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Review

The Anthropocene in the Aspiring UNESCO Global Geopark Schelde Delta Area: Geological History, Human Resilience and Future Landscape Management

Sjoerd Kluiving [1,*] and Ronald Waterman [2]

1 Faculty of Humanities, Department of Art & Culture, History, and Antiquity/Faculty of Science, Institute for Environmental Studies, Vrije Universiteit Amsterdam, NL-1081 HV Amsterdam, The Netherlands
2 Faculty of Civil Engineering and Geosciences, Delft University of Technology, NL-2628 CN-1 Delft, The Netherlands; buildingwithnature@gmail.com
* Correspondence: s.j.kluiving@vu.nl

Abstract: In north-western Europe, the Rhine, Meuse and Scheldt rivers have created a large river delta over the past 3 million years. Geological phenomena in the Scheldt region in north-western Belgium and in the southern Netherlands testify from a highly dynamic landscape, showing a range from very old (50 MY) to very young (recent) geological processes. The great diversity in geological processes and resulting landscapes is unprecedented on a global scale and has had its impact on the region's cultural and economic history, shaping today's reality in the global polycrisis. However, the area is usually observed by people as a flat and featureless type of terrain, although sometimes, unexpected elevation differences and sharp contrasts in landscapes occur alternating with omnipresent waterways. Therefore, here, the seven most conspicuous landforms are reviewed and presented in conjunction with the geological history of the area, including the typical lowland theme of the human battle against water. This study aims to (a) reconstruct the Tertiary and Quaternary to Holocene Dutch–Flemish Schelde Delta history, (b) review a cultural history that evolves into the present of the Anthropocene, and (c) project the desired future for sustainable landscapes in the aspiring UNESCO Global Geopark Schelde Delta between plural landscape management scenarios of Revitalised Land- and Waterscape and Improved Biodiversity.

Keywords: Anthropocene; geology; archaeology; land- and waterscape; sustainable landscape management scenarios; AquaPuncture; Nature Futures Framework; UNESCO Geopark

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1. Introduction

The aspiring UNESCO Global Geopark Flemish-Dutch Schelde Delta (aUGGP ScheldeDelta) covers an area of 5500 km^2, with 63 municipalities in total and a population of 1,500,000 divided over two countries (Belgium and The Netherlands) [1]. It comprises three Flemish provinces (Antwerpen, Oost-Vlaanderen and West-Vlaanderen), the Dutch provinces Zeeland and the western part of Noord-Brabant. This international and interregional area comprises, beyond urban and agricultural areas, geologic morphological sites, sites with nature and landscape values, archaeological and cultural historic sites, touristic education sites, and military sites and fortifications.

Importantly, the aUGGP ScheldeDelta depicts not only terrestrial sites (75%), but also complementary (often neglected) aquatic phenomena (25%) in the form of estuaries, rivers, lagoons, lakes, canals, aquaculture, harbour basins, and small-scale canals and brooks [1]. Within the latter, a complete salt (40%) and freshwater (60%) infrastructure is present, which has been primarily formed by nature and has, in most cases, been subsequently adapted and newly shaped by the action of humans.

Although the candidacy for a UNESCO Geopark is based on the unquestionable exceptional natural (and cultural) values of the area [1], the growing impact of humans on our environment has also been called the Anthropocene, alluding to the unsustainable use of the landscape and its resources [2–4]. For the very first time in geological history, humankind has become a significant factor through lifestyle and numbers and may have caused a new geological epoch/era [5,6]. Many scholars agree that currently we live in the Anthropocene, even if they are still debating the dates from which this epoch of humans can be said to have started [2,7–9]. In the Anthropocene, the forceful actions of mankind have so far caused a serious loss of biodiversity, notable climate change and severe ocean acidification in the natural world, next to a social and humanitarian world in different phases of a planet in transition [4–6,10].

Therefore, in this paper, sustainable landscape scenarios for the aUGGP ScheldeDelta will be discussed, targeted with an emphasis on the proposed landscape management of the aquatic nature of the area. Our partial focus on the water landscape (waterscape, next to the terrestrial landscape) of the aUGGP ScheldeDelta is also given in the present and future threats to our water quality, salinity % and all kinds of pollution and water quantity (shortage or excess) [11,12].

The aim of this paper is to address future landscape management strategies for the aUGGP ScheldeDelta in light of the geological, archaeological and historical developments from the Tertiary and Quaternary periods to the Holocene era. While the holistic desirable view on future landscape management in the Nature Futures Framework is captured in [13], we combine the approach here with AquaPuncture [14] and the future scenarios of the aUGGP ScheldeDelta [1]. This paper will focus on the land–water interface that is so apparent throughout the history of the area and analyse the potential for future developments in these marginal landscapes.

The bid book for the aUGGP ScheldeDelta, describing human action as a geological force, poses important 21st-century questions: (1) How do we (re)shape our (intrinsic) relationship with nature? (2) How do we inspire people to change their behaviour in a sustainable way [1]? The proposed area stimulates cross-border international cooperation and broad coalitions with a prominent role for educational and knowledge institutions, governments, businesses and end users (residents and visitors). Experience and imagination are the ultimate tools for engaging people (young and old) and stimulating awareness [1].

The urgency of landscape change from a continental via a regional to a local scale [10,15–17] addresses the importance of stakeholder participatory design of sustainable landscape management strategies that have been adequately indicated and advocated, including the potential of abandoned landscapes [18–20]. In addition, a continental approach to biodiversity loss is found in variable landscape management practices, such as extensive agriculture, and nature restoration tied to rewilding [21,22]. Hence, from global to EU perspectives, a sustainable agricultural landscape with improved biodiversity is desired that coops with climate adaptation and healthier soils, sustainable agricultural use and preservation and, wherever possible, increasing biodiversity values [17,23].

AquaPuncture is defined as an instrument for the optimal use, adaptation and management of inland waterways, their waterfronts and their adjacent terrain. It is an instrument for the benefit of safety against flooding, water storage, water level regulation, navigability, water quality, economy, employment, spatial quality and environmental values, water management, sewage, all forms of (renewable) energy, sustainable fisheries, seabed mining, eco-friendly construction, tourism, and governance [24]. In this paper, we review AquaPuncture and the Nature Futures Framework in its overall completeness, striving for sustainability on land and water, and the parts of the approaches that might or might not be applicable in the area will be discussed.

2. Background

Inland waterways always linked urban and rural areas. Globally, these waterways were always a focal point for settlement and economic activities along the slow waterways system through cities and lakes. However, these waterways were used for everything, from drainage and irrigation, drinking water supply, beer production, fishing, and transport of persons and goods, to open sewers [25]. Furthermore, many industrial activities along these waterways were present and resulted in emissions of chemicals in the water. The inland waterway system became, to a certain extent, obsolete, and its main transport function was taken over by the faster rail and road systems. The spatial relation between the waterway and urban development became neglected. Currently, the deteriorating state of nature and biodiversity is calling for transformative action [13,17]; therefore, we are once again fully aware of the significance of this unique relationship between the inland waterways and the adjacent urban and rural habitats [14,24].

Even the oldest exposed sediments at Rupel or at Nieuw-Namen testify from water processes and seas, such as rising sea levels, storm surges and tidal currents, which built these deposits and landforms [26]. The clear presence of water in the northern lower part of the proposed Geopark is dominated by the Grevelingen Lake and the Eastern and Western Schelde. The river Scheldt in the Flemish Valley and the Rupel River are dominating the southern higher part [27]. Secondary waterways originate from peat reclamation, industrialisation (channels) or natural causes, such as demarcating old islands that are now embedded in a polder structure, drained from the seawater. Nature reserve areas, such as the tidal flats of Land van Saeftinghe, with multiple tidal gullies, comprise and are adjacent to the remains of lost villages and polder structures [1].

Geoheritage in the aUGGP ScheldeDelta with 40 geosites in total is explored, developed and celebrated, linked to all other aspects of the natural, cultural and intangible heritage of the region [1]. In this paper, the deep history of the area will be demonstrated along the seven most conspicuous landmarks. The main geological highlights in the proposed Geopark Schelde Delta (Figure 1), divided over coastal dunes, the marine clay region with polders, the Campine coversand region, the sand region of the Flemish Valley, and the cuestas [1], are (1) the coastal dune complex of Schouwen, (2) the tidal delta of the Land of Saeftinghe, (3) the escarpment of the Brabantse Wal, (4) the Stekene-Maldegem coversand ridge, (5) the river dunes in the lower Scheldt valley, (6) the Pliocene beach at Nieuw-Namen, and (7) the cuestas and escarpments of Waasland, Temse (Oligocene), Zomergem-Oedelem and near Wetteren and Wichelen and Burghout (Figure 1). The cuestas and escarpments are all higher-situated areas along the southern rim of the Geopark. These elevations are part of Tertiary sand and clay layers that give significance to the deep history that dips (slope) to the north in the whole region of Ghent, Antwerp and Brussels [1,28]. Therefore, everywhere in this part of Flanders, this cuesta-like morphology in the oldest rocks appears because the cohesive (Tertiary) clay layers are more resistant to erosion than the loose-sand layers of the Quaternary processes [28]. A younger outcrop is The Netherlands' oldest beach, a Pliocene uplift near Nieuw-Namen beautifully exposed with evidence of sea, frost and soil formation [26]. The escarpment of the Brabantse Wal shows a Quaternary fluvial cliff face erosion in exposed Lower Pleistocene estuarine deposits [29]. In the Flemish Valley, a Pleistocene large valley during the last ice age created a polar desert in the area, while a forceful circum-polar wind created parabolic dunes in the river valley (and also on the Brabant escarpment). The same periglacial environment produced an extensive and elongated Stekene-Maldegem ridge that has effectively blocked an older Scheldt river course that was originally flowing northwards centrally into the Schelde delta. Through the formation of the cover sand ridge 11,000 years ago, the Scheldt river since then flows into the erosional valley of Hoboken via Antwerpen into the Westerschelde [27].

