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Ecosystem Services Approach and Natures Contributions to People (NCP) Help Achieve SDG6

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Definition

The United Nations "Sustainable Development Goals" (SDGs) are a collection of 17 global goals designed to be a "*blueprint to achieve a better and more sustainable future for all*" (UN 2015). The SDGs have been developed to be the world's best plan to build a better world for people and our planet by 2030.

Ecosystem Services (ES) are the contributions of nature to human wellbeing (Costanza et al. 1997; Millennium Ecosystem Assessment 2005; TEEB 2010; Haines-Young and Potschin 2014). Ecosystem services include *Provisioning Services* which are material outputs from ecosystems including food and water, *Regulation and Maintenance Service*s which are the less direct benefits such as flow regulation and water purification, and *Cultural Services* include the tangible recreational uses (e.g., kayaking, fishing, and walking along a river) and the less tangible benefits such as aesthetic or spiritual benefits as well as research and educational values. Supporting processes or intermediate services are the ecological functions and processes that underpin the three groups of ES and are often referred to as the final services (see Fig. 1).

Nature's Contribution to People (NCP) extends the concept of ecosystem services, by classifying NCP into material, regulating, and nonmaterial services, as well as explicitly recognizing the knowledge of local-indigenous communities (Díaz et al. 2018; IPBES 2019a).

Ecosystem function is the capacity of natural processes such as primary productivity or carbon cycling contributing to an ecosystem, to provide ES/NCP or Nature Based Solutions (NBS) to human populations (De Groot et al. 2002).

Nature Based Solutions (NBS) are actions which are inspired by, supported by, or copied from nature to provide environmental, social, cultural, and economic benefits (Nesshover et al. 2017).

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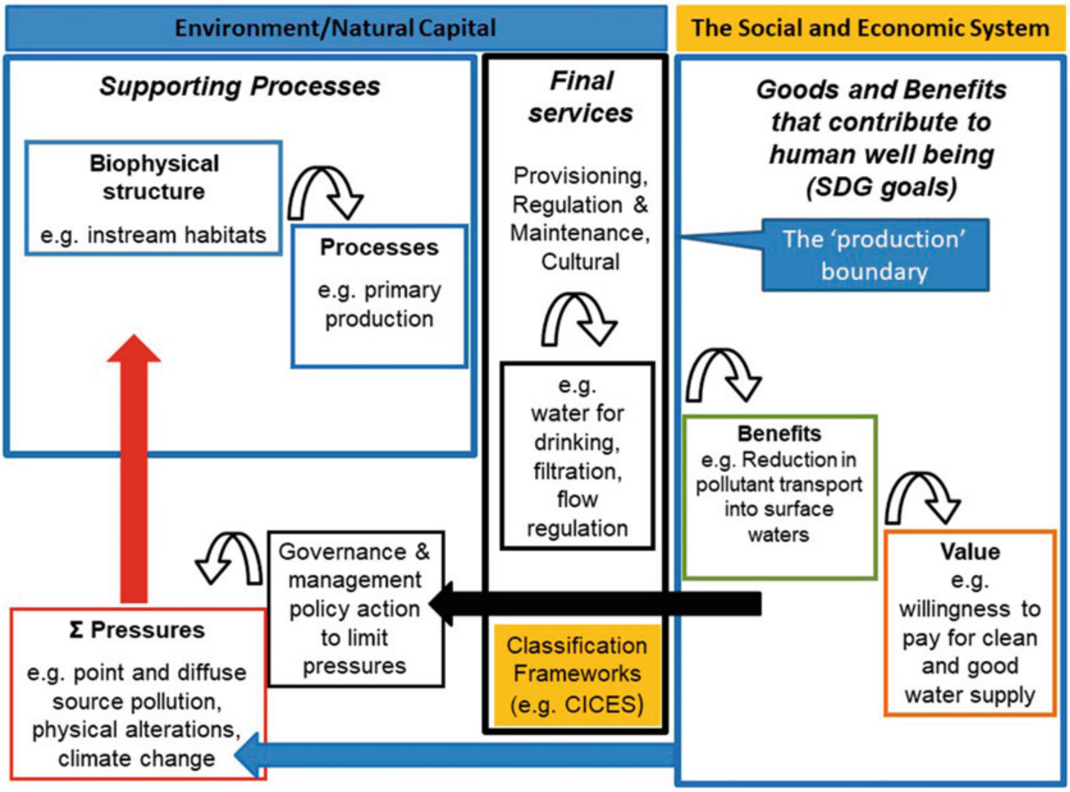

