Imagining a nature-based future for Europe in 2120

Nature-based solutions at the heart of a visionary approach for accelerating the transition to a climate resilient and nature-positive future

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Foreword

The Mansholt lecture is organised annually, in Brussels, by Wageningen University & Research (WUR) with the aim of inspiring European policymakers and other stakeholders in relation to pressing societal issues, in particular when they are related to sustainable food systems and the role that nature can play in improving the quality of life and well-being. The lectures are based on the innovative and inspirational thinking of our researchers and the role that technological advances can play in providing sustainable solutions to the greatest challenges facing the world today.

The implications of a changing climate and the accelerating loss of biodiversity for society, not least in relation to food systems and agricultural production, make it clear to me that as a university we must have a response that is timely and relevant in addressing and finding solutions to these critical issues and challenges. This year we therefore present an optimistic picture of how we might achieve a climate resilient and nature-positive future for Europe in 2120 and, in terms of realising this journey, we highlight the importance of tapping into the power of human imagination.

In 2022 the Mansholt lecture looked at the food system's role as a catalyst for developing nature-positive futures. As part of further developing this narrative, in this year's lecture we focus on the role of nature-based solutions as an essential part of finding an achievable pathway that will lead us towards climate resilience and a liveable future. Biodiversity and the power of nature are at the forefront of this action driven approach, moving us from facing challenges to realising opportunities across society and the key sectors that can make change happen.

I do not think that this will be an easy journey. In spite of the almost daily evidence of highly-impacting environmental change we still have a long way to go in relation to implementing meaningful policy and practice. By sharing this inspiring vision, we aim to create movement and focus effective collective and individual responses. We therefore need leadership at all levels of governance and within society as a whole. The work we present here can be seen as a first step towards co-designing an initiative that can shape nature-based futures across Europe, whilst at the same time accelerating local and regional actions. The key recommendations for designing such a process provide the focal points of this lecture. Whilst we bring evidence-based science to support our narrative, our hope for the future is rooted in inspiration and we are confident that our message will resonate deeply with our audience. We want it to create a spark within you that will lead to unified and collective action.

Sjoukje Heimovaara
President Executive Board
of Wageningen University & Research

Summary

Wageningen University & Research (WUR) organises the Mansholt lectures to provide inspiration for European policy makers and other stakeholders. This year, we highlight the importance of the power of imagination and we present an initial hopeful perspective of a climate resilient and nature-based future for Europe in 2120. Continuing from the previous Mansholt lecture in 2022, which discussed the food system's role as a catalyst for developing nature-positive futures, in this lecture we focus on the potential of nature-based solutions as an essential part of a cohesive, collaborative approach towards the development of a climate resilient and nature-based future for Europe. This approach places climate action and biodiversity at the forefront, interlinking these themes across society as a whole and shifting the paradigm from confronting challenges to accepting opportunities.

Key messages

Embracing climate and biodiversity action: Seizing the opportunity

There is common agreement that climate change and biodiversity loss are the world's greatest challenges for the 21st century. It is not too late to take action for global climate and biodiversity, but the urgency of the matter requires unprecedented transformative change in order to secure a liveable future for humanity. Both IPCC and IPBES, call for joint action for climate and biodiversity.

Giving priority to large-scale implementation of nature-based solutions is essential

While the rapid reduction of carbon emissions through the gradual elimination of fossil fuels and a transition towards a decarbonised society remains essential, the large scale implementation of Nature Based Solutions (NBS) is now recognised as a crucial evidence-based approach for achieving a liveable future. Despite the clear benefits they offer, large-scale implementation of NBS is still lacking. To give momentum to the delivery of a nature-based transformation in Europe, we need to provide an overarching nature-based narrative at a European scale.

Accelerating European leadership in the forefront of global climate and biodiversity action

Europe is currently witnessing intensifying climate impacts across the continent and is at the forefront of global climate action. The European Commission is aiming not only to establish Europe as the world's first climate resilient and carbon-neutral continent but also to position itself as a global leader in promoting and implementing nature-based solutions. That ambition was formalised through the adoption of the Nature Restoration Law by the European Parliament in July 2023.

Creating a narrative of hope and action: Imagining the future we want

Achieving sustainability and resilience in the context of climate change requires a narrative of optimism and

proactive engagement. To realise this, transformative and multi-scale visions are essential in order to stimulate coherent thinking and for taking positive steps toward radically different trajectories. In order to create a liveable future for the coming generations, there is a need to adopt a far-reaching and integrated strategy that extends beyond 2050 and connects to society, also in the short term. Developing an inclusive, long term narrative for a nature-based future for Europe holds the power to foster awareness and accelerate short term actions, making the future as a whole imaginable, viable and desirable.

Inspiring Action

Imagining a nature-based future for Europe holds the potential to raise awareness and foster public participation, speeding-up proactive measures. This Mansholt lecture sets out a preliminary outline of a narrative that could shape a positive, nature-based future for Europe. This vision was co-designed by an international community of students and researchers at Wageningen University & Research (WUR). In this creative process an international group of students and young professionals took the lead, supported by experts from WUR, resulting in a first sketch of Europe's desired nature-based future. More significantly this process can be seen as a powerful example of the transformative outcomes that can be achieved through holistic engagement and cocreation. Beyond its initial output, this perspective provides valuable insights into dilemmas, obstacles and how to deliver a collaborative construction of an imaginable future.

This Mansholt lecture can be seen as a first step towards a Europe-wide initiative for co-designing nature-based futures. It doesn't represent a definitive outcome, but acts as a catalyst for rethinking an entirely different and optimistic future, shaping our collective role in its realisation. Rather than providing or predicting the future, it's about collaboratively shaping sustainable futures. This perspective aims to spark inspiration and foster further discourse about our desired future and the collective journey towards it. Our central recommendation involves initiating a collaborative process uniting the European scientific community, students and young professionals, regional experts and stakeholders to co-design nature-based futures on three scales: (1) the European continent, (2) the five European ecoregional clusters and (3) European cities and regions.

As the essence of our lecture is rooted in inspiration, we hope for it to resonate deeply as you read the narrative. More importantly, we hope it will create a spark within you that will lead to unified and collective action towards a nature-based future.

1 Introduction

It’s not too late for climate and biodiversity action

Climate change and biodiversity loss are the most important global crises of our time, and will be for future generations. Both challenges are already causing social, ecological and economic disruptions around the world.[1] Failing to act will increase human vulnerability, inequality, poverty, food insecurity, involuntary displacement and political instability and conflict. Many of the other global crises we are facing are directly linked to climate change, biodiversity loss and the pressures of a changing environment. Failing to take action continues to jeopardise the functioning of our planet and, as a consequence, the very existence of a thriving humanity. However, it is not too late to act. If society as a whole turns insights into committed action, we still can turn the tide.

According to the Intergovernmental Panel on Climate Change (IPPC), the extent to which current and future generations will experience a hotter and different world depends on choices made now and in the near-term (figure 1.1).[2] To secure a liveable future, comprehensive and never before seen levels of global climate action are required, encompassing both climate mitigation and adaptation. This future should integrate biodiversity by default, as climate and biodiversity are strongly coupled global challenges and vital for our society and economy.[3]

We are witnessing unprecedented levels of biodiversity loss, with over 1 million species threatened and accelerating rates of extinction. Biodiversity loss is accelerating climate change whilst, at the same time, climate change is aggravating biodiversity loss.[4] The rise in global temperatures and the more frequent occurrence of extreme events disrupt ecosystem functioning, adding further strain to already weakened systems. Climate change and biodiversity loss are crises that have been caused and exacerbated by human choices. Overexploitation, pollution and the degradation of nature and natural resources, coupled with exceeding natural limits, have not only led to these crises but also hindered resilience, posing risks to our society and economy. The vital contributions of nature to human well-being, livelihoods, economies and climate change adaptation and mitigation, are now at risk and should be safeguarded as a fundamental priority.[5] Over the past decade, the focus on limiting climate change, adapting to its impacts, and addressing biodiversity decline, has grown significantly. The shift from simply doing less harm to adopting a more positive and constructive approach is becoming evident.

While the task of reversing these global crises may seem daunting, there is hope. Both the IPCC and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) emphasise that it is not too late to take rapid and unprecedented action for climate change and biodiversity loss, as long as it is

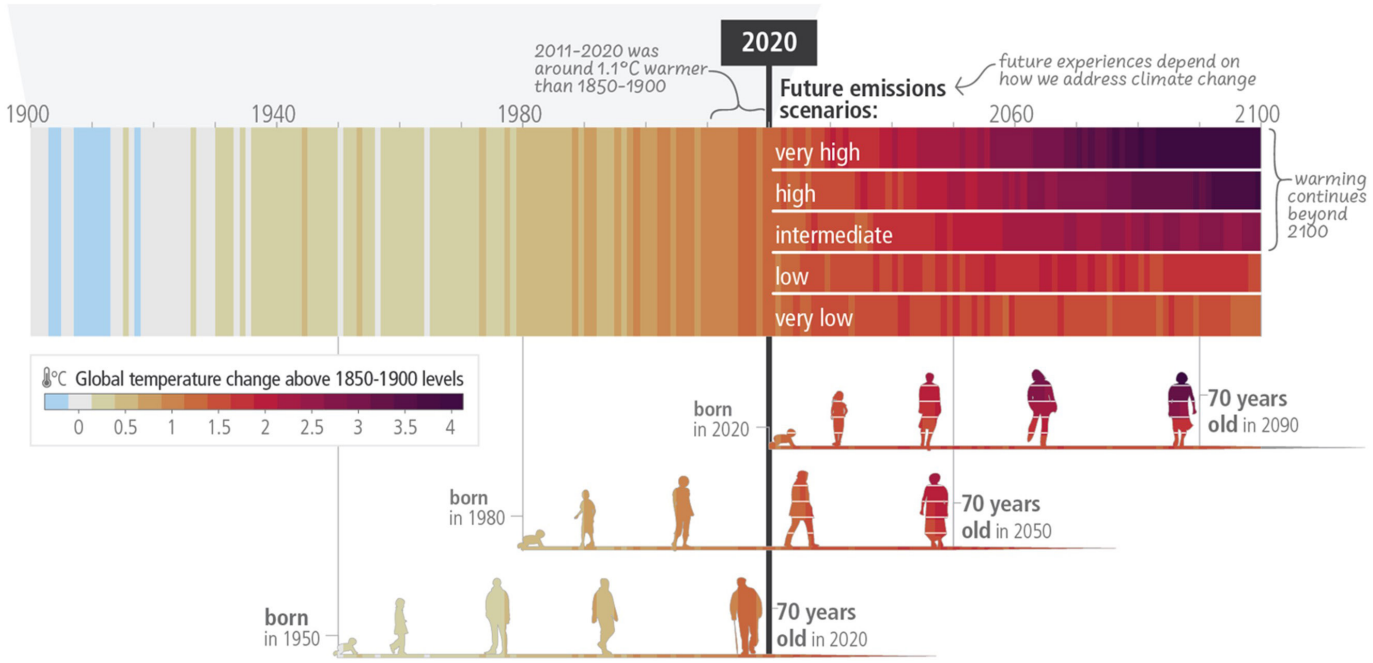

Figure 1.1 The extent to which current and future generations will experience a hotter and different world depending on choices now and in the near-term (source: IPCC Sixth Assessment Report, 2023).

initiated in this decade. Encouragingly, most solutions are already available worldwide and can be scaled up to mobilise and accelerate action. By adopting an integrated, whole-of-society and nature-based approach, we can transform the current negative trend into a positive and accelerating virtuous cycle, leading to a nature-based transformation that will benefit us all.

Towards a safe and just operating space

The concept of a safe and just operating space for humanity recognises the need to navigate the complex challenges facing our planet while ensuring the well-being of both current and future generations. By understanding the interplay between environmental sustainability and social justice, we can strive to create a harmonious and prosperous future for all. The Earth is a finite system with limits and humanity must operate within these boundaries to ensure a sustainable and equitable future. Operating beyond these boundaries risks irreversible environmental damage and threatens the well-being of both human societies and the planet. Likewise, a socially just foundation acknowledges that environmental sustainability cannot be addressed without addressing social inequities and ensuring fair access to resources, opportunities and decision-making power. The boundaries of the safe environmental ceiling and socially just foundation represent the operating space in which a diversity of solutions can be implemented.

Several planetary boundaries, constituting the 'safe' boundary, have been identified, including climate change, biodiversity loss, land use change, freshwater use, issues related to ocean acidification, ozone depletion and the excessive release of nitrogen and phosphorus into the environment. Alarmingly, recent research shows that seven of eight globally quantified safe and just Earth System Boundaries have already been exceeded (figure 1.2).[6] When these boundaries are crossed certain irreversible tipping points are reached and the damage may be catastrophic. For some environmental components, such as climate and biodiversity, these tipping points are within reach.[7]

The 'just boundary' encompasses dimensions such as poverty eradication, equitable distribution of wealth, gender equality, human rights and inclusive governance. Creating a just operating space requires addressing systemic inequalities and ensuring the well-being and empowerment of all individuals and communities. There are many pathways towards an Earth system where both people and nature thrive. These pathways interact across people and places and the synergies and trade-offs should be carefully evaluated to ensure that future pathways remain within an environmentally safe and socially just operating space.[8]

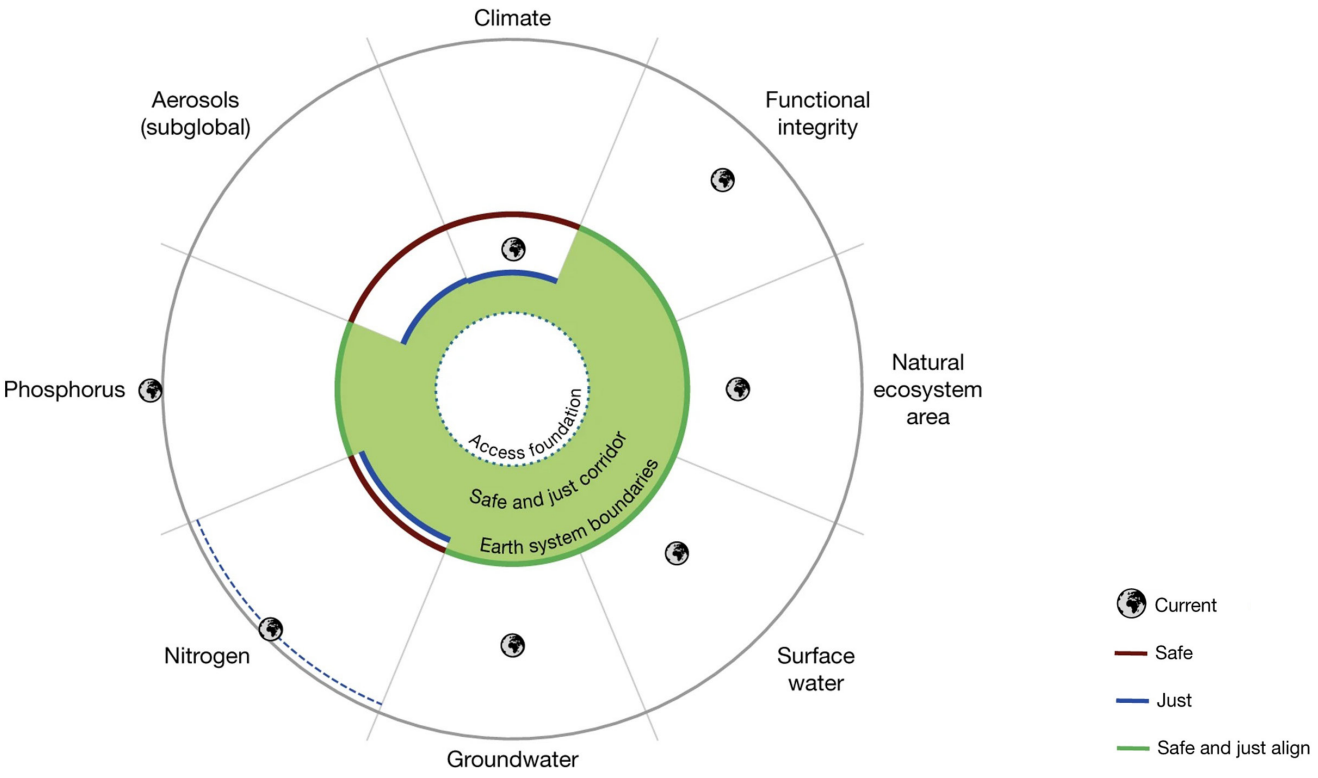

Figure 1.2 Safe and just Earth System Boundaries (Rockström et al., 2023).

It is not only about leaving no one behind, the emphasis is on actively engaging everyone, and considering their unique capacities, values and needs. Most importantly, our approaches must engage with individuals and communities on a more personal level, catering to their distinct circumstances. This means that there is a shared platform for participation, which considers everyone's values and propositions, and facilitates group deliberation to identify collective ways to work in a safe and just operating space towards shaping a positive and hopeful future together.

In 2021, the G7 stated that *"our world must become not only net zero but also nature-positive, for the benefit of both people and the planet".* Global leaders increasingly acknowledge the fact that climate and biodiversity actions are interlinked, and that protecting, restoring, and sustainably managing natural ecosystems is essential for the solution. In addition to the 2015 Paris climate agreement, a landmark UN Biodiversity Agreement was signed in Montreal in December 2022, with countries committing to protect 30% of the land and 30% of the sea by 2030. [9],[10] Alongside the urgent need to rapidly reduce carbon emissions and transition to a decarbonised society by phasing out fossil fuels, large-scale implementation of Nature-Based Solutions (NBS) is being acknowledged as a crucial step towards a safe and just future.

Large scale implementation of nature-based solutions is essential

A healthy biosphere should be at the core of achieving a sustainable and liveable future for all. The SDG 'wedding cake' illustrates the interconnectedness and importance of social, economic and ecological systems to achieving the United Nations Sustainable Development Goals (figure 1.3). NBS play a vital role in achieving a healthy biosphere and have the potential to address multiple global sustainable development challenges simultaneously. The European Commission defines nature-based solutions as: *"Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions".* Scientific evidence supports NBS as promising climate solutions that contribute to climate mitigation, climate adaption and biodiversity conservation. Additionally, NBS offer significant societal benefits, ranging from environmental and socio-economic improvements to well-being and health. Many NBS have demonstrated cost-effectiveness, resilience and adaptability, making them suitable for large-scale combined implementation. Despite the growing awareness and evidence for the potential benefits of NBS globally, including in Europe, actual implementation of NBS and financial support lag behind.[11]

Globally, scaling up implementation of NBS can provide up to one-third of the cost-effective climate mitigation required by 2030 to meet the goals of the Paris climate agreement while safeguarding livelihoods, natural ecosystems and biodiversity.[12] However, currently less than 10% of climate finance is allocated to NBS. Presently, around USD 154 billion per year is invested in NBS, but an annual investment of USD 674 billion is needed by 2050 to effectively limit climate change to below 1.5 °C. To achieve this, financial flows to NBS must be doubled by 2030 and quadrupled by 2050. It is important to recognise that one-size-fits-all solutions are not sufficient. NBS strategies should be tailored to specific local and regional circumstances, combining and customising different approaches. Policymakers and practitioners must carefully consider the synergies and trade-offs associated with NBS when designing strategies for climate change and biodiversity conservation.

