The global assessment report on BIODIVERSITY AND ECOSYSTEM SERVICES

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GLOBAL ASSESSMENT REPORT OF THE INTERGOVERNMENTAL SCIENCE-POLICY PLATFORM ON BIODIVERSITY AND ECOSYSTEM SERVICES

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CHAPTER **6**

OPTIONS FOR DECISION MAKERS

EXECUTIVE SUMMARY

1 The Sustainable Development Goals and the 2050 Vision for Biodiversity cannot be achieved without transformative change, the conditions for which can be put in place now *(well established)* {6.2; chapters 2, 3, 5}. In the short term (before 2030), all decision makers can contribute to the sustainability transformation, including through the rapid and improved deployment of existing policy instruments and new initiatives that more effectively enlist individual and collective action for transformative change, and the reform and removal of harmful existing policies and subsidies *(well established)*. Additional measures are necessary to enable transformative change in the long term (up to 2050) to address the indirect drivers that are the root causes of nature deterioration (*well established*), including changes in social, economic and technological structures within and across nations {6.2, 6.3, 6.4}.

2 Transformative change needs innovative approaches to governance. Such transformative governance can incorporate different existing approaches, such as integrative, inclusive, informed and adaptive governance. While these governance approaches have been extensively practiced and studied separately, their combined contribution to enabling transformative change has not yet been thoroughly explored (*established but incomplete*) {6.2}. Integrative approaches, such as mainstreaming across government sectors, are focused on the relationships between sectors and policies and help to ensure policy coherence and effectiveness (*well established*). Inclusive approaches help to reflect a plurality of values and ensure equity (*established but incomplete*), including through equitable sharing of benefits arising from their use and rights-based approaches (*established but incomplete*). Informed governance entails novel strategies for knowledge production and co-production that are inclusive of diverse values and knowledge systems (*established but incomplete*). Adaptive approaches, including learning from experience, monitoring and feedback loops, contribute to preparing for and managing the inevitable uncertainties and complexities associated with social and environmental changes (*established but incomplete*) {6.2}.

3 Empowering all actors can promote sustainability and ensure inclusiveness and equity. Current policies and actions for nature, nature's contributions to people (NCP) and good quality of life (GQL) often privilege elite actors and their value systems, which hampers their legitimacy and effectiveness *(well established)*. Empowerment strategies can be implemented by governments and civil society groups, and include education and information instruments, but also redistribution of power and rights so that all can assume responsibility and control over their lives and futures *(well established)*. Existing approaches such as co-management and community-based natural resource management can be effective in ensuring the equal distribution of the costs and benefits of conservation and reconciling different interests and values, provided that they recognize and address trade-offs and uneven power relations *(well established)*. Inclusiveness and equity will imply recognizing the inevitability of hard choices, costs and common responsibilities *(well established)* {6.2; 6.3; 6.4}.

4 Effective decision making for transformative change uses a mix of instruments and tools, and bridges across different sectors, levels and scales *(established but incomplete).* Since no single instrument or tool is sufficient *(well established)*, policy mixes need to be carefully tailored to – together – effectively address all direct and indirect drivers of nature deterioration **(Table 6.1)**. Sectoral policies and measures can be effective in particular contexts, but often fail to account for indirect, distant and cumulative impacts, which can have adverse effects, including exacerbating inequalities *(well established).* Cross-sectoral approaches, including landscape approaches, integrated watershed and coastal zone management, marine spatial planning, bioregional scale planning for energy and new urban planning paradigms, offer opportunities to reconcile multiple interests, values and forms of resource use, provided that these cross-sectoral approaches recognize trade-offs and uneven power relations between stakeholders (*established but incomplete*) {6.3; 6.4}.

5 Since the effectiveness of alternative actions and policies depends on the decision context, there are no generic recipes for success *(established but*

incomplete). All decision makers can contribute to enhancing the effectiveness of instruments in specific contexts over time through informed and adaptive governance approaches. The comprehensive review of the application of policy instruments presented in this chapter indicates that the implementation of many existing instruments (e.g. protected areas) can be further enhanced, while on the other hand the effectiveness and application of other instruments (e.g. information campaigns for consumers or agricultural certification schemes) requires more research. Since the effectiveness of many instruments for the conservation of nature and its contributions in different contexts is currently unknown, more research and appropriate monitoring is needed {6.3; 6.4}.

6 Decision makers have a range of options and tools for improving the sustainability of economic and financial systems *(well established)* {6.4}. Achieving a sustainable economy involves making fundamental reforms to economic and financial systems and tackling poverty and inequality as vital parts of sustainability *(well established)* {6.4}. Governments could reform subsidies and taxes to support nature and its contributions to people, removing perverse incentives, and instead promoting diverse instruments such as payments linked to social and environmental metrics, as appropriate *(established but incomplete)* {6.4.1}. Trade agreements and derivatives markets could be reformed to promote equity and prevent deterioration of nature, although there are uncertainties associated with implementation (*established but incomplete*) {6.4.4}. To address overconsumption, voluntary measures can be more effective when combined with additional incentives and regulation, including promotion of circular economies and sustainable production models *(well established)* {6.4.2; 6.4.3}. Although market-based policy instruments such as payments for ecosystem services, voluntary certification and biodiversity offsetting have increased in use, their effectiveness is mixed, and they are often contested; thus, they should be designed and applied carefully to avoid perverse effects in context (*established but incomplete*) {6.3.2.2; 6.3.2.5; 6.3.6.3}. Alternative models and measures of economic welfare (such as inclusive wealth accounting, natural capital accounting and degrowth models) are increasingly considered as possible approaches to balancing economic growth and conservation of nature and its contributions and recognizing trade-offs, value pluralism and long-term goals *(established but incomplete)* {6.4.5}.

7 Recognizing the knowledge, innovations and practices, institutions and values of Indigenous Peoples and Local Communities and their inclusion and participation in environmental governance often enhances their quality of life, as well as nature conservation, restoration and sustainable use, which is relevant to broader society *(well established)* {6.2.4.4}. Governance, including customary institutions and management systems, and co-management regimes involving Indigenous Peoples and Local Communities, can be an effective way to safeguard nature and its contributions to people, incorporating locally attuned management systems and indigenous and local knowledge. The positive contributions of Indigenous Peoples and Local Communities to sustainability can be facilitated through national recognition for land tenure, access and resource rights in accordance with national legislation{6.3.2.3}, the application of free, prior and informed consent {6.3.6}, increasing participation in resource management decision-making (including through capacity development and financial support) {6.2.4.4, 6.3.4}, and improved collaboration, fair and equitable sharing of benefits arising from the use, and co-management arrangements with Indigenous Peoples and Local Communities *(well established)* {6.2.4, 6.3.2.3}.

8 Multi-functional landscapes consisting of mixed land systems that include intensive and extensive forms of land use are critical for food security and rural livelihoods, generate a diversity of nature's contributions to people, and can harbour considerable biodiversity (*well-established*) {6.3.2}. At the same time, these landscapes are the space where the largest conflicts with nature take place *(well established).* Policy mixes harmonized across sectors, levels of governance and jurisdictions can account for ecological and social differences across and beyond the landscape, build on existing forms of knowledge and governance and address trade-offs between tangible and non-tangible benefits in a transparent and equitable manner *(established but incomplete).* Options for the private sector – especially local land managers – include diversified land uses and crops, including agroforestry practices, crop rotations, maintenance of semi-natural habitats, soil conservation practices and habitat restoration activities *(well established)*. Options that require the engagement of all actors related to the landscape (e.g., regional governments, producers, neighboring urban inhabitants, protected area authorities) include context-sensitive combinations of participatory approaches to resolve trade-offs and conflicts among objectives, certification schemes for landscape products, direct payments such agri-environmental schemes and PES, research on ecological intensification practices, technical outreach and information campaigns *(established but incomplete)* {6.3.2}.

9 Feeding the world in a sustainable manner, especially in the context of climate change and population growth, entails food systems that ensure adaptive capacity, minimize environmental impacts, eliminate hunger, and contribute to human health and animal welfare *(established but incomplete)* {6.3.2.1}. Ensuring the adaptive capacity of food production incorporates measures that conserve the diversity of genes, varieties, cultivars, breeds, landraces and species. Essentially, this refers to further improvement and harmonization of present global mechanisms of genetic material transfers (e.g., the Nagoya Protocol, the International Treaty on Plant Genetic Resources for Food and Agriculture and the International Convention for the Protection of New Varieties of Plants*) (well established).* Options for the private sector – especially food producers – include expanding and enhancing sustainable intensification, engaging in ecological intensification and sustainable use of multi-functional landscapes, increasing focus on climate-resilient agriculture, and improving food distribution *(established but incomplete).* Options for governments at the international and national levels include regulating commodity chains, managing large-scale land acquisitions, and expanding food market transparency and price stability. Options that address and engage other actors in food systems (including the public sector, civil society and consumers, grassroot movements) include participatory on-farm research, promotion of low-impact and healthy diets and localization of food systems. Such options could help reduce food waste, overconsumption, and demand for animal products from unsustainable production, which could have synergistic benefits for human health *(established but incomplete)* {6.3.2.1}.

10 Sustainable forest management can be better achieved through promoting multifunctional, multi-use, multi-stakeholder and improving community-based approaches to forest governance and management (*well established*) {6.3.2.2}. National and subnational governments can further promote and strengthen community-based management and governance, including customary institutions and management systems, and co-management regimes involving Indigenous Peoples and Local Communities with due recognition of their knowledge and rights who manage almost one third of the forests in the Global South; and improve the conservation and sustainable use of (old-growth) forests through a combination of measures and practices, including protected and other conservation areas; sustainable management and reduced impact logging, forest certification, PES and reducing emissions from deforestation and forest degradation (REDD+); supporting reforestation and forest restoration; transparent monitoring; and addressing illegal logging *(established but incomplete).* International agencies can technically and financially support governments and other stakeholders in achieving the above, including through effective implementation of multilateral environmental agreements (MEAs) and other relevant international agreements *(well established).* Decision makers at all levels can also improve forest governance by recognizing different value systems while formulating forest policies and making management decisions and adopting informed and adaptive decision-making practices *(established but incomplete)* {6.2.4.1; 6.3.2.2; 6.3.2.3}.

11 Expanding and effectively managing the current network of protected areas, including terrestrial, freshwater and marine areas, is important for safeguarding biodiversity (*well established*), particularly in the context of climate change. Conservation outcomes also depend on adaptive governance, strong societal engagement, effective and equitable benefit-sharing mechanisms, sustained funding, and monitoring and enforcement of rules *(well established)* {6.3.2.3}. Protected areas support nature, deliver NCP and contribute to good quality life *(well established)*. National Governments play a central role in supporting primary research and effective conservation and sustainable use of multi-functional landscape and seascape. The latter include planning ecologically representative networks of interconnected protected areas to cover key biodiversity areas and managing trade-offs between societal objectives that represent diverse worldviews and multiple values of nature *(established but incomplete)*. Governance diversity, tailored to the local conditions, includes co-management schemes, local empowerment, and formal recognition of IPLCs rights over their territories *(well established).* Large-scale, proactive landscape planning, including transboundary conservation planning, helps prioritize land uses that balance nature, NCP and GQL *(well established)*. Implementation beyond protected areas includes combating wildlife and timber trafficking through effective enforcement and ensuring the legality and sustainability of trade in wildlife. Such actions include prioritizing wildlife trafficking in criminal justice systems, using community-based social marketing to reduce demand and implementing strong measures to combat corruption at all levels (*established but incomplete)* {6.3.2.3}.

12 Managing coastal and near-shore ocean management for sustainable and resilient futures, in the face of economic pressures and climate change, entails applying policy mixes, including integrated coastal planning and restoration, designation and expansion of Marine Protected Areas, control of plastic and other pollution, and reform of fishery subsidy strategies (*established but incomplete*) {6.3.3.3}. Marine protected areas (MPAs) have demonstrated success in both biodiversity conservation and improved local quality of life when managed effectively. MPAs can be further expanded through larger or more interconnected protected areas or new protected areas in currently under-represented regions and key biodiversity areas *(established but incomplete)* {6.3.3.3.1}. The fishing industry, a major source of aquatic biodiversity losses, can be supported by positive incentives and the reform and removal of harmful existing policies and subsidies to change current practices and remove derelict gear that threatens nature *(well established)* {6.3.3.3.2}. Improved surveillance and investment in scientific research are critical due to major pressures on coasts (including development, land reclamation and water pollution), implementing marine conservation outside protected areas, such as integrated coastal planning, is important for biodiversity conservation and sustainable use *(established but incomplete*) {6.3.3.3}. Other measures to expand multi-sectoral cooperation on coastal management include corporate social responsibility measures, standards for building and construction and eco-labelling (*well established*) {6.3.3.3.2, 6.3.3.3.5}. Additional tools could include economic instruments for financing conservation both non-market and market based, including for example payment for ecosystem services, biodiversity offset schemes, blue-carbon sequestration, cap-and-trade programs, green bonds and trust funds and new legal instruments {6.3.3.1.3}.

13 Governance for the oceans and high seas is currently marked by policy fragmentation leading to nature deterioration *(established but incomplete)* {6.3.3.1}. To sustain biodiversity and fisheries in the high seas, existing sectoral regulatory agencies such as shipping authorities and Regional Fisheries Management Organizations can increase the pace of mainstreaming nature into their policies *(well-established)* {6.3.3.2}. Based on the experience of regional fisheries management organisations, a strong science foundation for informed governance is essential for effective protection, although costly in terms of human resources and technology *(well established)* {6.3.3.2.2}. Cost-effectiveness can be achieved through sharing and integrating information systems across agencies and sectors (e.g., shipping, fishing, mining, and port agencies) and through collaboration between industry, governments and non-governmental organizations *(well established*) {6.3.3.1.1}. New legal instruments such as the proposed international legally binding instrument under the United Nations Convention on the Law of the Sea (UNCLOS) on the conservation and sustainable use of marine biodiversity of areas beyond national jurisdiction could accelerate national action to provide nature protection, particularly when combined with strengthened regional cooperation *(established but incomplete)* {6.3.3.3.1, 6.3.3.1.1}.

14 Inclusive water governance can promote informed decisions, facilitate stronger interaction between communities and conservation activities, and foster equity among water users (*well established*) {6.3.4}. Creating a space for stakeholder engagement and transparency in water conservation and transboundary water management can help to minimize environmental, economic and social conflicts as well as risks *(well established)* {6.3.4.3, 6.3.4.7}. Integrated freshwater management depends, *inter alia*, on recognizing the functional interdependencies between and among rural landscape management and urban demands, incorporating a regional view of the water cycle, understanding of conflicting interests for water uses, and assessing the opportunities for cooperation among users *(established but incomplete)* {6.3.4.1, 6.3.4.2, 6.3.4.6}. In the short term, collection and monitoring of data remains crucial to governments and private actors for water abstraction and management due to the interconnected nature of surface and groundwater (*well established)* {6.3.4.1}. With regard to watershed payment for ecosystem services programmes, their effectiveness and efficiency can be enhanced by acknowledging multiple values in their design, implementation and evaluation and setting up impact evaluation systems (*established but incomplete*) {6.3.4.4}. National regulatory frameworks, policy guidance, institutional arrangements, and water quality standards can set benchmarks for better performance and attract investment to improve water resources and conditions *(well established)* {6.3.4.5, 6.3.4.6}.

15 Nature-based solutions can be cost-effective for meeting the Sustainable Development Goals in cities, which are crucial for global sustainability *(established but incomplete)* {6.3.5}. Integrated urban planning can play a significant role in reducing the environmental impacts of cities and the transformation to sustainability *(well established)* {6.3.5.1, 6.3.5.3}. Nature-based approaches include safeguarding or retrofitting of green and blue infrastructure such as green spaces, water, and vegetation and tree cover into existing urban areas and in new settlements. They can contribute to flood protection, temperature regulation, urban food production, recreation, cleaning of air and water, treating wastewater and the provision of energy, locally sourced food and the health benefits of interacting with nature. They can also enhance urban biodiversity, and they can provide cost effective solutions for local climate change adaptation and promoting low carbon cities *(well established)* {6.3.5.2}. Nature-based solutions and integrated planning also enable improved access to social services, such as sanitation and housing *(well established)* {6.3.5.4}.

16 Recognizing pluralistic values and diverse interests are key to mitigating the impacts, and enabling the sustainable management of energy, mining and infrastructure *(established but incomplete)* {6.3.6}. At all levels of governance, it is crucial to integrate sustainability criteria and internalize the impacts of bioenergy projects on nature *(established but incomplete)* {6.3.6.1}. Promoting innovative financing and ensuring compensation for environmental and social impacts of energy, mining and infrastructure projects are important measures in the sustainable energy transition and responsible mining *(established but incomplete)* {6.3.6.2, 6.3.6.3, 6.3.4.6}. Community-based management and respect for the rights of Indigenous Peoples and Local Communities to land and water has emerged as a way to ensure access to clean, reliable and affordable energy *(well established)* {6.3.6.4, 6.3.6.5}. Incentive programs and policies can also aim at reducing consumption, improving energy efficiency, and supporting community-based management and decentralized sustainable energy production {6.3.6.1,6.3.6.3, 6.3.6.4,6.3.6.5}.

Table 6 1 Main options for decision makers: Instruments that can be included in smart policy mixes.

