The thematic assessment report on

INTERLINKAGES AMONG BIODIVERSITY, WATER, FOOD AND HEALTH

SUMMARY FOR POLICYMAKERS

Summary for policymakers of the thematic assessment of the interlinkages among biodiversity, water, food and health (nexus assessment) of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

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Annex

Summary for policymakers of the thematic assessment of the interlinkages among biodiversity, water, food and health (nexus assessment)

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[2] David Obura served as co-chair of the assessment until his election as Chair of IPBES at the tenth session of the Plenary, with his term as co-chair corresponding to the preparation of the second draft of the chapters and the first draft of the summary for policymakers. He then served as a member of the management committee for the assessment.

Preamble

The thematic assessment of the interlinkages among biodiversity, water, food and health (nexus assessment) of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) addresses the complex and interconnected character of the crises and challenges of biodiversity loss, water availability and quality, food insecurity, health risks and climate change. It does so by providing a critical evaluation of evidence on interlinkages among five nexus elements: biodiversity, water, food, health and climate change. Although not mentioned in the title of the assessment, climate change has important and increasing, yet often overlooked, interactions with all nexus elements through climate change impacts and mitigation and adaptation actions. Climate change is a key direct driver of biodiversity loss, and thus is considered one of the five nexus elements. While energy is not considered as a nexus element, relevant aspects of energy systems are assessed where they have interlinkages with biodiversity, water, food, health and climate change adaptation and mitigation. Other systems, such as land, soil and air, are considered to be cross-cutting rather than stand-alone nexus elements.

Nexus approaches are crucial because, despite the intertwined nature of the drivers and underlying causes of degradation of biodiversity, water, food, health and climate, decisions to address them are often taken in isolation, resulting in potential misalignment, unplanned trade-offs and/or unintended consequences. Nexus approaches recognize that challenges within each element are interconnected with other elements across multiple spatial and temporal scales. By improving understanding of these interconnections and identifying opportunities for collaboration across sectors and scales, the findings of the nexus assessment can contribute to synergistic and holistic management and governance. Key concepts and definitions related to the nexus assessment are provided in **Figure SPM.1**.

This summary for policymakers is based on evidence from multiple knowledge systems It assesses the state of knowledge on past, present and possible future trends in the interlinkages among the five nexus elements, with a focus on biodiversity and on nature's contributions to people. It further assesses evidence regarding a diverse range of response options that address specific objectives, challenges or opportunities in the governance and management of these interactions among nexus elements (e.g., the influence of the elements on one another). These response options and governance actions can be designed to facilitate coherent and coordinated decision-making that overcomes trade-offs and enables synergies between biodiversity, water, food, health and climate change, while also supporting transformative change [TCA citation] toward just and sustainable futures, in line with global policy goals and frameworks such as the 2030 Agenda for Sustainable Development and its Sustainable Development Goals[3], the Convention on Biological Diversity and the Kunming-Montreal Global Biodiversity Framework[4], and the United Nations Framework Convention on Climate Change[5] and the Paris Agreement[6]. Hereafter, we refer more concisely to these global policy goals and frameworks as the Sustainable Development Goals, the Kunming-Montreal Global Biodiversity Framework, and the Paris Agreement.

The summary for policymakers has four parts: A. Past and current nexus interactions; B. Future nexus interactions; C. Response options that address nexus interactions; D. Governing the nexus for achieving just and sustainable futures. This report provides a set of key and background messages as approved by the members of IPBES. It contains key messages and background messages. Key messages describe the high-level findings from the assessment for decision-makers. More detailed evidence is given in background messages, with traceability between the key and background messages indicated in curly brackets after each key message. In turn, traceability to evidence in the chapters is indicated in curly brackets within each background message. Confidence terms based on the IPBES communication of the degree of confidence approach explained in Appendix I are also provided in each background message.

[3] Resolution adopted by the United Nations General Assembly, A/RES/70/1

[4] Adopted by the Conference of the Parties to the Convention on Biological Diversity, in decision CBD/COP/DEC/15/4

[5] United Nations, Treaty Series, vol. 1771, No. 30822

[6] Adopted by the Conference of the Parties to the United Nations Framework Convention on Climate Change, Decision 1/CP.21, FCCC/CP/2015/10/Add.1

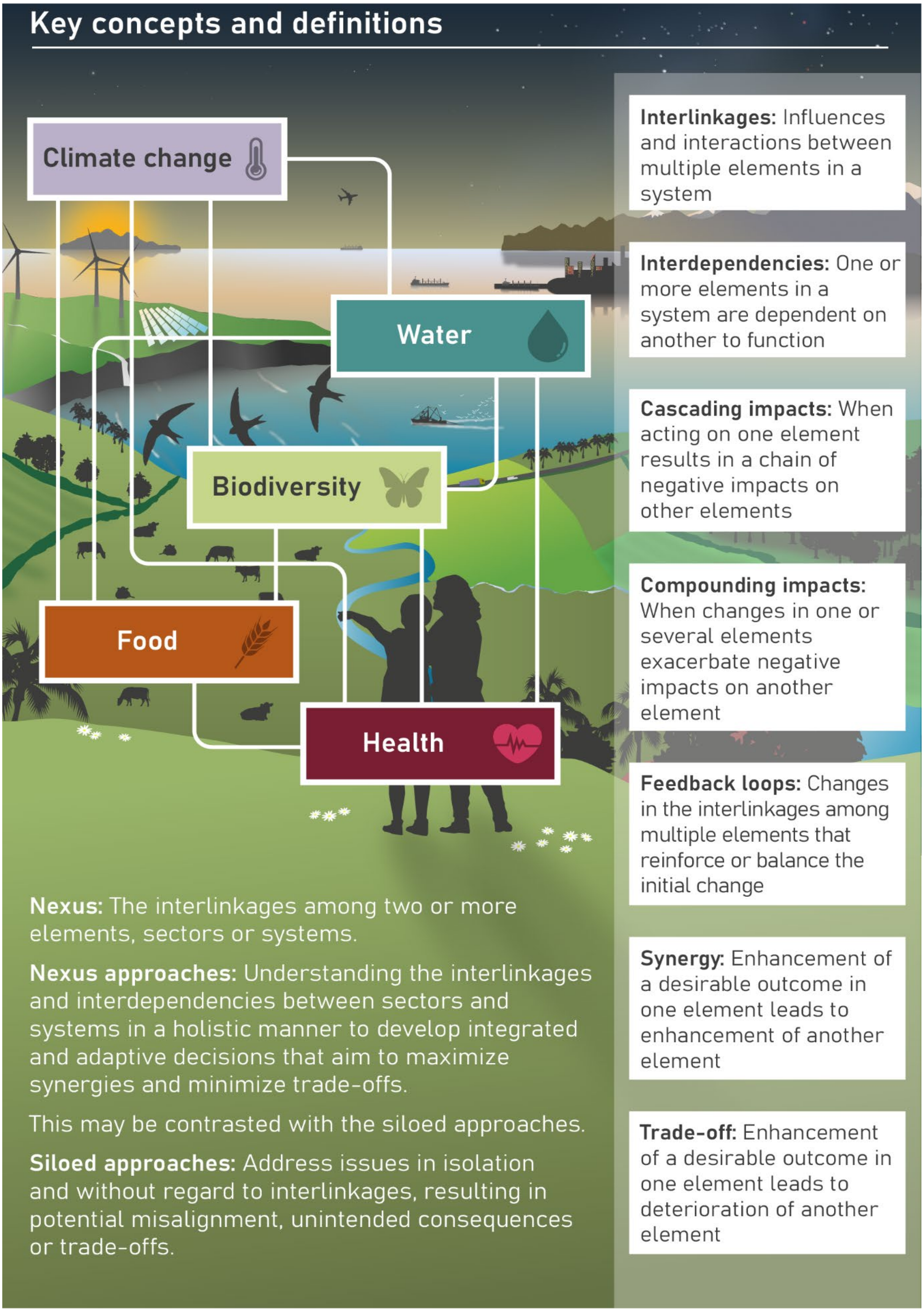

Figure SPM.1. Key concepts and definitions used in the nexus assessment. Detailed definitions of the five nexus elements are given in chapter 1, Box 1.1. Each nexus element is represented by a unique colour throughout the figures in this assessment: biodiversity is represented by light green; water is represented by teal; food is represented by orange; health is represented by dark red; and climate is represented by light purple.

Key messages

A. Past and current nexus interactions

KM-A1. Biodiversity is essential to our very existence, supporting our water and food supplies, our health and the stability of the climate. Biodiversity is declining in all regions of the world and at all spatial scales, impacting ecosystem functioning, water availability and quality, food security and nutrition, human, plant and animal health and resilience to the impacts of climate change. Biodiversity loss and climate change are interdependent and produce compounding impacts and impacts that threaten human health and human well-being {A2, A3, A4, A5}. Biodiversity and functioning ecosystems play a vital role in providing nature's contributions to people, including regulating the climate and nutrient and hydrological cycles that are essential for providing sufficient and clean water, sustaining food systems, regulating pests and pathogens, improving physical and mental health, providing traditional and modern medicines and supporting cultural identities. However, for the last 30-50 years, all of the assessed indicators show biodiversity declines of between 2 to 6 per cent per decade. Biodiversity loss and climate change interact and compound each other to negatively impact ecosystem resilience and all the other nexus elements. Functioning and resilient ecosystems contribute to climate change mitigation and adaptation, such as by buffering extreme weather events and acting as a carbon sink. However, biodiversity loss reduces the ability of ecosystems, such as forests and oceans, to sequester carbon, thereby increasing greenhouse gas concentrations and accelerating climate change. Biodiversity loss reduces water availability, increases pathogen emergence and exacerbates some forms of water pollution, undermining human, plant and animal health. Biodiversity supports resilient and productive marine, coastal and freshwater fisheries, as well as agricultural systems through pollination, pest control and soil health**.** Yet, unsustainable agricultural practices have contributed to biodiversity loss, greenhouse gas emissions, and air, water and land pollution with some systems such as fisheries approaching tipping points. Increased food production has generally improved human health helping to lower child mortality and lengthen human life spans. Sufficient and healthy food, including a variety of fruits, vegetables, legumes, whole grains and nuts, contribute to a sustainable healthy diet[7]. However, a lack of agrobiodiversity and diet diversity continues to limit these health gains, especially for people with lower incomes and those in vulnerable situations. There are persistent inequalities in food security, with 80 per cent of the undernourished concentrated in developing countries. Less diverse and unhealthy diets are a leading cause of non-communicable diseases globally.

KM-A2. In the last 50 years global trends in a wide range of indirect drivers have intensified direct drivers of biodiversity loss and caused negative outcomes for biodiversity, water availability and quality, food security and nutrition, health and contributed to climate change {A1, A3, A6}. Global trends in indirect drivers of biodiversity loss, including economic, demographic, cultural and technological change (such as overconsumption and waste) have led to intensified trends in direct drivers (such as land- and sea-use change, unsustainable exploitation, pollution, invasive alien species, and climate change) in terrestrial, freshwater and marine ecosystems. This is made worse by fragmented governance of biodiversity, water, food, health and climate change with different institutions and actors[8] often working on disconnected and siloed policy agendas, resulting in conflicting objectives and duplication of efforts. These direct and indirect drivers interact with each other and cause cascading impacts among the nexus elements. For example, increases in unsustainable food production have been associated with land conversion and the expansion of unsustainable agricultural practices, particularly driven by affluence. Such practices have led to biodiversity loss, reduced water availability and quality, increases in greenhouse gas emissions and increases the risk of pathogen emergence. Overharvesting, overfishing and unsustainable exploitation and production activities on land and sea also degrade freshwater and marine systems that are crucial for water cycles, food security and climate change mitigation.

KM-A3. Societal, economic and policy decisions that prioritize short-term benefits and financial returns for a small number of people while ignoring negative impacts on biodiversity and other nexus elements lead to unequal human well-being outcomes. Existing governance approaches have often failed to account for and address these negative impacts in degrading nature, with the negative impacts disproportionately affecting the well-being of some more than others {A6, A7}. Current economic and financial systems invest $7 trillion per year in

[7] Sustainable healthy diets promote all dimensions of individuals' health and well-being; have low environmental pressure and impact; are accessible, affordable, safe and equitable; and are culturally acceptable (FAO/WHO, 2019).

[8] Actors in the context of the nexus are any individual or group that is directly or indirectly, formally or informally associated with or affected by the nexus elements and response options. Actors seek to influence public decisions and enable action to address societal aspirations, needs and concerns {1.3.2, 1.3.3, 4.2.6}. Examples of actor categories include global and regional institutions, national, sub-national and local governments, knowledge and educational communities, civil society and community-based organizations, Indigenous Peoples and local communities, the private sector and business organizations, science-policy interfaces, financing institutions, and media and the arts, each of whom have their own stakes and interests.

activities that damage biodiversity and other nexus elements. Dominant economic systems can result in unsustainable and inequitable economic growth and prioritize only a limited set of nature's contributions to people (e.g., water and food) while not accounting for diverse values of nature. Consequently, more than half of the world's population is living in areas experiencing the highest impacts from declines in biodiversity, water availability and quality and food security, and increases in health risks and negative effects of climate change. These burdens disproportionately affect developing countries, including small island developing states, Indigenous Peoples and local communities as well as those in vulnerable situations in higher-income countries. Despite these pressures, Indigenous Peoples and local communities successfully conserve biodiversity and sustainably manage other nexus elements using their knowledge and practices, supporting arguments for their recognition as rights holders and increased inclusion and participants in decision-making. Efforts to improve the status of the nexus elements (e.g., environmental regulations) have been partially successful. However, they are unlikely to be fully effective without more concerted efforts to address interlinkages among the nexus elements and their direct and indirect drivers. Governance can also be improved through inclusion of a wider range of actors and values, with a particular focus on equity, alongside economic and financial reforms.

B. Future nexus interactions

KM-B1. Continuation of current trends in direct and indirect drivers will result in substantial negative outcomes for biodiversity, water availability and quality, food security and human health, while exacerbating climate change. Scenarios that prioritize objectives for a single element of the nexus without regard to other elements (i.e., solely for biodiversity, water, food, human health or climate change) will result in trade-offs across the nexus {B1, B2, B3, B4, B5, C6, Box SPM.1}. Scenarios in which current trends in direct and indirect drivers continue into the future are characterized by increases in material resource extraction and overconsumption, unsustainable and inequitable economic growth that impacts negatively on the environment and inefficient efforts to combat climate change.-Delaying action to meet policy goals and failing-to tackle these drivers increases costs. For example, the costs of addressing biodiversity loss would double if delayed by ten years (e.g., from 2021 to 2030), and add an estimated minimum of $500 billion per year for addressing climate change. Scenarios that prioritize single-sector objectives or actions in isolation, such as biodiversity conservation, water provision, food production, human health or climate change mitigation, do not achieve nexus-wide benefits due to interdependencies between the elements that can create trade-offs. Nexus-wide benefits depend on reducing climate change and ensuring that climate change mitigation approaches do not negatively impact other nexus elements (e.g., conserving coastal and marine ecosystems that contribute to carbon sequestration). Similarly, improvements across the nexus elements are reliant on curbing biodiversity loss, which benefits other nexus elements if done in an integrated and just manner (e.g., integrated landscape and seascape approaches and learning from and considering the rights and needs of Indigenous Peoples and local communities).

KM-B2. Nexus-wide benefits with positive outcomes for people and nature are feasible in the future, but achieving the highest levels of positive outcomes across all nexus elements is challenging. Scenarios that achieve balanced benefits across the nexus elements tend to include response options that effectively conserve, restore and sustainably use and manage ecosystems, reduce pollution across marine, freshwater and terrestrial realms, adopt sustainable healthy diets and mitigate and adapt to climate change {B1, B2, B3, B4}. Positive scenarios show outcomes that include halting and reversing biodiversity loss, improving water availability and quality and food security, improving human health outcomes and slowing the rate of climate change. These scenarios include integrated and timely adoption of multiple response options that do not focus solely on a single nexus element but include combinations of effective biodiversity conservation (in marine, freshwater and terrestrial systems), ecosystem restoration and sustainable healthy diets. They are characterized by sustainable management of natural resources, inclusive economic growth that ensures just distribution of benefits across different societal groups, and sustainable consumption patterns. In addition, these scenarios tend to include climate change mitigation actions and response options that target the drivers of habitat conversion and degradation, such as sustainable production and consumption interventions, to reverse biodiversity loss while achieving multiple benefits for water, food, human health and climate.

KM-B3. Scenarios focused on synergies among biodiversity, water, food, human health and climate change have more beneficial outcomes for global policy goals, such as the Sustainable Development Goals. Siloed policy approaches and actions that prioritize a single nexus element limit the achievement of benefits across policy goals {B3, B5}. In scenarios that continue or reinforce current policy trends, and that focus on food, biodiversity or climate change policy in isolation, global policy goals are largely unachieved. In contrast, scenarios that have positive impacts on biodiversity and on the other nexus elements also have more positive effects on multiple policy goals, showing that synergies among policy goals can be achieved through greater levels of coordinated, timely and enhanced objectives and actions across policy sectors. Transforming to more efficient, inclusive, resilient and sustainable food systems would deliver multiple benefits to the nexus elements and would help countries address land conversion and unsustainable agricultural practices that have led to environmental degradation, biodiversity loss, and health risks, such as emerging infectious diseases and malnutrition. Climate change mitigation policies are more effective in future scenarios that minimize trade-offs across the nexus elements, such as planning actions in an integrated way to avoid competition for land and other resources between climate change mitigation actions and the other nexus elements. Policies that support sustainable healthy diets, sustainable resource use and waste reduction, consider multiple actors, and associated values and knowledge systems, play a critical role in scenarios that successfully achieve sustainable futures.

C. Response options that address nexus interactions

KM-C1. Numerous highly synergistic response options are already available to actors in multiple sectors for sustainably managing biodiversity, water, food, health and climate change. Response options not typically focused on biodiversity can often have greater benefits for biodiversity than those specifically designed as such. Response options, when implemented at appropriate scales and contexts, provide many benefits to different degrees across the nexus elements, and many are low cost {C1, C2, C3, C4, C5, C6, C7, C8, C9}. Seventy-one response options were assessed in depth, representing 10 broad categories of actions: conserve or halt conversion of ecosystems of high ecological integrity; restore natural and semi-natural ecosystems; manage ecosystems in human-exploited lands and waters; consume sustainably; reduce pollution and waste; integrate planning and governance; manage risk; ensure rights and equity; align financing; and an "others" category containing several other important options. Response options vary widely in their nexus-wide impacts. For some response options, evidence indicates potential benefits across all nexus elements: examples include integrated landscape and seascape management, efficient water use in agriculture, sustainable healthy diets, biodiversity management for zoonoses, sustainable bioeconomy and restoration of ecosystems that contribute to climate change mitigation and adaptation (e.g., forests, soils, wetlands, peatlands and mangroves). For other response options, there are benefits to fewer nexus elements. Some response options originating in one element may have unintended negative consequences on other nexus elements if not carefully implemented (e.g., offshore wind power, dam operation). Many response options are low cost (e.g., agroecology, integrated multi-trophic aquaculture, health impact assessments, ecological intensification of agriculture). Options that unlock new forms of financing, change business models or better align incentives, while challenging, can create opportunities for more system-wide changes and increase sectoral synergies now and in the future. Brief descriptions of all response options, referred to here only by name, are in Appendix IV.

KM-C2. Response options can facilitate or impede each other, leading to potential synergies and trade-offs among them. The efficacy of response options in realizing nexus-wide benefits can be enhanced by implementing them together or sequentially, as some response options enable others or amplify their benefits {C6, C8, C10, D2}. Response options that reduce competition for land or other resources can facilitate other response options in achieving positive outcomes across several nexus elements. For example, sustainable healthy diets, reduced food loss and waste and ecological intensification and sustainable intensification of agriculture and ecosystem restoration can be combined (i.e., bundled together) and incentivized and driven by behaviour change to reduce land conversion and water pollution, halt or reverse biodiversity loss, improve human health, and reduce greenhouse gas emissions. Some response options in and of themselves are similar to bundles in that they comprise multiple synergistic actions, such as Indigenous food systems that emerge from Indigenous and local knowledge and traditional practices and which are based on holistic worldviews. Response options designed and implemented in isolation, without considering interconnections among them, may result in fewer benefits across the nexus elements. Integrated planning and governance approaches and rights-based approaches[9] and aligning finance can facilitate the bundling and sequencing of response options to achieve synergies or multiple co-benefits and address trade-offs and even achieve cost savings. Ensuring the full and effective participation of a wide range of actors, including Indigenous Peoples and local communities, in the co-design, coordination and implementation of bundles of response options can help to increase the magnitude and equity of benefits as well as facilitate the emergence of new options from collaborative contexts.

KM-C3. Response options can strongly advance global policy efforts, including the Sustainable Development Goals, the Kunming-Montreal Global Biodiversity Framework and the Paris Agreement, to achieve just and sustainable futures. Response options designed to benefit multiple nexus elements support multiple goals and targets across global policy frameworks, strengthening synergies and alignment among them {C10, Box SPM.2}. Implementing the 71 assessed response options would collectively support the achievement of all 17 Sustainable Development Goals, all 23 targets of the Kunming-Montreal Global Biodiversity Framework, and the long-term mitigation and adaptation goals of the Paris Agreement. Those Sustainable Development Goals that are directly aligned with nexus elements (i.e., Goals 2, 3, 6, 13, 14 and 15) are supported by the largest numbers of response options, but these and other response options also contribute substantially to the achievement of the remaining 11 Goals. Twenty-four response options each advance more than five Sustainable Development Goals and more than five Kunming-Montreal Global Biodiversity Framework targets. These include ecosystem-based adaptation

[9] In line with consideration of section C for implementation of the Kunming-Montreal Global Biodiversity Framework.

in rural landscapes, transboundary water cooperation, Indigenous food systems, urban green infrastructure, urban nature-based solutions and agroecology. Response options based on mainstreaming biodiversity across and within sectors, while primarily targeting biodiversity, also have considerable potential to benefit other nexus elements and thereby support global policy frameworks. In addition to helping achieve global goals, these response options have direct and tangible benefits to Indigenous Peoples and local communities where they are implemented.

D. Governing the nexus for achieving just and sustainable futures

KM-D1. Transforming current siloed modes of governance through more integrative, inclusive, equitable, accountable, coordinated and adaptive approaches enable successful implementation of response options to manage the nexus elements in an integrated manner and their associated direct and indirect drivers with benefits for people and nature now and into the future {A1, A7, D1, D2}. Existing governance fails to address the complex, interconnected and interdependent challenges resulting from the pace and scale of environmental change and rising inequalities. Institutions that are fragmented and siloed and policies that are short-term, contradictory or non-inclusive, undermine the achievement of global policy frameworks. Addressing the indirect drivers of environmental change and the underlying values and behaviours influencing those drivers is crucial for tackling declines in nature and its contributions to people and is integral for improving governance approaches. "Nexus governance approaches" provide more synergistic, holistic and transdisciplinary framings of problems and solutions, includes more actors across multiple nexus interactions, emphasizes explicit values like equity and accountability, enables policy alignment, collaboration and integration, and are experimental, adaptive and reflexive. Integrating these components of nexus governance and decision-making with multiple actors across sectors and scales can foster a whole-of-society approach, as enshrined in many global policy frameworks.

KM-D2. Gaps in finance to meet biodiversity needs are $0.3–1 trillion per year, and additional investment needs to meet the Sustainable Development Goals most directly related to water, food, health and climate change are at least $4 trillion per year. Urgent action to transform values and structures and address the dominance of a narrow set of interests within economic and financial systems can enable increased investments for biodiversity and the other nexus elements {D3}. Transformation of economic and financial systems can take place through strengthening the capacity of decision-makers to understand and respond to the connections between economic and ecological systems and to use sustainable finance and economic instruments. Changes in the fiscal and regulatory enabling environment can adjust financial incentives by increasing the costs of causing harm to nature and encouraging changes in business models including]through improving returns to investments that benefit nature. Complementary response options can help align economic and financial systems with biodiversity and reduce negative incentives that drive damage to biodiversity and nexus elements. More transformational changes can include adoption and use of metrics beyond GDP and the inclusion of diverse values and actors in economic and financial decision-making. This can be supported by improving access to and availability of financial resources, in particular for developing countries and by tackling existing debt concerns and acknowledging the need for just and equitable transitions. People historically and currently marginalized, and Indigenous Peoples and local communities; face particular challenges in accessing financing for required needs. Collectively, these efforts could reform the relationship between the economy and nature, enhance equity and deliver sustainable development outcomes.