Ecosystem Services Approach and Natures Contributions to People (NCP) Help Achieve SDG6, Fig. 1 The ecosystems cascade model highlights the role of supporting processes and intermediate services in the delivery of final provisioning, regulation and maintenance, and cultural services, and the goods and benefits humans derive from these freshwater ecosystem services. (Source: Modified after Potschin and Haines-Young (2011); also see http://cices.eu/supporting-functions/)

Introduction

The UN Sustainable Development Goals (SDGs) are the central focus of the United Nations "*2030 Agenda for Sustainable Development*" (UN 2015). The UN specify 17 SDGs, which are further split into 169 targets and 232 indicators. The SDGs aim to provide guidelines for individual countries to implement policies that support development and human well-being, while minimizing impacts on the Earth's natural capital and associated ecosystem services (Costanza et al. 2014).

Sustainable Development Goals 6 "Clean Water and Sanitation"

Sustainable Development Goal 6 aims to "*ensure availability and sustainable management of water and sanitation for all*" (UN 2015). It comprises six targets (Box 1). SDG 6.1 and 6.2, respectively, aim to achieve access to safe and affordable drinking water and access to adequate sanitation and hygiene for all, the most essential uses of water. These are in effect the overarching targets that are heavily dependent on the achievement of the other SDG 6 targets that deal with the protection of water quality from pollution (SDG 6.3), increased water-use efficiency (SDG 6.4), integrated water resources management (SDG 6.5), and protection of water-related ecosystems (SDG 6.6). In fact, all of the SDG 6 targets are interdependent and intrinsically linked to each other, and must be considered in this respect to enable effective integrated water resources management. For example, SDG 6.3 aims to protect water quality which is essential to human health (SDG 6.1) as well as ecosystem health (SDG 6.6).

Box 1 Targets of SDG 6 "Clean Water and Sanitation"

SDG 6.1: By 2030, achieve universal and equitable access to safe and affordable drinking water for all.

SDG 6.2: By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.

SDG 6.3: By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and substantially increasing recycling and safe reuse globally.

SDG 6.4: By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.

SDG 6.5: By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate.

SDG 6.6: By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes.

Also included in SDG 6 are international cooperation and capacity building (6.A) and local participation in water and sanitation management (6.B). (Source: https://sustainabledevelopment.un.org/sdg6)

Ecosystem Services Approach and NCP

Figure 1 illustrates the key elements within the ecosystem services framework as proposed by the Common International Classification of Ecosystem Services (CICES) (Potschin and Haines-Young 2011). This framework draws on a "cascade" model to demonstrate the links between ecosystems (e.g., the biophysical structures of for example instream habitat), through ecological functions (e.g., primary production) to a range of provisioning, regulation and maintenance, and cultural ES. These ES then contribute to human well-being, which in turn can support public policy goals. Given that the SDGs also aim to enhance human well-being, it is postulated that there are synergies between policies targeted to enhance ecosystems and their services and policies aimed at achieving the SDG goals.

Nature's Contribution to People (NCP), as previously defined, extends the concept of ES, by classifying NCP into material, regulating and non-material services, as well as explicitly recognizing the knowledge of local-indigenous communities (Díaz et al. 2018; IPBES 2019a): this is expanded on in a later section.