Decision maker	Instruments that can be included in smart policy mixes within or across issues {Tables 6.3, 6.4, 6.5, 6.6,				
	Landscape approaches	Food	Forest	Conservation	
Intergovernmental organizations	Support and facilitate the development of transformative landscape governance networks together that develop policy mixes for sustainable use of multi-functional landscapes	Support and facilitate expansion and enhancement of sustainable intensification, ecological intensification and sustainable use of multi-functional landscapes Develop and harmonize agreements on genetic resources for agriculture	Improve reducing emissions from deforestation and forest degradation (REDD+) and payment for ecosystem services (PES) policies Address illegal logging and trade in illegal timber Facilitate enhanced forest monitoring	Facilitate expansion and improved management, functionality and connectivity of (transboundary) protected areas Address illegal wildlife trade Facilitate enhanced implementation of and coordination between multilateral environmental agreements Promote mainstreaming of biodiversity into other sectors Enable more financial support for conservation	
Governments (national, subnational, local)	Support, facilitate and engage in transformative landscape governance networks	Encourage dietary transitions and alternate consumption Support and facilitate expansion and enhancement of sustainable intensification; ecological intensification and sustainable use of multi-functional landscapes Facilitate localization of food systems and reduction of food waste Facilitate improvement certification standards Enable conservation of genetic resources for agriculture Manage large-scale land acquisitions	Improve the conservation of (old-growth) forests Enable expansion and improvement of community-based forest management and co-management Improve REDD+ and payment for ecosystem services policies Support reduced impact logging Promote improvement and implementation of certification Support reforestation and forest restoration Address illegal logging and trade in illegal timber Enhance forest monitoring	Expand and improve management, functionality and connectivity of (transboundary) protected areas Recognize management by IPLCs and Other Effective area-based Conservation Measures Strengthen enforcement and implementation of law and multilateral environmental agreements (MEA) and address corruption Enforce free, prior and informed consent (FPIC) and recognize IPLC rights Enhance approaches to invasive alien species (IAS) management Develop participatory approaches to restoration and link restoration to revitalizing indigenous and local knowledge Raise level of financial support for conservation Mainstream biodiversity into other sectors	
Non-Governmental Organizations	Engage in transformative landscape governance networks	Encourage dietary transitions and food waste reduction Engage in expansion and enhancement of sustainable intensification Engage in ecological intensification and sustainable use of multi-functional landscapes Improve certification standards	Engage in improvement of REDD+ and PES Engage in promoting and improving certification Engage in addressing illegal logging	Engage in expansion and improved management, functionality and connectivity of (transboundary) protected areas Support management by IPLCs and Other Effective area-based Conservation Measures Engage in addressing illegal wildlife trade	

6.7, 6.8}

Marine	Water	Cities	Energy	Sustainable economies
Implement global marine environmental agreements for shipping Promote comprehensive protection of biodiversity and ecosystem services of the High Seas Mobilize conservation funding	Address fragmentation of freshwater treaties Promote integrated water resource management and transboundary water management Strengthen rights- based approaches & freshwater standards	Promote sustainable urban planning Promote nature-based solutions and green infrastructure Promote increasing access to urban services	Develop standards for sustainable renewable energy projects Promote biodiversity inclusive environmental impact assessments	Promote sustainable production and consumption; circular economy models Reform trade system and World Trade Organization Promote reform of subsidies Promote reform of models of economic growth
Mainstream biodiversity conservation and promote ecosystem services Support shared and integrated ocean governance Promote stronger implementation of fisheries conservation measures Strengthen integrated management of coastal waters	Promote interlinkage among water-energy-food systems Develop integrated rights-based and participatory approach to water management Encourage stakeholder engagement Develop water-efficient agricultural practices Promote and facilitate nature-based solutions Restrict groundwater abstraction	Implement sustainable urban planning, including bioregional planning, biodiversity-friendly urban development, increasing green spaces, and creating space for urban agriculture Implement nature-based solutions and green infrastructure Reduce the impacts of cities by encouraging articulated density; discouraging car use and promoting public transportation; developing energy efficient building codes; and encouraging alternative business models Enhance access to urban services, including through sustainable urban water management, integrated sustainable solid waste management, incentive programs and participatory planning	Develop sustainable bioenergy strategies Strengthen and enforce biodiversity inclusive environmental impact assessment laws and guidelines Strengthen biodiversity compensation policies for development and infrastructure loss	Address over and under consumption through taxes on consumption, product labeling, discouraging overbuying, promotion of sharing economy Sustainable public procurement Reduce unsustainable production through taxes on resource consumption and degradation; promotion of circular economy models; capping of resource consumption; applying life cycle assessment Reform derivative and futures markets Reform subsidies by assessing impacts of all subsidies policies and long-term removal of all environmentally-unsound subsidies Application of alternative measures of economic welfare and Natural Capital Accounting; move towards steady state economics paradigm and degrowth agenda
Develop conservation programs to raise awareness on local ecosystems, species values and knowledge Engage stakeholders Contribute to global assessments and participate in the global standard setting Engage in developing and monitoring fishery certification schemes	Organize awareness raising activities Engage in nature-based solutions Engage in developing and monitoring water quality and abstraction related standards	Engage in sustainable urban planning Promote the reduction of the impacts of cities Engage in enhancing access to urban services	Participate in community led initiatives Engage in developing and monitoring bioenergy standards and schemes	Develop initiatives to discourage overbuying; engage in development of product labeling Promote circular economy Promote initiatives for transformation to sustainable economy

Decision maker	Instruments that can be included in smart policy mixes within or across issues {Tables 6.3, 6.4, 6.5, 6.6,				
	Landscape approaches	Food	Forest	Conservation	
Citizens, community groups, farmers	Engage in transformative landscape governance networks	Change to sustainable consumption (diet, reducing waste) Engage in localized food systems Engage in expansion and enhancement of sustainable intensification; ecological intensification and sustainable use of multi-functional landscapes Engage in conservation of genetic resources for agriculture	Engage in community-based forest management and co-management Change to sustainable consumption	Engage in conservation efforts	
Indigenous People and Local Communities	Engage in transformative landscape governance networks	Engage in conservation of genetic resources for agriculture	Engage in community-based forest management and co-management Engage in forest monitoring	Engage in management Engage in addressing illegal wildlife trade; sustainable wildlife management Engage in restoration and revitalization of indigenous and local knowledge	
Donor agencies	Support transformative landscape governance networks	Support reduction of food waste; localized food systems; sustainable intensification; ecological intensification	Support community-based forest management and co-management; improvement of REDD+ and PES policies; improvement and implementation certification; initiatives addressing illegal logging; enhanced forest monitoring	Support expansion and improved management, functionality and connectivity of (transboundary) PAs; management by IPLCs and Other Effective area-based Conservation Measures; addressing illegal wildlife trade Raise level of financial support for conservation	
Science and educational organizations	Engage in transformative landscape governance networks	Engage in expansion and enhancement of sustainable intensification and ecological intensification Engage in transformation food storage and delivery systems Facilitate conservation and sustainable use of genetic resources for agriculture	Support reduced impact logging Support improvement of certification Engage in enhancing forest monitoring	Analyze social and economic impacts of restoration Analyze conservation impacts of Official Development Assistance	
Corporate actors	Engage in transformative landscape governance networks	Contribute to expansion and enhancement of sustainable intensification Contribute to ecological intensification Transform food storage and delivery systems Improve certification standards Engage in conservation of genetic resources for agriculture	Implement reduced impact logging Engage in improvement and expansion of forest certification Address illegal logging and trade in illegal timber	Engage in addressing illegal wildlife trade Engage in restoration Raise level of financial support for conservation	

6.7, 6.8}					
	Marine	**Water**	**Cities**	**Energy**	**Sustainable economies**
	Engage in policy decision making, remedial actions, and educational programs Engage in awareness campaigns to influence consumer behaviour and consumption	Participate in ecosystem restoration activities Engage in collaborative initiatives	Engage in sustainable urban planning Engage in development and maintenance of nature-based solutions and green infrastructure Change to sustainable consumption (reduced waste, increased public transport) Engage in initiatives to access to urban services	Actively engage in community led activities	Engage in reduced consumption movements and change towards sustainable consumption; local reuse or fix-up initiatives Support companies with sustainable production models
	Engage in coastal management and MPA Collaborate in integrated management of marine resources	Support co-management regime for collaborative water management Engage, where appropriate, with payment for ecosystem services or other local water ecosystem services provisioning schemes	Engage in advocacy networks for sustainable cities	Participate in formulating sustainable bioenergy strategies Engage in the implementation of Free, Prior and Informed Consent	Engage in discussions over values in a sustainable economy and good life
	Support funding sources in the High Sea that ensure conservation Ensure funding promotes sustainable fishing practices Promote innovative and longer term financing through market based mechanisms	Establish standards and guidelines that improve water quality and integrate social and environmental considerations	Support sustainable urban planning Support initiatives to enhance access to urban services	Promote innovative financing for sustainable infrastructure Establish sustainable bioenergy guidelines	Support initiatives to transform to sustainable economy Fund projects on use of alternative welfare measures
	Promote mainstreaming climate change adaptation and mitigation into marine and coastal governance regimes	Promote awareness raising activities	Support sustainable urban planning, development of nature-based solutions and green infrastructure, reduction of the impact of cities and enhancing access to urban services	Promote awareness raising activities	Support circular economy; further include BES in life cycle assessment Research on environmental impacts of futures and derivatives Support reform of models of economic growth
	Engage in CSR activities, certification and best practices in fisheries and aquaculture production methods Mobilize conservation funding for the oceans Take account of ecological functionality into coastal infrastructure	Engage in setting water quality and abstraction related standards Engage in water restoration schemes Promote sustainable investment in water projects Invest in clean and environmentally sound technology	Engage in sustainable urban planning Develop energy efficient buildings Engage in alternative business models Engage in partnerships and other initiatives to enhance access to urban services	Engage in setting sustainable bioenergy strategies Promote sustainable infrastructure practices Strengthen biodiversity compensation policies Promote innovative financing for sustainable infrastructure	Implement sustainable sourcing practices; design for sustainability; engage in development of product labeling; apply life cycle assessment; contribute to circular economy Engage in corporate social responsibility Engage in reform of models of economic growth

6.1 INTRODUCTION

In recent decades, the extent and scope of societal responses to environmental problems, including biodiversity decline, have been extensive and diverse. The outcomes, however, have been mixed across sectors and levels of governance, with limited success in reverting global trends and in addressing the root causes of degradation. Lessons and opportunities also abound, amid new challenges and scenarios. This chapter discusses opportunities and challenges for all decision makers to advance their efforts in meeting, synergistically, internationally agreed goals for sustainable development, biodiversity conservation, and climate change mitigation and adaptation. In doing so, the chapter builds on the analysis in the previous chapters, which have identified direct and indirect drivers of change, evaluated progress or lack of progress in achieving the Aichi Biodiversity Targets, the Sustainable Development Goals (SDGs), and several environmental conventions, and assessed plausible scenarios and possible pathways. Previous chapters of the present assessment show that, despite progress on various goals and targets and improvements in environmental indicators in many regions, species diversity, ecosystems functions and the contributions they provide to society continue to decline, further reinforcing both environmental and societal problems.

While progress can be made to achieve the Aichi Biodiversity Targets, the CBD 2050 Vision and the SDGs using current policies, practices and technologies, and within current national and international governance structures, these are not enough to address current and projected trends. It has become widely recognized that transformative change is needed to fully realize these ambitions (CBD/SBSTTA/21/5, 12 October 2017; CBD/SBSTTA/21/2, 15 September 2017). In fact, the adoption of the SDG shows that the international community has committed itself to such transformative change: "*We are determined to take the bold and transformative steps which are urgently needed to shift the world on to a sustainable and resilient path*" (UNGA, 2015).

Transformative change can be defined as a fundamental, system-wide reorganization across technological, economic and social factors, including paradigms, goals and values (IPBES, 2018a; IPCC, 2018). Such fundamental, structural change is called for, since current structures often inhibit sustainable development, and actually represent the indirect drivers of biodiversity loss (Díaz *et al.,* 2015) (See Section 6.2. below). Transformative change is thus meant to simultaneously and progressively address these indirect drivers. The character and trajectories of this transformation will be different in different contexts, with challenges and needs differing, among others, in developing and developed countries.

Transformative change is facilitated by innovative governance approaches that incorporate existing approaches such as integrative, inclusive, informed and adaptive governance. While such approaches have been extensively practiced and studied separately, it is increasingly recognized that together they can contribute to transformative change (see section 6.2). The concept of governance refers to the formal and informal (and public and private) rules, rule-making systems, and actor-networks at all levels of human society (from local to global) that are set up to steer societies towards positive outcomes and away from harmful ones (adapted from Biermann *et al.,* 2010).

In response to the interconnected challenges of sustainable development, biodiversity conservation,

Table 6 2 **List of decision makers.**

	Decision maker
1	Global and regional (inter)governmental organizations (UN, MEA secretariats etc.)
2	National, sub-national and local governments
3	Private sector
4	Civil society, including: • Citizens (households, consumers), community groups, farmers • NGOs (e.g., environmental, human development, consumer, trade unions)
5	Indigenous Peoples and Local Communities (IPLCs)
6	Donor agencies (public and private)
7	Science and educational organizations

and climate change identified in previous chapters, this chapter organizes its analysis on the options for decision makers around sustainability pathways in five domains: terrestrial landscapes (6.3.2), marine, coastal and fisheries (6.3.3); freshwater (6.3.4); cities (6.3.5); and energy and infrastructure (6.3.6). Finally, the chapter discusses approaches and conditions that enable transformation towards sustainable economies (6.4). Each of these major issues is considered in terms of short- and long-term options, and against possible obstacles for decision makers to enable transformative change. The chapter distinguishes different decision makers (see **Table 6.2**).

Our analysis of options implemented so far shows that, already in the short-term (before 2030), all decision makers can contribute to the transformation towards sustainability by applying existing policy instruments, which need to be enhanced and used together strategically in order to become transformative – in other words – not only address direct drivers, but especially indirect drivers. The existing instruments discussed in sections 6.3 and 6.4 can thus be further enhanced based on the lessons learned from earlier experiences with implementation. In the long-term (today-2050), transformative change will entail additional measures and governance approaches to change technological, economic, and social structures within and across nations.

Below, the chapter first discusses transformative change and transformative governance (section 6.2), after which the options for decision makers on the main issues are discussed (section 6.3). Section 6.4 highlights more generic options for a sustainable economy. The options in sections 6.3 and 6.4 are based on a systematic literature review of existing and emerging governance instruments and approaches. The review especially highlights lessons relevant to transformative governance, including cross-sectoral approaches and synergies and trade-offs between different societal goals, the impact of telecoupling of distant drivers, and lessons learned from incorporating diverse values, rights-based approaches and equity concerns in decision making and policy implementation (see section 6.2).

Due to the scope of the chapter's coverage and the extent of the literature review supporting it, the chapter includes a Supplementary Material document. A significant amount of the literature evidence supporting statements made in the chapter are presented there, thus we encourage the reader to consult Supplementary Material when cross-references are made in the main chapter.

6.2 TOWARDS TRANSFORMATIVE GOVERNANCE

As introduced in 6.1, transformative change can be defined as societal change in terms of technological, economic and social structures. It includes both personal and social transformation (Otsuki, 2015), and includes shifts in values and beliefs, and patterns of social behaviour (Chaffin *et al.,* 2016).

Transformative change has emerged in the policy discourse and is increasingly seen as both necessary and inevitable for biodiversity-related issues and sustainable development more broadly. The Convention on Biodiversity (CBD), European Environment Agency (EEA, 2015), OECD (OECD, 2015), World Bank (Evans & Davies, 2014), UN (UNEP, 2012), UNESCO (ISSC/UNESCO, 2013), European Union, national governments and the German Advisory Council on Global Change (WBGU, 2011), for example, have over the past years launched reports and policy programs in support of sustainability transformations or transitions. This attention is based upon the increasing understanding of the persistency of the complex sustainability challenges we face: in spite of high ambitions, policy commitments, large-scale investments in innovation and voluntary actions, our economies are still developing along unsustainable pathways pushing ecological boundaries (Rockstrom *et al.,* 2009; Future Earth, 2014). To escape this path-dependency it is increasingly clear that structural, systemic change is necessary, and continuing along current trajectories increases the likelihood of disruptions, shocks and undesired systemic change.

This process of nonlinear systemic change in complex societal systems has become the object of research especially since the late 1990s under the headers of 'transformation' (Feola, 2015; Olsson *et al.,* 2014; Folke *et al.,* 2010; Moore *et al.,* 2014) and 'transition' (Geels, 2002; Grin *et al.,* 2010; Markard *et al.,* 2012; Rotmans *et al.,* 2001; van den Bergh *et al.,* 2011; Turnheim *et al.,* 2015). While having different disciplinary origins (Hölscher *et al.,* 2018), both terms are increasingly used in a similar way referring to a particular type of change, namely nonlinear and systemic shifts from one dynamic equilibrium to another (Patterson *et al.,* 2016). A range of different scientific disciplines has studied underlying patterns and mechanisms of such transformation. Prominent fields of research include resilience, sustainability transition, innovation studies and social innovation research. While these debates have often remained rather a-political, a more critical perspective is emerging (see e.g. Blythe *et al.,* 2018; Chaffin *et al.,* 2016; Lawhon & Murphy, 2012; Meadowcroft, 2009; Scoones *et al.,* 2015) that incorporates politics, power, legitimacy and equity issues, recognizing that transformations include the making of "hard choices" by decision makers (Meadowcroft, 2009).

Governing transformative change, or *transformative governance,* can be defined as "an approach to environmental governance that has the capacity to respond to, manage, and trigger regime shifts in coupled socio-ecological systems at multiple scales" (Chaffin *et al.,* 2016). Transformative governance is deliberate (Chaffin *et al.,* 2016), and inherently political (Blythe *et al.,* 2018), since the desired direction of the transformation is negotiated and contested, and power relations will change because of the transformation (Chaffin *et al.,* 2016). Current vested interests (including in certain technologies) are thus expected to inhibit, challenge, slow down or downsize transformative change, among others through "lock-ins" (see e.g., Blythe *et al.,* 2018; Chaffin *et al.,* 2016; Meadowcroft, 2009). The debate on the related term "transition management" (Rotmans & Loorbach, 2010) points to the importance of (facilitating) emergent and co-evolutionary changes in cultures, structures and practices that challenge incumbent 'regimes' (Frantzeskaki *et al.,* 2017). This in itself requires forms of governance that complement more institutionalized, consensus-based and incremental policies by facilitating transformative actor-networks, back-casting processes, strategic experimentation and reflexive learning.

Transformative governance often needs a 'policy' or 'governance' mix aimed at navigating transformations (Kivimaa & Kern, 2016; Loorbach, 2014; Berkes *et al.,* 2008). In such a mix, instruments that facilitate the build-up of alternatives, the gradual change of institutional structures and the managed phase-out of undesirable elements need to be combined, dynamically based on a systemic understanding of the present transition dynamics (Loorbach *et al.,* 2017). How this is operationalized depends on the type of organization and level of operation and the types of (transformative) capacities, instruments and methods available (Wolfram, 2017; Fischer & Newig, 2016; Patterson *et al.,* 2016). Through co-creative multi-actor processes (Avelino & Wittmayer, 2015; Brown *et al.,* 2013) of seeking joint understandings of collective transition contexts and formulating shared desired future directions, different actors can align long-term agendas and more strategically use and implement short-term actions to guide and direct emerging transitions towards sustainable futures.

Transformative change thus needs innovative approaches to governance. Such transformative governance can incorporate different existing approaches, which we group into four domains, namely integrative, inclusive, informed and adaptive governance. While these approaches have been extensively practiced and studied separately, their combined contribution to enabling transformative change has not yet been thoroughly explored.

Transformative governance is: 1) *integrative,* since the change is related to and influenced by changes elsewhere (at other scales, locations, on other issues) (see e.g., Chaffin *et al.,* 2016; Karki, 2017; Reyers *et al.,* 2018; Wagner & Wilhelmer, 2017); 2) *informed*, based on different and credible knowledge systems (Blythe *et al.,* 2018; Chaffin *et al.,* 2016; Couvet & Prevot, 2015); 3) *adaptive,* based on learning, experimentation, reflexivity, monitoring and feedback (Colloff *et al.,* 2017; Chaffin *et al.,* 2016; Laakso *et al.,* 2017; Meadowcroft, 2009; Otsuki, 2015; Rijke *et al.,* 2013; Wagner & Wilhelmer, 2017); and finally 4) *inclusive* since transformative change per definition includes different types of actors, interests and values, and needs to address issues of social justice (Chaffin *et al.,* 2016; Otsuki, 2015; Blythe *et al.,* 2018; Li & Kampmann, 2017; Meadowcroft, 2009; Thomalla *et al.,* 2018; Wolfram, 2016). Below we elaborate on each of these four approaches to governance (not presented in order of importance).

6.2.1 Integrative governance: ensuring policy coherence and effectiveness

Since the middle of the 20th century, hundreds of multilateral environmental agreements, governmental policies and (public-) private initiatives have been developed, many of which are focused on, or relevant for, biodiversity. Moreover, different economic and policy sectors (including biodiversity conservation, climate change, agriculture, and mining) are often governed in silos at all levels of governance. This raises questions per level of governance and across levels of governance on *synergies and trade-offs* between different societal goals (see e.g., Mauerhofer & Essl, 2018). This is especially important for transformative change – the SDG cannot all be achieved simultaneously if they are not approached in an integrative manner – as recognized by the UN, which have stated that the goals and their targets are "integrated in indivisible" (UNGA, 2015).

This fragmentation and complexity of the governance for sustainable development are well recognized among scholars (see e.g., Alter & Meunier, 2009; Bogdanor, 2005; Rayner *et al.,* 2010; Tamanaha, 2008; Young, 1996), and policy makers are actively trying to enhance synergies and address trade-offs. The CBD, for example, promotes mainstreaming of biodiversity concerns into sectors impacting biodiversity, such as agriculture, forestry, fisheries, and tourism (UNEP/CBD/COP/13/24).