KM-D3. Nexus governance approaches, decision-making and capacity strengthening can be enhanced through a series of deliberative steps and actions, informed by diverse evidence. A road map for nexus action can be used by a wide range of actors in multiple sectors to identify problems and shared values in order to work collaboratively towards solutions to help achieve just and sustainable futures aligned with global policy frameworks. Tools and methods facilitating a holistic understanding of nexus elements can increase knowledge and improve cooperation and decision-making {D2, D4, D5}. The steps of the road map can be applied to specific challenges or opportunities related to the nexus elements and their interactions and include: characterizing direct and indirect drivers and their impacts, identifying and convening governance actors across sectors and scales, understanding interactions and interdependencies among nexus elements, co-creating visions and aligning values, identifying response options and their synergies and trade-offs, assessing enabling conditions and overcoming barriers to coordinated and integrated action, negotiating implementation and scaling, and monitoring and learning iteratively. These steps can be undertaken by a range of actors working together and depend on more inclusive and cross-scale actor cooperation. However, there are many barriers to collaborative action, such as intersectional and compounding systems of marginalization, especially for groups such as Indigenous Peoples and local communities, young people, the elderly, migrants and displaced peoples, women and those living with disabilities. Improving capacities for governance can strengthen awareness of the need for change, enhance the co-production of knowledge, help navigate trade-offs and assist in addressing injustices. Actions within the road map can be both incremental and transformative, and all can improve the current situation and help move towards just and sustainable futures.

Background messages

A. Past and current nexus interactions

A1. Global trends in indirect drivers of biodiversity loss, including economic, demographic, institutional, cultural and technological change, have increased or accelerated over the last 50 years *(well established)* {2.3.2}. These have led to intensified trends in direct drivers (including land- and sea-use change, unsustainable exploitation of organisms, climate change, pollution and invasive alien species) with cascading effects on all nexus elements *(well established)* {2.3.1, 2.4, 2.5, 2.6.1} (Figures SPM.2 and SPM.3). Siloed governance that treats nexus elements in isolation further exacerbates these challenges *(well established)* {1.1.1, 1.1.2.2, 4.2.2, 6.2.5, 7.2.5}. Ten out of twelve indicators across five categories of indirect drivers (economic, demographic, institutional, cultural and technological) have increased since 2001 (*established but incomplete*) {2.3.2} (**Figure SPM.3**). Research and innovation (i.e., technological development), education, poverty reduction and some environmental regulations have led to improved trends in nexus elements (*established but incomplete*) {2.3.2.1, 2.3.2.2, 2.3.2.3, 2.3.2.4, 2.3.2.5} (**Figure SPM.3**). However, negative effects from other indirect drivers, such as growth in gross domestic product, trade, population and urbanization, as well as high per capita consumption in high-income countries and increased world per capita consumption, have intensified direct drivers, while noting the rate of change differs among regions and countries, resulting in cascading negative effects on nexus elements *(well established)* {2.3.1, 2.4} (**Figures SPM.2, SPM.3**). Governments and other actors have often failed to address these challenges, particularly as sectoral policies often do not take into account indirect drivers and remain fragmented across different institutions and actors; this results in governance gaps, conflicting objectives and incentives and leads to unintended consequences and inefficient use of resources *(well established)* {1.1.2, 1.3.4, 4.2.2, 4.5.4, 7.2.5}. Armed conflicts have increased in number since 2010 *(well established)* {2.3.2.3}. Conflicts have intensified some direct drivers and, in addition to loss of human life, may damage or destroy biodiversity, agricultural lands, water supply and impact human well-being. Armed conflicts also create barriers to collaboration, severely delaying collective and transformative action in support of sustainable development *(well established)* {2.3.2.3}.

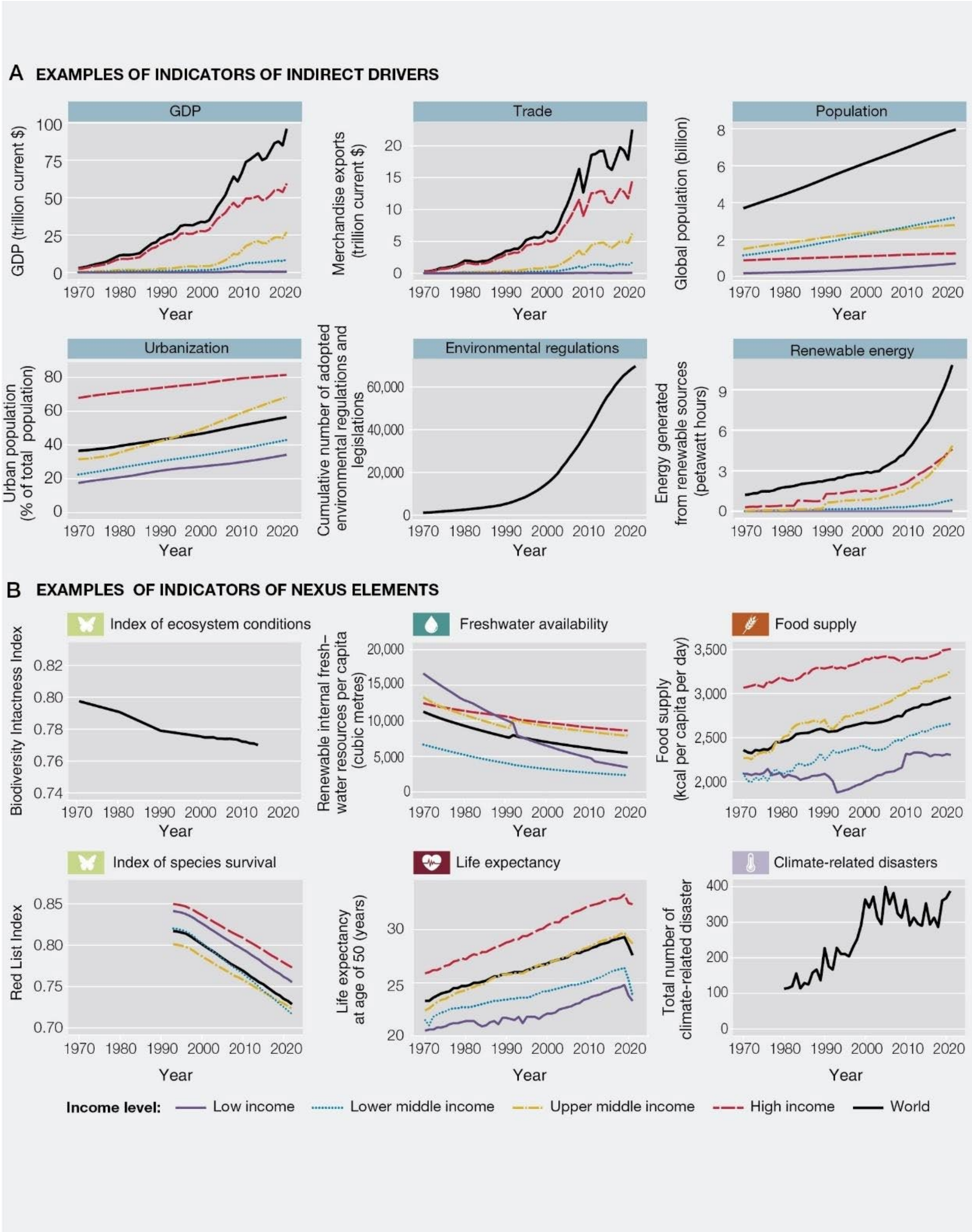

Figure SPM.2. A. Temporal trends in indicators of indirect drivers affecting the nexus elements. B. Temporal trends in indicators of the nexus elements. Trends are based either on global data or on national-level data that have been aggregated globally and for four World Bank income levels between 1970 and 2022, according to data availability. For refence, the categories Low income, Lower middle income and Upper middle income correspond to Developing Economies. (B), shows temporal trends of nexus indicators (1) Biodiversity: ecosystem condition displayed by Biodiversity Intactness Index (0–1), and species survival displayed by Red List Index (0-1). (2) Water: freshwater availability. (4) Health: life expectancy (life expectancy at age of 50 years); (5) Food: food supply (kilocalories per capita per day) and (6) Climate Change: climate-related disaster frequency (total number of climate-related disaster). For more details see chapter 2, section 2.3.3. *Abbreviations:* GDP: gross domestic product.

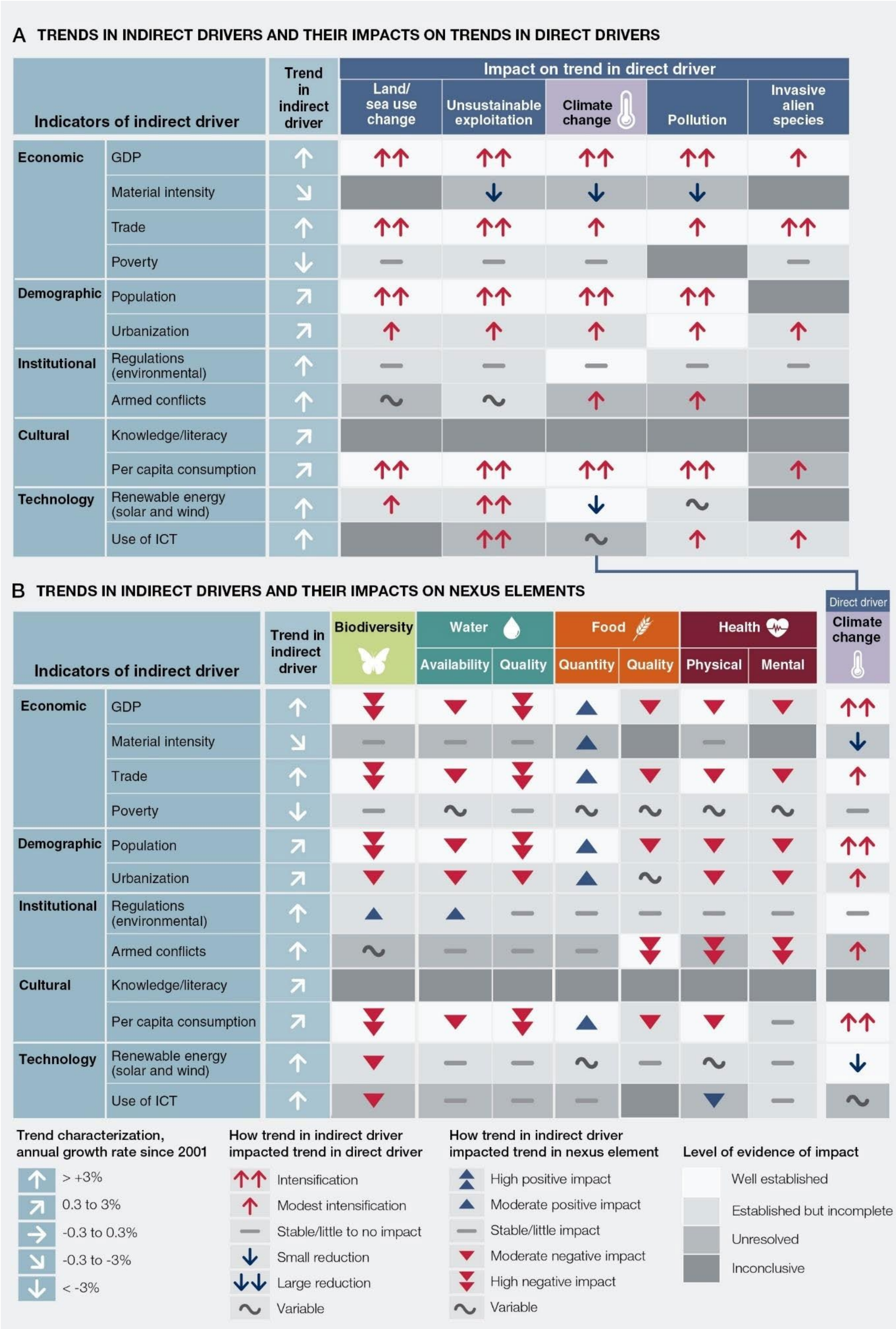

Figure SPM.3. A. Impact of trends in indirect drivers on trends in direct drivers of nexus elements. B. Impact of trends in indirect drivers on the nexus elements. (A) characterizes annual growth for selected indicators of indirect drivers and the impact of those on the trends of direct drivers {2.3.1, 2.3.2}. For the given period of time, trends of indirect drivers intensified direct drivers, and thus intensified climate change as one of the nexus elements.

To provide a comprehensive picture of the nexus, climates change is duplicated because it is both a driver (A) and nexus element (B). For (B), an analysis of the same indirect driver trends was used to assess the impact of these trends on the nexus elements biodiversity, food (availability and quality), water (availability and quality), health (physical and mental). This figure summarizes knowledge on the recent trends over the period 2001 to 2021 (according to data availability). These impacts must be interpreted using SPM.2, which shows the relative trends in indicators broken down by income levels, showing, for example, the relatively greater impact of indirect drivers such as consumption by high income countries. For more detailed information see chapter 2 {2.3.2, Figure 2.11}. For both panels A and B, if knowledge is inconclusive no impact score was given. *Abbreviations:* GDP: gross domestic product; ICT: information and communication technologies.

A2. Freshwater biodiversity is being lost faster than terrestrial *(well established)* {2.3.3, 2.4.1}. Unsustainable freshwater withdrawal, wetland degradation and forest loss have decreased water quality and climate change resilience to the impacts of climate change in many areas of the world *(well established)* {2.4.1, 2.5.2, 2.6}, impacting biodiversity, water and food availability with consequences for human, plant and animal health *(well established)* {2.4.1, 2.5.1, 2.5.2.3, 2.6}. Globally, many marine systems have been overharvested and degraded through anthropogenic activities *(well established)* {2.4.1, 2.5.2, 2.6}, causing declines in biodiversity and nature's contributions to people. Freshwater and marine coastal ecosystems are particularly sensitive because they accumulate anthropogenic stressors, such as pollutants and sediments, across ecosystem and watershed boundaries *(well established)* {2.3.1,1, 2.3.1.3, 2.4.1, 2.5.2}. Water extraction for food production is responsible for approximately 80 per cent of humanity's water demand *(well established)* {2.5.2.1}. The water cycle is regulated by ecosystem and geophysical processes that support biodiversity and provide nature's contributions to people essential to human health and well-being (**Figure SPM.4**). Wetlands and inland water bodies cover just 2.6 per cent of the terrestrial Earth surface but play a significant role in water regulation and climate change mitigation and adaptation. They are also the water bodies most affected by human activities and climate change, and a substantial proportion having been degraded or lost over past centuries *(well established)* {2.3.3, 2.4.1, 2.5.1, 2.5.2}. Forests are also crucially important for water regulation and provision; they capture, filter and regulate water through their vegetation and soils, ensuring clean and accessible freshwater for up to 75 per cent of the world's population (in 2005) *(well established)* {2.4.1}. Consequently, loss of forest cover decreases water regulation, quality, and availability, resulting in increasing water treatment costs and negative health outcomes *(well established)* {2.4.1}. At least 50 diseases are attributable to poor water supply, water quality and sanitation *(well established)* {2.5.2.3}. Among marine ecosystems, coral reefs are under combined threats from unsustainable fishing, land-based pollution, climate change and ocean acidification, with approximately a third of reef-building coral species already at high risk of extinction *(well established)* {2.3.1, 2.5.2}. Coral reefs are the most endangered ecosystems and may disappear globally in the next 10 to 50 years {2.4.1}. These impacts potentially affect nearly 1 billion people who live within 100 km of a coral reef (~13 per cent of the global population) and who benefit from them in terms of food, medicine, protection from coastal storms and erosion, tourism and recreation and livelihoods *(well established)* {2.4.1, 2.5.2.2}. {2.4.1, 2.5.2.2}.

A3. Increases in food production have improved health through greater caloric intake *(well established)* {2.3.3, 2.4.2, 2.5}. However, unsustainable agricultural practices that have contributed to such increases in food production have also resulted in biodiversity loss, unsustainable water usage, reduced food diversity and quality, and increased pollution and greenhouse gas emissions *(well established)* {2.4.2, 2.4.3, 2.5, 2.6.1} (Figure SPM.4). These effects are experienced unequally and mostly impact people in developing countries, particularly those in least developed countries *(well established)* {2.5, 2.5.3.1, 2.6}. Negative impacts on the nexus elements from food systems from both land conversion and unsustainable agricultural practices have decreased biodiversity and consequently many of nature's contributions to people, particularly through diminished regulating contributions (e.g., regulation of water quality and climate) *(well established)* {2.4.2, 2.5} and increased non-communicable disease risks *(well established)* {2.4.3, 2.5}, emerging infectious diseases *(established but incomplete)* {2.4.3, 2.5}, and global temperatures and other climatic changes *(well established)* {2.5.2.2.}. Rising global food demand, particularly driven by affluence, has led to an increase in agricultural production. This has been partially achieved through unsustainable agricultural practices that have led to unsustainable use of water and synthetic chemical substances, such as mineral fertilizers and pesticides, and also contribute to climate change and affect the other nexus elements, through increasing air, water and land pollution, and loss of biodiversity in terrestrial, freshwater and marine ecosystems *(well established)* {2.3.1, 2.4.2}. Climate change has also slowed growth in agricultural productivity over the last decades (well established) {2.4.4}. Global agrobiodiversity, including genetic resources for food and agriculture, is declining *(well established)* {2.4.2, 5.4.3.3} with global food production heavily dependent on just 9 crop species that contribute to 65 per cent of the world's crop production *(well established)* {2.4.2}. This impacts ecosystem functioning, food system resilience, food security and nutrition, and social (employment, health) and economic (income, productivity) systems *(well established)* {2.4.2}. Increased quantity of food production has not been matched by improved nutritional quality *(well established)* {2.4.2}. Global malnutrition and inequalities in food security persist despite a decline in the number of undernourished people *(well established)* {2.4.2, 2.5}. Eighty per cent of undernourished people are in developing countries primarily living in rural areas *(well established)* {2.3.3}. The costs of healthy diets can be high, particularly in developing countries, and, consequently, inaccessible to many: 42 per cent of the global population; 86 per cent of low-income country populations and 70 per cent of lower-middle-income country populations could not afford healthy diets in 2021 *(well established)* {2.4.2, 2.5}. Food insecurity affects over 800 million people in Asia and Africa and, globally in 2017, nearly 3 million deaths were associated with diets low in whole grains *(established but incomplete)* {2.3.1}. Unsustainable exploitation and pollution of freshwater and marine ecosystems impact millions of people, including those highly dependent on protein-rich food obtained from these ecosystems, such as Indigenous Peoples and local communities *(well established)* {2.4.2, 2.5}.

A4. Human health is directly affected by the nexus elements of biodiversity, water, food and climate change. Improvements in human health, including greater life expectancy and childhood survival, are partly a result of increased production of and access to food. Worsening outcomes from several communicable and non-communicable diseases are linked to biodiversity loss, unhealthy diets, lack of clean water, pollution and climate change among other causes (well established) {2.3.3, 2.4.3, 2.5.2.3}. Both positive and negative human health outcomes have been highly unequal *(well established)* {2.3.3, 2.4.3, 2.5}. Life expectancy has increased dramatically across the globe over the last centuries, particularly due to improvements in food security and health care, including medicines from biodiversity, but average life expectancy differs by about 20 years between regions (**Figure SPM.2**). Child mortality rates are 10 times higher in least developed countries than in high-income countries *(well established)* {2.3.3}. Unhealthy diets have become one of the most important drivers of global mortality, accounting for nearly 11 million adult deaths in 2017 and 255 million disability-adjusted life years (15% of all disability-adjusted life years among adults) *(well established)* {2.3.3, 2.5}. Unsustainable farming systems contribute to biodiversity loss, excessive water use, pollution and climate change, which further exacerbates health problems. Increased air and water pollution caused an estimated 9 million premature deaths in 2019 (16 per cent of all deaths worldwide) *(well established)* {2.4.3, 2.5} through diseases such as respiratory disease, cancer, allergies, birth defects, neurodegenerative disease and impaired cognitive development. Emerging and reemerging infectious disease events have been rising, with half of these driven by changes in land use, agricultural practices and activities that encroach on natural habitats and lead to increased contact between wildlife, domestic animals and humans *(established but incomplete)* {2.5}. In addition, the loss of Indigenous and local knowledge of biodiversity has resulted in declines in traditional medicine use by many Indigenous Peoples and local communities {p. 38 chapter 2}. Nature is also integral to physical, emotional and mental health and well-being, as more biodiverse environments and access to them facilitate recovery from stress, depression and other health-health-related conditions *(well established)* {2.4.3}.

A5. Climate change affects biodiversity, water, food and health through changes in average climatic conditions and the frequency and magnitude of extreme weather events *(well established)* {2.5.2.2} (Figure SPM.4). These nexus elements also influence climate change; for example, the food system is responsible for 21 to 37 per cent of all greenhouse gas emissions *(well established)* {5.3.1, 5.5.1}. Resilient ecosystems also make critical contributions to climate change mitigation and adaptation efforts *(well established)* {5.5.3}. Under current trends, climate change leads to irreversible loss of marine biodiversity, such as coral reefs, and negative effects on coastal fisheries; both of which provide diets that prevent malnutrition, stunted child growth and other conditions *(well established)* {2.5.2.2}. Climate change also impacts terrestrial food production through numerous pathways (e.g., heat-stress effects on crop yield, water availability and quality) with consequences for human health and well-being including exacerbating food insecurity for vulnerable populations. Other direct health impacts include extreme weather events such as heatwaves, flooding, droughts and wildfires, and increased dispersal of pathogens and pollutants (such as untreated wastewater, fertilizers, pesticides, sediments and air pollutants) that can be transboundary. Currently, 58 per cent (218 out of 375) of known human infectious diseases are likely to worsen owing to climate change *(established but incomplete)* {2.5.2.2}. Climate change directly contributed to 62,000 heat-related deaths in Europe in 2022 and more than 1,500 in the United States in 2023 and between 12,000 and 19,000 heat-related deaths in children in Africa between 2011 and 2020 *(well established)* {2.5.2.2}. In the past 50 years, extreme weather-, climate- and water-related events have caused nearly 12,000 disasters, leading to 2 million human deaths (90 per cent in low- and lower-middle-income countries) and $4.3 trillion in total costs globally *(well established)* {2.5}. Land use change associated with food production was responsible for an estimated 21 per cent of global carbon dioxide equivalent emissions in 2018 *(well established)* {2.5.2.1}. Functioning and resilient ecosystems make critical contributions to climate change mitigation and adaptation *(well established)* {5.5.3}, such as by buffering extreme weather events and acting as a carbon sink. For example, coastal ecosystems contribute to more than 50 per cent of carbon sequestration in the oceans and provide protection from flooding *(well established)* {2.4.1, 2.5, 5.5.3.13}.

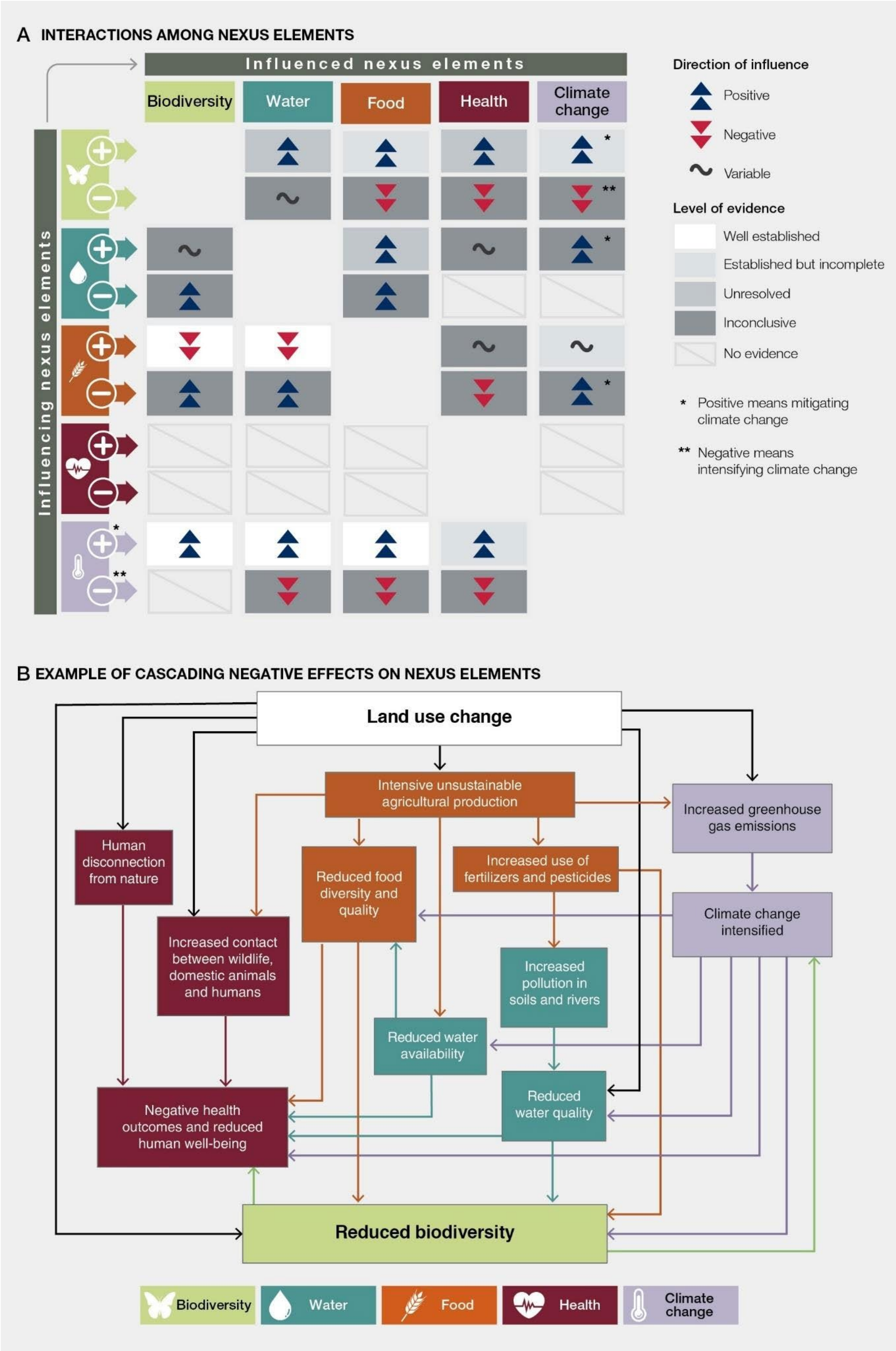

Figure SPM.4. A. Evidence on the directionality of interactions among nexus elements. **B.** Illustrative example showing negative cascading effects of land use change for unsustainable agriculture on the nexus elements. For (A), interactions among nexus elements are based on a systematic literature review of studies that included four and five nexus elements. The effect of either positive or negative trends in a nexus element, denoted by the (+) or (-) sign in the left column, on other nexus elements are displayed, with the level of evidence denoting the number of studies evidencing each effect. Note that a positive direction of influence on climate change corresponds to a decrease in, or mitigation of, climate change, while a negative direction corresponds to amplifying climate change. Levels of evidence: *inconclusive* denotes cases where a similar number of studies found both positive and negative effects for that interaction; *unresolved* denotes cases with evidence from only a small number of studies; and *no evidence* indicates that no study accessed showed relevant interlinkages using nexus approaches. Positive effects of decreasing water on biodiversity and food are related to evaluations of flood impacts.

