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Eco-Development Response to Climate Change and the Isostatic Uplift of Southwestern Finland

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Received: 20 September 2019; Accepted: 30 October 2019; Published: 1 November 2019

Abstract: To date, care for our planet is mainly focused on the remediation of climate change induced by the huge amount of anthropogenic emissions of greenhouse gasses and its precursors. Transforming fossil combustion to more sustainable energy worldwide is a wellknown example. In contrast, what is little known is that the environment shaped by humans is also challenged by relatively fast geological dynamical phenomena such as the isostatic uplift of Fennoscandia, parts of Canada and northwestern Russia. Due to this uplift, the archipelago along the coast of southwestern Finland and Sweden changes rapidly to mainland. This phenomenon deeply affects both nature as well as the environment, resulting in the relocation of human activities. Here, we interpret the on-ground observed regression of the Gulf of Bothnia on the coasts of southwestern Finland and its implications on countryside activities in the framework of the eco-development paradigm. Furthermore, remotely sensed data on surface wetness confirms this sea regression and the silting-up of the nearby lakes that drain precipitation to the Gulf. We show that this eco-development paradigm may rebalance nature, environment, humans and culture and that it is a valid alternative against the past and present-day socioeconomical approach that has accelerated the change in the Earth's climate.

Keywords: isostatic uplift; sea regression; development paradigm; ecosystem shift; climate change

1. From Dominant to Bioregional Development: A Paradigm Shift

In the last two millennia, human population expansion and human action has dramatically transformed the Earth. The new era of Antropocena started some 2000 years ago, and industrialization since the 18th century and worldwide globalization in the last three decades have impacted on the planet. According to Evanoff [1], the dominant development paradigm (DPP) conceptualizes the anthropogenic way of management of the Earth, which is created by a global economic market, a new world order based on borderless societies and neoliberal economics ruled by the principles of transnational coordination. In addition, he also mentioned the destructive impact of this global world concept on the sustainability of the environment and biodiversity.

The DPP starts from the triad capitalism, economy and scientific technology as the universal socioeconomic paradigm, excluding any reference to the particularity of the place and time of the human action. Each element of this triad is mutually supportive of the other elements. Nations all over the world create social terms and technical infrastructure in order to support the dynamics of the triad as a perpetual mobile, which is, according to Evanoff [1], responsible for an unsustainable world without social justice and wellness for everybody.

Indeed, the invisible hand of the global free market is deeply restricted by ecological phenomena such as climate change and unpredictable weather conditions (e.g., huge rainfall followed by long drought periods). Unfortunately, the remedies promoted by the International Panel on Climate Change (IPCC) are based on the deterministic global monovision, while local environmental issues are caused by specific local variables, natural as well as human induced. Moreover, the DPP with its unfortunate device "think global, act local" is completely useless because it denies human's and non-human's tight connection to a particular place and a particular history and, as a consequence, it denies the diversity of social and cultural organizations embedded into the environment. This policy, adopted by the EU and imposed by Brussels on all EU member states, clearly did not reduce the ecological footprint that exceeds Earth's maximum carrying capacity [2].

That is why Evanoff [1] has suggested a completely different way to manage climate change and diversity decline starting from the particular substantial local parameters influencing the local environment conditions—the so-called eco-development is a shift from the DPP to the bioregional paradigm (BP). To realize the paradigm shift, Evanoff [1] proposes a transactional framework which offers a dynamic and co-evolutionary understanding of how humans interact with their natural environment.

Therefore, Evanoff reformulates Steiner's [3] human ecological triangle environment-society -person as support for the paradigm shift. His transaction attempt suggests the bioregional model of participatory politics that expands the scope of moral concern beyond self to include both community and environment. He calls his model the third alternative to both capitalism and Marxism, and it is opposed to the centralization of decision-making power in either the hands of the state and government elites or in the hands of private enterprise and business elites [1]. In order to realize this transition to a Bioregional "World Order," he starts with a personal transformation based on three initial boundary conditions. Firstly, there must be a change not as the result of a top-down fashion, but through a process of inclusive deliberation. Secondly, there must be a pluralistic way to achieve such symbiotic relations with the local ecosystems. Thirdly, there must be room for a plural strategy for implementing change. The accompanying social transformation can follow many paths as Murphy [4] suggested but, finally, he prefers curtailing the current levels of production and consumption and creating sustainable communities at the local level.

Climate change, however, though recognized as a worldwide scientifically detectable observation, involves quite different evolutions of specific ecosystems. Moreover, some regions on Earth are characterized by interferential natural accidents such as earthquakes, tsunamis, glaciers melt, fault lines at the edges of continental plates, subsidence and uplift [5]. Consequently, to realize the bioregional paradigm shift, we claim a modified ecological interaction model based on the mutual influences of geological parameters, environment sustainability, human individual and cultural action.