Integrative governance defined and the theories and practices focused on the relationships between governance instruments or systems (Visseren-Hamakers, 2015; 2018), addresses these challenges of incoherence in sustainability governance. The literature suggests various options for integrative governance, including:

- Integrated management (Born & Sonzogni, 1995), landscape governance and approaches (Buizer *et al.*, 2015; Görg, 2007; Sayer *et al.*, 2013), the nexus approach (Benson *et al.*, 2015; Rasul & Sharma, 2016), multilevel governance (Hooghe & Marks, 2003; Marks *et al.*, 1996), and telecoupling (Liu *et al.*, 2013), which bring together (or highlight the relationships between) different sectors, policies or levels of governance in trying to enhance coherence;

- (Environmental) policy integration (Jordan & Lenschow, 2010; Persson & Runhaar, 2018) and mainstreaming (Karlsson-Vinkhuyzen *et al.*, 2017; Kok and de Coninck, 2007), which aim to strengthen attention for environmental issues in other sectors;

- Interaction management (Oberthür, 2016), metagovernance, and orchestration (Abbott & Snidal, 2010; Kooiman & Jentoft, 2009), which aim to improve the relationships between (groups of) governance instruments; and

- Smart regulation and policy mixes (Gunningham and Grabosky, 1998; Mees *et al.*, 2014), which combine different instruments to be more effective together.

Additional concepts used to discuss and study integrative governance include interorganizational relations (see e.g., Schmidt & Kochan, 1977), legal pluralism (Griffiths 1986; Merry, 1988), polycentric governance (Ostrom, 2010), regime complexity and fragmentation (Biermann *et al.,* 2009; Fischer-Lescano & Teubner, 2003), coordination (Peters, 1998), coherence (Jones, 2002), institutional interplay or interaction (Oberthür and Gehring, 2006), governance architectures and systems (Biermann *et al.,* 2009), regime complexes (Abbott, 2012; Raustiala & Victor, 2004), and governance of complex systems (Young, 2017) (see Visseren-Hamakers, 2015, 2018). See **Box 6.1** for an example of Integrative Governance.

6.2.2 Informed governance: based on legitimate and credible knowledge

Traditionally, biodiversity governance has relied on natural science tools including red lists, monitoring and indicator frameworks, and models and scenarios to characterize, assess and project ecological values such as productivity, species diversity, or threatenedness. In addition, multidisciplinary tools containing knowledge and information about ecosystems, social systems, and economics, such as cost-benefit analysis, sustainability indicators, or integrated assessments are widely used and considered valuable for their ability to offer an integrated perspective (Ness *et al.,* 2007). Increasingly, these information tools and systems focus on the measurement, modeling and assessment of natural capital and ecosystem services (Turnhout *et al.,* 2013; McElwee, 2017).

These information tools and systems have several challenges and limitations. These include technical challenges such as standardization, data quality and availability, and interoperability and commensurability of data (Bohringer & Jochem, 2007; Kumar Singh *et al.,* 2009). More important is that they are mostly not fit for purpose to inform transformative governance. One reason is that they often focus exclusively on environmental dimensions and are insufficiently inclusive of diverse values (Turnhout *et al.,* 2013; 2018; Gupta *et al.,* 2012; Elgert, 2010). For example, biodiversity and ecosystem services models and assessments often use causal and mechanistic frameworks, such as the DPSIR (Drivers, Pressures, States, Impacts, Responses) approach, which are limited in their ability to account for both complex

Box 6 1 Example of Integrative Governance – CCAMLR.

The Commission on the Conservation of Antarctic Marine Living Resources (CCAMLR) manages the currently active fisheries in the Antarctic Treaty System area (Patagonian toothfish (Dissostichus eleginoides), Antarctic toothfish (Dissostichus mawsoni), mackerel icefish (Champsocephalus gunnari) and Antarctic krill (Euphausia superba)). The commission exemplifies integrative governance since it uses a precautionary ecosystem-based approach that considers not just the commercial fish species but also the wider ecosystem, and because its management objectives balance conservation goals with the rational use of living resources, while safeguarding ecological relationships. It does so by using clear decision rules to agree on catch limits in each fishery. It also relies on detailed data from the fisheries and fishery surveys, and the CCAMLR Scheme of International Scientific Observation (https://www.ccamlr.org/en/science/ccamlr-scheme-international-scientific-observation) to monitor CCAMLR fisheries and to forecast fishery closures. Members implement compliance systems that include vessel licensing, satellite monitoring of vessel movements and transshipments, together with measures to specifically address the threat of illegal, unregulated and unreported (IUU) fishing. The CCAMLR conservation measures are generally seen to be efficiently implemented and represent a leading example of an agreement between over 50 States that has been effective in conserving the living resources of a significant part of the world's ocean.

causal pathways and societal factors such as institutions and values affecting them (Svarstadt *et al.,* 2008; Breslow, 2015). Equally, the usefulness of indicator and monitoring systems is hindered by their technical and specialized nature and by the way in which they prioritize specific values over others (Turnhout, 2009; Merry, 2011).

Transformative governance calls for expanding existing information systems and tools to include indicators and parameters to assess the integrative, informed, adaptive and inclusive nature of governance processes, policies and interventions as well as their intended and unintended effects on Nature, NCP and GQL. An interesting initiative in this respect is Conservation Evidence, which aims to improve conservation practice by collating, reviewing, assessing and summarizing all available evidence on the effectiveness of conservation interventions (Sutherland *et al.,* 2004, 2014, 2017). It is conceived to be a free, open-access and authoritative resource designed to support informed decisions about how to maintain and restore global biodiversity, thereby combatting the phenomenon of evidence complacency, where evidence is not used in conservation decision-making (Dicks *et al.,* 2014; Cook *et al.,* 2017; Sutherland & Wordley, 2017).

Informing transformative governance also requires reconsideration of the relationship between knowledge and decision-making. Scientific expertise is not in all cases required for effective and legitimate action, and the relationship between knowledge and decision-making is not straightforward or self-evident (Dessai *et al.,* 2009; Kolinjivadi *et al.,* 2017; Wesselink *et al.,* 2013. Dilling and Lemos, 2011, Sutherland *et al.,* 2004; Matzek *et al.,* 2014; Pullin *et al.,* 2014). This means that existing information systems and tools will need to be adapted to produce knowledge that is inclusive of multiple values and forms of scientific and non-scientific knowledge, including indigenous and local knowledge (ILK), and that is credible, legitimate and salient for all relevant stake- and knowledge-holders (Cash *et al.,* 2003; Robertson & Hull, 2001; Mauser *et al.,* 2013; Sterling *et al.,* 2017).

A crucial element in the production of legitimate and credible information is the facilitation of dialogue and learning (Lemos & Moorehouse, 2005; Breslow, 2015; Kok *et al.,* 2017; Peterson *et al.,* 2003; Turnhout *et al.,* 2007; Voinov & Bousquet, 2010). Literature on transdisciplinarity and coproduction offers a variety of tools and methods that can be used by governments, NGOs but also in bottom-up processes, to organize processes of participatory knowledge production that are able to bridge practical, scientific and technical knowledge, as well as ILK (Tengö *et al.,* 2014, 2017; Clark *et al.,* 2016). Experiences with participatory modeling and scenario planning have shown amongst others that participants were better able to grapple with complexity and uncertainty and that scenarios developed on the basis of input from stakeholders were helpful in identifying different interests and facilitated communication between stakeholders and governments (De Bruin *et al.,* 2017; Tress & Tress, 2003; Whyte *et al.,* 2014). Similarly, participatory – or citizen science – approaches involving stakeholders in the selection and monitoring of indicators cannot just contribute to the availability of relevant data, but also to engagement with nature and enhanced decision-making (Fraser *et al.,* 2006; Danielsen *et al.,* 2014). An interesting example has come from the availability of real-time satellite data, which are used by initiatives like Global Forest Watch to support national and sub-national governments, civil society and the private sector to engage in forest monitoring and conservation (FAO, 2015; GFW, 2017; Nepstad *et al.,* 2014; Assunção *et al.,* 2015).

However, the application of these inclusive and participatory approaches so far is limited (Brandt *et al.,* 2013), and their ability to produce positive outcomes for problem solving and stakeholder empowerment depends on the presence of an enabling institutional context (Armitage *et al.,* 2011) which is able to effectively address unequal power relations between stake- and knowledge-holders (Nadasdy, 2003; Dilling & Lemos, 2011).

6.2.3 Adaptive governance: to enable learning

Transformative change is in essence adaptive – it represents a learning process that needs regular opportunities for reflection on to what extent and how progress is being made, the main bottlenecks, and the best ways forward. Adaptive governance is a result of continuously learning about and adjusting responses to uncertainty, social conflicts and complexity in socio-ecological systems (Chaffin *et al.,* 2014; Dietz *et al.,* 2003; Walker *et al.,* 2004; Folke *et al.,* 2005; Folke, 2006; Karpouzoglou *et al.,* 2016).

Adaptive governance includes policy processes that highlight uncertainties, developing and evaluating different hypotheses around a set of outcomes and structuring actions to evaluate these ideas (Berkes *et al.,* 2003; Paul-Wost, 2009). Adaptive governance also focuses on enhancing the resilience of socio-ecological systems by increasing their capacity to adapt, and by recognizing the importance of learning in coping with change and uncertainty (Evans, 2012). Studies on adaptive governance advocate for an experimental approach to governing such as creating institutions that can experiment with different solutions and make adjustments in the process (Holling, 2004).

There are various challenges stated in the literature that can be seen as problematic in engaging with an adaptive governance paradigm. According to Gunderson (1999) these are inflexible social systems, ecological systems that lack resilience, and technological incapacity to design experimental and innovative approaches. Also, the question of scale is essential in adaptive governance mechanisms. The scale for adaptive governance responses needs to be adapted to the social and ecological nature of the problem with sufficient response flexibility within and between political boundaries (Cosens, 2010, 2013; Huitema *et al.,* 2009; Termeer *et al.,* 2010).

Adaptive management, through monitoring and feedback, is widely recognized as a management approach to ensure effective conservation (Walters, 1986). Several studies confirm the benefits of adaptive management and "learning through doing" (Kenward *et al.,* 2011; CBD, 2004; Bern Convention, 2007), and adaptive management has been applied in the ecosystem approach in order to deal with the complex and dynamic nature of ecosystems and the absence of complete knowledge or understanding of their functioning (CBD, 2017). According to Lebel *et al.* (2006), adaptability is determined by two factors: (1) the absolute and relative forms of social, human, natural, manufactured, and financial capital, and (2) the system of institutions and governance. In order to enable a capacity to adapt, it is crucial to build trust and shared understanding between diverse stakeholders to motivate co-learning and adaptation. Accordingly, deliberation and polycentric governance are offered as tools for enabling adaptive governance.

Dietz *et al.* (2003) propose a general list of criteria necessary for adaptive governance: inclusive dialogue between resource users (analytic deliberation); complex, redundant, layered institutions (nesting); mixed institutional types (e.g., market- and state-based); and institutional designs that facilitate experimentation, learning, and preparation for change. See **Box 6.2** for an example of adaptive governance.

6.2.4 Inclusive governance: ensuring equity and participation

Inclusive governance refers to governance approaches through stakeholder engagement, including Indigenous Peoples and Local Communities, in decision-making processes. It is argued that inclusive governance improves the quality of decisions and secures legitimacy for the decisions that are taken. Reform of decision-making processes is also necessary to enhance accountability and legitimacy (Keohane, 2003; Bernstein, 2005; Biermann & Gupta, 2011; Evans, 2012).

Participatory mechanisms that introduce dialogue and negotiation can be used to discover varying and potentially competing values and knowledge systems and identify options for more equitable decisions and implementation of these decisions, and enable learning (see e.g. Innes and Booher, 1999). However, power asymmetries can also affect the manners in which values and knowledge systems are represented in such participatory platforms. Policymaking processes have often inadequately addressed minority groups or the interests and values of people who are actually or potentially affected, directly or indirectly. Procedural equity deals with power asymmetries that affect whose voice is heard and who has a say in access and control of nature (McDermott *et al.,* 2013).

Deliberative processes are widely recognized by practitioners as useful in many contexts, including urban planning, healthcare and water governance (Andersson & Ostrom, 2008; Neef, 2009; Parkins & Mitchell, 2005). Deliberative approaches are based on the assumption that competing interests and values can only be discovered, constructed and reflected in a dialogue with others (Rhodes, 1997; Dryzek, 2000; Kenter, 2016). Examples of deliberative institutions are citizen juries, consensus conferences and focus groups (Pelletier *et al.,* 1999; Smith, 2003; Lienhoop, 2015). Deliberative approaches are mostly applied at the local level but can also be used at other levels of governance Deliberative valuation can also capture the interests of future generations (Soma & Vatn, 2010; Stagl, 2006; Sagoff, 1998).

Deliberation is considered to be an integrating and bridging approach to valuation (Pascual *et al.,* 2017). Howarth and Wilson (2006) also describe the ways in which deliberative monetary valuation could contribute to social fairness. However, after deliberation it will nevertheless be essential that results be articulated in a metric that is comparable with conventional ecosystem service valuation techniques such as the contingent valuation method (Wilson & Howarth, 2002).

Box 6 2 Example of Adaptive Governance – Urban green spaces and urban agriculture:

Uses of vacant lots in urban areas are increasingly recognized as important sites for enhancing provisioning of nature's contributions, such as water provisioning or climate regulation, and can also be used for food provisioning through urban agriculture. Adaptive governance principles have been realized in several "land bank" systems in the USA, such as in Cleveland, which join public and private organizations to purchase or reclaim parcels and then manage them adaptively for multiple objectives. Such strategies include plans to increase connectivity between lots and incorporate community involvement in lot management (Green *et al.,* 2016).

Inclusive governance to enhance transformative change thus needs to consider the importance of including diverse value systems, rights-holders, genders and IPLCs. These are discussed in more detail below (see **Box. 6.3** for an example of inclusive governance).

6.2.4.1 Value Systems

Decisions – made at the individual or institutional level and at different scales – are necessarily embedded in a given value system, historically rooted in the socio-cultural context and power relations; yet, such value systems may not be explicitly reflected upon (Barton *et al.,* 2018; Berbés-Blázquez *et al.,* 2016). Depending on whether a unidimensional or a more diverse (value pluralism) lens is applied by the decision maker, policy objectives, as well as policy instruments will be determined differently through formal and informal institutions (Pascual *et al.,* 2017; also see Chapter 1). Legal, economic and socio-cultural instruments currently regulating the use of nature and its contributions usually fail to address plural and multiple values of nature, instead they focus on unidimensional values (Chan *et al.,* 2016; Kolinjivadi *et al.,* 2017; Tallis *et al.,* 2014; Spangenberg & Settele, 2016) (See Supplementary Materials 6.1.1 for a discussion on market-based instruments). Additionally, they often have unintended consequences, such as motivational crowding[1] (Rode *et al.,* 2015; Vatn, 2010; Vatn *et al.,* 2014), trade-offs and conflicts (Kovács *et al.,* 2015; Turkelboom *et al.,* 2018, Whittaker *et al.,* 2018), or impacts on justice and power relations (Berbés-Blázquez *et al.,* 2016; Pascual & Howe, 2018; Sikor, 2014). Being transparent about underlying value systems and accommodating plural values and knowledge forms in decision-making widens collaboration and creates more inclusive institutional arrangements (Ainscough *et al.,* 2018; O'Neill & Spash, 2000). However, decision making in this context might be technically challenging (Dendoncker *et al.,* 2018; Phelps *et al.,* 2017; Primmer *et al.,* 2018), because value articulation needs to be equitable; conflicts often emerge between stakeholders holding different values; and plural and incommensurable values are difficult to operationalize in decision making (e.g., include in accounting), among others.

6.2.4.2 Rights-based approaches

Rights-based approaches, at the substantive and procedural level, are multifaceted, and crucial to various aspects of governance including inclusive (e.g., participation rights) and informed (e.g., information rights) governance. In order to promote GQL, national laws and policies integrate the substantive right to a healthy environment, life, water, food, standard of living, and health (Knox, 2013, 2017; Draft Framework Principles on Human Rights and the Environment, 2018). Regional and national laws and policies also integrate procedural rights to information and participation in decision-making (Aarhus Convention, 1998; *Escazú Agreement, 2018;* Knox, 2013, 2017).

In addition, strong *land and sea rights*, including ownership and use rights, can promote local empowerment, reduce tensions between the authorities and resource users, and can be successfully integrated in community management of forests, use of non-timber forest products, communal grazing lands and subsistence fisheries (Oxfam *et al.,* 2016; FAO, 2012; Ring *et al.,* 2018; Acosta *et al.,* 2018; Stringer *et al.,* 2018). Granting land and sea rights to IPLCs is also a critical means for connecting IPLCs with environmental protection policies, including economic instruments such as carbon offsets, REDD+, PES and micro-credits (Gray *et al.,* 2008; de Koning *et al.,* 2011; van Dam, 2011; McElwee, 2012; Larson *et al.,* 2013; Duchelle *et al.,* 2014; Sunderlin *et al.,* 2014). As for *customary rights*, examples confirm that if competing interests between state and customary systems are adequately balanced, policy measures incorporating customary rights are likely to protect traditional values and ILK, respect local power structures and institutions of IPLCs, and contribute to biodiversity conservation (Acosta *et al.,* 2018; Willemen *et al.,* 2018). *Animal rights* are an example of non-anthropocentric development that recognizes intrinsic values of animals and the (ecological) interdependence of humans and animals (Birnie *et al.,* 2009; Kymlicka & Donaldson, 2011). *Rights of Nature* refers to the entitlement of nature with rights as a collective subject of interest, acknowledging its intrinsic values (Rühs & Jones, 2016; Gordon, 2017; Kotzé & Calzadilla, 2017; Rogers & Maloney, 2017). Policy options for the recognition of such rights often imply the articulation of a co-management regime (e.g., Whanganui River, New Zealand; Strack, 2017), and have been codified in national constitutions (e.g., Ecuador; Kauffman & Martin, 2017), national legislation (e.g., Bolivian Law of Mother Earth; Pacheco, 2014) and in local policies (e.g., United States; Sheehan, 2015). Also see Supplementary Materials section 6.1.2.

6.2.4.3 Gender

Gender literacy, women's empowerment, financial support, gender responsive approaches and integrating gender into nature conservation solutions are crucial to reinforce links between gender and biodiversity, achieve biodiversity objectives, and SDG 5 (gender equality) (CBD SBI/2/2 Add.3 (2018); IUCN, 2017). Lack of gender sensitive funding mechanisms and structural inequality hinder gender mainstreaming at the national and local level (Sweetman, 2015; UNEP, 2016). While *gender rights* acknowledge the interdependence between gender, biodiversity conservation

1. Motivational crowding means that the intended motivational impact of an incentive interacts and often changes the internal / intrinsic motivations of actors. Crowding-in means that an external incentive strenghtens intrinsic motivations, while crowding-out means that the incentive decreases intrinsic motivations to protect biodiversity (Rode *et al.,* 2015; Vatn *et al.*, 2014).

and sustainable use of resources (CBD Gender Plan of Action, 2008; Aichi Target 14, 17 and 20), poverty, religious and cultural practices (e.g., when gender disparities are entrenched in cultural and religious beliefs), and unequal social, economic and institutional structures are some of the key obstacles women encounter (CBD/IUCN, 2008; FAO, 2013; UNEP, 2016). The fundamental role women play in, among others, agriculture, forestry, fisheries, tourism, water management, wildlife management, and nature conservation and management underpin the need for effective participation in decision-making (Jenkins, 2017; Howard, 2015). To mainstream gender considerations, governments can take actions in policy (e.g., mainstream gender into NBSAPs), organizational (e.g., giving women collective and individual voice, gender equality training and awareness-raising among decision makers, and gender responsive budgets), delivery (e.g., participatory mechanisms, capacity development and empowerment to enable effective participation), and constituency (e.g., ensure consistency with relevant conventions) spheres (CBD Decision XII/7 (2014).