Ecosystem Services Underpinning the SDG 6 Targets

While the ESA or associated ES/NCP have not been explicitly mentioned in the various SDG targets, there is a growing body of evidence that ES/NCP underpin the achievement of the SDG targets. As highlighted by Vörösmarty et al. (2018) ecosystem processes and biodiversity that sustain the flow of ES need to be viewed as "*an integral building block of the sustainable development agenda*." Wood et al. (2017), using results from a survey of experts, highlighted the perceived contribution of ES to the achievement of 41 targets across 12 SDGs. In this section, the results from Wood et al. (2017) and others are used to illustrate the role of ES in the delivery of SDG 6 targets (Fig. 2). Specifically, the Common International Classification of Ecosystem Services (CICES; Haines-Young and Potschin 2018) is used to categorize the ecosystem services (see Fig. 2).

Central to all of the SDG 6 targets are the provisioning services of "*water for drinking*" and "*non-drinking purposes*" by surface and groundwater resources but particularly in

Ecosystem Services Approach and Natures Contributions to People (NCP) Help Achieve SDG6, Fig. 2 Linkages between ES and SDG 6 targets, and between the various targets. The ES classification is based on CICES version 5.1, categories (provisioning, etc.), group and class are provided.

achieving equitable access to water (SDG 6.1) and protection of water-related ecosystems (SDG 6.6). Water resources are not evenly distributed and there are conflicting demands within the water-energy-food nexus, captured to some extent in integrated water resources management (Target 6.5). It is argued that equitable allocation of water resources between sectors requires better consideration of the ES provided by the various water resources (Hülsmann et al. 2019).

Regulation and maintenance services influence both the quality and quantity of freshwaters. Capitalizing on water purification services ("*bio-remediation by microorganisms, plants and animals,*" "*dilution, filtration, storage,*" "*control of erosion rates*," "*smell reduction*" – see Fig. 2) of riparian zones, wetlands and floodplains can help minimize costs associated with treatment and provision of clean water (SDG 6.1), particularly in areas with limited resources (TEEB 2010), as well as minimizing pollution impacts (SDG 6.3) and protecting aquatic biodiversity (SDG 6.6). According to Trimmer et al. (2019), bridging the gap between sanitation and ecosystem services reveals opportunities to support sustainability goals. Although not specifically mentioned, it is important to note that biodiversity and their ecosystem processes underpin the purification services (Balvanera et al. 2014).

The "*regulation of baseline flows and extreme events*" is critical for sustaining the yield of water for human uses (drinking water SDG 6.1, sanitation SDG 6.2, reducing water scarcity SDG 6.4) and water-related ecosystems (SDG 6.6). Equally important, the flow regulation helps protect citizens from the effects of flooding. It has been defined by Le Maitre et al. (2014) as "*as the ability of watersheds and catchments to capture and store water from rain storms, reducing the direct runoff and flood peaks as well as releasing the water more slowly so that flows are sustained into or through the dry season*." It is strongly influenced by soil structure and the capacity for infiltration as well as land and instream vegetation. This service is central to many nature-based solutions (see later section).

"*Maintenance of nursery populations and habitats*" (including gene pool protection) is central to the protection of water-related ecosystems (SDG 6.6).

Cultural ES (e.g., "*physical and experiential interactions,*" "*spiritual, symbolic, and other interactions with the environment*") although not directly affecting supply or quality of water have an influence on how people perceive water and water-related issues, and can be an important way to connect people to water and its protection (Kelly-Quinn et al. 2020). Cultural services can, therefore, be influential in the integrated management of water resources and success (SDG 6.6).

Apart from the dependence of the SDG 6 targets on many of the aforementioned ES, the various SDG targets themselves, as previously mentioned, are interdependent as illustrated in Fig. 2. They collectively are key elements of integrated water resources management.

The freshwater-related services also provide water to coastal ecosystems and have an influence on their ecological health (SDG 14). Estuarine and coastal ecosystems (ranging from mangroves to reefs) are also intrinsically tied to clean water and sanitation for society, providing a range of services summarized in Barbier et al. (2011). Furthermore, desalination plants provide an alternative freshwater resource in many areas with limited freshwater resources such as Israel and the southwestern United States (Baawain et al. 2015).