We demonstrate the significance of the unique relationship between the geoheritage, the inland waterways and the adjacent urban and rural habitats. Because the water quality has been improved considerably through various measures and regulations, we want to rediscover and revitalise the waterway network and its waterfronts through AquaPuncture for the benefit of its users. Waterways are a vital backbone in the urban and rural landscapes. AquaPuncture is an already successfully proposed development level elsewhere [14,24]. Important for the AquaPuncture development is taking into account the cultural and natural history of the region and its biodiversity. The Schelde Delta region is by its aqueous nature fit for revitalisation development and water transport. A new and sustainable vision for Geopark tourism needs to be defined alongside the application of AquaPuncture. Transport through the UNESCO Geopark by foot, bicycle and electric boats will add to the experience of the area.

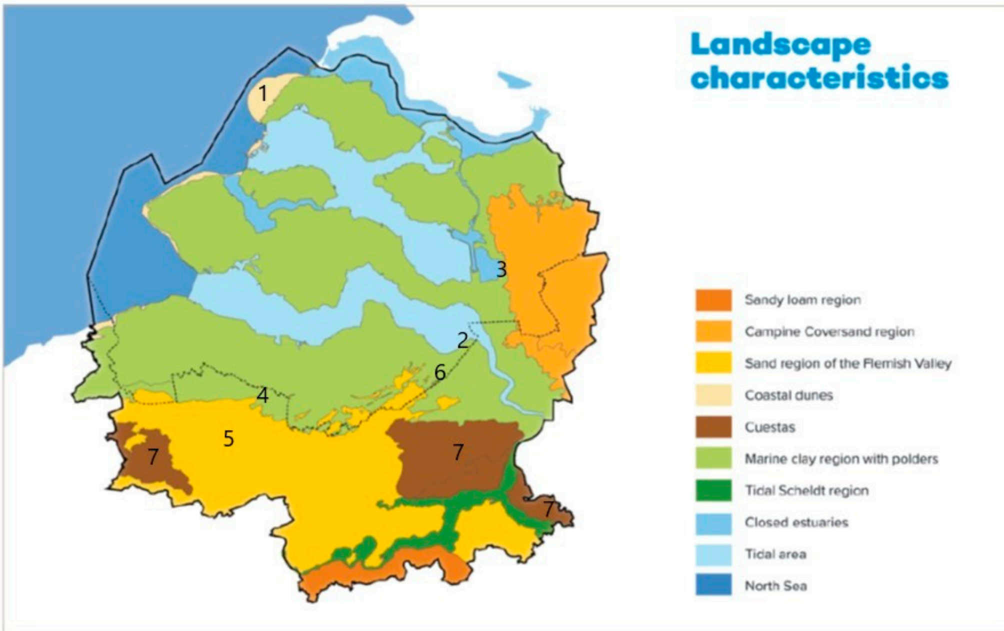

Figure 1. Overview map with landscape characteristics in SW Netherlands and W Flanders region with annotated the seven most conspicuous landmarks in the aUGGP Schelde Delta: (1) Coastal dune complex Schouwen, (2) Tidal delta of Land van Saeftinghe, (3) Escarpment of Brabantse Wal, (4) Cover sand ridge Stekene-Maldegem, (5) River dunes in the lower Schelde valley, (6) Pliocene beach at Nieuw-Namen, (7) Cuestas and escarpments of Waasland and Temse, Zomergem-Oedelem and near Wetteren and Wichelen (after and copyright from [1]).

Due to the interaction between geology and humans at the transitions of land and water, high and low, fresh and salt, and sand and clay, an enormous wealth of geomorphology, landscapes, cultural history (material and intangible) and nature has been created [1]. We assume that inhabitants and visitors of this area, when confronted with a deep history of its geology, can take a strong identity, belonging and a sense of pride and place value to this region [30].

3. Review: Aspiring UNESCO Global Geopark Schelde Delta Area

3.1. Geological and Geomorphological Landscape Reconstruction and Delta History

The Waasland cuesta, the Rupel area (Oligocene high of Temse), as well as the Nieuw-Namen sites, share in common the Tertiary history of the landscape in the Geopark. A diachronic history can be drawn from south to north with 50 MY old Eocene deposits at the Oedelgem-Zomergem cuesta, Oligocene deposits exposed at Temse and the Waasland cuesta front in the south to the 3 MY old Late-Pliocene beach deposits at Nieuw-Namen [1,26,31]. A distinct landscape feature within Brabant and Flanders is the Brabantse Wal, with a suggested tectonic origin and being formed by Pleistocene and Holocene processes and in particular the flow of the river Schelde [29]. In the southern part from the lower to the upper Scheldt river valley, Late-Glacial large-scale meanders with associated river dunes testify of the river and aeolian processes during the Late-Glacial period [27].

On geological time scales, the Dutch and Belgium river deltas all are a result of the interplay between fluvial and tectonic processes, as they represent a structural part of the European Cenozoic Rift System. Tectonic processes in this region are driven by the rift system of the Lower Rhine Graben that causes faults, uplift and downwarping of terrain in NW Europe, including within the aUGGP Schelde Delta area [28,32–34]. The tectonic setting of and resulting processes in the region are exemplified by the general tilt of the terrain towards the north, as well as the escarpments and cuesta fronts throughout the area [1,28]. Due to the continental tilting towards the North Sea basin, all major rivers (Rhine, Meuse, Schelde and Weser) are discharging in this marine basin. In the aUGGP Schelde Delta area, we observe the overall terrain sloping north, as well as the Schelde discharging northwards.

The Waasland cuesta in the southern part of the Geopark area is a so-called clay cuesta. The maximum height of the cuesta near Waasmunster is about 30 m above sea level. This cuesta, together with its continuation in the Rupel area (cuesta of Boom), is the geomorphologically clearest example of a clay cuesta in Flanders. Other clay cuestas with similar orientation, but less distinct than the Waasland-Boom cuesta, comprise the cuesta of Oedelem-Zomergem [1] and the cuesta of the Campine Clay towards the east [35] (7 in Figure 1).

The Waasland cuesta is a landscape feature that originates from the fact that NNE-sloping geological layers have a differential erosional resistance [28,29]. In the Waasland area, the Oligocene clay layer offered more resistance to erosion than under- and overlying sands, which resulted in a sharply pronounced cuesta front that extends from Waasmunster over Temse to Rupelmonde, with a gentle northward slope to Vrasene (on the line Beveren-Sint-Gillis-Waas) that has been covered with a (Weichselian) coversand sand layer with a thickness of multiple metres [27,29]. Although the Rupel clay layer extends in the eastern direction in the area around Boom, the cuesta is bounded at Rupelmonde by the erosional valley of Hoboken (a 'water gap'), which has been used by the river Schelde for at least the past 20,000 years [1,27].

The geomorphology of the Flemish part of the region is dominated by an extended coversand ridge, stretching from Stekene to Maldegem in a west–east orientation [27]. The Flemish Valley is positioned south of this ridge, in which several rivers converged, along with the river Scheldt as the most important one. In the Late-Pleistocene period, the coversand ridge blocked the water of the river Scheldt from discharging directly into the North Sea and forced it in an eastward direction, crossing the ridge near Antwerp [27].

During the last ice age (Weichselian) in the Flemish sand landscapes, Middle Palaeolithic habitation has been found [36]. More intensive habitation occurred during the transition to the Holocene (Late-Glacial period). Numerous prehistoric sites are present with a discontinuous spread of sites dating from the Final Palaeolithic to the Neolithic [37,38]. During the Holocene, as higher places in a wetland environment, the sand ridges such as the Stekene-Maldegem were also preferred dwelling spots for (Late-)Mesolithic hunter–gatherers, whose presence has been amply documented by archaeological investigations [39]. When rapid sea-level rise started to slow down between 6000 and 5000 BP, peat marshes were formed, covering the valleys in between the sand ridges and, increasingly, the sand ridges as well. Many Mesolithic archaeological spots were covered by peat (and later clay or sand deposits), ensuring their preservation [39].

The delta processes that have shaped the entire province of Zeeland and adjacent areas started at the beginning of the Holocene epoch when the sea level was rising with the Scheldt river continuously discharging [40]. The coastal dune complex of Schouwen is a conspicuous landform through its multiple parabolic shapes of land dunes that are formed within one giant parabolic shape [1]. The particular shape and formative processes of these coastal dunes have been anthropogenically influenced. The adoption of agriculture with associated deforestation caused widespread aeolian erosion and deposition in parabolic land dunes. Finally, the Land of Saeftinghe shows a unique modern-day marine tidal landscape around a major inner bend of the Scheldt river, with gullies and tidal flats, biodiversity plants and fauna [40].