6.2.4.4 IPLCs and ILK

Inclusive governance requires robust participatory mechanisms supporting the inclusion of IPLCs in policies and planning decision affecting them and the environment at large (Bray *et al.,* 2008, 2012; Ojha *et al.,* 2009; Kerekes & Williamson, 2010; Kothari *et al.,* 2012, 2013; Mooney & Tan, 2012; Buntaine *et al.,* 2015). As discussed in chapter 2, IPLCs hold territorial rights and/or manage a substantial proportion of the world's conserved nature, freshwater systems, and coastal zones, providing contributions to society at large (Maffi, 2005; Gorenflo *et al.,* 2012; Renwick *et al.,* 2017; Garnett *et al.,* 2018). There is well-established evidence that IPLCs can develop complex, sophisticated, innovative and robust institutional arrangements and management systems for successfully governing the management of watersheds, coastal fisheries, forests and grasslands and a variety of biodiversity-rich landscapes around the world (Ostrom, 1990; Berkes, 1999; Agrawal, 2001; Colding & Folke, 2001; Lu, 2001; Toledo, 2001; Gadgil *et al.,* 2003; Bodin & Crona, 2008; Pacheco, 2008; Waylen *et al.,* 2010; Basurto *et al.,* 2013; Stevens *et al.,* 2014; Fernández-Llamazares *et al.,* 2016) to govern their land- and seascapes in ways that align with biodiversity conservation (ICC, 2008, 2010; Stevens *et al.,* 2014; Ens *et al.,* 2015, 2016; Trauernicht *et al.,* 2015; Blackman *et al.,* 2017; Schleicher *et al.,* 2017; Vierros, 2017).

The inclusion of IPLCs in governance can be enhanced through processes of knowledge coproduction at local, national and global scales (Brondizio & Le Tourneau, 2015; Sterling *et al.,* 2017; Wehi & Lord, 2017, Turnhout *et al.,* 2012; Tengö *et al.,* 2014, 2017; FPP & CBD, 2016; see also 6.2.2 and Chapter 1). Such enhanced participation has been shown to improve dialogue and advance the legitimacy of decisions and the recognition of the value and rights of IPLCs (Schroeder, 2010; Redpath *et al.,* 2013; Brugnach *et al.,* 2014; Wallbott, 2014, Brodt, 1999; Young & Lipton, 2006; Berkes, 2009; Davies *et al.,* 2013; Robinson *et al.,* 2014; Stevens *et al.,* 2014; Gavin *et al.,* 2015; Alexander *et al.,* 2016; Berdej & Armitage, 2016, Ostrom, 1990; Gibson *et al.,* 2005; Hayes, 2006, 2010; Chhatre & Agrawal, 2008, 2009; Waylen *et al.,* 2010; Porter-Bolland *et al.,* 2012; Reyes-García *et al.,* 2012; Gavin *et al.,* 2015; Martin *et al.,* 2016). However, long-term capacity development, empowerment and continued funding support are critical conditions to ensure IPLCs involvement in biodiversity conservation, including specifically women, youth and non-Indigenous communities (Brooks *et al.,* 2009; Ricketts *et al.,* 2010; Eallin, 2015; Escott *et al.,* 2015; Reid *et al.,* 2016; Reo *et al.,* 2017).

There are many tools available to set up such inclusive and participatory mechanisms (Green *et al.,* 2015; Pert *et al.,* 2015; Brondizio & Le Tourneau, 2016; Schreckenberg *et al.,* 2016; Fernández-Llamazares & Cabeza, 2017; Zafra-Calvo *et al.,* 2017), including IPLC-led codes of ethical conduct in conservation (e.g., Akwe: Kon Guidelines and The Tkarihwaié:ri Code of Ethical Conduct; CBD, 2004, 2011), the Free, Prior and Informed Consent principle (Cariño, 2005; Doyle, 2015; Herrmann & Martin, 2016; MacInnes *et al.,* 2017; UNDRIP, 2007), and tools for dialogue such as the Whakatane Mechanism (Freudenthal *et al.,* 2012; Sayer *et al.,* 2017), as well as legal approaches that draw inspiration from ILK and customary institutions (Archer, 2013; Hutchinson, 2014; Akchurin, 2015; Humphreys, 2015; Strack, 2017; also see rights-based approaches above). In this vein, the laws promoting the Rights of Nature (e.g., Bolivia, Ecuador, India, New Zealand) have been, in most cases, heavily influenced by IPLC philosophies placing nature at the center of all life (Akchurin, 2015; Díaz *et al.,* 2015; Borràs, 2016; Archer, 2013; Hutchinson, 2014; Strack, 2017; Kothari & Bajpai, 2017). Moreover, securing connection to place and granting land- and sea tenure rights to IPLCs are also a critical means to ensure IPLC participation in environmental governance and key enabling factors to IPLCs' well-being (Gray *et al.,* 2008; de Koning *et al.,* 2011; van Dam, 2011; McElwee, 2012; Larson *et al.,* 2013; Sunderlin *et al.,* 2014; Sterling *et al.,* 2017). Finally, global policy arenas such as IPBES and the CBD can facilitate knowledge co-production for enhanced environmental governance (Turnhout *et al.,* 2012; Tengö *et al.,* 2014, 2017; FPP & CBD, 2016). **Figure 6.1** outlines several public policies that can facilitate IPLC inclusion in transformative governance. Also see Supplementary Materials section 6.1.3 for background material on IPLCs and ILK, and **Box 6.3** for an example of inclusive governance.

Box 6 3 Example of Inclusive Governance – The Arctic Council.

The interconnected and complex challenges faced by the Arctic have been argued to be better addressed through transformative governance, including stronger transboundary cooperation and globally-coordinated policy responses (Aksenov *et al.,* 2014; Chapin *et al.,* 2015; Sommerkorn & Nilsson, 2015; Nilsson & Koivurova, 2016; Armitage *et al.,* 2017; Edwards & Evans, 2017; van Pelt *et al.,* 2017; Burgass *et al.,* 2018). As one of the fastest changing regions on Earth (ACIA, 2004; Wassmann *et al.,* 2011; Cowtan & Way, 2014), the Arctic is facing vast social-ecological challenges that have required all levels of governance –particularly the Arctic Council– to constantly adjust their modes of operation, ensuring a governance system that is transformative, flexible across issues and sectors, and adaptable over time (Axworthy *et al.,* 2012; Young, 2012; Chapin *et al.,* 2015; Ford *et al.,* 2015). The Arctic Council (AC), established in 1996, is an intergovernmental forum promoting cooperation, coordination and interaction among the Arctic States, Arctic Indigenous communities and other Arctic inhabitants on common Arctic issues, with an overall focus on encouraging transformative change towards sustainability (Young, 2012; Bloom, 1999; Axworthy *et al.,* 2012; Nilsson & Meek, 2016). Inclusiveness is an important principle for the AC and is best reflected by the unique formal status accorded to Arctic Indigenous Peoples as Permanent Participants, sitting at the table alongside State representatives (Bloom, 1999; Young, 2005). The AC has advanced the inclusion of Indigenous knowledge and expertise in AC assessment reports by placing Indigenous representatives in the steering committees of the different constituencies, task forces and working groups of AC (Kankaanpää & Young,2012) and has catalyzed Indigenous Peoples' participation in international policymaking more generally (Koivurova & Heinamäki, 2006). The AC has however also been criticized for continuing to rely on fixed governance fundaments (e.g., soft law nature, ad-hoc funding; Koivurova, 2009) and for failing to offer the kinds of firm institutional, financial and regulatory frameworks that are considered necessary (Berkman & Young, 2006; Greenpeace, 2014; Hussey *et al.,* 2016; Edwards & Evans, 2017; Harris *et al.,* 2018). (See for more details Supplementary Materials section 6.1.4).

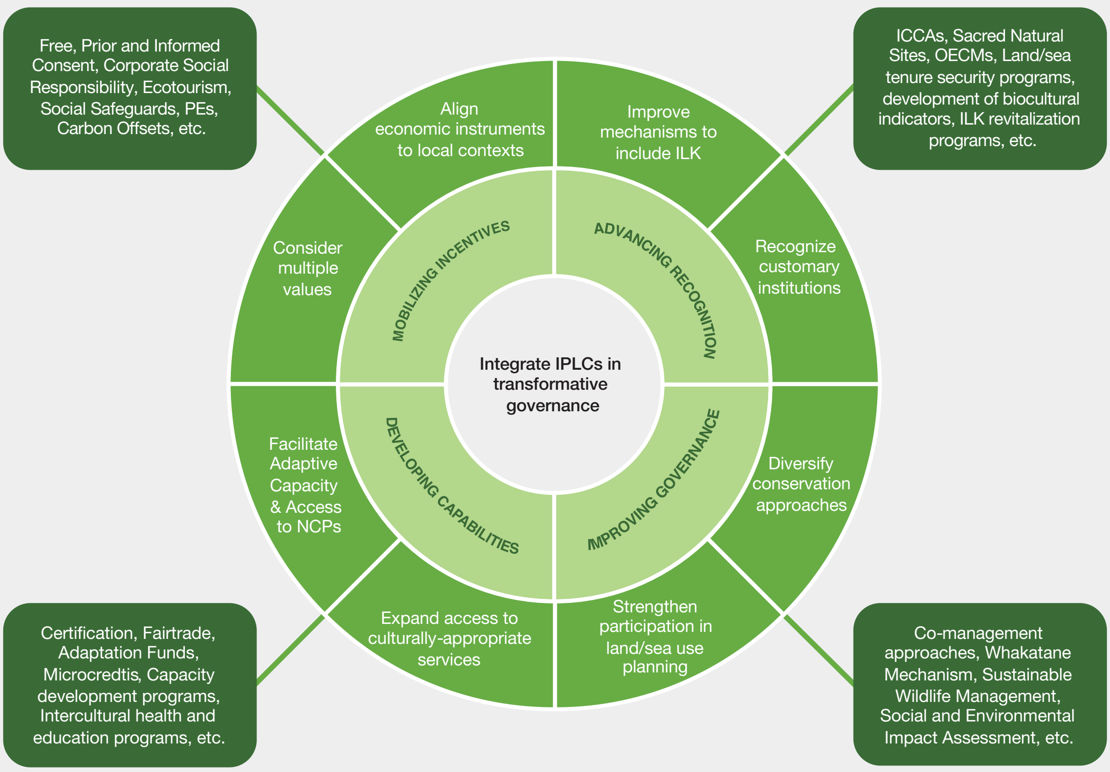

Figure 6 1 **Suite of policy opportunities and actions to better integrate Indigenous Peoples and Local Communities in transformative governance for sustainability.**

Design adapted from Strassburg *et al.* (2017).

6.3 TRANSFORMATIVE CHANGE IN AND ACROSS ISSUES, GOALS AND SECTORS

6.3.1 Introduction

As discussed in the above, the SDG are integrated and indivisible. Therefore, action on one SDG may (positively or negatively) affect progress on other SDG, and the implementation of different targets under an SDG are mutually dependent. Moreover, biodiversity is at the core of many of these complex interdependencies. To the global North and South, the comprehensive implementation of the goals offers major and different challenges to achieve sustainability in the environmental, social, and economic spheres.

Furthermore, as previous chapters have discussed, climate change is exacerbating and reinforcing other drivers of biodiversity loss and environmental degradation, such as habitat loss and degradation, agricultural expansion, unsustainable utilization, invasive alien species and pollution (particularly in marine and freshwater ecosystems; see Chapter 2.1). Various manifestations of climate change such as drought, extreme weather fluctuations, flooding, extreme heat and cold, storms, conditions for accidental fire, ocean water warming and acidification, and rising sea levels, are hindering our ability to meet the Aichi Biodiversity Targets and the SDG.

In this context, the aim of this section is to review both short-term (today-2030) and long-term (today-2050) options available to different decision makers **(Table 6.2)** to achieve the SDG on major biodiversity-related issues and policy domains, including terrestrial landscapes (6.3.2); marine, coastal and fisheries (6.3.3); freshwater (6.3.4); cities (6.3.5); and energy, mining and infrastructure (6.3.6). The overview table in each section summarizes the options that policy makers can include in policy mixes to together address the indirect drivers. The tables include the short- and long-term options, the main problems expected in their implementation, the main decision maker(s) involved, the main levels of governance involved (from the global to the local), and the main targeted indirect driver(s). Some of the common threads emerging from the synthesis below are the following:

First, integrated approaches within an SDG (various targets within one SDG) or among SDG (e.g., the water-food-energy-infrastructure nexus) offer opportunities to foster policy coherence, minimize unforeseen externalities and reduce potential conflict or tensions between different objectives or policies. Promising interventions include practicing integrated water resource management and landscape planning across scales, integrated coastal management, and bioregional scales for energy etc. In addition, policy mixes play a crucial role to address externalities and incorporate diverse values.

Second, data gathering, monitoring and reporting enable decision makers to understand the function and inter-related dynamics of nature, its contributions, and quality of life. Different types of assessment and analytical tools (e.g., cost benefit analysis, life cycle analysis, environmental impact assessment, strategic impact assessment, and participatory assessment) synthesize different types of knowledge, including indigenous and local knowledge. In addition, telecoupled information flows have the potential to contribute to monitoring, surveillance and control. Examples of these options are zero-deforestation pledges, certification schemes for key commodities or biofuel, and the use of satellite surveillance of at-sea fishing operations.

Third, collaborative efforts such as partnerships and other multi-stakeholder approaches among state, market and civil society actors can contribute towards achieving sustainability on all major issues discussed here. In addition, the development of robust, evidence-based, participatory and inclusive decision-making processes optimizes the participation of IPLCs and marginalized social groups (e.g., urban slum dwellers) in environmental governance. Enhanced participation and leadership of IPLCs in environmental processes can advance the recognition of the social, spiritual and customary values of IPLCs in environmental management decisions and influence the outcome, thereby enhancing their legitimacy.

Fourth, it is acknowledged that the effectiveness of policy instruments is context specific, and the implementation of different policy options needs to be adaptive. Moreover, the effectiveness of various policy instruments is not yet well understood and further research on the effectiveness of different policy options, separately and in combination, is necessary to achieve transformative change.

6.3.2 Integrated Approaches for Sustainable Landscapes

Landscapes are the geographical space where socio-ecological systems are shaped and develop. They are the most important source of food, water, materials and bio-energy, and provide space and quality for human habitation. Hence, landscapes are also the space where multiple land uses and values converge. Historically, landscapes have been governed by policies and decisions from different sectors and governance levels, i.e. agriculture, rural development, water, forestry, infrastructure, energy and urban planning, acting often independently without taking due consideration of the interdependencies and trade-offs among different societal objectives that often arise in landscapes.

The lack of articulation of these multiple objectives has been the cause of the large environmental, health and biodiversity loss challenges today, including the conversion and fragmentation of species habitats, one of, and in some regions the main driver of global biodiversity loss (Barnosky *et al.,* 2011; Ceballos *et al.,* 2015; Pimm *et al.,* 2014, Chapter 3 section 3.2.1), the levels of mechanization and resource inputs leading to landscape and biological homogenization (Newbold *et al.,* 2015; Pepper *et al.,* 2017), the lack of adequate attention for the protection of genetic resources of crops, trees, their wild relatives, and livestock (Collette *et al.,* 2015), the skewed representation of biodiversity in protected areas (Butchard *et al.,* 2012, 2015), and the loss of the capacity of soils, cropland and forested areas to maintain ecosystem services (Vitousek *et al.,* 1997; Schiefer *et al.,* 2016, Fornara *et al.,* 2008), including natural pest control and pollination. These challenges are associated with depletion, eutrophication and pollution of water, health problems related to undernourishment and simplified diets (United Nations, 2015), increased costs and risks in food and forestry production due to the introduction of invasive alien species (IAS), and the contribution of landscapes to greenhouse gas (GHG) emissions (FAO & ITPS, 2015, Supplementary Materials 6.2.1).

One unresolved question is how to shape landscapes that fulfil current and future needs of food and materials production, without the negative impacts on nature and society listed above. "Land-sparing" and "land-sharing" represent two extreme models about how landscapes can be shaped and refer to the degree of compatibility between different land use intensities, the conservation of biodiversity and generation of ecosystem services within a landscape (Balmford *et al.,* 2005; Fischer *et al.,* 2008; Phalan *et al.,* 2011, 2016, see also Supplementary Materials 6.2.1). This simplified dichotomy ("land sparing" vs. "land sharing") limits future possibilities (Chapter 5 section 5.3.2.1). There is increasing consensus in that visions of sustainable land-use systems will lie in between these contrasting models, by considering the specific social, economic, ecological and technological context (Fischer *et al.,* 2008; Tscharntke *et al.,* 2012; Chapter 5 section 5.3.2.1). A landscape-focused participatory approach to policy design and implementation is an option to better address dilemmas about land use allocation and intensity of use.

This section analyses the evidence on the effectiveness of policy options that could be used by different decision makers to promote the transition to sustainable landscapes. To contribute to transformative change, options for sustainable agriculture and forest management and conservation would need to be approached with policy mixes (as discussed in 6.2.1 above on integrative governance): "…a combination of policy instruments that (evolves to) influence the quantity and quality of biodiversity conservation and ecosystem service provision in public and private sectors" (Ring & Schröter-Schlaack, 2011). These mixes can include policy instruments beyond the landscape, for instance to regulate the distance drivers of change (i.e., telecouplings) (see section *Regulating commodity chains,* below), including the effect of distant consumption patterns (see section on *Encouraging dietary transitions and alternate consumption,* below).

A policy mix approach is motivated because even in simple settings, no single policy instrument is superior across all evaluation criteria (including effectiveness, cost-minimization, equity) (Vatn, 2010), and cannot possibly address all policy goals and targets. In contrast, well-integrated and implemented policy mixes can help counteract these and other deficiencies, such as economic externalities occurring with market power, unobservable behaviour and imperfect information; and address multiple jurisdictions and policy linkages across jurisdictions (Barton *et al.,* 2013). Successful policy mixes acknowledge the socio-ecological context (Andersson *et al.,* 2015), address conservation and sustainable use challenges, and recognize their cross-sectoral and multi-scale nature (Verburg *et al.,* 2013). If well planned, policy mixes can also address different objectives across the landscape, such as through a 'policy scape' perspective. A 'policy scape', understood as the spatial configuration of a policy mix (Barton *et al.,* 2013; Ezzine-de Blas *et al.,* 2016), recognizes the spatial variation of ecological and biodiversity features, suitability for sustainable food and materials production, and trade-offs between sustainable production and conservation (Schröder *et al.,* 2014; 2017).

Transformative landscape governance networks can further develop policy mixes that integrate across sectors, land uses, actors and levels of governance (Carrasco *et al.,* 2014), addressing important trade-offs among NCP in a transparent and equitable way. Options in the short and longer-term incorporate decision makers and stakeholders from within and outside the landscape while addressing power dynamics (Ishihara *et al.,* 2017; Berbés-Blázquez *et al.,* 2016). These networks are thus multi-actor (including different types of actors), multi-level (including multiple levels of governance, from the global to the local) (Verburg *et al.,* 2013), and multi-sector (including representatives from different sectors, including the entire value chain, from producer to end user) (Lim *et al.,* 2017). Decision makers and stakeholders in these networks need to recognize different values and be cognizant of power dynamics in the networks in order to enable transformative change. Any type of decision maker could initiate such networks.

The options discussed in the remainder of this section, and summarized in **Table 6.3**, can be potential elements of these policy mixes for integrated landscape approaches. They mainly include existing instruments aimed to support sustainable agriculture, sustainable forest management and biodiversity conservation, and thus represent options that can be implemented in the short term. Water governance, although an integral part of landscapes, is discussed in section 6.3.4. However, it is only when these options are strategically combined in integrated landscape approaches that transformative change towards sustainability can take place. Such approaches can be started in the short term but need to be continuously enhanced through transformative governance in the longer term.