Ecosystem Degradation Challenges Achievement of SDG 6 Goals

As shown in Fig. 1, "healthy" ecosystems can deliver a wide range of ES that contribute to human well-being and hence the SDG goals. However, unsustainable human economic and social development is degrading ecosystems and their associated ES. For example, in water-based ecosystems, developments such as the construction of hydraulic structures (e.g., dams or interbasin water transfers) to generate hydroelectric energy, guarantee water supply to large cities, or divert water to other basins with water deficits, seriously impact the hydrological regime of rivers (Jansson et al. 2007). Furthermore, the middle and lower reaches of many rivers have become isolated from their floodplains due to grey engineering infrastructure developments such as levees, which has led to a loss of lateral connectivity (Amoros and Roux 1988). Associated with these developments is the loss of natural riparian vegetation: more than half of the area occupied by riparian zones on a global scale has disappeared or been degraded (Zedler and Kercher 2005). The loss of riparian areas has led to a total or partial loss of associated ES including water pollution attenuation capacity and flood mitigation (Costanza et al. 1997; Clément et al. 2002), carbon storage (Lal 2004), and the delivery of cultural services (Schaich et al. 2010). In other areas, water withdrawals are exceeding natural surface flows or replenishment of groundwater (Carpenter et al. 2011). Pollution is also causing widespread degradation of water quality (Carpenter et al. 2011), which may result in catastrophic loss of freshwater biodiversity as highlighted in Reid et al. (2019).

Human development activities have thus led to alterations in the natural cycles of water, carbon, and nutrient resulting in land and water degradation (Carpenter et al. 2011). This has implications for the flow of ES/NCP (discussed in more detail later), and as such present significant challenges in terms of achieving the SDG goals. These observations suggest that we need to rethink how we manage natural resources. In this regard, the ESA is "*a way of understanding the complex relationships between nature and humans to support decision making, with the aim of reversing the declining status of ecosystems and ensuring the sustainable use/management/conservation of resources*" (Martin-Ortega et al. 2015). This evidence-based approach helps communicate the material and nonmaterial costs and benefits of healthy versus degraded ecosystems (Hein et al. 2006). The next step then is to identify and measure the extent to which ES underpin and support achievement of SDG 6 targets.

What Can Evidence on the Status and Trends in ES/NCP Tell Us About Progress Towards Achieving the SDG 6 Targets?

Over the past few decades, a body of evidence has developed that assesses the state of, and trends in, the Earth's biodiversity and the associated changes in the provision of ES and subsequent impacts on human welfare (TEEB 2010; IPBES 2019a). In this section, the evidence is used to assess progress towards achieving the SDG6 targets.

The IPBES "*Global assessment report on biodiversity and ecosystem services*" (IPBES 2019a) arguably provides the most comprehensive and up-to-date evidence on the status and trends in biodiversity and associated ES at the global scale. Furthermore, the Global Assessment explicitly provides evidence on how changes in biodiversity and related ES might be used to assess progress towards achieving the SDGs (IPBES 2019a, b). Rather than using the term "ecosystem services," IPBES has coined the term "Nature's contribution to people" (NCP). NCP extends the concepts of ES to include "Nature's gifts" associated with indigenous peoples and local communities. In this section, the focus is on evidence from two IPBES NCPs that are directly linked to freshwater:

- NCP 6 "Regulation of freshwater quantity, location, and timing."
- NCP 7 "Regulation of freshwater and coastal water quality."

In terms of linking back to the CICES categories of ES (Fig. 2), NCP 6 would incorporate water provision and water flow regulation, while NCP 7 would incorporate several of the CICES services relating to water quality.

The 50-year trend in both NCP 6 and 7 is declining, although there is variability within NCP 6 across regions (IPBES 2019a). The Global Assessment further highlights that land-use change (e.g., agriculture, forestry, and urbanization) is the direct driver that has had the largest relative impact on freshwater ecosystems and thus ES/NCP delivery.

