

The Biodiversity Crisis

WHITE PAPER

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Disclaimer

These white papers are informative content pieces which aim to shed light on the important developments, challenges and issues regarding our water resources that we are facing as society. Our aim is to increase awareness on water related challenges and how the Dutch water sector can be part of the solution.

Information can become outdated as new developments continue to occur.

What is biodiversity?

Biodiversity, or species richness, is what our natural world is made up of. It encompasses all plants, animals and microorganisms as well as the genetic variations within these. Otherwise known as biological diversity, it is directly linked to today's major challenges such as food security, climate and health. Almost everything we eat and most of our building materials and medicines come from biological resources (Wageningen University and Research, n.d.). All the species in an ecosystem are interdependent and create a balance in nature (World Wildlife Fund, n.d.).

Biodiversity is an indispensable aspect in a healthy ecosystem. From the water we drink and the foods we enjoy to the very air we breathe, biodiversity upholds and maintains the vitality of our Earth's biomes. Some regions, particularly in tropical areas, are experiencing a more accelerated loss of biodiversity than others. Freshwater ecosystems are hotspots of biodiversity and although they occupy just 1% of the Earth's surface, these ecosystems house at least 10% of its species (Almond, Grooten, & Petersen, 2020).

As scientists continue to study and explore previous, existing, and

diminishing biodiversity, it is becoming increasingly clear how little we know. Estimates of the number of species that we do not know about (approximately 1.9 million different species) varies considerably among scholars, though a 2011 study (Mora, et al., 2011) estimated around eight million undiscovered species. More recent projections after continued study (Chao, et al., 2014; Sigwart & Garbett, 2018; Magurran, 2021) have repeatedly bolstered this number. Yet with biodiversity decreasing at alarming rates, species are disappearing before we even know they exist.



The biodiversity crisis

The UN Intergovernmental Platform on Biodiversity and Ecosystem Services warns about the devastating impacts in its Global assessment report on biodiversity and ecosystem services. It is estimated that of the eight million species that inhabit our earth, one million will be threatened with extinction in the coming decades (KWR, 2019). This is not only a major loss in terms of species richness, but also poses a serious threat to the liveability of the planet.

Ecosystem services that we depend on such as for food or oxygen are directly affected by the loss and decline of species. Insects are one of the most rapidly declining groups of organisms and insect pollination is crucial for our food supply and the economy. 'Amid deforestation, pesticide use, artificial light pollution and climate change, these critters are struggling – along with the crops, flowers and other animals that rely on them to survive' (Janicki, Dickie, Scarr & Chowdhury, 2022). Insects are the foundation of many food chains, enabling life in the upper layers of the food chain and connecting aquatic and terrestrial ecosystems. Moreover, there seems to be a correlation between biodiversity loss and outbreaks of infectious diseases (Rosenberg, 2021). The reduction of available land is expected to increase the chances of diseases spreading from animal species to humans, and if we do not combat habitat loss, pandemics will only occur more frequently and intensively.

What is clear is that, as our natural world continues to degrade, biodiversity protection is becoming increasingly important. With more than 40,000 species on the International Union Conservation of Nature's Red List of

threatened species, there is widespread agreement among the scientific community that we are witnessing the sixth mass extinction as a result of human-induced climate change (Barnosky, et al., 2011; Ceballos & Ehrlich, 2018; Díaz, et al., 2019). The crucial difference between the first five waves of extinction and the one in which we currently find ourselves, is that this one could have been prevented. Ecosystems are highly interdependent at all levels – from the species level to the interactions between species and environment – hence the disappearance of a species from an ecosystem can trigger a chain reaction, leading to catastrophic effects (Novacek, 2001; Barnosky, et al., 2011; Ranjbar, et al., 2021).

Many species have co-evolved or occupy a specific niche in their habitat. The extinction of some species may lead to the collapse of an entire ecosystem. Each ecosystem will experience different variants and intensities of problems relating to the crisis. Freshwater populations have declined by an estimated 84% (4% per year on average) since 1970 and one-third of all freshwater species are threatened (Almond, Grooten, & Petersen, 2020).



As we face a biodiversity crisis brought about by the combined impacts of climate change, invasive species, habitat loss, overharvesting, and pollution (Novacek, 2001), it is of prime importance that we understand what, why, and how this is happening. Through a better understanding of this process, we can work towards increasingly better solutions. Amid the vast amount of unstudied knowledge relating to the biodiversity crisis, there are a few key threats upon which many scientists can agree (Arias, et al., 2021).