Drawing from Seddon et al (2021), we highlight four science-based guiding principles that optimise the role of NBS and which will ensure sustainable benefits to society: NBS are complementary, not a replacement, to the urgent phase-out of fossil fuels; NBS should encompass a wide range of ecosystems, both on land and in the sea; NBS require the active engagement and consent of diverse societies, respecting their cultural and ecological rights; and NBS should be purposefully designed to deliver measurable benefits for biodiversity. By adhering to these guidelines, we can accelerate large scale implementation of NBS that effectively address the urgent challenges of climate change and biodiversity loss, ensuring the well-being of both nature and humanity, now and in the future.[13]

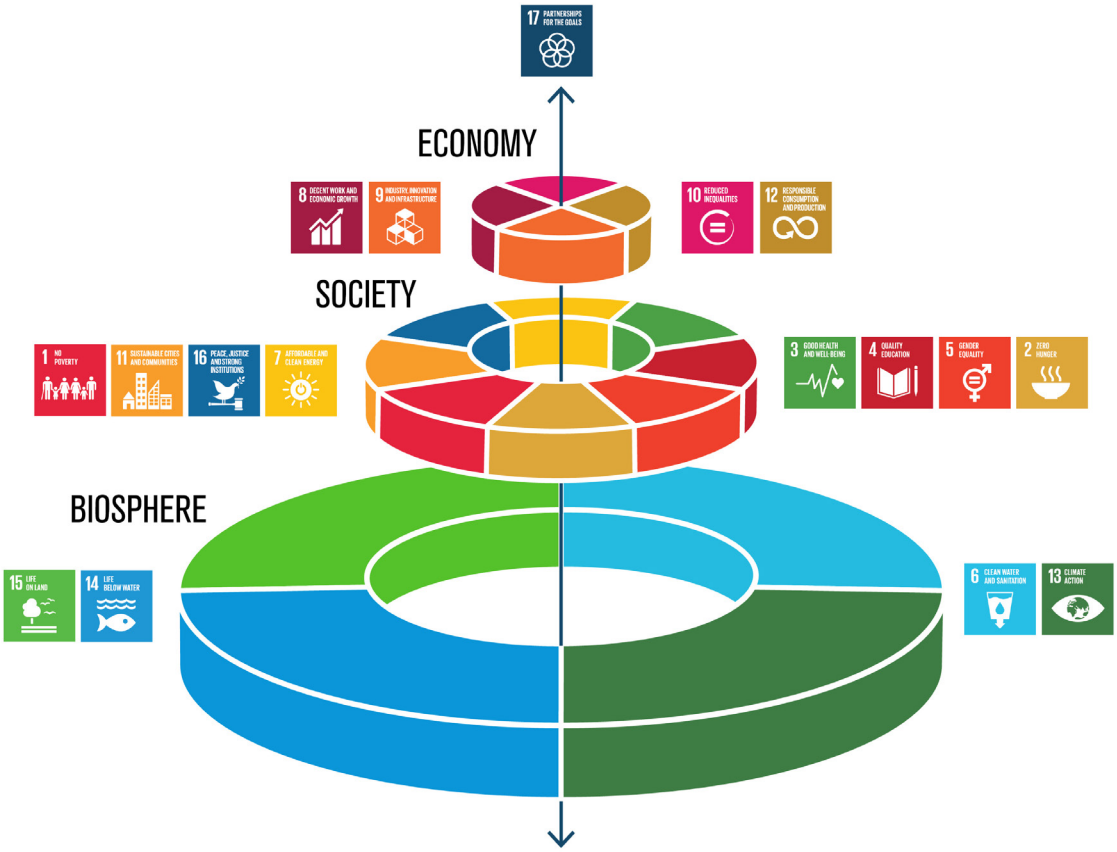

Figure 1.3 The (SDG) 'wedding cake' illustrates the interconnectedness and importance of social, economic and ecological systems to achieving the United Nations Sustainable Development Goals (Source: Stockholm Resilience Centre).

In conclusion, NBS must be given higher priority and positioned at the forefront of all our actions, with broad political and societal support and engagement. Political leaders, businesses, financial institutions and citizens must fundamentally shift their relationship with nature, to work with it rather than against it. NBS can be seen as a new conceptual approach to the human-ecological connection. This requires moving beyond the nature-based solutions discourse, towards nature-based thinking.[14] Our vision entails forging a strong human-ecological connection – making it imaginable, viable and desirable for everyone. Rather than contributing to the issue and initially imposing rigid goals, we promote the adoption of a fresh, captivating, and all-encompassing narrative that envisions the nature-based future we aspire to create.

Imagining nature-based futures

Achieving sustainability and building resilience under climate change requires transformative and multi-scale visions, which stimulate coherent thinking and action towards profoundly different future scenarios. Long-term visions are important tools for guiding long-term change on the way to increased sustainability, aiding in the reconciliation of diverse societies. However, they remain insufficiently employed within scientific and policy discussions.[15] The sense of urgency surrounding climate change and biodiversity loss permeates daily news and media. However, the continuous barrage of alarming messages can also paralyze individuals. Global studies reveal that climate anxiety is a growing and significant concern, particularly among young people who fear a doomed future. The combination of distressing news and insufficient collective action contributes to what is now termed 'climate depression' in young people.[16] On the other hand, the most challenging aspect of transitions lies in phasing out existing practices and habits, especially when the alternatives remain uncertain or unclear. This presents a serious obstacle as we require widespread engagement and commitment from society in order to tackle these major crises. Everybody must be actively involved. This leads us to a crucial question: how can decision- and policy-makers at European, national and regional landscape levels inspire and be inspired to lead the transformation towards a nature-based future?

We firmly believe that imagining nature-positive futures can be a powerful inspirational tool to bridge the gap between urgency, awareness and required actions. Generating shared European visions at various scales, could provide inspiration and an overarching direction while engaging diverse audiences and raising

environmental awareness and stewardship.[17] These narratives should offer room for imagining more desirable collective futures and provide actionable pathways to achieve them.[18]

In 2019 Wageningen University & Research developed an integrated long term vision for a nature-based future for The Netherlands in 2120 (box 1). It inspired policy-makers and citizens and helped to create awareness for the importance of restoring nature and nature-based solutions as an essential part of a liveable future. It raised the question about whether we also can imagine a nature-based future for Europe? In this Mansholt lecture we set out an initial sketch of **what could be a nature-positive future** for Europe. It builds on the previous Mansholt lecture (2022) about the food system as catalyser for developing nature-positive futures; here we focus on the potential of nature-based solutions as an essential part of an integrative shared strategy that will move us towards a climate resilient and nature-positive future for Europe.[19] This vision for a nature-based future was co-designed by an international community of students and researchers at Wageningen University & Research. Not as blueprint or to predict the future, but **to inspire** and instigate further discussion about the future we desire and how to make this journey together. It could be seen as a first step towards a Europe-wide process of co-designing nature-based futures in European regions, while at the same time accelerating local and regional actions.

Box 1 A nature-based future for The Netherlands in 2120.

In 2019 Wageningen University & Research (WUR) developed and visualised a nature-based future for The Netherlands in 2120.[20] The Netherlands faces major challenges: the energy transition, transition towards a sustainable food system, nature restoration, urbanisation and climate adaptation. Major changes are needed to cope with rising sea levels, periods of extreme weather, an increasing demand for food production and a need to reduce greenhouse gas emissions. It is inevitable that the Netherlands will look very different in a hundred years. An integrated long term vision for the future of The Netherlands is required for short term decision making. WUR experts aimed to highlight the importance of a healthy biosphere for the future of The Netherlands by visualising a nature-based future for their country.

NBS were at the heart of this vision, which was presented as a new map of the Netherlands with more room for water and nature, with regenerative agriculture, green cities, renewable energy and a circular bio-based economy that results in a genuinely nature-inclusive and sustainable society. The story generated significant attention in the Dutch media and this vision has been discussed and further developed with and by many stakeholders such as ministries, provincial authorities, water authorities, municipalities, NGOs and businesses. It empowered and inspired many regions to further develop this vision together with local stakeholders leading to concrete actions supported by substantial government funding. In the context of the alarming news about climate and biodiversity, this vision NL2120 created a sense of hope for the future.

2 Europe is facing major challenges

Europe's climate crisis: Alarming Trends and Intensifying Impacts

Europe has been warming more than twice as fast than the global average, making it the fastest warming continent in the world according to the World Meteorological Organisation (WMO). Scientific evidence overwhelmingly supports the assertion that climate change is profoundly impacting Europe. Rising temperatures, changing precipitation patterns, extreme weather events, sea-level rise and ecosystem disruption are all significant consequences of this global phenomenon. These impacts extend beyond environmental concerns, affecting human health, food security, infrastructure and socio-economic stability. The impact of climate change is already being experienced all over the continent. Looking at recent figures and events, it is undeniable that the effects of climate change are widespread and continuing to intensify. At the time of writing (July 2023) Europe has just experienced a record-breaking day, week, and month with the hottest and driest conditions ever recorded. Additionally, some parts of Europe were again facing record-breaking temperatures, wildfires and heavy rainfall causing severe floods across the continent.

The impact of climate change is already being experienced across the continent

Heatwaves have become more frequent but also more severe with serious impacts, for example, on health and mortality. In 2022, Europe experienced its hottest summer on record. According to recent WMO data, Europe experienced an increase in average temperatures of 2.3 degrees in 2022. Most of western Europe faced heatwave conditions with highest temperatures approximately 10 ºC higher than usual during the summer. These heatwaves impacted human health, with southern Europe recording a record number of days with 'very strong heat stress'. Over 60,000 excess deaths in the EU were reported during the summer of 2022, a figure that may - at least partly - be attributed to the heatwaves affecting various parts of Europe.[21] These heatwave events are not isolated incidents; they have also been observed in previous years. There were notable heatwaves in 2019, setting all-time high temperature records in many Western European countries, as well as in 2018, 2006 and 2003, often coinciding with prolonged drought conditions.

Temperatures in Europe have warmed significantly over the 1991–2021 period, at an average rate of about +0.5 °C per decade.[22] The ten warmest years on record for Europe

have all occurred since the year 2000, and the five warmest years have all occurred since 2014.[23] As a consequence of high temperatures, glaciers in Europe lost a volume of 821 billion m^3 of ice from 1997 to 2021, according to the WMO. Glaciers are continuing to lose mass at alarming rates, contributing more than 1 mm per year to mean global sea level rise. In 2022 the Alps suffered a record loss of 5 km^3 glacier ice.[24]

The high temperatures and lack of precipitation in recent years have resulted in widespread and prolonged droughts that have affected much of Europe and impacted crucial sectors such as agriculture, drinking water, energy and river transport. The lack of rain persisting into summer leads to critically dry soil which contributes to extreme high temperatures and an increased risk of wild fires. In summer 2022, river discharge was the second lowest on

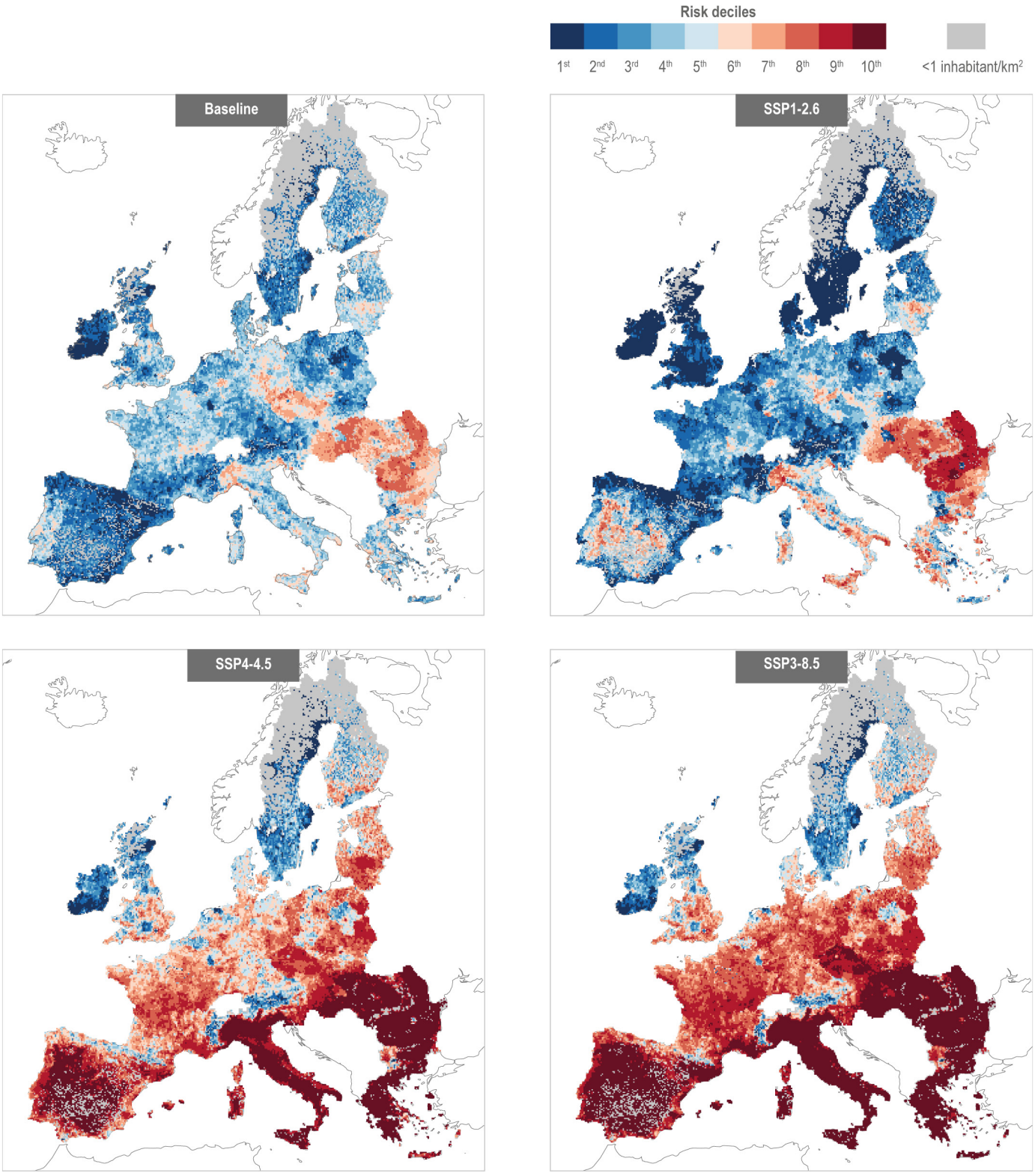

Figure 2.1 Projected heat stress risks for people in Europe (2040-2060). Source: IPCC, 2022.

record across Europe, marking the sixth consecutive year of below-average flows. In terms of area affected, it was the driest year on record, with 63% of European rivers seeing below average flows. The average sea surface temperature across Europe's seas was also the warmest on record.

Driven by persistent drought and heat conditions, the risk of wildfires is rapidly increasing, particularly in Central and Northern Europe, regions that are not typically prone to fires. In 2022, the burnt area reached the second-largest on record, just less than the 2017 figures. Although wildfires are a natural part of many ecosystems, an increase in their frequency and intensity can have many negative impacts such as habitat destruction, damage to property and loss of life. Furthermore, severe wild fires can trigger a chain reaction of risks, such as (flash) floods, due to the compromised natural defences and the soil's inability to cope with widespread and intense rainfall.

Western Europe experienced some of the most severe flooding on record in mid-July 2021. The worst-affected areas were western Germany, eastern Belgium and the southern part of The Netherlands, where over 200 mm of rain fell in just 48 hours, over a wide area. Across Europe there were at least 243 fatalities and an estimated total damage of at least €10 billion. In 2023, severe flooding occurred in Italy, Spain, The Balkans, Slovenia and Scandinavia. Many of these flooding events were preceded by prolonged periods of drought. On a positive note, the number of fatalities due to flooding has been declining, reflecting better early warning systems and preparedness, while the exposure to flooding has been increasing.[25]

The impact of climate change is expected to increase in the coming decades

Extreme weather and climate-related hazards such as heatwaves, floods and droughts will become more frequent and intense in the coming decades. In its latest Assessment Report, the IPCC lists four key risks to Europe that become more severe at higher levels of global warming: (1) Mortality and morbidity of people and

changes in ecosystems due to heat; (2) Heat and drought stress on crops; (3) Water scarcity; (4) Flooding and sea level rise. These extreme events will lead to adverse impacts on economic sectors, food production and human health and well-being and also affect ecosystems. Climate change is causing significant disruption to Europe's ecosystems. Although most of these risks are relevant for all of Europe, the way they manifest differs across the continent; the risks and potential impact of climate change vary from region to region. Adaptation measures must therefore be tailored to specific regional circumstances.

Many of the impacts of extreme weather events are the result of a combination of factors. Vulnerability depends greatly on how we have organised and arranged our society, both socially and spatially. The state of the environment and available coping mechanisms significantly influence resilience to climate impacts. Intensified land use, opportunistic spatial planning, environmental degradation, current land and water management practices and socio-economic conditions, all contribute to the exposure and vulnerability of communities and ecosystems to climate hazards. This balance in Europe and globally is often very fragile and ongoing climate change will further disrupt this balance. Extreme weather events and climate-related hazards are projected to intensify in the future, leading to adverse consequences for ecosystems, economic sectors, food production and human health and well-being. European society is vulnerable to the impacts of climate change, yet it also stands at the forefront of international efforts to mitigate these effects and develop innovative adaptation solutions for the new climate Europeans will face. Restoring nature will be an essential part of this transformation.

Europe's declining state of nature

Europe's ecosystems play a crucial role in building resilience against the impacts of climate change. However, our ecosystems - as a crucial safety net for mitigating the effects of climate change - are currently in a declining state. Intensive land use, pollution and the effects of climate change have resulted in a significant decline in biodiversity in recent decades. To address the increasing impact of climate change in the future, it is imperative to protect and restore nature. The latest report on the State of the European Environment confirms worrying trends in biodiversity loss, resource use, climate change impacts and environmental risks to health and wellbeing.[26] The message about biodiversity is further reinforced by the latest Member State reports (see box 2).

Box 2 Key findings from the latest EEA State of Nature report and other recent studies highlight the declining state of Europe's ecosystems[27],[28],[29].

- Agricultural activities, land abandonment and urbanisation are the major pressures on habitats and species, followed by pollution.
- The conservation status of only 14% of habitats assessments and 27% of non-bird species is 'good'. Pollinators' habitats have worse conservation status and trends than other habitats.
- The population status of almost half of the bird species in the Birds Directive is 'good'; however, the lowest number of improving trends is that for farmland birds.
- Natura 2000 sites cover 18% of land and 10% of marine waters in the EU.
- Only 14% of forest habitats are in a favourable conservation status, with only 2-4% of primary and old growth forests remaining in Europe
- Only 14% of grassland habitats are in a favourable conservation status and 83% of habitats dependent on adequate agricultural management are in inadequate conservation status
- Fisheries stocks continue to be over-exploited, with fishing pressure in the Mediterranean Sea and Black Sea being particularly high. The target of achieving good environmental status of European marine waters by 2020 had not been reached in relation to key pressures such as contaminants, eutrophication, fishing, invasive alien species and marine litter. In fact, the vast majority of protected species and habitats have either poor or bad conservation status, and the protected area network falls far short of the recently adopted 30% targeted area, covering only 18% of the land and 10% of marine waters.
- 60-70% of soils in Europe are considered degraded
- Only 40% of Europe's surface water bodies achieve good ecological status and wetlands are widely degraded, as are 80-90% of floodplains.
- The recovery of European freshwater biodiversity has come to halt due to pressures on freshwater ecosystems, including emerging pollutants, climate change and spread of invasive species.[30]
- Climate change is a rising threat for ecosystems, especially because of increased drought and lower precipitation.