Table 6 3 **Options for integrated approaches for sustainable landscapes.**

Short-term options (incremental and transformative)	**Long-term options (in the context of transformative change)**	**Key obstacles, risks, spill-over, unintended consequences, trade-offs**	**Major decision maker(s)** (see Table 6.2)	**Main level(s) of governance**	**Main targeted indirect driver(s)**
Sustainable landscapes					
Harmonized, synergetic, cross-sectoral, multi-level and spatially targeted policy mixes, developed through transformative landscape governance networks		Sectoral policy formulation; limited resources and technical capacity; limited resolution of trade-offs; lack of policies inclusive of the entire market that address leakage and telecoupling	Governments; Science and educational organizations; private sector; civil society, IPLCs	All	Economic; institution; governance
Feeding the world without consuming the planet					
Expanding and enhancing sustainable intensification in agriculture (including crops and livestock)		Limited public investment in innovation and outreach activities; limited research and innovation in production embracing sustainability principles; economic and social inequalities	FAO, OIE, governments; science and educational organizations; civil society; donors	National and sub-national	Technological; economic
Encouraging ecological intensification and sustainable use of multi-functional landscapes		Lack of cross-sectoral policy integration; potential high risk of conflict with conservation; limited spatial/territorial planning; limited capacity to resolve trade-offs; lack of understanding about production benefits from improved biodiverse/multiple-value use of land; limited landholder buy-in; pressure to further intensify ('productivist' agricultural paradigm)	Governments; science and educational organizations; private sector; civil society; donors	National; sub-national and local	Institutions; governance; economic
Improving certification schemes and organic agriculture		Limited demand for certified products; lack of landscape level coverage; risk for leakage; voluntary; tends to prioritize brokers and industries; less participation of poor farmers; requires market integration; standards unclear for consumers	Civil society; private sector; governments	Global; regional; national	Cultural; institutions; economic; governance; technological
Regulating commodity chains		Small-farmer exclusion due to high transaction costs of certification and lack of domestic markets; limited expansion of certified area; risk of limited acknowledgement of local customary rights; lack of effective external control; promotion of segregated landscapes; overlooks root causes of land-use expansion; voluntary standards	Civil society; private sector	Global; regional; national	Institutions; governance; cultural; economic
Conserving genetic resources for agriculture		Lack of integration of local genetic resources networks and global processes; lack of integration of genetic resources in biodiversity conservation; risk of increasing social and economic inequalities; lack of recognition of IPLCs and intellectual property rights; limited trait control and seed quality standards	Global and regional (inter-) governmental organizations; private sector; IPLCs; science and educational organizations	All	Institutions; governance; technological

Short-term options (incremental and transformative)	Long-term options (in the context of transformative change)	Key obstacles, risks, spill-over, unintended consequences, trade-offs	Major decision maker(s) (see Table 6.2)	Main level(s) of governance	Main targeted indirect driver(s)
Managing Large-Scale Land Acquisitions (LSLA)		Risk of leakage effects; social and economic marginalization of local farmers; increased tenure insecurity in surrounding lands	Intergovernmental organizations, private sector; farmers	All	Economic; institutions, governance
Encouraging dietary transitions		Lack of consumer awareness of environmental, health and animal welfare implications of food types; lack of effectiveness of information campaigns; voluntary labeling of products; limited market shares of certified products, labeling often emphasizing documentation not performance; low price of unsustainable food	National, subnational and local governments; private sector; citizens; NGOs, science and education organizations	All	Economic; cultural
Reducing food waste	Transformations in food storage and delivery	Failures in food distribution and storage systems; limited consumer education; wasteful marketing practices; limited recycling of food waste; wasteful supply chains and business models	Private sector; citizens (consumers); national and subnational governments; donors; science and education organizations	National; subnational; local	Institutions; governance; cultural
Improving food distribution and localizing food systems		Disconnect between production, consumption and waste management; poor integration in urban planning; limited connection between producers and consumers	National and subnational governments; private sector; citizens (consumers)	National and subnational	Economic; institutions; governance; technological
Expanding food market transparency and price stability		Opposition to government role in stabilizing food prices and food security; limited social targeting to support poor populations	Intergovernmental organizations; National governments; private sector	National	Governance; economic; institutions
Sustainably managing multi-functional forests					
Expanding and improving community-based forest management and co-management		Bureaucratic (and political) apathy; institutional resistance from forest bureaucracies	Governments; civil society; IPLCs	National; sub-national and local	Institutions; governance; demographic
Improving policies relating to PES and REDD+		Informational and other asymmetries among stakeholders; complexities in benefit sharing; unclear or contested tenure; unfavorable institutional and policy settings; over-prioritization of market incentives; limited range of ecosystem services compensated for; international disagreement; trade-offs and conflicts between carbon and other benefits (including biodiversity conservation); stakeholders not always involved in policy design	Global institutions (UN, MEAs); governments; donor agencies; civil society	All	Governance; institutions; economic; technological
Supporting Reduced Impact Logging (RIL)		Insufficient technical and financial capacity, especially in forest-rich tropical countries	Governments; science & educational organizations, private sector	National; sub-national and local	Technological; economic
Promoting and improving forest certification		Limited technical and financial capacity for forest management; low demand for certified products; lack of information among consumers	Governments; science & educational organizations; private sector; NGOs; donors	All	Economic; institutions; governance; cultural; technological
Controlling illegal logging		Weak local governance, poor level of compliance; difficulties with monitoring and traceability; insufficient reward for legal forest harvests in global timber market; difficulties with monitoring and traceability	Intergovernmental organizations; governments; private sector, donors; civil society	All	Governance; institutions; economic

Short-term options (incremental and transformative)	Long-term options (in the context of transformative change)	Key obstacles, risks, spill-over, unintended consequences, trade-offs	Major decision maker(s) (see Table 6.2)	Main level(s) of governance	Main targeted indirect driver(s)
Monitoring and regulating forest use		Insufficient technical and financial capacities; poor understanding of the needs and benefits; weak local governance; poor level of compliance; difficulties with monitoring and traceability systems	International organizations (e.g. FAO); governments; educational organizations; IPLCs	All	Governance; economic, technological
Protecting nature					
Improving management of protected areas (PAs)		Inadequate resources and weak governance; increased human pressures; climate change; limited enforcement, limited monitoring; lack of robust ecological data to assess effectiveness across spatial & temporal scales	International organizations (e.g. IUCN); governments; NGOs; donors	All	Governance; institutions; technological
	Improving spatial and functional connectivity of PAs	Isolation of PAs; geographical and ecological biases; limited spatial planning; trade-offs among societal objectives	Global organizations; governments; NGOs; donors	All	Governance; institutions; technological
	Improving transboundary PA and landscape governance	PA planning usually depends on individual governments	Global organizations; national governments; NGOs; donors	All	Governance; institutions
Recognizing management by IPLCs and OECMs		History of conflicts between IPLCs and legal PA management; potential displacement, exclusion, distress of IPLCs due to strict PA governance; unequal sharing of costs and benefits between different actors; erosion of ILK	Governments; NGOs; private sector; IPLCs; donors	All	Cultural; governance; institutions; regional conflicts
Addressing the illegal wildlife trade		Poor law enforcement; limited capacity for detection; limited surveillance; corruption; limited capacity of crime investigation	Global institutions (CITES); national governments; citizens; IPLCs; NGOs	All	Governance; cultural; economic
Improving Sustainable Wildlife Management		Lack of recognition of IPLC rights; unequal distribution of benefits; elite capture; leakage effects; lack of enforcement of law and international agreements; corruption	Governments; IPLCs; private sector; NGOs	All	Governance; institutions; economic
Manage IAS through multiple policy instruments		Legal and institutional barriers to effective management; information management challenges; lack of resources; limited perception of risks; jurisdictional issues; lack of coherent systemic and community-partnered approach to IAS management; lack of economic incentives to engage private landowners; limited engagement of IPLCs	Global organizations; governments	All	Governance; institutions; cultural; technology; economic
Expanding ecosystem restoration projects and policies					
Expanding ecosystem restoration projects and policies and link to revitalization of ILK		Uncertainty about effectiveness; limited formal and empirical evaluation of projects; risk for limited acceptance of project (neglect of community culture and values); rapid cultural change	Governments; science and education organizations; private sector; IPLCs	National and local	Technology; economic; cultural
Improving financing for conservation and sustainable development					
Improving financing for conservation and sustainable development		Lack of understanding of what financing mechanisms are most effective; priorities for financing in other sectors above biodiversity; lack of consistent monitoring of ODA for biodiversity	Global organizations; national governments; donors	Global; regional; National	Economic; governance; institutions

6.3.2.1 Feeding the world without consuming the planet

Expanding and enhancing sustainable intensification in agriculture

To address land degradation (IPBES, 2018b) and other environmental impacts of agriculture, two forms of ecological modernization are currently considered: (i) sustainable intensification (Sustainable intensification or efficiency-substitution agriculture (Duru *et al.,* 2015, Schiefer *et al.,* 2016), which aims to improve input use efficiency and minimize environmental impacts. This is currently the dominant modernization alternative (see Supplementary Materials 6.2.2; Chapter 2.3 about trends in production for marketed commodities). (ii) *biodiversity-based agriculture* aims to develop agriculture enhancing ecosystem services generated by agro-diversity (Duru *et al.,* 2015) (see section on "Encouraging sustainable use of multifunctional landscapes", below).

Efficiency-based agriculture consists of adjusting practices in specialized systems to comply with environmental regulations and follows the logic of economy of scale and expression of comparative advantages (e.g., for soil fertility, climate, knowledge, labour costs, infrastructure, and regulations) (Duru *et al.,* 2015), aiming at closing yield gaps (Mueller *et al.,* 2012, Chapter 5 section 5.3.2.1). Implementation is based on good agricultural practices (e.g. FAO), and international voluntary standards, including those on animal health and welfare of the World Organization for Animal Health (OIE), and uses also new technologies such as precision agriculture (Supplementary Materials 6.2.2).

The adoption of these practices can be supported by investment in technological development and outreach, regulations, and public and private quality standards such as voluntary certification schemes and roundtables (see sections on *Improving certification schemes* and *Regulating commodity chains*, below). One recent example of the mixes of measures that can promote this kind of agricultural modernization is the program to encourage the sustainable increase of crop yields in smallholder farms in China. In 2003–11, the country increased its cereal production by about 32% (more than double the world average), largely by improving the performance of the least-efficient farms, through a comprehensive package of measures that included public investment, development and testing of technologies adapted to specific agro-ecological zones that improved yields, conserved soils and reduced fertilizer application, and outreach and farmer engagement (Zhang *et al.,* 2013). Development of new crop varieties remains one of several areas of fundamental research that feed into this approach to increase yields and reduce the use of insecticides (Zhang *et al.,* 2013).

Efficiency agriculture is applied to both crops and livestock production. Industrial production systems produce over two-thirds of global production of poultry meat, almost two-thirds of egg production and more than half of world output of pork, with beef and milk production remaining less intensified (FAO, 2009). The environmental impacts, including water, soil and air pollution, of intensive livestock production are significant, and these systems often harbor poor animal welfare conditions (HLPE, 2016). Challenges of efficiency agriculture, including the industrial production of livestock, generally rely on high levels of anthropogenic inputs and include the extensive use of non-renewable resources such as mineral fertilizers and energy, the risk of pest resistance to agro-chemicals (Duru & Therond, 2014), human health problems associated with the use of pesticides and veterinary drugs, the homogenization of crops, and the biological deterioration of the land. This kind of intensification may trigger land conversion as has been the case of soybean expansion in South America (Fearnside, 2001; Pacheco, 2012). Shortcomings can also involve leakage effects and failure to address the conservation of semi-natural and open habitats (Supplementary Materials 6.2.2), issues due to the shift of agricultural production from small and medium household farms to international agroindustry pools (Strada and Vila 2015), and exposure to market volatility.

Encouraging ecological intensification and sustainable use of multi-functional landscapes

Land-use systems consisting of mosaics of cropland, grasslands and pastures, and forests, are widely spread globally and are critical for food security and sovereignty (Supplementary Materials 6.2.2). Encouraging use of multi-functional landscapes can be the basis for a shift towards *ecological intensification or biodiversity-based agriculture* including diversification of food sources, ecological rotation and agroforestry, promotion of agroecology with a view to promoting sustainable production and improving nutrition (McConnell, 2003). At the same time, these landscapes are the space where the largest conflicts with nature conservation can take place (Ravenelle & Nyhus, 2017), especially in the case of wildlife – human interactions.

Multi-functional landscapes also support NCP critical to IPLC diets and food systems. These are also gaining attention in the context of global discourses around food sovereignty (Patel, 2009) and cultural identity (Charlton, 2016; Coté, 2016; Kuhnlein *et al.,* 2009; Nolan & Pieroni, 2014). Many IPLCs and a wide range of rural and peri-urban populations, remain highly dependent on hunting, fishing and gathering for their diets, which play a critical role in supporting IPLC health and well-being (Kuhnlein, 2014; Kuhnlein & Receveur, 2007; ICC, 2015; Nesbitt & Moore, 2016). As such, drivers of landscape homogenization and biodiversity loss have been largely associated with rapid nutritional shifts among IPLCs, through the reduction in consumption of locally-sourced foods as well as the incorporation of industrially processed products, often leading to increasing rates of overweight, obesity and chronic disease (Popkin, 2004; ICC, 2015; Galvin *et al.,* 2015; Iannotti and Lesorogol, 2014; Reyes-García *et al.,* 2018). Measures to promote multi-functional landscapes are easier to govern when they are broadly defined and linked to values or objectives in the sector or local practices (Runhaar *et al.,* 2017). Community-driven and culturally-appropriate responses to address these changes posit a reconnection of land-based food systems and have recurrently called for supporting the recognition of IPLC food sovereignty (Wittman *et al.,* 2010; Morrison, 2011; Rudolph & McLachlan, 2013; Martens *et al.,* 2016). Also, targeting specific measures by identifying agro-ecological constraints and characteristics of farming systems such as population pressure, urbanization, governance, income and undernourishment, can further help select suitable measures to promote ecological intensification in agriculture (Sietz *et al.,* 2017) and the management of NCP based on biodiversity.

Policy options that have been implemented to promote ecological intensification of farming systems include, although not exclusively, direct payments such as agri-environmental schemes (AES) to conserve and better provision ecosystem services (Supplementary Materials 6.2.2) and to maintain and restore habitats (Montagnini *et al.,* 2004), payments for ecosystem services (PES) to protect water sources (Frickmann Young *et al.,* 2014), with biodiversity conservation as a co-benefit (see section on *Improving REDD+ and PES),* below), and standards and certification schemes (see section on *Improving Certification Schemes and Organic Agriculture*, below). A form of biodiversity-based agriculture is permanent (agri)culture, based on broad principles defined as mimicking ecological patterns, locally designed and recuperation of traditional ecological practices (Roux-Rosier *et al.,* 2018).

Technical assistance and investment (including micro-credits) have been used to promote land uses such as agro-forestry systems that enhance on-farm provisioning (e.g. timber and non-timber products in addition to crops and pastures (Montagnini, 2017, Part III) and regulating services such as carbon sequestration. Direct payments (e.g., PES) can be combined with technical assistance since they are effective in overcoming initial economic and technical obstacles to the adoption of agro-forestry practices (Cole, 2010), but the practices need short to medium-term technical support to ensure their long-term retention. These measures have been combined with REDD+ (see section on REDD+, below) to promote carbon sequestration and halt forest clearing.

Participatory approaches and compensation schemes have helped resolve conflicts between food and material production and nature conservation, including wildlife conservation in these mixed-use systems (see section on *Improving Sustainable Wildlife Management*, below) where multiple objectives converge. Finally, the farmers' level of adoption of practices in voluntary schemes (AES, PES, REDD+, technology adoption and certification schemes) is, in many instances, low and largely determines the effectiveness of the measures (Giomi *et al.,* 2018; Runhaar *et al.,* 2017). Two obstacles related to direct payments, a widely used policy instrument, include its voluntary character and that subsidies often do not cover all costs (Runhaar *et al.,* 2017). Farmers who do not voluntarily engage in nature conservation could be incentivized by showcasing farmers who have made advances, critical consumers, and stricter rules in direct payment schemes or in generic agri-environmental legislation (Giomi *et al.,* 2018). Farmers need to be motivated, able, or enabled (e.g. through investment in technological development and outreach), demanded (through regulations and quality standards as the IFOAM-Organic standard and roundtables (see *Improving Certification Schemes and Organic Agriculture*, below), and legitimized to participate and act (Runhaar *et al.,* 2017). There are also other private forms of governance including the cooperation of farmers with conservation NGOs, or compliance to conservation standards requested by companies in agricultural supply chains as part of their Corporate Social Responsibility programmes (Runhaar *et al.,* 2017).

Improving certification schemes and organic agriculture

Over the last decades, voluntary sustainability standards (VSS) and certification schemes (VCS) have become a key governance mechanism affecting land-use decisions and land-use shifts (Sikor *et al.,* 2013) aiming to mitigate the negative impacts of agricultural expansion and intensification, including deforestation (Milder *et al.,* 2014; Tscharntke *et al.,* 2015), by promoting environmental and biodiversity-friendly practices at the farm level. Studies reveal increases in the abundance or species richness of a wide range of taxa, including birds and mammals, invertebrates and arable-land flora in certified farms (Hole *et al.,* 2005; Bengtsson *et al.,* 2005; Tuomisto *et al.,* 2012; Tayleur *et al.,* 2018), and ecosystem services (Supplementary Materials 6.2.2, Kremen *et al.,* 2002; Bengtsson *et al.,* 2005; Hutton & Giller, 2003), mainly due to lower agrochemical inputs (Aude *et al.,* 2003; Hutton & Giller, 2003; Pimentel *et al.,* 2005; Birkhofer *et al.,* 2008)

However, most certification schemes are too recent to evaluate detectable impacts (Tayleur *et al.,* 2018) and results on environmental and biodiversity performance are in many cases limited (Gulbrandsen, 2010; Gulbrandsen, 2009) or variable (Bengtsson *et al.,* 2005). In some cases, certification schemes have spurred more intensive and degrading land-use practice (Guthman, 2004; Klooster,

2010) and caused higher deforestation in neighbouring old-growth forest areas (Tayleur *et al.,* 2016).

A few studies have also documented positive livelihood outcomes from certification (Bacon, 2005; Bolwig *et al.,* 2009; Gulbrandsen, 2005; Ruben and Fort, 2012) and improved management institutions, but impacts on poverty alleviation are mixed (Yu Ting *et al.,* 2016). Many schemes have exacerbated problematic political and economic inequalities (Gómez Tovar *et al.,* 2005; Ponte, 2008) or failed to enhance market access or benefits (Font *et al.,* 2007), especially for smallholder farmers (DeFries *et al.,* 2017; Tayleur *et al.,* 2018). There are also issues of high transaction costs, transparency, legitimacy and equity in certification schemes (Supplementary Materials 6.2.2; Eden, 2009; Klooster, 2010; Havice & Iles, 2015; Hatanaka *et al.,* 2005).

Certification of tropical agricultural commodities shows clear aggregations in Central America, Brazil, West Africa and parts of East Africa and Southeast Asia and has poor representation in the world's 31 poorest countries (Tayleur *et al.,* 2018), and schemes remain limited in geographic scope (Ebeling & Yasué, 2009; Rametsteiner & Simula, 2003, Tayleur *et al.,* 2016).

Certification could better contribute to sustainability goals if targeted where benefits can be optimized (Tayleur *et al.,* 2016), i.e. areas of high nature conservation value (including landscape level quality) (Hole *et al.,* 2005), in areas of social and economic development priority, and where enabling conditions exist (e.g. governmental complementary policies) (Tayleur *et al.,* 2016). Governments can facilitate the impact of certification schemes by promoting certification uptake and supporting strategic targeting. Governments involved in international aid could engage in coordinating efforts to finance certification in identified priority areas for social and economic development (Tayleur *et al.,* 2016).