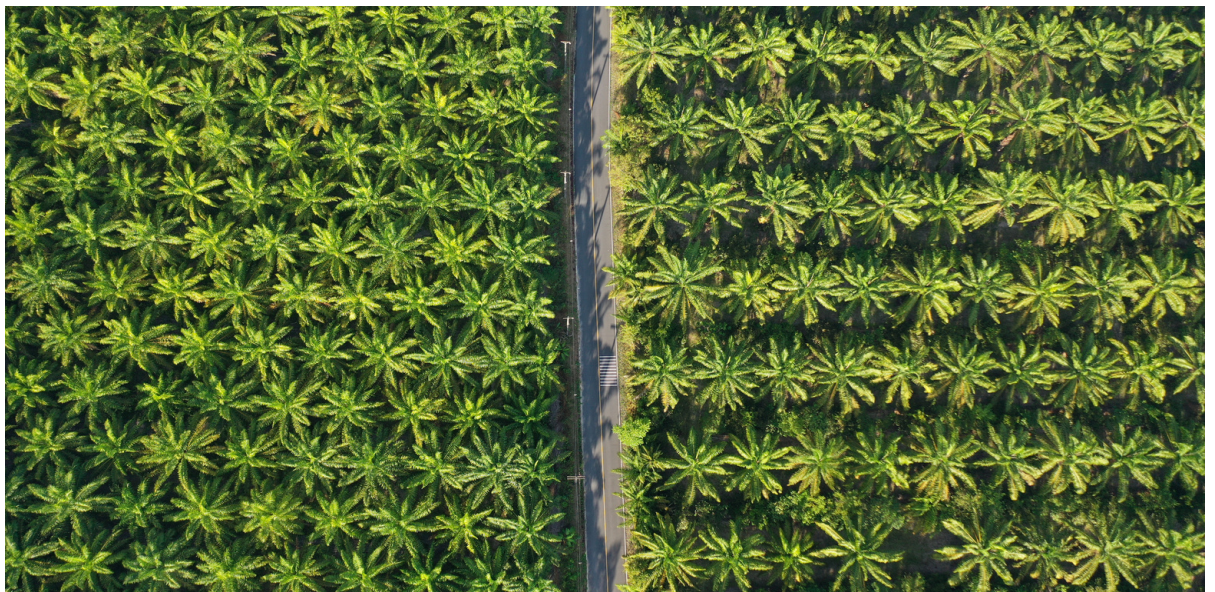
1 Habitat loss

Globally, habitat loss is the biggest threat to biodiversity. Habitat loss occurs because of human induced alterations in the landscape and changing land use. Throughout history, more and more natural land has been altered to serve productive purposes such as agriculture, housing, infrastructure, industry and other land requiring services to support global living standards. Areas that are already losing large portions of habitat at a high pace include forests, plains, lakes and reefs. Large scale deforestation gives way to agricultural expansion and harvesting of timber and other forest products.

Almost 70% of the worldwide deforested area has been converted to agricultural land (WWF, n.d.). Large plantations, such as palm oil, are a major driver of tropical forest destruction, while population growth, urbanisation, consumption, industrialisation, land-use and tourism drive coastal degradation and the destruction of coastal and marine habitats. The creation of protected areas is one of the most effective tools for

conservation. Through protection, communities can be supported.

Livelihoods are created around the planning and management of protected areas, which help protect freshwater and food supplies, which in turn helps reduce poverty and allows the protected area and the human inhabitants to become more resilient to the consequences of natural disasters.



2 Overexploitation, modification, and pollution

Direct human activities such as sand mining in rivers, river flow modification, fertiliser use, waterway pollution, the construction of dams, extraction, and chemical runoff have all contributed significantly to the changes in and increased pressure on freshwater systems (Arias, et al., 2021). Water contaminated by chemicals can experience toxic algal blooms, oil spills devastate fish and bird populations and more. In addition to pesticides, chemical runoff and fertilisers, the flow of pharmaceutical waste into water has major consequences for organisms and ecosystems.

Evidence suggests that the incorporation of pharmacological substances by organisms affects genetic diversity and endangers the diversity of species and community. 'There are several pathways through which waste pharmaceuticals can reach organisms; the main one is through sewage discharge into aquatic ecosystems affecting organism such as microorganisms, fishes, and invertebrates, which can be consumed by higher trophic levels and cause trophic cascade effects. Also, the use of treated wastewater for agricultural irrigation can affect the plants which are at the base of the trophic chain' (Martinez & Cuautle, 2017).

Plastic pollutants have, thus far, impacted freshwater systems worldwide disproportionately more than marine systems (Azevedo-Santos, et al., 2021). Giarrizzo, et al. (2020) calculated that

over 150,000 tons of plastics are siphoned into the Brazilian Amazon every year. This is an enormous cause for concern. Because plastics can take centuries to degrade, the materials remain and microplastics accumulate in the food web. Microplastics have already been detected in human blood, placentas of fetuses, agricultural soils and the air we breathe. Moreover, animals and plants can also easily become entangled in plastic waste (Derraik, 2002; Chae & An, 2017; Guilhermino, et al., 2018). Additionally, changing patterns in human activity such as urban living, nocturnal activity, travelling, 24/7 production activities cause much noise and light pollution that affects the behaviour, safety and breeding outcomes of many species.

3 Invasive species

Along with islands and coastal regions, freshwater systems are vitally threatened by species alien and invasive to their ecosystems. Invasive species can be both plants and animals that have been brought to a different ecosystem by humans, on purpose or by accident (Ecowatch, 2021; WWF, n.d.). These species cause major disruption to the natural order and crowd out the native species populations. The effects are unimaginable and are often irreversible in nature. Many extinctions in the past have been caused by invasive species, leading to loss of and alterations to native ecosystems and nature. Examples are the introduction of the cat in New Zealand which caused the Stephen's Island Wren to go extinct, the introduction of the European red fox in Australia and the United States, threatening among others small- and medium sized rodents, marsupial species as well as canids and ground nesting birds respectively.

In the Netherlands the introduction of the Japanese Oyster almost completely

wiped out the indigenous flat oyster in the Eastern Scheldt, and in Europe the accidental introduction of the American Comb Jellyfish is threatening various sea basins (van den Berg et al., 2005). It was first introduced in the Black Sea, from which it rapidly spread through the Caspian Sea and more recently the Baltic Sea. Warming water temperatures give them an ecological advantage, so their impact is expected to increase (Marine Biological Laboratory, 2008).

In freshwater environments, the most worrying group of organisms is extremely adaptable to various environmental conditions: cyanobacteria. These organisms impact the ecosystem in several harmful ways, largely through the production of cyanotoxins and inhibiting sunlight from reaching past the water surface (Lopez, et al., 2008; Harke, et al., 2016; Ranjbar, et al., 2021). Harmful algal blooms (HABs) can develop in any water source that has become overly rich in nutrients (caused largely by agricultural runoff, pollution or invasive species). Though HABs can occur naturally – for



example due to seasonal temperature changes – human activities have played an increasingly salient role (EPA, 2002; Arias, et al., 2021).

The reason native ecosystems are often so severely harmed by the introduction of invasive species is because though new species do not necessarily always survive, they often do thrive. More often than not native species are unprepared

to fight off the invaders. When combined with habitat loss, native species often lose the battle and become extinct. Records of all the species that have gone extinct have not been kept, as awareness has only increased throughout history. Currently there is a better understanding of the importance of balanced ecosystems and the ecological costs caused by invasive species in terms of biodiversity.

4 Human-facilitated climate change

The changing climate has had a massive impact on freshwater ecosystems whose biodiversity is constantly being reduced. At the most fundamental level, the changing climate impacts the web of interactions in an ecosystem. Any changes, from the micro to the macro scale, impact the entire web given species' high level of interdependence. Scientists have found, and continue to find, key ways that climate change has disrupted freshwater webs of interactions.