2. Research Objectives and Structure

The bioregional paradigm has to be realized in a bioregion. Sale [6] defined a bioregion as a life territory, a place defined by its life forms, its topography and its biota, rather than by humans dictates: a region governed by nature, not legislature. He determines three types of bioregions [6]. First, the ecoregion, with similar native vegetation and soil types, sometimes situated on an old pre-Cambrian geological shield, for our interest, for instance Fennoscandia. Furthermore, there are the geo-regions, existing inside ecoregions identified by clear physiographic features, such as the archipelago or shear coast of western Finland. Finally, there are the morpho-regions within the geo-regions. They are identifiable by distinctive life forms on the surface—villages, towns, fields, farms, forests, marshes, coastal bays—giving a particular feature.

We started our investigation to propose an eco-development project (ED) in the Mustalahti area, Ahlainen, Pori (60°40′30″ N, 21°37′14″ E), situated in the geo-region of the archipelago or shear coast of Finland, a part of Fennoscandian ecoregion. The research questions deal with how clearly the isostatic uplift can be observed from both ground as well as from spaceborne observations (i), how the uplift effects the interaction of people with their environment in a global economy framework (ii), and how an alternative development strategy can be formulated. The Mustalahti area is already in the last stage of silting-up due to the isostatic uplift and, consequently, it precedes what will happen in the greater southern area of Finland where the uplift is slower. This case study of the Ahlainen area around the Mustalahti is considered to be a standard case for the whole countryside of Finland's southwestern coast. Thus, the Mustalahti area provides a model for constructing the landscape in the Vaasa area with the Kvarken or Merenkurkku archipelago, where an even faster uplift is occurring, which in the end will create a Bothnia inland sea within a period of 500 years, and in other regions of the world.

We introduce the concept of eco-development in Section 3 and we propose the modified eco-development theory applied on the mentioned study area in Section 4. The sea regression due to continental uplift is demonstrated in Section 5, quantified based on ground-based and remotely sensed observations of the Mustalahti lake. In Section 6, we discuss the consequences of this isostatic uplift on the eco-systems in the study area in combination with climate change. The socioeconomic situation is described in Section 7 in the framework of the current dominant development paradigm. Section 8 deals with the alternative socioeconomic option for southwestern Finland based on the modified eco-development paradigm. Finally, the conclusions are formulated in Section 9.

3. Eco-Development and Transactionalism

The term eco-development (ED) was first developed by Riddel [7] to formulate a proper answer to the interaction between humanity and nature. ED indicates a best attempt to optimize the balance between populations, local available resources, and cultural desired lifestyles [7]. It is based on an eco-evolution of nature and society. Sachs quoted by Burkey [8] specified eco-development as a style of development that, in each ecoregion, calls for specific solutions to the particular problems of the region in light of cultural as well as ecological data and long-term as well as immediate needs. Environmental conditions give rise to cultural modifications and vice versa. Eco-development implies a co-evolutionary process wherein causation is never unidirectional but always multidirectional: organism, human and non-human both modify and are modified by their environment [9]. Organisms and ecosystems are created mutually or as stated by Lewontin [10]: " ... an environment is nature organized by an organism ... " [11].

However, the difference between nature and environment is not widely accepted. Basic writings of ecology from Passmore [12] do not differentiate the two. Achterberg [13] mentioned this by referring to comments of de Haas [14]. For two millennia, however, humanity transformed large parts of nature into environment. Moreover, a new geological era—the so-called Anthropocene—is characterized by human's rational management of Earth. Instead of social participation according to Earth's common dish, Western culture encourages individual emancipation by technical intervention. Natural ecosystems are irreversibly affected, disappear or make room for new environmental systems. Natural sustainability is broken, the sustainability of the environment has to be maintained by human technical intelligence, particularly in recent decades since Western emancipation of the individual is globally adopted by middle class people all over the world.

Obviously Riddel´s [7] ED needs to be updated by analyzing environment and nature separately, and articulating society by its two actual driving forces, namely individual emancipation and human culture. Consequently, this makes room for a fourfold transactionalism made up by four pillars supporting the new ecosystems, just like the four legs of a table. Furthermore, four pillars can only produce an equilibrium if they are well balanced.

To update Riddel´s ED [7], we reject Steiner´s triangle environment-society-person [3] as Evanoff [1] does, because we reject any conceptual approach and follow the process trail of Whitehead [15] and Naess [16]. Indeed, the mentioned fourfold multiplicity is not at all conceptual, but four pillars represent four ensembles of events, mutually interacting in a dynamic way. In the more general scope, the modified eco-development (MED) relies on Whitehead´s process vision about nature [15] and Naess' relational, total-field image [16]. Besides, MED makes room for Evanoff´s [1] conception of transactionalism that sees the human-nature relationship not as isolated entities, but rather in terms of relationships they have with both nature and society. We enlarge Evanoff´s transactionalism by human technological and rational faculties, embracing natural phenomena encouraged by basic principles of the culture he belongs to. This is also in correspondence with Leopold's Land Ethics [17] and more recent reformulations [18].