A general headline message from the IPBES Global Assessment is that "*Nature is essential for achieving the Sustainable Development Goals*" and that "*Past and ongoing rapid declines in biodiversity, ecosystem functions and many of nature's contributions to people mean that most international societal and environmental goals, such as those embodied in . . . the 2030 Agenda for Sustainable Development, will not be achieved based on current trajectories*" (IPBES 2019a).

Chapter 3 of the Global Assessment (IPBES 2019b) provides further evidence of how trends in nature and ES/NCP support progress towards the SDG 6 targets. This evidence suggests "partial support" for SDG 6.5, that is, that the overall global status and trends in nature and NCP were positive, but that there may be negative trends in some aspects or regions. Evidence on SDG 6.3, 6.4, and 6.6 indicated "poor/declining support," which indicates poor status or substantial negative trends in nature and NCP at a global scale. The following sections draw on the Global Assessment to provide insights into how ES/NCP contribute evidence on measuring progress towards achieving the SDG targets.

What Can Evidence on NCP 6 "*Regulation of Freshwater Quantity, Location, and Timing*" Tell Us About Progress Towards Achieving the SDG 6 Targets?

Evidence on the status and trends in NCP 6 "*Regulation of freshwater quantity, location and timing*" may be used to assess progress towards achieving increase water-use efficiency (SDG 6.4). The IPBES (2019b) Global Assessment provides evidence on the trends in the *sustainable use of water sources*. Nearly 80% of the world's human population is exposed to high-level threats to water scarcity (Mekonnen and Hoekstra 2016). Water withdrawals, from both dam infrastructures and groundwater abstraction, have significantly increased over the past 50 years, with the most significant recent increases being found in Africa, Asia, Western USA, Mexico, and Central South America (Chao et al. 2008; Wada et al. 2011). Wada et al. (2014) further highlighted that around 30% of human water consumption is supplied from unsustainable water resources. Agriculture accounts for over 70% of freshwater withdrawals globally and for over 90% in the majority of Least Developed Countries (IPBES 2019b). Water-use efficiency improvements are therefore considered essential to address water scarcities, and in particular for sustainable food production. The above evidence suggests that increasing unsustainable water extraction has negatively impacted the "*Regulation of freshwater quantity, location and timing*" (NCP 6), which in turn has impacted progress towards achieving SDG target 6.4, as well as impacting progress towards achieving SDG 12 "Food and feed." The biggest impacts are likely to be found in poorer countries.

NCP 6 may also provide evidence of progress towards achieving integrated water resources management **(SDG 6.5).** A key issue here relates to how water is managed across boundaries. Around 150 countries attain water from rivers that have transboundary basins (WWAP 2012). Although there is increasing competition for this water, around two-thirds of the world's transboundary rivers do not currently have a cooperative management framework (Samuelson et al. 2015). This evidence suggests that the lack of water management across boundaries impacts the "*Regulation of freshwater quantity, location and timing*" (NCP 6), which in turn has impacted progress towards achieving SDG 6.5.

What Can Evidence on NCP 7 "*Regulation of Freshwater and Coastal Water Quality*" Tell Us About Progress Towards Achieving the SDG 6 Targets?

Maintaining and enhancing water-based ecosystems can improve the delivery of NCP 7 "*Regulation of freshwater and coastal water quality.*" Assessing the status and trends associated with NCP 7 may be useful to assess progress towards achieving SDG 6.3 water quality improvements. Specifically, natural habitats may help to reduce wastewater pollution, organic pollution and salinity pollution.