3.2. The Lowland Theme of Human Entanglement with Water

A remarkable feature of the landscape of the Scheldt Delta Geopark is the omnipresent theme of living with the water, formerly known as the human battle against water in this region. A specific relict of these human water entanglements is the widely occurring drowned landscapes and villages in an extended area of Zeeland and along the fringes of Noord-Brabant and Flanders [41–43]. These landscapes and villages contribute significantly to the historical, current and future themes of the interaction of humans with water, coping with extreme conditions, as well as the vulnerability and resilience to a changing wetland environment and increasing flood risk [43]. In this region, the drowned landscape is a predominantly covered landscape; different archaeological layers testify of different periods of occupation and settlement, and each layer—whether Mesolithic or Late Medieval—has been sealed by subsequent deposits of peat, sand and clay [41–44].

Specific historical features of the vanished and drowned landscapes in the western part of the Dutch province of Noord-Brabant previously have been used as key features of future landscape redevelopment [42,43]. In the highest part of the area of the Brabant Wal Pleistocene, sandy soils are dominant on a surface that is gently sloping down towards the north and more steeply to the west. Here, mainly clayey soils and remnants of peat occur, lying slightly above sea level (barely) and covering human activity [42].

Around 5000–6000 years ago, the rate of sea-level rise slowed down, which formed the start of major peat growth behind sand barriers. The relative rise of sea level in the last part of the Holocene was caused by subsidence and erosion of the peat layer [40]. The major floods that occurred during the first part of the 2nd millennium AD were the cause of more than 100 drowned villages in the Zeeland, Brabant and Flanders regions combined [41–44]. Islands of the current province Zeeland were formed as islands in the major river delta that the Scheldt river formed over the past millennia.

In medieval times, long-term flooding affected the lowlands of the landscape tremendously. Large parts of the flooded landscape were eventually covered with a thick layer of clay that also covered most medieval settlements and large parts of the old infrastructure, freezing it in time [42]. In other parts, flooding was quite destructive, because new channels were formed that completely washed away all archaeological remnants. Then, a second settlement period began by gradually re-embanking the flooded lands, which was completed by the end of the 19th century [43]. The Holocene history of Zeeland is a major record of Scheldt fluvial discharge in the North Sea, while the sea level was rapidly rising in the first half of the Holocene [40].

Additionally, in Flanders, there was renewed flooding over the pre-existing peat marshes in the (late-)medieval period. In some periods, an alternation of floods and reclamations occurred, resulting in deposits of sand and clay, which covered medieval field systems dating back to the 12th and 13th centuries [45]. Only in the higher sandy areas in the south of the region (such as the 'Waasland cuesta'), settlements from these periods have been preserved. Large-scale peat extraction was an important goal of the reclamation, as peat was the main fuel for the booming Flemish Cities in the 13th and 14th centuries [45]. Floods of 1530 and 1570 AD created the drowned landscapes of Zuid-Beveland and Saeftinghe. By the 16th century, most of the late medieval floods had been undone, and the entire area was reclaimed. Close to the river Scheldt, the polder Doel (from c. 1567) was one of the last major embankment projects before the Eighty Years' War (1568–1648) [45].

Between the 17th and the early 20th centuries, the drowned medieval landscape was again reclaimed in what can be called an 'extreme make-over'; what remained of the medieval landscape was often deliberately erased by new, much more rational and geometric landscapes, which symbolised both the cost-efficiency of the Polder Capitalism that flourished in this area, and the appetite for landscape design by its wealthy merchant and noble creators [46]. Just as in neighbouring Zeeland, the Flemish part of the Geopark still contains several of these 'grandiose' 17th-, 18th- and 19th-century Polders, with their highly recognisable visual and historical landscape qualities [1].

4. Review: Future Landscape Management Scenarios

Based on the cultural development within the polder landscape and from the start of the Industrial Revolution, the Flemish part of the aUGGP ScheldeDelta had an earlier start of the Industrial Revolution than The Netherlands [47]. Whereas Flanders developed industrialisation after the 1830 independence of The Netherlands as the most industrialised country of Europe, The Netherlands followed only half a century later, and the prevalence of agriculture played a role. After the Second World War, through the Great Acceleration [48], the entire Scheldt Delta area has developed in an Anthropocene landscape, where most, if not all, features and surfaces of the landscape are influenced or made by humans.

This influence is omnipresent in the harbours of Antwerp, Gent-Terneuzen and Sluis-Sas van Gent and, to a lesser extent, in the smaller harbours of Vlissingen and Bergen op Zoom. The harbour of Antwerp and its associated industries, petroleum refineries, petrochemical industries, chemical plants and the automotive industry, restructured large scale as one of the most important petrochemical centres globally. The harbour of Antwerp, together with the nuclear energy plant at Doel, seen from the north, forms a fascinating (and threatening) anthropogenic façade. The area has from the past centuries until today also experienced a north–south transport route for industry, business travel and tourists [42]. The great accessibility also attracted wars; from multiple periods, battlefields and signs of battles and defence lines are prominently seen in the landscape [42].

In the Zeeland area, all land is continuously anthropogenically influenced as a consequence of its long history of flooding and disasters associated with low elevation. The name Zeeland, 'land of the sea' in Dutch, implies that the name is derived from islands and peninsulas (former islands) [41].

The preceding part of this paper has highlighted the dynamic and deep history of the entire Scheldt Delta area. In the past 150 years, the influence of industry has increased in this area with an acceleration in the past 70 years. The results of these human-induced influences are more modern and convenient landscapes suitable for 20th- and 21st-century lifestyles, but also delivered contaminations due to the chemical industry (e.g., PFAS from 3M). The impact of all these contaminating influences is still continuing to be received and recorded in the land- and waterscape of today and calls urgently for a global societal and political response [16].

Based on these considerations and taking into account the (deep) history of the landscape and adjoining waters, we review two scenarios for the future landscape management of the Scheldt Delta area. The first scenario is the Revitalised Landscape and Waterscape and introduces and discusses the concept of AquaPuncture in the Scheldt Delta area (4.1) [14,24,25]. The second scenario for future landscape management is Improved Biodiversity, discussing the introduction of the Nature Futures Framework in the area to revitalise the landscape (4.2) [13]. The outcome is important in addressing the future of the transnational aUGGP Schelde Delta [1] and therefore inspires other global Geoparks and beyond these in other areas.

4.1. Scenario: Revitalised Land- and Waterscape

The scenario describes AcquaPuncture to revitalise the landscape and waterscape. AquaPuncture is meant to revitalise the inland waterways and their waterfronts. In this scenario, the UcGP vision of sustainable tourism and economy is expanded to come to a more societal and economic approach [1,14,24]. Water was always omnipresent and has determined the fate of many inhabitants first in creating the delta and dry land in a period of sea-level rise. Later, the area lost property or houses or experienced damages due to flooding. Here, we propose AquaPuncture as a potential future 'land- and waterscape' management based on a thorough analysis of the urban and rural characteristics of the inland waterways and their waterfronts. First of all, the characteristics, history, typology and classification of the waterway itself (river, canal, lake) must be studied, followed by a study of the waterfronts and adjacent territories. Good plans have their roots in the past and are pointing towards the future [24]. To implement AquaPuncture successfully on these rural and urban characteristics, within the region, the following order of elements and pathways need to be taken into account [14]: (1) inland waterways and their waterfronts, (2) user groups, (3) physical adaptations (interventions), and (4) organisation for waterway and waterfront development. Within physical adaptations (interventions), preventing further contamination and improving water quality are also incorporated (see below 12. in Waste water purification.

AquaPuncture is defined as the optimal use, adaptation, experience and management of inland waterways and their waterfronts for safety against flooding, water storage, water level regulation, water quality, navigability, economy, employment, environment and natural landscape. For the sustainable future of inland waterways, the first item to consider when applying AquaPuncture is the urban and rural characteristics of the inland waterways and their waterfronts (Table 1). Within the aUGGP Schelde Delta report, a significant portion of these characteristics is covered [1]. Landscape and nature have been thoroughly described in the bid book, which is summarised above in 'Review: Geological and Geomorphological Landscape Reconstruction'. Therefore, in this paper, we describe the Revitalised Land- and Waterscape scenario through the available waterways, the user groups, the physical adaptations or interventions needed and the organisation for the waterway and waterfront development (Table 2).

Table 1. Presence and characteristics of areas with regard to the waterfront in the Revitalised Landscape and Waterscape scenario of AquaPuncture.

Presence and Characteristics of Waterfront Areas
Residential areas
Leisure parks
Tourist and recreational facilities
Museums and monuments
Commercial and industrial zoning
Infrastructure
Agricultural areas
Landscape and nature

4.1.1. Water (Ways) in the Schelde Delta Area

To describe the potential of applying AquaPuncture in this region, here, a large part of available waterways in the area of the Scheldt Delta has been listed. The Schelde Delta area has in the north three major waterways: Westerschelde, Oosterschelde (salt water) and the Grevelingen (brackish water), which are, in the east, connected via the Oesterdam and Markiezaatskade to the Schelde-Rijn canal and, in the west, by the North Sea. In this aqueous area of large waterways, some local water bodies are present, such as Krabbenkreek between Anna Jacoba polder and Tholen, Markiezaatsmeer near Bergen op Zoom, and Veerse Meer between Noord-Beveland and Zuid-Beveland. On a smaller scale, the Kanaal door Walcheren is present, with an equal waterway through Zuid-Beveland.

