure found in thesis (Flantua & Hooghiemstra 2017&2018)

		stadial < - > mild interstadial < - > warm interglacial conditions	
	<p>Introduce the FCS The interaction between topography & climate change causes páramo <i>fragmentation</i> and <i>connectivity</i> at different moments in time This is what we call the “Flickering connectivity system”</p>	Show the flickering connectivity system over the entire Northern Andes Show the word “Flickering connectivity system”	Closer of FCS
	<p>Introduce the mountain fingerprint Connectivity and isolation occurred in a spatially and temporally unique way Therefore each mountain has a different timing and patterns of species diversification. This is what we call the mountain fingerprint. It is a unique mountain identifier.</p>	Create a mountain fingerprint image from the topographic landscape of the Northern Andes	12
30	<p>The appearance of new species during time 1. Species responded to the flickering connectivity system by dispersing to different regions during cold periods. 2. During warmer periods, species were isolated again and new species could evolve.</p>	Visualize the dispersal of species through the landscape	13
	((here make wrap-up to repeat hypothesis))		14
	Future climate change threats to páramo	<i>Discuss this part more with Catalina</i>	15
15	<p>Final credits and acknowledgments Hugo de Vries-foundation Rotterdam Academy . . . Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam Personal thanks</p>		

1

2 **Flickering Connectivity System / the Sky Islands**

3 **1-2 (Earth scene and biodiversity).**

4 Biodiversity is unevenly distributed around the globe.

5 In and around mountains in particular high levels of biodiversity are concentrated.

6 For example, the Northern Andes, the African Rift Valley, and the Hengduan Mountains
7 in the Eastern Himalaya are fine examples of species-rich areas.

8 How can we explain these concentrations of biodiversity ?

9 Let us focus on the Northern Andes to explore this question.

10 **3. (Uplift of Andes)**

11 The Northern Andes is – geologically speaking - a “young” mountain

12 The uplift started some 10 million years ago and lasted to 3 million years ago.

13 This movement created high topography in the landscape with parallel running
14 mountain ranges called ‘Cordilleras’.

15 **4-5. (Photography)**

16 The area in the highest parts of these mountains, above the upper forest line, is home to
17 cold treeless grasslands, called 'páramo'.

18 The páramo is a tropical alpine ecosystem and considered the richest alpine flora in the
19 world.

20 (Camera flow over Andes from Northern to south).

21 The páramo biome includes almost 4000 different vascular plant species, including 22
22 families of Ferns, 1 family of Gymnosperms, and 100 families of Angiosperms. Genera
23 with a remarkably high diversity are *Lupinus*, *Hypericum*, *Bartsia* and *Puya*, amongst
24 others.

25 But the most striking megadiverse plant group is that of the Astereaceous “frailejónes”
26 with woody stem rosettes varying from sitting on the ground to giants of 6 meter tall.

27 The scientific name of this group is “*Espeletiinae*”, including 6 different genera.

28 The genus *Espeletia* is the best known.

29 **6. (phylogenetic tree or something else, I am preparing a scene to show speciation 30 also, maybe useful here).**

31 Phylogenetic studies show that the páramo harbor many rapidly diversifying plant
32 lineages.

33 Diversification, or “radiations” in the evolutionary tree, occurred in the last 3 million
34 years, in particular.

35 So, what could have driven these radiations in the Northern Andes?

36 **7. (Distribution of páramos from north-south camera view oblique/above from Andes 37 with camera view overflying. Finishing with a zoom into the Puracé to show the 38 changing páramos extent)**

39 Records of environmental change have shown that the páramo experienced hundreds of
40 upslope and downslope migrations during the last 2.5 million years – the period of the
41 Pleistocene ice ages.

42 During the last million years in particular, these altitudinal shifts were up to 1500
43 vertical meters.

44 The distribution pattern of the páramo has changed dramatically through time.
45 The topography with numerous mountain peaks, valleys, plateaus, and mountain passes
46 played an important role.
47 The present-day surface of páramo covers only 5% compared to the Last Glacial
48 Maximum, some 20,000 years ago.
49 Today páramos are restricted to mountain tops and form an archipelago of “páramo sky
50 islands”.

51 7-8. [\(Flickering\)](#)
52 When climate is warming, mountain ecosystems move upslope, and the mountain
53 topography fragments the páramo in smaller patches.
54 When climate is cooling, these ecosystems move downslope where the mountain
55 topography offers much more space and connections.
56 A pollen-based record of climate change from the Bogotá Basin in Colombia showed
57 that climate fluctuated continuously during the Pleistocene.
58 As a result, the total surface and connectivity between páramo fragments varied
59 dramatically.
60 This caused that plant populations and their the gene pools also became isolated and
61 mixed up hundreds of times.
62 This important mechanism is what we call the “Flickering Connectivity System”.