A6. Negative trends in biodiversity, water, health and climate change are the result of misaligned economic and societal value systems that are reflected in incentive structures that prioritize short-term thinking and private financial returns and disproportionately provide significant benefits to small sections of society *(well established)* {6.2.3, 6.2.5, 7.2}. Current economic and financial indirect drivers incentivize investment in activities that damage biodiversity and other nexus elements (estimated at approximately $7 trillion) while only a fraction of this amount (estimated at $200 billion) is going to improve the status of nature *(established but incomplete)* {6.1.3, 6.2.2, 6.2.3, 6.2.6, Figure SPM.3}.** Existing policies and international agreements have shown limited success in controlling the impacts of economic pressures on nexus elements, despite estimates that over half of global GDP ($58 trillion of economic activity in 2023) is generated in sectors that are moderately to highly dependent on nature *(established but incomplete)* {6.1.3}. For example, negative externalities (costs not considered as part of decision-making processes) across the fossil fuel, agriculture and fisheries sectors are currently estimated in the range of $10–25 trillion per year, reflecting the negative impacts of production and consumption in these sectors on biodiversity, climate change, water and health *(established but incomplete)* {6.1.3, 6.2.3, 7.2.3}. Private sector financial flows that are directly damaging to biodiversity are estimated at $5.3 trillion, and public subsidies incentivizing such activities, distorting trade and increasing pressure on natural resources are estimated at approximately $1.7 trillion per year *(established by incomplete)* {6.2.3} (Figure SPM.12**). Additionally, illegal resource extraction activities, including in the wildlife, timber and fish trades, are valued at $100-300 billion per year or more *(established but incomplete)* {6.2.3}. In contrast, expenditure aimed at improving the status of biodiversity amounts to significantly less than 1 per cent of global gross domestic product (these positive flows are estimated at $200 billion per year) *(well established)* {**Figure SPM.12**, 6.2.2}. The economic impacts of biodiversity loss vary between countries and regions, with higher relative impacts in developing countries where there are also higher barriers to mobilizing sustainable financial flows (exacerbated in some cases by burdens of high debt) *(well established)* {6.1.4, 6.2.5}.

A7. The impacts of changes in biodiversity, water, food, health and climate are unequally distributed *(well established)* {2.5.3.1}. People in developing countries are more commonly affected by nexus elements being degraded *(well established)*.] Similarly, lands inhabited by Indigenous Peoples are also more affected by degraded nexus elements than other areas *(well established)* {2.5.3.1}. Sixty-five per cent of the world's population live in areas where at least one nexus element is in relatively positive condition, which predominantly stems from 50 per cent of people living in areas with high food provisioning *(established but incomplete)* {2.5.3.1}. Fifty-two per cent of people live in areas showing degradation of at least one nexus element. For example, 41 per cent of the world's population live in areas that experienced an extremely strong decline in biodiversity between 2000 and 2010, 9 per cent in areas that have experienced very high health burdens (high disability-adjusted life years) and 5 per cent in areas that have experienced high levels of malnutrition *(well established)* {2.5.3.1}. These burdens disproportionately affect developing countries, including small island developing states, and those in vulnerable situations in high-income countries and Indigenous Peoples *(well established)* {2.5.3.1, 2.5.4.1, 2.5.4.2}. Pressures on Indigenous lands, such as those driven by illegal and unregulated resource extraction, have also caused serious impacts across nexus elements that are essential to livelihoods, including alarming levels of mercury found in sediments, fish and water near mining sites {Box 2.14}. Compounding these problems are losses of language and culture among some Indigenous Peoples and local communities, and exclusion from research, decision-making and funding *(well established)* {1.2, 2.5.4, 4.5.2, 6.2.4}. When recognized and supported, successful cases of management of conserved areas {4.5.2, Box 5.1.3} and food systems {5.3.3.15, Appendix 7.1} by Indigenous Peoples and local communities show delivery of nexus-wide benefits *(well established)* {2.5.4.1, 2.5.4.2}. These promising outcomes reflect the often high dependence of Indigenous Peoples and local communities on biodiversity for their livelihoods, and the holistic approaches and worldviews that shape how they relate to nature and sustainably manage the nexus elements *(well established)* {1.2.2, 4.5.2}.

B. Future nexus interactions

Box SPM.1. Nexus scenario archetypes: Implications for biodiversity and the other nexus elements

Nexus scenario archetypes have been created based on the assessment of 186 individual scenarios from 52 studies with interactions among at least three nexus elements {3.1, 3.7}. These scenarios covered multiple time periods, mostly ending between 2050 and 2100, although some scenarios were not tied to a specific time frame or period (e.g., scenarios of protected areas). Approximately 60 per cent of the scenarios addressed the role of indirect drivers and 12 per cent were based on stakeholder engagement, but only 8 per cent included Indigenous Peoples and local communities' knowledge systems. Twelve per cent of the studies were qualitative, while around 88 per cent of the studies were quantitative. The scenarios covered the terrestrial and freshwater realms (59 per cent) and the marine realm (41 per cent). Fifty-seven per cent of the scenarios focused on the global scale, while 27 per cent covered the regional scale, 6 per cent the national scale and 10 per cent the local scale. Local and regional scenarios focused mainly on the IPBES regions of Europe and Central Asia, followed by Asia-Pacific and the Americas.

The scenarios were clustered statistically into six nexus scenario archetypes based on an analysis of the positive and negative outcomes for biodiversity, water, food, human health and climate change {3.7.1}. The analyzed scenarios focused exclusively on human health. The archetypes represent different, plausible outcomes for the nexus elements and the interlinkages among them. Scenario archetypes 1 and 2 represent different types of sustainability scenarios; 3–5 prioritize a specific nexus element; and archetype 6 represents scenarios with little or no concern for environmental challenges. Business-as-usual scenarios, which represent the continuation of current trends, fall into both archetypes 5 and 6.

(1) ***Nature-oriented nexus:*** significant positive impacts on biodiversity and broadly positive impacts on the other nexus elements, although impacts on food and human health are slightly lower, reflecting competition for land. *Nature-oriented nexus* scenarios focus on protected areas, especially in marine systems, with high levels of protection effectiveness and broadly ambitious climate action. They are characterized by strong environmental regulation, sustainable agricultural practices, lower rates of global per capita consumption and strong development of green technologies.

(2) ***Balanced nexus:*** broadly positive impacts across all nexus elements, but with less positive impacts on biodiversity, water and climate and slightly more positive impacts for food and human health compared to the *nature-oriented nexus*. *Balanced nexus* scenarios are characterized by stronger environmental regulation than *nature-oriented nexus* and less reliance on technologies. Besides biodiversity conservation, this archetype also strongly focuses on restoration and sustainable use of natural resources. Similarly to *nature-oriented nexus,* it is characterized by sustainable lifestyles and consumption changes. Besides biodiversity conservation, this archetype also strongly focuses on restoration and sustainable use of natural resources, and sustainable agricultural practices. Similarly to *nature-oriented nexus*, it is characterized by sustainable lifestyles and consumption changes.

(3) ***Conservation first:*** prioritizes positive outcomes for biodiversity through area-based conservation but fails to improve conservation effectiveness or to set up a sufficiently holistic and reinforcing system of sustainable management across all nexus elements. Thus, unintended consequences can arise from the need to increase food production outside of protected areas, which may also lead to increases in food prices and food insecurity. This results in moderately positive impacts on biodiversity in general, slightly positive impacts on climate, but moderately negative impacts on food and variable impacts on water and human health. The archetype includes higher economic growth then *nature-oriented nexus* and *balanced nexus*, and fails to stabilize global aggregate consumption levels. Hence, the overall biodiversity benefits are less than in the *nature-oriented nexus* scenarios.

(4) ***Climate first:*** Scenarios in the climate first archetype prioritize positive impacts on climate but result in negative impacts on biodiversity and food and variable effects on water. The scenarios in this archetype assume competition for land and other resources between climate change mitigation actions and the other nexus elements, if actions are not planned in an integrated way. This archetype relies very strongly on technological innovation and solutions and also stabilizing per capita consumption.

(5) ***Food first:*** In contrast to nature-oriented and balanced nexus, which focus on sustainable agriculture, the *Food first* archetype focuses on unsustainable agriculture. This set of scenarios prioritizes food production with positive impacts on nutritional health, arising from unsustainable intensification of production and increased per capita consumption. Scenarios in the *Food first* archetype have negative impacts on biodiversity due to the land conversion for agricultural areas, unsustainable agricultural practices and unsustainable fishing and pollution. They also have negative impacts on water because of increasing agricultural irrigation and negative impacts on climate change because of increases in greenhouse gas emissions from agriculture.

(6) ***Nature overexploitation:*** this set of scenarios has negative impacts on biodiversity, food, human health and climate, and variable impacts on water. Scenarios in *nature overexploitation* are characterized by overconsumption of natural resources, especially in marine ecosystems, unsustainable energy demand including but not limited to fossil fuels and by weak environmental regulation exacerbated by delayed action.

B1. Scenarios with positive outcomes across the nexus elements are characterized by timely adoption of sustainable consumption and production practices, enhanced climate change mitigation and adaptation action and considerations of multiple values and knowledge systems *(established but incomplete)* {3.7.1, 3.7.3}. However, none of the scenarios maximize benefits across all the nexus elements at all scales and for all contexts *(well established)* {3.7.1}. Scenario studies (**Box SPM.1**; **Figure SPM.5**) while noting that there are regional differences, suggest that business-as-usual scenarios (*nature overexploitation* and *food first*) include lifestyles that are intensive in material and energy consumption, increased greenhouse gas emissions, intensive land use and unsustainable exploitation of natural resources, result in negative impacts on biodiversity and the other nexus elements *(established but incomplete)* {3.2.1, 3.3.1, 3.4.1, 3.5.1, 3.6.1, 3.7.1}. Scenarios in which there is failure to implement strong and integrated environmental regulations while emphasizing unsustainable and inequitable economic growth result in severe trade-offs among the nexus elements *(conservation first*, *climate first* and *food first) (well established)* {3.7.1, 3.7.2}. In contrast, sustainability scenarios (*nature-oriented nexus* and *balanced nexus*) are associated with sustainable consumption and production and lifestyles, sustainable healthy diets[10] reduced food loss and waste, reduction of water use. They are also characterized by more equal distribution of benefits from economic growth, as well as policies enabling behavioural change and pro-sustainability regulations *(established but incomplete)* {3.7.1, 3.7.2}. Such scenarios often consider multiple actors, and associated values and knowledge systems, including those of Indigenous Peoples and local communities *(established but incomplete)* {3.7.3}. Changes in indirect drivers in future scenarios, such as institutional (e.g., governance and power relations), technological and cultural drivers (e.g., lifestyles), influence direct drivers and have strong individual impacts on biodiversity, water, food, human health and climate change and on the interconnections among them *(well established)* {3.7.1, 3.7.2, 3.7.3}. Scenarios show that timely implementation of response options is critical, as options implemented early are associated with positive outcomes for biodiversity, food, water, human health and climate change *(established but incomplete)* {3.6.3, 3.7.1}, with increasing evidence of the greater effectiveness of investing in actions now rather than later *(established but incomplete)* {7.2.4}.

[10] Sustainable healthy diets promote all dimensions dietary patterns that promote all dimensions of individuals' health and well-being; have low environmental pressure and impact; are accessible, affordable, safe and equitable; and are culturally acceptable (FAO/WHO, 2019).

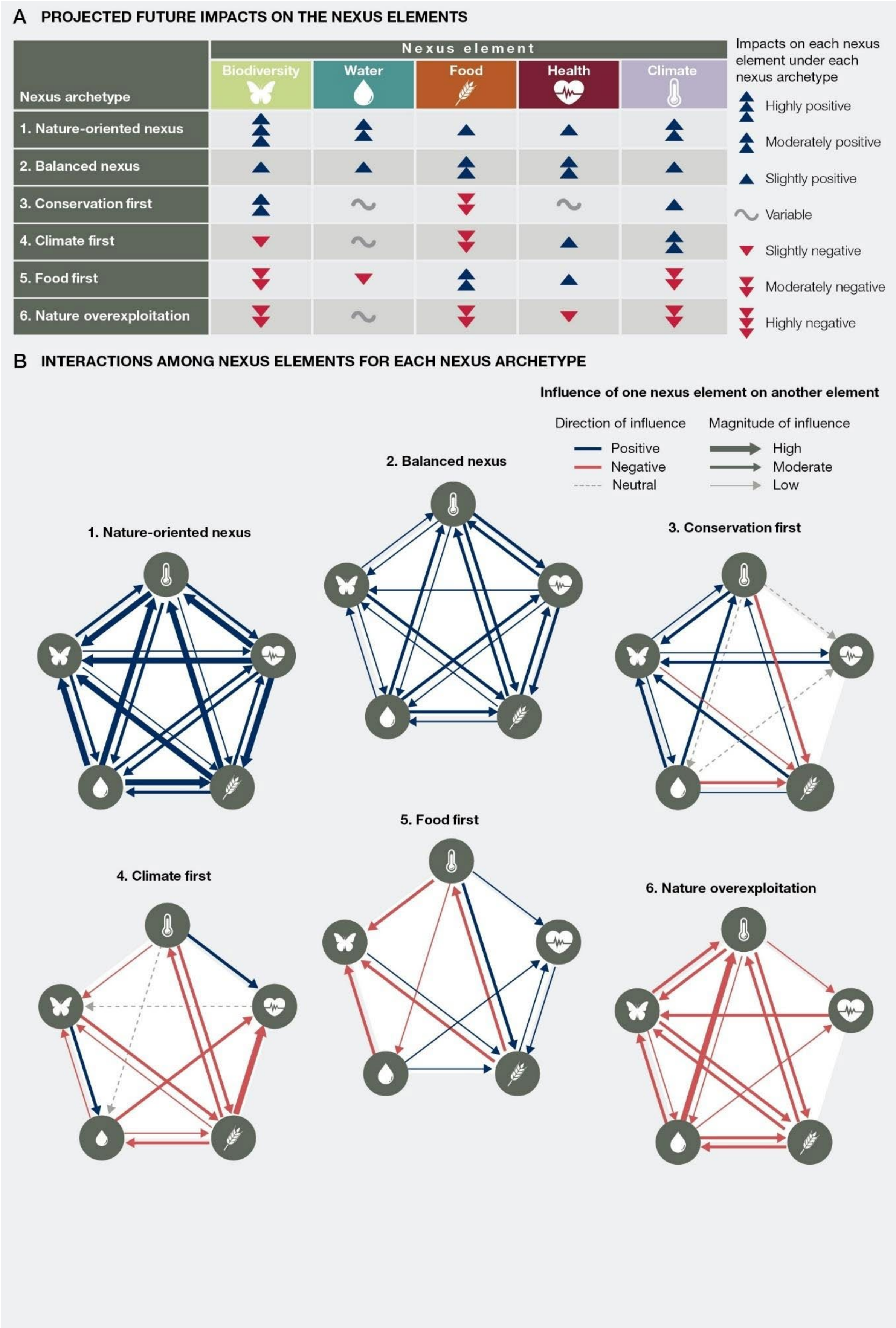

Figure SPM.5. Projected future impacts of nexus scenario archetypes on the nexus elements and their interactions. A. Average magnitude of impact of each nexus scenario archetype on each nexus element; B. Interactions among nexus elements for each nexus archetype showing how nexus elements influence each other and the direction and average magnitude of these impacts (see chapter 3, section 3.7.1 for methodology. The characteristics of the six nexus archetypes are described in **Box SPM.1**. Scenario archetypes *nature-oriented nexus* and *balanced nexus* represent different types of sustainability scenarios. *Food first* and *nature overexploitation* represent business-as-usual scenarios that assume the continuation of current trends.

B2. Scenarios with enhanced actions for nature conservation, restoration and sustainable use of biodiversity lead to multiple benefits for water, food, human health and climate change mitigation and adaptation *(well established)* {3.2.3, 3.6.3, 3.6.4} (Figure SPM.5). *Nature overexploitation* and *food first* scenarios show declining outcomes for biodiversity, mainly driven by unsustainable food production and resource extraction as well as climate change *(well established)* {3.2, 3.7.1}. *Nature-oriented nexus* and *balanced nexus* scenarios that include integrated approaches combining enhanced conservation, restoration and sustainable use and climate change mitigation actions with measures targeting the drivers of habitat conversion and degradation, such as sustainable production and consumption interventions, succeed in reversing biodiversity loss while achieving multiple benefits for water, food, human health and climate change mitigation and adaptation *(established but incomplete)* (**Figure SPM.6**) {3.2.2, 3.2.3, 3.7.1}. Such scenarios project positive long-term outcomes across nexus elements by supporting socio-ecological processes that are essential for clean water (e.g., filtration), food production (e.g., pollination, soil formation and maintenance and pest control), human health and quality of life (e.g., air quality, nature's contributions to people related to positive physical and mental health), adapting to and mitigating climate change (e.g., carbon sequestration) and its impacts (e.g., flood mitigation) *(established but incomplete)* {3.5.3, 3.6.3, 3.6.4, 3.7.1, 3.7.2}. *Nature-oriented nexus* scenarios aim to increase and improve the effectiveness of protected areas, conservation of key biodiversity areas and other effective area-based conservation measures and highlight the importance of integrated spatial planning and deliberate efforts to address existing and emerging injustices and inequality *(established but incomplete)* {3.2.3}. Evidence from scenarios shows that protecting up to 30 per cent of terrestrial, freshwater and marine areas can provide nexus-wide benefits, if these are effectively managed for nature and people *(established but incomplete)* {3.2.3, 3.7.1}.[11] Higher levels of protection in terrestrial systems beyond 30 per cent would have greater biodiversity benefits, but can have trade-offs for food production and food security and nutritional health, including increases in food prices *(established but incomplete)* {3.2.3.1}. In marine ecosystems, nature protection, if managed effectively, could deliver synergies across all the nexus elements (*established but incomplete*) {3.2.3, Box 3.5}.

B3. Transforming to more efficient, inclusive, resilient and sustainable food systems would deliver multiple benefits related to biodiversity, water, human health (particularly nutritional outcomes) and climate change, as well as reducing exposure to pollutants *(well established)* {3.4.2, 3.4.3, 3.4.4}. Conversely, a *food first* scenario approach could lead to negative outcomes for these nexus elements *(well established)* {3.7.1} (Figure SPM.5). Globally, the environmental impacts of food systems in terms of greenhouse gas emissions, land-use change, water use, and nitrate and phosphorus pollution are projected to increase under *food first* scenarios which prioritize unsustainable food production and consumption above other nexus elements *(well established)* {3.4}. Such scenarios also project significant negative impacts on biodiversity through degradation of ecosystems, habitat loss and habitat fragmentation *(well established)* {3.4}. Transforming food systems would produce nexus-wide benefits, including reducing pressures for land conversion, greenhouse gas emissions and water pollution *(well established)* {3.4, Table 3.2}. Food system transformations assessed in *nature-oriented nexus* scenarios combine a range of response options comprising sustainable agricultural practices (such as improving nitrogen use efficiency, integrated pest management, agroecology, agroforestry and sustainable intensification), reductions in food losses and waste, adoption of novel food/feed sources (e.g., macroalgae, microbial protein) and sustainable healthy diets {3.4}. Such transformations would enable the current agricultural land area to meet the calorific and nutritional needs of future generations in the medium to long term (e.g., through improved productivity), enabling positive outcomes for human health and for biodiversity as well as sustainability *(well established)* {3.4}. Scenarios show that sustainable healthy diets and the reduction of food loss and waste decrease greenhouse gas emissions as well as benefiting other nexus elements; in addition, sustainable healthy diets also reduce human deaths *(well established)* {3.4.2, 5.3.3, 5.5.3}. If sustainably managed, aquatic ecosystems can also contribute to biodiversity conservation and health. Scenarios based on sustainable and inclusive food production from the oceans and sustainable aquaculture have nexus-wide benefits and include sustainably managing fisheries, favouring low-impact fishing techniques that reduce discard, bycatch and the destruction of habitat, shifting towards sustainable healthy diets that are less resource intensive, and distributing food more equitably *(well established)* {3.4.2, 3.4.3}. Such transformative scenarios are based on proactive policies, such as marine protected areas, and are inclusive of the practices of Indigenous Peoples and local communities. They also show the importance of connecting biodiversity, water, food, human health and climate change policy to reduce trade-offs *(established but incomplete)* {3.7.1, 3.7.2, 3.7.3}.

B4. Climate change impacts are projected to increase over the coming decades in scenarios that assume a continuation of current trends into the future, negatively affecting biodiversity, water and food systems and human health and exacerbating trade-offs among them *(well established)* {3.6.2}. However, a *climate first* scenario approach could lead to additional negative outcomes for biodiversity and food as a result of primarily

[11] This evidence supports target 3 of the Kunming-Montreal Global Biodiversity Framework.

prioritizing climate change mitigation actions *(well established)* {3.6.3, 3.7.1} (Figure SPM.5). Exposure to risks from climate change is projected to double between 1.5°C and 2°C global warming levels (*well established*) and double again between 2°C and 3°C, across multiple sectors *(established but incomplete)* {3.6, 3.6.2}. This presents a growing challenge to biodiversity and the integrity and functioning of ecosystems in terrestrial, freshwater and marine environments. Intensifying climate change will also stress water resources and undermine agricultural productivity and food productivity in food production systems, exacerbate droughts and flooding, cause increased mortality from heat waves and expand the epidemic belt for vector-borne diseases towards higher latitudes and altitudes *(well established)* {3.5.1, 3.5.2, 3.6.2, 3.6.3}; the impacts of climate change can also interact with other drivers such as land-use change potentially leading to tipping points *(established but incomplete)* {3.6.1}. Scenarios have explored the potential implications of delayed mitigation action for future large-scale implementation of land- and ocean-based carbon dioxide removal options to achieve the Paris Agreement long-term temperature goals. If not planned in an integrated way and accompanied by ambitious emission reduction strategies, these scenarios show that there could be adverse impacts on terrestrial biodiversity, water and food due to increased competition for land *(established but incomplete)* {3.6.3}. Conversely, marine scenarios show that climate change mitigation options, such as restoring seagrass meadows and mangroves, can have multiple benefits across the nexus *(well established)* {3.6.3}. However, climate change mitigation solutions that focus on the placement of excess carbon in deep water are still far from implementation and knowledge is lacking about potential impacts on biodiversity and food *(established but incomplete)* {3.6.3.2}. Scenarios that are characterized by integrated climate actions such as conserving and restoring ecosystems for carbon sequestration have nexus-wide benefits *(well established)* {3.6.3, 3.7.1, 3.7.2}. For example, many synergies across the nexus elements are possible for conserving coastal and marine systems that contribute to carbon sequestration and to adaptation to the impacts of climate change *(well established)* {3.2.4}. Scenarios show that climate change adaptation is urgently needed and can have multiple benefits for other nexus elements *(well established)* {3.6.4}. Inclusive and integrated planning of adaptation actions (e.g., urban blue-green infrastructure {3.6.4.1; 5.4.3.9}) can help avoid unintended consequences (or maladaptation), such as the risks of harm to the livelihoods of Indigenous Peoples and local communities *(established but incomplete)* {3.6.2, 3.6.4, Box 3.8}.

