

# Supplementary information

## Supplementary information

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## A. Description of international policy frameworks and targets

We used two internationally agreed policy commitments:

- United Nations Sustainable Development Goals (2015-2030) (<http://www.un.org/sustainabledevelopment/sustainable-development-goals/>) (SDGs);
- The Convention on Biological Diversity (CBD) Aichi Targets (2010-2020) (<https://www.cbd.int/sp/targets/>) (ATs)

### A.1. United Nations Sustainable Development Goals (2015-2030)

The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries in a global partnership.

- Goal 1. End poverty in all its forms everywhere
- Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture
- Goal 3. Ensure healthy lives and promote wellbeing for all at all ages
- Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
- Goal 5. Achieve gender equality and empower all women and girls
- Goal 6. Ensure availability and sustainable management of water and sanitation for all
- Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all
- Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
- Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
- Goal 10. Reduce inequality within and among countries
- Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable
- Goal 12. Ensure sustainable consumption and production patterns
- Goal 13. Take urgent action to combat climate change and its impacts
- Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development
- Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
- Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
- Goal 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

Of the 17 goals, three are directed explicitly at the natural environment. Goal 13 is addressed at climate change and reflects the 2015 Paris Agreement for action on climate change. Goal 14 and Goal 15 are summarized as *Life Below Water* and *Life on Land* respectively. Both Goals 14 and 15 have specific targets, which are directed at reducing threats, securing ecosystem functions and services, and supporting the flows of benefits from biodiversity to people.

## A.2. The Convention on Biological Diversity (2011-2020)

The CBD Strategic Plan for Biodiversity is intended to be an overarching framework for biodiversity conservation, not only for the biodiversity-related conventions but for the entire United Nations system and all other partners engaged in biodiversity management and policy development. The Strategic Plan comprises a shared vision, a mission, strategic goals, and 20 ambitious yet achievable targets, collectively known as the Aichi Targets. The Strategic Plan serves as a flexible framework for the establishment of national and regional targets, and it promotes the coherent and effective implementation of the Convention on Biological Diversity.

- The vision: *“By 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet, and delivering benefits essential for all people.”*
- The mission: *“Take effective and urgent action to halt the loss of biodiversity in order to ensure that by 2020 ecosystems are resilient and continue to provide essential services, thereby securing the planet’s variety of life, and contributing to human well-being, and poverty eradication. To ensure this, pressures on biodiversity are reduced, ecosystems are restored, biological resources are sustainably used and benefits arising out of utilization of genetic resources are shared in a fair and equitable manner; adequate financial resources are provided, capacities are enhanced, biodiversity issues and values mainstreamed, appropriate policies are effectively implemented, and decision-making is based on sound science and the precautionary approach”*
- The targets: 20 Aichi Targets (AT) were to be delivered by 2020, classified into five strategic goals (A to E).
- Strategic Goal A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society
  - Target 1. By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.
  - Target 2. By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.
  - Target 3. By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio-economic conditions.
  - Target 4. By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of the use of natural resources well within safe ecological limits.
  - Strategic Goal B: Reduce the direct pressures on biodiversity and promote sustainable use
  - Target 5. By 2020, the rate of loss of all-natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.

- Target 6. By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem-based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.
- Target 7. By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring the conservation of biodiversity.
- Target 8. By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.
- Target 9. By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.
- Target 10. By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.
- Strategic Goal C: Improve the status of biodiversity by safeguarding ecosystems, species, and genetic diversity.
- Target 11. By 2020, at least 17 percent of terrestrial and inland water, and 10 percent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascapes.
- Target 12. By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.
- Target 13. By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.
- Strategic Goal D: Enhance the benefits to all from biodiversity and ecosystem services.
- Target 14. By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods, and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.
- Target 15. By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 percent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.
- Target 16. By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.

- Strategic Goal E: Enhance implementation through participatory planning, knowledge management, and capacity building.
- Target 17. By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.
- Target 18. By 2020, the traditional knowledge, innovations, and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.
- Target 19. By 2020, knowledge, the science base and technologies relating to biodiversity, its values functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.
- Target 20. By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan 2011-2020 from all sources and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization should increase substantially from the current levels. This target will be subject to changes contingent to resources needs assessments to be developed and reported by Parties.

## **B. Detailed description of the six explorative scenario archetypes**

To synthesize findings, and following the classification made by the IPBES (IPBES, 2016), we group all explorative scenarios for Europe and Central Asia into six “scenario archetypes” according to their underlying assumptions, storylines, and characteristics (IPBES, 2019).

### **B.1. Business-as-usual**

**Overview:** Business-as-usual assumes that the future will be characterized by a continuation of past and current social, economic, and technological trends. Sometimes referred to as a reference scenario. Although there is, on average, moderate population and economic growth under this archetype, development and income growth are uneven across countries. At the same time, inequality and societal stratification persist. International markets and institutions are mostly stable, but function imperfectly. Technological development is moderate, but without fundamental innovations, and the use of fossil fuels does not substantially decrease (O'Neill et al., 2015).

**Indirect drivers:** Most scenarios under the business-as-usual archetype represent reference scenarios that assume current trends in population, GDP, consumption and management of natural resources (Popp et al., 2010; Stehfest et al., 2009; Wirseniens et al., 2010). These scenarios generally assume moderate population and economic growth, and a continued expansion of global free-market enterprises (Haines-Young & Potschin, 2010; O'Neill et al., 2015; Stocker et al., 2012), with some national differences, e.g. a relatively high increase in the UK population (Haines-Young et al., 2011). While environmental improvement is seen as necessary, society and industry are reluctant to adopt many global or national environmental policies that would lead to substantial change (Haines-Young & Potschin, 2010).

**Direct drivers:** The business-as-usual archetype assumes moderate to the high intensity of climate change (Dullinger et al., 2015; Fronzek et al., 2012; Hickler et al., 2012). For Western Europe and parts of Central Europe, increases in woodland and reductions in grassland are assumed (Mitchley et al., 2006; Partidário et al., 2009; Sheate et al., 2008). Land homogenization trends differ across Western and Central Europe (e.g., substantial countryside homogenization in the UK - Haines-Young & Potschin, 2010) and limited concentration of agricultural land in Croatia (Pukšec et al., 2014). Moderate to high levels of pest outbreaks and alien species invasions are expected (European Union - Chytrý et al., 2012; UK - Haines-Young & Potschin, 2010; Austria - Seidl et al., 2008).

**Values:** This scenario archetype is strongly focused on instrumental values. It typically lacks any acknowledgment of relational or intrinsic values implying a lack of long-term focus on conserving nature. For example, Spangenberg et al. (2012) identified that an extension of current trends in European Union policies might slow down the loss of biodiversity in many cases and most biomes, but it will not be capable of halting or reversing the loss.

## **B.2. Economic optimism**

**Overview:** Global developments steered by economic growth result in a strong dominance of international markets with a small degree of regulation. Population growth varies from low (assuming a substantial drop in fertility levels) to stable and high depending on the specific scenario. Technological development is rapid, and there is a partial convergence of income levels across the world. Environmental problems are only dealt with when solutions are of economic interest. In terms of biodiversity and nature's contributions to people, this archetype can range from devastating (environmental destruction) to positive (economically viable nature-based solutions). In all cases, a reactive attitude to environmental management prevails.

**Indirect drivers:** Several scenarios corresponding to the economic optimism archetype describe a future with low population growth in Europe and Central Asia (European Union - Stocker et al., 2014; Central Europe - Fischer et al., 2011; Germany - Dietrich et al., 2012; Hattermann et al., 2015; Koch et al., 2011; Steidl et al., 2015), which is concentrated in cities and leads to substantial urban sprawl (Fazeni & Steinmüller, 2011; Kok et al., 2011; Louca et al., 2015; Reder et al., 2013). However, several national scenarios outline a contrasting trend, assuming high population growth, for example in Sweden (Milestad et al., 2014), the UK (world markets; Haines-Young et al., 2011) and Portugal (global orchestration; Pereira et al., 2009). This archetype is characterized by intensive economic development with the highest GDP growth of all archetypes (Reder et al., 2013) across the majority of countries in Europe and Central Asia (Garrote et al., 2016; Koch et al., 2011). The level of international cooperation is high (global orchestration - MEA, 2005; Reder et al., 2013); however, this may involve only the privileged few (economy first - Okruszko et al., 2011; Reder et al., 2013). The scenarios assume a reactive attitude towards environmental management (economy first - Kok et al., 2011; Reder et al., 2013). Lifestyles are resource-intensive, with high meat and material consumption (Haines-Young et al., 2011; Kok & Pedde, 2016; MEA, 2005; Stokal et al., 2014). The globalization of lifestyles also influences diets. For example, the world market scenario for the UK assumes increasing consumption of processed meals and fast food (Haines-Young et al., 2011). In Central Asia, the respective scenario assumes globalization of lifestyles with consumption patterns mirroring those in other parts of the world (SSP5; Kok & Pedde, 2016). Technological development is rapid (Koch et al., 2011; Reder et al., 2013; Stocker et al., 2014), with an emphasis on efficiency, including increasing agricultural

productivity (Seitzinger et al., 2010; Stokal et al., 2014; Kok & Pedde, 2016). For example, the respective scenario for the UK assumes investments in multiple types of technologies, including IT, transport, military, pharmaceutical, and genetic modification technologies (Haines-Young et al., 2011).