63 [\(Zoom into the Puracé. Show the changing páramos extent and the Ice ages clock-](#)
64 [Funza\).](#)
65 During the cold periods of the Pleistocene – some 20% of its time - páramos were large
66 and plant population connected, which enabled gene flow.
67 During the mild and warm periods of the Pleistocene - some 80% of its time – páramos
68 were small and restricted to the mountain tops, forming “archipelagos” of páramo
69 islands.
70 Connecting and disconnecting gene pools is an important mechanism for speciation.

71 9. [\(Shown the Northern Andes and the location of Funza record. Show a fossil pollen](#)
72 [record “appear” from the Bogotá Basin\).](#)
73 In current research, páramos distributions are mostly compared between the last glacial
74 maximum (20.000 years ago) and today.
75 Thanks to a pollen-based reconstruction of climate change that comes from a sediment
76 core near Bogotá of more than half a kilometer deep, we know how the páramo has
77 shifted over the slopes of the Northern Andes during the last 2 million years.
78 As a consequence, we also know how climate has varied during the last 2 million years.

79 11. Flickering connectivity system
80 The availability of a long record of climate change allows us to precisely reconstruct the
81 changes of the páramo during the last 2 million years.
82 Different cordilleras have a different topography.
83 As a result, a single climate event has different effects in different mountains,
84 Fragmentation and connection occurred at different elevations, at different degrees,
85 and at different moments in time.
86 [\(Closer to show islands of isolation and connectivity with flickering\).](#)
87 Again, this is what we call the “Flickering Connectivity System”.

88 12. Mountain Fingerprint.
89 For each mountain, depending its profile, connectivity and isolation of gene pools
90 occurred in a spatially and temporally unique way.
91 Therefore, the timing of radiation in the phylogenetic trees, in each mountain is
92 different; it is mountain-specific.
93 This is what we call the “Mountain Fingerprint”. It is a unique mountain identifier.
94 Geologically old, and eroded mountains that lost already much of their topography
95 show a different ‘Mountain Fingerprint’ as geologically young mountains that still have
96 much of their rough (rugged?) original topography

97 13. “Mountain Fingerprint” is the template on which the “theatre of Pleistocene climate
98 change” is acting; the páramo biome is dancing up and down the mountains, the “gene
99 pools” of the páramo species suffer the results, and branching of the “phylogenetic trees
100 of diversity” is the result.
101 The Flickering Connectivity System includes two essential mechanisms.
102 First of all, fragmentation of populations causes isolated small distributions at high
103 elevations during warm periods.
104 Speciation (ramification in the phylogenetic tree) occurs after the gene pool had
105 changed during the period of isolation and when individuals do not produce fertile seeds
106 any more.
107 Merging together during cold periods of numerous small patches of montane species
108 into large areas allows exchange of genes between formerly isolated populations (gene
109 flow).

110 14. ((here make wrap-up to repeat hypothesis))
111 So the “Mountain Fingerprint” is the template on which the “theatre of Pleistocene
112 climate change” is acting.
113 Driven by climate change, the páramo dances up and down the mountains, and the
114 gene pools of the páramo species suffer repeated isolation and merging together,
115 reflected in the “Flickering Connectivity System”.
116 During isolation (some 20% of Pleistocene time) mutations in the genomes may drive
117 individual species apart to a level that later offspring is not able any more to produce
118 fertile seeds. At that moment a new species is “born” which is marked by a ramification
119 in the phylogenetic tree of diversity,

120 15. Future climate change threats to páramo
121 Records of past climate change have shown that páramo conditions may last maximally
122 some 2000 years stable before they change. During transitions from glacial to
123 interglacial conditions changes accelerate and the páramo biome may shift upslope at a
124 speed of 1000 vertical meters per 100 years. The páramo biome is able to respond to
125 the fastest events of climate change.
126 However, anthropogenic impact on the páramo is of a different character. Páramo is
127 being extensively degraded and destroyed.
128 In the past, páramo was able to naturally respond to the high velocity of Pleistocene
129 climate change, but today, great concerns arise if the páramo will survive global climate
130 change and human impact.
131 Final credits and acknowledgments

132 Hugo de Vries-foundation

133 Nuffic

134P Piet Zwart Institute, Rotterdam University of Applied Sciences.

135I Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam

136T The late professor *Thomas van der Hammen* developed much understanding of páramo
137 dynamics. The late professor *José Cuatrecasas*, and professor *Antone Cleef* probably
138 have visited most of the 2100 islands in the present-day archipelago of páramo
139 localities. *James Luteyn* is thanked for bringing so much floristic information together.

140 his vizualization stands at the end of a 60 years period of páramo research. While
141 several hypermodern scientific technologies are speeding up our understanding, the
142 páramo biome is at the same time being damaged at an unprecedented intensity. A
143 scenario is emerging that within decades we know everything of a lost biome.

144 Personal thanks

145 x