B5. Scenarios with benefits that are balanced across the nexus elements achieve multiple global policy goals, whereas scenarios with trade-offs achieve fewer goals. In particular, conserving biodiversity in combination with actions that benefit other nexus elements supports the achievement of sustainability policy goals and avoids many future financial and systemic risks *(established but incomplete)* {3.7.2, 3.7.3} (Figure SPM.6). Scenarios rarely assess implications for poverty and inequality, which represents an important knowledge gap {3.7.2}. *Nature-oriented nexus* and *balanced nexus* scenarios support the achievement of most of the Sustainable Development Goals, whereas *food first* and *nature overexploitation* scenarios support the fewest Goals *(established but incomplete)* {3.7.2}. The nexus scenario archetypes show that maximizing all nexus elements simultaneously is unlikely to be possible, but achieving balance across policy goals will likely lead to beneficial outcomes for nature and people. *Nature-oriented nexus* and *balanced nexus* scenarios have the largest benefits for Goals 14 (life below water) and 15 (life on land). Scenarios with the least benefits for multiple policy goals (*food first* and *nature overexploitation*) contain many marine scenarios associated with unsustainable fishing. Nexus scenarios rarely assess Goals 1, 5, 7, 10, 16 and 17, which represents an important knowledge gap *(well established)* {3.7.2}. Scenarios, including those under the *nature-oriented nexus* and *balanced nexus* archetypes, inadequately deal with the complex issues of poverty and social inequalities; those that do consider these issues use simplified metrics that inadequately capture distributional impacts. Delaying action to meet policy goals will likely increase costs over time. For example, some estimates indicate that delaying action on biodiversity policy goals to 2030 could double the eventual costs of action, while also increasing the probability of irreplaceable losses such as species extinctions *(established but incomplete)* {6.1.2.4, 7.2.4}. Similarly, it has been estimated that delaying action to meet climate goals could increase the costs of adaptation and mitigation by a minimum of approximately $500 billion per year *(established but incomplete)* {7.2.4, 7.2.5}.

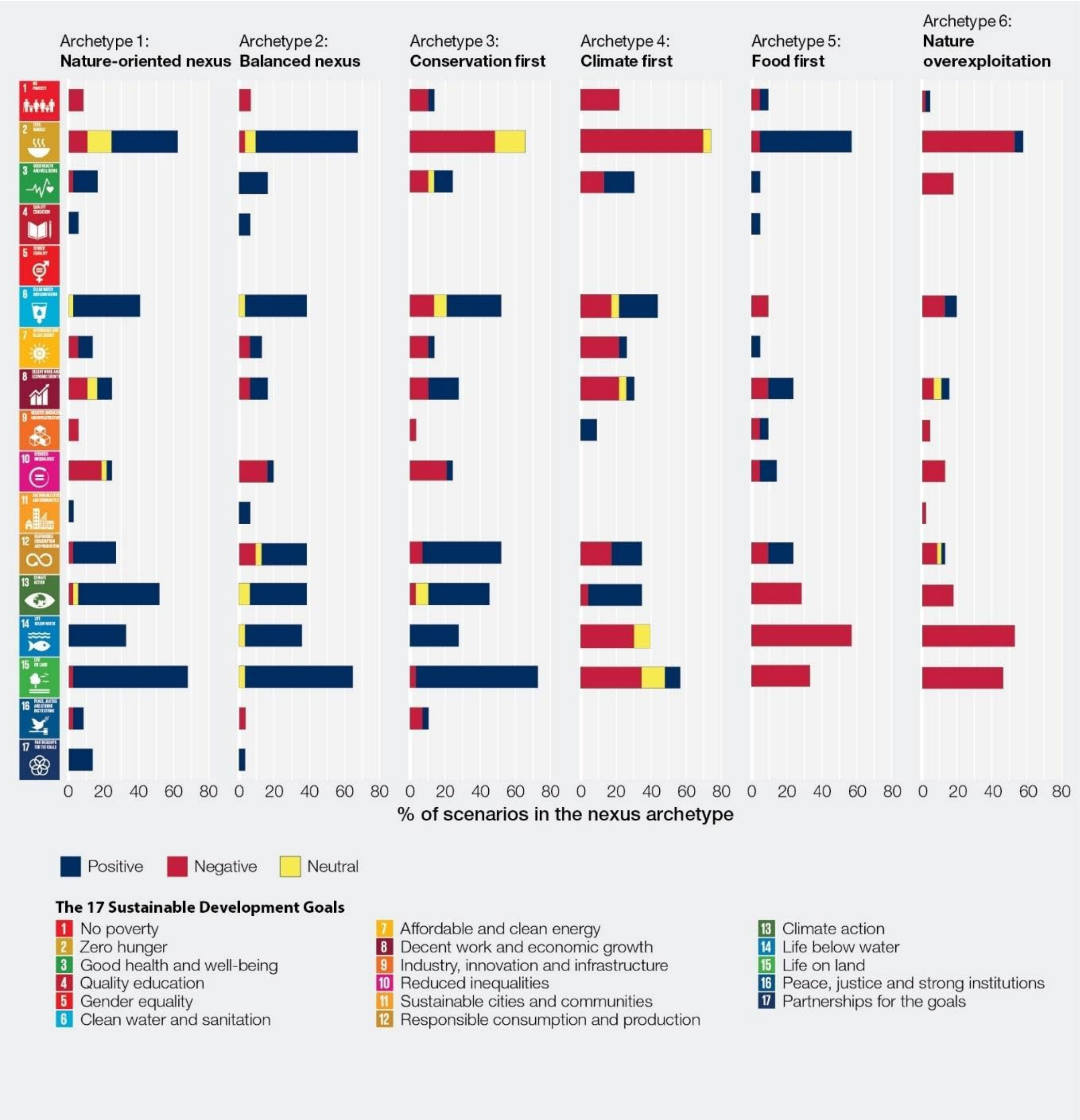

Figure SPM.6. Summary of the extent to which the Sustainable Development Goals may be achieved under the different nexus scenario archetypes. The horizontal bars indicate the number of scenarios (as a percentage of the total number of scenarios per archetype) that have a positive, negative or neutral impact on each Goal. The direction of impact for each nexus scenario archetype is indicated, but not its magnitude. Where bars are absent, the Goal was not considered in the assessed nexus scenarios. The archetypes were not interpreted specifically for the 2030 timeframe of the Goals but reflect a more generalized perspective on whether a Goal could be achieved at some point in the future. Scenario archetypes *nature-oriented nexus* and *balanced nexus* represent different types of sustainability scenarios. *Food first* and *nature overexploitation* represent business-as-usual scenarios that assume the continuation of current trends.

C. Response options that address nexus interactions

The response options considered here are actions or policies that can help advance governance and sustainable management of one or more elements of the nexus. The 71 response options that were assessed in depth in chapter 5 {5.1, 5.2, 5.3, 5.4, 5.5. 5.6}[12] were clustered into 10 categories that form the structure for section C (**Figure SPM.7**): conserve or halt conversion of ecosystems of high ecological integrity {C1}, restore natural and semi-natural

[12] Authors in the five subchapters of chapter 5 identified a representative set of 71 response options. These response options were assessed using thorough reviews of available evidence against common criteria. Criteria included potential to produce benefits across multiple elements of the nexus, feasibility and breadth of applicability, impact on equity and potential to advance the goals of existing global policy frameworks {5.0.3}.

ecosystems {C2}, manage ecosystems in human-exploited lands and waters {C3}, consume sustainably {C4}, reduce pollution and waste {C5}, integrate planning and governance {C6}, manage risk {C7}, ensure rights and equity {C8}, and align financing {C9}; and a tenth category "others" (**Figure SPM.7**). Response options are not meant to be an exhaustive list, but rather to represent a range of evidence-based options involving different actors and sectors, spatial and temporal scales, and feasibility levels that can be adapted to different national and local circumstances. They represent a menu of options that can be applied in different contexts. Some response options may not be appropriate in all countries, and all would be implemented in accordance with national legislation and sovereignty and in accordance with relevant international obligations. Even within countries, effectiveness and acceptability depend critically on political, social, and ecological context. We emphasize this important point here, as it applies to all response options summarized below. These categories are neither exhaustive nor exclusive; for example, response options that elsewhere might be considered types of 'nature-based solutions' and 'ecosystem-based approaches' are categorized here by their primary goals (e.g., reducing disaster risks or managing ecosystem functions such as carbon sequestration).[13] In addition to these 71 response options, chapter 6 assessed several financial response options using different evaluation methods {6.2}, some of which are discussed in C9.

[13] Nature-based solutions are defined as "actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience and biodiversity benefits" (UNEP/EA.5/Res.5, 2022). In this assessment, a number of response options could be considered to fall under this umbrella definition.

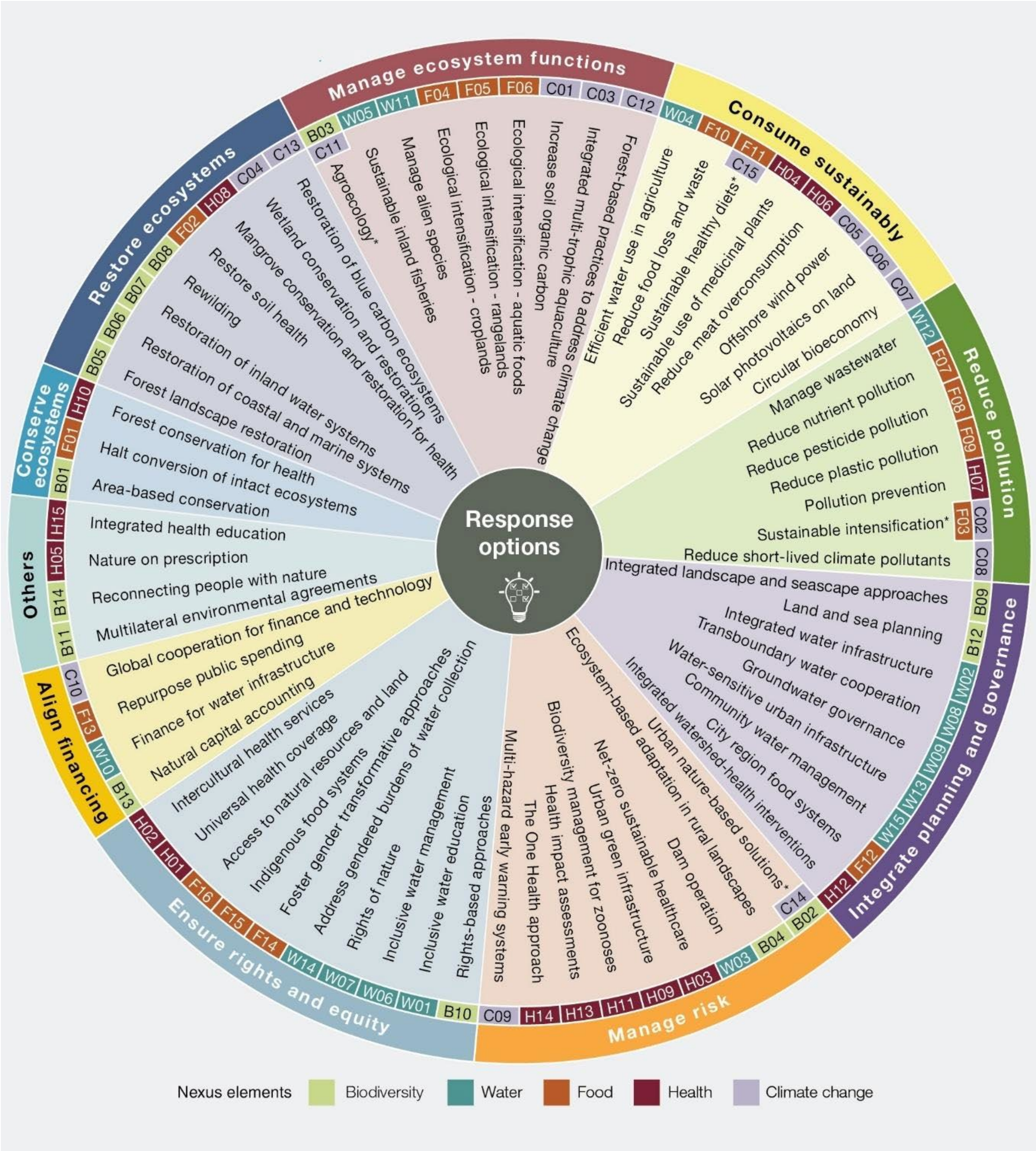

Figure SPM.7. Many response options already exist that a range of actors can implement. The 71 response options assessed in chapter 5 are displayed as wedges and are grouped into 10 broad categories of actions (labelled on the outer edge of circle). Unique alphanumeric codes for each response option indicate its nexus element (B for biodiversity, W for water, F for food, H for health and C for climate change) and unique number. These codes are used to identify response options throughout the report. For brief descriptions of response options, see Appendix IV. Several response options correspond to more than one category but, for clarity, are displayed only in their primary category. The "Others" category includes four important response options that do not correspond easily to the nine main categories. Response options with an asterisk (agroecology, sustainable healthy diets, sustainable intensification and urban nature-based solutions) each were assessed by two different subchapters and both alphanumeric codes are therefore shown.

C1. Conserving or halting the conversion of terrestrial, freshwater and marine ecosystems of high ecological integrity maintains biodiversity and supports the health and well-being of humans, plants and animals and ecosystems *(well established)* {5.1.3.1, 5.3.3.1, 5.4.3.10} (Figure SPM.7). Many successful examples of area-based conservation (B01) exist in different parts of the world that directly support target 3 of the Kunming-Montreal Global Biodiversity Framework to effectively conserve 30 per cent of the terrestrial, inland water and coastal and marine areas by 2030, and these include the creation of public and private natural reserves, national parks and conservation of areas and other effective area-based conservation measures of special interest. Successful establishment and management are dependent on aligning the values of multiple actors, such as through ensuring the full and effective participation of Indigenous Peoples and local communities in processes from co-design to governance (e.g., through rights-based approaches, among others, in accordance with national legislation and international instruments) and sharing the multiple benefits of conservation across public and private stakeholders and rights holders *(well established)* {5.1.3.1, 5.3.3.1, 5.4.3.10}. For example, marine protected areas in Chile and Australia have led to increases in biodiversity, greater abundance of fish for human consumption, and improved incomes for local communities and, in the case of Australia, increased tourism revenues (B01) *(well established)* {5.1.3.1}. Indirect actions such as improving the sustainable production and consumption of certain foods and increasing resource-use efficiency can complement and enable ecosystem conservation and adaptation by reducing pressure on land and aquatic resources (F01) *(established but incomplete)* {5.3.3.1}. In some cases, commodity-wide and private industry commitments, such as Brazil's Amazon Soy Moratorium, have reduced pressures on important ecosystems through better monitoring and more transparent efforts (F01) *(well established)* {5.3.3.1}. Conserving or halting conversion of forests and other ecosystems protects human health and well-being by combating climate change, reducing the impact of extreme weather events, such as storms, droughts and landslides, increasing water and air quality and reducing disease risk (H10) *(well established)* {5.4.3.8, 5.4.3.10} (**Figure SPM.8**).

C2. Restoration of natural and semi-natural ecosystems complements the protection of ecosystems to secure water, food and health while enhancing biodiversity and mitigating climate change and adapting to its impact *(well established)* {5.1.3.5, 5.1.3.6, 5.1.3.7, 5.1.3.8, 5.3.3.2, 5.4.3.8, 5.5.3.4, 5.5.3.13} (Figure SPM.7). Restoring ecosystems supports targets 2, 8, 10 and 11 of the Kunming-Montreal Global Biodiversity Framework. Restoring ecosystems provides multiple benefits by increasing the capacity of degraded lands and waters to provide habitat functions, improve water quality and availability, and restore productive capacity *(well established)* {5.1.3.5, 5.1.3.6, 5.1.3.7} (**Figure SPM.8**). Restoration contributes to climate change adaptation and socio-ecological resilience and can also contribute to climate change mitigation when it targets carbon storage in forests, peatlands, seagrass beds, salt marshes and marine and coastal ecosystems that contribute to carbon sequestration (B05, B07, H08, C04, C13) *(well established)* {5.1.3.5, 5.1.3.7, 5.5.3.4, 5.5.3.12, 5.5.3.13}. For example, mangrove restoration in Senegal (C13) has resulted in significant carbon sequestration, increases in biodiversity, reductions in coastal erosion and improved water quality, food security, livelihoods and health for local populations {Box 5.5.3}. Likewise, soil restoration improves soil health, enhancing water regulation and food production potential (F02) *(well established)* {5.3.3.2} and supporting climate change mitigation through increasing carbon storage as well as providing adaptation benefits *(well established)* {5.5.3.1}. When targeting areas of biodiversity concern, restoration can protect endangered species and also preserve culturally important food sources and practices (B08, F15) *(well established)* {5.1.3.8, 5.3.3.15}. Restoration is most effective when coordinated across actors (for example, among Indigenous Peoples and local communities, government actors and other stakeholders and rights holders) and implemented at large scales (B05, B06, B07, F02) *(well established)* {5.1.3.5, 5.1.3.6, 5.1.3.7, 5.3.3.2}. However, such broad efforts can face challenges stemming from their long-term nature, financial requirements and dependence on enduring and resilient partnerships *(well established)* {5.1.3.5, 5.1.3.6}. Successful projects often include multiple stakeholder concerns, ensure equity in decision-making, implement systematic planning and monitoring, and have secure financing *(well established)* {5.3.4, Box 5.3.1, Box 5.3.2}. For example, in south-central Niger, the co-development of farmer-managed natural regeneration has empowered local farmers through widely applicable and low-cost efforts, and led to regreening of 5 million hectares with native trees and agroforestry systems, enhancing soil health and biodiversity and increasing cereal yields by 30 per cent (F02) {5.3.3.2, Box 5.3.3}.

C3. Managing human-exploited lands and waters to conserve and enhance biodiversity, as well as to support sustainable use, can safeguard the long-term delivery of nature's contributions to people *(well established)* {5.1.3.3, 5.2.3.5, 5.2.3.11, 5.3.3.4, 5.3.3.5, 5.3.3.6, 5.5.3.1, 5.5.3.3, 5.5.3.11, 5.5.3.12, 5.5.3.14} (Figure SPM.7). Several response options can directly improve the sustainable use and management of ecosystems and support targets 10, 11 and 12 of the Kunming-Montreal Global Biodiversity Framework. This is particularly important in agricultural systems, as the way food is produced, what foods are produced and consumed, where they are produced, and how much food is lost and wasted impact both nature and people *(well established)* {2.5.2.1, 5.3.1}. Agroecology represents a shift to production systems where equitable access to land and a blend of scientific and Indigenous and local knowledges guide the sustainable management of biodiversity, crops and other resources (B03, F04, F05, F06, C11) *(well established)* {5.1.3.3, 5.3.3.4, 5.3.3.5, 5.3.3.6, 5.5.3.11}. Ecological intensification of croplands and rangelands uses ecological processes and reduces external inputs, creating habitat and connectivity for biodiversity (B03, F04, F05) *(well established)* {5.1.3.3, 5.3.3.4, 5.3.3.5} while enhancing water retention (W04) *(established but incomplete)* {5.2.3.4}, crop productivity (F04) *(well established)* {5.3.3.4} and soil health (F02), including soil organic content (C01) *(well established)* {5.3.3.2, 5.5.3.1} (**Figure SPM.8**). Ecological intensification benefits from creating and supporting markets for sustainable products, payments for ecosystem services and other positive incentives *(well established)* {5.3.3.3} when in accordance with relevant international trade obligations.In aquatic ecosystems, ecological intensification of aquatic foods (F06), sustainable inland fisheries management (W05) and integrated multi-trophic aquaculture (C03) have positive impacts on food production, nutrition, biodiversity, climate change adaptation and livelihoods *(established but incomplete)* {5.3.3.6, 5.2.3.5, 5.5.3.3}. Sustainable intensification can lead to land-sparing and is a globally applicable response option for increasing agricultural production efficiency and overall food production, while reducing land conversion and social, environmental and some health impacts *(well established)* {5.3.3.3, 5.5.3.2}. Different response options acknowledge the importance of combining land-sparing and land-sharing practices in a context-specific manner. Managing ecosystems in other settings such as forests through forest-based practices to address climate change (C12) and in cities through urban nature-based solutions (C14) and/or ecosystem-based approaches can have multiple benefits, including for climate regulation, water availability and mental and physical health *(well established)* {5.5.3.12, 5.5.3.14}.

C4. Shifting to sustainable consumption patterns reduces pressures on biodiversity, water, food systems and health, while contributing to climate change mitigation *(well established)* {5.2.3.4, 5.3.3.10, 5.3.3.11, 5.4.3.4, 5.4.3.6, 5.5.3.5, 5.5.3.6, 5.5.3.7, 5.5.3.15} (Figure SPM.7). Response options can enable and encourage sustainable consumption and support target 16 of the Kunming-Montreal Global Biodiversity Framework. These include shifting to sustainable healthy diets (F11, H06, C15) and reducing food waste (F10), which together benefit food security and health, reduce greenhouse gas emissions and could free up land, providing in a range of cases co-benefits for nexus elements such as biodiversity conservation and carbon sinks *(well established)* {5.3.3.10, 5.3.3.11, 5.4.3.6, 5.5.3.15}. Other options include improving the efficiency of water use in agriculture (W04), which can benefit food production and water conservation *(well established)* {5.2.3.4} and sustainable bioeconomy (C07) which benefits all nexus elements *(well established)* {5.5.3.7} (**Figure SPM.8**). The adoption of new and renewable energy technologies, such as solar and wind power, supports a rapid transition to renewable energy (C05, C06) {5.5.3.5, 5.5.3.6}, helping to mitigate climate change and its negative impacts on all nexus elements *(well established)* {5.5.1}, but environmental assessments and appropriate policies would be needed to avoid trade-offs, particularly on biodiversity and food systems *(well established)* {5.5.3.5, 5.5.3.6}. Behaviour change will be necessary to shift consumption practices and can be enabled by increasing accessibility-and desirability, and taking into account cultural acceptance of sustainable healthy diets (F11, H06, C15) *(well established)* {5.3.3.11, 5.4.3.6, 5.5.3.15} and making sustainable energy and water consumption default options (C07) (*well established*) {5.5.3.7}. For example, implementing food-based dietary guidelines into public food procurement, particularly targeting public school feeding programmes, can create a structured demand for healthy food in combination with increased opportunities for on-farm diversification aimed at increasing supply and consumption of local seasonal foods *(well established)* {5.3.3.11, Boxes 5.3.8 and 5.3.9}. Protecting the diversity and availability of medicinal plants can also promote their sustainable consumption (H04) *(well established)* {5.4.3.4}.

C5. Pollution is a key driver of degradation of biodiversity, water quality and human health *(well established)* {5.1.1, 5.4.1}; however, a range of response options exist to reduce air, soil and water pollution that benefit all nexus elements *(well established)* {5.2.3.12, 5.3.3.3, 5.3.3.7, 5.3.3.8, 5.3.3.9, 5.4.3.7, 5.5.3.2, 5.5.3.8} (Figure SPM.7). Response options can directly reduce pollution through regulations and incentives (W12, F07, F08, F09), as well as indirectly through reduced and more efficient use of fertilizers, improved waste management and reduced use of pesticides (F03, C02) *(well established)* {5.2.3.12, 5.3.3.3, 5.3.3.7, 5.3.3.8, 5.3.3.9, 5.5.3.2}, leading to improved water quality, air quality, ocean quality and soil health (**Figure SPM.8**). These support target 7 of the Kunming-Montreal Global Biodiversity Framework. Some countries have successfully implemented pollution controls in the form of reduced subsidies to agricultural production systems (e.g., leading to declines in nitrogen pollution in Denmark) {Box 6.2}. However, developing countries may face multiple barriers in the reduction of such subsidies *(well established)* {6.2.3}. Levels of pollution, such as air contaminants, that are hazardous to health can be reduced through international and national standards and regulations (C08), including emissions standards for motor vehicles and power plants (H07), which also improve environmental protection more broadly *(well established)* {5.4.3.7, 5.5.3.8}. Reducing pollution from all sources is particularly significant for people in developing countries. For example, 90% of premature deaths from pollution occur in low-and middle-income countries of which air pollution is the major cause {traceability} and the benefits to humans and nature are often greater than the costs of such policies. Furthermore, access to adequate sanitation services and domestic wastewater treatment is a critical issue in Latin American and the Caribbean, Asian, and African countries *(well established)* {5.2.3.12, 5.3.3.7, 5.3.3.8, 5.3.3.9, 5.4.3.7, 5.5.3.2}. Reducing plastic pollution (F09) has led to increased water quality and wildlife protection, fewer floods and reductions in incidence of associated water-borne diseases. Nevertheless, some measures to reduce plastic pollution have not been effective in some countries, and subsidizing recycling often requires costly government intervention (*established but incomplete*) {5.3.3.9}.