About the latter table leg of new ecosystems, the outstanding research of Klückshohn [19] and Hofstede [20] can contribute to the better understanding of human´s transaction from nature to environment. Particularly, both authors mentioned human behavior with respect to nature as one of the basic features of any culture. They distinguish a dominant human behavior with respect to nature contrary to a more harmonic behavior. Western cultures are rather dominantly governing nature. According to Verstraeten and Verstraeten [21], the former cultures situate ecosystems in an open space-time container, with a linear time-like evolution and a human active observer from without—the latter adopt a rather participating attitude to ecosystems with a cyclic time evolution according to natural seasons.

Nature has its own laws of the creation and corruption of biotic life as well as the dynamics of the energy transitions of sun light, tides, erosion, subsidence and uplift of continents. The environment contains cycles of water, C, N, P, etc., landscape stress due to biotic and particularly human interaction, climate change due to interactions of nature and biotic life in their struggle for life or comfort. Culture gives meaning to nature and environment and enlarges the essence of human biotic life to human existence. Human settlement transformed nature into environment, partly breaking down the sustainability of nature. The interference, however, enforces humanity to establish a new equilibrium between ecological sustainability, human well-being and social justice in order to reconstruct dynamical equilibriums within the basic fourfold multiplicity. As an overview summary, Figure 1 illustrates the different development paradigms in a more schematic way.

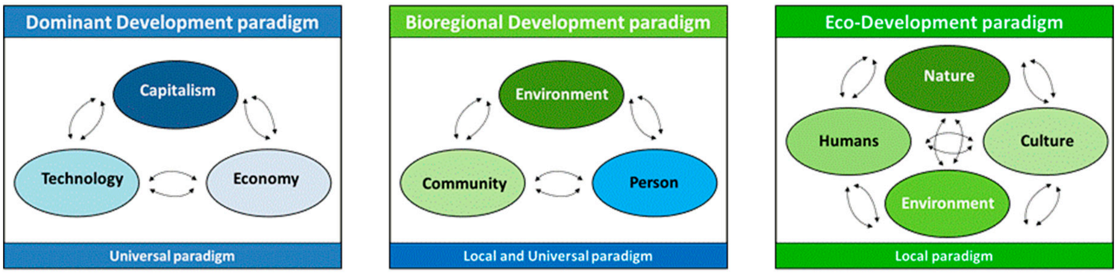

Figure 1. An overview of the mentioned development paradigms, its elements and its interactions.

4. Environmental Pillar of Modified Eco-Developmental; Climate Change and the Hemiboreal Forest in the Southwestern Coast of Finland

A policy project was conducted on the impact of climate change on habitat for certain animals and plant species with extension to human action, economics and social cultural aspects [22]. The project paper [23] covers an excellent overview on what can happen if the average temperature increases 1.5 K in southwestern Finland [24,25]. In this hemiboreal area, the frost period will reduce to 40–50 days [25] and precipitation will increase in winter, but it is unknown what will happen during summertime [26]. The precipitation will be more intense, and droughts will become longer and more dramatic. The increase in CO_2 levels may result in more sequestering of CO_2 and consequently an increase in forest growth and timber wood production. In addition, the tree species composition in hemiboreal forest will change [27]. During the period 2021–2050, Scots pine will increase from 54% of the forest area to 62% by 2100. Norway spruce, however, will reduce to 33% and end at 8%. On the contrary, the birch fraction will increase to 13% and finally to 30%. In fact, the hemiboreal forest will change from a pure coniferous forest to a deciduous forest [28]. Birch will replace spruce and partly pine, as it profits from global warming. Furthermore, exotic species are favored by climate change.

5. Natural Pillar Events and Environmental Consequences: Sea Regression Due to Continental Uplift Despite Global Warming

5.1. Description of the Study Area

Despite rising oceans, some parts of Finland are experiencing relative falls in sea level due to the crustal (isostatic) uplift. Uplift is not exceptional, and, in some parts of the world, it balances the increasing sea level due to global warming [29]. More specifically, the bottom of the Gulf of Bothnia around Kvarken Archipelago is rising at an annual rate of over 8 mm in southwestern Finland due to the postglacial rebound and isostacy. This rebound started with ice sheet melting and will continue for thousands of years [30]. Numerical calculations predict an annual uplift between 2 and 9 mm [31], which would create an inland lake in the next 2000 years [32,33]. The effect of the predicted greenhouse warming, however, suggests an average sea level rise of approximately 5 mm per year in the next 100 years, with an uncertainty of 2–9 mm [34]. This will balance the isostatic uplift [35].

Notwithstanding this less dramatic prospect for the Finnish and the northern Swedish coast, the local climate becomes more unpredictable. As the flat Finnish coast is very indented with shallow bays, the ecosystems are extremely affected by the double effect of isostatic rebound and global warming. Particularly, we examine the variations of the ecosystem on the peninsula around the old town of Ahlainen (Satakunta province in southwestern Finland) as situated in Figure 2. Fifty years ago, the sea was entering twice a day in the land by small canals linking marshes and small pools and lakes (Figure 3). The surface of the Mustalahti lake is approximately 56 ha, and the catchment area is 4.6 km^2 [36].