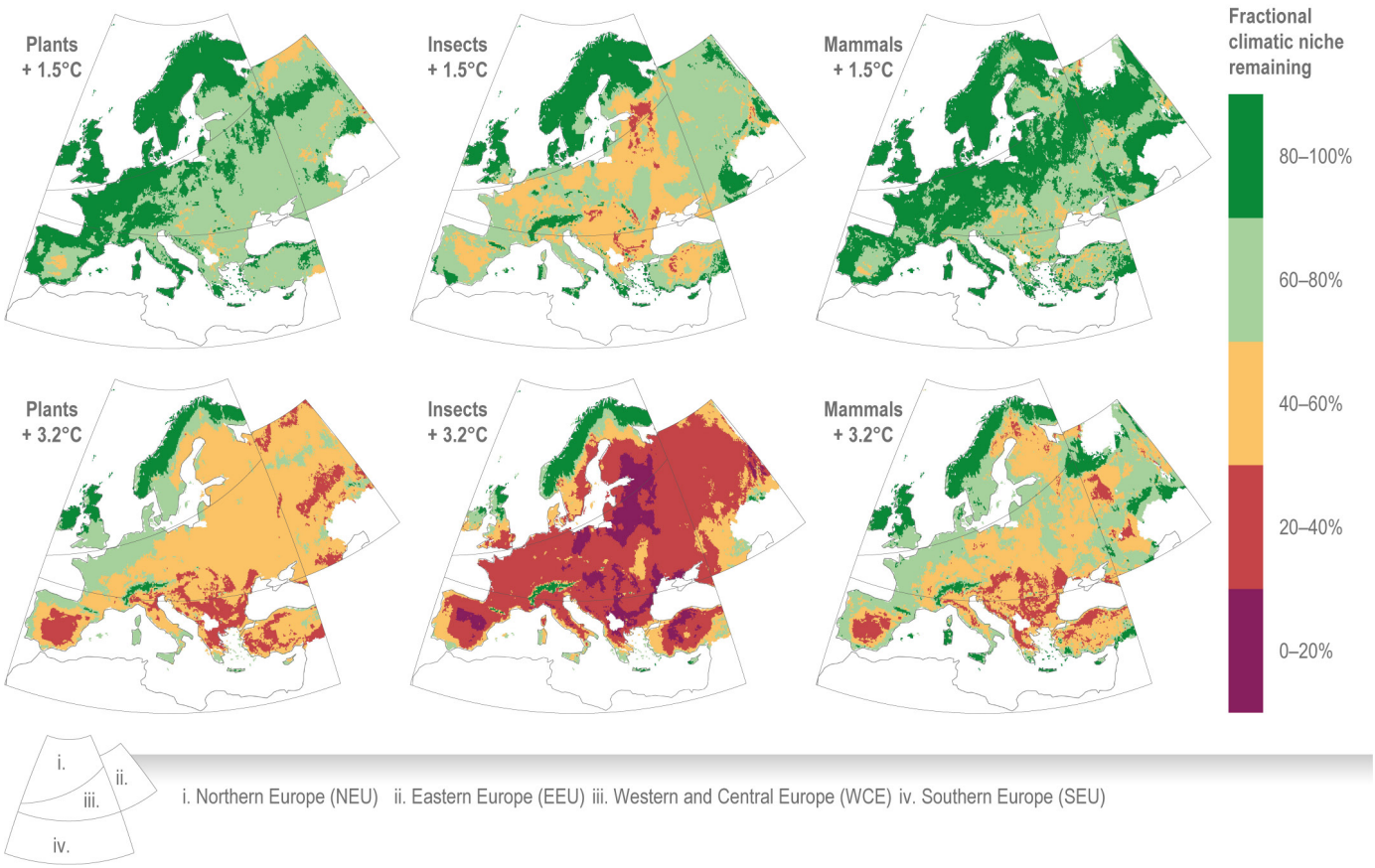

Figure 2.2 Species projected to remain in suitable climate conditions in Europe. Source: IPCC, 2022.

The reasons for these continuing negative trends are clear. For biodiversity, overall, the main threats continue to be land and sea use change, invasive alien species, pollution, overexploitation of natural resources and climate change. Shifting temperatures and precipitation patterns affect the distribution and behavior of plant and animal species, leading to changes in biodiversity. The IPCC Sixth Assessment report emphasises the risks of climate change posed to ecosystems such as forests, wetlands and marine habitats. These changes can result in ecosystem collapse, loss of ecosystem services, and have the potential to cause cascading impacts on food production, water resources and human livelihoods. Indeed, the climate crisis and the biodiversity crisis are closely interconnected: climate change has a detrimental effect on numerous species, habitats and ecosystem services, which in turn speeds up climate change and aggravates its effects. Both components therefore need to be addressed simultaneously, looking for synergies and mutual gains.

It is crucial to safeguard and cherish these natural ecosystems to keep up with climate change and to safeguard our economy and society. Biodiversity provides the foundation of our social system and for the economy and damage to the biosphere translates into damage to society and to the economy.

The capacity of ecosystems to mitigate the effects of climate change and to limit climate change has already been impaired. We must ensure that the ongoing negative effects of climate change do not harm ecosystem functions. Improving health of ecosystems is an important step towards a resilient future. However, as IPCC stated, there is a rapidly narrowing window of opportunity for climate resilient development and the current state of our safety net is in critical condition.

From ambitious European policy to accelerating action

The European Green Deal (EGD) is Europe's ambitious roadmap for tackling two of the biggest challenges faced by humanity: climate change and biodiversity loss.[31] The European Commission aims not only to make Europe the first climate resilient and carbon-neutral continent in the world, but also to position itself as a global leader in promoting and implementing NBS. The EGD aims *"to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use"*. It also seeks to *"protect, conserve and*

enhance the EU's natural capital, and protect the health and well-being of citizens from environment-related risks and impacts" and *"at the same time, this transition must be just and inclusive."*

As a key pillar of the European Green Deal, the EU Biodiversity Strategy for 2030 (BDS2030) includes an EU nature restoration plan which has the potential to strongly support the uptake of restorative NBS in Europe.[32] Restoring nature and enabling biodiversity throughout society and economy in a just and inclusive strategy, provides hopeful opportunities for a more sustainable, safe and prosperous future. Building on previous strategies and long-standing EU nature legislation it puts much emphasis on more effectively protecting nature and on restoring habitats and ecosystems, in line with the UN Decade on Ecosystem Restoration. We hope that this ambition will be formalised through the adoption of the Nature Restoration Law by the European Parliament in 2023 or early in 2024. The Nature Restoration Law is specifically targeted at habitat and ecosystem restoration and will require that each Member State delivers a national restoration plan.

Pre-existing legal instruments like the Birds and Habitats Directives (BHD) and Invasive Alien Species (IAS) Regulation are at the core of BDS2030. Natura 2000, the network of EU protected areas, requires effective conservation and extensive restoration efforts to achieve good conservation status for species and habitats. The new Strategy builds on these instruments while introducing new measures to meet their objectives. The BDS2030 commitments are closely linked to various environmental and policy sectors, including climate, soil, urban development, fisheries and agriculture. The Farm to Fork Strategy, adopted jointly with the Biodiversity Strategy, aims to make the food system more sustainable. Both strategies have influenced discussions on greening the Common Agricultural Policy (CAP) and align with the EU Water Framework Directive (WFD) for freshwater ecosystems and the EU Marine Strategy Framework Directive (MSFD) for marine environments.

Furthermore, the European Commission launched an EU Climate Adaptation Strategy that highlights the value of

NBS as multi-purpose and multi benefit solutions.[33] There are many opportunities for mainstreaming and large-scale implementation of NBS in Europe. The scientific evidence base supporting NBS is rapidly expanding and these approaches are now acknowledged as key elements within the European policy framework. However, despite this growing attention, the large-scale implementation of NBS in Europe still faces challenges, including lack of awareness and a clear long-term vision for their potential. Although research and policy in Europe have made progress in conceptualising and operationalising NBS, a much wider adoption is needed to reach the ambitious goals of the EGD and fulfil its vision of transforming the EU into a sustainable, climate neutral, climate resilient, fair, and prosperous place to live by 2050.[34] By putting NBS at the forefront, Europe can forge a path towards a more sustainable and resilient future for all.

The European Commission has developed five European missions within Horizon Europe, the EU Research and innovation programme for 2021 – 2027.[35] EU missions are new initiatives to bring solutions to some of our greatest challenges. Nature-based solutions play an important role in at least 3 of the 5 missions: (1) Adaptation to climate change: support at least 150 European regions and communities to become climate resilient by 2030; (2) Restore our Ocean and Water by 2030; (3) A Soil deal for Europe: 100 living labs and lighthouses to lead the transition towards healthy soils by 2030.[36] The Implementation Plan for the Mission Restore our Ocean and Waters by 2030 describes Europe's ambition to co-develop visualisations of Europe by 2050, showcasing how Europe will look once the objectives of the Missions and the EGD have been achieved.[37]

Can we imagine a nature-based future for Europe?

Today, Europe has the opportunity to address these challenges, by showing strong leadership and bold vision for future generations and the European-level policy framework provides a strong enabling environment. What is needed now is to inspire and mobilise large-scale action that builds on this positive momentum, while also recognising the urgency and critical timing for a new chapter in Europe's history. Despite ambitious policy and political leadership a continuous effort to increase public awareness and engagement in order to accelerate climate action is required. Public awareness and interest in engaging further also seems to be on the increase, as signalled by more climate-related legal actions and protests by citizens. In anticipation of the growing interest and urgent need for mobilising collective action we believe there is a need for new stories on climate and biodiversity, giving people hope that their actions can make a difference and tangible guidance on what actions to take.

The key question is: Could imagining a nature-based future for Europe help to accelerate the transformation towards a nature-positive future? In the following chapters, we will take you on a journey that explores how a nature-based Europe could look like in 2120.

3 Imagining a nature-based future for Europe in 2120

The power of imagination

In this decade of action there is a strong and compelling need to design and visualise an appealing hopeful and nature-based perspective for a climate resilient and nature positive future for Europe. Co-creating an inspiring long term vision can help to create a sense of hope, based on what is possible and desirable.[38] In order to face Europe's challenges we need a compelling narrative for the nature-based future we want. This will place our current actions into the right context, provides a message of hope and, importantly, unites all efforts into an imaginable, viable and desirable path. This approach fosters constructive discussions about the future we want, what it could and should look like and how each individual can play a crucial role in shaping that future, as well as discovering their role in the quest for a sustainable Europe. European citizens that are born today could still be alive in the year 2120. Present day developments, such as the construction of houses, infrastructure, nature development and land use transformation, will impact our landscapes for the next decades and are likely to remain visible in 100 years from now. Developing resilient and nature-positive landscapes and making the transformation to a safe and just Europe requires a long term approach, certainly beyond 2050, linked to short term actions that need to begin now.

By envisioning positive outcomes that result from complex transformation processes, we tap into the realm of possibility and hope, fostering motivation and unlocking our potential to overcome obstacles. Shared optimism becomes as a unifying force, encouraging collaboration, and inspiring collective efforts towards a common objective. The journey towards ambitious goals is seldom smooth, but positive scenarios help guide us through challenges and past obstacles. Optimistic perspectives provide fertile ground for creativity and help innovation to flourish, encouraging us to think beyond conventional boundaries and to explore unconventional approaches. A holistic nature- and landscape-based vision for the future of Europe can support short-term decision making and address synergies and trade-offs.

Our approach: Landscape-based design

The climate and biodiversity challenges and the consequences for the future spatial development of Europe addressed in chapter 2 can be seen collectively as unstructured or 'wicked' problems. The characteristics of such issues are the constantly changing conditions, the manifold interdependencies and related physical and societal systems. As advocated by many experts, design is the most appropriate method for addressing issues such as this, using an integrated systems approach.[39] This is due to the fact that design is about "situations that are not yet known". Landscape-based design is considered an important strategy that shapes the physical form the landscape as the basic condition. It is an transdisciplinary effort to safeguard sustainable and coherent development, to guide and shape changes which are brought about by socio-economic and environmental processes, and to establish local identity through tangible relationships to a region. The regional design is like an open-ended strategy, aimed at protecting resources, guiding developments and setting up future conditions for spatial development by means of landscape planning and design.[40]

Three design-cycles

Based on the insights gained from experience of the Netherlands 2120 project, a first cycle of survey, analysis and synthesis for Europe was conducted. The major characteristics, issues and nature based strategies were clarified with a group of interdisciplinary WUR experts, resulting in a design assignment for the second cycle. Next, a two-day design atelier was organised during which a diverse group of forty-five international (WUR) students were divided into five 'regional' teams that each engaged in a collaborative visualisation exercise. Beginning at a 1:1.5 million map scale, every group developed and visualised an integrated strategy for a part of Europe. Five design principles (next section) were provided to guide the application of nature-based solutions to the issues in question. On the second day of the atelier, one part of each of the five regions was selected for focussed attention, now at a scale of 1:100.000. This allowed NBS to be elaborated at a more intricate level. In the final stage, our core-group of experts and designers synthesised all the material into the perspective of a nature-based Europe in 2120, as presented and visualised in this report. The result of this design process serves as an initial version of a more comprehensive and in-depth process that could be further developed, involving stakeholders and experts from European.

Five clusters of ecoregions

Europe can be organised in different biogeographical regions. Biogeographical regions are considered to be useful geographical reference units delineated by their shared challenges and inherent characteristics and were originally defined for describing habitat types and species which live under similar conditions in different countries.[41] Europe has eleven biogeographical regions and seven regional seas. In order to gain a deeper understanding of the regions and seas, we amalgamated them into five distinct 'Ecoregional Clusters' for a more comprehensive analysis and targeted approach towards addressing their specific challenges (figure 3.1). In our view these 'ecoregions' offer a necessary starting point for sustainable future development of Europe. Ecoregions consider all essential characteristics of the landscape, including ecology, topography, water flows, economies, and regional identities. By recognising and leveraging the shared characteristics and challenges within these Ecoregional clusters, we believe that Europe can foster more effective and efficient (nature-based) solutions. The clusters we selected were:

1. North: Arctic and Boreal biogeographical regions, including the Baltic Sea;
2. West: Atlantic biogeographical region, including the North Sea and the Atlantic Ocean;
3. East: Continental biogeographical region, including the Black Sea;
4. Central: Alpine and Pannonian biogeographical regions (no sea included);
5. South: Mediterranean biogeographical region, including the Mediterranean Sea.

Five guiding principles for a nature-based future

Designing a nature-based future for Europe in 2120 is based on the following five guiding principles:

1 **A healthy biosphere as the cornerstone for Europe's future**
A healthy biosphere is considered as the cornerstone of Europe's future. The need for healthy waters from source to sea and vital soils are essential to all future developments in European landscapes, with an emphasis on fostering well-functioning ecosystems. NBS play a crucial role in curbing carbon emissions, promoting carbon storage, bolstering resilience against extreme weather events, restoring biodiversity, and enhancing the overall quality of life for European citizens.

2 **Adaptive and resilient**
Europe is facing the challenges of climate change: sea level rise, extreme weather events, persistent and slow-onset events and shifting climatic zones. This involves continuous adaptation to changing circumstances, working with nature rather than against it and harnessing the full potential of natural processes. European countries adopt a nature-based approach to enhancing resilience against the impacts of climate change.

3 **A climate-positive and circular bioeconomy**
Europe's economy will not only become climate neutral but will transform to a climate-positive and circular bioeconomy with renewable biological resources at the basis. More greenhouse gases will be sequestered than are emitted. This transition to a bioeconomy is truly circular and balances and symbiotically integrates with nature and people.

4 **Nature-positive society**
Regenerating biodiversity and embracing nature-inclusivity has become the norm. European society will have a stronger connection to nature, recognising that a healthy biosphere is vital for the economy, human health and wellbeing. Nature protection, restoration efforts and enhanced ecosystem services will underpin a nature-positive society.

5 **Inclusive and just**
The transformation towards a nature-positive Europe has been locally embedded, is inclusive and just. It will benefit all Europeans by generating millions of jobs, providing affordable water, food and energy and improving overall health and wellbeing. The key lies in full engagement and finding different ways for everyone to be part of the solution.

In the following two chapters, we will provide an overview of the broader perspective on Europe in 2120, as well as elaborate on the principles specific to the five ecoregions. It is important to note that this is not a blueprint, but rather a collection of building blocks and an initial step towards further exploration and engagement.

4 A snapshot of Europe in 2120

In this chapter, as a prelude to Chapter 5 and based on the five guiding principles presented in chapter 3, we will illustrate in the 'future tense' how a climate and nature-based Europe could look in 2120. Europe is bound to have undergone significant changes by then, with a nature-based approach leading to resilient and green landscapes, thriving cities, clean and healthy seas and coastal zones and vibrant economies, fostering a prosperous future for nature and society as a whole.

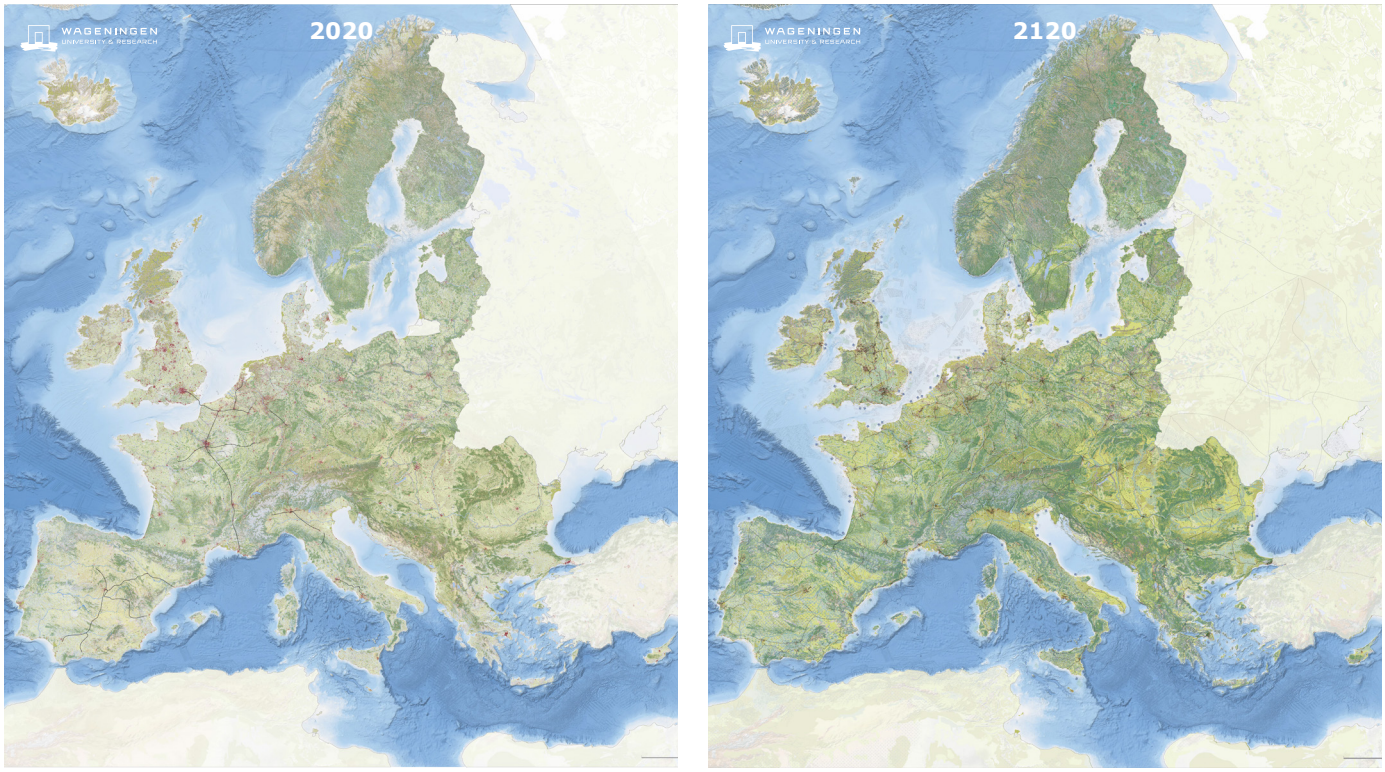

Figure 4.1 The actual map of Europe (left) and the image of a climate and nature based Europe in 2120 (right).