C6. Integrated approaches incorporating planning and governance for use of landscapes and seascapes are effective for addressing complex sustainability challenges for biodiversity, food, water, health and climate change *(well established)* {5.1.3.9, 5.1.3.12, 5.2.3.2, 5.2.3.8, 5.2.3.9, 5.2.3.13, 5.2.3.15, 5.3.3.12, 5.4.3.12, 5.6} (Figures SPM.7 and SPM.8). Response options involving mainstreaming biodiversity across sectors, primarily target biodiversity, but they also have considerable potential to benefit other nexus elements and thereby important policy goals including the Kunming-Montreal Global Biodiversity Framework, and the Sustainable Development Goals and the Paris Agreement *(well established)* {5.1.1.4, 5.1.3.9, 5.1.3.12, 5.3.3.12, 5.4.3.12}. Response options that integrate across landscapes and seascapes (B09) and that involve strategic land and sea planning (B12, F12) produce nexus-wide benefits by implementing several actions either together (i.e., in bundles) or sequentially, to take advantage of synergies *(well established)* (**Figure SPM.9**) {5.1.3.9, 5.1.3.12, 5.3.3.12}. Nexus-wide benefits of such integrated approaches include conservation of both marine and terrestrial biodiversity, improved water quality in both freshwater and coastal zones, strengthened natural infrastructure (e.g., mangroves, riverside forests) to buffer climate extremes, and more equitable sharing of these benefits resulting from the involvement of Indigenous Peoples and local communities in decision-making, development and implementation *(well established)* {5.1.3.9, 5.1.3.12, 5.3.3.12}. These response options support targets 1 and 12 of the Kunming-Montreal Global Biodiversity Framework. Transboundary water cooperation facilitates sustainable management of resources at the basin scale, and better collaboration between sectors and stakeholders (W08) *(well established)* {5.2.3.8}. Improving groundwater governance (W09), through cooperation across scales, where appropriate, and support for community water management (W15), increases benefits across the nexus elements, while integrated water infrastructure (W02) and water-sensitive urban infrastructure (W13) take advantage of natural systems to reduce risks from floods and other hazards, deliver benefits for food production and contribute to climate change mitigation and adaptation *(well established)* {5.2.3.2, 5.2.3.9, 5.2.3.13, 5.2.3.15}. Integrating disease management within landscapes, including inland water bodies, and seascapes can reduce risks of waterborne and other diseases and provide wider benefits from protecting water quality and biodiversity (H12) *(well established)* {5.4.3.12}. Local solutions often emerge from coordinated networks by drawing on social knowledge and integrating actions across sectors by increasing collaboration among diverse actors *(well established)* {5.1.3.9, 5.1.3.12, 5.2.8, 5.2.3.15, 5.3.1, 5.4.3.12, 5.5.4.1} (**Figure SPM.9**). For example, in the lower Mekong basin, multi-sectoral development agreements and investments, alongside integrated governance from local to watershed level, were critical for implementing a long-term intergovernmental sustainable river management plan {5.2.3.8, Box 5.2.10}.

C7. Effective risk management can reduce climate and health risks to people and ecosystems, particularly risks that are multi-scale, multi-dimensional and interlinked and thus best managed through nexus approaches *(well established)* {5.1.3.2, 5.1.3.4, 5.2.3.3, 5.4.3.3, 5.4.3.9, 5.4.3.11, 5.4.3.13, 5.4.3.14, 5.5.3.9} (Figure SPM.7). Response options can be direct actions to limit climate and health risks or contribute indirectly to risk reduction and can support targets 8, 11 and 12 of the Kunming-Montreal Global Biodiversity Framework. Direct actions may include urban nature-based solutions and ecosystem-based approaches (B02, H09, C14) that increase urban green and blue space to manage heat island effects, improve water quality and availability and reduce air pollution as well as allergens and zoonotic disease risk *(well established)* {5.1.3.2, 5.4.3.9} (**Figure SPM.8**). In rural landscapes, conserving and restoring natural or semi-natural ecosystems (B04), including coastal vegetation and mangroves, reduces risks from flooding and other climate extremes *(well established)* {5.1.3.4}. Indirect approaches include systems for early warning and risk communication (C09), which allow communities to respond quickly to extreme weather events and to make longer-term adaptation decisions, with many successful examples, including weather forecasts and index-based crop insurance (*well established*) {5.5.3.9}. There are opportunities for countries with resource intensive health care sectors to reduce negative impacts across the nexus elements, by increasing investment in disease prevention and by reducing pollution, waste and greenhouse gas emissions (HO3). Increasing investments in risk identification, disease prevention and health promotion, including as a community led process, provides multiple nexus benefits (H13) *(well established)* {5.4.3.3, 5.4.3.13}.

The One Health approach (H14) supports integrating food system and biodiversity management with local health services to reduce risks from zoonotic pathogen emergence and spillover at source (H11), malnutrition and other risks such as to wildlife health, food production and ecosystems such as to wildlife health, food production and ecosystems *(established but incomplete)* {5.4.3.11, 5.4.3.14}. Successful examples, such as the Unified Health System in Brazil, have involved human health professionals, veterinarians and environmental health practitioners working together with farmers and policymakers to jointly design holistic practices aimed at addressing social and environmental determinants of health and contributing to preventing pathogen emergence and thus reducing disease outbreaks for both people and animals *(well established)* {5.4.3.11}.

C8. Promoting rights and equity leads to positive outcomes for people and nature but wider scaling and support is critical for improved justice and gender equality *(well established)* {5.1.3.10, 5.2.3.1, 5.2.3.6, 5.2.3.7, 5.2.3.14, 5.3.3.14, 5.3.3.15, 5.3.3.16, 5.4.3.1, 5.4.3.2, 5.5.4.4} (Figure SPM.8). Several response options emphasize rights to health, food, water, land and a clean, healthy and sustainable environment and provide possible ways of recognizing and implementing these human rights for all, including Indigenous Peoples and local communities and women (B10, W01, W06, W07, W14, F14, F15) *(well established)* {5.1.3.10, 5.2.3.1, 5.2.3.6, 5.2.3.7, 5.2.3.14, 5.3.3.14, 5.3.3.15} (**Figure SPM.7**). These options can support targets 22 and 23 of the Kunming-Montreal Global Biodiversity Framework. These options can support targets 22 and 23 of the Kunming-Montreal Global Biodiversity Framework. Response options that focus on gender equality, such as addressing the gendered burdens of water collection (W14) and inclusive water management (W06), can improve access and availability to clean and safe water and improve mental and physical health, leading to enduring and transformative social outcomes *(well established)* {5.2.3.6, 5.2.3.14}. Socially just and gender-inclusive tenure systems for food are explicitly supported through agroecological practices (F14, F16) *(well established)* {5.3.1, 5.3.3.14, 5.3.3.16}. Indigenous food systems (F15), grounded in reciprocal worldviews and values regarding people and nature in balance and in the sustainable use of biodiversity, are supplying sustainable and healthy foods from lands, inland waters and oceans while also contributing to biodiversity conservation and climate change mitigation and adaptation *(well established)* {5.3.3.15, 5.5.4.3, Appendix 7.1}. However, further support and recognition would help counter pressures from unsustainable agricultural practices, loss of land and declines in interest in Indigenous foods among young people *(established but incomplete)* {Appendix 7.1}. Universal health coverage (H01) increases access to primary healthcare services and women's sexual and reproductive health and rights, while intercultural health services (H02) also uphold the right to health and recognize nature's contributions to human well-being *(well established)* {5.4.3.1, 5.4.3.2}. Rights-based approaches to conservation are grounded in rights related to access and management of natural resources, including land tenure and resource rights, as well as relating to recognition of the rights of nature[14] (B10, W07, F16), in accordance with national legislation and international principles of national sovereignty over natural resources *(well established)* {5.1.3.10, 5.2.3.7, 5.3.3.16, **Box 4.11**}. These approaches show strong effectiveness in improving nexus elements; for example, in Brazil, formalizing and enforcing tenure rights to territories of Indigenous Peoples and local communities resulted in decreases in deforestation and increases in forest restoration *(established but incomplete)* {5.1.3.10}.

[14] Not all countries recognize rights of nature.

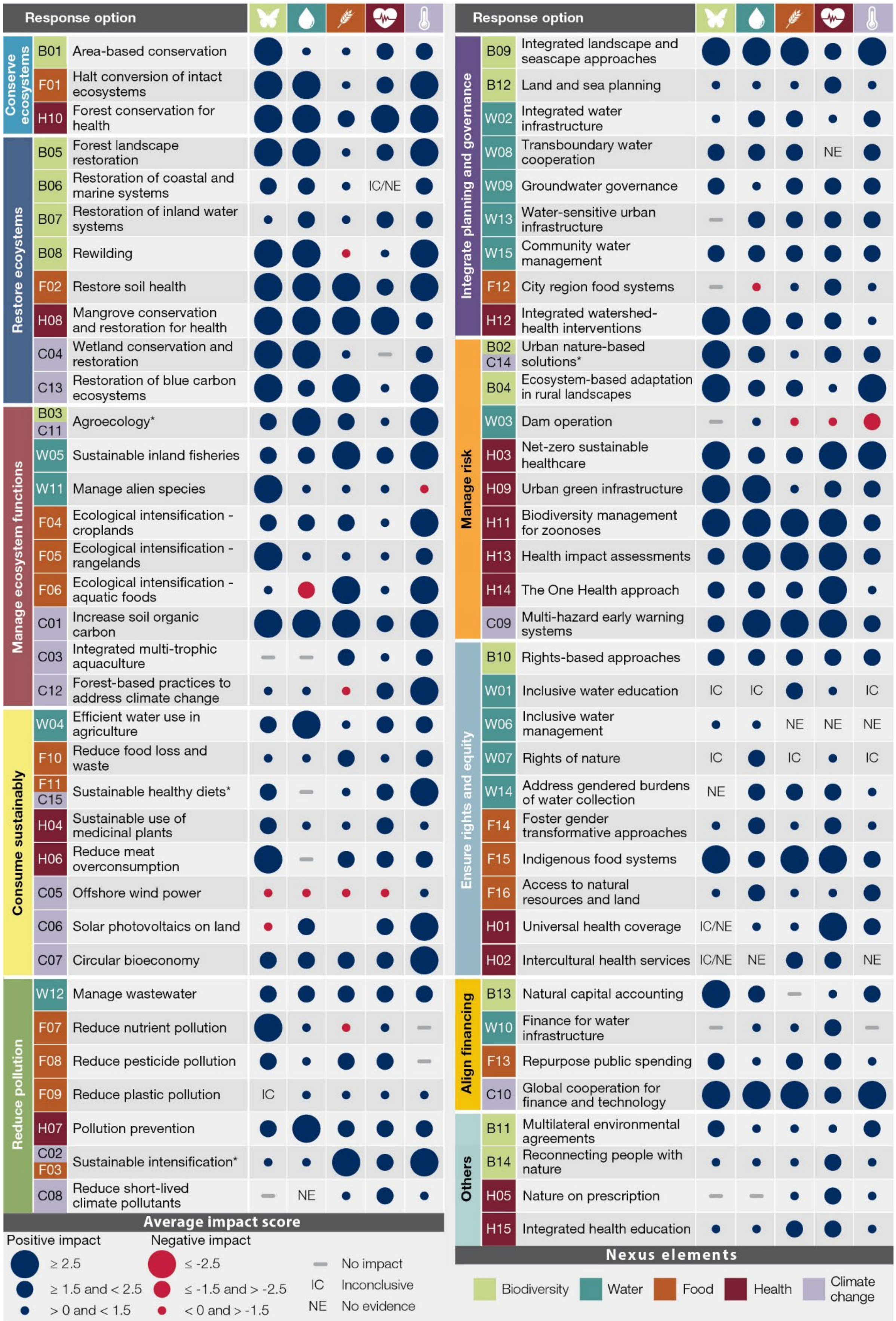

Figure SPM.8. Response options have substantial but widely varying impacts on the five nexus elements of biodiversity, water, food, health and climate change. For each of the response options assessed in chapter 5, circles indicate the estimated impacts on each element of the nexus. Larger circles indicate stronger impacts on that element and several large circles in a row indicate more widespread impacts across elements of the nexus. Most impacts are positive (blue), but a few response options have negative impacts (red) on some nexus elements. Response options are organized into the same categories used in **Figure SPM.7** and are labelled with their unique codes from chapter 5. Impact scores are based on a thorough review of existing evidence, synthesized and averaged across several component criteria using the expertise of author teams on a scale of -3 to +3 for each nexus element {5.0}. Response options for which evidence for component indicators was inconclusive (IC) or non-existent (NE) are labelled as such, and those for which evidence for some criteria were IC and evidence for NE are labelled as IC/NE. Response options with an asterisk (agroecology, sustainable healthy diets, sustainable intensification and urban nature-based solutions) each were assessed by two different subchapters and both alphanumeric codes are therefore shown. For these response options, circles represent an average score from the two subchapters that assessed them. For brief descriptions of each response option, see Appendix IV, and for more details on the scoring, see subchapters 5.1 - 5.5.

C9. Additional economic and financial resources are required to implement response options, but their impact and uptake could be amplified with wider reforms to align financial and environmental interests *(well established)* {6.2}. Multiple financial response options, instruments and approaches exist which can help support targets 15, 18 and 19 of the Kunming-Montreal Global Biodiversity Framework, but they face challenges of implementation, accessibility and scale *(well established)* {5.6.4, 6.2.4.1}. For example, some instruments (e.g., green and blue bonds) can raise funds to explicitly target multiple nexus benefits, but their implementation is limited and scaling up has been slow *(established but incomplete)* {6.2.2.1}. Other promising response options aim to increase financing and improve access to it: examples include payments for ecosystem services, which have mobilized up to $42 billion per year from both public and private sources *(well established)* {5.5.3.12, 6.2.6.2}, and microfinance, which is currently at low levels for nexus approaches such as agroecology (*established but incomplete*){6.2.6.2} (**Box 6.12**). Response options can also shift enabling environments, such as internalizing costs of environmental degradation through water pricing (W10) *(established but incomplete)* {5.3.2.10} and natural capital accounting (B13), which identifies and values natural assets *(well established)* {5.1.3.13}. Implementation of response options that incentivize trade in sustainable products in accordance with relevant international obligations have shown positive impacts on nexus elements (*established but incomplete*) {5.3.3.1, 6.2.5.1, 6.3.3}. Global cooperation (C10) on meeting financing needs and access to technological innovations also remain crucial in particular to support developing countries *(well established)* {5.5.3.10, 6.2.2}. Eliminating, phasing out, or reforming subsidies that damage nexus elements, if implemented in accordance with international obligations, would contribute to shifting business models towards sustainability and recognize the benefits of and reduce pressures on] biodiversity, providing benefits for biodiversity and its contribution to nexus elements, *(well established)* {5.3.3.13} taking note of the differing needs of developing countries. Some response options, such as natural capital accounting (B13) and integrated watershed-health interventions (H12), can help align the interests of financial and other stakeholders (*established but incomplete*) {5.1.3.13, 5.4.3.12}.

C10. Implementing response options together or in sequence can enhance nexus-wide benefits, because some response options enable others or amplify their impacts *(established but incomplete)* {5.1.6, 5.2.6, 5.3.6, 5.4.6, 5.5.6, 5.6} (Figure SPM.9). Current approaches to managing nexus elements have failed to harness the full potential of nexus-wide benefits because they have been designed and implemented in isolation, at more limited scales or without adequate consideration of the interdependencies and interconnections among nexus elements and among response options *(well established)* {5.6, 7.3}. Coordinated implementation and scaling of multiple response options is likely to increase their cumulative impacts and potential for transformative change but will require effective governance by and collaboration among disparate actors and reliable sources of finance *(established but incomplete)* {4.4, 5.6, 7.3}. Well-coordinated implementation of response options can also result in cost savings compared to siloed and duplicative policies *(established but incomplete)* {7.2.5}. Bundling or sequencing response options would support the achievement of the global policy frameworks set out under the 2030 Agenda for Sustainable Development, the Kunming-Montreal Global Biodiversity Framework and the Paris Agreement *(well established)* {5.6} (**Box SPM.2**, **Figure SPM.10**). The goals and targets of these policy frameworks interrelate strongly, and response options that address challenges or opportunities associated with multiple nexus elements can simultaneously support these global policy frameworks. To be effective, response options need to be implemented in context specific ways that are appropriate to specific regional, national and local circumstances, as there is no one-size-fits-all approach *(well established)* {5.6, 7.3.5}. Importantly, however, many response options will be less effective or impossible to implement if climate change is not urgently addressed *(well established)* {2.5.2.2, 3.6.2}.

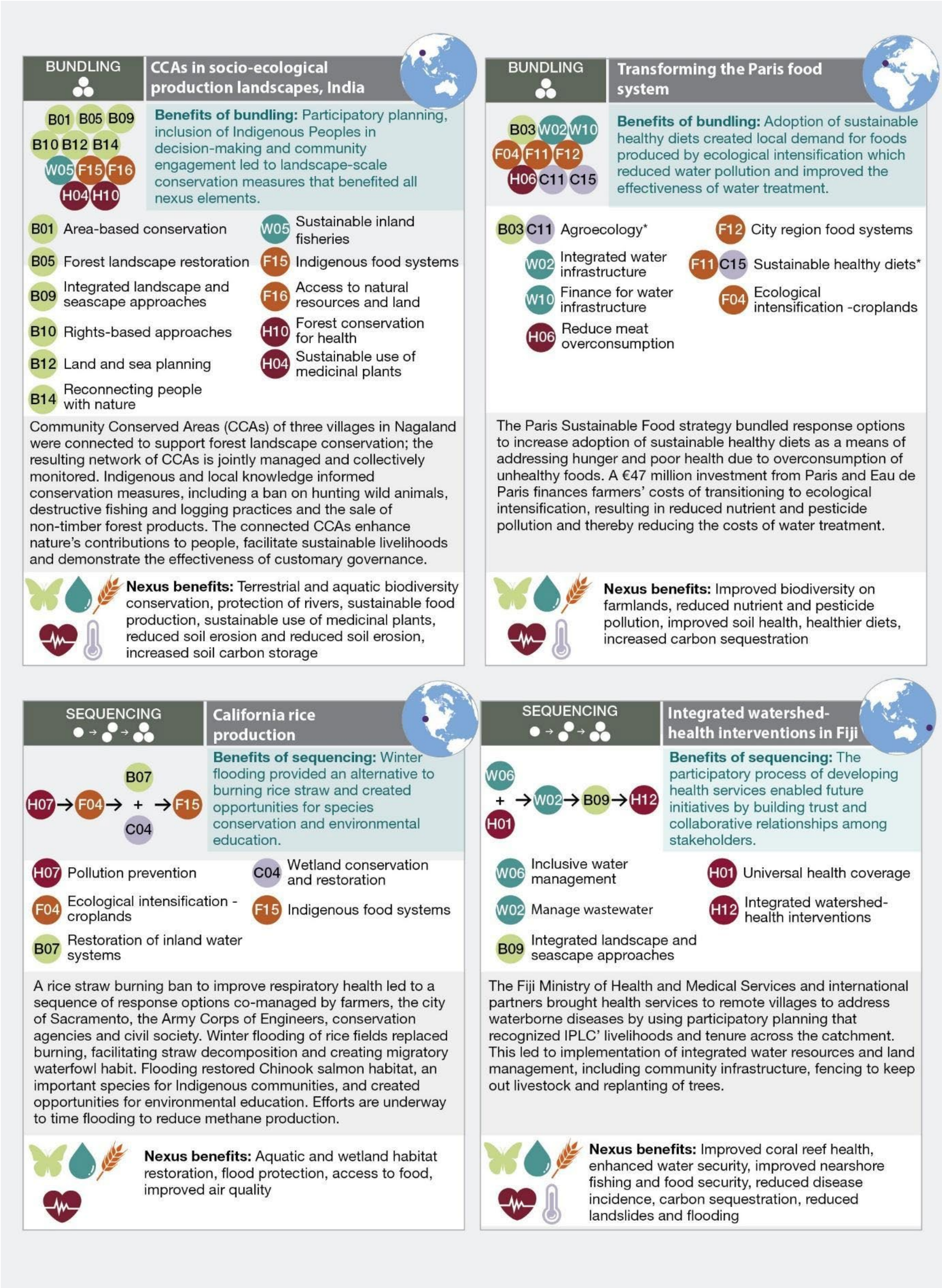

Figure SPM.9. Response options can have amplified effects when implemented in bundles together or in strategic sequence. The figure contains four case studies, drawn from chapter 5, to illustrate these potential synergies. Bundling several response options and implementing them together can result in greater cumulative impacts because some response options enable or synergize with others. Similarly, by sequencing response options, those implemented first can establish enabling conditions for others implemented later, increasing their impacts. In each case study, response options involved in the bundle or sequence are indicated with their alphanumeric codes used throughout the report; a paragraph briefly describes the case study, including a statement describing the added value derived from bundling or sequencing; and the benefits across nexus elements are summarized. Below each case study is a key to the response options involved, linking codes to brief names. Response options with an asterisk (agroecology and sustainable healthy diets) each represent response options that were assessed by two different subchapters. More information on case studies can be found in 5.1.3.9 (for India), 5.3.3.12 (for Paris), 5.3.3.3 (for California) and 5.4.3.12 (for Fiji). *Abbreviations:* CCA – community conserved area; IPLC – Indigenous Peoples and local communities; USA – United States of America.

Box SPM.2. Contribution of response options to global policy frameworks

Response options contribute to the implementation and achievement of the Sustainable Development Goals, the Kunming-Montreal Global Biodiversity Framework and the Paris Agreement *(well established)* {5.6.7} (**Figure SPM.10**). In fact, many response options support all three frameworks, thereby offering valuable mechanisms for addressing challenges and priorities in an integrated manner and improving implementation across global policy goals *(well established)* {5.6.7}. Mapping response options to the specific goals and targets of each framework illustrates their alignment.

Each of the 17 Sustainable Development Goals is supported by at least three response options, and 11 Goals are supported by 10 or more response options (**Figure SPM.10A**). As expected, Goals that focus on the nexus elements (life on land, life below water, clean water, zero hunger, health and well-being, and climate action) have the most alignment with response options *(well established)* {5.6.7}. However, response options align substantially with all the other Goals, illustrating broad support for the global agenda for just and sustainable futures.

The Kunming-Montreal Global Biodiversity Framework is similarly well supported by response options. Each of the 23 targets is supported by at least three response options, and 16 are supported by 10 or more response options (**Figure SPM.10B**). Targets advanced by a large number of response options include those focused on habitat conservation, pollution reduction, climate change adaptation, biodiversity within food systems, and nature's contributions to people. As with the Sustainable Development Goals, response options also provide substantial support to targets of the Kunming-Montreal Global Biodiversity Framework that are less directly related to the five nexus elements.

The capacity to contribute to multiple goals simultaneously is a common and powerful feature of nexus approaches. These response options are therefore a promising mechanism for integrating efforts and accelerating progress towards multiple policy goals and frameworks. Response options in each of the nine categories (**Figure SPM.7**) align with both frameworks discussed above as well as with the Paris Agreement (**Figure SPM.10C**). Each category supports between 7 and 12 Sustainable Development Goals, between 9 and 19 Kunming-Montreal Global Biodiversity Framework targets, and the long-term goals for mitigation and adaptation of the Paris Agreement. Individual response options also can improve implementation of global frameworks; 24 response options simultaneously advance more than five Sustainable Development Goals and more than five Kunming-Montreal Global Biodiversity Framework targets: B01 Area-based conservation, B02/C14 Urban nature-based solutions, B03/C11 Agroecology, B04 Ecosystem-based adaptation in rural landscapes, B09 Integrated landscape and seascape approaches, B10 Rights-based approaches, B11 Multilateral environmental agreements, B12 Land and sea planning, B14 Reconnecting people with nature, W08 Transboundary water cooperation, W13 Water-sensitive urban infrastructure, F02 Restore soil health, F03/C02 Sustainable intensification, F04 Ecological intensification – croplands, F06 Ecological intensification - aquatic foods, F11/C15 Sustainable healthy diets, F13 Repurpose public spending, F15 Indigenous food systems, H09 Urban green infrastructure, H10 Forest conservation for health, H12 Integrated watershed-health interventions, C07 Sustainable bioeconomy, C12 Forest-based practices to address climate change, C13 Restoration of coastal and marine ecosystems for carbon sequestration.

These can help overcome gaps within existing frameworks; for example, a spatial disconnect exists between the national to global scales at which progress toward goals is monitored and the more local scales at which many nexus elements and systems are managed. In order to facilitate nexus governance and approaches, new types of indicators, data and processes may need to be put in place to reflect nexus interlinkages and monitor them over time (*established but incomplete)* {7.3.8}.