**Direct drivers:** In terms of climate change, Europe and Central Asia are affected by the most severe warming compared to other archetypes (Okrusko et al., 2011; Reder et al., 2013). Surface and groundwater availability is expected to decrease in many countries due to changing precipitation patterns and higher evapotranspiration (Germany - Barthel et al., 2012; Dietrich et al., 2012; Hattermann et al., 2015; Mediterranean - Garrote et al., 2016), with subsequent implications for agricultural irrigation (Germany - Steidl et al., 2015; Mediterranean - Garrote et al., 2016). At the same time, the scenarios assume a substantial increase in natural resource and water consumption (around 30% in the European Union - Flörke et al., 2012; Kok et al., 2011; Okrusko et al., 2011) and intensive utilization of biofuels (Milestad et al., 2014; van Wijnen et al., 2015). Accordingly, trends in fertilizer use and nutrient input are increasing (MEA, 2005; Reder et al., 2013; Stokal et al., 2014), with subsequent implications for environmental degradation and pollution (Kok et al., 2011; Reder et al., 2013).

**Values:** As with business-as-usual, this scenario archetype consists of predominantly instrumental values. Management of nature and its contributions to people is based on an economic "internalization of externalities" (Reed et al., 2013) and single-value approaches, which are unlikely to offer practical, sustainable solutions to the progressive environmental degradation (Jacobs et al., 2016).

### B.3. Regional competition

**Overview:** Regional competition assumes a world regionalized according to economic developments. The market mechanism fails, leading to a growing gap between rich and poor. This gap results in increasing problems with crime, violence, and terrorism, which results in significant trade and other barriers. The effects on the environment and biodiversity are mixed. Overall, there is a tendency towards increased security, which can be either positive (by protecting biodiversity) or negative (by intensifying agricultural production).

**Indirect drivers:** The regional competition archetype assumes fragmentation and disintegration within Europe and Central Asia, leading to weak cooperation between countries, and regionalism (Kok et al., 2011, 2013; Kok & Pedde, 2016). Population growth projections are variable at the national level, ranging from low (Portugal -Pereira et al., 2009) to high (Switzerland - Neteler et al., 2013; Lithuania - Ozolincius et al., 2014), and with contradictory trends projected for the whole of the European Union (Eliseev & Mokhov, 2011; Gao & Giorgi, 2008; Kok et al., 2011; MEA, 2005; Milestad et al., 2014; Neteler et al., 2013; Seitzinger et al., 2010). By contrast, economic development is assumed to be slow in almost all scenarios (Eliseev & Mokhov, 2011; van den Hurk et al., 2005; van Slobbe et al., 2016). The archetype is characterized by high inequality, declining social cohesion, and decreases in human capital (Kok et al., 2011; Kok & Pedde, 2016). The emphasis on self-sufficiency is high (Thaler et al., 2015), and the predominant approach to environmental issues is reactive (Kok et al., 2011; MEA, 2005). Barriers in collaboration lead to slow technological development (Latkovska et al., 2012; Reidsma et al., 2006; van Meijl et al., 2006), even described as sharply decreasing or failing (Kok et al., 2011; Kok & Pedde, 2016). In Central Asia, this archetype suggests potentially severe consequences for societal functioning (Kok & Pedde, 2016).

**Direct drivers:** Climate change is expected to be relatively severe (Bourdôt et al., 2012; Eliseev & Mokhov, 2011; Kelly et al., 2014; Latkovska et al., 2012; Neteler et al., 2013). The pattern of land-use change mainly differs among countries, with mixed trends in the extent of agricultural land (Eliseev & Mokhov, 2011; Pereira et al., 2009), land-use intensification (Haines-Young et al., 2011; Seitzinger et al., 2010) and land homogenization (Haines-Young et al., 2011; Milestad et al., 2014). Conflicts regarding natural resources are expected to increase (MEA, 2005), with substantial use of local energy resources (Haines-Young et al., 2011). Similarly, projections of the likelihood of biotic invasions vary from high (Kelly et al., 2014; MEA, 2005; Ozolincius et al., 2014) to low (Haines-Young et al., 2011).

**Values:** This scenario archetype is strongly focused on relational and instrumental values. Although scenarios under this archetype include relational values (good quality of life indicators), they assume that regions will focus more on self-reliance, national sovereignty, and regional identity. This archetype leads to diversity in values, but also tensions among regions or cultures (van Vuuren et al., 2012). In such futures, it may be challenging to protect biodiversity because of a combination of active control of institutions (generally top-down) and lack of synergy between different levels of governance. Approaches to biodiversity protection are local (if any) and further constrained by a lack of concern for global environmental problems (Kok et al., 2013).

#### **B.4. Inequality**

**Overview:** Inequality assumes increasing economic, political, and social inequalities and fragmentation both across and within countries. This future is characterized by power becoming more concentrated in a relatively small political and business elite across the globe. Economic growth is moderate in industrialized and middle-income countries, while low-income countries lag. Technology develops unevenly. Environmental policies focus on local issues and are limited to higher-income areas (O'Neill et al., 2015). The European Union increases its commitment to finding innovative solutions to the depletion of natural resources and climate change, which initiates a shift towards a high-tech green Europe. However, there are increasing disparities in economic opportunity, leading to substantial proportions of populations having a low level of development. The European Union becomes an essential player in a world full of tensions. In Central Asia, the concentration of wealth and power in a small class of elites grows, while the standard of life of the majority gradually deteriorates. Political regimes in the region are increasingly authoritarian and repressive, with a growing incidence of social unrest, conflicts and ethnic clashes on the one hand, and outmigration and resignation on the other. Environmental issues are addressed only to a limited extent, particularly about water and energy supplies, so as not to threaten the position of the elites (Kok & Pedde, 2016).

**Indirect drivers:** Scenarios under this archetype show contrasting trends in population for Europe and Central Asia with the population increasing in Central Asia until the middle of the century when it stabilizes, but decreasing in Western and Central Europe (Kok & Pedde, 2016). Similar differences are seen for economic growth, which remains stable in Central Asia compared to high economic development in Europe. Although the efforts of the elite mostly aim at increasing (economic) power, there is increasing interest in addressing specific environmental issues, including fundamental rules of conduct regarding water management, infrastructural projects (water, road, rail), and energy production, which further drives technological development (Kok et al., 2013; Kok & Pedde, 2016). In Central Asia, the national governments gradually increase their power by concentrating wealth and power in the upper class (Kok & Pedde, 2016). Anti-elite



movements gradually become more widespread, resulting in social unrest, but the elite ensures the masses receive a minimum of services to decrease the chance of revolts.

**Direct drivers:** This archetype is associated with an intermediate level of climate change in Europe and Central Asia (which has temperature increases of between 2 and 3°C). Land use in Europe sees a steadily declining agricultural area and an increase in forests and biofuels. Alternatively, in Central Asia, there is a gradual move towards large collective farms controlled by elites. Little information is provided on pollution and invasive alien species, but these issues are expected to be strongly regulated when advantageous to the elites (Kok & Pedde, 2016).

**Values:** As in business-as-usual, this scenario archetype is strongly focused on instrumental values. In such a future, it may be challenging to conserve biodiversity because of a lack of acknowledgment of the diverse values of nature resulting in conservation efforts focusing on nature's contributions to people (i.e., anthropocentric instrumental values). Additionally, the increasing trend of social inequalities might create social conflict amongst different stakeholders around environmental issues (van Egmond & de Vries, 2011).

## **B.5. Global sustainable development**

**Overview:** Global sustainable development assumes a globalized world with an increasingly proactive attitude of policymakers and the public at large towards environmental issues and a high level of regulation. Essential aspects on the road to sustainability are technological change, strong multilevel governance, behavioral change through education, and a relatively healthy economy. All variations of this archetype are beneficial for biodiversity, either through behavioral change, top-down "green" policies or through green technology development. In all cases, this is reinforced by a proactive attitude to dealing with environmental problems. Sub-types include: a) Focus on technological development and technology transfer: Solutions are mainly found in (green) technological change in all sectors, including for example engineered ecosystems to deliver nature's contributions to people; b) Focus on strong governments: Strong, mostly topdown, governance structures are useful in enforcing a more sustainable world, e.g., through taxes, pricing mechanisms, and strict regulations; c) Focus on paradigm shift: An increased collaboration of private and public partners across scales leads to intense behavioural change towards environmental protection and sustainable development.