Public campaigns on the environmental, health, conservation, and social benefits of certified products are likely to increase consumer demand for these products, and measures aiming to enhance social responsibility in multi-national corporations can be effective (Tayleur *et al.,* 2018). Engaging in more equitable food value chains (see sections on *Improving food distribution and localizing food systems*, *Expanding food market transparency and price stability* and *Regulating commodity chains*) have the potential to expand the geographical range and enhance social outcomes. Critical to promoting VCS that balance conservation and economic demands is: 1) managing stakeholder expectations; 2) targeting priority habitats, species and social groups and 3) implementing adequate post-certification monitoring of impacts (Yu Ting *et al.,* 2016; Tayleur *et al.,* 2018). New technology (e.g., environmental data management and sharing infrastructure, modelling, web-based communication) and data availability could help improve monitoring and assessment of certification impacts, including bio-physical (e.g., nutrient leakage, water use efficiency, biodiversity), social and economic criteria.

Regulating commodity chains

Two major efforts to regulate commodity chains, particularly for tropical agricultural products, and to deal with telecoupling issues and the unsustainable expansion of these commodities include multistakeholder fora and commodity moratorium policies. Examples of multistakeholder fora are the Roundtable on Sustainable Palm Oil (RSPO), the Roundtable on Responsible Soy (RTRS) Better Sugar Cane Initiative, and the Roundtable on Sustainable Biomaterial, which aim to engage all private stakeholders of an agricultural supply chain, including growers; processors; consumer goods manufacturers; environmental NGOs; social NGOs; banks and investors; and retailers to establish a "sustainability" standard, and unlike labels that focus on a specific market, these standards envision to transform the entire sector towards sustainability. However, the RSPO standard overlooks the root causes of palm oil expansion in the tropics, such as land rights, commodity prices, agricultural systems and market access, resulting in a rather small and local level impact of certification on biodiversity conservation (Ruysschaert & Salles, 2014; Ruysschaert, 2016). At the global level, the RSPO is promoting a segregated landscape with large-scale plantations and conservation areas. This could make sense, as large oil palm plantations are very productive. However, this fails to recognize that the main environmental and social gains can be made by supporting smallholders, who currently produce half as much as the large-scale plantations (Ruysschaert, 2016; GRAIN, 2016).

Although the RSPO standards may be based on principles of inclusive participation from each member category; consensus building; and transparency in the negotiation process (RSPO, 2013, Schouten & Glasbergen, 2011), in practice, its implementation is more complex, with RSPO certification favouring three dominant groups of stakeholders: the downstream agro-business firms, international environmental NGOs, and the largest palm oil producers (Ruysschaert, 2016). For the downstream firms, RSPO certification fulfils their initial goal to secure their business in the long-term and protect their reputation (RSPO, 2002), but it often fails to cover costs of producers, particularly, the forgone economic opportunity to convert the areas identified as high conservation value (HCV) (Ruysschaert & Salles, 2014). RSPO has tended to favour large-scale producers seeking to get access to international markets; smaller firms and smallholders are largely excluded either because they sell to domestic markets where certification is not valued by consumers, or because they find certification too costly and its managerial requirements too demanding (Ruysschaert & Salles, 2014; Ruysschaert, 2016; and Supplementary Materials 6.2.2)

The case of moratoria such as the Brazilian Soy Moratorium (Supplementary Materials 6.2.2) appears to have been more successful in delivering biodiversity conservation outcomes (i.e. halting deforestation, Rudorff *et al.,* 2011; Gibbs *et al.,* 2015) and has set the stage for other initiatives to improve the sustainability of soy production and raise the awareness of the markets, like the RTRS and the Soja Plus Program. These initiatives are additional to zero-deforestation agreements and include other issues related to environmental compliance, social justice and economic viability at the farm and the supply chain level. Although there are leakage risks due to Moratorium restrictions (Arima *et al.,* 2011), recent analysis is showing no evidence for this (Le Polain de Waroux *et al.,* 2017). In contrast, there are opportunities for soy production in degraded pasture areas without increasing deforestation; combined with the identification of suitable areas, pasture intensification techniques and controlling new deforestation, the soy supply chain in the Amazon may become a good example of reconciliation of forest conservation and agricultural production. However, despite the good results, there are still threats to the Moratorium. Policy mixes supporting this package of measures can be enhanced if they address failures related to market shares, like the lack of engagement of traders and importers and the competition with farmers not covered by the Moratorium, which may further demise the motivation of the private sector in keeping the agreement.

Conserving genetic resources for agriculture

The diversity of cultivated plants, domestic animals and their wild relatives is fundamental for food security globally (Asia, Africa, Central and South America) (McConnell, 2003; Dawson *et al.,* 2013), and essential to the adaptation of agriculture to new and uncertain patterns of climate change. Most of the global genetic diversity in agriculture is kept in low-input farming systems (McConnell, 2003), and it is central to food sovereignty and to food as a non-material contribution to GQL (Chapter 1), also in IPLCs, where it can also involve cultural keystone species which support community identity and traditional roles (e.g. taro in the Pacific, corn in Central and South America, buffalo in North America). Globally, policy options to protect genetic resources for agriculture and forestry include support to on-farm conservation (*in situ*) (Enjalbert *et al.,* 2011; Thomas *et al.,* 2012, 2015) integrated with the conservation of germplasm in gene banks (*ex situ*). *In situ* conservation requires that the farmers, livestock keepers and foresters who conserve and manage these varieties, breeds and species benefit from maintaining this global common resource (CBD, 2014 Nagoya Protocol; Collette *et al.,* 2015). The genetic diversity in agriculture underlie current debates on food and seed sovereignty, and the implications of intellectual property rights to conservation of biodiversity and plant germplasm (Coomes *et al.,* 2015, see also Chapter 2.1 section 2.1.9.1.1). The debates have involved researchers, policy makers, seed producers for the market and IPLCs, bringing tension over seed legislation, regulation and commercialization (FAO, 2004; CBD The Nagoya Protocol, 2014; European Seed Association, 2014).

The case of social networks (e.g. farmer seed networks and community seed banks (Coomes *et al.,* 2015; Pautasso *et al.,* 2013; Lewis & Mulvany, 1997), illustrate the potential and challenges of the conservation and sustainable use of local genetic resources of global significance. Seed networks are cornerstones in maintaining the diversity of crops and their wild relatives (Tapia, 2000); they account for 80-90% of the global seed transfers and supply (Coomes *et al.,* 2015) and are important channels of innovation and diversity (Coomes *et al.,* 2015), and therefore show considerable potential for innovation and transformation of agricultural systems aligned with the SDG, especially if entry points for improvement are identified (Buddenhagen *et al.,* 2017). Seed networks are found in all regions of the world: Central and South America, Africa, Asia; in the Australia, Canada, the UK and the USA, and particular types of community seed banks have emerged (Vernooy *et al.,* 2015; Dawson *et al.,* 2011; Urzedo, 2016).

Options examined in the literature include aspects of seed quality and distribution, social and economic dimensions and global governance issues. Developing quality standards for traits, seeds and other material, and quality control schemes would considerably enhance the potential for integration into global processes of sharing and exchange of genetic resources (Coomes *et al.,* 2015; Jarvis *et al.,* 2011), but the mechanisms of seed sharing require attention, so that barriers that discriminate disfavored social groups can be addressed and eliminated (Tadesse *et al.,* 2016). Vernooy *et al.* (2017) summarize a series of measures to maintain *in situ* genetic diversity, which include support to local institutions, actively protect plants and livestock breeds that can survive extreme conditions, facilitate the restoration of varieties no longer used, develop platforms to facilitate access and availability of seeds at the community level, and help access novel diversity not conserved locally. Since in many cases, farmers have few market or non-market incentives, different public measures will be necessary to protect genetic resources (Jarvis *et al.,* 2011).

Given that these resources are of global importance (see also Chapter 2.2 section 2.2.3.4.3 on agro-biodiversity hotspots and Chapter 3 on Aichi Target 13) the national and global mechanisms need to be developed and harmonized. Global mechanisms are governed by three agreements originating from different sectors: The Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization under the CBD (CBD, 2014; Nagoya Protocol), the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) (FAO, 2004), and the International Convention for the Protection of New Varieties of Plants (UPOV http://www.upov.int/portal/index.html.en). Despite efforts to harmonize implementation, there are considerable gaps in the coordination of the agreements.

Managing large-scale land acquisitions (LSLA)

Concerns about LSLA (also sometimes called "land grabbing") have increased considerably over the past decade (Borras *et al.,* 2011; Balehegn *et al.,* 2015) and include issues of food security, equity, leakage and environmental effects (Grant & Das, 2015; Coscieme *et al.,*, 2016; Borras *et al.,* 2011; Adnan, 2013). While some see land acquisitions as investments that can contribute to more efficient food production at larger scales (World Bank, 2010; Deininger & Byerlee, 2012), there are strong concerns that food security (especially at local levels) may be threatened by these large agribusiness deals (Daniel, 2011; Lavers, 2012; Golay & Biglino, 2013, Ehara *et al.,* 2018; and Supplementary Materials 6.2.2).

Displacement of smallholders from LSLA can potentially lead to impoverishment and increased (unsustainable) production elsewhere once they are removed from lands (Borras *et al.,* 2011; Adnan, 2013); these have happened with frequency in many countries in Africa, where communal land tenure authorities have allowed expropriation of locally used lands without other farmers' knowledge or compensation (Osinubi *et al.,* 2016). There is some evidence that LSLA have already led to the impoverishment of some communities and as many as 12 million people (Adnan, 2013; Davis *et al.,* 2014). In at least some cases, the causal process is that land grabs contribute to increased tenure insecurity in surrounding lands, leading farmers to shift to cultivating smaller farms with less investments, potentially leading to food shortages (Aha *et al.,* 2017). There is some evidence that land grabbing is also weakening local systems of common property management, which can make some communities less able to adapt to climate changes in the future (Gabay & Alam, 2017; Dell'Angelo *et al.,* 2017), including reducing the forest resources they may depend on as safety nets (Kenney-Lazar, 2012).

The primary policy mechanisms for combatting large scale land acquisitions have included restrictions on the size of land sales (Fairbairn, 2015); pressure on agribusiness companies to agree to voluntary guidelines and principles for responsible investment (Collins, 2014; Goetz, 2013); attempts to repeal biofuels standards (Palmer, 2014); and direct protests against the land acquisitions (Hall *et al.,* 2015; Fameree, 2016). REDD+ has the potential to provide a counterbalance with funding to combat land grabbing, but evidence is unclear if this is really happening yet or if REDD+ will mostly protect areas not under threat from large-scale investments (Ziegler *et al.,* 2012; Phelps *et al.,* 2013). Some have also accused REDD+ projects of being akin to land grabs in that they may displace smallholder agriculture without proper compensation (Lyons & Westoby, 2014; Corbera *et al.,* 2017). Future policies to regulate LSLA will need to rely on better monitoring data as a first step, as it is difficult to track the scale and impact of such LSLA.

Encouraging dietary transitions

The characteristics of today's global(ized) food system and the increasing industrialization of agricultural production, food consumption, and in particular animal protein consumption, are associated with a range of challenges, including food sovereignty, biodiversity loss, climate change, pollution, and animal health and welfare (HLPE, 2016; Steinfeld *et al.,* 2006; Garnett *et al.,* 2013; HLPE, 2016; Visseren-Hamakers, 2018; McMichael *et al.,* 2007; Jones & Kammen, 2011; Tilman & Clark, 2014). These problems are especially urgent given the fact that the global production of different animal products is expected to double by 2050 (Steinfeld *et al.,* 2006). The expansion of soybean in South America illustrates the challenges of current globalized industrial food production, with 45% of livestock feed in the EU based on soybean imported from Brazil and Argentina (EEA, 2017; Strada & Vila, 2015).

Current consumption of animal products is very unequally distributed, and animal protein can continue to play a role in ensuring food security in much of the developing world (Steinfeld & Gerber, 2010). However, substantially reducing the consumption of animal products in developed countries and emerging economies has the potential to greatly lower the negative impacts of farming while at the same time generating significant dividends in terms of people's health (Pelletier & Tyedmers, 2010; Smith *et al.,* 2013; Tilman & Clark, 2014; Bajzelj *et al.,* 2014; Ripple *et al.,* 2014; Springmann *et al.,* 2016, see also Chapter 2.3).

Different types of policy instruments aimed at lowering and changing consumption have been tried and studied (Story *et al.,* 2008; Vinnari & Tapio, 2012). Informational policy instruments aim to foster more sustainable food choices by offering information on production characteristics or health implications of food types or products. They range from certification schemes and (requiring) labels listing product ingredients or voluntary labels, signaling superior production methods (in terms of environmental, social or animal welfare aspects), to health campaigns (Reisch *et al.,* 2013), and would seem promising given a lack of consumer awareness of the implications of animal protein, an inaccuracy of messages on the health implications of (red) meat consumption, and the potential for altering relevant consumer attitudes and motivations identified by research (Boegueva *et al.,* 2017, Dagevos &Voordouw, 2013).

Economic policy instruments such as subsidies or taxes have been used to influence consumer choice via economic incentives and have shown to be particularly effective at driving dietary change, at least in developed countries (Dallongeville *et al.,* 2010; Capacci *et al.,* 2011; Mytton & Clarke, 2012; Thow *et al.,* 2014; Whitley *et al.,* 2018). Regulatory standards, in turn, prescribe what may be sold to consumers. However, the use of such policy instruments in the food sector has for the most part been restricted to the case of age-related prohibitions on the purchase of tobacco or alcohol (also see 6.4).

However, while the political *Zeitgeist* has favored informational policy tools, they often lack effectiveness. Studies have identified the prevalence of an attitude – action gap, and showed that structural constraints, such as information asymmetries and overflow as well as restrictions on time and other relevant resources by consumers, have prevented informational policy instruments from achieving major changes in food consumption patterns (Fuchs *et al.,* 2016; Horne, 2009). Among private certification schemes, those with the largest market shares often have little actual impact on the sustainability characteristics of a food product, as they tend to emphasize documentation rather than performance or fail to tackle the most impactful aspects of food production, distribution and consumption (Fuchs & Boll, 2012; Kalfagianni & Fuchs, 2015). Simultaneously, studies inquiring into the drivers of meat consumption have highlighted its promotion via advertising and media images that transport images of identity (especially masculinity, but also national and cultural identity) as well as artificially low meat prices (Bogueva *et al.,* 2017).

Thus, policy efforts to improve the sustainability of food consumption in general, and reduce animal protein consumption in particular, would require a policy mix reaching far beyond the (nudging of the) individual consumer (Fuchs *et al.,* 2013, 2016; Glanz & Mullis, 1988; Wolf & Schönherr, 2011). Such policies would need to focus on regulating the advertising of animal products, as well as sources of low meat prices, among others through lowering subsidies and enhancing (implementation of) animal welfare, labor and environmental standards. Simultaneously, policies could support (elements of) alternative food systems such as community-supported agriculture and different forms of farmers markets (Hinrichs & Lyson, 2007). Altering current dietary trajectories should not compromise the needs of low-income populations and of IPLCs and will face significant cultural and psychological barriers (Kuhnlein *et al.,* 2006; Whitley *et al.,* 2018).

Reducing food waste

Food waste currently runs at ~30-40% of all food production in developing and developed countries alike (Gustavsson *et al.,* 2011; Bond *et al.,* 2013; FAO, 2015, 2017; Bellemare *et al.,* 2017). Causes and hence possible solutions differ geographically, and they include more effective pest control (Oerke, 2006; Oliveira *et al.,* 2014), improved food distribution and better food storage in developing regions (Sheahan & Barrett, 2017), and consumer education (Kallbekken & Saelen, 2013; Aschemann-Witzel *et al.,* 2017; Young *et al.,* 2017) and less wasteful marketing practices in developed countries (Garrone *et al.,* 2014; Halloran *et al.,* 2014; Rezaei & Liu, 2017). Some countries, such as Japan, South Korea, Taiwan and Thailand have established operating systems that safely recycle more than one-third of their food waste as animal feed (Menikpura *et al.,* 2013; zu Ermgassen *et al.,* 2016; Salemdeeb *et al.,* 2017). However, several studies suggest an upper bound to feasible reduction in food waste of around 50% (Parfitt *et al.,* 2010; Bajzelj *et al.,* 2014; Odegard & van der Voet, 2014). Cutting food waste will thus require substantial changes in food supply chains and business models (Parfitt *et al.,* 2010; Papagyropoulou *et al.,* 2014; Aschemann-Witzel *et al.,* 2015; Roodhuyzen *et al.,* 2017).

Improving food distribution and localizing food systems

Localization of food systems is advocated by research (Hines, 2000) and by social movements, and has entered policy making at various levels (see e.g., the EU Regulation 1305/2013 on support for rural development or city-level food policies such as in Toronto or Manchester) emphasizing territoriality and sovereignty in food production and consumption. The major arguments supporting short food supply chains (SFSCs), beyond their socio-economic impacts such as revitalization of rural areas and local cultures (Brunori *et al.,* 2016; Schmitt *et al.,* 2017) are their potential to enhance food security and decrease food miles, the latter one addressing land-use change (less physical infrastructure for transportation), climate change (lower CO_2 emissions due to less transportation) and energy use (Mundler & Rumpus, 2012). However, the shortcomings of the local scale are also mentioned in literature, acknowledging that local is not necessarily better in terms of ecological sustainability, health, social justice etc. (Born & Purcell, 2006; Brunori *et al.,* 2016; Recanati *et al.,* 2016; Schmitt *et al.,* 2017). Evidence shows that the ecological impacts of SFSCs can be diverse, depending on the product type, the farming system (Rothwell *et al.,* 2016), the manner of transportation/logistics (Mundler & Rumpus, 2012; Nemecek *et al.,* 2016), the natural resources available locally and the actual social (Recanati *et al.,* 2016), economic and policy context (Leventon & Laudan, 2017).

Positive environmental impacts of SFSCs can be improved if the localization of agricultural production is coupled with: i) closing the loops between production, consumption and waste management (Benis & Ferrão, 2017; Sala *et al.,* 2017) (see also the section on circular economy in

6.4), ii) urban planning (integrating agriculture into the management of urban systems) (Barthel & Isendahl, 2013) through novel technological solutions that enable sustainable but more intensive food production (e.g., vertical gardens) (see also 6.3.5), iii) alternative food distribution options (e.g. social supermarkets or food banks) (Michelini *et al.,* 2018), iv) dietary changes as discussed below (Benis & Ferrão, 2017), and v) novel governance solutions across the food chain that enable more direct engagement of local communities in food production (Sonnino, 2017) and the (re)connection of various types of producers and consumers (Mount, 2012).

Expanding food market transparency and price stability

Food price increases during the 2007-08 world financial crisis resulted in severe impacts on the quality of life in many countries (Ivanic & Martin, 2008; Bellemare, 2015), leading many to assert that policies to increase food market transparency might lead to less volatility (Clapp, 2009; Minot, 2014). Policy responses to price increases have included reductions on food taxes and import tariffs, and increasing subsidies and food-based safety nets, although there is mixed evidence on which policies have been most effective in supporting poor populations (Wooden & Zama, 2010), indicating that social targeting is needed in combination with food support programs.

Public food procurement policies can also play a role in stabilizing price support for farmers. In Brazil, where government expenditures represent 20% of the GDP, two initiatives of public procurement of around US$300 million in expenditures are innovating to merge social and environmental targets. The Food Acquisition Program (created in 2003) and the National Program of School Feeding (created in 2009) have the purpose of: (i) providing healthy and balanced food respecting the culture, values and eating habits, especially for populations in socioeconomic vulnerability, and (ii) supporting the sustainable development of smallholding agriculture by incentives for producing local and seasonal food (Brazil, 2017). While the impact of these programs requires further evaluation, their goals to acquire locally produced food for school consumption while encouraging small-scale agricultural economies can be applicable in different contexts.