- *Pollution from untreated wastewater* has continued to worsen over the last two decades (UNEP 2016) and is expected to escalate in the future (IFPRI and VEOLIA 2015). It is estimated that over 80% of global wastewater is released to the environment without adequate treatment (Corcoran et al. 2010; WWAP 2012): with significantly lower levels of treatment in low-income countries (8% treated), compared to high-income countries (70% treated) (Sato et al. 2013). It is estimated that the health of hundreds of millions of rural people in Latin America, Africa, and Asia is at risk from water-borne pathogens (UNEP 2016). In Europe, point sources such as effluent discharges from urban wastewater account for 68% of surface water pollution (EEA 2018).
- *Organic pollution* has increased in over 50% of rivers in South America, Africa, and Asia over the past 30 years (WWAP 2017), although there is evidence of reduced organic pollution in developed countries. In Europe, diffuse pollution from agricultural sources affects 38% of surface water bodies (EEA 2018). Organic pollution increases the biochemical oxygen demand (BOD), nitrogen and phosphorus loads in rivers, which in turn results in eutrophication, the proliferation of algae, the depletion of oxygen in water, and ultimately killing fish and other aquatic species (which also impacts SDG 1 (Habitat creation and maintenance) and SDG 18 (Maintenance of options). These impacts are often found in poorer countries, in which people may be more dependent on fisheries (thus also impacting SDG 12 (Food and feed)).
- *Salinity pollution*, as measured as the mass of "total dissolved solids" (TDS), has increased in 31% of the rivers in Latin America, Africa, and Asia (UNEP 2016). Sources of salination include irrigation return flows, domestic wastewater and runoff from mines. Salinity pollution can also obstruct water supply for irrigation

(impacting SDG 12 Food and feed) and has wide-ranging negative impacts on aquatic ecosystems (Canedo-Arguelles et al. 2013).

The above evidence suggests that increases in multiple sources of pollution have negatively impacted the "*Regulation of freshwater and coastal water quality*" (NCP 7). In Europe, only 40% of surface water bodies are in good or better ecological status (EEA 2018), while in South Asia almost 70% of surface waters are contaminated (Evans et al. 2012). Water pollution has impacted progress towards achieving SDG 6.3, as well as impacting progress towards achieving SDG 1, SDG 12, and SDG 18. Here again, the biggest impacts are likely to be found in poorer countries, with some high-income countries making some progress towards achieving SDG 6.3. Evidence from IPBES (2019b) suggests that protecting and restoring water-based ecosystems (SDG 6.6) can reduce pollution levels in water systems and thus help achieve a number of SDG targets.

NCP 7 also directly links to progress towards SDG 6.6 protect and restore water-related ecosystems. In particular, the designation of protected area status to water-based ecosystems may be used to help improve water quality and therefore also contribute towards SDG 6.6. The IPBES (2019a, b) Global Assessment provides data on trends in protected area coverage of water ecosystems. The Global Assessment highlights that key threats to water-related ecosystems are changes to water source (land-cover change), timing (flow regime), quantity (over extraction), and quality (pollution). BirdLife International et al. (2018) estimated that, on average, only 44% of freshwater Key Biodiversity Areas have protected status. Further, the health of many freshwater protected areas, such as the 2300 Ramsar Wetlands of International Importance, are impacted by the lack of protection upstream of the sites. Thus, much more needs to be done to protect water-related ecosystems. Forty percent of the watersheds that supply water to the world's largest cities (which host around one-third of the world's population) also show high to moderate levels of land degradation, which will impact water quality. This evidence suggests that the lack of protection of water-related ecosystems impacts the "*Regulation of freshwater and coastal water quality*" (NCP 7), which in turn has impacts progress towards achieving SDG 6.6.

Given the links between ES/NCP and the SDG 6 targets, information on the status and trends in ES/NCP, such as that undertaken in the IPBES (2019a, b) Global Assessments, can provide useful evidence on progress towards achieving SDG 6 and other SDG goals. Specifically, evidence on the trends of NCP is likely to reflect the trends towards achieving the SDG targets.

How Can Insights from Ecosystem Services and the Ecosystem Services Approach Be Capitalized on to Help Achieve SDG 6 Goals – Opportunities and Evidence?