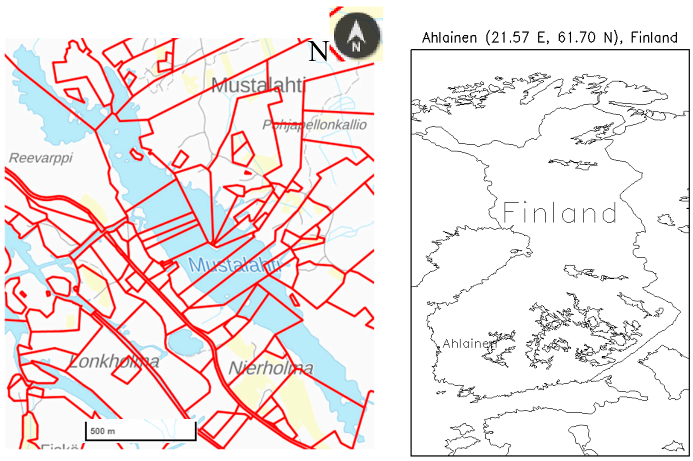

Figure 2. A recent detailed map of parcels of the Mustalahti area in Ahlainen taken from the website of the National Land Survey of Finland [37] (free data: open data license see website https://www.maanmittauslaitos.fi/en/opendata-licence-cc40). Ahlainen is situated on the overview map of Finland. Owners of parts of the lake possess the water, but not the land under the waterline.

To date, as a consequence of the uplift of Fennoscandia, the seawater cannot enter into several bays anymore and they become landlocked and less salty (see Figure 2). The connecting canal silted up and is now a wet meadow between Nordic pine trees (Figure 3). In the southeastern part of the bay, a small canal was dug connecting Mustalahti and the Ahlainenjoki river so that rain water can be drained into the shallow bay. A small canal connects the relict of the former bay with the open sea. By these artificial canals, rivers are draining the rainwater into the sea, but gravel, silt and clay particles are not being transported [38,39].

Figure 3. The original canal (photo in right panel) between Mustalahti and the open sea is transformed into a wet meadow. The arrow indicates the position on the map (left panel). This map is the northwest part of the map in Figure 2 (left panel).

The absence of tides prevents the erosion of sediments accumulating in the former bays, so that the mean bay depth has reduced to 0.7 m—the bottom is covered by a mud layer of 0.3 m to 2.0 m and is based on a hard, sandy basal layer. Reed fields precede the silt up. The Ahlainen area is highly contaminated by P (905.45 mg/kg to 1255.87 mg/kg), and the bottom contains high concentrations of Ca, Mg and K (1444.73 meq/kg) as well as concentrations of Fe (2148.85 meq/kg) and Al (3026.89 meq/kg) [40]. These contaminations have a natural origin (eroding minerals) and are from former uncontrolled high doses of fertilizers from agriculture. During wintertime, the oxygen conditions deteriorate and there is even total oxygen depletion. The conductivity, alkalinity and pH values are high. Together with the dramatic uplift, the natural drainage of the peninsula is reduced so that grassland losses its quality and forests are too wet and so is the arable land. The slow drainage of the precipitation and the conifers result in a decline in the pH of the woods, dry meadows and land, while the presence of silicon-rich minerals such as granite and mica already enforce acidity.

5.2. Remotely Sensed and Ground-Based Observations

The changing coastlines over time and its vegetation in southwestern Finland are illustrated in Figure 4, showing the well-known normalized difference vegetation index (NDVI) [41], derived from Landsat 7 data on 12 May 2000 and for Landsat 8 on 23 April 2019, characterized by a 30 m × 30 m pixel resolution. The NDVI combines the reflectance in the near-infrared which increases with vegetation presence and the reflectance in the red part of the light spectrum that is absorbed by vegetation. There is a clear increase in NDVI in 2019, indicating that there is more vegetation activity. This is corroborated using a 2007–2018 time series of sun-induced fluorescence derived from space (GOME-2A) [42], showing a yearly increase of 3.8% in vegetation activity for the Ahlainen area. Based on third-generation data for May of NDVI [43] derived from the Advanced Very-High-Resolution Radiometer spaceborne sensor with a grid resolution of 8 km x 8 km available for the period 2000–2015, a yearly increase in NDVI of 0.53% was found. The normalized difference wetness index (NDWI) [44] was computed for both Landsat images to estimate the wetness of the land surface. The NDWI combines the shortwave infrared with the red part of the light spectrum. By subtracting the NDVI from the NDWI, surface water and very wet land can be detected [45]. The surface wetness is shown in Figure 5 for 2000 (Figure 5a) and 2019 (Figure 5b). The shrinking lake of the Mustalahti is clearly illustrated. By subtracting both images and filtering for differences larger than 0.75, the ground-observed reduction of the lake and other surface water for the Mustalahti–Ahlainen area is demonstrated from satellite imagery (Figure 5c, red squares representing the newly formed banks of the lake/coastlines) and confirms the ground-based measurements of the lake reduction which started on the banks of the Mustalahti in spring 2010. The procedure was repeated yearly including spring 2019. The shoreline extended by 4 m. Compared to the situation during summertime in 2010, the land reclamation accelerated each year and the shoreline actually advanced over 15 m.