6.3.2.2 Sustainably managing multifunctional forests

Expanding and improving community-based forest management and co-management

Community-based forest management has emerged as a promising forest management alternative to state-controlled forest management (Charnley & Poe, 2007; Flint *et al.,* 2008; Krott *et al.,* 2014; Paudyal *et al.,* 2017). Almost one third of the forests in the Global South are now managed by IPLCs **(Figure 6.2)**, more than twice the share of protected areas (Chape *et al.,* 2005; RRI, 2014; Blackman *et al.,* 2017). Global trends towards decentralized management of forests, articulated through the active recognition of IPLCs rights to self-governance, have substantially improved the quality of life of forest-dependent communities, by providing them with greater livelihood benefits (Agrawal *et al.,* 2008; Gautam *et al.,* 2004; Larson & Soto, 2008; Phelps *et al.,* 2010; Duchelle *et al.,* 2014; RRI, 2014, 2016; Lawler & Bullock, 2017) including capital formation, governance reform, community empowerment and societal change (Pokharel *et al.,* 2007, 2015). Expanding and improving of community-based forest management have provided substantial opportunities for the conservation of forest ecosystems (Ostrom & Nagendra, 2006; Chazdon, 2008; Sandbrook *et al.,* 2010; Porter-Bolland *et al.,* 2012; Naughton-Treves & Wendland, 2014; van der Ploeg *et al.,* 2016; Asner *et al.,* 2017; Robinson *et al.,* 2017; Stickler *et al.,* 2017).

Many countries in Asia, such as the Philippines, Vietnam, Indonesia and Thailand have put forward new organizations, authorities and bottom-up approaches to promote community-based approaches to forest management (Sato, 2003; Poffenberger, 2006; Salam *et al.,* 2006; Sunderlin, 2006; Sikor & Tan, 2011), in the light of growing evidence of their effectiveness at contributing to poverty reduction (Ostrom, 1990; Brown *et al.,* 2003; Gautam *et al.,* 2004; Gilmour *et al.,* 2004; Gautam and Shivakoti, 2005; Sunderlin, 2006). These large areas managed by IPLCs do not usually attract financial and other resources akin to that provided for government-managed forest and protected areas. Moreover, there have been challenges in ensuring that communities have the right to benefit from co-management arrangements, such as from the sale of timber (Gritten *et al.,* 2015) and ensuring that IPLCs do not suffer from community forestry arrangements (such as in loss of food security or access to resources) (Sikor & Tan, 2011; Tuan *et al.,* 2017).

Forest titling programs have improved inclusion of settlers and secured alienation rights (Nelson *et al.,* 2001; Ostrom *et al.,* 2002; Pagdee *et al.,* 2006; Jacoby & Minten, 2007; Riggs *et al.,* 2016). However, forest tenure may not change management patterns without supporting the customary institutions of IPLCs that enforce exclusion rules and legitimize claims to them (Place & Otsuka, 2001; Ojha *et al.,* 2009; Kerekes & Williamson, 2010; Gabay & Alam, 2017).

Co-management of forest resources between the state and IPLCs, as well as other stakeholders, has also been promoted as an alternative to centralized governance approaches to achieve socio-economic and environmental objectives in developing countries (Carter & Gronow, 2005;

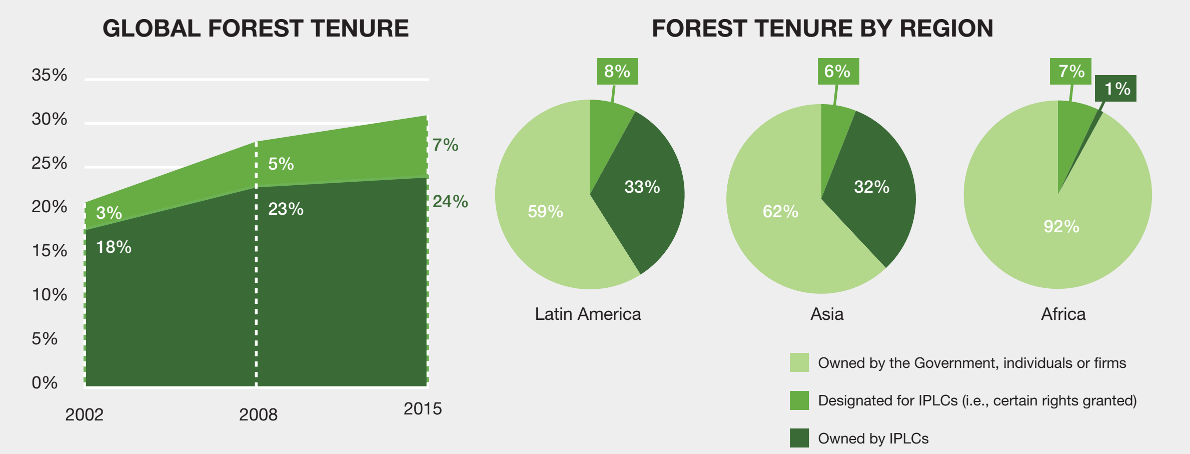

Figure 6 2 **Global patterns of forest owned by and designated for IPLCs.**

Source: RRI (2016).

Kothari *et al.,* 2013; Akamani & Hall, 2015). As forests are common-pool resources from which the exclusion of potential users is difficult, achieving sustainable forest management can be regarded a collective responsibility, especially in developing countries where the government has limited capacity to implement appropriate forest policy and needs support of diverse stakeholders (Sikor, 2006; Ostrom, 2010; Pokharel *et al.,* 2015). In the above context, collaborative governance is an appealing arrangement for sustainable forest management because of its potential to combine strengths of different management approaches and stakeholders (Carter & Gronow, 2005; Fernández-Giménez *et al.,* 2008).

Improving policies relating to PES and REDD+

There has been a rapid expansion in the number of payments for ecosystem services (PES) schemes and projects globally over the past 20 years, and many decision makers, from governments to NGOs, are considering either initial experimentation or continued expansion of PES. There is a great diversity of institutional configurations in PES arrangements, many of which involve a strong role of the state (McElwee, 2012; Shapiro-Garza, 2013). However, the effectiveness of PES approaches is currently unknown, namely because they are interpreted and implemented in many different ways (Borner *et al.,* 2017; Salzman *et al.,* 2018). Overall, the literature indicates that PES approaches are not a panacea (Muradian *et al.,* 2013), due to high preparation and transaction costs, uneven power relations, and distribution of benefits (Porras *et al.,* 2012; Salzman *et al.,* 2018; Berbés-Blásquez, 2016; Cáceres *et al.,* 2016; Van Hecken *et al.,* 2017). In other words, the performance of PES depends not just on economic incentives but also on other factors like motivations and environmental values (Hack, 2010; Hendrickson & Corbera, 2015; Grillos, 2017). Lessons learned from the literature on these economic financing instruments for conservation include the need to have in place strong regulatory frameworks; have clear metrics and indicators; have motivated buyers and sellers of services; recognize pluralistic value systems alongside financial considerations; acknowledge the importance of distributional impacts when designing economic instruments; and recognize that economic approaches are not a panacea (Ezzine-de-Blas *et al.,* 2016; Robalino & Pfaff, 2013; Pascual *et al.,* 2017; Hack, 2010; Hendrickson & Corbera, 2015; Grillos, 2017; van Hecken *et al.,* 2017; Salzman *et al.,* 2018; see also section 6.3.4.5 on watershed PES)

One important PES-like initiative is REDD+ (Reducing Emissions from Deforestation and forest Degradation), part of the negotiations under the UNFCCC since 2005 as a climate mitigation strategy to compensate developing countries for reducing GHG emissions from deforestation and forest degradation. REDD+ also aims to contribute to poverty alleviation of smallholders (through sale of carbon credits or direct forest products) and biodiversity conservation. Carbon forestry projects have expanded particularly rapidly in Latin America (Osborne, 2011; Corbera & Brown, 2010; Rival, 2013) and Africa (Namirembe *et al.,* 2014). However, the literature is currently mixed on the success rates of forest carbon projects in general and REDD+ has faced a number of challenges. These include a lack of a strong financial mechanism to ensure sufficient funding and demand for credits (Turnhout *et al.,* 2017), the high costs involved in setting up REDD+ projects (Luttrell *et al.,* 2016; Bottazzi *et al.,* 2013; Visseren-Hamakers *et al.,* 2012a), meeting the technical requirements of REDD+ (Turnhout *et al.,* 2017; Cerbu *et al.,* 2013) and REDD+'s ability to deliver non-carbon benefits such as biodiversity conservation (Hall *et al.,* 2012; Venter *et al.,* 2013; Duque *et al.,* 2014; Murray *et al.,* 2015) and social livelihoods (Atela *et al.,* 2015; Boyd *et al.,* 2007; Reynolds, 2012; Caplow *et al.,* 2011; Lawlor *et al.,* 2013). REDD+ has also been observed to contribute to a recentralization of forest governance by bringing forests under renewed forms of government control, with potentially negative consequences for nature, NCP and GQL (Ribot *et al.,* 2006; Phelps *et al.,* 2010; Sunderlin *et al.,* 2014; Duchelle *et al.,* 2014; Vijge & Gupta, 2014; Abidin 2015).

The future of REDD+ depends on its ability to safeguard against negative side effects of REDD+ and ensure that forests continue to deliver noncarbon benefits (Chhatre *et al.,* 2012; Visseren-Hamakers *et al.,* 2012b; Tacconi *et al.,* 2013; Luttrell *et al.,* 2013, Ojea *et al.,* 2015). As part of this, REDD+ will need to be inclusive of multiple values and perspectives, including historical, cultural and spiritual values (Gupta *et al.,* 2012; Brugnach *et al.,* 2014). This will require adequate formal arrangements for the participation of IPLCs. This involvement is crucial, since IPLCs control substantial areas of tropical forests (Anon, 2009; Bluffstone *et al.,* 2013). However, arrangements for participation by IPLCs in REDD+ policies are not clear in most country readiness plans for REDD+, despite safeguard guidance from UNFCCC (Ehara *et al.,* 2014), and participation has generally been weak in pilot activities, with many communities only consulted, rather than being involved in a systematic manner in all aspects of REDD+ planning (Hall, 2012; Brown, 2013). There is evidence that projects where IPLCs have been included from the beginning are stronger (Chernela, 2014). There is also potential for inclusion of IPLCs in community-based carbon monitoring, which has proven accurate and low cost (Danielsen *et al.,* 2013; Pratihast *et al.,* 2013; Brofeldt *et al.,* 2014; McCall *et al.,* 2016). See Supplementary Materials 6.2.3 for a detailed discussion on PES and REDD+.

Supporting Reduced Impact Logging (RIL)

More responsible logging practices, such as Reduced Impact Logging (RIL), are options to avoid deforestation and forest degradation. RIL, which involves close planning and control of harvesting operations, has increased in importance in the past decades. Such logging practices lower the ecological impacts of logging, especially on biodiversity (Bicknell *et al.,* 2017; Chaudhary *et al.,* 2016; Martin *et al.,* 2015). For example, in a study in East Kalimantan in Indonesia, application of RIL techniques have been found resulting in nearly half (36 vs 60 trees per ha) of collateral damage of trees as compared to the conventional harvesting methods (Sist, 2000). RIL techniques along with postharvest silvicultural treatments have also been found effective in enhancing canopy tree growth and regeneration and controlling invasion by alien and undesirable species (Campanello *et al.,* 2009). Moreover, improved logging practices in tropical forests can substantially reduce forest carbon loss and enhance retention (Putz *et al.,* 2008).

Promoting and improving forest certification

Forest certification, an economic instrument introduced in the early 1990s to improve forest management, can help address the concerns of deforestation and forest degradation and promote conservation of biological diversity especially in the tropics by promoting sustainable forest management and establishing deforestation-free supply chains (Rametsteiner & Simula, 2003; Auld & Gulbrandsen, 2008; Damette & Delacote, 2011). For instance, certification has been found to have positive impacts in terms of ecological outcomes (forest structure, regeneration, and lower fire incidences) (Kalonga *et al.,* 2015; Pena-Claros *et al.,* 2009) and biodiversity conservation in some places (Van Kuijk *et al.,* 2009; Kalonga *et al.,* 2016). Positive social impacts, such as better working and living conditions, active local institutions for discussions among the forestry company and local communities, and benefit sharing have also been documented (Cubbage *et al.,* 2010; Cerutti *et al.,* 2014; Burivalova *et al.,* 2016). There has also been criticism of different certification schemes, and forest certification more generally, among others on the fact that most certified forests are in the global North, instead of the South (Rametsteiner & Simula, 2003), in part due to the technical and financial demands for becoming certified can represent a hurdle for small and medium-sized enterprises in the South. For instance, current certification schemes tend to favor large forestry operations and do not directly translate to smaller operations. While there is still limited evidence of the impacts of different forest certification schemes (Visseren-Hamakers & Pattberg, 2013), improved assessment practices are suggesting ways forward (van de Ven and Cashore, 2018).

Controlling illegal logging

Illegal logging, which can be viewed as a symptom of failure of governance and law enforcement, is a major problem in achieving sustainable forest management in many countries, particularly forest-rich developing countries (Brack & Buckrell, 2011). Forest dependent poor people are the most harmed by illegal logging while powerful economic groups benefit the most from it (ODI, 2004). International trade in illegally logged timber is an important factor associated with this problem (Brack & Buckrell, 2011). In recent years, however, consumer countries have been paying increasing attention to trade in illegal timber and have taken different measures to exclude illegally produced timber from the market. The European Union's Action Plan for Forest Law Enforcement, Governance and Trade (FLEGT), published in 2003, is an example of such measures. The FLEGT regulations and approaches have often been combined with improved management of concessions in countries participating in FLEGT through Voluntary Partnership Agreements with the EU (Tegegne *et al.*, 2014). Apart from the European Union's Timber Regulation 995/2010, some other countries, including Australia, Indonesia, Japan and USA, have their own law to control illegal logging (Hoare, 2015).

Monitoring and regulating forest use

The development and availability of transparent forest monitoring data is a major step to establish and improve the forest sector (Fuller, 2006). By identifying the extent of deforestation on a regular basis, decision makers have the option to coordinate actions, prioritize areas and develop policies to reduce forest losses. In the Brazilian Amazon, where the deforestation was substantially reduced from 2004 to 2017 (INPE, 2017), the understanding of forest change patterns was essential to allocate public resources and to provide the first reaction to the illegal processes that were leading to deforestation in that region. The monitoring systems have been improved to the point of offering daily real-time data, constituting one of the most important tools for the fight against deforestation in Brazil (Nepstad *et al.,* 2014; Assunção *et al.,* 2015). Also, global initiatives like the Global Forest Watch are supporting national and sub-national governments to implement national law (as in the case of the law Nr 26331on "Minimum Standards of Environmental Protection of Native Forests" in Argentina), as well as civil society and private sector engagement in forest monitoring and conservation (FAO, 2015; GFW, 2017). Reforestation projects have contributed to reversing the deforestation trend and increasing forest cover in some countries (Supplementary Materials 6.2.3). Especially REDD+ and PES schemes have contributed to expand reforestation and afforestation projects in recent years (Carnus *et al.,* 2006; Madsen *et al.,* 2010). REDD+ projects have expanded particularly rapidly in Latin America (Osborne, 2011; Corbera & Brown, 2010; Corbera & Brown, 2008) and Africa (Jindal *et al.,* 2012; Namirembe *et al.,* 2014).

Land tenure recognition and cadastral registers are tools that contribute to the implementation of regulations aimed to protect forest and support reforestation actions. For instance, the Rural Environmental Registry (CAR) in Brazil records and analyses information about land use and environmental compliance in all private properties. CAR registration is mandatory and linked to official credit support, environmental licensing and regularization. It is also used in voluntary agreements for trading agricultural products and facilitating the process of forest restoration to reach legal compliance (Soares-Filho *et al.,* 2014; Servicio Florestal Brasileiro, 2016). The implementation of the CAR system in Brazil is an example of confronting the simultaneous challenges of monitoring, enforcement and compliance, and reconciling forest and water conservation and other production sectors, particularly agriculture.

Forest concessions can also be an option to protect forest cover and regulate use, reducing the pressure to replace the natural vegetation with other land uses. Concessions give the holder rights, including harvesting timber (or other forest products) and use of forest services (e.g. tourism, watershed protection) (Gray, 2002). Concessions, if properly governed, can be an important instrument to provide economic value to forests and reduce the pressure to replace the natural vegetation with other land uses around the world. Besides employment and revenue creation, forest concessions may reinforce the presence of the state and improve the rights over land tenure (FAO, 2015). Concessions are also a good governance tool for the state, considering the establishment of conditions and compensation, such as the development of local services (schools, medical assistance, security) and infrastructure (water supply, transport, roads, bridges). This instrument can be applied not only by entrepreneurs and companies, but also by IPLCs with different land tenure regimes (van Hensbergen, 2016). Poorly governed concession schemes, however, can drive deforestation and marginalize local communities. Governments can enhance the contributions of forest concessions by requiring participatory planning, long-term sustainable forest management, and control of illegal logging.

Problems of forest concessions in tropical countries are related to weak local governance, poor level of compliance, difficulties with monitoring and traceability systems, low technical capacity of managing the forest, and insufficient rewards for sustainable forest management in the global timber market (Azevedo-Ramos *et al.,* 2015; van Hensbergen, 2016; Segura-Warnholtz, 2017). Therefore, forest concessions are often regarded drivers of forest degradation (PROFOR, 2017). Corruption in attaining timber concessions is another problem associated with this instrument, especially in developing countries. There are initiatives of implementing monitoring and traceability systems, but it is important to manage the bureaucracy and additional transaction costs that may deter potential investors (Azevedo-Ramos *et al.,* 2015).

6.3.2.3 Protecting nature within and outside of protected areas

Improving management of protected areas

There is a large literature that has evaluated the performance of protected areas (PAs) in halting biodiversity loss and securing ecosystem services into the future, showing mostly positive (albeit moderate) conservation outcomes (Carranza *et al.,* 2014; Barnes *et al.,* 2016; Eklund *et al.,* 2016; Gray *et al.,* 2016). However, research also points to substantial shortfalls in PA effectiveness around the world (Laurance *et al.,* 2012; Guidetti *et al.,* 2014; Watson *et al.,* 2014; Geldmann *et al.,* 2015, 2018; Schulze *et al.,* 2018). Poor PA performance is attributed to management deficiencies related to inadequate resources and weak governance. It also includes low compliance due to inhibited local access to important resources (Stoll-Kleemann, 2010; Bennett & Dearden, 2014; Bruner *et al.,* 2001; Eklund & Cabeza, 2016; Leverington *et al.,* 2010; Watson *et al.,* & Hockings, 2014). Evidence shows that improving PA effectiveness depends on enforcing sound management (Juffe-Bignoli *et al.,* 2014), monitoring (Schulze *et al.,* 2018) and adequate resourcing (McCarthy *et al.,* 2012). Using robust methods, such as those available via the global Protected Areas Management Effectiveness (PAME) initiative, controlling potential bias, and integrating data on ecological outcomes (e.g. temporal and spatial counterfactual analysis) and social indicators could make the assessment of PA effectiveness more systematic and comparable across spatial and temporal scales, addressing the needs of different decision makers more effectively (Coad *et al.,* 2015; Eklund *et al.,* 2016; Stoll-Kleemann, 2010; Watson *et al.,* 2016) for all decision makers.

PAs generate multiple benefits to both local and distant populations (Chan *et al.,* 2006; Ceausu *et al.,* 2015; Egoh *et al.,* 2011; Larsen *et al.,* 2012; Schröter *et al.,* 2014a), and provide fundamental contributions such as protecting watersheds, buffering extreme events, regulating local climate, harboring biodiversity, and providing spaces of emotional, social and spiritual fulfilment. Protected areas and these multiple contributions also have associated costs in limiting and regulating land uses and forms of access to resources (Birner & Wittmer, 2004; Holzkamper & Seppelt, 2007; Wätzold *et al.,* 2010; Wätzold & Schwerdtner, 2004; Nalle *et al.,* 2004). Balancing the benefits and costs of PAs across different stakeholders can increase the management effectiveness of PAs (see also Supplementary Materials 6.2.4). Options include co-management governance regimes (i.e. sustainable-use PAs), which engage communities in maintaining cultural and livelihood benefits (Oldekop *et al.,* 2016), and jointly consider approaches to mitigating conflicts and managing trade-offs. PA effectiveness can also be enhanced by supporting local households to establish or find alternative livelihood and income options (i.e., improving options and capabilities; Neudert *et al.,* 2017), supporting benefit-sharing mechanisms that eliminate inequalities (Swemmer *et al.,* 2017) and securing the availability of financial resources to support these measures for a sufficiently long period to ensure sustainability (Wätzold *et al.,* 2010).