**Indirect drivers:** The global sustainable development archetype is characterized by a high degree of international cooperation (MEA, 2005) and top-down governance (Kok et al., 2011). The scenarios corresponding to this archetype assume low to medium population growth across the European Union (Ozolincius et al., 2014; Reidsma et al., 2006; van Meijl et al., 2006; van Slobbe et al., 2016), but moderate population growth in Central Asia (Kok & Pedde, 2016). The assumptions regarding future economic development in the European Union under this archetype are highly variable, ranging from rapid (Kok & Pedde, 2016; Haines-Young et al., 2011; Gálos et al., 2011) through to medium (Kok & Pedde, 2016; Uthes et al., 2009; Milestad et al., 2014) and slow (Kok et al., 2011; Louca et al., 2015). In both Europe and Central Asia, the scenarios envision steady increases in human and social capital, and high levels of social respect and cohesion (Kok et al., 2013; Kok & Pedde, 2016). In Central Asia, global sustainable development is the only archetype under which the cooperation between countries in the region increases, and transboundary water governance is implemented (Kok & Pedde, 2016). In terms of cultural trends, the scenarios assume low to medium material consumption for the European Union (Kok & Pedde, 2016; MEA, 2005) with a proactive approach to environmental management (Kok et al., 2011;

MEA, 2005). Technological development is rapid, focusing on green and resource-efficient technologies (Kok et al., 2011; Kok & Pedde, 2016; MEA, 2005), biotechnology and sustainable technologies (Haines-Young et al., 2011; Kok et al., 2011).

**Direct drivers:** Climate change is assumed to predominantly follow the lowest increase in surface temperature compared to other scenario archetypes (Fischer et al., 2011; Ozolincius et al., 2014; Scholten et al., 2014). In terms of water regime, the discharge from major rivers is assumed to decrease, for example in the case of the Black Sea and the Mediterranean Sea (Garrote et al., 2016; Ludwig et al., 2010). Multiple studies assume medium dispersion of invasive species both at the European Union level (Chytrý et al., 2012) and in individual countries (Central Europe - Fischer et al., 2011; the Baltic countries - Ozolincius et al., 2014).

**Values:** As with regional sustainability, global sustainable development is balanced on instrumental, intrinsic, and relational values. Again, due to the inclusiveness and balance among different types of values, this archetype favors sustainability efforts. This scenario explores visionary solutions to the sustainability challenge on a global scale, including new socio-economic arrangements and fundamental changes in values (Kubiszewski et al., 2017).

## **B.6. Regional sustainability**

**Overview:** Regional sustainability assumes a regionalized world based on an increased concern for environmental and social sustainability. International institutions decline in importance, with a shift toward local and regional decision-making. Decision-making is increasingly influenced by environmentally aware citizens, with a trend toward local self-reliance and stronger communities that focus on welfare, equality, and environmental protection through local solutions. A proactive attitude to environmental management prevails, which is beneficial for biodiversity and nature's contributions to people. The strong regional character and poor international collaboration, however, causes problems with technology transfers, generates a relatively high demand for agricultural land, and obstructs coordination to solve global issues such as climate change, which all put pressure on the environment. Two subtypes can be discerned: a) Focus on local governance: Fundamental change is initiated by a broadly supported and bottom-up enforced paradigm shift, often accompanied by a dematerialization process and a "back to nature" attitude. b) Focus on collaborative solutions to local issues: Fundamental change is initially fostered by higher-level institutions, recognizing the value of local action in a slowly regionalizing world.

**Indirect drivers:** The regional sustainability scenario archetype is characterized by the empowerment of local decision-making and bottom-up governance both at the national (Haines-Young et al., 2011) and the European Union level (Kok et al., 2011). Most scenarios corresponding to this archetype assume average population growth in both the European Union (Reidsma et al., 2006; van Meijl et al., 2006) and individual European Union countries (Germany - Dietrich et al., 2012; Latvia - Latkovska et al., 2012). In contrast, in some scenarios population growth is assumed to be low (Germany and the UK - Haines-Young et al., 2011; Koch et al., 2011), or even to decrease (European Union - Hauck et al., 2017). The estimates of potential future economic development at the scale of Western Europe and parts of Central Europe under regional sustainability range between slow and medium (Kok et al., 2011; Stokal et al., 2014). Several scenarios assume uneven levels of economic development among countries (MEA, 2005; Seitzinger et al., 2010). Furthermore, contrasting projections are reported for several countries (e.g., Germany - Dietrich et al., 2012; Koch et al., 2011; Cyprus - Gao & Giorgi, 2008; Louca et al., 2015). The archetype is characterized by consumption patterns oriented towards local food and products, as well as food self-sufficiency (UK - Haines-Young et al., 2011; Austria - Fazeni & Steinmüller, 2011; Sweden -

Milestad et al., 2014) and organic farming (Austria – Thaler et al., 2015). Meat consumption is medium both in global and national scenarios, with an emphasis on different regional and local products, fresh food, meat and fish (local stewardship - Haines-Young et al., 2011; adapting mosaic - MEA, 2005). As with economic development, technological development is assumed to be medium and uneven across the European Union (Latkovska et al., 2012; Reidsma et al., 2006; van Meijl et al., 2006), ranging from energy-related technologies (Germany - Koch et al., 2011) through clean and resource-efficient technologies (Austria - Thaler et al., 2015; Cyprus - Louca et al., 2015; Black Sea region - Stokal et al., 2014) to a highly diversified technological portfolio developed at a moderate pace (Germany - Dietrich et al., 2012; Latvia - Latkovska et al., 2012). In general, a strong focus on sustainability is assumed, namely in terms of the development of sustainable technologies and increasing energy efficiency (local stewardship - Haines-Young et al., 2011), higher efficiency in fertilizer use (adapting mosaic - Stokal et al., 2014) and water-saving technologies (sustainability eventually – Kok et al., 2011), as well as higher standards for environmental protection and strong conservation policies (Bolliger et al., 2007; Koch et al., 2011).

**Direct drivers:** Climate change assumptions range from medium (Mediterranean - Gao & Giorgi, 2008; Ireland - Kelly et al., 2014; Latvia - Latkovska et al., 2012) to high (Germany - Dietrich et al., 2012; Koch et al., 2011), particularly in terms of temperature increases across the European Union (Okruszko et al., 2011). The regionalized character of this archetype results in diverse, heterogeneous patterns of land use and land cover change both within individual countries (particularly northern Europe Union - Haines-Young et al., 2011; Milestad et al., 2014) and across Western and Central Europe (increase in non-intensive open land in Switzerland - Bolliger et al., 2007; increase in artificial surfaces in Cyprus - Louca et al., 2015). Similarly, projected trends in natural resource exploitation are mixed. For example, although some scenarios assume decreases in total water withdrawals at the European Union level (Okruszko et al., 2011), scenarios for Germany (Dietrich et al., 2012) project increasing water consumption and decreasing water availability. In terms of pollution, the emphasis on sustainability leads to stable or decreasing fertilizer use (Nol et al., 2012; Stokal et al., 2014), low increases in O<sub>3</sub> emissions across the European Union (Jiménez-Guerrero et al., 2013) and a substantial decline in nutrient emissions to the Black Sea and the Mediterranean (Ludwig et al., 2010). The regionalized character of the archetype leads to low dispersion of invasive alien species and reductions in invasions due to stricter border control (local stewardship, adapting mosaic - Haines-Young et al., 2011; MEA, 2005).

**Values:** The regional sustainability archetype is centered on a broad and even coverage of intrinsic, instrumental, and relational values. The inclusiveness and balance among different types of values are favorable for sustainability efforts because it leads to regional solutions for environmental and social problems, often through combining drastic lifestyle changes with the decentralization of governance (van Vuuren et al., 2012). These diverse values could have positive effects on biodiversity conservation through a focus on management styles such as low-impact farming and energy-efficient lifestyles based on local low-tech development (Kok et al., 2013).

## C. Methods

We designed an analytical framework (Figure S1) that allows comparative analysis between scenarios and estimates distances to policy goals/targets, based on plural values of nature. We apply this approach for a comparative valuation of the six scenario archetypes used in the IPBES

regional assessment for Europe and Central Asia based on the policy priorities set by the SDGs and ATs. Our analytical framework is operationalized using a four stepwise methodological approach. Each of these four steps are described in the following sections.