One key point of consensus is that the changing oceans have enormous impacts on freshwater. For example, the Antarctic Ice Sheet is rapidly melting, leading to increased water fluxes in freshwater (Bintanja et al., 2015; Pauling et al., 2016; Zhang et al., 2017). Meanwhile, changes to ocean circulation patterns and polarising ocean salinity levels significantly affects the transportation of heat and freshwater (Buckley & Marshall, 2016; Liu et al., 2017; Mecking et al., 2017).

In addition, the rapidly changing climate has forced species to adapt much faster

than the previous five mass-extinctions. In order to adapt to a change in habitat, species can move geographic location, adjust the timing of their life cycle events, or change their very physiology (Bellard, et al, 2012).

When species are not able to adjust, they will become threatened, endangered, and extinct. The larger animals within their taxonomic group are of serious concern. Their characteristics such as long lifespan, limited offspring, large size and uniqueness usually make them both vulnerable to extinction as well as less resilient to climate changes (He, et al., 2017).

The disappearance of these species is often an indicator that an ecosystem is under threat (Almond, Grooten, & Petersen, 2020). In particular the freshwaters are losing species at a rapid pace, much faster than marine or terrestrial ecosystems. Paradoxically, thus far, conservation efforts and science have mainly been organised around terrestrial and marine megafauna (He, et al., 2017).



The aforementioned threats are some of the key factors that put biodiversity and ecosystem health in general at risk. Additionally, threats such as the wildlife trade, hunting and poaching, as well as bycatch are detrimental for populations and severely disrupt the ecosystem balance. Education and protection are key to establishing an overall understanding of the importance of conservation.

What are scientists still debating?

Much of the academic debate on biodiversity in general revolves around approaches to prevention and mitigation. Scientists have been working on predicting which parts of an ecosystem need to be bolstered in order to prevent biodiversity loss. As this field of study is new and evolving, we cannot fully predict what methods will work for every scenario.

Because ecosystems are so closely interlinked, one change can have a devastating impact on the entire system. A study of 9,650 interspecific systems found that one in three species would disappear if their associated species did (Koh, et al., 2004). This 'web of interactions' is particularly fragile in 'tipping point' ecosystems, where their 'thresholds can lead to irreversible shifts in biomes' (Bellard et al., 2012).

One other aspect in this debate is whether species will be able to adapt quickly enough to the changing climate. Some species can change their diet, activity, life-cycle events, or location in order to cope with the changes in their habitat (Bellard, et al., 2012). This aspect is challenging to predict and will need to be investigated over time.



Why is this relevant to the water sector?

To build a climate resilient future and a healthy planet to live on, it is absolutely necessary to prioritise the protection and care of our biodiversity. The impacts of climate change is most visible and widely seen through water in terms of sea level rise, warming ocean temperatures, increased droughts and floods, extreme weather events and more. Many other events are also likely to happen that cannot yet be seen, and many changes are already happening, and will continue to happen, particularly in freshwater ecosystems.

The international community is paying increasing attention to ecology and biodiversity. There have been recent major global events on biodiversity which have put some promising developments in motion. The most outstanding example is the Global Biodiversity Framework (GBF) that was initiated at the biodiversity summit in Montreal in 2022. The World Biodiversity Summit took place alongside not one, but three pivotal events: UNGA in New York, UNFCCC COP27 in Sharm el-Sheikh, and UNCBD COP15 in Montreal. The main points (Briggs, 2022) of the GBF include:

- maintaining, enhancing and restoring ecosystems, including halting species extinction and maintaining genetic diversity;
- the 'sustainable use' of biodiversity - essentially ensuring that species and habitats can continue to provide services for humanity such as food, clean water, recreation and medicine;
- ensuring that the benefits of resources from nature, like medicines that come from plants,

are shared fairly and equally and that indigenous peoples' rights are protected; and,

- paying for and putting resources into biodiversity: ensuring that money and conservation efforts get to where they are needed.

In more practical terms, the GBF will be looking to close the biodiversity finance gap, which is estimated at EUR 660 billion per year, by 2050. Manageable goals will help guide society towards the right point. A selection of the measures (Ferrer, 2022) that countries agreed to in the GBF are:

- reduce pollution risks to levels that are not harmful to biodiversity and ecosystem functions;
- minimise the impact of climate change and ocean acidification on biodiversity;
- ensure areas used for agriculture, aquaculture, fisheries and forestry are sustainably managed;
- reform EUR 471 billion of environmentally damaging subsidies;

- secure EUR 28 billion annually for conservation;
- require governments to ensure that transnational companies share 'their risks, dependencies and impacts on biodiversity'; and,
- protect 30 percent of the planet through effective conservation.

As is apparent from the points of attention of the Global Biodiversity Framework, water is essential to

achieving nature restoration, climate action, sustainable fisheries and agriculture, and much more. The image below visualises the importance of water, aquatic and terrestrial biodiversity, and climate action for all forms of life and a thriving economy if we are to achieve our global goals. The biosphere is considered the foundation for achieving the SDGs (Obrecht, Spehn, Pham-Truffert, Payne, 2021).



Figure 1 – The SDG Wedding Cake (Source: Azote Images for Stockholm Resilience Center, Stockholm University)

The SDGs relating to water, climate, life below water and on land are extremely intertwined. The SDGs distinguish between two types of biodiversity: below water and on land. Water impacts them both, but is also dependent on them. Terrestrial and aquatic ecosystems by definition depend on the availability of clean and sufficient water. The quality and quantity of water reserves on the other hand is determined by aspects

such as healthy soils and microorganisms. As can be seen in figure 1, progress on the four goals at the bottom, contributes to the achievement of the SDGs above them. The four goals are the foundation of all life and enable a decent lifestyle.