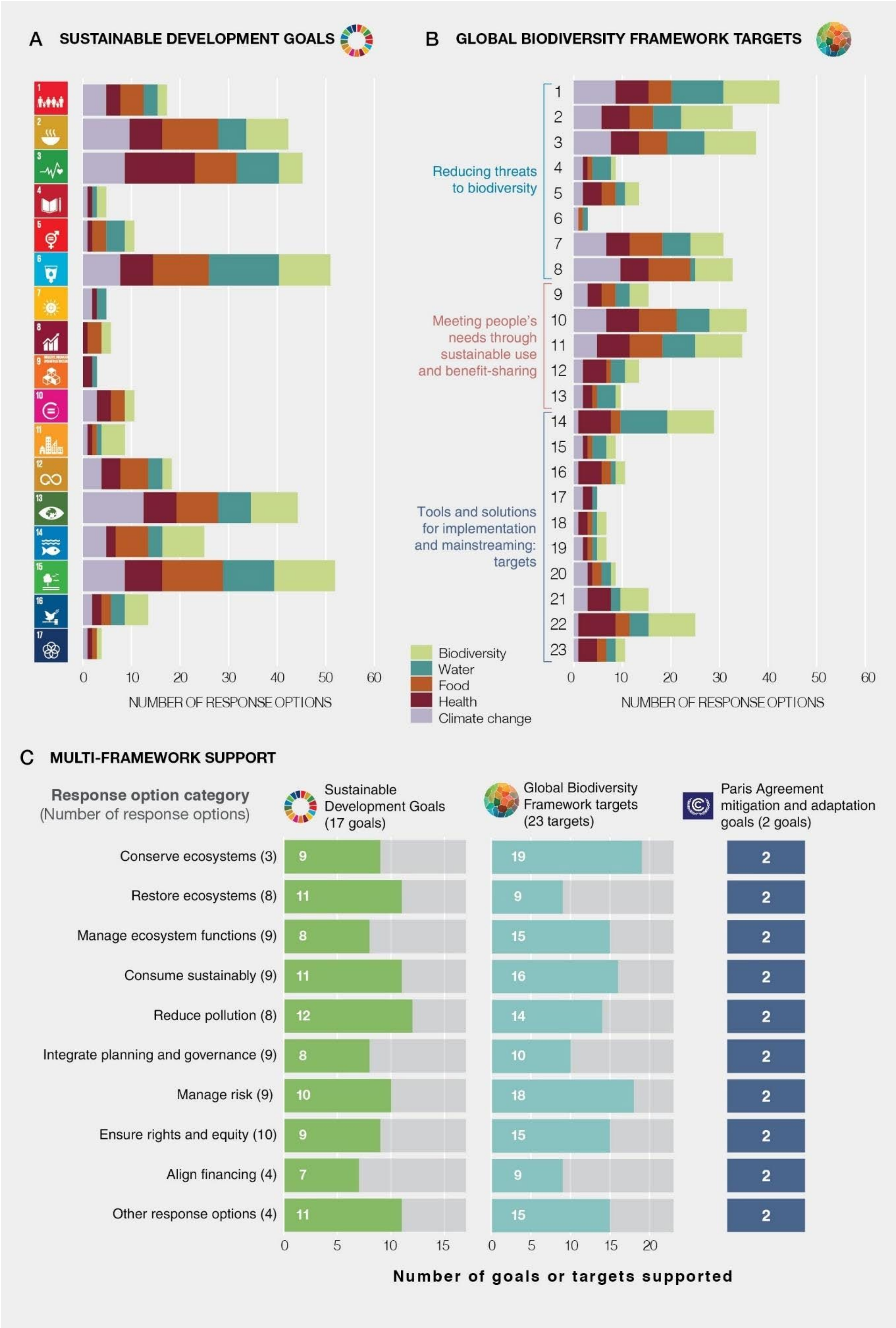

Figure SPM.10. Response options provide broad and varying support to goals and targets of global policy frameworks. Panel A: Number of response options supporting achievement of the Sustainable Development Goals. Stacked bars correspond to each Goal, with each section of a given bar indicating the number of response options from each nexus element. Panel B: Number of response options supporting achievement of the Kunming-Montreal

Global Biodiversity Framework targets, using the same format as Panel A. Panel C: Number of goals or targets for three global policy frameworks supported by each category of response options. For each of the 10 main categories of response options indicated in **Figure SPM.7**, bars represent the degree of support for each policy framework. Bar length represents the percentage of all goals or targets supported by response options in that category, while numbers indicate the number of goals or targets supported. For example, the category "Conserve ecosystems" supports 11 (out of 17) of the Sustainable Development Goals, 15 (out of 23) of the Kunming-Montreal Global Biodiversity Framework targets, and both of the Paris Agreement's long-term goals for mitigation and adaptation (the third long-term goal, for climate finance, was not assessed in this chapter). Appendix 5 provides more detail by showing assessed support from each individual response option to goals and targets of all three policy frameworks.

D. Governing the nexus for achieving just and sustainable futures

D1. Improved governance approaches across biodiversity, water, food, health and climate change can help respond to interlinked and compounding challenges by focusing on policies, institutions and actions that promote integration, inclusion, equity and accountability, and coordinated and adaptive approaches *(established but incomplete)* {1.3.4, 4.5, 7.3}. However, existing policies and approaches arising from sectoral and narrow perspectives have resulted in misaligned, duplicative and inconsistent governance and have failed to address direct and indirect drivers of change (*well established*) {1.1, 1.2, 4.2}. Challenges for governing the nexus include navigating socio-ecological complexity to address fragmented and sectoral decision-making; multiple and diverse values; insufficient, inaccessible and unpredictable finance; and inadequate and inappropriate scaling of actions *(established but incomplete)* {1.1.2, 4.2, 4.5, 7.1}. These challenges can be addressed through improved and reoriented "nexus governance approaches" (**Figure SPM.11**), defined as the development and use of coordinating structures and processes that enhance the engagement of multiple actors through horizontal (e.g., across various nexus elements and associated sectors) and vertical (e.g., cross-scale connectivity or multilevel governance) channels to address nexus challenges, identify policy and sociopolitical options, and manage their implementation *(established but incomplete)* {4.5}. Nexus governance approaches, building on and in line with different national and international obligations, can provide an alternative to current siloed approaches and address indirect drivers through:
(i) integrative, holistic and transdisciplinary framings of problems and solutions; (ii) inclusive approaches that bring about enhanced opportunities for diverse actor engagement; (iii) considerations of equity and justice, alongside accountability; (iv) enhanced mechanisms and processes for collaboration and coordination across scales and sectors; and (v) adaptive, reflexive and experimental approaches to learn from successes and to scale these solutions *(established but incomplete)* {4.5.4} (**Figure SPM 11**). Attention to scaling can also assist in accelerating the adoption, implementation and amplification of response options over wider regions and longer time frames. Scaling opportunities include scaling out (applying response options to new places), scaling down (localizing response options that are highly adaptive), scaling up (institutionalizing at the level of policy, rules and laws) and scaling deep (changing relationships, unsustainable and unjust worldviews, mindsets or beliefs) *(well established)* {4.4.1}. When combined with capacity strengthening processes {D5}, scaling can enable transformative change *(established but incomplete)* {4.4, 4.5.5, 7.3}.

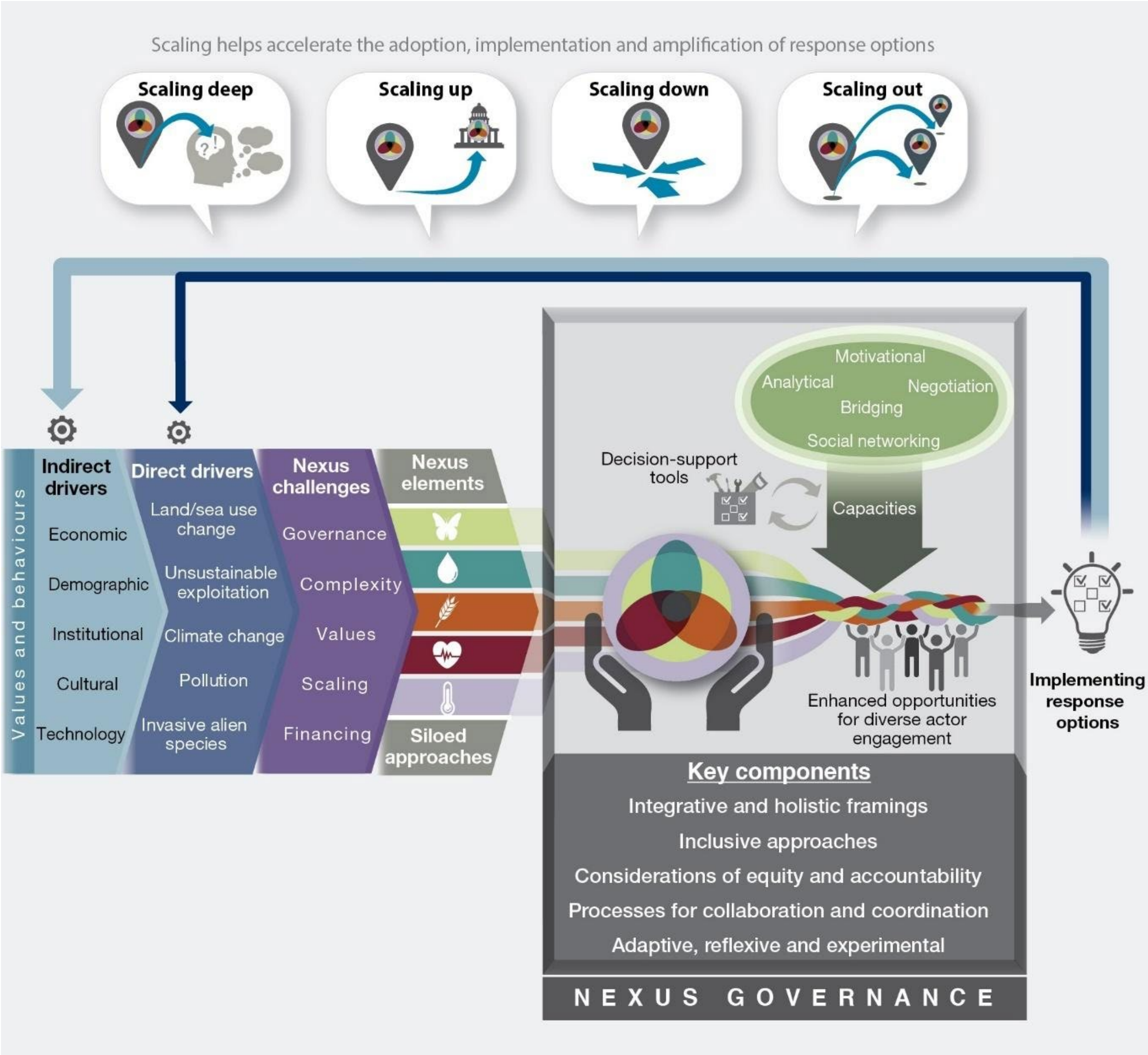

Figure SPM.11. Nexus governance addresses the challenges associated with governing interactions across multiple elements, including implementing response options to influence the impact of direct and indirect drivers. The five key components of nexus governance {D1} shown in the figure include: integrative and holistic framings, inclusive approaches, considerations of equity and accountability, processes for collaboration and coordination, and adaptive, reflexive and experimental approaches, and these components can guide implementation of response options and address negative direct and indirect drivers of change, including unsustainable and unjust values and behaviours {4.2, 4.5, 7.3}. Mobilizing and strengthening existing and new types of capacities {D5} can also help drive coordinated action by actors and institutions working in a variety of contexts. The use of specific decision support tools {4.6} can help strengthen capacities which can facilitate enhanced opportunities for actor engagement, supporting nexus governance and the selection and implementation of response options to address direct and indirect drivers of change. Scaling of response options can also ensure more widespread, just and sustainable outcomes.

D2. Response options are likely to be most effective when co-designed with a variety of actors and institutions using processes and approaches that acknowledge and address trade-offs and facilitate and strengthen enabling conditions and synergies *(established but incomplete)* {4.2.5, 5.1.4, 5.2.4, 5.3.4, 5.4.4, 5.5.4, 5.6.4, 5.6.5, 7.3}. The intertwined nature of nexus elements means that nearly all actors (local to global, informal and formal, public and private, individual and collective) have a potential role to play. Nexus governance approaches can help align actors across sectors, foster a shared understanding of challenges and opportunities, reduce tensions arising over trade-offs, improve effectiveness and potentially reduce costs of duplication and support and incentivize collective action and collaboration *(established but incomplete)* {4.5, 5.6.4, 7.3}. Transdisciplinary engagement of all actors, especially those historically and currently marginalized, in the collaborative design, implementation and monitoring of response options is important. This increases acceptability, transparency and effectiveness as it incentivizes cooperation and fosters co-learning, especially among diverse actors who may have conflicting values and objectives *(established but incomplete)* {4.5, 5.1.5, 5.6.4, 7.3} (**Figure SPM.11**). Ensuring both procedural and distributional equity also improves outcomes: response options assessed to have higher equity impacts also provided greater potential benefits across the nexus elements *(established but incomplete)* {4.5.3, 5.6.5.2}. Response options not co-created with relevant actors can lack credibility and legitimacy, leading to poor performance, low adoption rates, protest, resistance, protest, resistance and poor equity outcomes *(well established)* {4.3.5, 4.5.1.1, Table 4.1 A}. However, because not all actors and institutions have power, agency and resources to act, strengthening their capacities and skills and improving enabling conditions, including supportive and inclusive finance and incentive mechanisms and transparent monitoring and accountability, are foundational to changing trajectories *(established but incomplete)* {4.5, 6.3.3.2, 7.3.7}.

D3. Financial and economic policy reform can shift incentives, change business models and help resources flow towards supporting and restoring biodiversity and related benefits across nexus elements as well as financing just and equitable transitions *(established but incomplete)* {6.2.6, 6.3}. However, current economic and financial systems are driving declines in nature resulting in costs now and growing nature-related risks, thus increasing the urgent need for action *(established but incomplete)* {6.1.3, 6.1.4, 7.2}. Nature-related risks to economic and financial systems, estimated in the trillions of dollars and mutually reinforcing with risks from climate change, are increasing interest in and opportunities for reforming the relationship between the economy and nature *(established but incomplete)* {6.1.4, 7.2}. Despite this, and the fact that financial resources flowing to biodiversity (particularly from public sources) have increased in the last decade, progress has been inadequate and gaps remain to meet resource needs for biodiversity, which are estimated in the range of $0.3–1 trillion per year *(established but incomplete)* {6.2.2} (**Figure SPM.12).** Gaps in financing to meet the Sustainable Development Goals related to nexus outcomes beyond biodiversity add at least $4 trillion to these investment needs each year *(established but incomplete)* {6.2.1}. While some current biodiversity finance flows and mechanisms aim to take advantage of nexus interactions by promoting effectiveness and multiple co-benefits, identifying additional nexus finance options is important to deliver nexus solutions to the degree required for just and sustainable futures {1.1.2.5} (**Figure SPM.12**). Three complementary categories of response options were identified which could collectively help align economic and financial systems with biodiversity and/or help direct increased financial resources towards biodiversity and other nexus elements. Firstly, measures to improve the accessibility, availability and use of information, including information related to the diverse values of nature by economic and financial decision makers. Examples in this category include the adoption and use of metrics beyond GDP, the incorporation of nexus related information in the appraisal of public spending and, transparency and reporting requirements in the private sector. Secondly, options aimed to improve access to and the availability of financial resources through the use of financial and economic instruments. Examples in this category include green bonds, microfinance and payments for ecosystem services, as well as tax policy to increase the availability of public funds. Thirdly, options to reduce negative incentives that drive damage to biodiversity and nexus elements. Examples in this category include improving safeguards and standards for investments and, where contextually appropriate and in accordance with international obligations, tackling negative incentives such as harmful subsidies {6.2.6}. Available evidence shows a clear bias in the current distribution of biodiversity finance, with absolute levels of domestic public spending concentrated in countries in North America and Europe, and China. Yet, only 5% of private finance flows globally for biodiversity are allocated to least developed countries and other low-income countries. This highlights the challenges faced by all developing countries, including those already devoting much public finance to biodiversity, in mobilising resources from all sources and recognizes that developing countries may not be able to dedicate sufficient resources to the nexus elements and recognizes the need to strengthen the capacity to implement economic and financial response options. It also highlights the importance of complementary reforms to the economic and financial system, including to tackle existing debt concerns and the cost of finance linked to perceived investment risks, can help ensure adequate, accessible and affordable finance in developing countries and help finance just and equitable transitions (*well established*) {6.2.1, 6.2.5.4}. Indigenous Peoples and local communities face particular challenges in accessing finance and funding across scales, indicating a further area for action *(well established)* {6.1.3, 6.2.4}. Wider transition risks related to the uncertain costs of adapting to changes in operations can be reduced through providing policy certainty and improving business awareness of impacts and dependencies on nature, and the opportunities created by innovative business models that contribute to the conservation and sustainable use of biodiversity and through working with nature *(established but incomplete)* {6.1.4, 6.2.6}.

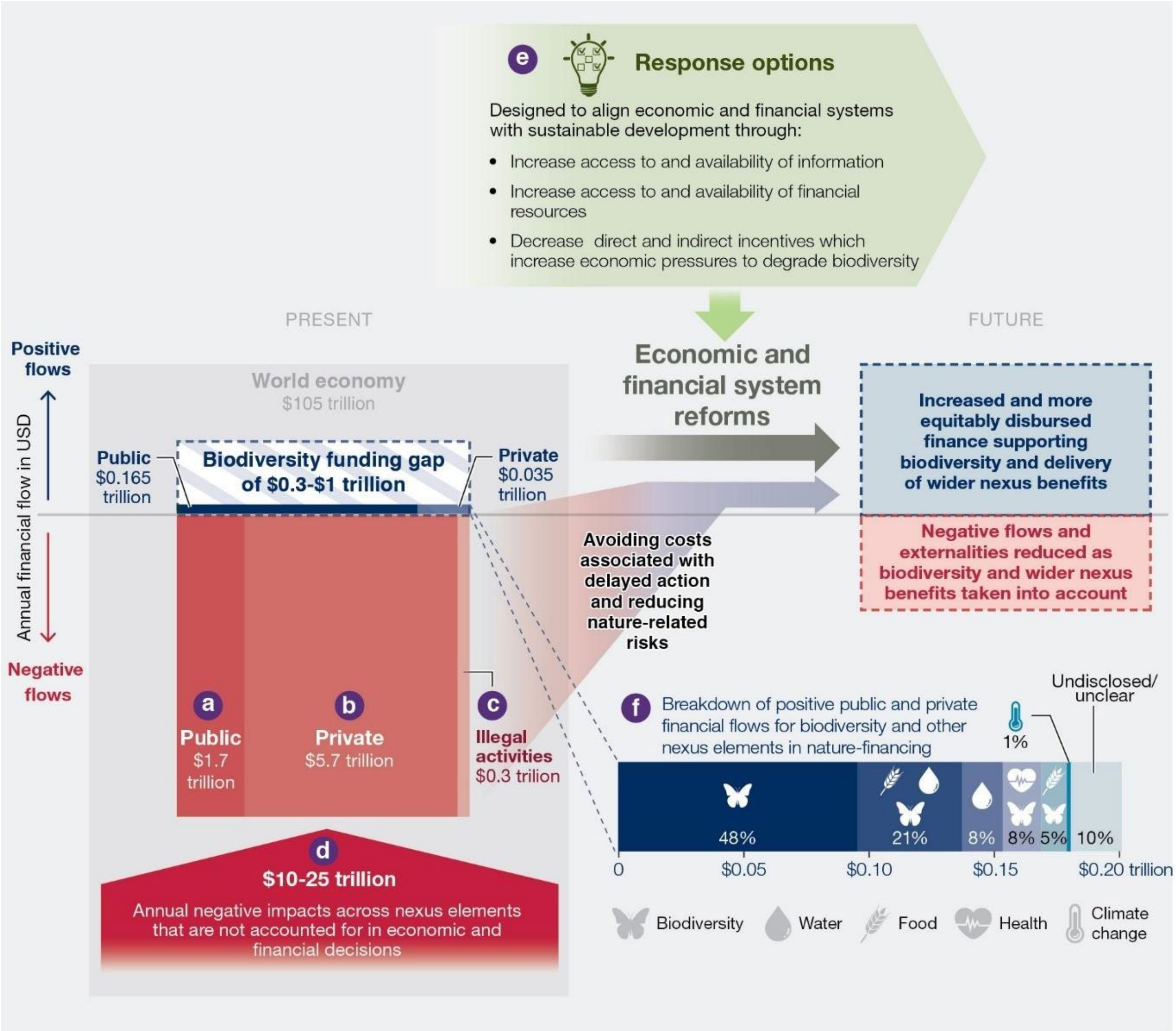

Figure SPM.12. Biodiversity and nexus funding in the context of the wider economy. A. Current economic and financial systems allocate 35 times more resources towards economic activities that directly damage biodiversity than they provide to support nature. Private investment in activities that damage biodiversity is incentivized both by direct subsidies (a – negative public funds) and the wider enabling environment that permits externalities (negative impacts estimated at many trillions of dollars across nexus elements that remain unaccounted for in production and consumption choices (d). Illegal flows of finance that damage biodiversity (c) and nexus elements are also estimated to be greater than total positive investments in biodiversity. While the estimates of negative subsidies (a), negative private finance flows investments (b) and illegal activities (c) represent annual flows of financial resources and can be added together, the externality figures represent estimates of the annual monetary value of various different impacts, so they are not a financial flow, but an (often neglected) outcome of economic activity (d). There are tools and actions (e – response options) that can mainstream nexus approaches within financial and economic decision-making. These are aimed at aligning economic and financial interests with sustainable development but require significant transformations, especially to ensure affordable finance is accessible to developing countries. The breakdown of the current status of positive public and private biodiversity financial flows shows some existing synergies with other nexus elements (e.g., water funds, sustainable agricultural investments). Note that current estimates of combined climate and biodiversity finance are small as these focus only on investments in nature that specifically target climate change benefits (e.g., voluntary carbon markets) and do not reflect overall volumes of global financing for climate change.

D4. Reforms to governance and economic systems can be facilitated by deliberate steps that identify existing challenges and contexts, increase actor engagement through coordination, knowledge co-production and strategic action, and seek iterative, adaptive and scalable solutions *(established but incomplete)* {4.5, 5.6, 6.2, 7.3}. These steps can be visualized as a road map (Figure SPM.13) that encourages actors to work together to identify problems and solutions using tools and methods that can increase knowledge and improve cooperation and decision-making, aiming for just and sustainable futures *(established but incomplete)* {4.6, 7.3}. Key steps towards improved and holistic decision-making may include, characterizing underlying causes of nexus challenges and impacts of direct and indirect drivers on nexus elements *(well established)* {7.3.1}; identifying and convening governance actors who may currently not work collaboratively across scales *(well established)* {7.3.2}; understanding nexus elements and the interactions among them *(well established)* {7.3.3}; co-creating visions for just and sustainable outcomes of interventions and surfacing and aligning values, which can broaden spaces for dialogue, shift power dynamics, increase inclusion and participation and create greater support and legitimacy for response options *(well established)* {4.5.1, 4.5.3, 7.2, 7.3.4}; identifying response options and assessing trade-offs and synergies (*well established*) {7.3.5}; assessing enabling conditions and overcoming barriers, which can include considerations of policy design and implementation, equity and diversity, institutional capacity, behaviour and lifestyles, technology and material endowments *(well established*) {4.2.5, 7.3.6}; negotiating implementation and strengthening transformative outcomes of response options, including through scaling and strengthening capacities of actors (*well established*) {7.3.6}; and embedding experimentation, evaluation, evaluation, reflection and learning through monitoring to foster adaptive governance *(well established)* {4.2.2, 4.5.4, 7.3.8}. Decision support tools can be particularly useful at each step of the road map, with more than 200 tools available for supporting nexus approaches related to biodiversity, water, food and climate change (although health is commonly not included in these tools) *(well established)* {4.6.1}. Measures along the road map that can also assist with "course correction" are needed to enhance social and environmental outcomes and equity; examples include the use of free, prior and informed consent procedures and other human rights-based approaches *(well established)* {4.5, Box 4.11}. These steps to improved decision-making and governance can be incremental or more transformative, depending on how they are implemented *(established but incomplete)* {7.3} and could be used to inform decision-making across scales. For example, actors involved in sub-national, national, regional or transboundary development planning processes could use steps of the road map, where relevant, when, for example, co-developing National Biodiversity Strategies and Action Plans, Nationally Determined Contributions and National Adaptation Plans (**Figure SPM.13)**.