Healthy water and soil

Healthy oceans and waters from source to sea and vital soils are the foundation of a resilient and healthy Europe. Water is acknowledged as our most precious resource and is a fundamental lifeline for the future. We envision healthy rivers and wetlands in blue-green landscapes as crucial components for building resilience on land. Water connects and has the potential to unite Europe, but it also poses a range of challenges that necessitate a balanced and strategic approach.

Healthy rivers and wetlands in blue-green landscapes

In the early 21st century, concerns about the quality and accessibility of freshwater prompted comprehensive actions across Europe to restore water systems. Recognising the vital role that ecosystems play in

Figure 4.2 Healthy water and soil. In upstream areas, improved infiltration increases groundwater replenishment and re-establishes normal river flow rates. Major rivers are widened to restore their natural characteristics, retain water and prevent flooding. New forests are established to protect soils in steep terrain, capturing and slowing the run-off of water. Coastal zones are better protected through the creation of tidal flats, islands, (artificial) reefs and other NBS adapted to the specific geographical features and physical characteristics of the landscapes involved.

maintaining water quality and availability, ecosystem-based approaches to water management emerged as a sustainable alternative to technology-dominated methods. By protecting and restoring ecosystems, such as wetlands and forests, we harnessed nature's inherent capacity to regulate water cycles, filter pollutants and mitigate the effects of floods and droughts. This systemic approach benefits our water resources, biodiversity and overall environmental health.

Regenerative water management has emerged as the highest priority for governments, businesses, and citizens across all levels in Europe. Continental-scale efforts restore water systems, reduce pollution from industry, urban areas and agriculture, have revitalised European waters, promoting their health and sustainability. Smart water technology, such as water efficiency measures, advanced waste water treatment and re-use of water for agriculture or industry, has created business opportunities and increased the availability and supply of affordable clean water for all Europeans. Water optimisation within the complex relationship between ecosystems, food and energy has enhanced agricultural production.

NBS such as wetland and river basin restoration have been scaled-up to address extreme weather events. Increased retention of water in upstream natural systems has increased the sponge capacity of blue-green landscapes. Healthy soils across these landscapes further support water management practices that emphasise water retention, reuse, and storage. River basins have been restored by removing artificial dams, creating more space for the rivers to flow in order to reduce flood risk and by developing ecological river corridors that connect European landscapes. These measures have helped to restore thriving populations of migratory fish along many European rivers, including Atlantic salmon, Atlantic sturgeon, Beluga sturgeon and European eel. Restored habitats have benefited large and small mammals such as European otter, Eurasian lynx and the semiaquatic Pyrenean desman, as well as populations of migratory birds and bats. Most European rivers have become drinkable and are places where nature and people can thrive, while still providing their important transport function. Healthy rivers and wetlands are strongly linked to the health of marine ecosystems.

Healthy seas and coastal areas

The well-being of European society depends on the vitality and resilience of oceans and seas, which serve as cornerstones for a healthy future. In 2120, coastal and marine ecosystems play an important role in climate mitigation and adaptation by storing carbon, regulating temperatures and providing coastal protection in relation to rising sea levels. At least 30% of Europe's coastal and offshore areas are now protected, while pollution by plastics, contaminants and nutrients has been drastically reduced. Restored ecological corridors reconnect rivers and the sea, contributing to the marked recovery of European marine ecosystems, including large predators such as rays, sharks and sea mammals as well as foundation species such as sea grasses, oysters and *Sabellaria* reefs. Nonetheless, increasing temperatures have altered species composition and distribution, leading to significant changes in ecosystem functioning, food webs and fisheries practises. An ecosystem approach to maritime spatial planning effectively manages the increased demands for renewable energy, seafood (mainly seaweed and shellfish) and sand for coastal protection. Offshore hydrogen production, using renewable energy and seawater, has become a reality with former oil and gas infrastructure repurposed for green hydrogen storage and distribution. As Europe charts its course towards a nature-based future, our seas and coastal areas hold the key to a thriving and sustainable tomorrow.[42]

Healthy soils

Healthy soils contribute to Europe's water strategy. Vital soils provide clean water, host rich fauna and flora, and contribute to climate resilience. Life on earth depends on healthy soils that provide the foundation for our food systems. It is remarkable that one centimetre of soil can take hundreds of years to form, but can be lost in just a single rainstorm or industrial incident. Moreover, it supports our cultural heritage and landscapes forming the basis of our economy and prosperity. In the 21st century sustainable soil management and restoration has become an important part of a wider green transition in urban and rural areas In 2120 European soils have been restored and regenerated through the implementation of a long term strategy and they now provide the functions demanded by society.[43]

Connected resilient nature

By 2120, Europe has a landscape that is characterised by cohesive and functional ecological networks, that effectively connect diverse ecosystems and which facilitate species movement and migration. Society clearly recognises the value and advantages of nature, people have increased opportunities for its enjoyment and acknowledge the ecosystem services it provides. Business and industry, including agriculture, view nature as a pivotal element within their operational strategies, marking a significant advancement towards a productive, mutually beneficial coexistence with the natural world.

Over 30% of Europe's land and sea have been designated as protected and restored nature

By 2120, Europe has achieved significant progress in establishing connected and resilient nature across its

Figure 4.3 Connected and resilient nature in Europe 2120. An extensive, highly functional ecological network links new and existing protected areas. Forests are resilient and biodiverse, providing habitats for numerous species adapted to evolving climate patterns. Corridors, especially along the main rivers, connect biogeographical regions, seas and oceans across the continent and beyond. The area of wetlands, particularly in peat-dominated areas, has increased significantly.

landscapes. With a heightened understanding of nature's significance as the bedrock of the economy, resilience, and human well-being, substantial investments have been made throughout Europe in the first half of the 21st century. As a result, over 30% of Europe's land and sea have been designated as protected and restored areas for nature.

Climate change has led to loss of biodiversity and changes to ecosystems. However, a comprehensive long-term strategy for nature conservation and restoration, that integrates climate change mitigation and adaptation, has resulted in a network of natural areas connected by ecological corridors and natural 'stepping stones'. *Natura 2120* protected areas have been connected through natural and semi-natural terrestrial ecosystems, facilitating the migration of species across fast-changing climate zones. The strategic approach of rewilding in its broadest sense has become commonplace in a nature-inclusive society in which nature co-exists with people. By creating optimal conditions for nature and supporting nature-driven processes, wilder landscapes have flourished throughout Europe. By 2120 this has led to the successful establishment of viable populations of the European 'Big five' mammals: the European bison, lynx, wolverine, brown bear and wolf. Glacier shrinkage has revealed new ecosystems, providing important habitats for carbon-storing plants and threatened animals.[44]

Investments made in nature restoration have resulted in increased ecosystem services such as improved air and water quality, enhanced crop pollination and carbon sequestration. The restoration of degraded ecosystems, including rivers, wetlands, forests, grasslands and marine ecosystems, has contributed to a resurgence of biodiversity and bolstered Europe's resilience against natural disasters including the impacts of climate change. Moreover, these efforts have played a crucial role in mitigating risks to food security and have provided increased opportunities for the implementation of NBS.

Europe's commitment to actively conserving and restoring its natural spaces has safeguarded biodiversity, preserved critical habitats and protected essential ecosystem services. Through the establishment of protected areas, habitat restoration projects and rewilding initiatives, these ecosystems have been set on the path to long-term sustainability, ensuring that future generations can enjoy the ecological benefits they provide.

Climate smart and biodiverse forests

Forestry has a leading role in addressing climate change, enhancing biodiversity and promoting renewable resources through afforestation and carbon sequestration. Restoration efforts that encompass improvements in both quantity and quality have strengthened forest resilience and facilitated the circular bioeconomy. Diverse forests and their associated products contribute to emission reduction, carbon storage and the provision of ecosystem services such as wood products, energy and biodiversity conservation. There is a growing trend of retaining standing and fallen deadwood, managing towards uneven-aged forests and forest connectivity that encourage an abundance of common forest birds and which increase organic carbon stock. Climate-smart forestry practices have become standard, emphasising the need for careful tree establishment and subsequent management that includes support to local communities and bioeconomies. Climate-smart forestry revolves around three key objectives: (1) ensuring sustainable production and income growth, (2) building adaptation and resilience, and (3) reducing or removing greenhouse gas emissions[45]. The heightened risk of wildfires and bark beetle infestations has necessitated focused attention on adaptive management measures. These measures are based on improved, near-real-time monitoring systems, enabling prompt responses to emerging situations.[46] Building houses and buildings with timber from sustainably managed forests has become mainstream practice.

People, society and economy reconnected with nature

Convincing scientific evidence has shown that any kind of contact with nature enhances people's health and well-being and is strongly related to pro-environmental behaviour.[47] This evidence has led to a growing European-wide movement in education and communication highlighting the importance of nature for our common future. In 2120 most Europeans are reconnected with nature.

Regenerative food and primary production systems

Like water, food is one of the basic amenities of life. In 2120, Europe has sustainable food systems that are inherently regenerative, nature-positive and just. These systems depend on healthy soils and are linked to the availability and quality of our water and the resources they provide are fairly distributed. Rooted in a genuine belief in the significance of planetary-health diet, these food systems are built on new circular approaches that strike a balance between regionalisation and global justice. Overall, the transformation of Europe's food systems has been a catalyst for change, providing opportunities for a resilient and nature-positive future.[48] The shift to a regenerative food system has improved the

Figure 4.4 Regenerative food and primary production systems. In 2120 nature-inclusive agriculture, consistent with a variety of soil conditions, has replaced industrial animal production and monoculture crops. The most fertile soils, rich in loam and clay, are used for innovative food crops and cropping technology like strip-cropping and agroforestry, and are adapted to the evolving climate. Sustainable agriculture and forestry, even in less favourable soil conditions such as peat, sand and steep slopes, contribute organic raw materials that foster a circular economy. Farmers are the stewards of these emerging landscapes.

health of millions of Europeans and has created more space for nature to thrive.

Healthy soils as foundation for healthy food

Recognising healthy soils as the foundation for growing robust crops, agro-ecological principles have been introduced and scaled up across European farms. This has resulted in a resilient and robust, plant-based food production system. Minimal use of pesticides and fertilisers has increased crop diversity at field. Strip cropping, growing multiple crops at the same time on the same field, results in higher productivity and more efficient use of nutrients compared to monoculture, while also reducing the spread of diseases and pests. The combination of crop diversity and a healthy soil life plays a key role in making soil nutrients available to plants, improving plant health and soil fertility. These practices contribute to maximising carbon storage in the soil, so called carbon farming.[49] Healthy soils provide the basis for the production of healthy food.

Planetary health diet and affordable food for all

Europe's population has embraced the concept of a planetary health diet.[50] Plant biomass is now the primary source of food for humans and fertile arable land is no longer used to produce feed crops for animals. Most Europeans have switched to a diet that is mainly plant-based and more in balance with planetary boundaries. Over two-thirds of the proteins consumed by European citizens now come from plant-based sources, and less than one third is derived from animal-based foods. This includes farmed fish, seafood and algae, which have a lower carbon footprint than animal production on land. Every European has access to affordable, nutritious and sustainable food that adheres to high standards of safety, plant health and animal health and welfare, while catering to diverse dietary needs and food preferences. Dietary guidelines, adapted to the physical limits of ecosystems, food availability and the cultural needs of different regions support sustainable consumption and healthy diets and lifestyles. Healthy and sustainable food is affordable for all.

A circular food system

The adoption of a circular food system has emerged as a new paradigm, leading to the redesign of the European food system based on circularity principles.[51] This transformation has yielded significant environmental benefits for both Europe and the global community. In some regions, the amount of land used for food production has decreased, creating space for nature restoration. Greenhouse gas emissions have decreased, and a self-sufficient food system produces healthy food.[52] Essential nutrients are efficiently recycled from soil, water and atmosphere, circulating among living organisms and traversing farms and regions. Reducing food waste has brought savings for consumers and operators, while surplus food that would otherwise be wasted is recovered and redistributed offering important social benefits. Food waste has decreased by 80% and valuable nutrients from human excreta are now used to fertilise soils. Unavoidable by-products that are neither suitable for human consumption nor necessary for soil fertility restoration and conservation are directed towards farm animals, which now include farmed fish or insects. These animals effectively convert these by-products into valuable sources of food and nutrient-rich manure. Livestock continues to have significance within this circular food system, but with reduced numbers of animals to reflect the increase in plant based foods. Small farms, often run by cooperatives, provide nutritious high-quality food, recreational opportunities and are integrated into ecosystem restoration programmes. Just as citizens seek to reconnect with nature, engaged consumers want to reconnect with their food, understanding more about how it is sourced, processed and produced. The transition towards a circular food system has minimalised Europe's contribution to tropical deforestation and ecosystem conversion globally.[53] Europe does not only produce food for Europeans but also contributes to the food security of other continents such as Africa.

Supporting nature with technology

By 2120, technology is used widely to support regenerative and climate-smart agriculture. Farmers use drones and robots to monitor, weed and harvest the multiple crops on their land. They combine drone-recorded images of crop fields with soil data obtained from remotely collected and analysed environmental DNA (eDNA) samples to optimise crop growth by precisely meeting nutrient requirements, minimising usage of inputs and reducing losses of nutrients to air, water and soil. Domestic animal and plant varieties and breeds are adapted to the new climate and to local needs. Innovative technologies are used to effectively and sustainably protect crops against pests and diseases. These technological advancements mean that crops are now more resistant to climate change, are more nutritious and productive and agriculture has become nature positive. In response to climate change, cropping systems have been modified and climate smart technology ensures food production remains resilient in relation to climate extremes. Smart irrigation, drought-resistant and salt-tolerant varieties have significantly reduced the water needed for food production, and agriculture is less vulnerable to prolonged droughts.

Production of biomass for the bioeconomy

Biomass has become one of the main raw materials for the production of food, clothes, chemicals, energy medicines and construction materials. In 2120, the

production of biomass as a component for the bioeconomy has been fully embedded in agriculture, forestry and so-called productive landscapes. Biorefineries extract fibres, proteins, sugars, fats and other valuable compounds from biomass, which are used for the production of biobased materials and chemicals. Biomass production takes place mostly in polyculture cultivation systems such as strip cropping and agro-forestry, which are designed to balance high yields and efficient production with biodiversity and the provision of eco-system services in alignment with the needs of local eco-systems. Many agricultural regions that had previously been abandoned have been revitalised as nature restoration and sustainable production of biomass has created new perspectives for these areas. Natural resources are managed with the aim of maximising biodiversity and ecosystem health and resilience, rather than solely focusing on economic returns.

Farmers as stewards of European landscapes

In 2120 the number of smaller farms and farmers has grown significantly. Farmers are widely recognised for their role as stewards and managers of landscapes and the restoration of biodiversity. They maintain a fine balance between production of food and biomass, nature restoration and landscape management. Pesticides are rarely applied and do not enter the food chain. Nature is once again an integral part of the farmed landscape, with agroforestry, including food forests, becoming widespread. Habitat restoration and rewilding has allowed biodiversity to flourish, not only in designated nature areas but also within the nature-inclusive areas focused on food production. There is thriving biodiversity in agricultural and other soils, providing ecosystem services such as nutrient cycling, water buffering and purification, carbon storage and the provision of habitat functions. The food system has also gained increased resilience to shocks and stresses such as those caused by climate and pests. Across Europe decision-making about which crops to grow, where to grow them and how they should be grown has improved significantly allowing a nature- and climate-positive balance to be struck between food production, soil health and biodiversity.

A climate-positive and circular bioeconomy

By 2120, Europe has undergone a profound socio-political and economic shift, reversing some of the societal changes of past centuries. This change in mentality has partly been driven by the impact of climate change, with weather extremes and disasters affecting large parts of the population, as well as the desire of younger generations for society as a whole to have a more positive relationship with nature.[54]

Economy in balance with nature and human wellbeing

Economic growth is no longer the primary objective of development. Beyond GDP thinking has replaced the exclusive reliance on GDP as a measure of economic growth and progress.[55] Environmental and human wellbeing are now the highest priorities for future developments. Recognising the interdependence between

Figure 4.5 Renewable energy sources can facilitate a climate positive and circular economy. Wind farms and solar panels mounted on floating islands at sea play a central role in renewable energy production. These 'solar islands' also serve as 'hydrogen hubs', accommodating sustainable, energy-intensive industries and logistical transfer facilities. On land wetlands, forests or agricultural areas may provide biomass-based energy.

the economy and the environment, the inclusion of ecosystem services in economic decision-making has gained prominence. As a result there has been a decrease in environmental degradation, accompanied by substantial investments in nature restoration by both public institutions and private companies, facilitated through financial funds (e.g. pension funds).

Circular bioeconomy

At the beginning of the 21st century, the circular bioeconomy represented a largely untapped potential, with less than 10% of the economy considered as circular.[56] The increased awareness of our dependence on nature has led to a fully-fledged implementation of a circular bioeconomy, with a focus on managing healthy and resilient ecosystems.[57] Production and consumption practices, like extended producer responsibility and new consumer ownership models, are now governed by the principles of the circular economy. The resources used in this circular biobased economy are of renewable origin, including biomass, carbon or recycled feedstock. The system is designed for circularity, keeping products and materials available for production as long as possible by cascading from long life span high-quality products to shorter life span lower quality products which are eventually used as fertiliser or for energy production. The use of fossil resources has been phased out and waste as such no longer exists, but has become a new raw material, with almost everything being reused.

Large-scale investments and policy initiatives have led to innovations and technologies, making Europe a global champion of the circular economy. The transformation of the industrial sector took a generation. Energy-intensive industries such as steel, chemicals and cement have been decarbonised and modernised. Circular design of all products fostered new business models and created millions of jobs.

Renewable and affordable energy for all

Ambitious European policy and disruptions in the global energy market have led to a rapid phasing out of coal and gas and significant investments in renewable energy. Since 2020, the cost of electricity from renewable sources has considerably decreased compared to fossil fuels. Disruptions to the global energy market caused by Russia's invasion of Ukraine accelerated Europe's ambitions to become the world's first climate neutral continent. Europe's dependence on fossil energy from Russia and the Middle East has been minimised. A range of complementary actions, including reduced energy consumption, increased energy efficiency and large scale investments in renewable energy sources and research and development for innovations like advanced batteries, hydrogen electrolysers and smart grids, has made Europe largely self-sufficient for energy.[58] Solar PV and wind have become the primary sources of electricity. Investments have been made in new industrial ecosystems, known as nature-inclusive food-water-energy parks. Large scale offshore wind production, photovoltaics (PV), green hydrogen and increased energy efficiency of buildings have resulted in carbon neutrality and the creation of millions of new jobs in Europe. Air quality, especially in urban areas, has significantly improved, leading to health benefits for tens of millions of European citizens.

Linking nature-based solutions to the energy transition was a new development in the early 21st century, which led to large scale innovations such as nature-inclusive offshore wind parks, nature-inclusive solar farms combined with water storage and solar PV on smart blue-green roofs.[59] The European renewable energy network is based on a nature-positive approach that, where appropriate, includes the development of ecological corridors and flower-rich grasslands. In marine energy installations, artificial reefs made from recycled materials have enhanced breeding populations of fish, shellfish and crustaceans and have provided surfaces for algae and seaweed growth, with positive commercial spin-offs and contributions to the protein transition.

The energy transition had led to an increased demand for rare earth metals such as lithium, nickel, silicon, copper and aluminium for the construction of solar panels and wind turbines, batteries, and hydrogen electrolysers. Whilst these resources are limited, large scale investment in appropriate programmes and technologies to stimulate circular material use of these metals has made Europe self-sufficient for rare earth metals.[60] Renewable energy has become widely available, secure and affordable for all Europeans. Thanks to the swift decline in renewable energy costs, coupled with supportive policies, accessible and affordable energy has been made available for all, contributing to a general increase in the standard of living.