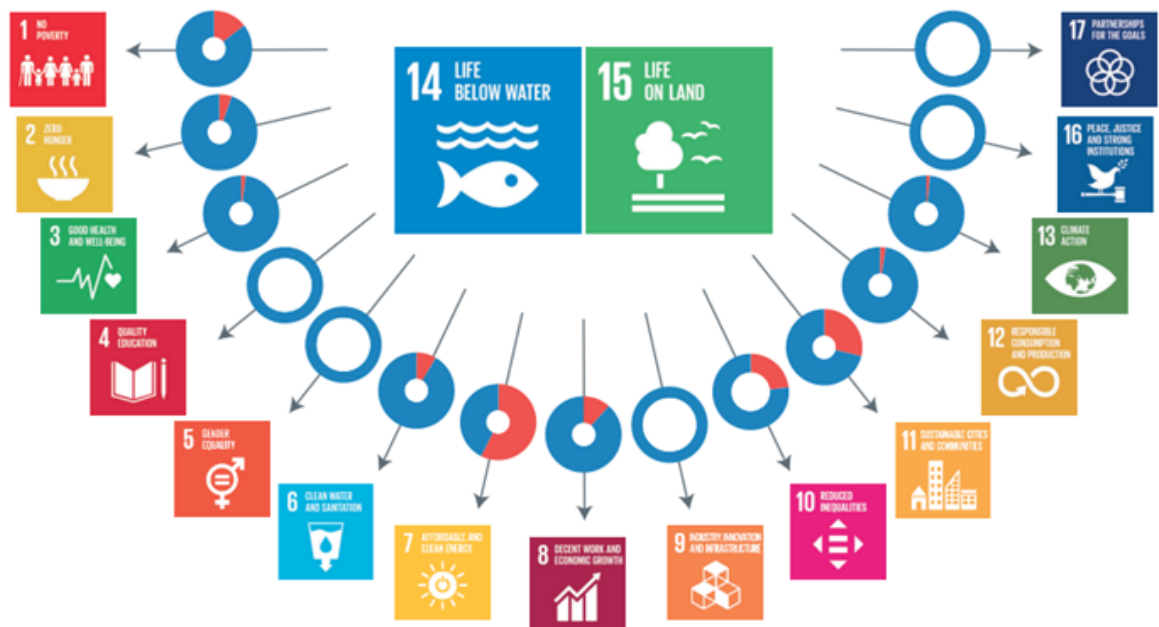


Figure 2 – Impact of SDGs 14 and 15 on other SDGs.

Figure 2 above was presented in a paper by Obrecht et al. (2021) and shows the role of Life below Water and of Life on Land (SDGs 14 and 15) in the other SDGs. ‘The data is the result of a systematic compilation of the current state of knowledge about interactions among the SDGs, in terms of co-benefits (blue) and trade-offs (red). The compilation is based on a total of 65 global assessments (UN reports and international scientific assessments), as well as 112 scientific articles published since 2015 with explicit reference to the SDGs. The slim donuts show either gaps in knowledge or weaker interactions.’ (Obrecht et al. 2021). This figure clearly shows that biodiversity enhancing efforts on SDGs 14 and 15 have major interactions, and primarily bring benefits to most of the other SDGs.

The challenges that need to be addressed in SDGs 14 and 15 are related to a number of issues. The ocean is the planet’s largest ecosystem, covering more than 70 percent of its surface area. Its health is severely threatened by marine pollution, overfishing, rising ocean

temperature, acidification of the water, and eutrophication. The ocean is vital for our food supply, climate regulation, carbon storage, livelihoods, and the global economy. All these depend on the health of life below water. SDG 14 aims to reduce the pressures and impacts on ocean life that often come from life on land. SDG 15 focuses on the protection, restoration and promotion of the sustainable use of terrestrial ecosystems, sustainable management of forests, combating desertification, as well as halting and reversing land degradation and biodiversity loss (UN). It is clear where opportunities for nature-inclusive investments lie. In order to measure the effectiveness of investments in nature conservation, indicators should include both monetary and non-monetary values.

The water sector can have a major impact. Decisions taken on water management, resilient climate adaptation, integrated design, building with nature and nature positive engineering strategies can boost biodiversity conservation, recovery and



restoration at different levels.

The Dutch water sector has in the past proven successful in achieving innovative, sustainable solutions and offering green alternatives to, for example, traditionally grey infrastructure. This White Paper features the work of NWP members Altenburg & Wymenga, Wageningen University and Research, and Dunea, each of which makes efforts to enhance biodiversity and increase awareness and understanding on the topic in their own fields of work.

Dutch Sector Activities

1

Altenburg & Wymenga

The connection with water management is extremely important for biodiversity and ecosystem services. Altenburg & Wymenga (A&W) is an independent ecological research and consultancy firm with a high level of understanding of this connection and the dynamics of ecology. The core of A&W's work revolves around water management and biodiversity, and its experts have over 30 years of experience in research and monitoring in these fields. Erik Klop, a biologist at A&W, has much experience living and working abroad in water and ecology related projects.

Klop explains the strong relationship between these topics in his work experience. In terms of biodiversity, one of the areas that A&W works in is West Africa, where it has conducted several studies on biodiversity as well as Environmental Impact Assessments (EIA). "We often try to operate in collaboration with other institutes, like NGOs or other consultancies. Biodiversity is an increasingly important part of that."

Altenburg & Wymenga



ECOLOGISCH ONDERZOEK

Case study

Inland Niger Delta

One example is a project in the Inner Niger Delta in central Mali. The way in which water systems are managed, determines the characteristics of that area's ecology and the ecosystem services that can be generated for the local communities. The Inner Niger Delta is classified as a temporal wetland, and is a massive nature reserve. Many European

bird species like various water birds migrate here in the northern winter. Great efforts are made in the Netherlands to protect the populations of bird species, but to fully protect them, efforts need to be made in their wintering grounds too.

The importance of water is directly visible in the Delta. Too little rainfall in the Sahel region severely impacts some of the bird populations in their wintering grounds. Equally, the extent to which vegetation remains intact is also dependent on the availability of water. These examples show how a whole natural system functions. The dams on the Niger and Senegal Rivers control the quantity and timing of the influx of water and are thus a determining factor for the way in which the system functions. They can either make or break it.

The Senegal River is the main source of water for south Mauritania on the edge of the desert. However, over time it has become an artificial system regulated by dams and has changed the river's natural flow. This has had major consequences for animal

species and people in the area. The reduced river dynamics have led to some of the smaller channels slowly being taken over by plants like Cattail (Typha) which has blocked the water channel. It is A&W's job to think about these complex issues and how to mitigate these kinds of effects. In this case, approximately seven years ago, we followed the natural system and investigated its functionality and its impact on the local ecology and agriculture. We also looked at acacia flooded forests that are used for wood or honey harvesting. In our experience an integrated vision in the management of a system is crucial. Over the years, we see that impacts on ecology and biodiversity as opposed to maximising the ecosystem services of an area, are being considered increasingly important.