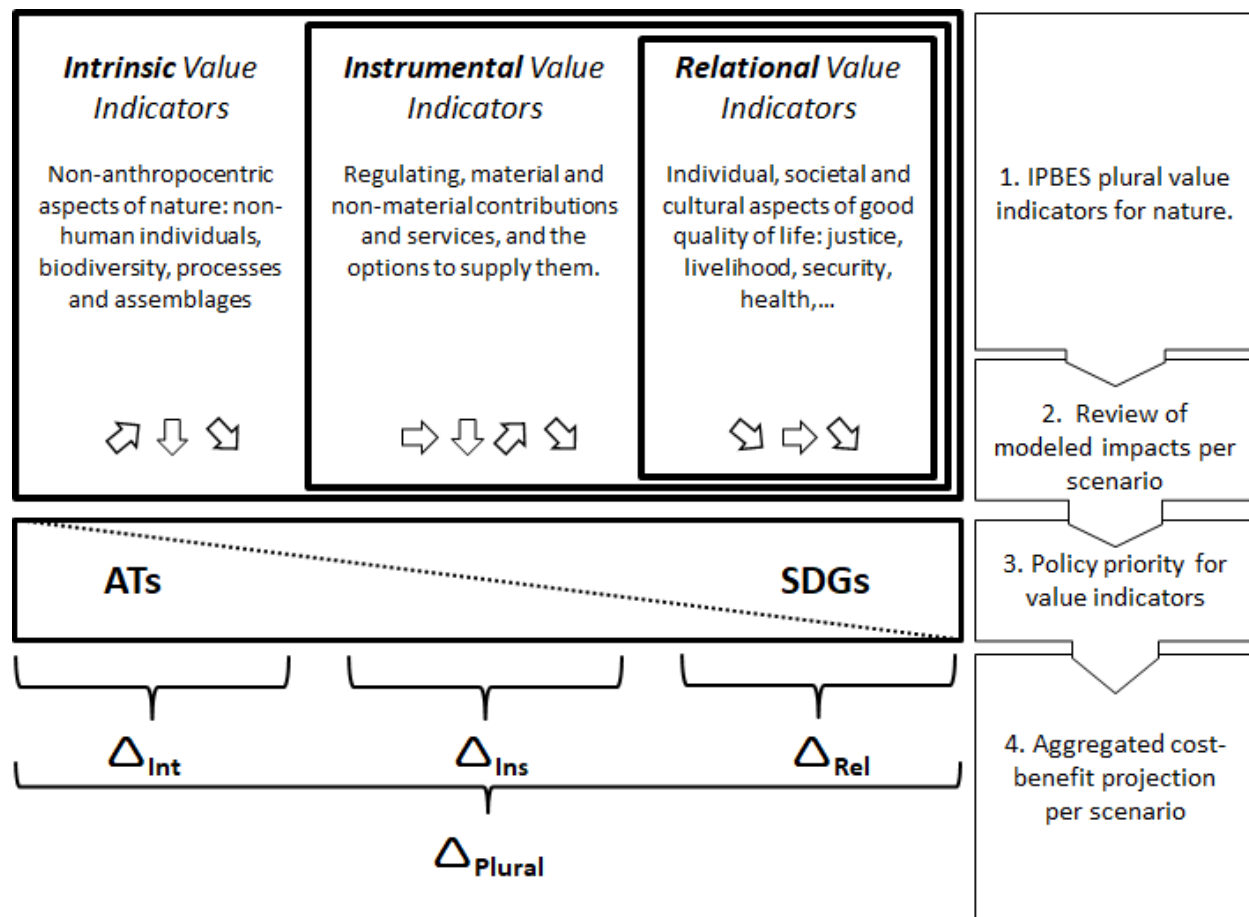


Figure S1. Plural valuation analytical framework (left) and stepwise approach (right): (1) Selection of multiple indicators for plural values of nature; (2) Review and synthesis of modeled changes (arrows) from the literature for each indicator per scenario archetype; (3) Multiplication by the policy priority of each value indicator as derived from their mentioning in individual biodiversity targets (CDB) and policy sustainable goals (SGD); (4) Evaluation of the plural scenarios analysis across all policy goals per scenario archetype.

The design of any assessment rarely takes account of the diverse values of nature (IPBES, 2018). Following the Regional Assessment for Europe and Central Asia, in this study we recognise three main value dimensions: values directly linked to nature itself (including biodiversity and ecosystem structure and functioning); values derived from nature's contributions to people (including ecosystem services); and values more directly linked to a good quality of life (Figure S1). The following provides definitions applied in the Regional Assessment for Europe and Central Asia for the main value components (IPBES, 2018).

- Intrinsic values are independent of any human experience or evaluation. Since intrinsic value can be recognized, but not quantified, by humans it is not the target of any valuation process (Pascual et al., 2017). However, intrinsic values are one of the main motivations for nature conservation. The concept of “nature” refers to nature at large, encompassing a continuum from nature as an autonomous functioning and evolving system to nature

involving domesticated plants and animals. Within the context of science, it includes categories such as biodiversity, ecosystems, ecosystem functioning, evolution, the biosphere, humankind's shared evolutionary heritage, and biocultural diversity. Within the context of other knowledge systems, nature also includes different beliefs and concepts held around the world by indigenous peoples and local communities, such as “Mother Earth” and “systems of life” (Díaz et al., 2015).

- Instrumental values refer to the value attributed to something as a means to achieve a particular end for humans, and in this study are referred to as nature's contributions to people or ecosystem services. Nature's contributions to people. Defined by Pascual et al. (2017) as “all the positive contributions, or benefits, and occasionally negative contributions, losses or detriments, that people obtain from nature. It resonates with the original use of the term ecosystem services in the Millenium Ecosystem Assessment (MEA, 2005), and goes further by explicitly embracing concepts associated with other worldviews on human–nature relations and knowledge systems (e.g. “nature's gifts” in many indigenous cultures) (Díaz et al., 2015)”. They can be assessed in many different ways, including economic, social and biophysical valuation methods. Each of these methods elicits different values and, so, requires a broad set of approaches (Boeraeve et al., 2014; Jacobs et al., 2016).
- Relational values are the positive values assigned to “desirable relationships”, such as those among people and between people and nature (Díaz et al., 2015). Relational values refer to both desirable human-human interactions and human-nature interactions. “Living in harmony with nature”, “living-well in balance and harmony with Mother Earth” and “human well-being” are examples of different perspectives referred to as good quality of life. The achievement of a fulfilled human life, the criteria for which may vary greatly across different societies and groups within societies. It is a context-dependent state of individuals and human groups, comprising aspects such as access to food, water, energy and livelihood security, and also health, good social relationships and equity, security, cultural identity, and freedom of choice and action (Díaz et al., 2015). These values are assessed using various methods. A valuation that looks at the social-ecological system as a whole is essential for fully understanding relational values. Such valuation combines data from, for example, narratives, preference assessments, participatory geographical analyses, historical studies and biophysical models. First-hand information from individuals holding relational values is essential.

### **C.1. Selection of specific indicators to assess multiple values of nature**

Indicators are defined in this study as data aggregated in a manner – quantitative or qualitative – that reflect the status, cause or outcome of an object or process, especially towards targets such as the Aichi Biodiversity Targets or those included under the Sustainable Development Goals. In this study we have consulted widely to arrive at a comprehensive list of indicators that cover the analytical framework (Figure S1). Meaningful indicators require long-term monitoring data. Indicators can help to simplify the enormous complexity of datasets, variables, frameworks and approaches available. In each of the three main value dimensions, different indicators were distinguished and selected (Table S1). Indicators of nature (e.g. biodiversity, individual organisms,

biophysical assemblages and ecological processes), of nature's contributions to people (e.g. production of commercial crops, regulation of climate, physical and psychological experiences), of contributions to a good quality of life (e.g. amount of calories, governance and justice) and of values (e.g. market or cultural values). It is, however, important to recognize the limitations of a given set of indicators in capturing the complexities of the "real world", since indicators are restricted to what can be measured and for which there is available data. Notably, these limitations are especially significant when it comes to assessing the non-material contributions of nature to people and a good quality of life. Moreover, the choice of indicators relates to diverse cultural perspectives. For the review, a slightly adapted list of 28 indicators was used (see Table S2) .