Green and liveable cities

By 2120, climate, nature and circular systems all link urban and rural communities. The interdependencies between them are acknowledged and strategies are integrated. Liveable, healthy cities are seen as a precondition for a healthy society and a thriving economy.

Cities for people

Cities built in the 20th century were not designed for the realities of the new climate. Increased flooding, heat waves, traffic congestion and bad air quality resulted in large problems in urban areas, affecting people, society and our economy. Cities in 2120 are the places where most people live and work and, adhering to the "15-minute cities" concept, they allow residents to meet most of their daily needs within a short walk or bike ride from their home. This is in sharp contrast to the urban-planning paradigms that dominated the previous century, which saw residential areas separated from businesses,

Figure 4.6 Green and liveable cities. The result of redesigning cities and towns has been an increase in green spaces and surface water bodies, connecting them to the surrounding natural and cultural landscapes. New '15-minute' towns may be developed in sparsely populated areas within Continental, Atlantic, and Boreal regions as climate conditions ameliorate. A network of high-speed railways connects all European cities.

retail, industry and entertainment. In the past, cars played a central role in city design, but by 2120 most cities are car-free and have carbon neutral public transport, resulting in an impressive improvement in air quality and human health. Designing car free cities for people has resulted in increased quality of life for citizens and more space for urban greenery.

Resilient and healthy green cities

The 21st century has seen the creation of green and healthy cities. Concrete dominated spaces and car parks have given way to green public spaces. The resilience of cities to escalating weather extremes has been enhanced by implementing NBS on a large scale. These solutions include the incorporation of green public spaces, urban forestry and increased access to open water within urban environments. Trees and woodlands have been introduced into the streets, squares and parks and now cool the cities during heat waves. Foot and cycle routes provide shade and ventilation, incorporate 'fitness pathways' and are intertwined with green spaces. These routes allow pleasant access to work places and leisure areas, offering opportunities for exercise, physical activity and recreation while being deliberately integrated with natural environments.

Cities have been redesigned to function as sponges for water. Water-sensitive urban design, with more open water and green infiltration areas, has reduced the risk of flooding and water shortages. Buildings are designed to consume less energy, lose less heat and are cooler as a result of massive public and private renovation programmes. They are more nature-inclusive, with green roofs and walls, collect and recycle rainwater and timber construction is commonplace. Cities in 2120 produce more energy than they consume. Purified wastewater is re-used for drinking water, for industry and irrigation for agriculture. Rainwater is used optimally. Green cities with street trees, urban parks, edible green walls and community and rooftop gardens also keep us cool amid rising temperatures. Increasing tree coverage to at least 30% has proved to be an effective way to lower temperatures and prevent heat-related death.[61]

Circular and connected green cities

In resilient and healthy cities, energy and water systems have become circular. Cities and their regions have also adopted circular food production and fabrication. Farming in and around densely populated urban areas has added to Europe's sustainable food systems. (Peri)urban farming comes with vital social benefits and connects people to the food system. It is a combination of low tech urban farming and high-tech, high value cropping. Vertical farming involves cultivating crops in vertically stacked layers or structures, often on the vertical surfaces of occupied buildings, enabling circular, year-round production in urban areas with limited space. Urban food production also involves using space on rooftops, creating small-scale 'patches' of (for example) vegetables, salad, herbs or fruit, in streets, on walls or on balconies.

The connected city, through footpaths and cycle routes, has also reconnected with its surroundings. Green corridors connect the urban to the rural, incorporating walkways and cycle paths, allowing people to enjoy visits to farms, food forests, cultural heritage sites and nature areas, increasing their understanding and connection with rural food production, where most of their food still is being produced. Consumers therefore have good awareness about the seasonality of food production and the connection between consumers and producers, nature and production. Circular cities use local and regional products and reuse valuable materials from waste and discarded products.

An efficient network of high-speed trains and long distance cycle paths connects cities across Europe. Short distance air travel has become very expensive, but public transport in and between cities is now efficient and affordable and available to all Europeans. The transport industry is dominated by zero-emission vehicles and they are the primary means of transport in and between European cities. Powered by alternative energy sources such as electricity, hydrogen fuel cells, or renewable fuels, they produce no emissions of greenhouse gases or other pollutants. Zero-emission vehicles on demand are widely available around city centres.

Inclusive European Society: Diversity & Well-being

As Europe continued to evolve into a more diverse and inclusive society, it became crucial to envision a future that prioritises the well-being and happiness of diverse perspectives and cultures. Moving beyond traditional economic indicators, such as GDP, allowed for a more comprehensive understanding of progress — one that invests in public services (e.g. education, housing, health, food) and which encompasses social cohesion, inclusivity and wellbeing.

Assessing the well-being of individuals and communities has taken on a central role in evaluating societal progress. Well-being indicators encompass various dimensions, including physical and mental health, education, social connections, environmental quality, and sense of purpose. By prioritising well-being, European societies have the potential to foster conditions that promote happiness, resilience, and fulfilment among all citizens, irrespective of their cultural backgrounds.

By acknowledging the interconnectedness between the environment and human well-being, Europe has adopted policies that promote an integrated approach to investing in resource conservation, climate change mitigation and biodiversity protection. Emphasising sustainable practices, NBS, renewable energy sources, and ecological awareness has ensured the development of a vibrant and liveable environment for future generations. By valuing and preserving the natural world, Europe has enhanced the physical and psychological well-being of its multicultural society.

Social capital - the networks, relationships, and trust within a society - is essential for building a healthy and happy European multicultural society. Encouraging community engagement, volunteering and civic participation has fostered social cohesion and strengthens the bonds between individuals and communities. Social capital contributes to the overall well-being of society, promoting a sense of belonging, support networks and collective problem-solving. Europe can nurture social capital by creating opportunities for collaboration, fostering community spaces and encouraging active citizenship. A nature-based future for Europe in 2120 has been achieved through an inclusive process that involved European citizens in co-designing their desired future. As well as emphasising the importance of nature in enhancing well-being, this collaborative effort has laid the groundwork for a harmonious and sustainable future for all. The delivery of such an approach will be one of our cornerstone recommendations.

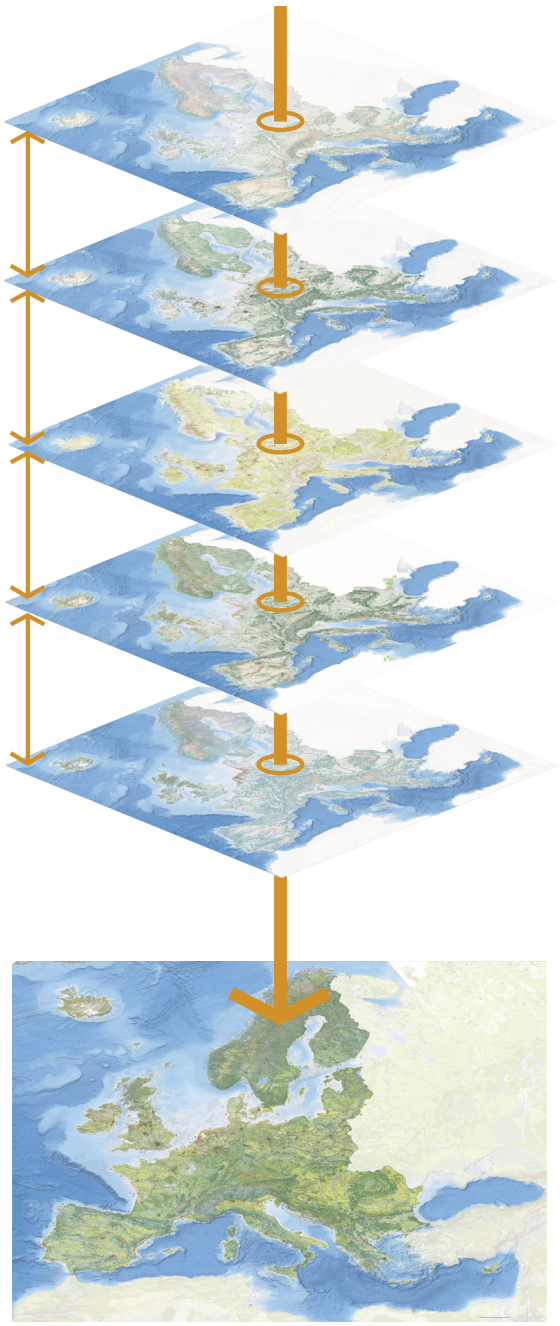

Figure 4.7 the synthesis of the seperate themes.

Imagining a nature based vision for Europe

The final step in the design process for Europe in 2120 is the synthesis of the separate themes from the previous sections in a vision (figure 4.7). The result is the map as presented in figure 4.8. The following chapter describes the main features of this vision by discussing the five bioregions. The main characteristics of the areas are described. It is indicated which NBS are applicable and how these may be used to tackle the issues in the areas concerned.

river widening that retains water and prevent flooding

wetlands to restore soils and retain surface water

new forests that protect soils and avoid run-off

improved infiltration for groundwater replenisment

flood-prone areas

nature-based coastal protection

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most fertile clay soils used for regenerative food and primary production

most fertile loam soils used for regenerative food and primary production

other loam soils used for nature-inclusive agriculture and multiple uses

poor sandy soils used for multi-functional land use

peat soils used for wetland farming and wetland re-development

saline soils used for salt tolerant crops

food and biobased production at sea

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ecological core areas

transforming existing forests into climate-smart and

biodiverse woodlands

existing and newly-developed wetlands

biodiversity 'hotspots' at sea (beds, reefs, rocks)

ecological corridors

river widening with riverine forests and wetlands

new forests on steep hill-sides

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renewable energy from floating solar parks and hydrogen hubs at sea

renewable energy from windfarms at sea

renewable energy from biomass produced in forests

renewable energy from biomass produced in agricultural areas

renewable energy from biomass produced in peat areas and wetlands

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extended green areas and surface water in existing urban areas

new 'green and blue' 15-minute towns

nature-based coastal protection for flood-prone urban areas

nature areas for eco-tourism and outdoor recreation

new high-speed railways

Figure 4.8 Europe in 2120.

5 Ecoregional Clusters

European landscapes exhibit remarkable diversity across the continent, each region presenting unique challenges and corresponding nature-based approaches. In this chapter we describe the nature-based strategies tailored to the five distinct ecoregions. These strategies served as the foundation for imagining a journey across Europe towards the year 2120, approximately a century into the future.

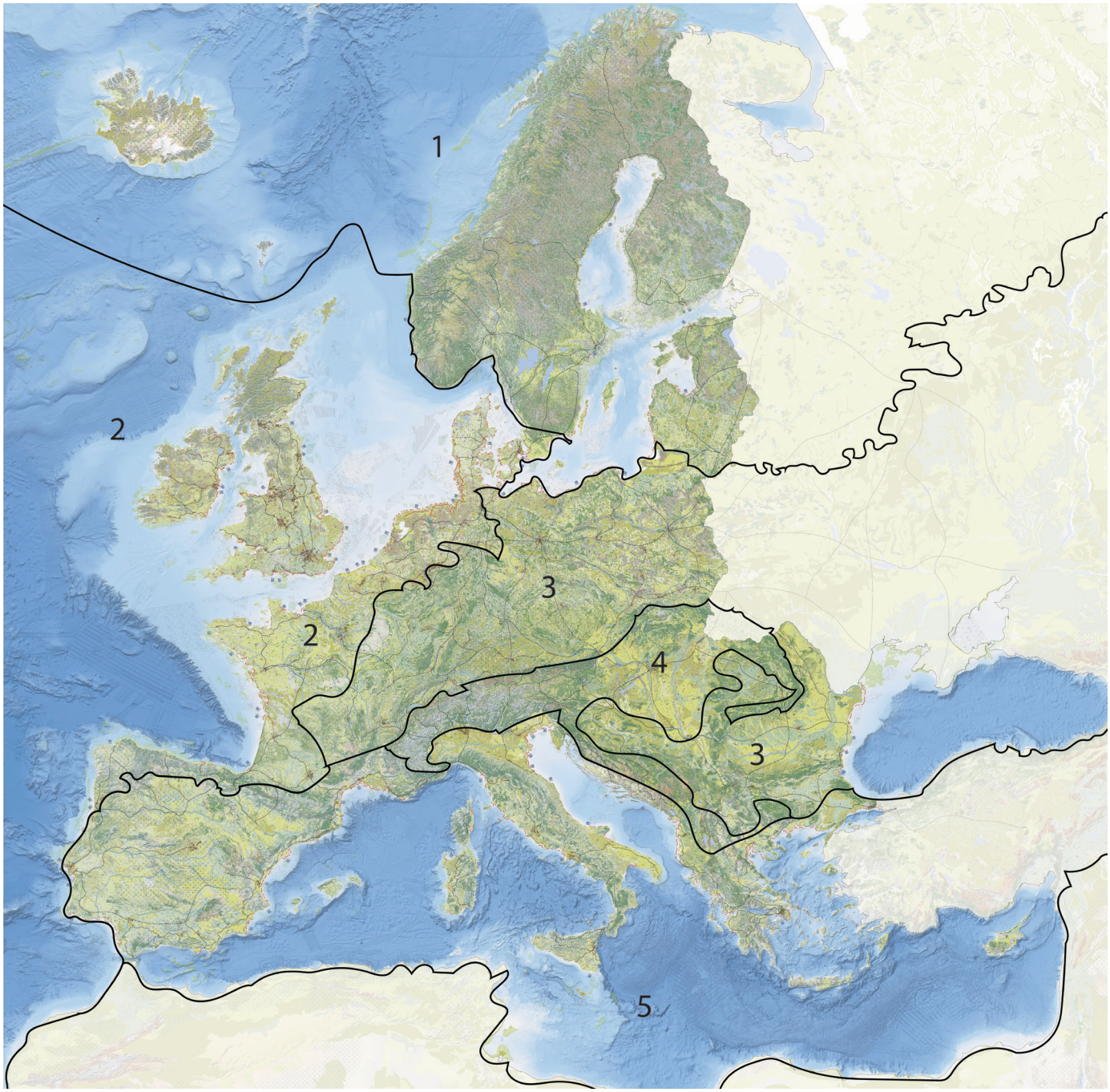


Figure 5.1 The five 'ecoregional clusters' as used in this report. (1) North; (2) West; (3) East; (4) Central; (5) South.

North: the Arctic and Boreal region

The Northern region is known for its large areas of wilderness, that encompass endless forests, mires, wetlands and lakes, as well as various types of permafrost. Its distinct climate is characterised by long, cold winters and short summers. Moreover, the North is recognised for its thriving economy and distinctive culture. Industries such as forestry, fisheries and the extraction of natural resources like oil, gas and iron ore contribute significantly to its wealth, aligning it with the typical Nordic economic and social model. In spite of the large uninhabited areas, urbanisation rates are high, with up to 60% of the population concentrated in distinct city regions along the coastline and in the hilly, fertile lowland in the South. These urban areas differ greatly from the rural regions in terms of population size, composition and development. The proximity of the cold waters of the Atlantic and the Baltic means that fisheries and fish farms play an important role alongside navigation. The intriguing pattern of the rivers and the presence of vast areas of peatland further contribute to the region's unique landscapes.

The challenges and their nature-based strategies

As the climate undergoes changes, temperatures continue to rise and extreme weather events will impact the region. In large areas of this region, the temperature rise exceeds the global average, leading to a significant reduction in snow, lake and river ice cover. Additionally, there is a northward shift of the typical permafrost boundary, resulting in an overall decrease in permafrost extent. These changes have several consequences, including additional greenhouse gas emissions, drying out of peatlands and increased pressure on existing natural forests and ecosystems. However, these climatic changes also present opportunities. For instance, tourism is already experiencing growth in the region. Furthermore, the new climate conditions provide a longer and more favourable growing season, which benefits agriculture, and forestry. As a result, migration to this ecoregion is expected to increase. This ecoregion faces a significant dilemma: striking a balance between preserving its natural qualities, enhancing resilient and vital ecosystems, whilst simultaneously creating new economic and social opportunities to accommodate a growing population. An integrated nature-based strategy holds the potential to provide an effective response to both aspects. By implementing the following nature-based solutions and actions, the Northern ecoregion can better address its challenges, preserve its unique natural qualities and promote sustainable development for a prosperous future.

Climate smart and biodiverse forestry

Through implementing sustainable management practices, the extensive forests in the region will be transformed into multifunctional, mixed, and biodiverse woodlands. Implementing improved water strategies that retain, store, and regulate discharge and provide ground water replenishment is crucial for enhancing the resilience of these forests, contributing to sustained water availability. It will also mitigate potential water and fire hazards both upstream and downstream. A combination of agroforestry and diverse production forests will not only have export value, but will also create a circular (bio)economy for materials and food at the regional level.

Regeneration of rivers and wetlands

Rivers and streams within the Northern ecoregion will evolve into blue-green ecological corridors, crossing and linking landscapes, and contributing to improved practices in sustainable water management. This will enhance water availability, mitigate flood risk and fire hazards. Peatlands and mires are valuable carbon sinks with high ecological value, and it is essential to preserve and restore these areas. They offer possibilities for alternative economic utilisation, such as wet cropping and ecotourism, while rewilding also holds importance as a key strategy.

Nature-inclusive and regenerative agriculture

A prolonged and more favourable growing season creates opportunities for food and biomass production. Agricultural landscapes will become more nature-inclusive and diverse through the introduction of new cropping methods and crops, and agroforestry. Sustainable practices will replace unsustainable pressures from fisheries and fish farms at sea, aligning with regional food and bioeconomy strategies while preserving water quality and enhancing biodiversity.

Sustainable and resilient urbanisation and coastal development

The sparsely populated areas present opportunities for new, sustainable and 'green' urban development to accommodate population growth in the region. The location, layout and management of these new urban areas will be harmonised with the underlying natural systems. Existing urban areas will evolve into a patchwork of built-up and natural areas connected with local food production. New urbanisation will accommodate population growth and tourism, utilising biobased construction materials from the region. Responsible ecotourism will be promoted in the region, aligned with changing climatic conditions and aimed at minimising environmental impact. A broader, more natural coastline incorporating NBS in the form of dunes, saltmarsh and other wetlands will minimise the impacts of coastal erosion and flooding and will provide protection for lower lying areas.