Looking at the connection between water and the biodiversity crisis from a global perspective, climate change is having a huge impact. We worked closely with the Potsdam Institute for Climate Impact Research (PIK) on calculating climate scenarios. This is incredibly complex. In the Sahel region for example, where models converge on expected changes in temperature, it is much more difficult to predict rainfall patterns. The Sahel region is subject to influences from both the ocean and the Sahara Desert, as well as the tropical savannah and the rainforest. All of these influence precipitation. This, however, does not only apply to the Sahel region, but also to South America and other areas on the planet. Many factors influence climate patterns, vegetation, rainfall, and biodiversity, and we can see the consequences in the field.

The water sector has a crucial role to play and can make the biggest contribution by taking an interdisciplinary approach instead of staying in silos. This involves collaborating with various organisations that bring their own experiences and expertise. A&W regularly works with different partners, ranging from NGOs to technical engineering consultancies. People approach a problem from different angles. The challenges we deal with in today's society are much too complicated to approach from only one angle. Doing that will not enable you to solve the problem.

“We have partnered Wetlands International for years. They also have local offices and our collaboration in the Niger River Basin and the wider Sahel region dates back a long time. As a small and specialised ecological consultancy, we are a niche

organisation that can go into depth but that lacks the broader scope. For large, interdisciplinary projects we need – and want – to work with others. It is both easier and more fun.”

A&W has had a presence in the regions where it works for several decades and, over the years, has witnessed the change in local, climatic conditions. In the 1970s and 1980s, there were long periods of drought in the Sahel region. We now see an increase in precipitation, which is good news from an ecological/water perspective. Nevertheless, fluctuations in rainfall are the norm here, so predictability is low. Experts do say that land that had become completely unproductive has not managed to recover. The coastal areas have become more saline, causing changes to the local vegetation and preventing agricultural opportunities.

Looking to the future, one noteworthy development is that the scale of the processes that impact local systems is increasing. The processes could be a dam built 1,000 kilometres away or climate change. These large-scale events often have a profound local impact. To achieve change locally, we need to look at the larger scale where aspects such as politics and transboundary management come into play. That is not to say that local actions alone will not have a positive impact, only that large-scale influences are increasingly important. What we need to do to make progress is to scale up and approach local problems from an international and integrated perspective. Anything that happens upstream impacts the entire area downstream. You need both an international approach as well as local understanding, which makes it both complex and interesting.

Case study

Environmental Impact Reporting

Environmental Impact Assessments (EIA or Milieueffectrapportages in Dutch) are an important part of our work. The International Finance Corporation – Performance Standard 6 (Biodiversity Conservation and Sustainable Management of Living Natural Resources) guidelines are applicable in many international projects. This concerns impacts on

so-called Critical Habitats for endangered species and how to manage them. It can be quite complicated, especially in bigger projects where political and financial interests are also at play. Nevertheless, it is important and necessary to gain an understanding of the impact on biodiversity and to avoid or mitigate negative impacts.

“We always try to work with local organisations and partners in our projects. We seek out that collaboration because we believe it is key for knowledge exchange. These organisations understand the local context and problems. We can learn a lot from their expertise and experience. We do this even when we have been coming to an area for a long time. It is enjoyable to work together and learn from one another.”

partners, and this process takes time.

In our experience, carrying out projects successfully usually leads to new projects in the same area. That experience is important. Some of my colleagues have been working for several decades in the areas we work in now. We have become a familiar face; we know the people and organisations. At this point in time, we are dealing with conflicts and insecurity in parts of the Sahel region. We are trying to broaden our scope, but that also means expanding our network and getting acquainted with new local

2

Wageningen University & Research

Wageningen University & Research (WUR), a long-standing member of the Netherlands Water Partnership, is committed to its mission statement – ‘exploring the potential of nature to improve the quality of life’ – and is a leading entity in addressing biodiversity issues. Jeanne Nel, biodiversity scientist specialising in freshwater biodiversity, heads the Biodiverse Environment Programme at WUR. Nel believes that key to the work is bringing biodiversity into other sectors and helping them design mandates for biodiversity. Her niche expertise is at the junction between ecosystem-based management and water.

One focus area of WUR, specifically in the Wageningen Biodiversity Initiative, is Bending the Curve of biodiversity loss. This principle is all about bringing biodiversity back into our lives and reversing the trend of biodiversity loss. It is an aspiration as well as a philosophy. Bending can be shown with models and technology, but it is also a fundamental shift in mindset. It suggests moving away from a ‘doing no harm’ approach, to active restoration. The graph below visualises what this transition could look like.