Table S1. Typology of values of nature as applied in IPBES ECA

| Value Dimension     | Value Focus*            | IPBES-Valuation Targets                                            |
|---------------------|-------------------------|--------------------------------------------------------------------|
| <b>Intrinsic</b>    | Individual organisms    | Individual organisms                                               |
|                     | Biophysical assemblages | Biophysical assemblages                                            |
|                     | Biophysical processes   | Biophysical processes                                              |
|                     | Biodiversity**          | Biodiversity                                                       |
| <b>Instrumental</b> | Options for NCP         | 18 Maintenance of options                                          |
|                     | Regulation NCP          | 1 Habitat creation and maintenance                                 |
|                     |                         | 2 Pollination and dispersal of seeds and other propagules          |
|                     |                         | 3 Regulation of air quality                                        |
|                     |                         | 4 Regulation of climate                                            |
|                     |                         | 5 Regulation of ocean acidification                                |
|                     |                         | 6 Regulation of freshwater quantity, flow and timing               |
|                     |                         | 7 Regulation of freshwater and coastal water quality               |
|                     |                         | 8 Formation, protection and decontamination of soils and sediments |
|                     |                         | 9 Regulation of hazards and extreme events                         |
|                     |                         | 10 Regulation of organisms detrimental to humans                   |
|                     | Material NCP            | 11 Energy                                                          |
|                     |                         | 12 Food and feed                                                   |
|                     |                         | 13 Materials                                                       |
|                     |                         | 14 Medicinal, biochemical and genetic resources                    |
|                     | Non-material NCP        | 15 Learning and inspiration                                        |
|                     |                         | 16 Physical and psychological experiences                          |
|                     |                         | 17 Supporting identities                                           |
| <b>Relational</b>   | cultural                | Living well in harmony with nature                                 |
|                     |                         | Identity and Autonomy                                              |
|                     |                         | Spirituality and Religions                                         |
|                     |                         | Art and Cultural heritage                                          |
|                     | societal                | Sustainability and Resilience                                      |
|                     |                         | Diversity and Options                                              |
|                     |                         | Governance and Justice                                             |
|                     | individual              | Health and Wellbeing                                               |
|                     |                         | Education and Knowledge                                            |
|                     |                         | Good social relations                                              |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Security and Livelihoods |
| <p>*: The categorisation in the "value focus" column strictly serves as an aid for balanced aggregation and depiction of the diverse value dimensions, rather than mutually exclusive categories</p> <p>** : In the ECA assessment, the term "biodiversity" is used in different senses, from its scientific sense of biological diversity up till use of the natural environment in general (see also Mace et al 2012)</p> <p>***: In the ECA assessment, both terms "nature contributions to people" and "ecosystem services" are used. The latter is used when referring to literature dealing with specific ecosystem services, while "nature contributions to people" is applied to convey statements referring to the broader category of anthropocentric values (which includes ecosystem services).</p> |                          |

## C.2. Review of modeled scenario impacts on value indicators

To gather evidence in the Europe and Central Asia region, a systematic review on biodiversity and ecosystem service impact modeling studies was performed. For this review, we searched the Scopus database for peer-reviewed articles on the use of integrated modeling approaches to predict future impacts on nature, its contributions to people, and good quality of life, for Europe and Central Asia. As the majority of impact assessment studies still rely on single-component models (e.g., one driver, one scenario; Harrison et al. 2015), only 37 articles met the search criteria. For each study, we extracted information about the scenario(s) assessed (e.g., drivers and sectors included) and their correspondence to one of the scenario archetypes (business-as-usual, economic optimism, regional competition, regional sustainability, global sustainable development, and inequality). We also recorded 28 model system indicators (values) assessed, including the indicator type - i.e. nature, nature's contributions to people and good quality of life -, their predicted future trend (stable: change  $\pm 5\%$ , increase: change  $> 5\%$  or decrease: change  $> -5\%$  during the period assessed in each study) and whether trade-offs of synergies between indicators were explicitly evaluated. We generated a unique record for each combination of integrated approaches, scenarios, and model system indicators within each of the 37 articles (full list at the end of this section). This led to a total of 3,151 entries in the database.

Table S2. Number of indicator-scenario combinations in the review, per value types and scenario archetype

| Number of modelling studies according to impact => |                                                                  | Decrease          | Increase | Stable | Total | Decrease                       | Increase | Stable | Total | Decrease                | Increase | Stable | Total | Decrease             | Increase | Stable | Total | Decrease   | Increase | Stable | Total | Decrease          | Increase | Stable | Total |
|----------------------------------------------------|------------------------------------------------------------------|-------------------|----------|--------|-------|--------------------------------|----------|--------|-------|-------------------------|----------|--------|-------|----------------------|----------|--------|-------|------------|----------|--------|-------|-------------------|----------|--------|-------|
| scenario =>                                        |                                                                  | Economic Optimism |          |        |       | Global Sustainable Development |          |        |       | Regional Sustainability |          |        |       | Regional Competition |          |        |       | Inequality |          |        |       | Business-As-Usual |          |        |       |
| Nature                                             | Biophysical assemblages                                          | 51                | 19       | 5      | 75    | 5                              | 15       | 11     | 31    | 2                       | 3        | 0      | 5     | 26                   | 14       | 14     | 54    | 4          | 2        | 4      | 10    | 8                 | 5        | 16     | 29    |
|                                                    | Biophysical processes                                            | 18                | 18       | 7      | 43    | 2                              | 1        | 10     | 13    | 8                       | 2        | 2      | 12    | 17                   | 33       | 8      | 58    | 0          | 0        | 0      | 0     | 2                 | 1        | 12     | 15    |
|                                                    | Biodiversity                                                     | 35                | 21       | 22     | 78    | 42                             | 15       | 5      | 62    | 28                      | 18       | 6      | 52    | 51                   | 25       | 12     | 88    | 0          | 0        | 0      | 0     | 1                 | 0        | 0      | 1     |
|                                                    | Maintenance of options                                           | 0                 | 0        | 0      | 0     | 0                              | 0        | 4      | 4     | 0                       | 0        | 0      | 0     | 0                    | 0        | 4      | 4     | 0          | 0        | 0      | 0     | 0                 | 0        | 4      | 4     |
|                                                    | Habitat creation and maintenance                                 | 8                 | 2        | 0      | 10    | 1                              | 8        | 1      | 10    | 8                       | 2        | 0      | 10    | 19                   | 0        | 1      | 20    | 9          | 0        | 0      | 9     | 0                 | 26       | 10     | 36    |
| Regulating NCP                                     | Pollination and dispersal of seeds and other propagules          | 1                 | 0        | 0      | 1     | 0                              | 1        | 0      | 1     | 0                       | 1        | 0      | 1     | 1                    | 0        | 0      | 1     | 0          | 0        | 0      | 0     | 0                 | 0        | 0      | 0     |
|                                                    | Regulation of air quality                                        | 0                 | 1        | 0      | 1     | 0                              | 1        | 0      | 1     | 0                       | 1        | 0      | 1     | 0                    | 1        | 0      | 1     | 0          | 0        | 0      | 0     | 0                 | 0        | 0      | 0     |
|                                                    | Regulation of climate                                            | 14                | 8        | 1      | 23    | 4                              | 9        | 4      | 17    | 7                       | 4        | 2      | 13    | 10                   | 13       | 3      | 26    | 0          | 0        | 0      | 0     | 11                | 3        | 15     | 29    |
|                                                    | Regulation of freshwater quantity, flow and timing               | 0                 | 0        | 1      | 1     | 0                              | 1        | 0      | 1     | 0                       | 1        | 0      | 1     | 0                    | 1        | 0      | 1     | 0          | 0        | 0      | 0     | 0                 | 0        | 0      | 0     |
|                                                    | Regulation of freshwater and coastal water quality               | 5                 | 1        | 0      | 6     | 0                              | 1        | 0      | 1     | 4                       | 1        | 0      | 5     | 2                    | 1        | 0      | 3     | 0          | 0        | 0      | 0     | 2                 | 0        | 0      | 2     |
|                                                    | Formation, protection and decontamination of soils and sediments | 9                 | 1        | 0      | 10    | 1                              | 3        | 0      | 4     | 3                       | 5        | 1      | 9     | 5                    | 1        | 0      | 6     | 0          | 0        | 0      | 0     | 2                 | 2        | 0      | 4     |
|                                                    | Regulation of hazards and extreme events                         | 1                 | 1        | 1      | 3     | 5                              | 1        | 2      | 8     | 0                       | 1        | 1      | 2     | 5                    | 5        | 3      | 13    | 5          | 0        | 1      | 6     | 12                | 3        | 0      | 15    |
|                                                    | Regulation of organisms detrimental to humans                    | 1                 | 0        | 0      | 1     | 0                              | 1        | 0      | 1     | 0                       | 1        | 0      | 1     | 1                    | 0        | 0      | 1     | 0          | 0        | 0      | 0     | 0                 | 0        | 0      | 0     |
| Provisioning NCP                                   | Energy                                                           | 0                 | 0        | 2      | 2     | 0                              | 1        | 1      | 2     | 0                       | 1        | 1      | 2     | 0                    | 2        | 3      | 5     | 0          | 0        | 0      | 0     | 0                 | 1        | 0      | 1     |
|                                                    | Food and feed                                                    | 23                | 43       | 6      | 72    | 10                             | 14       | 3      | 27    | 9                       | 7        | 1      | 17    | 27                   | 47       | 5      | 79    | 6          | 11       | 1      | 18    | 18                | 23       | 12     | 53    |
|                                                    | Materials                                                        | 9                 | 5        | 2      | 16    | 0                              | 0        | 0      | 0     | 4                       | 0        | 0      | 4     | 5                    | 4        | 3      | 12    | 0          | 0        | 0      | 0     | 0                 | 0        | 0      | 0     |
|                                                    | Timber and Forest Products                                       | 3                 | 5        | 3      | 11    | 10                             | 4        | 6      | 20    | 2                       | 5        | 0      | 7     | 17                   | 5        | 6      | 28    | 6          | 2        | 2      | 10    | 17                | 2        | 1      | 20    |
|                                                    | Water provisioning                                               | 1                 | 2        | 0      | 3     | 4                              | 15       | 6      | 25    | 0                       | 3        | 0      | 3     | 8                    | 21       | 7      | 36    | 3          | 11       | 3      | 17    | 2                 | 26       | 6      | 34    |
| Non-Material NCP                                   | Learning and inspiration                                         | 1                 | 3        | 1      | 5     | 1                              | 4        | 0      | 5     | 0                       | 5        | 0      | 5     | 3                    | 2        | 0      | 5     | 0          | 0        | 0      | 0     | 0                 | 0        | 0      | 0     |
|                                                    | Physical and psychological experiences                           | 3                 | 4        | 1      | 8     | 4                              | 7        | 0      | 11    | 2                       | 5        | 1      | 8     | 4                    | 4        | 3      | 11    | 0          | 0        | 0      | 0     | 3                 | 2        | 7      | 12    |
|                                                    | Supporting identities                                            | 3                 | 0        | 1      | 4     | 2                              | 0        | 2      | 4     | 0                       | 3        | 1      | 4     | 1                    | 1        | 2      | 4     | 0          | 0        | 0      | 0     | 0                 | 0        | 0      | 0     |
| Human Wellbeing                                    | Education & Knowledge                                            | 0                 | 0        | 1      | 1     | 0                              | 1        | 0      | 1     | 0                       | 1        | 0      | 1     | 1                    | 0        | 0      | 1     | 0          | 0        | 0      | 0     | 0                 | 0        | 0      | 0     |
|                                                    | Governance and justice (equity)                                  | 0                 | 1        | 0      | 1     | 0                              | 0        | 1      | 1     | 0                       | 1        | 0      | 1     | 1                    | 0        | 0      | 1     | 0          | 0        | 0      | 0     | 0                 | 0        | 0      | 0     |
|                                                    | Free choice                                                      | 1                 | 0        | 0      | 1     | 1                              | 0        | 0      | 1     | 1                       | 0        | 0      | 1     | 1                    | 0        | 0      | 1     | 0          | 0        | 0      | 0     | 0                 | 0        | 0      | 0     |
|                                                    | Good social relations                                            | 1                 | 0        | 0      | 1     | 1                              | 0        | 0      | 1     | 0                       | 1        | 0      | 1     | 1                    | 0        | 0      | 1     | 0          | 0        | 0      | 0     | 0                 | 0        | 0      | 0     |
|                                                    | Health & wellbeing                                               | 0                 | 0        | 1      | 1     | 0                              | 1        | 0      | 1     | 0                       | 1        | 0      | 1     | 1                    | 0        | 0      | 1     | 0          | 0        | 0      | 0     | 0                 | 0        | 0      | 0     |
|                                                    | Security and livelihoods                                         | 10                | 49       | 5      | 64    | 0                              | 2        | 1      | 3     | 1                       | 2        | 0      | 3     | 11                   | 44       | 7      | 62    | 0          | 0        | 0      | 0     | 2                 | 0        | 0      | 2     |
|                                                    | Resource intensive lifestyle                                     | 1                 | 0        | 0      | 1     | 1                              | 0        | 0      | 1     | 1                       | 0        | 0      | 1     | 0                    | 1        | 0      | 1     | 0          | 0        | 0      | 0     | 0                 | 0        | 0      | 0     |
|                                                    |                                                                  | 0                 | 0        | 0      | 0     | 0                              | 0        | 0      | 0     | 0                       | 0        | 0      | 0     | 0                    | 0        | 0      | 0     | 0          | 0        | 0      | 0     | 0                 | 0        | 0      | 0     |