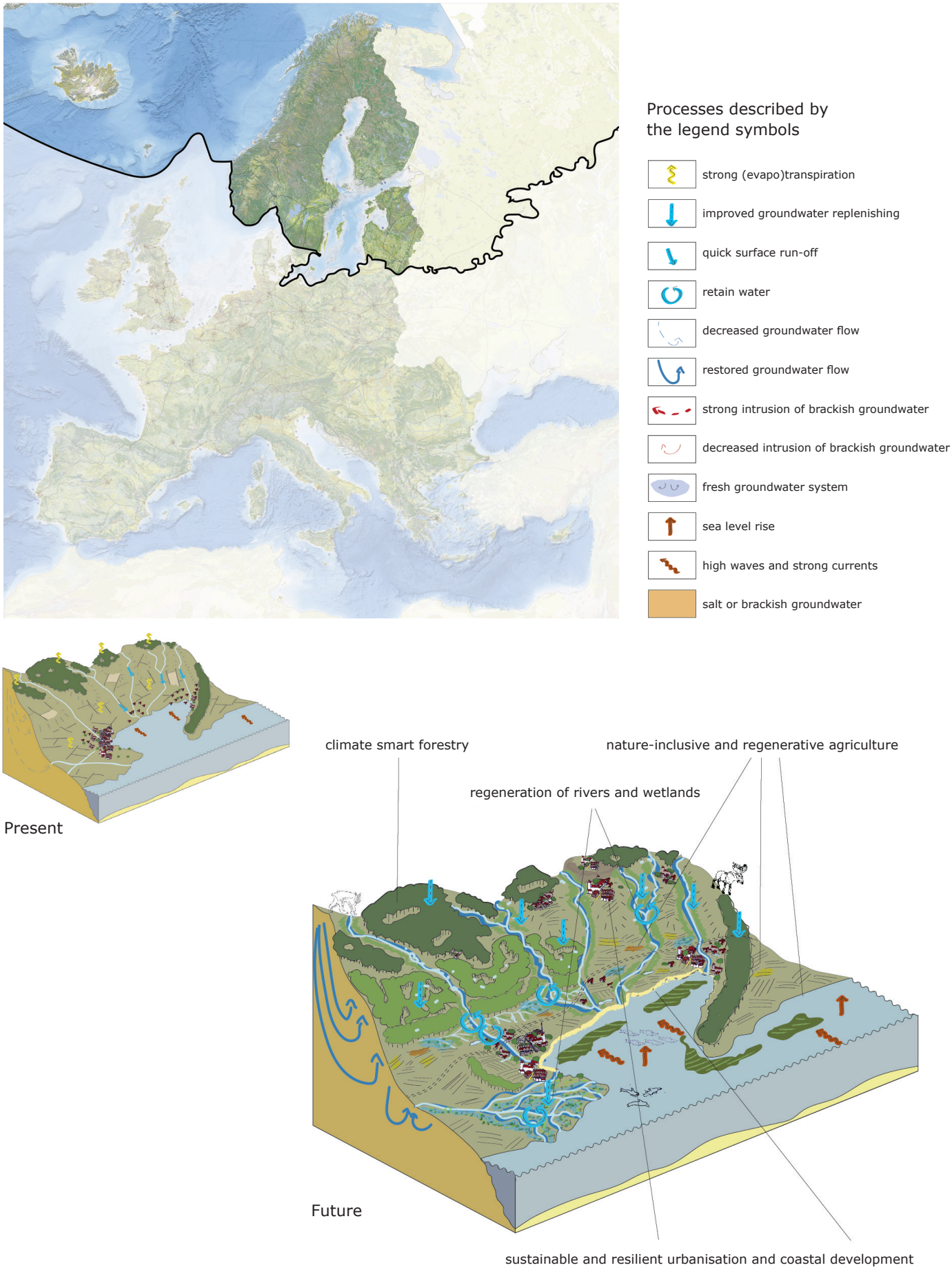


Figure 5.2 North: visualisation of the existing and the future situation.

West: the Atlantic and North Sea region

The Atlantic region is one of Europe's most densely populated regions. Whilst it includes mountainous, upland areas and major watersheds, its dominant feature is its coastlines which mainly face the Atlantic Ocean and the North Sea. It also hosts a diverse range of landscapes from low-lying coasts with shallow waters, lagoons, peat meadows and polders below sea level, to rocky coasts with fjords, rias, peninsulas and islands. This region has numerous rivers that serve as crucial gateways for international trade and fisheries, with some of the largest and busiest European ports and industrial areas. The regional climate is mild and humid. The region with its riverine and deltaic character is one of the most important global areas for bird life, but due to the mild climate and fertile soils there is also much intensive agriculture in the region.

The challenges and their nature-based strategies

As a result of climate change sea levels are rising and this ecoregion is now already affected by extreme weather events. It experiences a stark alternation between periods of heavy precipitation and extremes in river discharge, and challenges like droughts, prolonged warm spells and heatwaves. These changes not only increase coastal and riverine flood risks but also affect fresh water availability, increase salinisation, urban heat stress and occurrences of wildfires. Nevertheless, the shifting climate zones present opportunities for extended growing seasons and multiple crop cycles. The region is already affected by intensive use of land and water, which poses challenges to biodiversity, as well as to social and economic resilience.

The fate of the Atlantic and North Sea region is highly dependent on the extent of sea level rise and the decisions made in the upstream regions (Continental, Alpine, Boreal). The effects and challenges arising from these factors will shape the region's opportunities. By implementing the following nature-based solutions and actions, the Atlantic ecoregion can better address its challenges, preserve its unique natural qualities and promote sustainable development for a prosperous future.

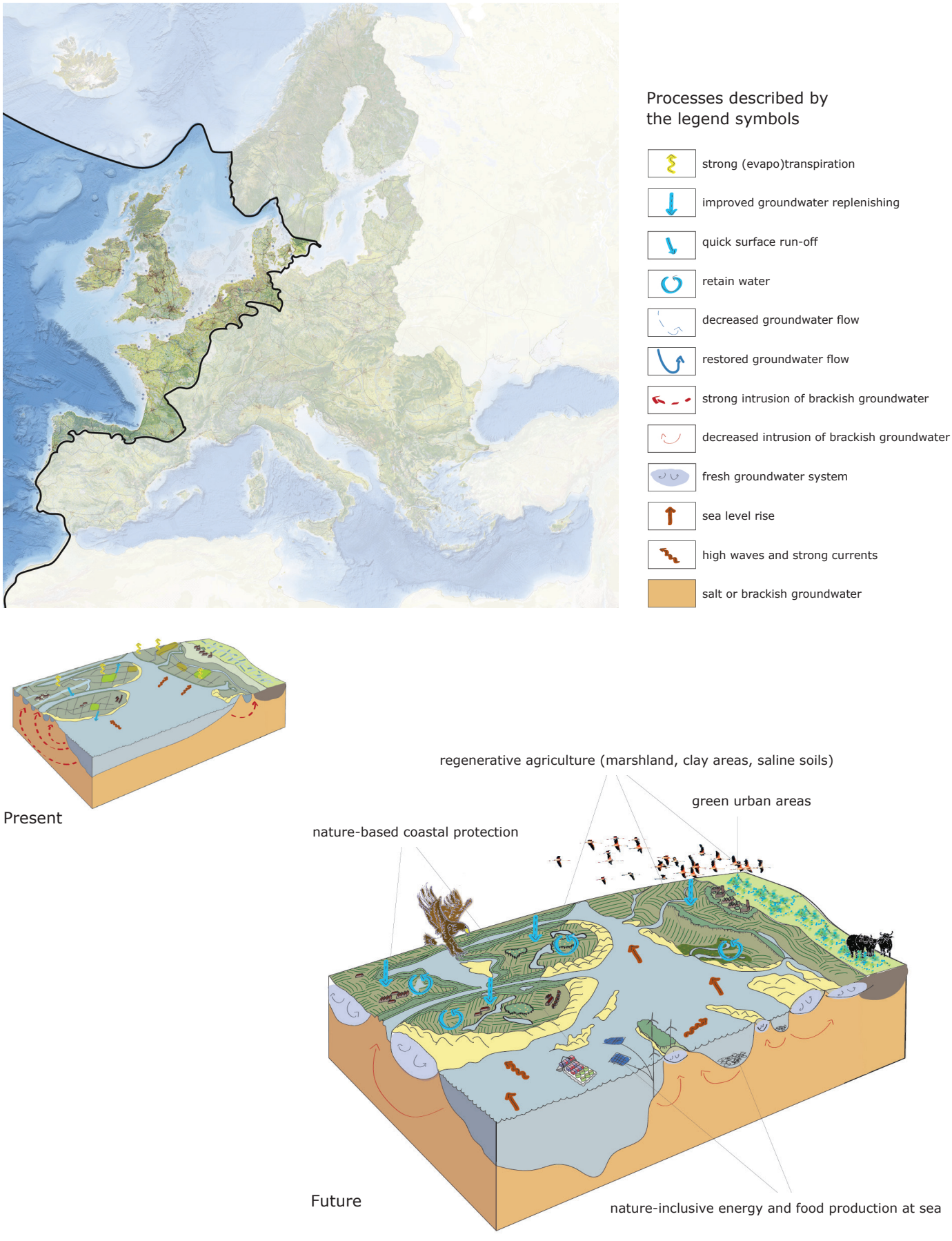


Figure 5.3 West: visualisation of the existing and the future situation.

Nature-inclusive energy and food production at sea
In 2120, the energy and biomass production in the North Sea region will be combined with nature development. The North sea will play an important role for the production of renewable energy for the European continent by the development of large wind farms and floating solar parks combined with developing opportunities for nature and food production at sea. Artificial reefs will provide habitats for many plant and animal species. On the foundations of the decommissioned installations for oil and gas extraction from the last century, floating islands will be developed for the production and storage of green hydrogen gas. Aquaculture, particularly around wind farms in the North Sea, involves the cultivation of mussels, flat oysters and seaweed. Fisheries have become completely sustainable; by-catch and seabed disturbance are kept to a minimum. Protection of marine areas in the Atlantic and North Sea and sustainable fishing practices will enhance marine biodiversity.

Nature-based coastal protection
The marine perspective is vital for the Atlantic and North Sea region, especially in the low lying areas where nature-based, future proof coastal defence strategies integrate safety measures with the expansion and enhancement of natural habitats. In preparation for rising sea levels a strategy of implementing NBS and working with nature for coastal protection will become mainstream. Nature-based coastal protection by sand nourishments and increased resilience of dunes in combination with civil engineering constructions will go hand in hand with enhancement of coastal and estuarine marine ecosystems. In the most vulnerable low-lying areas a range of 'hard and soft' options, will be used to defend against the sea. For example, we encounter mud flats, salt marshes, broad dikes and herbaceous vegetation that merge into marshes between double dike zones. Salt-loving crops, grown in brackish areas enclosed by the dikes, create new opportunities for agriculture. The sea deposits sediment between the dikes, which reinforces the dikes. By improving connections between river and sea and widening the estuaries where river water and sea water mix, new unique habitats are created for flora and fauna. These freshwater-salt water transition zones create important migration routes for fish. The biodiversity in the Atlantic and North Sea coastal zones is richer in 2120 than it is now. The coast is a still a major tourist attraction in 2120, with synergy between nature and recreation.

Regenerative and saline agriculture
This region has large areas of fertile soils that will play an important role for the circular production of plant-based food and biomass. Sustainable agricultural practices that prioritise biodiversity conservation and reduce water consumption will become mainstream. Freshwater basins will store the excess rainwater in the winter so that it can be used in the dry summer period. Land use policies that protect natural habitats and promote responsible development will be implemented. In low lying areas, where increased salinisation is inevitable, saline agriculture with salt tolerant crops will create new opportunities for farmers. Regenerating peat areas in low-lying areas will be an essential action for restoring carbon sinks, enhancing biodiversity and reducing soil subsidence. Waterlogging of peat soil grasslands provides natural back pressure against saltwater intrusion, and prevents soil subsidence and peat oxidation. These areas also offer potential for producing reed, marsh forest, peat moss, and cranberries, while at the same time serving as suitable habitats for water buffalo. As a result, they will play a role in generating biomass, fibre, insulation and construction materials, potting soil, medicinal resources, animal feed, as well as meat and cheese.

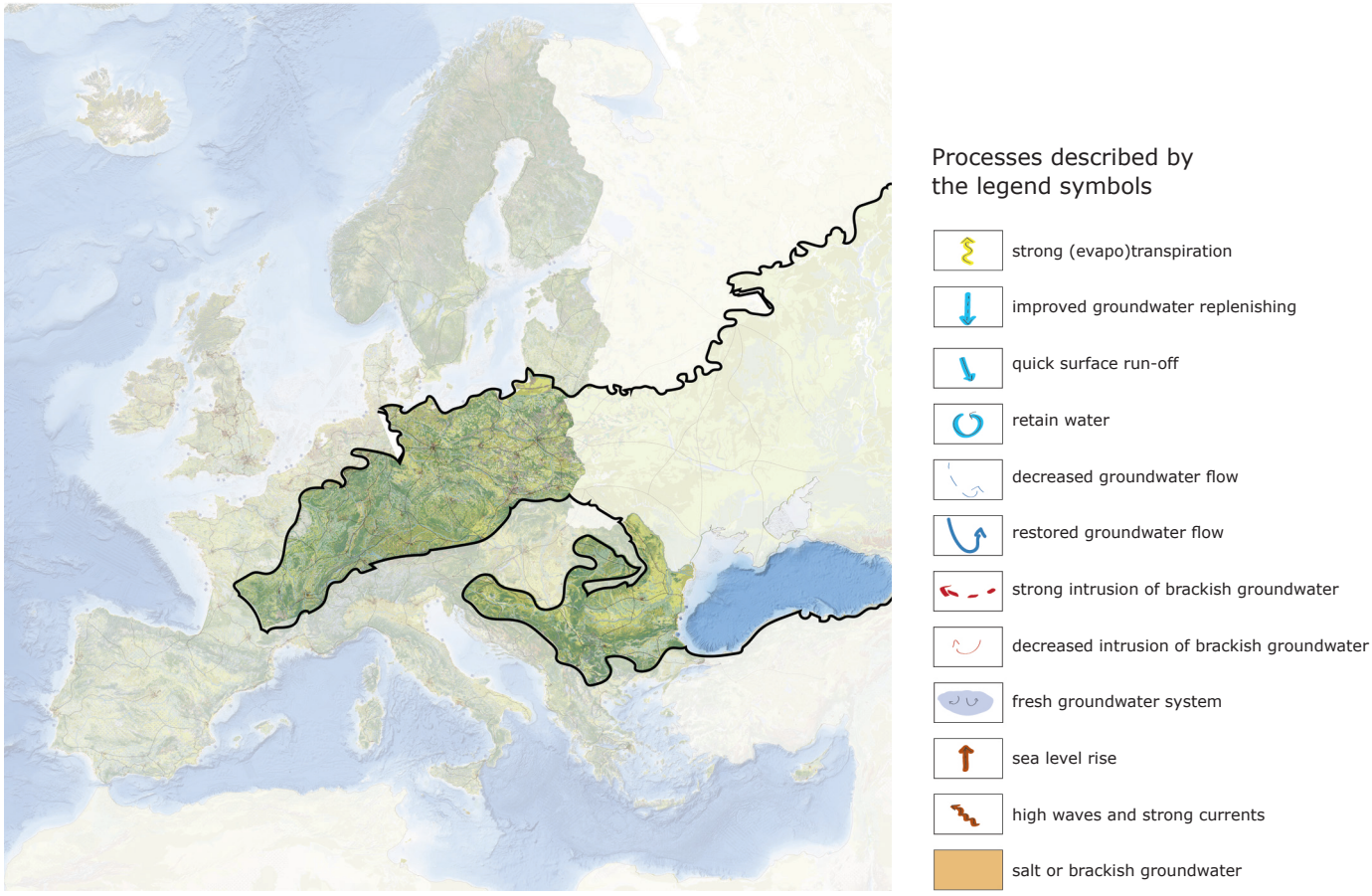
Green urban areas
The design of cities is no longer based on what is technically possible from a civil engineering perspective, but is based on the principles of a circular economy that emphasise resource efficiency, waste reduction, and the continual regeneration of materials and resources, with attention given to optimising quality of life, climate resilience and the inclusion of natural features. Timber construction has become dominant. New economic centres are no longer being developed in low lying flood prone areas, but on higher elevations. Better 'green-blue' connections are being developed between the city and the countryside. Furthermore, the urban environment has become a landscape characterised by trees and small wooded areas and is now surrounded by forests that include food forests and agroforestry. This is not only to enhance recreational opportunities and biodiversity, but also to reduce the heat island effect in the city.

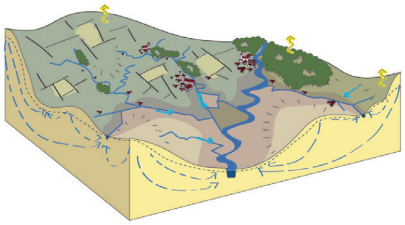
East: Continental region

The Continental region is one of the largest ecoregional clusters and is a central land mass that connects to most other regions. Moving from north to south, the landscape shifts from flat, to hilly terrain, even elevating in altitude to become mountainous. A similar north-to-south gradation can be observed in soil types and conditions, ranging from true podzols to grey and brown forest soils and highly fertile soils like the chernozems. This region encompasses the middle courses of many of Europe's most important rivers and experiences a climate characterised by strong contrasts, with warm summers and cold winters. Rainfall is most abundant during summer, contributing to its highly productive natural, agricultural and forest ecosystems. The predominant land uses are agriculture (over 52% arable land) and forestry (27%).

The challenges and their nature-based strategies
The Continental ecoregion faces a significant challenge in achieving sustainable land use. It will remain an essential area for both forestry and agriculture, which will continue to play crucial roles. However, the key to addressing this challenge lies in adopting sustainable practices and enhancing resilience through scaling nature-based approaches. The most densely populated areas lie in the north-western part of the region, with the eastern and southern parts being less densely inhabited. Despite this, urbanisation, new infrastructure and growing economic activity and industrial zones are expanding significantly, particularly in the east. Vast parts, especially in the East, are modified to benefit agriculture through drainage, river diversion and irrigation. However, intensified land use, agricultural practices, mining and industrial complexes have led to heavy pollution, water issues, soil erosion, fragmentation, and land degradation. Increasingly the region is having to deal with degraded forests and yield losses in agriculture, while experiencing intensified climate risks, such as (flash) floods and droughts in agriculture, forest fires, landslides and heatwaves in urban areas.

The nature-based strategy for the Continental ecoregional cluster centres around sustainable vitality. Thriving soils, forests and nature form the core of this vision, transitioning away from unsustainable practices toward regenerative and circular alternatives. By adopting the following nature-based strategies and actions, the Continental Ecoregional Cluster can address these challenges and work towards a more sustainable and resilient future for both the environment and the communities living within it.