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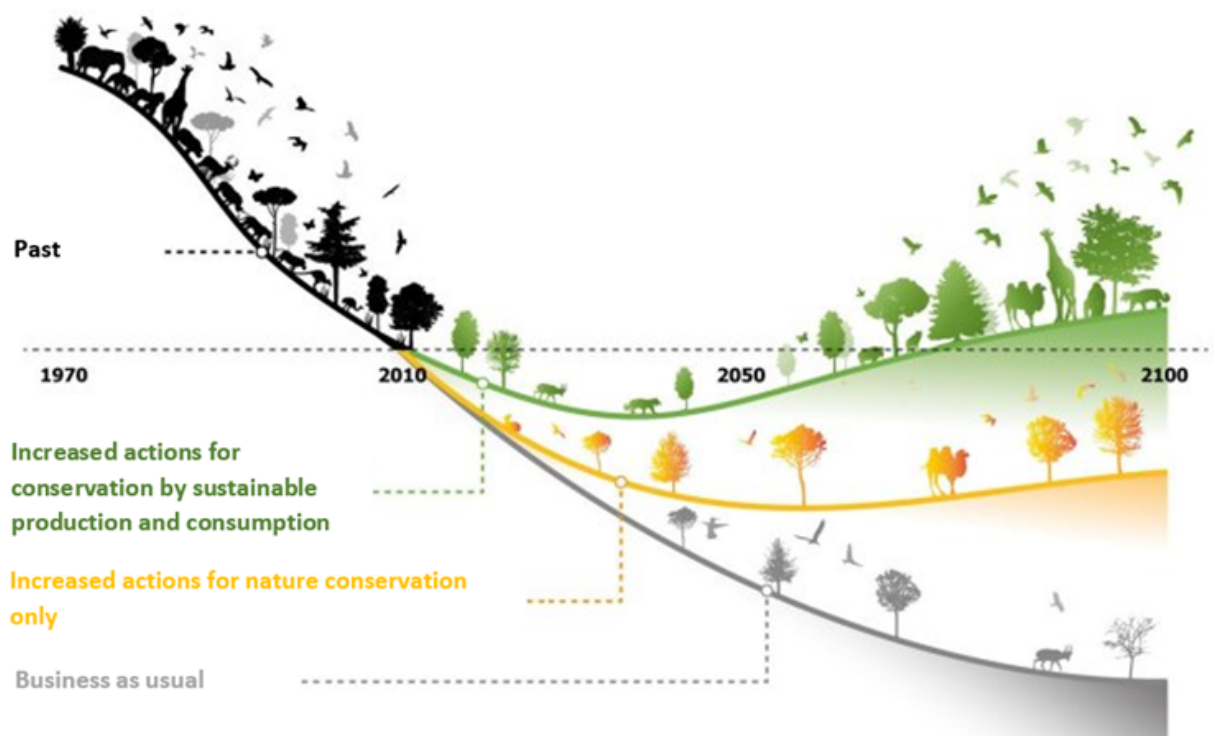


Figure 3 – Bending the curve of biodiversity loss (Wageningen University & Research)

One of the main obstacles to bending the curve of biodiversity loss is that land and water management, policy and science have been much separated. Biodiversity falls through the cracks. Land specialists consider it a water domain topic and vice versa. This is a fundamental problem.

WUR takes a project-oriented approach towards biodiversity and water. An interesting example of a project is one in which the effects of different management interventions have been tested to understand how organisms respond. This project is investigating the impact of different types and amounts of pesticides and how they translate throughout the chain. The Biodiversity Department monitors the common thread in all its projects to ensure connectedness and systems-thinking. Working project by project will not bend the curve, it is key to think in terms of systems and in the long term.

Furthermore, WUR engages in both technology and society, and this is crucial. The environmental risk assessment group is currently using chemists and lab researchers to look at the effects of pesticides and

pharmaceuticals and their impact on soil health and organisms. The researchers work with a team of modelists who make models from the information and investigate social implications. As a next step, governments will be involved to use the knowledge gained to optimise decision-making, policies and regulations. This connection to governance and societal relevance is crucial. Real impact is made when connecting and managing stakeholders, governmental departments, people and organisations is done well. People need to think beyond their silos and consider how things are interconnected. This explicitly includes indigenous people and women in their roles as stewards of the land and bringing their voices into water regulations, and the debate on ecosystem services and biodiversity.



Case study

Artificial Intelligence for Biodiversity Restoration

WUR is turning Artificial Intelligence (AI) and big data into solutions for societal challenges like biodiversity restoration and nature conservation. The illegal trafficking of flora and fauna is unfortunately a lucrative business, and is even the fourth biggest illegal trade in the world, after trade in drugs, humans and counterfeit product trafficking. A smart computer system, developed by Wageningen University and partners, enables herds of animals to send an alarm signal to national park guards. It is a special form of crowd management and in the area where pilots have been

conducted, poaching practically disappeared after the initial experiments.

In addition, apart from animal behaviour predicting unwanted visitors, the smart computer system can also generate information on disease amongst animals in the context of livestock farms. An important note though is that AI and big data are tools that will only work effectively when used in combination with knowledge of animals, plants, ecosystems and so on. It is in these intersections that WUR and its partners (Dutch universities of technology and OnePlanet) operate.

Biodiversity and its relevance to the water sector is that biodiversity is what enables life, and the quality and quantity of ecosystems and soil. For example, good infiltration and high-quality groundwater need the soil's buffering capacity. If there is no buffering zone, it will cause negative effects such as erosion or harmful chemical, such as pesticides, runoff into lakes. Optimal soil buffering capacity is all about water quality and quantity and their regulation over time. This is even more critical with climate change.

Droughts are becoming more severe and are occurring more frequently, resulting in compacted soil, which is problematic for groundwater permeation. As a result, less water infiltrates into the ground and groundwater reserves get depleted. In the dry season this is particularly problematic, and support is needed to get rivers running.

In degraded landscapes, for example in some sites in South Africa, the result is that water runs off. Floods occur more easily, decreased storage of water leads

to increased droughts, forest fires are getting worse and occur more often, and the ability to adapt to climate change is severely impacted by the absence of healthy functioning ecosystems.

“The quality of groundwater will be the first thing that gets hit in the Netherlands. We are really getting problems with groundwater quality. Biodiversity is a life support system for nature to function healthily, and this is the basis for good and sufficient water.”

The importance of healthy ecosystems is the crux of the matter. When we talk about restoring biodiversity, it should also include bringing back healthy ecosystems, so species actually get a fighting chance. It is not just plants and animals, but the interactions between them. Nature can be interpreted as a broad term, but the conversation should go beyond just ‘counting species’. WUR therefore advocates the following: ‘Biodiversity is the part of nature that is alive, and includes every living thing on Earth, humans too. Nature is all biodiversity together with the non-living systems – the soil, water, climate, mountains, and all other inanimate components – that comprise our planet.’

In the past, freshwater biodiversity was given insufficient attention and it needs to be put higher on the agenda. People look at water from a utilitarian perspective, just thinking of how this resource can be used for society. Although society has become more knowledgeable on water governance, real understanding has not grown enough.

The nature-based solutions approach highlights just how fundamental freshwater ecosystems are. Water must

be brought into the conversations on biodiversity.

Traditionally, as also demonstrated by the SDGs, life below water focuses on marine life. The other biodiversity focused SDG specifically covers land. The same goes for the biodiversity framework, which has both a terrestrial and marine component. Rivers are muddled up with land and are hence easily overlooked.