We grouped the entries of the literature review database by indicator value type and scenario archetype. We estimated the percentage of entries for each indicator that showed a consistent future trend (either stable, increasing, or decreasing) under each of the scenario archetypes. If a given trend was observed in 50% or more of the entries for a given indicator-scenario combination, we assumed this was the dominant future trend for that indicator under that particular scenario.

List of 37 publications included in the literature review:

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### C.3. Impact of each scenario archetype on policy goals and targets

For each value indicator, a weight for ‘policy priority’ was derived from their mentioning in formal description of the SDGs and their indicators (UN 2017) and of the ATs and the proposed list of actions to enhance their implementation (CBD 2018). Each value indicator was assigned a score: 4 - the value is explicitly mentioned in the title of the SDG/AT or is its primary focus, 3 – the value is explicitly mentioned in the text of the related indicators/actions, 2 – the value can clearly be inferred from the SDG/AT or the related indicators/actions, 1 – the value is related to the SDG/AT, 0 – value indicator is clearly unrelated. (See Table S3).

Table S3. Prioritization of value indicators by policy goals

| Prioritisation of values by policy goals             |                                                      | A/CHI 1 | A/CHI 2 | A/CHI 3 | A/CHI 4 | A/CHI 5 | A/CHI 6 | A/CHI 7 | A/CHI 8 | A/CHI 9 | A/CHI 10 | A/CHI 11 | A/CHI 12 | A/CHI 13 | A/CHI 14 | A/CHI 15 | A/CHI 16 | A/CHI 17 | A/CHI 18 | A/CHI 19 | A/CHI 20 | SDG 1 | SDG 2 | SDG 3 | SDG 4 | SDG 5 | SDG 6 | SDG 7 | SDG 8 | SDG 9 | SDG 10 | SDG 11 | SDG 12 | SDG 13 | SDG 14 | SDG 15 | SDG 16 | SDG 17 |   |   |  |
|------------------------------------------------------|------------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|--------|--------|--------|--------|--------|--------|--------|---|---|--|
| Intrinsic                                            | Individual organisms                                 | 2       | 2       | 1       | 0       | 1       | 3       | 1       | 1       | 2       | 2        | 2        | 4        | 4        | 0        | 0        | 0        | 1        | 1        | 2        | 1        | 0     | 1     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0      | 0      | 0      | 0      | 1      | 3      | 0      | 0      |   |   |  |
|                                                      | Biophysical assemblages                              | 2       | 2       | 1       | 0       | 3       | 1       | 1       | 1       | 2       | 3        | 3        | 3        | 1        | 0        | 2        | 0        | 1        | 1        | 3        | 1        | 0     | 2     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0      | 0      | 0      | 0      | 3      | 4      | 0      | 0      |   |   |  |
|                                                      | Biophysical processes                                | 2       | 2       | 1       | 0       | 1       | 1       | 3       | 4       | 1       | 4        | 3        | 2        | 1        | 3        | 4        | 0        | 2        | 1        | 4        | 1        | 0     | 0     | 0     | 0     | 0     | 3     | 0     | 0     | 0     | 0      | 0      | 0      | 0      | 2      | 4      | 0      | 0      |   |   |  |
|                                                      | Biodiversity                                         | 4       | 4       | 4       | 2       | 3       | 4       | 4       | 4       | 3       | 3        | 4        | 4        | 3        | 0        | 2        | 0        | 4        | 3        | 4        | 3        | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0      | 0      | 0      | 0      | 2      | 4      | 0      | 0      |   |   |  |
| Instrumental (NCP)                                   | 18 Maintenance of options                            | 4       | 1       | 3       | 4       | 1       | 3       | 2       | 2       | 0       | 3        | 1        | 2        | 3        | 2        | 2        | 0        | 0        | 2        | 0        | 0        | 0     | 1     | 0     | 0     | 2     | 0     | 0     | 0     | 0     | 0      | 0      | 2      | 2      | 1      | 1      | 3      | 0      | 2 |   |  |
|                                                      | 1 Habitat creation and maintenance                   | 0       | 1       | 1       | 0       | 4       | 3       | 2       | 3       | 3       | 3        | 4        | 3        | 0        | 3        | 4        | 0        | 1        | 0        | 0        | 0        | 0     | 1     | 0     | 0     | 0     | 3     | 0     | 0     | 0     | 0      | 0      | 2      | 0      | 0      | 4      | 4      | 0      | 0 |   |  |
|                                                      | 2 Pollination and dispersal of seeds and propagules  | 0       | 1       | 0       | 0       | 0       | 0       | 2       | 0       | 0       | 0        | 1        | 0        | 0        | 1        | 1        | 0        | 0        | 0        | 0        | 0        | 0     | 1     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0 |   |  |
|                                                      | 3 Regulation of air quality                          | 0       | 1       | 0       | 0       | 0       | 0       | 3       | 0       | 0       | 0        | 1        | 0        | 0        | 1        | 1        | 0        | 0        | 0        | 0        | 0        | 0     | 0     | 3     | 0     | 0     | 0     | 0     | 0     | 0     | 0      | 0      | 0      | 3      | 3      | 0      | 1      | 0      | 0 |   |  |
|                                                      | 4 Regulation of climate                              | 0       | 1       | 0       | 0       | 0       | 0       | 0       | 2       | 0       | 4        | 2        | 0        | 0        | 1        | 4        | 0        | 0        | 0        | 0        | 0        | 0     | 1     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0      | 0      | 3      | 1      | 4      | 1      | 1      | 0      | 0 |   |  |
|                                                      | 5 Regulation of ocean acidification                  | 0       | 1       | 0       | 0       | 0       | 0       | 2       | 0       | 4       | 1        | 0        | 0        | 1        | 1        | 0        | 0        | 0        | 0        | 0        | 0        | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0      | 0      | 0      | 1      | 2      | 3      | 0      | 0      |   |   |  |
|                                                      | 6 Regulation of freshwater quantity, flow and timing | 0       | 1       | 0       | 0       | 0       | 0       | 2       | 0       | 0       | 0        | 1        | 0        | 0        | 2        | 1        | 0        | 0        | 0        | 0        | 0        | 0     | 1     | 0     | 0     | 0     | 4     | 1     | 0     | 0     | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 1      | 0 | 0 |  |
|                                                      | 7 Regulation of freshwater and coastal water quality | 0       | 1       | 0       | 0       | 0       | 0       | 1       | 3       | 0       | 2        | 1        | 0        | 0        | 3        | 1        | 0        | 0        | 0        | 0        | 0        | 0     | 1     | 3     | 0     | 0     | 4     | 0     | 0     | 0     | 0      | 0      | 0      | 3      | 0      | 3      | 1      | 0      | 0 |   |  |
|                                                      | 8 Formation, protection and decontamination of soils | 0       | 1       | 0       | 0       | 0       | 0       | 2       | 2       | 0       | 0        | 1        | 0        | 0        | 1        | 2        | 0        | 0        | 0        | 0        | 0        | 0     | 3     | 2     | 0     | 0     | 0     | 0     | 0     | 0     | 0      | 0      | 0      | 3      | 0      | 0      | 4      | 0      | 0 |   |  |
|                                                      | 9 Regulation of hazards and extreme events           | 0       | 1       | 0       | 0       | 0       | 0       | 2       | 0       | 0       | 0        | 1        | 0        | 0        | 3        | 1        | 0        | 0        | 0        | 0        | 0        | 0     | 1     | 3     | 1     | 0     | 0     | 0     | 0     | 0     | 0      | 0      | 0      | 3      | 0      | 4      | 0      | 1      | 0 | 0 |  |
|                                                      | 10 Regulation of organisms detrimental to humans     | 0       | 1       | 0       | 0       | 0       | 0       | 1       | 0       | 4       | 0        | 1        | 0        | 0        | 1        | 1        | 0        | 0        | 0        | 0        | 0        | 0     | 0     | 3     | 0     | 0     | 0     | 0     | 0     | 0     | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 2      | 0 | 0 |  |
|                                                      | 11 Energy                                            | 0       | 2       | 0       | 1       | 0       | 0       | 0       | 0       | 0       | 0        | 1        | 0        | 0        | 1        | 1        | 0        | 0        | 1        | 0        | 0        | 1     | 0     | 0     | 0     | 0     | 0     | 4     | 0     | 0     | 0      | 0      | 0      | 0      | 0      | 0      | 1      | 0      | 0 |   |  |