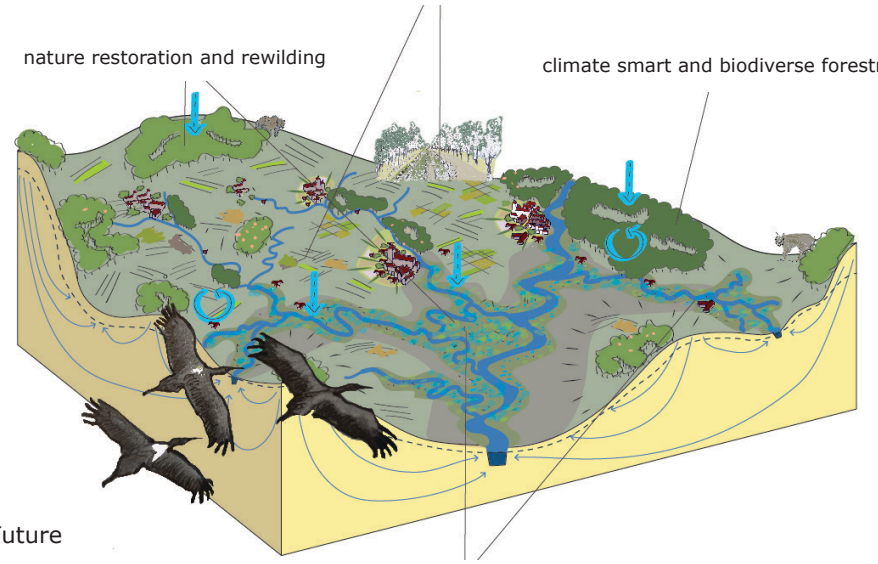


Present

nature-positive and circular agriculture

nature restoration and rewilding

climate smart and biodiverse forestry



Future

river restoration and improved sponge capacity of landscapes

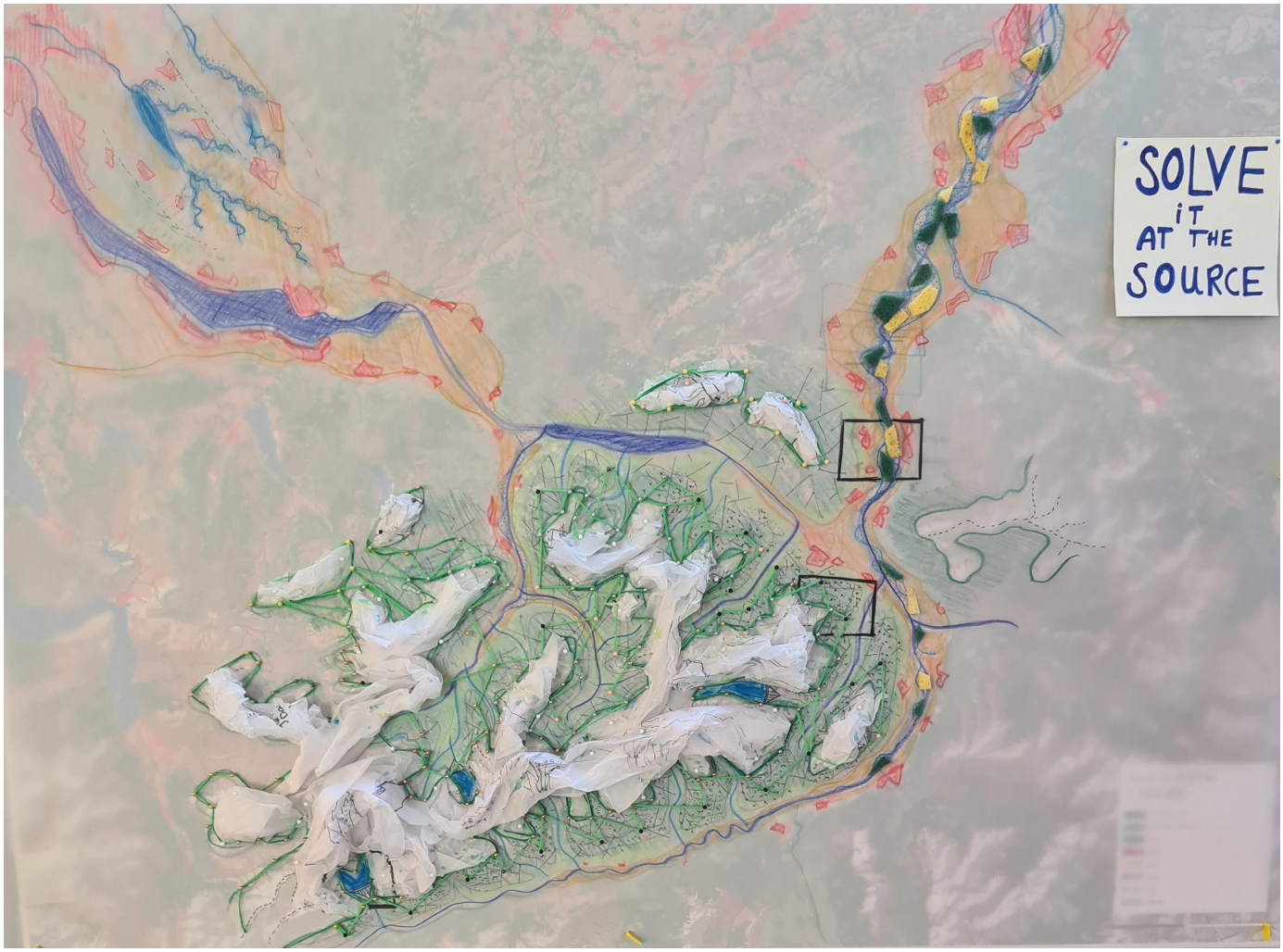
Figure 5.4 East: visualisation of the existing and the future situation.

River restoration and improved sponge capacity of landscapes
The main rivers within the Continental ecoregion serve as essential elements for constructing a resilient nature-based strategy. From their origins to where they meet the sea, these rivers form the basis of this approach, thus not only in this region but beyond to where the rivers run their course. An integral aspect of this strategy involves the restoration of landscape's sponge capacity, which is pivotal for effectively retaining and filtering water within river basins. Establishing resilient landscapes and creating more space for rivers to flow plays a central role in shaping a future-proof region by ensuring the availability of essential sources of drinking water, irrigation for agriculture and ensuring human safety during extreme weather events, while also maintaining water reserves during periods of drought.

Climate smart and biodiverse forestry
Adaptive climate smart forest strategies will transform the extensive forests into diverse, healthy and resilient ecosystems. Reforestation and afforestation will both play roles, with afforestation even expanding into urban areas. Diversifying forests and introducing an integrated wildfire strategy, encompassing fire breaks, grazing and increased biodiversity will increase resilience. Introducing an integrated wildfire strategy, including fire breaks, grazing and increased biodiversity, will be crucial for enhancing forest resilience and preventing uncontrolled wildfires.

Nature-positive and circular agriculture
In agriculture, new practices will conserve and regenerate valuable soils. Moreover, circular systems combined with a comprehensive water strategy and nature inclusiveness will serve as the foundation for a new economy and business model in the Continental region. Fertile land in and around urban areas will be developed for food forests and agro-forestry, high-value cropping and low and high tech urban farming. This approach will reduce the distance from farm to fork and bridge the gap between food and society, contributing to urban climate and the food system. As a consequence, the Continental ecoregion will become a 'circular hotspot' in Europe, fostering production within planetary boundaries and delivering resilience based on diversity. Community engagement will be encouraged, allowing local communities to actively participate in sustainable land use practices. The tradition of "homesteading" by supporting households in growing their own vegetables and food products will be fostered. Development of fertile land in and around urban areas will create opportunities for food forests, high-value cropping, and urban farming. Small-scale farming will find a new economic base.

Nature restoration and rewilding
Initiatives aimed at preserving and restoring natural habitats will lead to an increase in biodiversity that aligns with the need for adapting them to changing climatic conditions. Where appropriate, the development of rewilded landscapes, by enabling natural processes to shape land and sea, will repair damaged ecosystems and restore degraded landscapes and allow more resilient and biodiverse landscapes to be created. Areas with ample natural spaces, diverse ecosystems and limited human activity are likely to be the best areas for rewilding. They might include existing wilderness areas, national parks, protected areas and other locations where ecosystems can naturally regenerate and support a wide range of species. Rewilding, stimulates European wildlife, by rebuilding wildlife diversity and abundance and by reintroducing key native species. A network of rewilding corridors restores habitat connectivity between the five ecoregions.


SOLVE
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SOURCE

Central: Alpine & Pannonian region

The Alpine region encompasses the central mountainous areas of Europe, including the Alps, the Pyrenees and the Carpathians. The Scandinavian Mountains are considered to be 'Alpine', but in this study they are taken into account as part of the Northern region. This diverse region hosts a wide range of ecosystems and habitat types, significantly influenced by altitudinal gradients and geology. Approximately 90% of the area is still natural or semi-natural area, with forests being the dominant land cover. However, climate change is expected to heavily impact this region and its natural processes, not only within its borders but also in adjacent regions. The Alpine region plays a crucial role in Europe as a watershed and is the source of many of the great European rivers.

Challenges and their nature-based strategies

Changing climatic conditions are causing glaciers to melt at an increasing pace, while replenishment during winters is decreasing. These changes are resulting in significant changes to the discharge characteristics of downstream rivers, streams and groundwater systems. Furthermore, vulnerable ecosystems that are characterised by low productivity, slow response rates and their isolated geographical locations, will be greatly affected by climate change, accelerating shifts in biodiversity and species distribution. Global warming threatens the conservation status of alpine habitat types within the European Eastern Alps. Lowland species are expected to move upwards in altitude and upland, montane species may face extinction when populations become cut off and isolated as their habitats shrink and disappear. Glacier shrinkage and the development of post-glacial ecosystems are some of the fastest ongoing ecosystem shifts. These new ecosystems, many of which are currently unprotected, could provide important habitats for carbon-storing plants and threatened animals in the Alpine region.

The region's traditional balance between natural and cultural landscapes and land-use practice is under pressure. Fragmentation, land use changes and intensification, both in agriculture and tourism, have adverse effects on biodiversity and resilience. The heavy reliance of the tourist and recreational sectors on ice and snow make these economic sectors vulnerable as these elements become less predictable. To adapt to these likely irreversible climatic conditions, new forms of multi-functionality must be introduced. The Alpine region serves as an important source area for many adjacent regions, as water is vital for life. The primary goal is to solve water-related challenges at the source. Implementing the following nature-based strategies and actions will be crucial for safeguarding the Alpine region's ecosystems, biodiversity and natural resources, while promoting sustainable development and resilience in the face of climate change.

Nature restoration and rewilding

Establishing protected areas and wildlife corridors will conserve vulnerable ecosystems and enable species migration. Conducting rewilding efforts will restore natural habitats and promote species diversity. Support is needed for research and monitoring initiatives that assess changes in biodiversity and provide the basis for taking adaptive actions. Achieving a new balance in multifunctionality and natural systems is crucial. Many proposed measures are focused on retaining and infiltrating water, reducing uncontrolled runoff and mitigating risks of land degradation and landslides. Nature based strategies, that combine water and biodiversity challenges, revitalisation and rewilding, will work towards achieving this new balance.

Retain, replenish and restore water systems

The Alpine region, whether it is the Alps, the Pyrenees or the Carpathians, should play a central role in Europe's climate strategy. Not least because these areas serve as vital watersheds and the motors that drive Europe's most important rivers. It is essential to implement measures to store and discharge water to the main river systems, in synergy with the energy transition and the restoration of a new natural balance. Implementing measures to preserve and protect glaciers from further melting and runoff and promoting water retention and conservation and sustainable use practices to mitigate the impact of reduced replenishment during winters will be crucial. Regulations to safeguard water sources and maintain stable discharge characteristics of rivers and streams should be developed and enforced. Eco-friendly tourism alternatives that do not rely solely on ice and snow-based activities should also be explored and promoted.

Resilient Forest Management

Adopting adaptive forest management practices will enhance forest resilience to climate change. Promotion of reforestation and afforestation, especially on slopes in mountainous areas, will help to retain water and prevent erosion. Introducing wildfire prevention and management strategies is essential for protecting forests from increasing fire risks.

Eco- and agrotourism

Current winter sports tourism will become less widespread and have reduced business viability. However, new climate conditions, nature restoration and agro-ecological practices will support cultural landscapes and create opportunities for eco- and agrotourism in the Alpine region. Other forms of recreation may emerge or increase in popularity during the winter months.

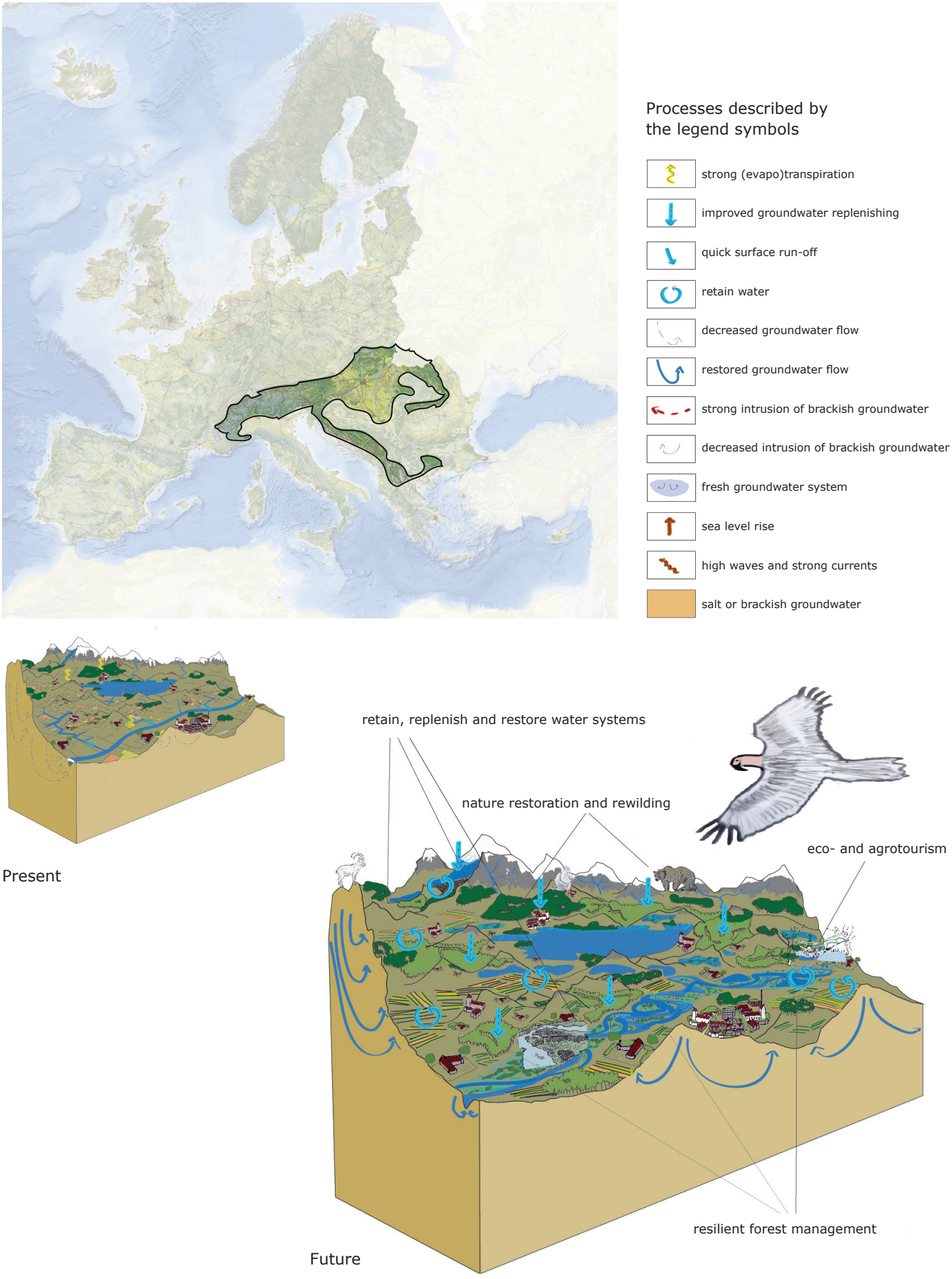

Figure 5.5 Central: visualisation of the existing and the future situation.

South: the Mediterranean region

The Mediterranean ecoregion is characterised by hilly and mountainous landscapes, inland plateaus, islands and long intensively used coast lines with a combination of rocky terrain, sandy beaches and coves. The combination of these landscapes with the vibrant and diverse cultural heritage shaped by millennia of history, encompassing art, cuisine, architecture and traditions, attracts tourists from all over the world. The soils are low in humus leading to an increased risk of erosion over the terrestrial surface of almost half of the region. Overgrazing, deforestation, wildfires and surface disturbances further exacerbate these issues, making rural areas contend with challenges like increased aridification, desertification, land abandonment and depopulation. Known for its production of olives, fruit and nuts, the region relies heavily on intensive agriculture, particularly for vegetables, olives and citrus orchards that all require substantial irrigation. Livestock farming is also on the rise in some parts of the region, leading to potential conflicts, especially during periods of extreme drought and heatwaves, affecting not only agriculture and industry but also nature. While rural areas experience depopulation, urban centres, especially along the coast, are growing. The region already accounts for over 35% of tourist visits in Europe, which places significant environmental pressure on land and water resources, adding to the competition for water. As sea levels rise, coastal areas, cities and heritage sites face challenges, and urbanisation poses threats to the natural qualities and richness of the Mediterranean Sea, which remains one of the most species-rich in the world.

Challenges and their nature-based strategies

Probably more than any other ecoregion, the Mediterranean is suffering from increased temperatures, prolonged droughts, water scarcity and heightened risk of wildfires. The spring of 2023 serves as an example of these challenges, as it was one of the hottest and driest seasons on record, leading to water shortages, the drying up of lakes and an extremely high risk of wildfires. The area is becoming increasingly arid and desert-like, leading to a scarcity of water resources. Additionally, during the same spring, heavy flooding occurred in the region due to intense rainfall. These multiple climate risks, often interconnected with land use practices, have become a daily reality in the region.

As a result the region finds itself at a critical juncture, a tipping point to a new reality. The key dilemma lies in overcoming existing crises and in making structural decisions and implementing measures that will revitalise and regenerate the area. Structural choices based on nature-based strategies can still turn the tide. These choices are centred on soil, water and involve rethinking the Mediterranean as a whole. By adopting the following nature-based strategies and actions, the Mediterranean region can therefore effectively address the challenges posed by climate change and foster a more resilient and sustainable future for the environment, communities and economies in the area.

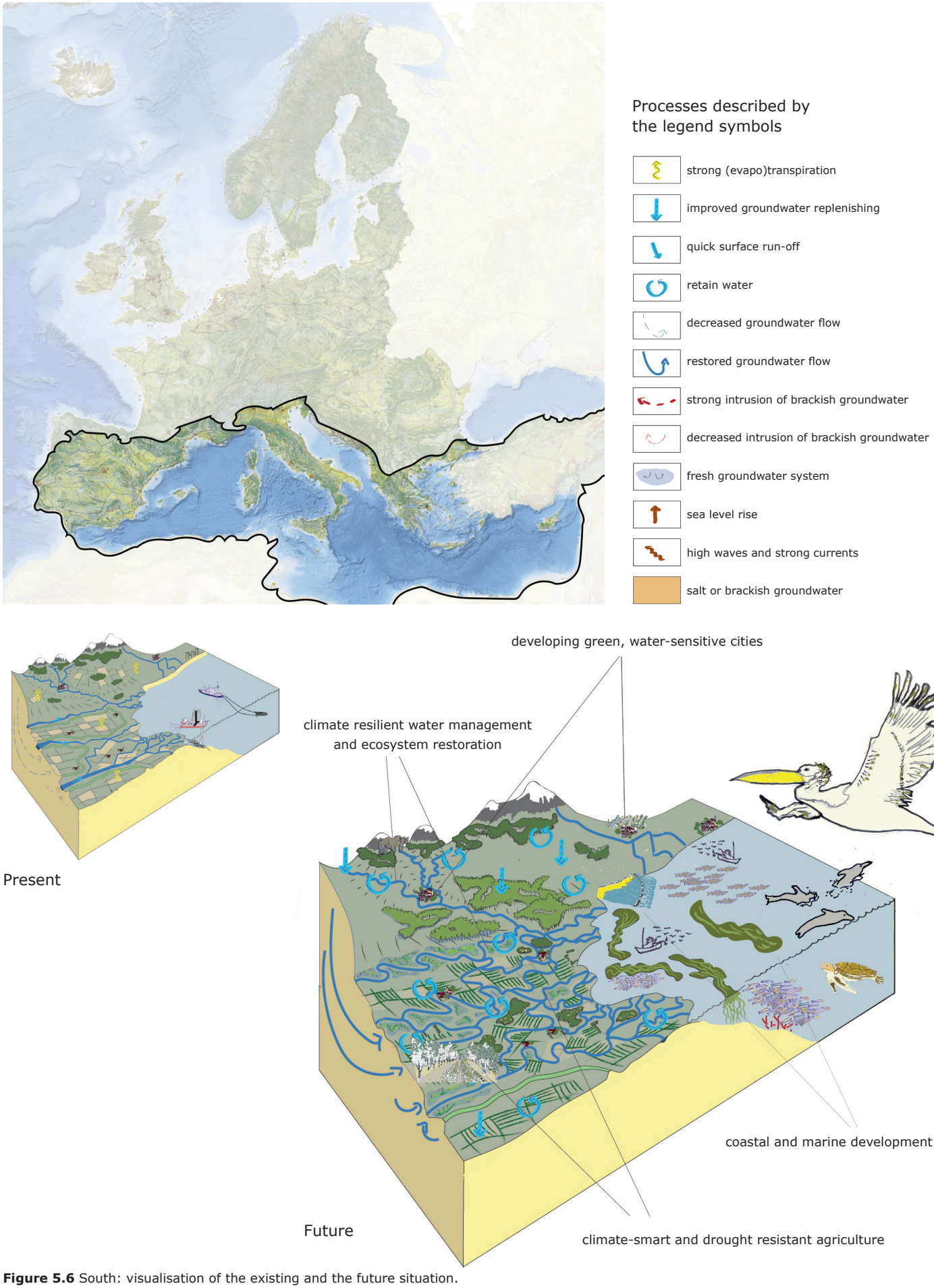

Figure 5.6 South: visualisation of the existing and the future situation.