There is more knowledge and awareness regarding biodiversity on land. In water, the focus is primarily on engineering without much attention for building with nature. There is some attention, but if you think of investments in traditional water infrastructure, it is only a small portion. What is needed is a sharing approach that addresses the goals for land and water, as opposed to a sparing approach which divides land according to function: urbanisation, agriculture, nature. The system is interconnected, so sharing should be natural.

Since at least the 1980s people have looked at drivers of change in nature. These drivers are often summarised as HIPPOC: Habitat destruction, Invasive species, Population growth, Pollution, Overexploitation, Climate change.

Even when researching entire ecosystems, the focus is usually on direct drivers. Since 2019 there has been increasing awareness that these drivers should not be our primary concern, but that we need to focus on indirect drivers – the root causes – of change. These indirect drivers include structural economic changes and financial indicators. They go further back and are more complex, and that is why systemic

approaches are needed. It is confrontational and challenging to get people to change their viewpoints. The biodiversity sector needs to head in that direction, requiring a shift in how experts are trained.

“If you replaced the word biodiversity with poverty or climate change, the process should be the same. That is the approach.”

Case study

WUR & Opportunities for Biodiversity Restoration

REEFolution in Kenya

This initiative was launched to counteract increasing environmental pressures and encourage active restoration as well as a more sustainable use of coral reefs. Important focal points of the project are sustainable fishing, environmental awareness, ecotourism, coral mariculture as well as research and monitoring. In this context WUR works with the Kenya Wildlife Service and the local Fisheries Department to organise educational campaigns, restore damaged areas, and build a community conserved area. More information can be found on the [webpage](#).

Nature and Health in the City

This project created an online resource for enhancing urban greening. This tool will provide citizens, governments and companies information about the opportunities and benefits of creating increased green spaces in urban areas as well as practical advice on how to start. The goals of this resource are threefold: enhancing biodiversity in the urban setting; contributing to climate adaptation and urban resilience; and improving overall health. More information can be found on the [webpage](#).

There is hope when people shift from a philosophy of minimising harm to engaging with nature again. A healthy ecosystem is where nature and people respect each other and flourish. It goes beyond measurable ecosystem services

in which nature is valued, and brings benefits such as mental and physical health for humans. It is key to bring the broad value of nature back into decision-making for a sustainable future.

3 Dunea

Dunea is a tap water company in the western part of the Netherlands which has been an NWP network member for a long time. It produces and supplies tap water to approximately 1.3 million customers in the western part of the Dutch province of South Holland. Dunea has also managed the nature conservation of the beautiful dunes and has protected tap water extraction for almost 150 years now.

Karin Rood is a Policy Advisor for Nature at Dunea, where she focuses on environmental management, recreation and cultural history. Mark Janssen Lok is the International Manager at Dunea and is responsible for Dunea's projects on knowledge exchange, international development, and strategy and policymaking on underground infrastructure.



Dunea is characterised by its work on both tap water production as well as nature conservation and management. As the principle of combining tap water production and nature conservation can be applied anywhere in the world, it is interesting to broaden the scope in terms of nature management internationally.

Karin explains Dunea's approach. "Our slogan is 'clean drinking water from a clean environment'. A clean environment can be interpreted very broadly, but biodiversity can be seen as the result of healthy natural parameters. If an area is healthy in terms of biodiversity, it means that its underlying processes are working properly. We need these natural processes. Proper management can safeguard these processes in several ways, for example by introducing the right grazers. In essence, biodiversity is the indicator of a healthy ecosystem.

Dunea's main operational area is the dunes and the other water intake points. Much of its area of operation has a Natura 2000 status that protects it by law. We also work within the Nature Network of the Netherlands (Natuur Network Nederland), which is not legally protected, but is protected in terms of planning. Dunea actively encourages and contributes to nature restoration, not only because it makes water extraction easier. We are always looking for that interconnectedness between water and nature. Although Dunea applies ecological principles primarily in the tap water system, they are applicable anywhere for any purpose.

Mark adds that clean tap water begins with the intake of clean water. "This not only means the physical and chemical condition of the water, but also the biodiversity in the system. We are

responsible for clean tap water and a clean environment. If life on land is in a good state, the same goes for life underground. For Dunea, both freshwater reserves and rivers are important. The freshwater reserve is where part of the purification process – the decrease of bacterial activity – takes place in the sand.

"The interconnectedness of above and below ground matters for tap water in any surface water area where you work. The interconnectedness in Dunea's projects involves minimising the negative impact on nature in our areas of work and enhancing their natural values while extracting tap water. This is the link between clean tap water and biodiversity, not only strategically but also in execution and management. The main benefit is that because the area has always been a source of tap water, it has been preserved for this purpose and protected as a natural area. Because of the function of this area as a drinking water source, the construction of villa parks in the 1930s and a highway in the 1970s was prevented. The law governing water and Natura 2000 help support our work in the dunes.

"Besides working in the dunes, Dunea also supports nature at other locations, for example at river water intake points. Apart from dunes alongside coasts, rivers and other surface waters such as lakes, are also freshwater sources around the world. Looking internationally, the same principles regarding the interconnectedness of life above and below ground level can be applied to any water body that is part of the tap water system or groundwater. The hydrology of a system shows the impact should it be a

water extraction area. The impact goes beyond infiltration pools and vulnerable nature, it is also about biodiversity and micro-life around an intake point. Physically, there is a direct connection between water extraction and groundwater dependent nature. It is important that the hydrology and abiotic characteristics are in a good state.

"Dunea cannot tackle the challenges alone. The biodiversity crisis is real and is here. There is a limit to what can be done in the dunes in terms of nature management. Maintenance will always be needed, but for maintaining biodiversity you need others. The dunes can be seen as an island in the middle of the country's Randstad urban area. It is key that the dunes are not isolated.

"The community is needed to keep biodiversity in good health. Partnerships are important, both in terms of water extraction as well as nature conservation, and Dunea has active partnerships. One of our core partners is the Nationaal Park Hollandse Duinen Foundation (NPHD), which has an interesting history. In 2016, Dunea entered the dune area where it works in the elections for the most beautiful natural area of the Netherlands. Dunea saw this as an opportunity as a water company to take responsibility to bring a special nature initiative to a higher level with regional partners. Over the years this initiative became the NPHD, which operates with a broad representation of stakeholders and partners. Together we raise awareness on the possibilities and prerequisites for building in the dunes.