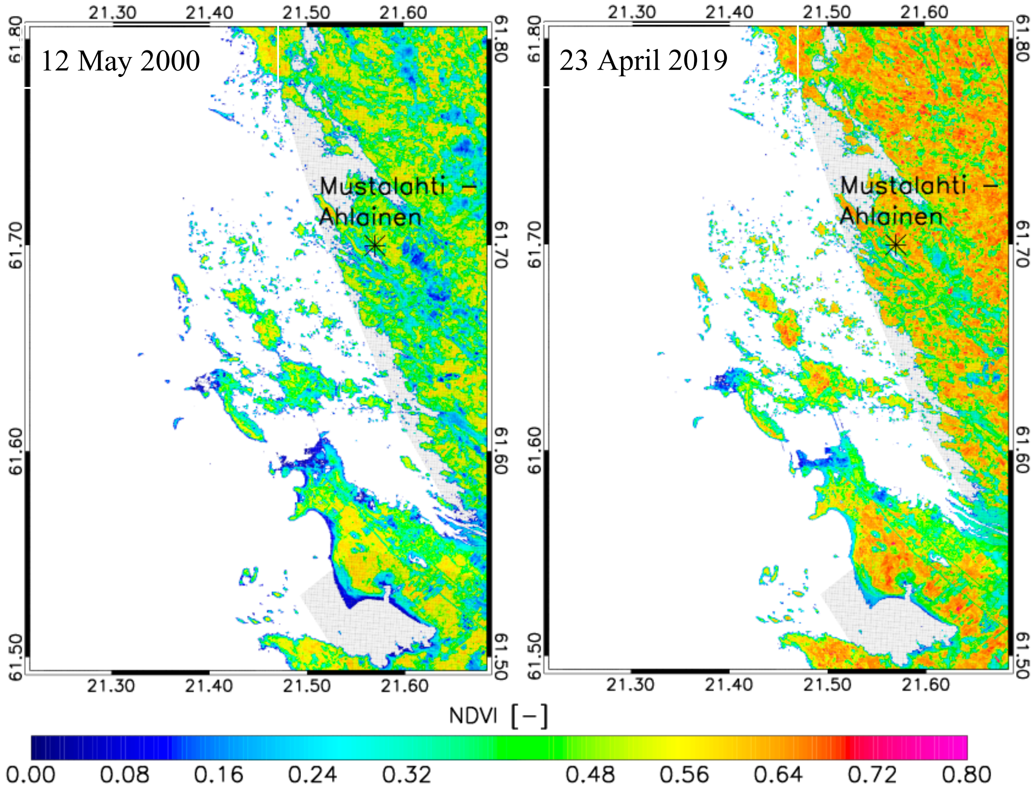

Figure 4. The normalized difference vegetation index (NDVI) for the southwestern coast of Finland in 2000 (left panel) and 2019 (right panel) derived from Landsat imagery at a 30 × 30 m spatial resolution. The NDVI values in the right panel are higher and more vegetation pixels appear in the Gulf of Bothnia.

6. Ecosystem Shifts: Varying Water Quality and Declining Biodiversity

Biodiversity concerns the species richness and the relative species abundance in space and time. Within an interval of 10 years, a study about the biodiversity of the Mustalahti area was established [46,47]. No difference was reported between the ecological community—defined as a group of trophic similar and sympatric species that actually or potentially compete in the Mustalahti for the same or similar resources—and the metacommunity, consisting of all throphically similar individuals and species in a regional collection of local communities. From the 1990s, the environmental conditions began to change dramatically in the sense that the ecological drift from the metacommunity became a substantial parameter in the changing climatological conditions [46,47].

As stated before, the shoreline extended by 4 m and, compared to the situation during the summertime in 2010, the land reclamation accelerated each year and the shoreline actually advanced over 15 m. This is confirmed by Figure 5c for the period 2000–2019 (almost twice the time span), where 30 × 30 m pixels around the banks of the lake are shown where there is no longer surface water. Young trees are replacing reed. As a consequence, the Mustalahti lake lost approximately 2% of its area and this process of lake shrinkage is accelerating dramatically. In addition to the shrinking shoreline, small creeks are cut off from the open water area by the growing reed fields.