Coastal and Marine development
The establishment of new marine protected areas and the enforcement of existing rules and regulations related to the protection of the marine environment will help to spark the recovery of the rich biodiversity of the Mediterranean Sea. This will also aid the re-establishment of fisheries, particularly if taken in combination with the promotion of sustainable fishing practices. Measures are needed to restore and increase the area of kelp forests and reefs, which play a vital role in maintaining a healthy marine ecosystem and provide coastal protection against rising sea levels and extreme weather events.

Climate resilient water management and ecosystem restoration
The implementation of long-term water management strategies to address water shortages caused by extreme droughts is essential. Natural water conservation and storage systems will contribute to the problem of coping with variations in rainfall and prevent drying up of lakes and water bodies. Fostering sustainable water use practices in agriculture, tourism and urban areas will reduce competition for water resources. Initiatives that revive and regenerate the inland rural areas, nature and soils are crucial. Relying solely on technical fixes to address crops and climate change will not be sustainable and might even exacerbate the situation. Instead, working on healthy soils and resilient vegetation that contribute to a robust food system and economy while reducing risks and dependence on scarce resources is essential. Local circularities and the re-use of resources, including water, along with indigenous species and traditions, can provide inspiration. Integrated green strategies focused on revegetation and reforestation should prioritise risk reduction, including fire risk reduction, flood risk management and erosion prevention.

Climate-smart and drought resistant agriculture
Climate-smart agricultural techniques that reduce dependence on intensive irrigation for crops like vegetables, olives, and citrus need to be developed and put into practice. Encouraging agroforestry will diversify agricultural landscapes and improve water retention. Incorporating traditional practices into land management and conservation efforts will prevent overgrazing and surface disturbances, reducing erosion risks. Initiatives to attract and retain population in rural areas will counter depopulation and land abandonment and create opportunities for agriculture and ecotourism in rural regions, providing opportunities for the promotion of economic development.

Developing green, water-sensitive cities
As for other regions, the significance of green, water-sensitive cities is very clear, especially given the rising temperatures in the Mediterranean. Investment in green infrastructure and water-sensitive urban design to reduce urban heat stress and manage stormwater runoff is therefore a logical approach. Furthermore, learning from traditions, such as compact building, utilising wind, and incorporating functional green and high density tree cover, will reduce urban heat and improve quality of life in cities. This should be combined with encouragement for the use of renewable energy sources in urban areas to reduce greenhouse gas emissions.

6 The future starts today

Co-creating nature-based futures at various scales

In this Mansholt lecture we highlight the potential of combining multidisciplinary knowledge and the power of imagination to co-design a resilient and nature-based future for Europe. An ongoing interactive process of visualising nature-based futures will create more awareness for the potential and benefits of nature-based solutions. Further elaboration of this process across different scales is recommended in order to establish an inclusive dialogue that collectively envisions desirable nature-based futures and which accelerates actions for implementing these solutions during this decade of action.

Our primary recommendation is to initiate a process that unites the European science community, young professionals, regional experts and stakeholders in a collaborate effort to co-design nature-based futures at the scale of (1) the European continent, (2) the five European ecoregional clusters and (3) European cities and regions (figure 6.1). The success of this process hinges on region-specific knowledge and multidisciplinary expertise, as well as broad representation and engagement of regional experts, stakeholders and young people.

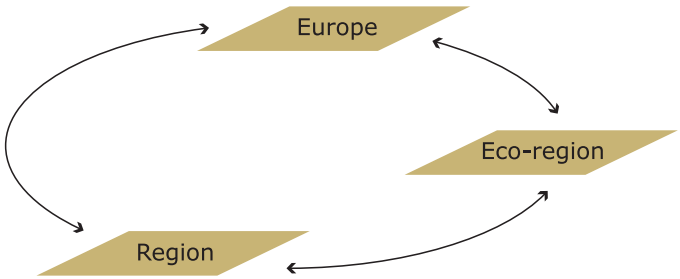

Figure 6.1 Co-creating nature-based futures at various scales: (1) European continent; (2) European Eco-regional clusters; (3) European cities and regions.

Collectively, we have the opportunity to foster a growing community based on an expansive vision and an engaging, ongoing process. This overarching vision will evolve and be enriched through continuous engagement with regional processes where the actual implementation takes place. Europe has already set ambitious goals for supporting at least 150 European regions and communities in becoming climate-resilient by 2030. The Mission on Adaptation to Climate Change sees the challenge of climate adaptation as an opportunity for enhancing Europe's resilience, preparedness, and equity. The Missions provide an ideal platform for mobilising stakeholders and citizens and involving them in the creation of nature-based futures for Europe. Their collective vision involves close cooperation with regions and communities across Europe, offering assistance in designing and implementing ambitious transformation agendas for climate, ocean, waters, cities and soils.

Europe, an ambassador for present and future generations

Europe stands at a pivotal moment in history, with the opportunity to shape a sustainable and nature-inclusive society for future generations. Renowned for its rich biodiversity and cultural heritage, Europe can take on a leadership role for present and future generations by championing climate and biodiversity action on the global stage. This requires the prioritisation of nature protection, promoting sustainable practices and fostering a harmonious relationship between humanity and the environment.

Society currently stands at a strategic point in time where nature-based solutions and associated concepts have the potential to serve as crucial instruments in tackling the combined challenges of climate and biodiversity. These approaches also have the capacity to accelerate transformative change.

The ultimate goal is to lay the groundwork for a sustainable and adaptable Europe for generations to come. By bringing together various stakeholders, but in particular policy- and decision-makers from both public and private sectors, leaders of civil society and young people, we can collaboratively develop pluralistic and actionable pathways that lead to the realisation of the changes we envision should take place in the future. While there is no one-size-fits-all blueprint for the way forward, co-designing nature-based futures provides us with a sense of direction as we navigate along the various adaptive pathways, translating a comprehensive, long-term vision for the future of Europe into actionable short-term perspectives. Through collective effort and commitment, we can pave the way to a more resilient and nature-positive Europe, step by step turning our long-term vision into a reality. As the essence of our lecture is rooted in inspiration, we hope for it to resonate deeply. More importantly, we hope it will create a spark within you that will lead to unified and collective action.

The IPCC Sixth Assessment Report made it very clear that there is a rapidly narrowing window of opportunity to secure a sustainable and liveable future for all (figure 6.2). As IPCC stated *'the choices and actions implemented in this decade will have impacts now and for thousands of years'.* In other words: the actions and decisions we take today will determine the future of the current and next generations.

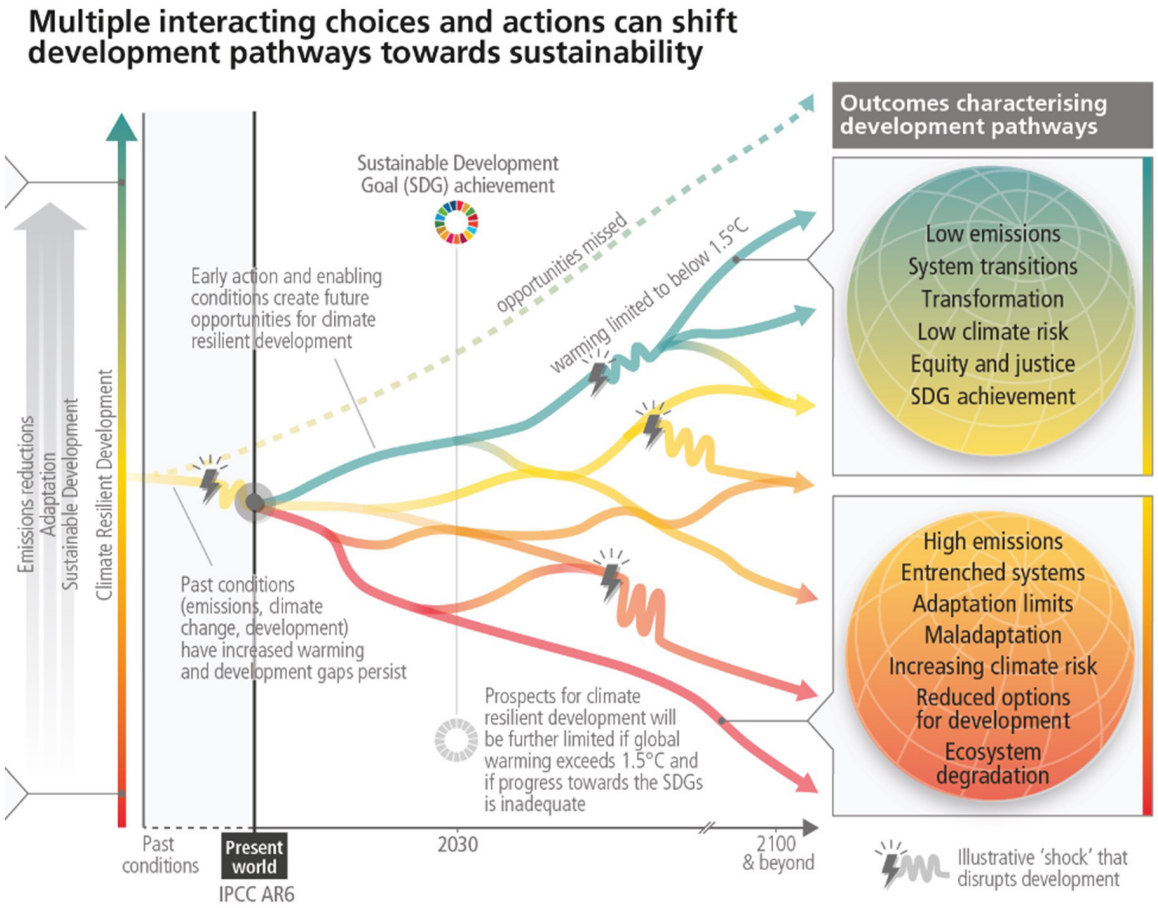

Figure 6.2 The illustrative development pathways (red to green) and associated outcomes (right panel) show that there is a rapidly narrowing window of opportunity to secure a liveable and sustainable future for all (source: IPCC Sixth Assessment Report, 2023).

References

1 World Economic Forum (2023). Global Risk Report 2022. WEF report
2 IPCC (2023). Climate Change 2023: Synthesis Report. A Report of the Intergovernmental Panel on Climate Change. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.). IPCC, Geneva, Switzerland, (in press)
3 Dasgupta (2021). The Economics of Biodiversity: The Dasgupta Review. London: HM Treasury
4 IPBES (2019). Global Assessment Report on Biodiversity and Ecosystem Services. IPBES, 2021
5 Portner et al. (2023). Overcoming the coupled climate and biodiversity crises and their societal impacts. Science 380, 256 (2023)
6 Rockström et al. (2023). Safe and just Earth system boundaries. Nature, April 2023
7 Willcock et al. (2023). Earlier collapse of Antropocene ecosystem driven by multiple faster and noisier drivers. Nature Sustainability, June 2023
8 Oliver et al. (2022). A safe and just operating space for humanity: a system perspective. The Lancet Planetary Health, Vol. 6, November 2022
9 UNFCCC (2015). Paris Agreement. Paris, December 2015
10 UN (2022). Landmark UN Biodiversity Agreement. Convention on Biological Diversity. Montreal, December 2022
11 UNEP (2022). State of Finance for Nature 2022. Nairobi
12 Griscom et al. (2017). Natural Climate Solutions. PNAS, 114 (44), October 2017
13 Seddon et al. (2021). Getting the message right on nature-based solutions to climate change. Glob Change Biol. 2021;27:1518–1546
14 Randrup et al. (2020). Moving beyond the nature-based solutions discourse: introducing nature-based thinking. Urban Ecosystems, Vol. 23, 2020
15 Holscher et al. (2022). Co-producing transformative visions for Europe in 2100: A multi-scale approach to orientate transformations under climate change. Futures 143 (2022)
16 Hickman et al. (2021). Climate anxiety in children and young people and their beliefs about government responses to climate change: a global survey. The Lancet, Vol. 5, December 2021.
17 Lubker et al. (2023). Imagining sustainable futures for the high seas by combining the power of computation and narrative. Nature Ocean Sustainability, Vol. 2, 2023
18 Guardian (2023). Why we need new stories on climate. Article
19 Wageningen University & Research (2022). Nature-positive futures. Food systems as catalyser for change. Wageningen University & Research. Mansholt lecture, 2022
20 WUR (2019). A Nature-based future for The Netherlands in 2120
21 Ballester et al. (2023). Heat-related mortality in Europe during summer of 2022. Nature Medicine, 29, 1857-1866 (2023)
22 WMO (2021). State of the Climate in Europe. WMO, 2021
23 Copernicus (2022). European State of the Climate. Copernicus, 2022
24 Copernicus (2022). European State of the Climate. Copernicus, 2022
25 Paprotony (2018). Trends in flood losses in Europe over the last 150 years. Nature Communications, 2018
26 EEA, 2019, The European environment — state and outlook 2020. Knowledge for transition to a sustainable Europe, European Environment Agency, Publications Office of the European Union, Luxembourg
27 JRC (2020). Mapping and Assessment of Ecosystems and their Services: An EU ecosystem assessment. JRC Science for policy Report, 2020
28 European Commission, Joint Research Centre, Maes, J., Teller, A., Erhard, M., et al., Mapping and assessment of ecosystems and their services: an EU wide ecosystem assessment in support of the EU biodiversity strategy: supplement (indicator fact sheets), Publications Office, 2020
29 https://www.eea.europa.eu/publications/marine-messages-2
30 Haase et al. (2023). The recovery of European freshwater biodiversity has come to halt. Nature Vol. 620, August 2023
31 European Commission (2019). European Green Deal. European Commission, Brussels, December 2019
32 European Commission (2020). Biodiversity Strategy for 2030
33 European Commission (2021). Climate Adaptation Strategy
34 Calliari et al. (2022). Building climate resilience through nature-based solutions in Europe: A review of enabling knowledge, finance and governance frameworks. Climate Risk Management, Vol. 37 (2022)
35 Missions in Horizon Europe | European Commission (europa.eu)
36 Implementation Plans for the EU Missions | European Commission (europa.eu)
37 European Commission (2021). Restore our Ocean and Waters by 2030. Implementation Plan
38 Bai et al. (2023). Plausible and desirable futures in the Anthropocene: A new research agenda. Global Environmental Change 39 (2016) 351–362
39 Van Buuren (2023). Research-based landscape design. Wageningen Environmental Research report (Dutch)

40 Nijhuis, S., & D. Jauslin (2015) Urban landscape infrastructures. Designing operative landscape structures for the built environment. *Research In Urbanism Series*, 3(1), 13-34.
41 Cervellini et al. (2020). A grid-based map for the Biogeographical Regions of Europe. Biodiversity Data Journal 8: e53720.
42 European Commission (2021). Restore our Ocean and Waters by 2030. Implementation Plan. European Missions
43 European Commission (2021). A Soil Deal for Europe. 100 living labs and lighthouses to lead the transition towards healthy soils by 2030. Implementation Plan. European Missions.
44 Bosson et al. (2023). Future emergence of new ecosystems caused by glacial retreat. Nature, Vol. 620, August 2023
45 Nabuurs et al. (2018). Climate-Smart Forestry : quantification of mitigation impacts in three case regions in Europe Outline – Concept of Climate-Smart Forestry – Three cases regions in Europe. Brussels.
46 Nabuurs, G.J. et al. 2021. Glasgow Forest Declaration needs new modes of forest data ownership. Nature Climate Change.
47 Barragan-Jason et al. (2023). Psychological and physical connections with nature improve both human well-being and nature conservation: A systematic review of meta-analyses. Biological Conservation, Volume 277, January 2023
48 Wageningen University & Research (2023). Nature-positive futures. Food-systems as a catalyser for change. Mansholt-lecture, 2022. Wageningen University & Research.
49 European Commission (2020). Farm to Fork Strategy
50 EAT-Lancet Commission (2019). Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. The Lancet Commission | Vol.393, ISSUE 10170
51 Boer et al. (2020). Re-rooting the Dutch Food System. The Dutch Food System in 2050: Healthier and circular. Food System Vision Prize, Rockefeller Foundation
52 Zanten et al. (2023). Circularity in Europe strengthens the sustainability of the global food system. Nature Food, 2023; 4(4): 320–330
53 WWF (2021). Stepping Up? The continuing impact of EU consumption on nature worldwide. WWF report, 2021.
54 EEA (2022). Imagining sustainable future for Europe in 2050. EEA, 2022
55 UN (2022). Valuing What Counts – United Nations System-wide Contribution on Progress Beyond Gross Domestic Product (GDP). UN, 2022
56 Circle Economy (2022). Circularity Gap Report. Five years of analysis and insights.
57 WUR (2021). Guidelines Report: Managing healthy and resilient ecosystems in the bioeconomy. Final report. Wageningen University & Research, 2021
58 International Energy Agency (2022). Net Zero by 2050. A Roadmap for the global energy sector. IEA, 2022
59 Razzaghi (2022). Re-powering the nature-intensive systems: Insights from linking nature-based solutions to energy transition. Frontiers in Sustainable Cities, Volume 4, 2022.
60 KU Leuven (2022). Metals for Clean Energy. Pathways to solving Europe's raw materials challenge. Ku Leuven, 2022
61 Santana, T. C., et al. (2023). 'Green roofs are effective in cooling and mitigating urban heat islands to improve human thermal comfort', Modelling Earth Systems and Environment 401(10376), pp. 577-589.

Colophon

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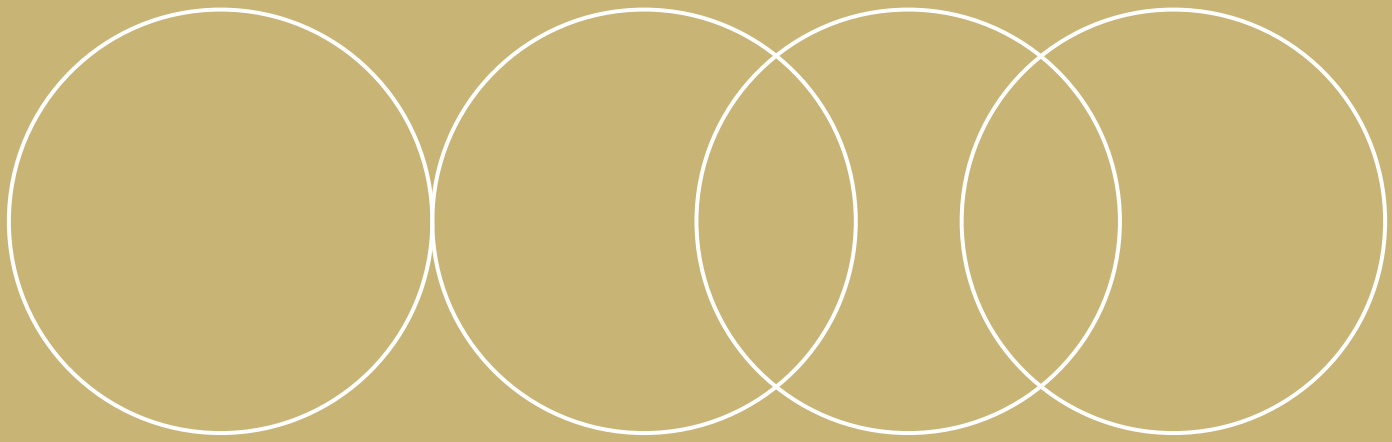

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