Case study

Engaging the community through the Nationaal Park Hollandse Duinen Foundation

Groene Tuinen in Hollandse Duinen (Green Gardens in the Dunes of Holland)

This project initiative invites and encourages people in the Hollandse Duinen area to turn their gardens into greener spaces to help biodiversity and help grow the reach of the national park. The project is involved in various societal challenges such as climate adaptation, enhancing biodiversity, counteracting the loss of clean ground and water, as well as boosting social cohesion. Various garden centres, gardening companies, municipalities and other partners are involved in this initiative.

Reducing Nitrogen in the Dunes

This initiative was initiated to reduce nitrogen emissions in the dune area and was given shape in the Gebiedsgerichte aanpak stikstof (Area focused Nitrogen Approach). The Foundation collaborated with Circular West to start this initiative which works with companies and partners. One example of how this translates into practice is the recent effort to move to zero emissions in supplying produce to beach restaurants.

More information on the work of Nationaal Park Hollandse Duinen Foundation can be found on the [website](#).

"Another project example is the Green Circle Bee Landscape (Groene cirkel bijenlandschap), where we work with municipalities in the area to establish ecological connections or corridors for insects and small mammals. More intervention is needed at a bigger scale. Robust ecological connections that allow flora and fauna migration is of utter importance for biodiversity conservation. Dunea is a prime investor

in keeping the status of Nationaal Park Hollandse Duinen. Biodiversity conservation and restoration can only be achieved if you collaborate outside of your silo.

Case study

Groene Cirkel Bijenlandschap (Green Circle Bee Landscape)

In this project Dunea and the Green Circles partnership work on promoting a healthy bee landscape through bee friendly design and management. The partnership involves creating a network of flower rich gardens, parks, motorway shoulders, industrial areas, recreation and nature reserves, with sufficient

food and nesting opportunities for bees, bumblebees and hoverflies. The partnership works with farmers, municipalities, residents, schools and more. In a timespan of three years, the number of bee species in the region has increased by 34 percent.

“Dunea uses a value creation model to show people in the surrounding area the benefits that come with dune protection, and what is needed in terms of effort in achieving it. It is important to create awareness of what nature has to offer. During the COVID-19 pandemic, many people chose to spend more time in nature. It was the only opportunity for people to go out. In essence nature

offers an experience, a sense of peace and space, and these were put under pressure with increased visits during the pandemic. These days recreational pressure in nature areas is a very sensitive subject. As Dunea wants to continue offering peace and space, we are successfully lobbying for a regional solution with NPHD. Although the concept of biodiversity that cannot be



experienced as such, the chance of spotting wildlife when out in nature is an experience. The chance of spotting wildlife is higher in healthy ecosystems. We try to turn experience into awareness.

“A clean environment is not necessarily nature alone. Sometimes it can be productive land, as is the case around our intake point. We also spread the message that it is not just unique species which are endangered, but the very general species people are used to seeing are also having a hard time. Insects are a good example. We raise awareness about the importance of insects for our subsistence by explaining what we do to protect insects and what we need from society to do this. Though a small player, Dunea is a frontrunner. For decades, Dunea has worked with an integrated approach towards water and nature, combining various kinds of expertise. Over time, we see that a more integrated approach is taking a more prominent place on agendas. This comes with new opportunities, such as ecological North-South-East-West connections when taking measures against climate change. In practice this is often still considered a challenge. One of the biggest obstacles is that today’s society believes too much in manufacturability and is hence under the impression that challenges can be fixed by technology and innovation only.

“The creation of added value can be achieved when biodiversity is included in the approach to a challenge, be it water, the energy transition, construction, or climate adaptation. Traditionally, investments in biodiversity and nature are considered additional costs, though it usually brings many non-monetary

benefits and avoids costs later.

Moreover, a healthy ecosystem is a precondition for life on our planet – we cannot make concessions. It is an opportunity to create extra value, and more biodiversity at the end of the process will bring gains to other domains. A tangible example is agriculture. Research shows that fighting and controlling pests in monoculture is costlier in the end than having diverse and rotating crops in your field.

“Another key challenge is the fact that biodiversity is in essence cross-boundary. Dunea can measure biodiversity here, but in the end we have limited control over it. Coasts and dunes are highly important steppingstones for species such as migratory birds. The berry bushes give migratory birds the energy they need to make the journey to wintering grounds. We have an impact on preserving that environment. In addition, international protection needs to ensure that efforts are taken globally. We bear the responsibility for our link in the chain. Dunea contributes to the work of international organisations by sharing the findings of our research on relevant topics. Another aspect of biodiversity is exotic species. These pose a real threat to indigenous species, especially when they are aggressive and dominant, and they occur in both fauna and flora. They usually do not enter a new ecosystem independently, but are introduced in one way or another. That said, climate change is causing more species to migrate by themselves. Rising temperatures are forcing species to migrate further north and extend the range of their boundaries.”



Conclusion

Today's society faces not only a water and climate crisis, but has entered what is referred to as the biodiversity crisis. The rapid loss of species is disrupting ecosystems, affecting our resilience to climate change and threatening our water resources, food production and, in the long-run, our way of life. Water and biodiversity are closely intertwined, biodiversity and healthy ecosystems are necessary to safeguard water quality and quantity, and water is needed to keep ecosystems alive. The water sector is a leader in finding nature inclusive and enhancing solutions, and a vital player in

making today's society more resilient to the impacts of climate change.

Although traditionally considered unnecessary investments, there is increasing overall awareness and understanding of the importance of biodiversity and nature in general. The most practical example of this is the Global Biodiversity Framework that was adopted by the majority of the international community during the UN Biodiversity Summit in Montreal in 2022. What is needed to restore and safeguard biodiversity are integrated approaches,

where nature is incorporated in every intervention, project and major investment, because in the end, everything is part of the same natural system. Healthy ecosystems are the foundation of sustainable development and a sustainable future, with quality of life for all.

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If you want to know more, collaborate, or get in touch with the experts, please contact us or reach out directly.

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