The southern part of the Scheldt Delta area is dominated by the Scheldt river and the canal Gent-Terneuzen; in the far west, the area is bounded by the North Sea (Het Zwin). Additionally, the so-called 'double canal' Schipdonk Kanaal dominates the landscape in western Flanders. The Scheldt river has a paleo-meander south of Temse and westward a tributary river course, the Durme, including a paleo-meander. A major waterway in the southern part is the harbour of Antwerp, with its many canals and tributaries. Harbour basins exist as well as rivers and tributaries, such as Rupel, Dender 'grote' Nete and 'kleine' Nete. In addition, smaller harbours are present, such as Gent, Terneuzen, Vlissingen, Bergen op Zoom, with significant waterways such as the Damse Vaart/Kanaal Brugge Sluis and Zoom lake, as well as multiple marinas along all waterways north and south.

Table 2. Physical adaptations and interventions (n = 24) in and along the waterways.

Potential Physical Adaptations and Interventions
1. Height of bridges above water level
2. Dredging depth via environment-friendly dredging
3. Expanding sluice capacity and bridge and sluice servicing
4. Dike/levee adaptation, river/canal widening and room for the river
5. Aqueducts and boat conveyors
6. Water level regulation via sluices, pumping stations and weirs;
7. Facilities for drainage/irrigation
8. Pier/jetty/quay wall/moorings and berths with facilities; realisation of facilities:
9. Loading/unloading platforms
10. Yachting harbours and inland container terminals
11. Introduction of environment-friendly banks/shores
12. Waste water purification
13. Implementation of water framework directive for physical, chemical and biological quality
14. Introduction of hotels, restaurants, cafés/pubs, museums and companies along the waterway
15. Linking inland waterways
16. Urban development with connecting waterways
17. Infrastructure, including bicycle lanes and footpaths and parking spaces along the waterway
18. Enhancing blue-green spatial qualities of urban and rural areas
19. Restoring and purposeful using cultural heritage values in and along the waterway;
20. Introduction of environment-friendly powered vessels
21. Nautical safety
22. Enhancing spatial quality
23. Environmental measures
24. Mitigating measures with regard to climate change: water use for agriculture, aquaculture, drinking water, cooling water and energy.

Old remnants of tidal gullies and streams are present in most terrains in the marine clay region, e.g., Zwaakse Weel, de Braakmankreek and Isabellakanaal, northeast of Sint-Laurens multiple waterways in natural and anthropogenically shapes. Another example is shown in Stierskreek in Zeeuwsch Vlaanderen. On the micro-scale, a multitude of wielen (results of dike breakthroughs) are present in Southern Beveland and to a lesser extent on other Zeeuwsche islands. Everywhere, a plethora of creeks and ditches are present. Scattered through the landscape are also the waters present that are clearly anthropogenic remnants of dredging and excavation activities resulting from mineral (clay, sand) extraction for construction purposes.

4.1.2. User Groups

For the optimal use of AquaPuncture and adaptation and management of the waterways and their waterfronts, six actual and potential user groups in and along the waterways should be considered [14] (Figure 2). All these user groups can be clearly identified in the Schelde Delta region, where all waterways and water infrastructures are related to them. In terms of environmental sustainability, the right and just balance between the five anthropogenic user groups and the sixth natural one, Acquatic/Terrestrial Flora and Fauna, need to be kept in place. Therefore, stakeholder interaction with the Nature Futures scenario is needed to safeguard and promote nature values (Section 4.2).

4.1.3. Physical Adaptations (Interventions)

To achieve a revitalised land- and waterscape for these user groups, physical adaptations (interventions) and organising measures are necessary [14] (Figure 3). Examples of these interventions and measures are physical adaptations from sluices to pumping stations, realisation of facilities from water depth to marinas, nautical safety, enhancing spatial qualities, and environmental and climate adaptation measures. For the aUGGP Schelde Delta, these physical adaptations and interventions in and along the waterways are listed from 24 potential choices to holistically manage the land- and waterscape (see full list in Table 2).

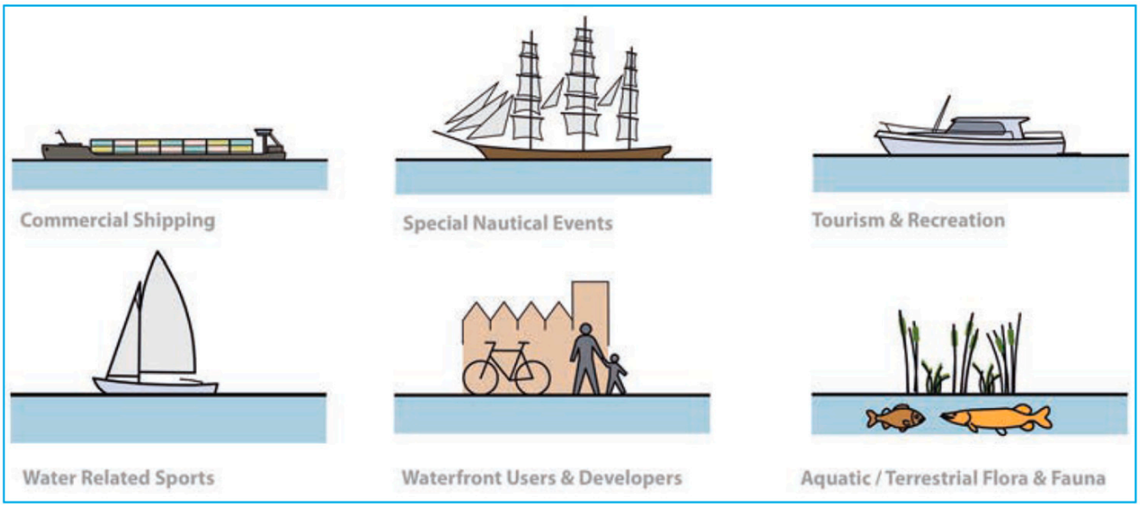

Figure 2. Actual and potential user groups in and along the waterways: Commercial shipping for persons and goods; Tourism and recreation; Special nautical events ("Sail", floating flower shows, regattas of heritage ships, dragon boat races, concerts on water, special cruises); Water related sports (sailing, surfing, rafting, rowing, canoeing, fishing, swimming); Waterfront users and developers; Aquatic/terrestrial flora and fauna and micro-organisms (copyright from [14]).

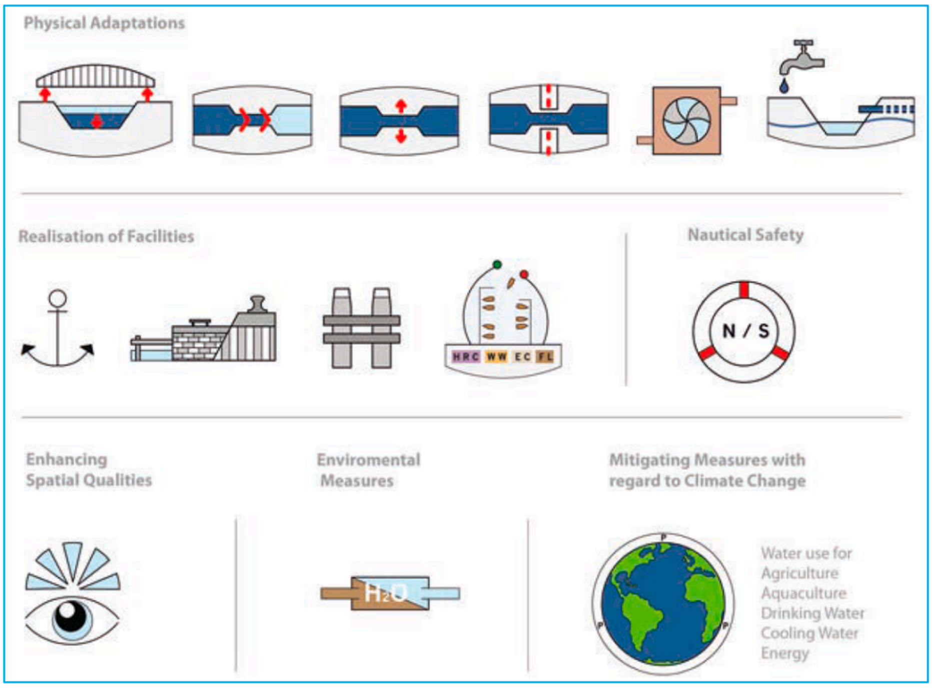

Figure 3. Physical adaptations and interventions managing the land- and aquascape (copyright from [14]).

4.1.4. Organisation for Waterway and Waterfront Development

To acquire adequate support for revitalised land- and waterscape, stakeholder analysis and participation are important, as well as representatives of the public–private partnership, in order to come to a societal cost–benefit analysis [14] (Figure 4). Different municipalities will take variable degree measures, e.g., water quantity (values) and drinking water supply (objectives). In these latter activities, a humane economy approach should be apparent that brings in balance the economical, societal and environmental interests [4]. Within the aUGGP Schelde Delta, the five levels of Government in NL and Belgium are international, national, provincial, communal and local. To organise these interactions, the network of the aUGGP ScheldeDelta is important in tying the private and societal partners to local governmental networks, as well as education, promotion, general outreach and communication tools [1].