D5. While some actors and institutions across the globe, including Indigenous Peoples and local communities *(established but incomplete)* {1.2.2, 4.5.1, 4.5.2}, already possess capacities for nexus governance approaches, strengthening specific capacities for many other actors can improve outcomes *(well established)* {4.5.5}. Capacity strengthening is an important enabling condition recognized in many global conventions and initiatives *(well established)* {4.5.5, Table 4.11}. Specific capacities to move towards improved nexus governance approaches include those which facilitate response option implementation; capacities to understand, leverage and mobilize equitable financial flows to support multiple co-benefits among nexus elements *(well established)* {4.5.4, 4.5.5, 6.2}; and capacities to scale and amplify options that show transformative potential *(well established)* {4.4, 4.5.4, 4.5.5, Table 4.12}. For example, response options that generate new practices and innovations, shift values and views, or change structures and institutions show the most transformative potential *(established but incomplete)* {5.6.6}. Important identified capacities to help actors achieve these aims include motivational capacities, which build awareness and desire for change *(well established)* {4.5.5}; analytical capacities, which enable actors to select, understand and use suitable decision support tools and strengthen institutional and research capacities which can help address inequalities among countries *(well established)* {4.5.5, 4.6.1, Table 4.13, 7.3.3}; bridging capacities and promoting transdisciplinary research including the ability to bring together different ways of knowing and doing through knowledge co-production processes *(well established)* {4.5.5, 4.6.2}; negotiation capacities to surface and navigate inevitable trade-offs between the values and interests of different actors and institutions, including those of Indigenous Peoples and local communities *(well established)* {3.1.2, 4.5.5, 7.3.7} and deeper considerations of equity and justice which can facilitate a greater intersectional understanding of how power mediates governance processes *(well established)* {4.5.1, 4.5.3.3, 6.3.3.2, Box 4.12, Table 4.8}; and social-networking capacities for facilitating co-learning opportunities by using knowledge and innovation brokers *(established but incomplete)* {4.5.5, Table 4.12, 7.5.5} (**Figure SPM.11**). While many capacity gaps still remain (*established but incomplete*) {7.4.1, Appendix III}, there are available response options, such as reconnecting people with nature (B14), community-based collective action (W15) and those that strengthen the capacities of women (W06), that both rely on and can build up actors' and institutions' capacities to help govern and manage across the nexus (*well established*) {5.1.3.14, 5.2.3.6, 5.2.3.15}.

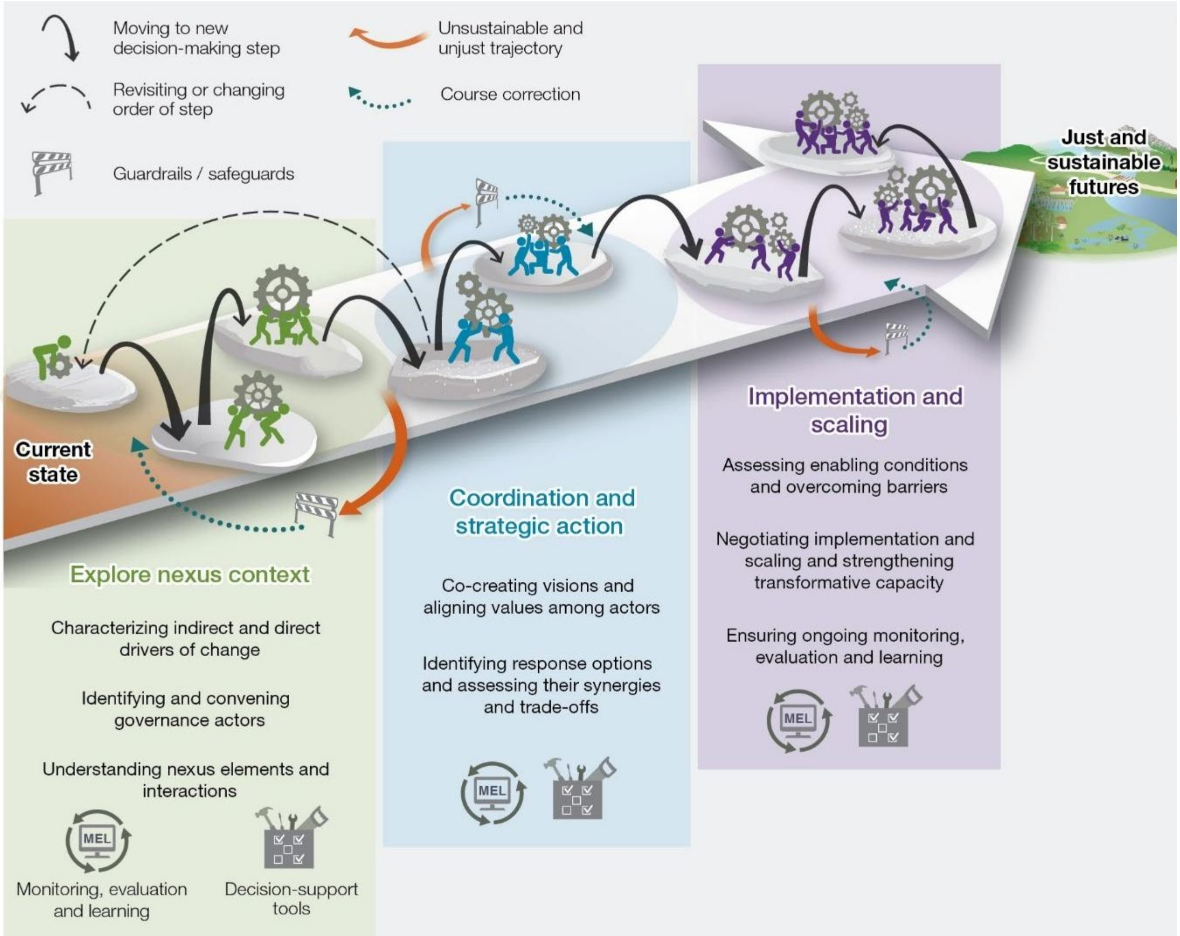

Figure SPM.13. Road map for applying nexus approaches. Actors working together on each of the eight suggested steps can move towards context-relevant and appropriate outcomes, including just and sustainable futures, particularly if enacted through collaborative problem-solving in an iterative manner. Clusters of steps cover exploration of the contexts of nexus problems {7.3.1, 7.3.2, 7.3.3}, coordination and strategic action to address problems using nexus approaches {7.3.4, 7.3.5}, and implementation and scaling of solutions {7.3.6, 7.3.7, 7.3.8}, with decision-support tools available along the way. Different types of decision support tools can be useful at each step of the road map, including tools that support public and other participatory processes, training and capacity building, social learning, innovation and adaptive governance, assembling data and knowledge, assessment and evaluation, selection and design of policy instruments and implementation, outreach and enforcement {4.6.1} (**Box 7.1)**. Each step along the road map is important but not necessarily sequential or linear, as demonstrated by the black arrows showing steps that move decision-making processes forward and the grey dashed arrows showing where steps may need to be revisited or implemented in a different order, thus entailing experimentation. Each cluster of steps highlights the importance of iterative monitoring, evaluation and learning. Green dotted lines indicate opportunities for course correction, where decisions could lead to unsustainable and unjust outcomes which can be addressed by consideration of specific environmental and social safeguards to ensure recalibration back to just and sustainable pathways.

Appendix I: Communication of the degree of confidence

In the thematic assessment of the interlinkages among biodiversity, water, food and health, the degree of confidence in each main finding is based on the quantity and quality of evidence and the level of agreement regarding that evidence (**Figure SPM.A1**). The evidence includes data, theory, models and expert judgement.

- ***Well established***: There is a comprehensive meta-analysis or other synthesis or multiple independent studies that agree.
- ***Established but incomplete***: There is general agreement, although only a limited number of studies exist; there is no comprehensive synthesis and/or the studies that exist address the question imprecisely.
- ***Unresolved***: Multiple independent studies exist but their conclusions do not agree.
- ***Inconclusive***: There is limited or no evidence, or evidence is based on suggestion or speculation.

Figure SPM.A1. The IPBES four-box model for qualitative communication of confidence. Confidence increases towards the top-right corner, as suggested by the increasing strength of shading. Source: IPBES (2016).15 Additional details about this approach are documented in the IPBES Guide on the Production of Assessments.[16]

[15] IPBES (2016): Summary for policymakers of the Assessment Report on Pollinators, Pollination and Food Production of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Potts, S. G., Imperatriz-Fonseca, V. L., Ngo, H. T., Biesmeijer, J. C., Breeze, T. D., Dicks, L. V., Garibaldi, L. A., Hill, R., Settele, J., Vanbergen, A. J., Aizen, M. A., Cunningham, S. A., Eardley, C., Freitas, B. M., Gallai, N., Kevan, P. G., Kovács-Hostyánszki, A., Kwapong, P. K., Li, J., Li, X., Martins, D. J., Nates-Parra, G., Pettis, J. S., Rader, R., and Viana, B. F. (eds.). IPBES secretariat, Bonn, Germany. http://doi.org/10.5281/zenodo.2616458.

[16] IPBES (2018): *The IPBES Guide on the Production of Assessments*. Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany. https://ipbes.net/guide-production-assessments.

Appendix II: Nexus elements and concepts mapped to key categories of the IPBES conceptual framework

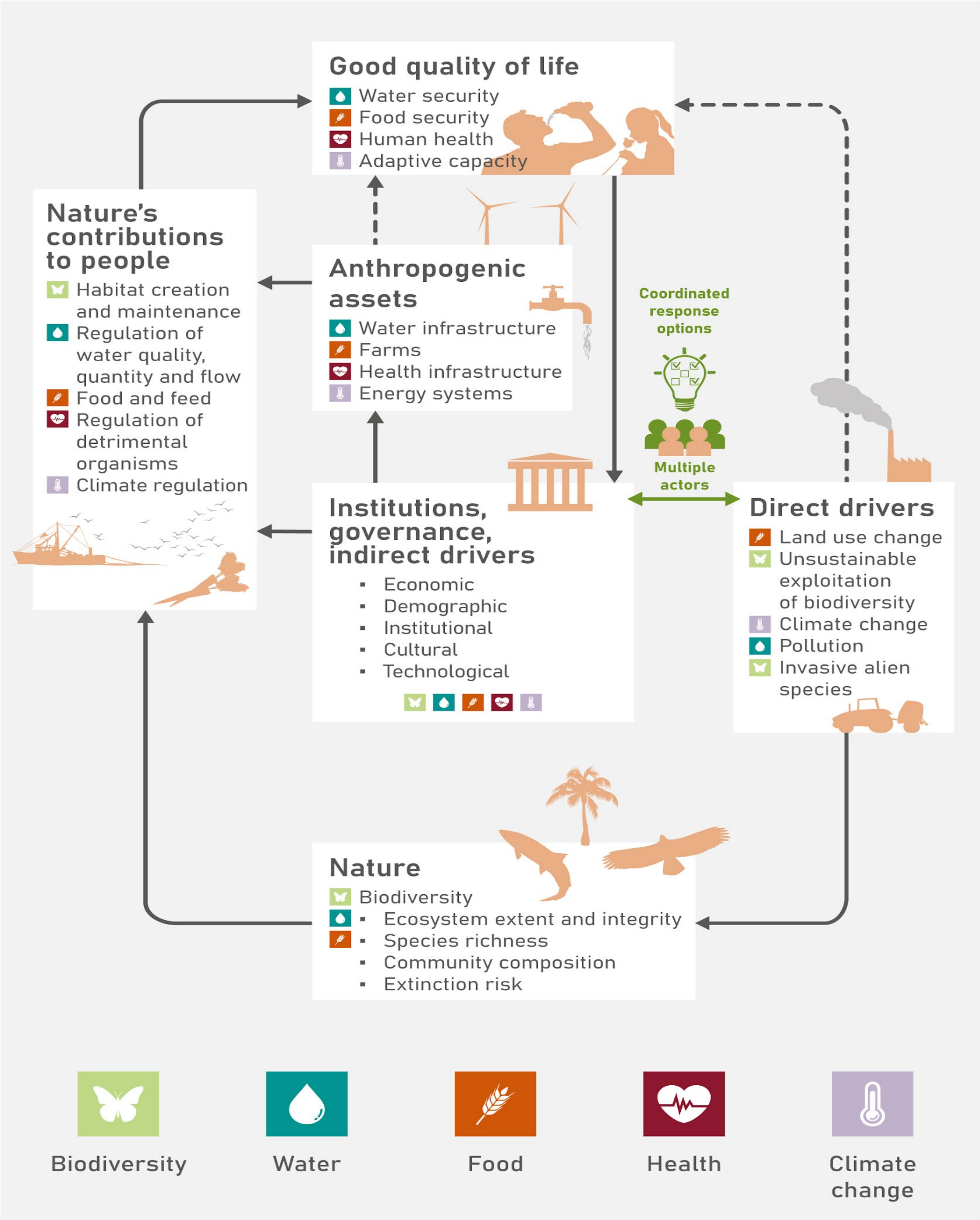

Figure SPM.A2. Nexus elements and interactions in the IPBES conceptual framework. Illustration of how the nexus elements of biodiversity, water, food, health and climate change intersect with the broad categories from the IPBES conceptual framework (see Díaz et al., 2015[17]) of "nature", "nature's contributions to people", "good quality of life", "direct drivers", "anthropogenic assets" and "institutions, governance and other indirect drivers" (boxes). Examples are added in each box in order of nexus element: biodiversity, water, food, health and climate change (where relevant). See chapter 1 {1.2.3}.

[17] Diaz et al. (2015). "The IPBES Conceptual Framework — connecting nature and people". *Current Opinion in Environmental Sustainability*, 14, 1–16. https://doi.org/10.1016/j.cosust.2014.11.002.

Appendix III: Synthesis of knowledge and data gaps

In the course of conducting this assessment key information needs were identified in the following categories:

- Nexus interlinkages
- Data and quantitative information availability and access
- Assessment methods, tools, scenarios, models
- Indigenous and local knowledge and the interactions of Indigenous Peoples and local communities with nexus elements, including impacts on these groups and actions they can take
- Nexus response options
- Nexus governance
- Nexus financing
- Capacity gaps
- Technology gaps

Examples of knowledge gaps are provided in Table SPM.A1. The full table of knowledge gaps is provided in chapter 7 {7.4}.

Table SPM.A1. Summary of key categories and types of knowledge and data gaps from the nexus assessment

Category	Knowledge gap	Traceability
Nexus interlinkages	Studies on higher-order nexus interlinkages involving three or more nexus elements, particularly studies involving health	{2.7, 3.7.5, 5.1.5, 5.2.5, 5.3.5, 5.4.5}
	Studies on nexus interlinkages spanning across the terrestrial, freshwater and marine realms	{3.7.5, 5.2.5}
	Studies on nexus interlinkages spanning distant regions (telecoupling effects)	{2.7, 5.3.5}
Data and quantitative information availability and access	Studies quantifying nexus interlinkages, including trade-offs and synergies among three or more nexus elements	{2.7, 5.2.5, 5.3.5, 6.3.2}
	Studies quantifying the role of biodiversity in interlinkages among nexus elements that go beyond simple indicators based on presence of certain ecosystems or species (e.g., ecosystem functioning, genetic diversity)	{2.7}
	Studies to identify indicators that can be used to assess and quantify linkages and interactions between indirect and direct drivers and their impact on the interlinkages among nexus elements	{2.7}
	Data on economic costs and benefits of nexus response options, particularly those in biodiversity and health	{5.1.5, 5.4.5, 6.2.6.2}
Assessment methods, tools, scenarios, models	Modelling tools that better account for nexus interlinkages and can simulate pathways to sustainable outcomes across multiple nexus elements at a range of spatial scales (global, regional, local), as well as accounting for inherent modelling uncertainties	{2.7, 3.7.5}
	Policy implementation scenarios and models representing multiple response options and interlinkages among three or more nexus elements that could assist in understanding how targets might be achieved across different temporal and spatial scales, including achieving synergies or multiple benefits among sectoral response options and related issues such as poverty, equity and power relation among actors	{3.7.5, 5.2.5, 5.3.5}
	Novel methods, models and decision support tools for assessing interlinkages among three or more nexus elements and actors in the implementation of nexus governance options, including methods focused on spatial/temporal dynamics and scaling up, out, down and deep of response options and their long-term outcomes for the nexus	{5.2.5, 5.3.5, 4.6}
ILK and IPLC	Studies to improve understanding of IPLC-managed systems that have nexus-wide benefits, their importance, monetary and non-monetary value, and potential to scale up, including consideration of contested property rights and traditional rights as well as financing	{5.2.5, 5.3.5, 6.2.5}

Category	Knowledge gap	Traceability
	Scenarios that better account for the visions embedded in ILK and include the participation of IPLC	{3.7.5, 5.2.5, 5.3.5}
	Studies on ILK-based response options that consider the role of IPLC cultural practices and innovation for the implementation of nexus response options, their context dependency and feasibility for scaling	{5.1.5, 5.3.5}
Nexus response options	Empirical evidence evaluating the impacts of response options on multiple nexus elements before and after implementation to understand synergies and trade-offs and how these are influenced by the implementation process, including across multiple scales and contexts	{3.7.5, 5.1.5, 5.2.5, 5.3.5, 5.4.5}
	Evidence on successful examples of scaling out response options plus evidence on where options are non-scalable owing to context-dependencies	{5.2.5}
	Evidence on the design and aggregate outcomes of combinations (bundles and/or sequences) of response options at landscape, national, regional and global scales	{3.7.5, 5.1.5}
	Studies on how the transformative potential of nexus response options can be harnessed	{5.4.6}
Nexus governance	Studies on alternative and innovative approaches to nexus governance, including improving understanding of what comprises good nexus governance, and for whom and under which conditions it takes place	{5.2.5, 4.6}
	Studies on how governance and policy can enable improved engagement, alignment and collaboration among actors from different nexus elements across a variety of scales taking account of actor networks across the nexus, power dynamics and effects on reducing inefficiencies and promoting inclusiveness	{5.1.5, 5.2.5, 5.3.5, 5.4.5, 5.5.5, 4.6}
	Studies on linking nexus approaches to their implications for multilateral agreements, such as the Kunming-Montreal Global Biodiversity Framework and the Paris Agreement, including consequences for the nexus elements (biodiversity, water, food, health and climate change) and their interlinkages	{5.1.6, 5.2.6, 5.3.6, 5.4.6, 5.5.6}
Nexus financing	Empirical evidence and understanding of the scale and distribution of financial flows impacting nexus elements and interlinkages among them, including subsidies that have the potential to harm other nexus elements or trade-off against other response options	{5.4.6, 6.2.2, 6.2.4}
	Studies of the spatial distribution of drivers of sustainable investments/disinvestments and the impacts of such investments/disinvestments on biodiversity and the other nexus elements, including their ability to reduce inefficiencies in resource management and outcomes	{6.2.4}
	Studies on how to integrate nexus benefits into financial decision-making and asset pricing, including how to scale up and amplify public-private investment and financing in synergistic outcomes among nexus elements	{6.2.6}
Capacity gaps	Training and capacity strengthening on understanding and overcoming the nexus challenges (high complexity, inadequate scaling, siloed governance, multiple values and lack of finance) associated with nexus approaches	{1.1.2, 2.7, 4.2, 4.5, 4.6, 5.4.6, 6.3.3}
	Strengthened partnerships to achieve more harmonized and holistic approaches among actors in the biodiversity, water, food, health and climate change sectors	{5.4.6}
	Training and capacity-building on boundary (bridging) work, negotiation and methodologies for incorporating multiple types of knowledge	{4.5.5, 4.6}
	Greater dissemination and communication of knowledge and good practice gained from implementation of nexus approaches and nexus response options	{2.7}

Category	Knowledge gap	Traceability
Technology gaps	Improved understanding of sociocultural and economic constraints on technology development and adoption related to nexus response options	{7.4.3}
	Studies on the potential of digital technologies, most notably artificial intelligence/data science, digital twins and integrated modelling platforms, to discover, explore and improve understanding of interlinkages in nexus assessments	{7.4.3.1}
	Improved mechanisms for open science and FAIR data practices to ensure equitable access to data and technology	{7.4.3.1}

Abbreviations: FAIR – findable, accessible, interoperable and reusable; ILK – Indigenous and local knowledge; IPLC – Indigenous Peoples and local communities.

This table of response options was prepared by the experts of the nexus assessment and presented to a working group established by the Plenary at its eleventh session. The Plenary did not approve this table as part of the summary for policymakers. It is therefore included in draft form, which does not imply working group or Plenary approval.

Draft descriptions of response options assessed and scored as shown in Figure SPM.8

Biodiversity response option	Brief description of response option	Chapter section
B01 Area-based conservation	Conservation strategies including, but not limited to, protected areas, and other effective conservation measures that use a nexus approach to conserve biodiversity across landscapes and seascapes.	5.1.3.1
B02 Urban nature-based solutions	Implementing nature-based solutions in urban areas to support sustainable development objectives and reconnect people with nature; current urban nature-based solutions focus primarily on climate risk management and adaptation to climate change.	5.1.3.2
B03 Agroecology	Designing and managing agricultural and food systems using ecological and social concepts and principles to support sustainable agricultural production, minimize negative environmental impacts of production and secure nature's contributions to people.	5.1.3.3
B04 Ecosystem-based adaptation in rural landscapes	Using biodiversity and nature's contributions to people to reduce human vulnerability to climate change by facilitating adaptation and building resilience to the impacts of climate change.	5.1.3.4
B05 Forest landscape restoration	Restoring forests at the landscape scale to increase forest cover and improve ecological functions on restored lands, including the restoration and enhancement of nature's contributions to people from forest ecosystems.	5.1.3.5
B06 Restoration of coastal and marine systems	Restoring coastal and marine systems (e.g., mangroves, salt marshes, seagrasses, seaweed, coral) to improve habitat integrity and connectivity, ecosystem functioning and ecosystem resilience and secure nature's contributions to people from these ecosystems.	5.1.3.6
B07 Restoration of inland water systems	Restoring inland water bodies (e.g., lakes, rivers (including riparian areas) and wetlands) to improve water flows, water quality and hydrologic connectivity, increase water security and support the sustainable use of aquatic biodiversity.	5.1.3.7
B08 Rewilding	An approach to restoring ecosystems that focuses on recovering ecological processes, improving ecological connectivity, restoring wildlife populations and reconnecting people with nature; natural processes lead the recovery rather than a defined ecosystem end state.	5.1.3.8
B09 Integrated landscape and seascape approaches	Multi-stakeholder, multi-sectoral, collaborative processes to adaptively co-manage landscapes and seascapes over the long term that emphasize connectivity between socio-ecological systems with synergistic outcomes for environmental, social and economic objectives.	5.1.3.9
B10 Rights-based approaches	Applying human rights principles to conservation and other measures, and accounting for the rights of nature and the rights of non-human entities; this includes recognizing the rights of Indigenous Peoples and local communities and of women, such as to land and territories, water, food, health and a safe and clean environment.	5.1.3.10
B11 Multilateral environmental agreements	International environmental agreements, particularly those focusing on flexible implementation processes that account for local knowledge and needs, foster intergovernmental cooperation and promote synergistic outcomes across agreements and development priorities.	5.1.3.11

B12 Land and sea planning	Employing spatial planning to configure the use of terrestrial and marine territories over the medium to long term to balance trade-offs between multiple uses of the natural environment, support sustainable development objectives and meet socio-cultural needs.	5.1.3.12
B13 Natural capital accounting	Measuring and reporting on the stocks and flows of natural assets (renewable, non-renewable, biotic, abiotic) at the individual and ecosystem level to manage, sustain and enhance nature's contributions to people.	5.1.3.13
B14 Reconnecting people with nature	Restoring and fostering a deep connection between people and the natural world, including deepening understanding and appreciation of nature; the process draws on multiple knowledge systems and benefits human health and well-being and nature.	5.1.3.14

Table SPM.A2 (*continued*)