Rehabilitation and restoration are of paramount importance to the recovery of the ES/NCP that people depend on and that underpin the achievement of SDG 6 goals as previously outlined. In this respect, green infrastructure or nature-based solutions (NBS) are good examples of how society can work with nature to capitalize on the natural processes and cycles that deliver ES/NCP. NBS target specific ES/NCP, generally regulatory, and have a key role to play in achievement of SDG 6 targets. These solutions are often more successful than traditional grey engineering (van Wesenbeeck et al. 2014), as they have lower implementation and maintenance costs, while favoring integrated management of catchments (e.g., flood risk reduction and ensuring the good status of water bodies, all in line with SDG 6.5), which supports sustainable socio-economic development (Vörösmarty et al. 2018).

In recent years, NBSs have become an alternative for the restoration of water-related ecosystems. Proof of this is the implementation of initiatives at the European level, such as the European Platform for Natural Water Retention Measures (http://www.nwrm.eu). This initiative aims to support green infrastructure by contributing to integrated goals dealing with nature, biodiversity conservation and restoration, or landscapes (here again supporting SDG targets). ES-based management is needed not only to reverse environmental degradation but also to enhance and sustain ES/NCP flows to people (Wood et al. 2018). Basically, NBS can help to improve or restore four ES/NCP: (i) flow/flood regulation; (ii) water quality regulation; (iii) water provision; and (iv) soil protection (Keesstra et al. 2018), which are key to all of the SDG 6 targets.

The intrinsic floodplain capacity can be achieved by restoring lateral connectivity between a river and its flood plain (Mitsch and Hernandez 2013). Accordingly, the severity and duration of flooding are dampened; therefore, flood risk is mitigated, whilst also restoring water and sediment dynamics in the riverine system (Acreman and Holden 2013). Restoring such connectivity renders riverine systems biogeochemically active as regards to their capacity to attenuate pollution and, thereby, act as a natural water treatment system (Russi et al. 2013). An example of this is natural denitrification by wetlands (Hernandez and Mitsch 2007). This natural attenuation process requires oxygen-restricted conditions and organic matter that are typically associated with hydric soils existing in most natural wetlands. Another benefit resulting from functional floodplains is their pivotal role in supporting the water cycle by fostering high water table elevations and providing soil moisture regulation (Hefting et al. 2004).

Research focusing on NBS in the wider river basin is also increasingly seen as a way to address urban water challenges such as supply shortages (key to SDG 6.4). For example, advocating the restoration of river-floodplain connectivity at the basin scale preserves the capacity of wetlands to maintain a steady supply of clean drinking water for humans and the environment (Horne 2000). Additionally, wetlands foster a steady recharge of the deep aquifer, contributing to efforts to optimize water resource management (Millennium Ecosystem Assessment 2005). Other approaches promote the articulation of water-retention landscapes (Blanco et al. 2018), which allow optimization of the timing of water supply, promoting infiltration and storage of water during the wet season, and its subsequent release during the dry season. Reduction of surface runoff can be promoted through infiltration (e.g., by improving soil structure from organic farming) and by inducing clogging of surface runoff through increasing surface roughness (e.g., by afforestation with native species). As regards soil protection, most NBS aim at reducing soil erosion and surface run-off, as both are the key processes that protect soil from degradation and loss to surface waters where it can become a major stressor on aquatic biodiversity and general water quality (Davis et al. 2018). The main measure to reduce erosion is soil cover (e.g., by mulching the soil with straw, protecting riparian vegetation, or seeding to establish vegetation cover).

The Dutch program “Room for the river” (Rijke et al. 2012), designed in response to the floods that devastated the Netherlands in 1993 and 1995, had as its primary objective flood mitigation compatible with preserving aesthetic, cultural and ecological elements linked to fluvial systems. Accordingly, measures such as removing levees or moving them away from riverbanks were implemented in order to optimize the storage effect of floodplains and, thereby, reduce flood peaks. Other countries have designed and deployed similar strategies. Thus, since 2004 Spain has been developing policies for the protection, conservation and restoration of rivers, which have been set out in the National Strategy for River Restoration (MAGRAMA 2010). Following Hurricane Katrina in 2005, whose impact was magnified by the degradation of wetlands of the Mississippi delta, the state of Louisiana (USA) created the authority for coastal protection and restoration (CPRA 2007), which has launched a comprehensive master plan for a sustainable coast. Its main objective is to reduce storm surge-based flood risk to communities, by capitalizing on natural processes, focusing protection on key assets, and adapting to changing coastal conditions. In the same vein, Chile, after the 2010 tsunami, approved measures to protect its coastal wetlands, aiming to optimize their potential to limit soil erosion and alleviate the impact of flooding (WWAP 2018).