(**A**) (**B**)

Figure 4. AquaPuncture: societal costs and benefits measurement model for municipalities along the connecting water ways. (**A**) (left). The values and corresponding objectives in the measurement model. (**B**) (right). The model can be used for benchmarking here as example for municipalities A and B (from [14]).

The adoption of AquaPuncture in the aUGGPScheldeDelta area will evolve differently in different regions, as will the opportunities for development vary as well [14,24]. The most chances to start with a development of revitalised land- and waterscape will be the Leisure domain, which is central in the management of the aUGGPScheldeDelta: 'The leisure domain offers opportunities as a trusted experimental space where behavioural change can be brought about' [1].

4.2. Scenario: Improved Biodiversity

The scenario Improved Biodiversity describes the emergence of the Anthropocene landscape of the aUGGP Schelde Delta and the Nature Futures Framework (NFF) [13] to revitalise the landscape.

The growing urgency of the biodiversity crisis [17], as well as the ongoing climate crisis [49], is demanding holistic approaches to future landscape management scenarios. The future plan of the aUGGP Schelde Delta calls also upon important questions such as how we do (re)shape our (intrinsic) relation with nature, and how do we inspire people to change their behaviour in a sustainable way [1,16]?

The essence of the NFF approach is to populate the NFF triangle with examples of how nature values are represented in different regions of the aUGGP Schelde Delta, across local scales, and how they could change in the future (Figure 5) [13]. For the implementation of new nature values, it is important to engage with society as stakeholders in diverse appearances within the region [19–22]. In addition, the already-established aUGGP Schelde Delta network can be elaborated and extended with the NFF approach (Figure 6). At first, we need to mobilise the scientific community (scientific chamber) and encourage local research groups to align ongoing work with the activities of IPPC, IPBES, as well as the (Dutch) national environmental agency [17,50,51]. Second, the aUGGP Schelde Delta indicates the leisure domain to engage with the general public, addressing major social issues such as those formulated in the SDGs [1]. Potential user groups are geotourists, local ambassadors, excursion guides and park visitors in general. Educational activities are aimed at (a) initiating 100 % Geopark product offer, mainly but not exclusively for the audience of the geotourist; (b) enriching existing touristic offers with Geopark content; and (c) creating tools the partners can use in their own products and communication. These roads of communication can be informed and enriched with the NFF approach in an iterative way, inspiring park users to (re)connect with nature in a co-design approach [13] (Figure 6).

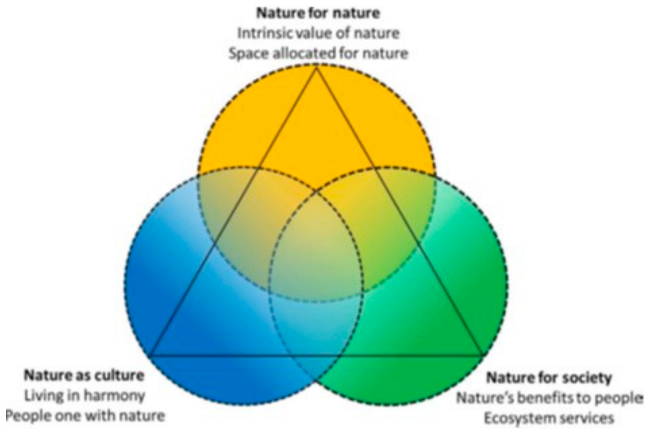

Figure 5. The Nature Futures Framework showing Nature for nature, Nature as culture and Nature for Society (copyright from [13]).

Within the aUGGP Schelde Delta, sustainable tourism is stimulated, as well as the distribution of visitors over the whole aspiring Geopark. Tourism entrepreneurs are stimulated to make their businesses more circular and with a lower carbon footprint [1]. Hiking and biking are promoted via routes and networks to motivate visitors circular in a climate-friendly way. The routes and networks are complemented by visitor centres with an important spill function. The aUGGp Schelde Delta adheres to the vision that leisure has to be in balance with society as a whole and contribute to flourishing communities [1].

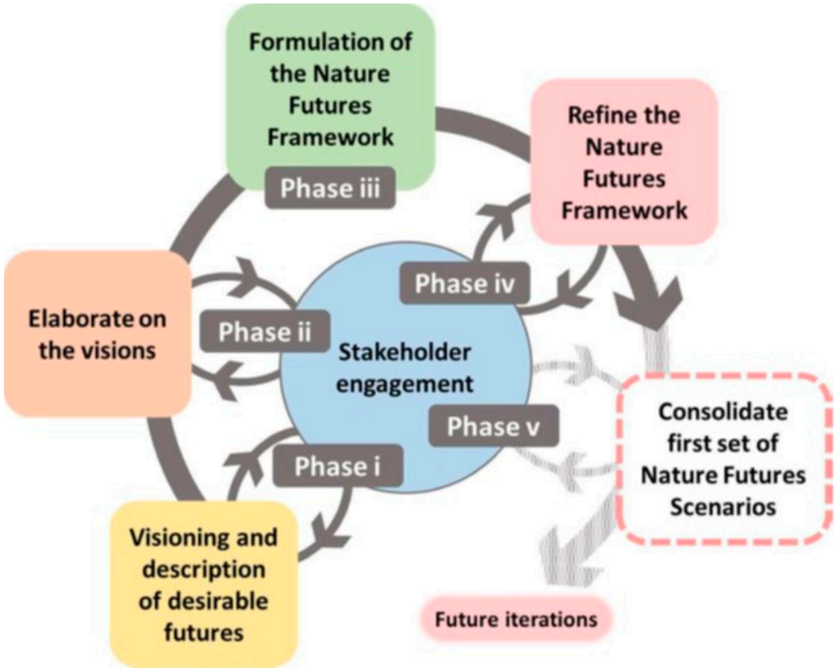

Figure 6. Five main methodological phases used for the development and co-design of Nature Future scenarios, whose process illustrates how the Nature Futures Framework evolved (copyright permitted from [13]).

The start of applying the NFF approach to the aUGGP Schelde Delta applies to the iterative steps on the 2nd Horizon of the stakeholder interaction. Via IPBES (Intergovernmental Science-Policy Platform on the Biodiversity and Ecosystem Services) [17] and The Netherlands Environmental Assessment Agency [50], local cycles, multiple-level schools and community groups and buildings need to be informed and inspired to reach more incremental steps in the horizon framework (Figure 7). Within these local cycles, the process of transition is clearly highly dependent on the stakeholder interaction, resulting in incremental steps, as well as progress over a long-term period [22]. Stakeholder interactions should be part of day-to-day or week-to-week returning frequency to build on incremental adjustments, e.g., to formulate diverse value perspectives for nature in the future [13].

Discussion and Synthesis

The deep-time history of the Scheldt Delta area with the UNESCO Geopark candidacy [1] bolsters regional cohesion in landscape history and between five provinces in two countries. The sometimes-sharp (Escarpment of Brabantse Wal, Oligocene cuesta of Temse, coastal dunes of Schouwen), often-modest (Waasland cuesta, outcrop Nieuw-Namen, coversand ridge Stekene Maldegem) to no-elevation differences (Land of Saeftinghe and many polder landscapes) are shaped by processes such as river (fluvial deposition and erosion [44]), sea (marine deposition), frost (periglacial action), wind (eolian dunes), and faults and uplift (tectonics).

Due to the dynamic interaction between geology and humans at the transitions of land and water, high and low, fresh and salt, and sand and clay, an enormous wealth of geomorphology, landscapes, cultural history (material and intangible) and nature has been created [1]. From 50 million years, from the Eocene to the Oligocene Boom clay until the ongoing sedimentation in the Wadden landscape in the Land van Saeftinghe today, different landforms may give a unique identity to the wider inhabitants of the region, stimulating the acceptance of landscape as heritage, suggesting a sense of pride that may facilitate a sustainable transition in the Anthropocene [30]. The views on Revitalised Land- and Waterscapes and Nature Futures adopted in this paper allow a new perspective on landscape management, including watercourses, big to small, in the Scheldt Delta area

(Figures 8 and 9). The overall nature of the geological processes relates to the aqueous nature of the area, expressed in major waterways, rivers, canals, tidal gullies, streams, pools caused by dyke breaches, creeks, ditches and many anthropogenic water bodies, such as from mineral extraction. Even the extended polder landscape of the northern part of the proposed Scheldt Delta area in Zeeland has been drained multiple times and with disastrous forces from water in the past 500 years. Good plans point to the future, rooted in the past, and humans play a crucial role but need to be steered in favourable directions, e.g., as demonstrated with revitalising land- and waterscapes in Singapore from sewer to stream [14] (Figure 8). Additionally, the iterative process of Nature Futures has the attractive value that it invites visitors and users of the landscape and the water to reflect on the type of nature values and the choice or selection of a sustainable society for itself (Figure 9).