Water response option	Brief description of response option	Chapter section
W01 Inclusive water education	Formal and informal environmental education efforts that incorporate multiple knowledge systems and values with the goals of increasing knowledge about and awareness of water resources and empowering people to protect and conserve those resources.	5.2.3.1
W02 Integrated water infrastructure	Multi-actor, multi-sectoral, basin-level approaches to managing infrastructure (built and natural) for water storage that balance societal needs for water with conserving and sustaining ecosystems and water resources.	5.2.3.2
W03 Dam operation	Managing water releases from dams to enable flow regimes that support biodiversity, connectivity of floodplains and ecological resilience; this response option includes dam removal.	5.2.3.3
W04 Efficient water use in agriculture	Planting drought-resistant crops to enable efficient use of water in crop production systems and optimizing fertilizer use to improve water quality by reducing chemicals in agricultural runoff.	5.2.3.4
W05 Sustainable inland fisheries	Assessing inland fisheries to enhance knowledge generation in support of sustainable fisheries management, which in turn benefits freshwater biodiversity, ecosystem function and resilience and human health and well-being.	5.2.3.5
W06 Inclusive water management	An approach to water management that is inclusive of genders, cultures and worldviews and enables and particularly empowers women to engage in decision-making processes that impact access to and management of water resources.	5.2.3.6
W07 Rights of nature	A legal framework recognizing ecosystems and species as rights-bearers subject to legal protection; the framework reflects Indigenous Peoples' cosmovisions, which view humans and nature as deeply interconnected, with harm to one causing harm to the other.	5.2.3.7
W08 Transboundary water cooperation	Cooperative action to assist with the management of transboundary rivers, lakes and aquifer systems to ensure sustainable, equitable use of transboundary water resources and shared costs and benefits.	5.2.3.8
W09 Groundwater governance	A decentralized governance process to address groundwater depletion, pollution and salinization and improve the effectiveness of groundwater management that includes knowledge generation, access to information, policy, planning and finance.	5.2.3.9
W10 Finance for water infrastructure	A cluster of options that includes (1) water accounting; (2) mobilizing financial resources; (3) finance systems with environmental and social safeguards; (4) enabling conditions for financial viability and creditworthiness of the water sector; and (5) climate action.	5.2.3.10
W11 Manage alien species	Managing aquatic invasive alien species to conserve freshwater biodiversity, primarily through reducing invasion pathways.	5.2.3.11
W12 Manage wastewater	Managing wastewater and implementing sustainable sanitation practices to reduce the volume of wastewater generated, prevent and reduce water contamination, and recover and reuse components of wastewater (e.g., nutrients).	5.2.3.12
W13 Water-sensitive urban infrastructure	A range of options for designing urban infrastructure based on the principles of water-sensitive urban design to conserve water, protect biodiversity and mitigate water-related risks such as pollution, flooding and water scarcity.	5.2.3.13
W14 Addressing gendered burdens of water collection	Technological tools, educational strategies and economic support for women responsible for collecting and carrying water to alleviate the time burdens, negative health impacts and safety concerns associated with this responsibility and improve equitable water access.	5.2.3.14
W15 Community water management	Collective action at the local level to manage common-pool water resources, with social capital and social knowledge underpinning solutions to address local water challenges and enable sustainable, equitable and just water stewardship.	5.2.3.15

Table SPM.A2 (*continued*)

Food response option	Brief description of response option	Chapter section
F01 Halt conversion of ecosystems of high ecological integrity	Stopping the conversion of ecosystems of high ecological integrity and reducing expansion of the land base used for food production.	5.3.3.1
F02 Restore soil health	Preventing soil degradation, reducing existing soil degradation and restoring degraded soils (including restoring function and structure) to support soil biodiversity and secure nature's contributions to people provided by soils.	5.3.3.2
F03 Sustainable intensification	Increasing agricultural yields without adverse environmental impacts and without expanding the land base used for agriculture (i.e., avoiding the conversion of intact ecosystems for the purpose of agriculture expansion).	5.3.3.3
F04 Ecological intensification - croplands	Managing and using ecological processes and biodiversity in, and reducing external inputs to, cropland systems to sustainably improve cropland productivity, conserve or restore habitat, enhance and sustain nature's contributions to people and secure farmers' livelihoods.	5.3.3.4
F05 Ecological intensification - rangelands	Managing and using ecological processes and biodiversity in, and reducing external inputs to, rangeland systems to sustainably improve rangeland productivity, conserve or restore habitat, enhance and sustain nature's contributions to people and secure farmers' livelihoods.	5.3.3.5
F06 Ecological intensification - aquatic foods	A range of approaches in freshwater, coastal and marine ecosystems to increase food production while protecting biodiversity, conserving and/or restoring ecosystems and securing nature's contributions to people.	5.3.3.6
F07 Reduce nutrient pollution	Reducing nutrient pollution from agricultural systems.	5.3.3.7
F08 Reduce pesticide pollution	Reducing pesticide pollution from agricultural systems.	5.3.3.8
F09 Reduce plastic pollution	Reducing the use of plastic in food systems.	5.3.3.9
F10 Reduce food loss and waste	Reducing food loss and waste throughout food supply chains, from production to consumption.	5.3.3.10
F11 Sustainable healthy diets	Sustainable healthy diets promote all dimensions of individuals' health and well-being; have low environmental pressure and impact; are accessible, affordable, safe and equitable; and are culturally acceptable	5.3.3.11
F12 City -region food systems	Linking urban, peri-urban and rural communities to enable and support sustainable food systems, including food production, processing, distribution and consumption, protect the environment, provide economic opportunities and secure human health and well-being.	5.3.3.12
F13 Reforming public spending	Eliminating, phasing out or reforming agricultural subsidies that support unsustainable food production practices and undermine small-scale producers' livelihoods to foster public spending models that enable sustainable food production and consumption and support producers.	5.3.3.13
F14 Foster gender-transformative approaches	A range of options to end gender-based discrimination in the context of food systems; for women this includes increasing access to resources and markets, securing land tenure, inclusion in value chains, improved labour conditions and economic empowerment.	5.3.3.14

F15 Indigenous food systems	Recognizing and respecting Indigenous Peoples' food production systems and food requirements, formalizing and securing their land tenure rights on traditional territories and supporting safe, healthy and sovereign Indigenous food systems.	5.3.3.15
F16 Access to natural resources and land	Promoting, enabling and securing equitable access to natural resources and land, and securing land tenure rights for vulnerable and marginalized groups, including Indigenous Peoples and local communities.	5.3.3.16

Table SPM.A2 (*continued*)

Health response option	Brief description of response option	Chapter section
H01 Universal health coverage	Increasing access to comprehensive primary healthcare, including essential health, reproductive health and family planning services.	5.4.3.1
H02 Intercultural health services	Formal arrangements between health departments and traditional health practitioners that enable inclusive, equitable and culturally relevant healthcare for Indigenous Peoples and local communities and are informed by diverse knowledge systems.	5.4.3.2
H03 Net-zero sustainable healthcare	Reducing negative impacts of resource-intensive healthcare sectors; this includes reducing greenhouse gas emissions, sustainable procurement practices, reducing pollution and waste, and a focus on preventive and community healthcare.	5.4.3.3
H04 Sustainable use of medicinal plants	Using medicinal plants in a manner that supports biodiversity, ecosystem functions and human health and well-being in the present and future; this includes plant conservation, cultivation, sourcing, harvesting and trade and compliance with the Nagoya Protocol.	5.4.3.4
H05 Nature on prescription	A complementary healthcare approach in which healthcare professionals prescribe activities in nature to individuals or groups to treat a range of health conditions.	5.4.3.5
H06 Reduce meat overconsumption	Reducing overconsumption of red and processed meat in support of adopting sustainable healthy diets that rely on sustainable food systems and contribute to human health and well-being.	5.4.3.6
H07 Pollution prevention	A broad response option that includes strategies for reducing air, water and soil pollution in the context of protecting human health and reducing disease burdens.	5.4.3.7
H08 Mangrove conservation and restoration for health	Conserving and restoring mangroves to mitigate disaster risks from coastal hazards, including the risk of lives lost to coastal disasters, protect coastal and marine biodiversity and habitat, and support sustainable coastal and marine fisheries and food systems.	5.4.3.8
H09 Urban green infrastructure	Natural, semi-natural and artificial green spaces in urban environments that contribute to human health, well-being and quality of life, increase biodiversity and ecosystem resilience and support nature's contributions to people.	5.4.3.9
H10 Forest conservation for health	Conserving forests or reducing deforestation to support human health and well-being while also maintaining biodiversity and sustaining nature's contributions to people; this includes forested Indigenous community conserved areas and territories.	5.4.3.10
H11 Biodiversity management for zoonoses	Conserving biodiversity to prevent the transmission of pathogens from animals to humans (i.e., reduce the risk of spillover), reduce the spread of emerging zoonotic diseases and reduce the risk of pandemics.	5.4.3.11
H12 Integrated watershed-health interventions	Place-based responses involving participatory planning that integrate health promotion and interventions with landscape, seascape and watershed management approaches to support human health and well-being and enhance nature's contributions to people.	5.4.3.12
H13 Health impact assessments	A decision-making tool to assess how a policy, programme or project may potentially affect population health; the tool is underpinned by stakeholder engagement, equity, sustainable development and the ethical use of evidence and can be used by many different sectors.	5.4.3.13
H14 The One Health approach	Application of the One Health approach to address interlinkages among humans, animals and ecosystems in the context of health challenges, such as emerging infectious diseases, antimicrobial resistance and food safety, to safeguard human, animal and ecosystem health.	5.4.3.14
H15 Integrated health education	Education informed by conceptualizations of health (e.g., planetary health, One Health, eco-health) that describe health in the context of Earth system functions, biodiversity, ecosystems and diverse worldviews, including Indigenous conceptualizations of health.	5.4.3.15

Table SPM.A2 (*continued*)

Climate change response option	Brief description of response option	Chapter section
C01 Increase soil organic carbon	Interventions in managed ecosystems and landscapes to increase carbon inputs to soils, enable carbon to persist in soils for longer periods of time or reduce carbon losses from soils.	5.5.3.1
C02 Sustainable intensification	Increasing agricultural yields without adverse environmental impacts and without expanding the land base used for agriculture (i.e., avoiding the conversion of intact ecosystems for the purpose of agriculture expansion).	5.5.3.2
C03 Integrated multi-trophic aquaculture	A traditional aquaculture method that uses waste products and uneaten food from higher trophic level species (e.g., farmed fish) to cultivate species at a lower trophic level (e.g., plants, invertebrates); the method reduces waste and increases harvestable biomass.	5.5.3.3
C04 Wetland conservation and restoration	Restoring degraded and conserving intact peatlands and non-coastal wetlands to improve or sustain the structure and functions of these ecosystems and the contributions they provide to people.	5.5.3.4
C05 Offshore wind power	The use of offshore wind energy to decarbonize energy systems and mitigate climate change.	5.5.3.5
C06 Solar photovoltaics on land	The use photovoltaics (i.e., solar panels or solar cells) in solar energy installations on land to produce renewable energy and mitigate climate change.	5.5.3.6
C07 Sustainable bioeconomy	An economic model based on the use of renewable natural capital, including biological resources, that minimizes waste and reduces the use of fossil-based energy and products to conserve nature, mitigate climate change and support sustainable, equitable development.	5.5.3.7
C08 Reduce short-lived climate pollutants	A range of strategies to reduce emissions of pollutants with strong near-term warming effects generated from the combustion of fossil fuels, biomass burning and agricultural activities; provides benefits to human health and mitigates climate change.	5.5.3.8
C09 Multi-hazard early warning systems	Early warning systems designed to anticipate, predict and generate warnings for individual or multiple hazards that threaten human health and well-being and ecosystems; they are integral to disaster risk reduction strategies.	5.5.3.9
C10 Global cooperation for finance and technology	International partnerships and commitments that include both public and private financing to support climate change mitigation and adaptation and to enable cooperation and equitable access to and benefits from technology.	5.5.3.10
C11 Agroecology	A variety of practices to support sustainable management of agricultural lands with environmental, social and economic benefits; this assessed option particularly focuses on agroforestry systems, in which trees and woody shrubs are integrated into crop and livestock farming systems.	5.5.3.11
C12 Forest-based practices to address climate change	Conserving, restoring and sustainably managing forests to support climate change mitigation and adaptation, conserve biodiversity and sustain nature's contributions to people from forest ecosystems.	5.5.3.12
C13 Restoration of coastal and marine ecosystems for carbon sequestration	Restoring mangrove, seagrass and salt marsh ecosystems to conserve and support biodiversity, contribute to climate change mitigation and adaptation and provide benefits to human health and well-being, including securing livelihoods.	5.5.3.13
C14 Urban nature-based solutions	The implementation of nature-based solutions in urban areas to support climate change mitigation and adaption, increase resilience to climate change, conserve and protect biodiversity and natural resources and promote human health and well-being.	5.5.3.14
C15 Sustainable healthy diets	Sustainable healthy diets promote all dimensions of individuals' health and well-being; have low environmental pressure and impact; are accessible, affordable, safe and equitable; and are culturally acceptable.	5.5.3.15

Appendix V: Response option support for the Sustainable Development Goals, Kunming-Montreal Global Biodiversity Framework targets and the Paris Agreement

Figure SPM.A3

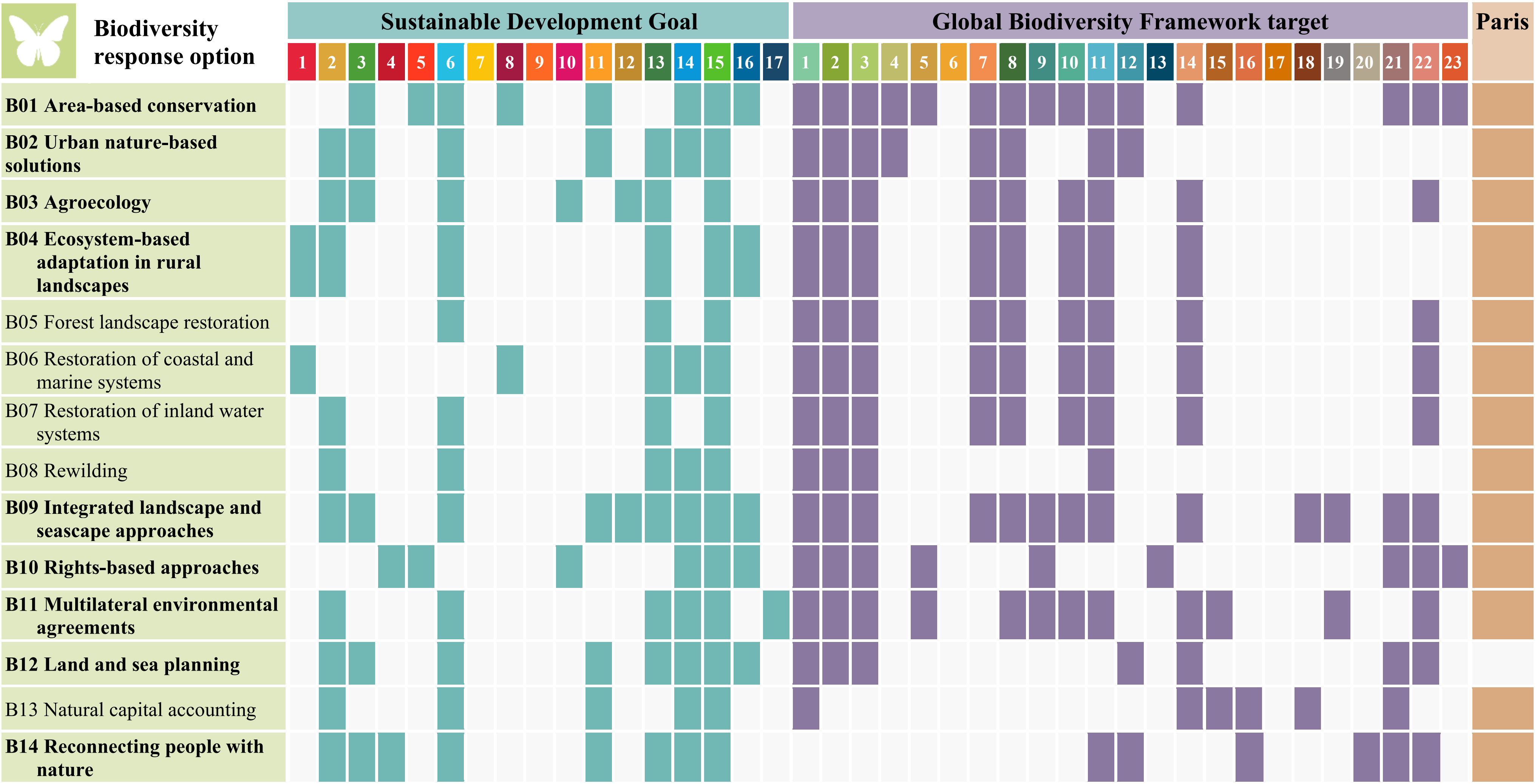

Figure SPM.A3 (*continued*)

Sustainable Development Goal

Water response option	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
W01 Inclusive water education				■	■	■											
W02 Integrated water infrastructure	■	■	■		■	■	■						■	■	■	■	
W03 Dam operation		■	■			■									■		
W04 Efficient water use in agriculture	■	■	■			■						■	■		■		
W05 Sustainable inland fisheries		■				■									■		
W06 Inclusive water management			■		■	■										■	
W07 Rights of nature						■									■		
W08 Transboundary water cooperation	■		■			■						■	■		■	■	
W09 Groundwater governance						■						■	■		■		
W10 Finance for water infrastructure			■			■											
W11 Manage alien species		■				■									■		
W12 Manage wastewater			■			■	■						■		■		
W13 Water-sensitive urban infrastructure			■			■			■		■		■	■	■		
W14 Addressing gendered burdens of water collection		■	■		■	■											
W15 Community water management						■							■	■	■		

Global Biodiversity Framework target / **Paris**

Water response option	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Paris
W01 Inclusive water education												■		■	■	■					■			■
W02 Integrated water infrastructure	■	■	■							■	■													■
W03 Dam operation	■	■	■							■	■													■
W04 Efficient water use in agriculture	■	■					■			■														■
W05 Sustainable inland fisheries				■	■				■	■				■										■
W06 Inclusive water management	■		■								■		■	■						■	■	■	■	
W07 Rights of nature			■											■										■
W08 Transboundary water cooperation	■	■	■				■	■	■		■			■	■					■				■
W09 Groundwater governance	■		■				■			■	■			■								■		■
W10 Finance for water infrastructure	■												■	■	■			■	■					
W11 Manage alien species	■			■		■	■										■							■
W12 Manage wastewater	■	■		■			■			■	■													■
W13 Water-sensitive urban infrastructure	■	■	■	■			■				■	■		■										■
W14 Addressing gendered burdens of water collection													■	■								■	■	■
W15 Community water management	■		■		■				■	■		■	■	■								■		

Figure SPM.A3 (*continued*)

Food response option	Sustainable Development Goal																	Global Biodiversity target																							Paris
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
F01 Halt conversion of intact ecosystems			■			■							■		■			■		■	■				■																■
F02 Restore soil health	■	■				■							■		■		■	■	■	■					■		■	■													■
F03 Sustainable intensification		■	■			■							■	■	■			■	■					■	■		■	■													■
F04 Ecological intensification - croplands		■	■			■							■	■	■			■	■					■	■		■	■													■
F05 Ecological intensification - rangelands		■				■							■		■			■	■				■	■	■		■	■													■
F06 Ecological intensification - aquatic foods		■	■			■							■	■	■			■	■			■		■	■	■	■														■
F07 Reduce nutrient pollution			■			■								■	■					■				■	■		■	■													■
F08 Reduce pesticide pollution		■	■			■								■	■					■				■				■													■
F09 Reduce plastic pollution			■			■						■			■					■				■	■			■													■
F10 Reduce food loss and waste		■				■						■	■		■										■		■						■								■
F11 Sustainable healthy diets		■	■			■						■	■	■	■							■		■	■	■	■				■		■								■
F12 City region food systems		■	■			■		■			■	■	■							■									■												■
F13 Repurpose public spending	■	■	■			■		■				■	■		■	■														■	■	■			■	■	■				■
F14 Foster gender-transformative approaches	■	■			■			■		■																													■	■	■
F15 Indigenous food systems	■	■			■					■		■		■	■					■		■				■	■	■									■		■		■
F16 Access to natural resources and land	■	■			■					■					■	■																							■	■	■

Figure SPM.A3 (*continued*)

Health response option	Sustainable Development Goal																	Global Biodiversity Framework target																							Paris
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
H01 Universal health coverage			●		●																																				●
H02 Intercultural health services		●	●			●				●						●					●	●								●	●		●						●		●
H03 Net-zero sustainable healthcare			●						●			●	●											●	●								●								●
H04 Sustainable use of medicinal plants			●									●			●							●				●				●	●			●					●		●
H05 Nature on prescription			●												●			●	●	●				●	●		●	●	●		●	●	●		●	●		●	●	●	●
H06 Reduce meat overconsumption		●	●			●						●	●		●									●	●		●						●		●						●
H07 Pollution prevention		●	●			●	●					●	●											●				●	●												●
H08 Mangrove conservation and restoration for health	●	●	●										●	●					●	●					●	●	●	●									●		●		●
H09 Urban green infrastructure	●	●	●			●			●		●		●		●			●	●	●					●			●	●												●
H10 Forest conservation for health		●	●			●		●		●			●		●			●	●	●		●				●	●	●											●	●	●
H11 Biodiversity management for zoonoses			●												●			●	●	●		●					●				●			●							●
H12 Integrated watershed-health interventions	●	●	●			●				●			●	●	●			●	●	●				●	●		●	●			●							●	●		●
H13 Health impact assessments			●													●		●											●		●							●	●	●	●
H14 The One Health approach			●			●									●		●	●									●	●	●		●							●	●	●	●
H15 Integrated health education			●	●																													●					●			●

Figure SPM.A3 (*continued*)

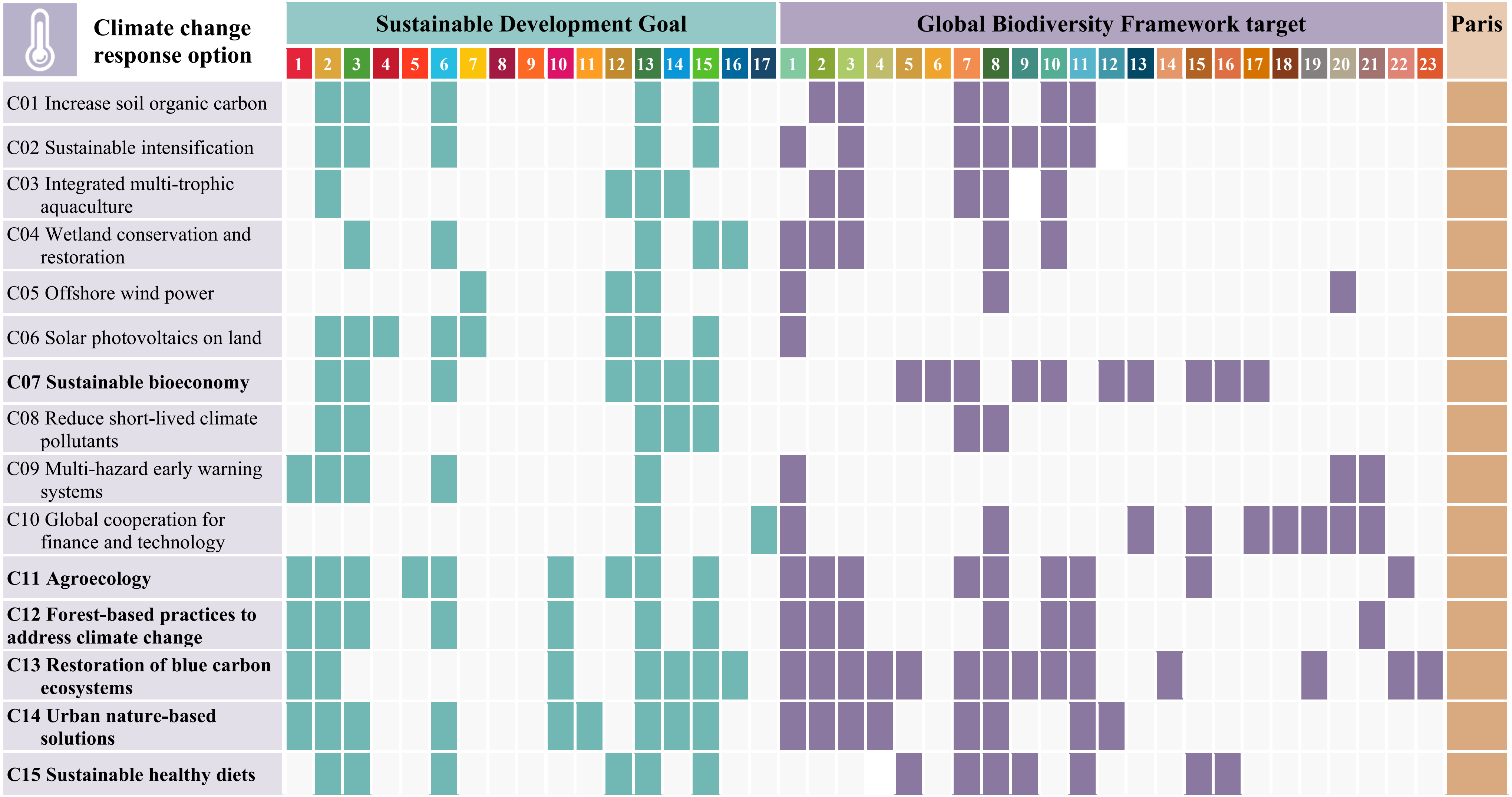

Figure SPM.A3. Response options supporting achievement of global goals. For each nexus element (biodiversity, water, food, health and climate change), the figure shows whether an individual response option contributes to the achievement of the Sustainable Development Goals, Kunming-Montreal Global Biodiversity Framework targets and the long-term goals for mitigation and adaption of the Paris Agreement. The figure includes all response options assessed in chapter 5; the response options independently assessed by two subchapters (agroecology, sustainable healthy diets, sustainable intensification and urban nature-based solutions) are presented separately in this figure for each of the subchapters that assessed these options. Response options are grouped by nexus element and listed in numerical order by response option code. Filled cells indicate support for a goals or targets. Response option titles in bold font indicate the response option supports the achievement of more than five Sustainable Development Goals and more than five Kunming-Montreal Global Biodiversity Framework targets.