|                                                      | 12 Food and feed                                     | 0       | 2       | 1       | 1       | 2       | 4       | 4       | 0       | 0       | 3        | 1        | 2        | 4        | 1        | 2        | 0        | 0        | 1        | 0        | 0        | 1     | 4     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0      | 0      | 0      | 0      | 3      | 0      | 3      | 2      | 0 | 0 |  |
|                                                      | 13 Materials                                         | 0       | 2       | 0       | 1       | 2       | 0       | 3       | 0       | 0       | 0        | 1        | 1        | 0        | 1        | 1        | 0        | 0        | 1        | 0        | 0        | 1     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 1      | 0 | 0 |  |
|                                                      | 14 Medicinal, biochemical and genetic resources      | 1       | 2       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0        | 1        | 0        | 4        | 1        | 1        | 4        | 0        | 2        | 0        | 0        | 0     | 3     | 1     | 0     | 0     | 0     | 0     | 0     | 0     | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 3      | 0 | 0 |  |
|                                                      | 15 Learning and inspiration                          | 3       | 0       | 0       | 0       | 0       | 0       | 1       | 0       | 0       | 0        | 0        | 0        | 0        | 0        | 1        | 0        | 0        | 0        | 3        | 3        | 0     | 0     | 1     | 0     | 3     | 0     | 0     | 0     | 0     | 0      | 0      | 0      | 1      | 0      | 0      | 0      | 1      | 0 | 0 |  |
|                                                      | 16 Physical and psychological experiences            | 1       | 1       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 2        | 1        | 0        | 0        | 1        | 1        | 0        | 0        | 0        | 0        | 0        | 0     | 0     | 0     | 1     | 0     | 0     | 0     | 0     | 0     | 0      | 0      | 0      | 3      | 0      | 0      | 1      | 1      | 0 | 0 |  |
| 17 Supporting identities                             | 0                                                    | 1       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 2        | 0        | 2        | 2        | 1        | 1        | 0        | 3        | 0        | 0        | 0        | 2     | 0     | 0     | 2     | 0     | 0     | 3     | 0     | 0     | 0      | 3      | 1      | 0      | 1      | 1      | 0      | 1      | 0 |   |  |
| Relational                                           | Living well in harmony with nature                   | 2       | 1       | 3       | 2       | 1       | 2       | 2       | 2       | 0       | 2        | 1        | 0        | 1        | 3        | 1        | 0        | 1        | 2        | 0        | 0        | 0     | 1     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0      | 0      | 2      | 3      | 0      | 1      | 2      | 0      | 2 |   |  |
|                                                      | Identity and Autonomy                                | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0        | 0        | 0        | 0        | 2        | 0        | 0        | 0        | 2        | 0        | 3        | 0     | 1     | 0     | 0     | 1     | 0     | 0     | 0     | 0     | 0      | 0      | 1      | 1      | 1      | 0      | 0      | 0      | 1 | 0 |  |
|                                                      | Spirituality and Religions                           | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0 |   |  |
|                                                      | Art and Cultural heritage                            | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0        | 0        | 0        | 0        | 4        | 2        | 0        | 0        | 0        | 3        | 0        | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0      | 0      | 0      | 3      | 0      | 0      | 0      | 0      | 0 |   |  |
|                                                      | Sustainability and Resilience                        | 4       | 2       | 3       | 4       | 3       | 4       | 4       | 2       | 0       | 3        | 1        | 3        | 2        | 3        | 3        | 1        | 0        | 4        | 0        | 0        | 0     | 0     | 3     | 0     | 2     | 0     | 2     | 1     | 1     | 3      | 0      | 4      | 4      | 2      | 4      | 4      | 1      | 2 |   |  |
|                                                      | Diversity and Options                                | 0       | 3       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0        | 0        | 0        | 0        | 1        | 0        | 0        | 0        | 0        | 0        | 0        | 0     | 0     | 0     | 0     | 1     | 2     | 0     | 0     | 3     | 0      | 1      | 2      | 1      | 2      | 0      | 0      | 2      | 2 |   |  |
|                                                      | Governance and Justice                               | 1       | 3       | 2       | 1       | 3       | 3       | 3       | 0       | 2       | 3        | 3        | 2        | 3        | 3        | 3        | 4        | 3        | 3        | 2        | 2        | 3     | 3     | 2     | 3     | 3     | 3     | 3     | 2     | 3     | 2      | 3      | 2      | 2      | 2      | 3      | 4      | 3      |   |   |  |
|                                                      | Health and Wellbeing                                 | 3       | 0       | 0       | 0       | 0       | 2       | 1       | 0       | 0       | 0        | 0        | 0        | 0        | 4        | 0        | 0        | 2        | 0        | 0        | 0        | 0     | 2     | 4     | 4     | 1     | 3     | 4     | 0     | 0     | 0      | 0      | 1      | 2      | 0      | 0      | 0      | 0      | 0 |   |  |
|                                                      | Education and Knowledge                              | 3       | 0       | 0       | 3       | 0       | 2       | 2       | 0       | 2       | 1        | 0        | 0        | 0        | 1        | 0        | 1        | 0        | 2        | 3        | 0        | 0     | 1     | 2     | 3     | 4     | 2     | 1     | 0     | 1     | 2      | 1      | 0      | 3      | 3      | 3      | 0      | 1      | 3 |   |  |
| Good social relations                                | 0                                                    | 0       | 0       | 2       | 0       | 0       | 0       | 0       | 0       | 0       | 0        | 0        | 0        | 1        | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0     | 0     | 0     | 1     | 1     | 0     | 0     | 0     | 0     | 0      | 2      | 1      | 0      | 0      | 0      | 4      | 1      |   |   |  |
| Security and Livelihoods                             | 0                                                    | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 3       | 0        | 0        | 2        | 3        | 2        | 0        | 0        | 0        | 0        | 0        | 1        | 4     | 3     | 3     | 2     | 2     | 2     | 1     | 4     | 2     | 2      | 4      | 0      | 3      | 2      | 2      | 2      | 1      |   |   |  |
| 4 value explicitly mentioned in the title/main focus |                                                      |         |         |         |         |         |         |         |         |         |          |          |          |          |          |          |          |          |          |          |          |       |       |       |       |       |       |       |       |       |        |        |        |        |        |        |        |        |   |   |  |
| 3 value explicitly mentioned in descriptions         |                                                      |         |         |         |         |         |         |         |         |         |          |          |          |          |          |          |          |          |          |          |          |       |       |       |       |       |       |       |       |       |        |        |        |        |        |        |        |        |   |   |  |
| 2 value mentioned as a synonym or as a group         |                                                      |         |         |         |         |         |         |         |         |         |          |          |          |          |          |          |          |          |          |          |          |       |       |       |       |       |       |       |       |       |        |        |        |        |        |        |        |        |   |   |  |
| 1 value related                                      |                                                      |         |         |         |         |         |         |         |         |         |          |          |          |          |          |          |          |          |          |          |          |       |       |       |       |       |       |       |       |       |        |        |        |        |        |        |        |        |   |   |  |
| 0 value not related                                  |                                                      |         |         |         |         |         |         |         |         |         |          |          |          |          |          |          |          |          |          |          |          |       |       |       |       |       |       |       |       |       |        |        |        |        |        |        |        |        |   |   |  |