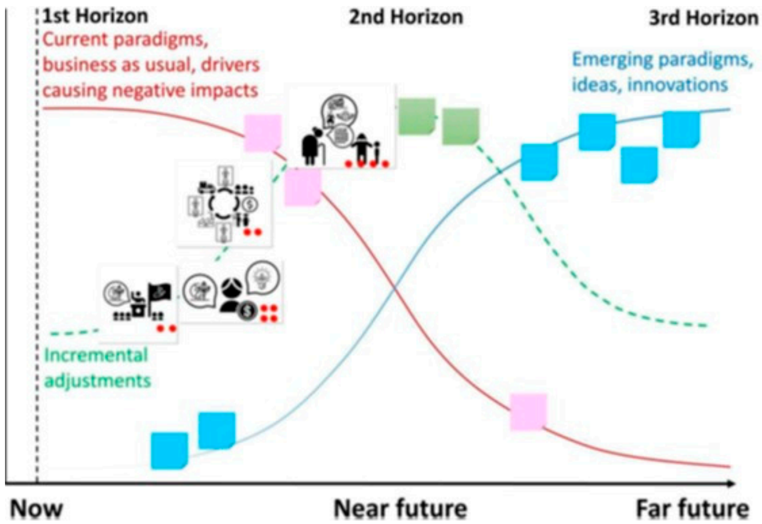

Figure 7. First horizon represents current paradigms and business as usual, while third horizon displays the emerging paradigms, ideas and innovations. The intermediate, second horizon represents the incremental adjustments needed for the transition between the first and the third horizon. The horizontal axis shows the time dimension, showing that all horizons can occur at the same time. The vertical axis represents the intensity and dominancy of the stakeholder interaction process (copyright permitted from [13]).

Humans have become a geological factor for the first time in the earth's history. Therefore, now, it is about letting human activity carry out natural processes. Humans, in their lifestyles and numbers, are acting as a geological factor, with the result that human action is present in natural processes as much as possible. What is needed to safeguard the environment for the complex and chaotic future in a sustainable landscape design? How can a deep and recent environmental history of an area contribute to acknowledging a desirable change? The importance of making people conscious of the landscape around them and making them aware of possible futures has never been more important than today. For two decades, a scientific and societal discussion has been taking place around the concept and potential starting date of the Anthropocene [2–4,6–9,51]. Therefore, popular awareness of the long-term formation of the landscape, as well as informing identity, belonging and a sense of pride and place to citizens and policy makers, in combination with the AquaPuncture approach, will also encourage a positive approach to creating a sustainable future for the planet.

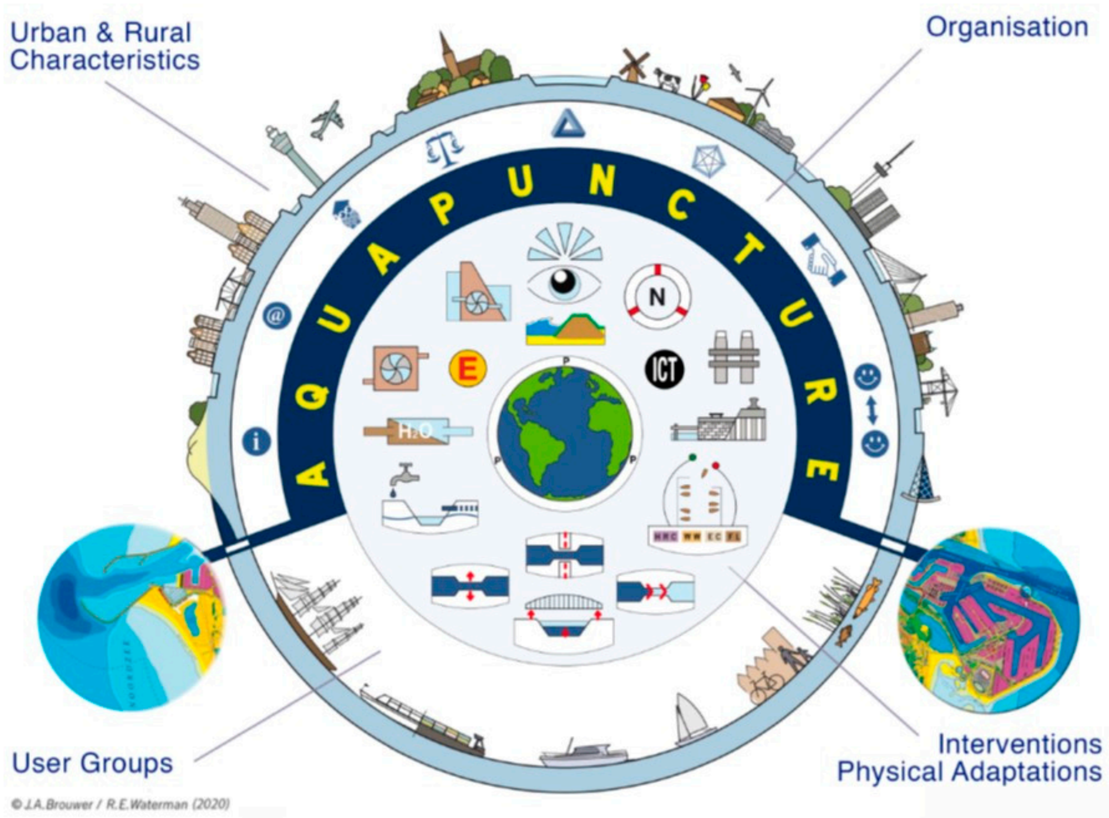

Figure 8. Relationship between user groups, urban and rural characteristics, organisation, and interventions and physical adaptations in a Dutch setting; note also the signs for E = environmental sustainability and ICT = digitisation of processes (copyright permitted from [14,24]).

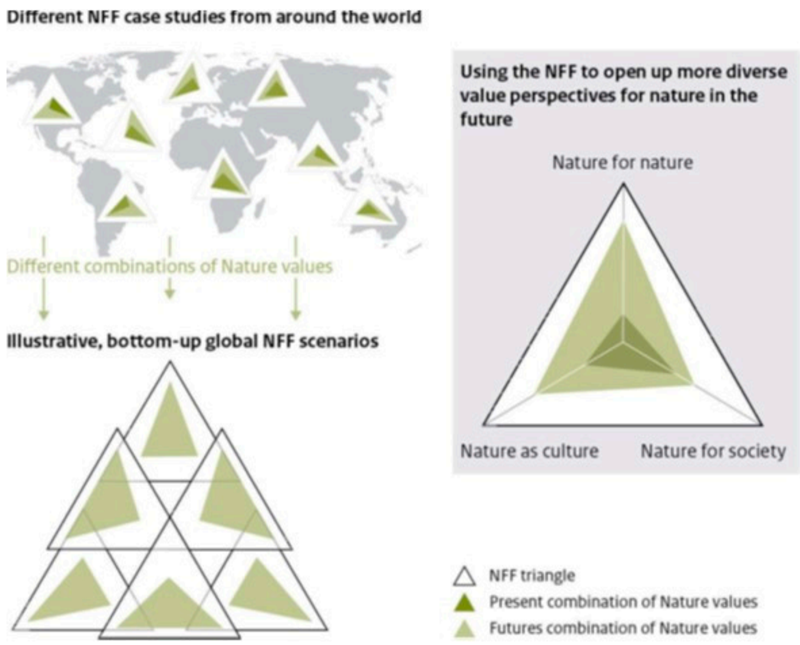

Figure 9. Perspective of Nature Futures Framework illustrating the bottom-up process on a global scale and to use the NFF to open up more diverse value perspectives for nature in the future (copyright permitted from: [13]).

Inhabitants and visitors of this area when confronted with a deep history of the geology can take a strong identity, belonging and a sense of pride and place value to this region [30]. To put emphasis on AquaPuncture and Nature Futures to be adopted by the proposed Geopark follows logically out of the deep history with ample focus on pure nature and water. The revaluation and revitalisation of waterways offer many potential avenues for sustainable development in the 21st century (Figure 8), e.g., Geopark visitors, tourists and citizens can enjoy electrical boats (whisper boats) to explore the natural and cultural landscape of the Scheldt area. These same visitors can marvel at rewilding initiatives and improved biodiversity habitats that will surround and be embedded within cultural centres such as villages and cities.

Apart from the dramatic history and drowned landscapes from the Middle Ages into the New and Modern Ages (1953), the entire area of the Scheldt Delta Geopark has witnessed two major transitions that have profoundly shaped the landscape. At first, the Industrial Revolution introduced mechanical power instead of horsepower and introduced energy fuels such as coal, oil and gas. In the centuries preceding this fossil revolution, the area has also witnessed peat (and salt) extraction as a precursor to the later more widely available fossil energy sources [16].

Second, our society, including the Scheldt Delta area, experienced a Great Acceleration after the Second World War [7,48], accelerating the use of resources, including the growth of industry and consumption, to currently unsustainable levels [4]. Observing the landscape in the Schelde Delta area is traditionally performed on a land-based approach, i.e., all features described are terrigenous and comprise mineral or rock materials. Rarely, the aqueous nature of the area has been described or witnessed. From historical records, a great example of a painting observed out of boats floating in the Medieval Scheldt depict villages and settlements at the Brabant scarp. In modern times, a dominance of land-based forms, landscapes and attributes is based on an anthropocentric behaviour that steers people's observations always on a terrigenous spectre e.g., [42]. This also is based on the notion that humans in the path of their long time evolution have always progressed and moved over land.