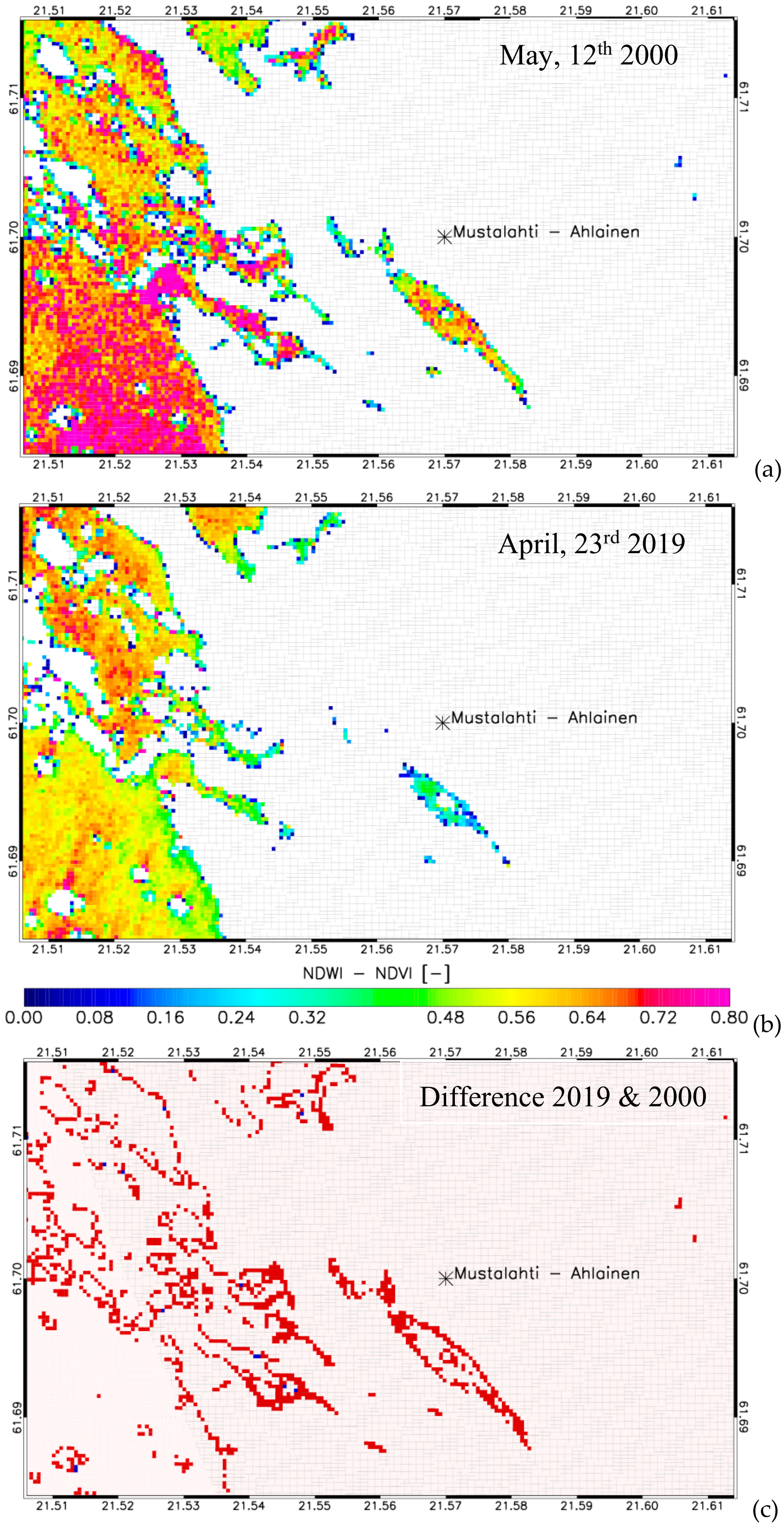

Figure 5. The surface wetness index for the greater Mustalahti–Ahlainen area (Finland) for 2000 (**a**) and 2019 (**b**) and its time difference (2019–2000) (**c**) derived from Landsat 7 (2000) and Landsat 8 (2019) imagery at a spatial resolution of 30 × 30 m. The red color in panel (**c**) indicates less surface water/wetlands. Blue indicates more. The surface wetness is approached as the difference between normalized difference wetness index (NDWI) and NDVI.

Moreover, the island in the middle of the bay is just separated from the land by water with a depth of 0.5–1.0 m. At this rate, the whole bay will be reclaimed completely within 25–35 years.

The uplift combined with the reclamation by vegetation results in the slowdown of water drainage. This fact implies serious impact on the biodiversity. Further, 20 years ago, there was a mix of deciduous temperate forest and conifers on the peninsula between Keikvesi and Katavakarinselkä (60°40′30″ N, 21°37′14″ E). A mosaic of small meadows was distributed between forest, small pools and agriculture. During these 20 years, the natural vegetation largely transformed in reed fields due to sediment accumulation. The vegetation of Mustalahti basin has been studied twice, in 1984 [46] and 1995 [47]. The driest parts of the flood meadows are dominated by sedges, the wetter parts by reed. In open water area, club-rush, nympheids and elodeids are common. Canadian waterweed (*Elodea canadensis*) is flowering at the Mustalahti basin (rare in Finland). Other rare or threatened species are *Rumex hydrolapathum Carex pseudocyperus* and *Oenanthe aquatica*. Both the uplift as well as the reduction in the natural drainage of the peninsula changed the quality of the grassland, forests and arable land. These ecosystems are shrinking and so is the food supply for migratory birds. The bird populations have also changed dramatically in the last 40 years due to varying fish populations [46,47]. The shallow bay sites and reed fields contain a deposit of $Fe(OH)_3$. Tree species such as black alder rooted in shallow flood meadows show a reduced grow and there is a decline in biodiversity. The wet reed fields in the shallow bay are an ideal environment for the reproduction of mosquitos, while the drier parts support long grasses, the refuges of ticks. Both species of insects are the preferential hosts of the *Francisella Tularensis* bacteria that can infect domestic animals and even humans. Actually, cattle of herds of 200 animals are grazing in the woods and on the driest meadows. This moderate elevation will increase possible infections by insects. Besides the varying water levels, the rising global temperature favors the conditions for insect reproduction because the appropriate temperature for mosquitos and ticks start in April and end in the middle of September [24,25]. Moreover, rodents also benefit from the synergy of the changing environment by local isostatic uplift and the global increase in temperature. Indeed, due to inadequate land ownership, the Eurasian lynx, with the grey wolf, on the top of the ecological pyramid cannot find satisfying protection against hunting. Their diet is composed largely of European hare and even smaller rodents. Fortunately, foxes are more adapted to the varying climate and environment. Their diet is composed of small rodents like bank voles, the hosts of the Puumala virus, a species of the hantavirus. However, rodents are very productive and global warming favors the multiple offspring [48] and the expansion of this viral disease.