Scores were compared between 5 independent raters (SJ, FSM, FB, EP, VP, MS) to assess the level of agreement between and identify deviating scores. While this weighting is straightforward and explicitly based on textual data, there is an inherent ambiguity of assigning value types to policy statements. Therefore, based on comparison of the first scoring round, each rater then rescored entries deviating from the average, and in a third round, consensus scores for remaining deviating scores were agreed upon.

#### C.4. Cost-benefit and distance to policy target projections

The obtained data was aggregated in two main ways. Each time, we are looking at scenarios, and aggregations are done within each scenario to allow comparison between them.

First, to compare distances to policy targets, the reviewed impacts on values are compared to the prioritization of these values by each policy goal. The sum-of-products per goal provides a straightforward projection of change for this goal.

With:

$s$  = a given scenario;

$g$  = a given policy goal;

$v$  = value indicator;

$p$  = policy weight for  $v$  (table...);

$i$  = modeled impact  $v$  on the value indicator under scenario  $s$  (from reviewed literature table...);

the total plural (33) values change  $C_{s,p}$  towards a policy goal  $g$  under a given scenario equals:

$$C_{s,p} = \sum_{v=1}^{33} (i * p)$$

Secondly, the sum-of-products per goal can be aggregated for all 37 goals to obtain an overall societal cost-benefit score per scenario  $B_s$ .

$$B_s = \sum_{p=1}^{37} (C_{s,p})$$

Not only does this include negative or positive impacts for diverse value indicators, but it also provides a weighting of these value indicators for ‘societal value’ using the entire policy. Even though unitless, this estimate is scientifically traceable to review literature and politically legitimate - providing a truly societal CBA in contrast to monetary estimates based on few benefit transfer studies performed in variable policy contexts.

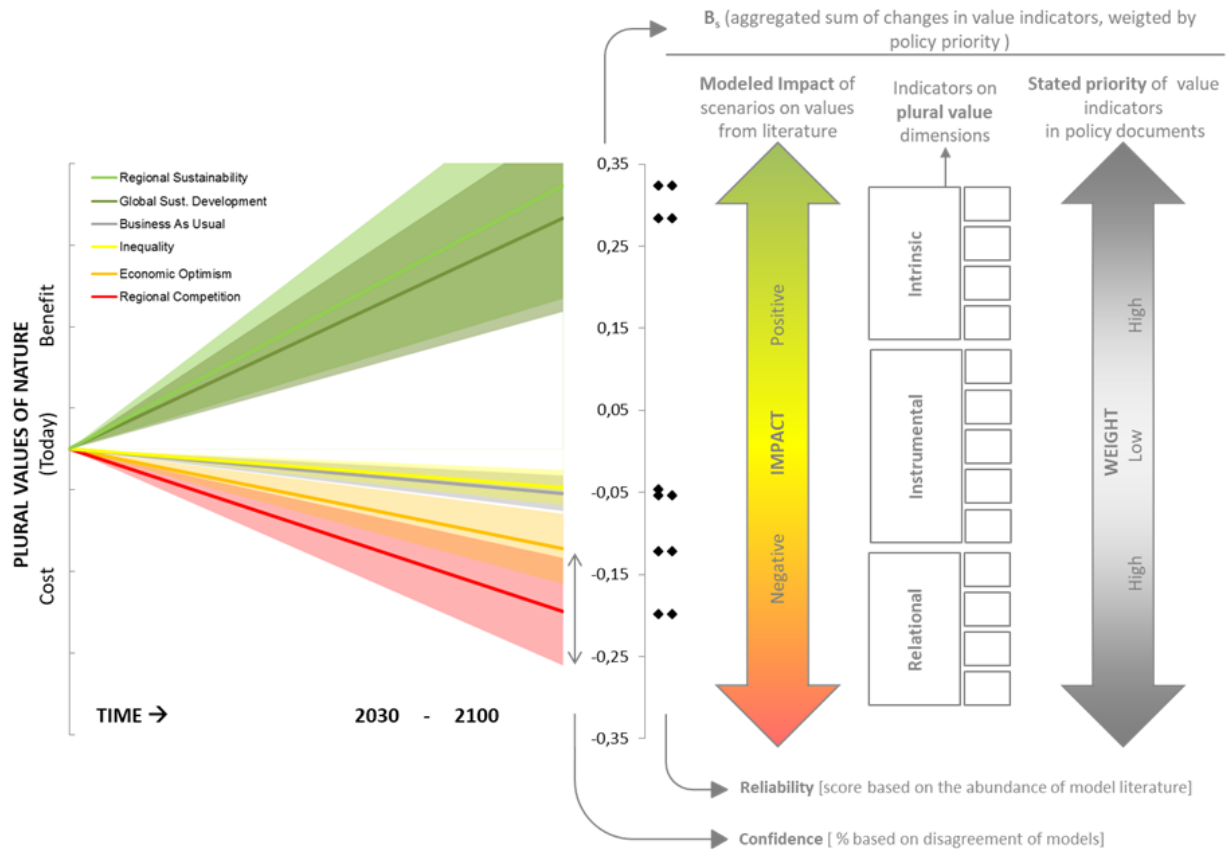


Figure S2. Projected change in the overall value of nature for the six scenario archetypes for Europe and Central Asia. The change in the values of nature for each scenario archetype (each coloured line) is represented as the sum of all impacts on value indicators, weighted for policy priorities. Reliability is represented by the amplitude of the shadow of each line. Time horizon of the reviewed literature varies from 2030 to 2100.

Reliability can be derived from the abundance of evidence for each scenario/value combination (Table S2) and is depicted here as low to medium (one or two dots) as models and estimations on future impacts are lacking for many aspects. Confidence is in this case defined by the consistency/disagreement of the available models (see also Table S2). Graphically, this is depicted as the impact based on average  $B_s$  value (line) plus/ minus the standard deviation (colored range).