Whereas acupuncture is applied to revitalise the nervous system and the human organs, AquaPuncture is applied to revitalise the inland waterways and their waterfronts [24]. The unique geography of the proposed Schelde Delta UNESCO Geopark application [1] is that due to its dynamic landscape history of flooding and river change, most locations and areas are located at waterways. The Geopark has as its main status, showing the beauty of the earth and environmental phenomena. To do that sustainably, the use of EV boats, potentially circular in energy, can be demonstrated to visit multiple Geosite locations throughout the area. In addition, the Nature Futures Framework will be targeted on the land part of the Geopark (75% of area [1]).

Since we are currently facing multiple crises (war, energy, and refugees) and are in a period of transitions (e.g., food, energy and climate), it is therefore important to address sustainability in transport systems, water quality, economic development, energy use and social welfare through more healthy environments and use the concept of AquaPuncture to revitalise the inland waterways and their waterfronts. However, water management, sewerage, all forms of energy, sustainable fisheries, see bed mining, eco-friendly building, tourism, a sustainable socio-sphere and governance can also be much more concrete than adopting 17 SDGs as a way of greenwashing organisations [24]. It needs to be further openly discussed how the 22 main functions (and derived) of nature, landscape and water [2] relate to the 17 SDGs and how we implement that in the Nature Future Framework. We also may need these multiple frameworks to couple and diversify functions to action and to alleviate class differences.

Adaptation of the inland waterways through AquaPuncture will continue to play a significant role in the total concept of achieving a smaller global footprint [24]. Because good plans have their roots in the past and are pointing to the future, the adoption of AquaPuncture and the Nature Future Framework also points to sustainable landscape management [15], as has been moved forwards in current discussions and political debates in the world around the nitrogen crisis [52]. Many political processes currently appear to be accelerating, caused by the pandemic, energy crisis and war, as well as climate and biodiversity targets for 2030 [17,46]. We propose that an approach of AquaPuncture and Nature Futures Framework applied to the area of the aUGGP Schelde Delta holds a promise for a sustainable future, especially when this novel approach will be coupled with circularity, waste control and biodiversity improvement in respectful and efficient stakeholder interaction [13,18,22,53].

5. Conclusions

- The Anthropocene landscape and waterscape of the aUGGP Schelde Delta will inspire and motivate inhabitants and visitors with geological history, identity, belonging and a sense of pride and place value.
- A deeper insight is achieved into the geological history of both aquatic and terrestrial surface and underground landscapes, including the interplay of rivers with the specific tectonic framework in the landscape.
- AquaPuncture's Revitalised Land- and Waterscape is an already elsewhere successfully implemented development while Nature Futures has also promising and inspiring values for the Geopark Scheldt Delta.
- Important for the AquaPuncture and Nature Futures Framework development is taking into account the special 'aqueous' cultural and natural history of the region and its biodiversity. It strives for stakeholder interaction with incremental steps in integrated, multifunctional, sustainable, development of co-designing landscapes and waterscapes.
- The aUGGP Schelde Delta region is by its aqueous nature fit for water transport and further (sustainable) developments. The surrounding area in all its aspects can be a source of inspiration for nature values in the NFF.
- A new and sustainable vision for Geopark tourism (leisure and economy) is defined and is prone to be followed up by AquaPuncture and Nature Futures as a response from bottom-up stakeholder interaction in society and to be supported and implemented by policy makers.

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References

1. Westrik, C.; Bernaerts, G.; Kiden, P.; Jonkers, W. (Eds.) *aUGGp Schelde Delta UNESCO Global Geopark Candidate's Application*; Aspiring UNESCO Global Geopark Schelde Delta: Middelburg, The Netherlands, 2022; pp. 1–50.
2. Waters, C.N.; Zalasiewicz, J.; Summerhayes, C.; Barnosky, A.D.; Poirier, C.; Gałuszka, A.; Cearreta, A.; Edgeworth, M.; Ellis, E.; Ellis, M.; et al. The Anthropocene Is Functionally and Stratigraphically Distinct from the Holocene. *Science* **2016**, *351*, aad2622. [CrossRef] [PubMed]
3. Lewis, S.; Maslin, M. Defining the Anthropocene. *Nature* **2015**, *519*, 171–180. [CrossRef] [PubMed]
4. Pattberg, P.; Kluiving, S.J. Introduction to the Special Issue: Accelerating and Scaling Transformative Change in Anthropocene: A Multi-Disciplinary Perspective. *Int. J. Environ. Sustain.* **2022**, *18*, I–VII. [CrossRef]
5. Crutzen, P. Geology of mankind. *Nature* **2002**, *415*, 23. [CrossRef] [PubMed]
6. Crutzen, P.J.; Stoermer, E.F. The "Anthropocene". *Glob. Change Lett.* **2000**, *41*, 17.

7. Waters, C.N.; Williams, M.; Zalasiewicz, J.; Turner, S.D.; Barnosky, A.D.; Head, M.J.; Wing, S.L.; Wagreich, M.; Steffen, W.; Summerhayes, C.P.; et al. Epochs, events and episodes: Marking the geological impact of humans. *Earth-Sci. Rev.* **2022**, *234*, 104171. [CrossRef]
8. Gibbard, P.L.; Bauer, A.M.; Edgeworth, M.; Ruddiman, W.F.; Gill, J.L.; Merritts, D.J.; Finney, S.; Edwards, L.; Walker, M.; Ellis, E.; et al. A practical solution: The Anthropocene is a geological event, not a formal epoch. *Epis. J. Int. Geosci.* **2021**, *45*, 349–357. [CrossRef]
9. Merritts, D.; Edwards, L.E.; Ellis, E.; Walker, M.; Finney, S.; Gibbard, P.; Gill, J.; Maslin, M.; Bauer, A.; Edgeworth, M.; et al. The Anthropocene is complex. Defining it is not. *Earth-Sci. Rev.* **2023**, *238*, 104340. [CrossRef]
10. Rockström, J.; Steffen, W.; Noone, K.; Persson, Å.; Chapin, F.S.; Lambin, E.F.; Lenton, T.M.; Scheffer, M.; Folke, C.; Schellnhuber, H.J.; et al. A safe operating space for humanity. *Nature* **2009**, *461*, 472–475. [CrossRef]
11. Sustainable water solutions. *Nat. Sustain.* **2020**, *3*, 73. [CrossRef]
12. Greve, P.; Kahil, T.; Mochizuki, J.; Schinko, T.; Satoh, Y.; Burek, P.; Fischer, G.; Tramberend, S.; Burtscher, R.; Langan, S. Global assessment of water challenges under uncertainty in water scarcity projections. *Nat. Sustain.* **2018**, *1*, 486–494. [CrossRef]
13. Pereira, L.M.; Davies, K.K.; den Belder, E.; Ferrier, S.; Karlsson-Vinkhuyzen, S.; Kim, H.; Kuiper, J.J.; Okayasu, S.; Palomo, M.G.; Pereira, H.M.; et al. Developing multiscale and integrative nature-people scenarios using the Nature Futures Framework. *People Nat.* **2020**, *2*, 1172–1195. [CrossRef]
14. Waterman, R.E. *Integrated Coastal Policy with Building with Nature*; Drukkerij Banda: Heerenveen, The Neterlands, 2010; 71p, ISBN 978-90-80522-3-7.
15. Lindholm, K.-J.; Fernández, N.; Svenning, J.-C.; Pereira, H.; Kluiving, S. Policy recommendations for sustainable landscape management strategies. *TERRA NOVA* **2020**, *2022*, 1–20. [CrossRef]
16. Snow, K.; Kluiving, S. Reading the Anthropocene through Landscape Archaeology: Historical and Contemporary Landscapes of Accumulation in the Netherlands and Lebanon. *Int. J. Environ. Sustain.* **2022**, *18*, 3–25. [CrossRef]
17. IPBES. *Summary for Policymakers of the Thematic Assessment of the Sustainable Use of Wild Species of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*; Fromentin, J.-M., Emery, M.R., Donaldson, J., Danner, M.-C., Hallosserie, A., Kieling, D., Balachander, G., Barron, E.S., Chaudhary, R.P., Gasalla, M., Eds.; IPBES Secretariat: Bonn, Germany, 2022. [CrossRef]
18. Fayet, C.M.J.; Reilly, K.H.; Van Ham, C.; Verburg, P.H. The potential of European abandoned agricultural lands to contribute to the Green Deal objectives: Policy perspectives. *Environ. Sci. Policy* **2022**, *133*, 43–44. [CrossRef]
19. Segar, J.; Pereira, H.M.; Filgueiras, R.; Karamanlidis, A.A.; Saavedra, D.; Fernández, N. Expert-based assessment of rewilding indicates progress at site-level, yet challenges for upscaling. *Ecography* **2022**, *2022*, 1–10. [CrossRef]
20. Diogo, V.; Helfenstein, J.; Mohr, F.; Varghese, V.; Debonne, N.; Levers, C.; Swart, R.; Sonderegger, G.; Nemecek, T.; Schader, C.; et al. Developing context-specific frameworks for integrated sustainability assessment of agricultural intensity change: An application for Europe. *Environ. Sci. Policy* **2022**, *137*, 128–142. [CrossRef]
21. Pereira, H.M. (Ed.) *Rewilding European Landscapes*; Springer International Publishing: New York, NY, USA, 2015.
22. Quintero-Uribe, L.C.; Navarro, L.M.; Pereira, H.M.; Fernández, N. Participatory scenarios for restoring European landscapes show a plurality of nature values. *Ecography* **2022**, *2022*, e06292. [CrossRef]
23. Bianchi, G.; Pisiotis, U.; Cabrera Giraldez, M. *GreenComp the European Sustainability Competence Framework*; Punie, Y., Bacigalupo, M., Eds.; Publications Office of the European Union: Luxembourg, 2022.
24. Waterman, R.E.; Brouwer, J. Aquapuncture for Sustainable Waterways. *Terra Et Aqua Nr 121* **2015**, 5–18.
25. Kranendonk, P.; Kluiving, S.; Troelstra, S. Chrono- and archaeostratigraphy and development of the River Amstel: Results of the North/South underground line excavations, Amsterdam, the Netherlands. *Neth. J. Geosci.* **2015**, *94*, 333–352. [CrossRef]
26. Kluiving, S.J.; Troelstra, S.R.; Kasse, C.; Lelivelt, R.A. Het oudste strand van Zeeland: Een hernieuwde kennismaking met de "Meester van der Heijden groeve" (de Kauter), Nieuw-Namen. *Grondboor Hamer* **2012**, *66*, 431–437.
27. Kiden, P. De evolutie van de Beneden-Schelde in België en Zuidwest-Nederland na de laatste ijstijd. *Belgeo. Rev. Belg. De Géogr.* **2006**, *30*, 279–294. [CrossRef]
28. Vandenberghe, N. Tectonic and climatic signals in the Oligocene sediments of the Southern North-Sea Basin (Ernest Van den Broeck medallist lecture 2016). *Geol. Belg.* **2017**, *20*, 105–123. [CrossRef]
29. Kasse, C. De Brabantse Wal, op de grens van hoog en laag, oud en jong. *Grondboor Hamer* **2009**, *63*, 173–178.
30. Kluiving, S.J. Heritage and Landscapes. In *The Encyclopedia of Archaeological Sciences*; López Varela, S.L., Ed.; Wiley Online Library: Hoboken, NJ, USA, 2018. [CrossRef]
31. Vandenberghe, N. *Sedimentology of the Boom Clay (Rupelian) in Belgium*; Paleis der Academiën: Brussel, Belgium, 1978; 137p.
32. Vanneste, K.; Meghraoui, M.; Camelbeeck, T. Late Quaternary earthquake-related soft-sediment deformation along the Belgian portion of the Feldbiss Fault, Lower Rhine Graben system. *Tectonophysics* **1999**, *309*, 57–79. [CrossRef]
33. Kübler, S.; Friedrich, A.M.; Gold, R.D.; Strecker, M.R. Historical coseismic surface deformation of fluvial gravel deposits, Schafberg fault, Lower Rhine Graben, Germany. *Int. J. Earth Sci.* **2018**, *107*, 571–585. [CrossRef]
34. Grützner, C.; Fischer, P.; Reicherter, K. Holocene surface ruptures of the Rurrand Fault, Germany—Insights from palaeoseismology, remote sensing and shallow geophysics. *Geophys. J. Int.* **2016**, *204*, 1662–1677. [CrossRef]
35. Kasse, C. *Early-Pleistocene Tidal and Fluviatile Environments in the Southern Netherlands and Northern Belgium*; Free University Press: Amsterdam, The Netherlands, 1988; 190p.