7. Dominant Development Global Economic Answers to Global Climate Change at the Local Scale

Since the 19th century, the Finnish public society encouraged the development of the countryside based on sustainability and social equilibrium of its residences [49]. It is a real nature-dominating culture. In addition, the Finnish culture of social levelling is mirrored in sharing the land. In that era, all citizens received an equal part of the available land and all families were entitled to access water. All families also received a proper area to conserve food for the long winter. As a consequence, the original Finnish countryside is a real mosaic of small parcels, with enclaves and sub-enclaves (as illustrated in Figure 2) all connected by free path corridors—particularly to rivers and the seaside [50]. Crop fields and grasslands are small (less than one ha) and surrounded by small heights with small and huge boulders, relicts of the last glacier and witnesses of the isostatic uplift since the decay of the last ice sheet. According to the Finnish common law, all individuals are entitled to access to the whole Finnish area, private as well as public. The environmental change also shifted the economic and social management of water and land [51].

While professional fishing activity disappeared in Ahlainen after the end of World War II, the land uplift makes this area less attractive for sport fishing and weekend cottages built around the bay. Moreover, the price of the land is going down. Finnish people want to spend the weekends and summertime in their own cottage near riversides or even more attractive are the cottages with private shoreline [52]. Moreover, the reed fields are transformed into swamps which contain more insects during the summertime. New economic has activity appeared, however. Some species of trees like ash have benefited from the changing environmental conditions and are producing more firewood in a shorter time period. Conifers produce excellent wood for making pellets, a new renewable energy source for combustion in households but also for industrial purposes. As a consequence, forest harvesting is becoming more profitable and farmers have interest to differentiate their economic activity. The small meadows and arable land are transformed to forest, while marshes to meadows and agriculture adopts crops for agro-industrial purposes, farmers organize the proper corporations to make contracts with local manufacturing [23,53].

In addition, firewood is the basic combustion for electricity production and corporations of farmers are created to provide the machinery, transport and management of the new sustainable harvest of fast-growing trees. Hence, the economic value of the Mustalahti area can increase again after a period of 25 years, when big trees are covering the dry meadows. However, at the same time, these new activities are silently switching the Finnish traditional society when the human answers to the ecologic consequences of the uplift are accompanied by purely top-down global economic logic. Indeed, big energy companies encouraged by the European Union administration will receive most of the benefits of this renewed wood production. Indeed, they offer low prices for the former private properties and invest their resources to planting trees and can wait 25 years for wood production. Moreover, this process is accelerated by the recent trend of country people migrating to cities such as Tampere, Turku and particularly the Helsinki-Vantaa-Espoo triangle [54]. Small property land meadows and forest have for the last 150 years been the saving box of most Finnish families [49]. Although the Finnish government encourages forest owners to enlarge their wood capacity by adopting silviculture [22], the new trend of the reduction of rural environmental capital to the profit of a few will dramatically change the classic relations between the social stratification of Finnish society, in particularly with regard to the situation of the agriculture.

8. Modified Eco-Development as an Alternative Option for Southwestern Finland

The modified eco-development based on a co-evolutionary view overrules environmental as well as cultural determinism. The first posits a causal relationship from nature to human culture and civilization. It is typical for many indigenous cultures and partly adopted by the Samen living in northern Fennoscandia. The second puts the human´s efforts as cultural beings on natural development. The latter is widely adopted by the actual global dominant economy and politics all over the world. In contrast, modified eco-development puts forward possibilism as claimed by Evanoff [1]. Possibilism based on the already mentioned co-evolutionary view claims that natural varying environments do not determine culture but make room for certain forms of human cultural activities and lifestyles [55–57]. For example, what are the possibilities offered by the new wetlands and marshes in the disappearing shear or archipelago coasts of western Finland?