Furthermore, in many regions where wastewater treatment is insufficient, constructed wetlands are being used successfully. These are natural systems involving aquatic macrophytes (wetland plants), which can be used as secondary or tertiary wastewater treatment units. These systems have been successfully used in Latin America (Gauss 2008) or in East Ukraine (Vergeles et al. 2015). NBS are also being developed to improve water resource management. Thus, since 2014 China is developing an urban water management program called "Sponge City" (Xia et al. 2017). It aims to mimic and restore the natural water cycle. For this purpose, cities such as Beijing are receiving generous annual subsidies that are being invested in the development of NBS such as green gardens, green roofs, constructed wetlands, and permeable pavement. The aim is to capture, slow down and naturally filter storm water. Consequently, aside from mitigating flood risk, rainwater harvested in this way can be reused for irrigation and residential use.

Conclusions

The ESA provides a framework that explicitly links biodiversity (e.g., aquatic biota in a river) with ecological functions and a range of ES/NCP that contribute to people's welfare and therefore help support the SDG goals. Indeed, several authors (e.g., Anderson et al. 2019; IPBES 2019b) emphasize that nature is central to achieving the SDG goals. Any changes to the status and trends in freshwater biodiversity and ES are likely to have an impact on people's well-being and thus will also impact on the likelihood of achieving the SDG goals. Human development activities have degraded many water-based ecosystems and therefore reduced their ability to deliver ES/NCP that could contribute to the SDG goals. Recent ecosystem assessments, such as the IPBES (2019a, b) Global Assessment, provide detailed evidence on the status and trends of ecosystem and their services. This invaluable evidence highlights how degradation of water-based ecosystems is likely to impact people's well-being and therefore impact progress towards achieving the SDG 6 targets. Furthermore, water permeates many other SDGs and represents one of the key interdependencies or nexus among the 17 SDG goals as it is essential for not only potable water but also to sustain terrestrial (including ago-ecosystems) and aquatic ecosystems and the flow of ES/NCP that support well-being and economic activities. Unless water-related ecosystem services are managed to meet the growing demand for clean reliable water supplies, achievement of the other SDGs may be curtailed (see Box 3 in Vörösmarty et al. 2018). Sustainable water supply (ecosystems) is in fact a prerequisites for achievement of SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 3 (Good Health & Well Being), SDG 4 (Education), SDG 5 (Gender Equality), SDG 7 (Affordable & Clean Energy), SDG 8 (Productivity), SDG 11 (Sustainable Cities & Communities), SDG 13 (Climate Action), SDG 14 (Life Below Water), and SDG 15 (Life on Land) because it directly influences the achievement of those goals through services they provide or cannot provide in the case of ecosystem breakdown.

Finally, NBS may provide an approach that could allow continued human and economic development, while also protecting natural habitats and associated ES/NCP. Adopting such approaches would also help to achieve a wide range of SDG goals. In conclusion, operationalizing the ESA approach opens up opportunities for not only mitigating impacts on aquatic resources but also optimizing resource management to maintain or maximize the flow of ES/NCP and make real progress towards achievement of SDG 6 targets.

Cross-References

- ▶ Ecological Risk
- ▶ Natural Wet Ponds' Role as Fresh Water Storage in Tropical Environment
- ▶ The Role of the Water-Energy-Food Nexus in Implementing the Sustainable Development Goals in Morocco
- ▶ Water Planning
- ▶ Water Quality and Economy of Growth
- ▶ Water Quality Monitoring in Protected Areas Supporting Water Supplies and Ecosystem Services

► Water Related Ecosystems
► Water Resources Management
► Water Treatment
► Water Uses and Global Change

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