36. Crombé, P.; Van Der Haegen, G. *Het Midden-Paleolithicum in Noordwestelijk België*; Archeologische Inventaris Vlaanderen: Ghent, Belgium, 1994; Volume 3.
37. Crombé, P.; Van Strydonck, M.; Boudin, M.; Van den Brande, T.; Derese, C.; Vandenberghe, D.; Zwertvaegher, A. Absolute Dating (14C and OSL) of the Formation of Coversand Ridges Occupied by Prehistoric Hunter-Gatherers in NW Belgium. *Radiocarbon* **2012**, *54*, 715–726. [CrossRef]
38. Derese, C.; Vandenberghe, D.; Gils, M.; Mees, F.; Paulissen, E. Final Palaeolithic settlements of the Campine region (NE Belgium) in their environmental context: Optical age constraints. *Quat. Int.* **2012**, *251*, 7–21. [CrossRef]
39. Crombé, P. (Ed.) The last hunter-gatherer-fishermen in Sandy Flanders (NW Belgium). In *The Verrebroek and Doel Excavation Projects. Volume 1: Palaeo-Environment, Chronology and Features. Archaeological Reports Ghent University 3*; Academia Press: Ghent, Belgium, 2005; p. 334.
40. Vos., P.C.; van Heeringen, R.M. Holocene geology and occupation history of the province of Zeeland. *Meded. Ned. Inst. Voor Toegep. Geowetenschappen TNO* **1997**, *59*, 109.
41. Kuiper, J.J.B.; van Dierendonck, R.M. (Eds.) *Sluimerend in Slik*; Den Boer: Middelburg, The Netherlands, 2004; 120p, ISBN 9789074576505.
42. Kluiving, S.J.; Brand, N.; Borger, G.J. *De West-Brabantse Delta: Een Verdronken Landschap Vormgeven. Geo- and Bioarchaeological Studies*; Instituut voor Geo- en Bioarcheologie: Amsterdam, The Netherlands, 2007; Volume 7.
43. de Kraker, A.M.J.; Kluiving, S.J. Verdronken landschap voor het voetlicht. Onderzoek naar de locatie en specifieke kenmerken van verdronken nederzettingen en structuren van West-Brabant voor 1600. In *Noordbrabants Historisch Jaarboek*; Stichting Matrijs: Utrecht, The Netherlands, 2007; pp. 59–70.
44. Missiaen, T.; Jongepier, I.; Heirman, K.; Soens, T.; Gelorini, V.; Verniers, J.; Crombé, P. Holocene landscape evolution of an estuarine wetland in relation to its human occupation and exploitation: Waasland Scheldt polders, northern Belgium. *Neth. J. Geosci.* **2017**, *96*, 35–62. [CrossRef]
45. Soens, T.; Tys, D.; Thoen, E. Landscape transformation and social change in the North Sea polders, the example of Flanders (1000-1800 AD). *Siedlungsforschung. Archäologie-Gesch.-Geogr.* **2014**, *31*, S.133–S.160.
46. Soens, T.; De Graef, P. Polder mania or marsh fever? Risk and risk management in early modern drainage projects: The case of Kallopolder, Flanders, 1649 to 1662. *Agric. Hist. Rev.* **2014**, *62*, 231–255.
47. Anzion, F.K.M. Hoe Jan Salie op stoom kwam: Nederland en de Industriële Revolutie, Themanummer. Spiegel Historiael: Zeist, the Netherlands, 2003; p. 38.
48. Steffen, W.; Richardson, K.; Rockström, J.; Cornell, S.E.; Fetzer, I.; Bennett, E.M.; Biggs, R.; Carpenter, S.; Vries, W.; de Wit, C.; et al. Planetary Boundaries: Guiding Human Development on a Changing Planet. *Science* **2015**, *10*, 1259855. [CrossRef]
49. IPCC. *Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*; Pörtner, H.-O., Roberts, D.C., Tignor, M., Poloczanska, E.S., Mintenbeck, K., Alegría, A., Craig, M., Langsdorf, S., Löschke, S., Möller, V., et al., Eds.; Cambridge University Press: Cambridge, UK; New York, NY, USA, 2022; p. 3056. [CrossRef]
50. Schoolenberg, M.; den Belder, E.; Okayasu, S.; Alkemade, R.; Lundquist, C.; Pereira, H.; Chettri, N.; Cheung, W.; Ferrier, S.; Hauck, J.; et al. Report on the Workshop 'Next Steps in Developing Nature Futures', PBL Netherlands Environmental Assessment Agency, the Hague, the Netherlands, nr 3411. Available online: https://www.pbl.nl/sites/default/files/downloads/3314_Report_on_The_Hague_workshop_June_2018_V9.pdf (accessed on 18 March 2023).
51. Martinez, A.; Kluiving, S.J.; Muñoz Rojas, J.; Borja Barrera, C.; Fraile Jurado, P. From hunter-gatherer subsistence strategies to the Agricultural Revolution: Disentangling Energy Regimes as a complement to cultural phases in Northern Spain. *Holocene* **2022**, *32*, 884–896. [CrossRef]
52. Gu, B.; Zhang, X.; Lam, S.K.; Yu, Y.; van Grinsven, H.J.; Zhang, S.; Wang, X.; Bodirsky, B.L.; Wang, S.; Duan, J. Cost-effective mitigation of nitrogen pollution from global croplands. *Nature* **2023**, *613*, 77–84. [CrossRef] [PubMed]
53. Fayet, C.M.; Leen, F.J.; Quintero Uribe, L.C.; Rigo, R.; Houet, T.; Lindholm, K.J.; Kluiving, S.J. TERRANOVA White Paper 2. An explorative opinion paper: 'Why do we need stakeholders' engagement in knowledge production: TERRANOVA's vision on landscape transformation. *Zenodo* **2021**, 1–11. [CrossRef]