Obviously, the draining of the shear area creates new common land. Since a part of these commons, particularly on the edges, is peat land, there is a risk of settling by drying out due to the increasing temperature which will lower the earth surface as consequence. This phenomenon has occurred due to the artificial draining of parts of the Zuiderzee, a former inland sea of the Netherlands. Fortunately, the rising sea level of the Gulf of Bothnia will trade-off the balance. Moreover, the isostatic uplift as well as the rising sea level due to global climate change, with the rapid melting of snow and ice during springtime, will accelerate the sea level rise between April and June. As such, water evacuation from the Finnish inland decelerates and sedimentation in the shear area accelerates.

Furthermore, what about the ownership of the drained bays between the shear islands? According to Finnish law, owners of parts of the bays just possess the water, not the land under the waterline (Figure 2). Does it make part of the global commons in the scope of the dominant global paradigm or does it create a perspective for a local commons experiment according to the modified eco-development paradigm? We refer to the work of Fokke Jan Vonck [58] about ground lease to inspire the Finnish government for a flexible management of the common shear grounds. The Finnish cultural pillar, however, influences substantially human management of the created new ecosystem despite the top–down regulations inspired by the dominant global paradigm. Indeed, according to Hofstede´s [20] giant experimental investigation, Finnish country people are characterized as small power distance, task oriented and existential. The latter means that varying situations of external or internal situations are removable. Since the MED transactionalism is a co-evolutionary non-essentialist and dynamic approach to biological and cultural diversity, it is straightforward for application in the Finnish bioregional and cultural context. Moreover, Klückshohn [19] mentioned the controlling nature management of all people of northern countries. Consequently, the transformation of the shear coast into marshes creates an additional opportunity for the people of the villages in the former lahti-area. Finnish people are very attached to their individuality [20]. However, the structure of ownership in the countryside, with exclaves, enclaves, rights to mooring boats and the associated easement of free passage, forced the owners to collaborate in the management of the land (Figure 2). This collaboration already exists in the area to save the fresh water supply since all owners are united in a local water survey corporation. Local commons administration prevents the complete exploitation of the new land according to old global dominant standards, obstructing the autonomous development of this new ecosystem and denying the self-resilience of the new created morpho-region. In addition, the bioregional emphasis on self-reliance does not imply self-sufficiency and complete isolation of the area [6]. On the contrary, it just encourages local activities for which there is no interest from surrounding areas, but these activities just promote the sustainable development, natural as well as human, of the transformed ecosystem. In the case of the Mustalahti as a testing ground for the whole shear area, we mention two of them. First, natural gas even right now evacuating out of the canals and marshes can be captured and used as a local energy source. Natural gas is a strong greenhouse gas and its radiative force is even more effective than that of CO_2. Consequently, it is better to transform it into CO_2 by using it for household energy. This local micro-energy source is already used in the Netherlands since the 17th century and the equipment to capture this natural gas requires a moderate budget according to a simple know how available in Holland [59]. In addition, temperature in the old shear coast area will be extremely variable because the damping effect of seawater on land temperature changes. Needle trees such as spruce make room for broadleaf trees with wood production of higher quality. However, the birch as a pioneer species will overrule the original coniferous forest. As already mentioned, the pH of the Mustalahti basin is rather high. However, the run-off from the forest will lower the pH due to the acidity of SiO_2-rich soils. In addition, the high concentration of $Fe(OH)_3$ in the wetlands and marshes involves the cleaning up of PO_4 anions [60]. Moreover, the silt-like debris of the bay gives good cation exchange capacity to neutralize the high concentrations of cations, while the invasion of reed fields by black alders provoke N-capturing from the air by bacteria concentrated in the small superficial roots of the invading trees. The base saturation is increasing as well as the N concentration. The latter encourages pine and, in the long term, it involves the increase in low and tall herb spruce-type vegetation (see Figure 8 in [60]). Finally, cattle breeding transforms the landscape in open grassland farms with common herds, while livestock for slaughter makes room for local dairy products and local vegetable markets.

9. Conclusions

Climate variation in the Ahlainen area and its consequences can be considered as a paradigm case for the whole southwestern area of Finland and even for some parts of the Swedish eastern coast. In the scope of a centralized dominant development approach, the whole area will be just a deserted area with ghost villages leaving the land in the hands of a few big energy companies. This implies not only a breakdown of the traditional Finnish democratic society but also a trend to involve a dual society: on the one hand, you have young people dwelling in central towns; on the other hand, you have old people occupying an archipelago of villages surrounded by land and forest in the hands of multinational energy companies.

However, another scenario is also possible when the challenges of climate and landscape changes are administered by bioregional principles, though global warming will persist unless EU projects for energy transition. By managing local natural phenomena such as the isostatic uplift of continental shields, and despite global climate change, the management of Earth must be based on co-evolutionary principles: the transactionalism of nature and culture. While conditions of human and non-human life are local, answers to natural and environmental changes require a proper local answer corresponding to the best traditional local management.

Author Contributions: Conceptualization and writing—original draft preparation, G.J.M.V. and W.W.V.; ground observations and investigations, G.J.M.V.; remote sensing and visualization, W.W.V.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

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