Improving spatial and functional connectivity of PAs

The functionality of PA networks cannot be maintained when the habitat area is too small and fragmented, and when the landscape beyond PA boundaries is inhospitable (Bengtsson *et al.,* 2003). PAs then become islands of biological conservation (Bauer & Van Der Merwe, 2004; Crooks *et al.,* 2011; Seiferling *et al.,* 2012; Barber *et al.,* 2014; Wegmann *et al.,* 2014) threatening the long-term viability of their biodiversity, especially many wildlife populations (DeFries *et al.,* 2005; Newmark, 2008; Riordan *et al.,* 2015). There are also significant geographic and ecological biases in the representation of habitats and ecosystems in PAs (e.g., Pressey *et al.,* 2003; Joppa & Pfaff, 2009, Butchart *et al.,* 2012, 2015), which result in unplanned assemblages of PAs confined to economically unproductive areas (Scott *et al.,* 2001; Evans, 2012), with little ecological relevance (Opermanis *et al.,* 2012), which ultimately compromise their overall conservation potential (Watson *et al.,* 2014).

Options to address these challenges include several policy support tools for (spatial) conservation prioritization to inform where to establish new PAs so that more biodiversity is conserved in a cost-effective way, accounting for multiple competing sea- or land uses and socioeconomic factors (e.g., Dobrovolski *et al.,* 2014; Forest *et al.,* 2007; Isaac *et al.,* 2007; Montesino Pouzols *et al.,* 2014; Nin *et al.,* 2016; Di Minin *et al.,* 2017). Spatial conservation planning can be a useful tool for enhancing landscape connectivity, maximizing the ecological representation of PA networks and safeguarding Key Biodiversity Areas (Edgar *et al.,* 2008; Krosby *et al.,* 2010, 2015; Dawson *et al.,* 2011; Cabeza, 2013; Dickson *et al.,* 2014, 2017; Kukkala *et al.,* 2016; Watson *et al.,* 2016; Saura *et al.,* 2018). Research has estimated that only 19.2% of the ~15,000 Key Biodiversity Areas identified around the world are fully protected, and that the proportion of the PAs comprising these areas is decreasing over time (Butchart *et al.,* 2012; UNEP-WCMC & IUCN, 2016). Therefore, protected areas are being disproportionately established in areas that are suboptimal from a biodiversity conservation point of view (Butchart *et al.,* 2012, 2015). Shifting PA establishment to focus on Key Biodiversity Areas is thus an important policy priority to reverse extinction risk trends.

Building on the expansion of PAs under Aichi Biodiversity Target 11, the next phase of global biodiversity targets offers an excellent opportunity to correct some of the geographic biases of establishing PAs in recent decades, often based on local and opportunistic criteria (Pressey *et al.,* 2003; Joppa & Pfaff, 2009; Lewis *et al.,* 2017). Especially the conservation of world's old-growth forests can be addressed in Multilateral Environmental Agreements, as targets for PA expansion (e.g., Watson *et al.,* 2018). Expanding PAs requires managing trade-offs among societal objectives, and improvement can be achieved with global coordination (DeFries *et al.,* 2007; Polasky *et al.,* 2008; Faith, 2011; Venter *et al.,* 2014) and consultation of different stakeholders.

Improving transboundary PA and landscape governance

Options to enhance PA effectiveness also need to address conservation planning and management at broader geographic scales (van Teeffelen *et al.,* 2006; Le Saout *et al.,* 2013; Kukkala *et al.,* 2016). Transboundary conservation planning is essential to improve the global status of biodiversity (Erg *et al.,* 2012; Pendoley *et al.,* 2014; Dallimer & Strange, 2014; Lambertucci *et al.,* 2014), particularly for wide-ranging species that cannot be conserved within political boundaries, such as large carnivores (Wikramanayake *et al.,* 2011; Wegmann *et al.,* 2014; Santini *et al.,* 2016; Di Minin *et al.,* 2017), species that migrate (Flesch *et al.,* 2010; Runge *et al.,* 2015; Owens, 2016) and species that might shift their range in response to climate change (Wiens *et al.,* 2011; Zimbres *et al.,* 2012; Johnston *et al.,* 2013; Pavón-Jordán *et al.,* 2015).

Research shows that setting conservation targets in a spatially coherent manner beyond national borders is vital for improving the effectiveness of PA networks (van Teeffelen *et al.,* 2015; Wegmann *et al.,* 2014). Different works have demonstrated a major efficiency gap between national and global conservation priorities, finding that if each country sets its own conservation priorities without international coordination, more biodiversity is lost than if conservation decision-making is done through international partnerships and globally coordinated efforts (Montesino-Pouzols *et al.,* 2014; Santini *et al.,* 2016). The European Union's Natura 2000 network of PAs provides an illustrative example of joint initiatives crossing political and national boundaries. With more than 27,000 sites across all EU countries, covering over 18% of the EU's land area and almost 6% of its marine environments, Natura 2000 is the most expansive coordinated network of PAs in the world (Milieu *et al.,* 2016). It is the cornerstone of the EU's Biodiversity Strategy to 2020, and one of the largest policy efforts in conserving biodiversity irrespective of national and political boundaries. A plethora of research studies has evidenced the overall ecological effectiveness of Natura 2000, with a special emphasis on terrestrial vertebrates and threatened habitats (Gruber *et al.,* 2012; Pellissier *et al.,* 2013; Kolecek *et al.,* 2014; Sanderson *et al.,* 2016; Beresford *et al.,* 2016; Milieu *et al.,* 2016). The Greater Mekong Subregion Biodiversity Conservation Corridors Project or the Mesoamerican Biological Corridor are also key initiatives illustrating the importance of transboundary conservation planning at the landscape level (ADB, 2011; Mendoza *et al.,* 2013; Crespin & García-Villalta, 2014). Policy options to promote transformative change towards sustainability in the Arctic include the application of new, multi-sector frameworks for integrated ecosystem management (Pinsky *et al.,* 2018), the establishment of a circumpolar network of Protected Areas (Fredrikson, 2015) and the proposal for the creation of a global Arctic sanctuary in the high seas (European Parliament, 2014; Greenpeace, 2014).

Recognizing management by IPLCs and OECMs

The conservation of a substantial proportion of the world's biodiversity and NCP largely depends on the customary institutions and management systems of IPLCs (Maffi, 2005; Gorenflo *et al.,* 2012; Gavin *et al.,* 2015; Renwick *et al.,* 2017; Garnett *et al.,* 2018). Evidence suggests that IPLCs are able to develop robust institutions to govern their land- and seascapes in ways that align with biodiversity conservation (ICC, 2008, 2010; Stevens *et al.,* 2014; Ens *et al.,* 2015, 2016; Trauernicht *et al.,* 2015; Blackman *et al.,* 2017; Schleicher *et al.,* 2017). These customary institutions and management systems are based on locally-grounded knowledge and encoded in complex cultural practices, relational values, usufruct systems, spiritual beliefs, kinship-oriented philosophies, and principles of stewardship ethics (Berkes *et al.,* 2000; Bird, 2011; Gammage, 2011; Kohn, 2013; Walsh *et al.,* 2013; Trauernicht *et al.,* 2015; Gaudamus & Raymond-Yakoubian, 2015; Fernández-Llamazares *et al.,* 2016; Renwick *et al.,* 2017).

Formal recognition of IPLC rights over their territories can be an effective means to significantly slow habitat loss (Nepstad *et al.,* 2006; Soares-Filho *et al.,* 2010; Ricketts *et al.,* 2010; Porter-Bolland *et al.,* 2012; Nolte *et al.,* 2013; Paneque-Gálvez *et al.,* 2013; Ceddia *et al.,* 2015; Blackman *et al.,* 2017). The growing recognition of governance diversity in global environmental policy offers numerous opportunities for sound management of nature and its contributions to the larger society (Berkes, 2009; Kothari *et al.,* 2012; Ruiz-Mallén & Corbera, 2013; Nilsson *et al.,* 2016), while improving the quality of life of IPLCs, including addressing some of the human rights violations associated with the establishment and governance of some PAs (e.g., Brockington & Igoe, 2006; Goldman, 2011; Kohler & Brondizio, 2016). Certain strict PAs have induced displacements and exclusion of IPLCs (West *et al.,* 2006; Mascia & Claus, 2008; Curran *et al.,* 2009; Agrawal & Redford, 2009; Brockington & Wilkie, 2015), undermining food sovereignty (Golden *et al.,* 2011; Foale *et al.,* 2013; Nakamura & Hanazaki, 2016; Sylvester *et al.,* 2016) and contributing to psychological distress and trauma (Dowie, 2009; Zahran *et al.,* 2015; Snodgrass *et al.,* 2016).

A crucial breakthrough in conservation paradigms over the last decades has been the emergence and growing awareness of a number of IPLC-centred designations to conservation, including co-management regimes, community-based conservation areas, integrated conservation and development projects, sacred natural sites, Indigenous Community Conserved Areas (ICCAs), and biocultural approaches to conservation (e.g., Berkes, 2004, 2007, 2009; Folke *et al.,* 2005; Armitage *et al.,* 2007;

Kothari *et al.,* 2013; Brooks *et al.,* 2013; Gavin *et al.,* 2015; Alexander *et al.,* 2016; Berdej & Armitage, 2016; Sterling *et al.,* 2017). Many of these approaches will contribute a substantial share of the world's "Other Effective Area-Based Conservation Measures" (OECMs) such as proposed under Aichi Target 11 (Jonas *et al.,* 2014, 2017; Laffoley *et al.,* 2017; Garnett *et al.,* 2018).

Sacred natural sites, as a specific example of OECMs, are areas of land or water that have spiritual values to certain IPLCs (Thorley & Gunn, 2007; Ormsby, 2011). They contribute to the conservation of diverse habitats and species as well as traditional land use practices (Salick *et al.,* 2007; Metcalfe *et al.,* 2009; Gavin *et al.,* 2015; Samakov & Berkes, 2017). Their governing institutions are diverse, including informal norms, rules and taboos passed on by generations (Anthwal *et al.,* 2010; Bhagwat & Rutte, 2006b; Bobo *et al.,* 2015; Ya *et al.,* 2014), and are under increasing pressure from globalization (Bhagwat & Rutte, 2006; Virtanen, 2002; Domínguez & Benessaiah, 2015; Fernández-Llamazares *et al.,* 2018). Sacred natural sites have been combined with legal and economic instruments, often with controversial results (Bhagwat & Rutte, 2006b; Brandt *et al.,* 2015). Appropriate legal recognition of sacred natural sites has been deemed as a critical factor to ensure their effectiveness in conserving nature and NCP (Davies *et al.,* 2013; Smyth, 2015; Mwamidi *et al.,* 2018). Specific legal recognition of sacred natural sites builds on prior broader recognition of collective IPLC tenure rights and self-determination (Kothari, 2006; Berkes, 2009; Almeida, 2015; Borrini-Feyerabend & Hill, 2015). However, there is evidence that top-down forms of recognition, without consultation often undermine local initiative and grassroots action (Borrini-Feyerabend *et al.,* 2010; Kothari *et al.,* 2013). Best practice cases indicated that knowledge-sharing and mutual learning are key success factors when sacred sites are recognized as OECMs (Aerts *et al.,* 2016b; Irakiza *et al.,* 2016; Jonas *et al.,* 2018).

Addressing the Illegal Wildlife Trade (IWT)

Despite intense worldwide efforts, the Illegal Wildlife Trade (IWT) still represents a major threat to endangered species. Research shows the major strengths and weaknesses of efforts to address the IWT. CITES currently lacks a global enforcement agency to oversee compliance, which has been argued to compromise its overall effectiveness (Phelps *et al.,* 2010; Heinen & Chapagain, 2002; Oldfield, 2003; Zimmerman, 2003; Reeve, 2006; Toledo *et al.,* 2012; Challender *et al.,* 2015). Further, CITES enforcement within countries is often sporadic at best, with many developing countries lacking the knowledge and identification facilities to help control and report illegal trade (Zhang *et al.,* 2008; Shanee, 2012). The International Consortium on Combating Wildlife Crime (ICCWC) has helped in providing support to countries in the fields of policing, customs, prosecutions and the judiciary, (e.g., through the creation of the ICCWC Wildlife and Forest Crime Analytical Toolkit; UNODC, 2012) and informing IWT decision-making (Nellemann *et al.,* 2014; Sollund & Maher, 2015). In the meantime, research shows that intergovernmental initiatives at the regional level, such as the ASEAN Wildlife Enforcement Network, including 10 Southeast Asian countries, and EU-TWIX, an online forum and database on IWT patterns within the European Union, are also essential for assisting national law enforcement agencies in detecting and monitoring IWT across national borders (Rosen & Smith, 2010; Sollund & Maher, 2015). Civil society and NGO support, such as through TRAFFIC, has been essential for many countries to keep their mandatory reporting requirements for CITES up to date (Reeve, 2006).

Some studies are examining where resources could best be prioritized for improved protected area management and law enforcement, as well as to disrupt shipping routes of IWT (Kiringe *et al.,* 2007; Plumptre *et al.,* 2014; Ihwagi *et al.,* 2015; Patel *et al.,* 2015; Tulloch *et al.,* 2015; Lindsey *et al.,* 2017). Improving detection capacity for "invisible" wildlife trades, through improved data, capacity-building and implementation of innovative technologies such as DNA barcoding and stable isotope analysis, is often cited as a global priority for IWT control (Phelps *et al.,* 2010; Nijman & Nekaris, 2012; Phelps & Webb, 2015; Symes, 2017).

Prioritization of IWT in criminal justice systems has generally led to more effective law enforcement responses (Lowther *et al.,* 2002; Sollund & Maher, 2015; EIA, 2016; Jayanathan, 2016). Similarly, increases in anti-poaching patrols in protected areas generally leads to significant declines in levels of poaching (Dobson & Lynes, 2008; Jachmann, 2008; Fischer *et al.,* 2014; Critchlow *et al.,* 2016; Henson *et al.,* 2016; Moore *et al.,* 2017). Implementing measures to combat corruption among rangers, crime investigators and other relevant officials and civil servants, is also deemed critical to halt IWT (Smith & Walpole, 2005; Bennett, 2015; UNODC, 2016). Also, IPLCs are important allies in global efforts to combat IWT on the ground (Roe, 2011; MacMillan & Nguyen, 2013; Ihwagi *et al.,* 2015; Cooney *et al.,* 2016; Humber *et al.,* 2016; Benyei *et al.,* 2017; Biggs *et al.,* 2017; Massé *et al.,* 2017; Roe *et al.,* 2017), although they often suffer from blanket hunting bans established at local levels that do not discriminate between endangered and common animals (McElwee, 2012) as well as use of trade bans to address other threats such as climate change (Weber *et al.,* 2015). Similarly, both NGO and research presence have been shown to deter wildlife poaching, particularly in areas with minimal governmental surveillance (Hohman, 2007; Pusey *et al.,* 2007; Campbell *et al.,* 2011; N'Goran *et al.,* 2012; Laurance, 2013; Mohd-Azlan & Engkamat, 2013; Daut *et al.,* 2015; Piel *et al.,* 2015; Sollund & Maher, 2015; Tagg *et al.,* 2015).

Finally, well-targeted, species-specific and evidence-based demand reduction policy interventions for illegally-sourced wildlife and its products are also growing in scope and extent, on the understanding that legally-sourced products are managed sustainably based on CITES non-detriment findings, and harvested and traded in accordance with national and international laws (CITES, 2017; Moorhouse *et al.,* 2017). Social marketing strategies (e.g. discouraging rhino horn consumption in Vietnam through TV ads with celebrities) coupled with broad outreach and educational campaigns, are a common strategy to change consumer behaviour (Drury, 2009, 2011; Dutton *et al.,* 2011; Gratwicke *et al.,* 2008a; Veríssimo *et al.,* 2012; Challender & MacMillan, 2014; TRAFFIC, 2016; Truong *et al.,* 2016), although evidence on the effectiveness of such policies is still virtually lacking (MacMillan & Challender, 2014; Challender *et al.,* 2015). Regular online monitoring of e-commerce platforms, websites and social media offers substantial opportunities for the enforcement of IWT regulations (Izzo, 2010; Hansen *et al.,* 2012; Lavorgna, 2015; TRAFFIC, 2015).

Improving Sustainable Wildlife Management (SWM)

Sustainable Wildlife Management (SWM) is an essential tool to conserve wildlife while considering the socioeconomic needs of human populations, including IPLCs (Gillingham & Lee, 1999; Spiteri & Nepal, 2006; Pailler *et al.,* 2015; Riehl *et al.,* 2015; Campos-Silva & Peres, 2016) and the generation of multiple contributions to people (Holmlund & Hammer, 1999; Díaz *et al.,* 2005; Kremen *et al.,* 2007; Whelan *et al.,* 2008, 2015; Kunz *et al.,* 2011; Moleón *et al.,* 2014; Ripple *et al.,* 2014; Poufoun *et al.,* 2016). Several best practices in fostering SWM (e.g., mitigating human-wildlife conflicts) have emerged over the last decades (Brooks *et al.,* 2013; FAO, 2016; Nyhus, 2016), and the debate increasingly includes animal welfare aspects, among others under the heading of "compassionate conservation" (Bekoff, 2013).

Both *incentive-driven* and *financial compensation* schemes can contribute widely to nature conservation and benefit sharing with IPLCs and provide economic compensation for those bearing most of the costs of maintaining public benefits associated with biodiversity conservation (Naughton-Treves *et al.,* 2003; Maclennan *et al.,* 2009; Persson *et al.,* 2015; Dhungana *et al.,* 2016, Supplementary Materials 6.2.4). However, the effectiveness of wildlife compensation schemes in conserving nature and contributing to local quality of life varies (Boitani *et al.,* 2010; Ravenelle & Nyhus, 2017). Some works show that wildlife compensation schemes can reduce conflict (Zabel & Hom-Müller, 2008), reduce wildlife killings (Okello *et al.,* 2014) and recover wildlife populations (Persson *et al.,* 2015), particularly in contexts where IPLCs are facing acute subsistence needs or with wildlife that imposes disproportionate costs. However, several pitfalls and operational issues undermine the effectiveness of wildlife compensation payments mostly related to their administration, including crowding-out effects, unequal distribution of benefits, elite capture, corruption or leakage (e.g., Bulte & Rondeau, 2005; Ogra & Badola, 2008; Spiteri *et al.,* 2008; Agarwala *et al.,* 2010; Uphadyay, 2013; Anyango-Van Zwieten, *et al.*, 2015). Also, some authors have questioned their financial sustainability in the long-term (Nyhus *et al.,* 2003; Bulte & Rondeau, 2005; Swenson & Andrén, 2005; Bauer *et al.,* 2015). In general, research highlights that wildlife compensation schemes are not a silver-bullet solution, although they might be indeed valuable in certain contexts and under certain conditions (Haney, 2007; Dickmann *et al.,* 2011; Ravenelle & Nyhus, 2017). *Conservation performance payments*, conditional on specific conservation outcomes (e.g., bird breeding success), have been argued to partially address some of the operational challenges of incentives focusing on compensation for losses to predation (Zabel & Holm-Müller, 2008).

Nature-based tourism is another revenue-generating use of certain wildlife that can provide incentives for IPLCs to conserve biodiversity in appropriate contexts (Bookbinder *et al.,* 1998; Kiss, 2004; Hearne & Santos, 2005; Lindsey *et al.,* 2005; Lai & Nepal, 2006; Stronza, 2007; Osano *et al.,* 2013). IPLCs with economically viable ecotourism programs linked to wildlife are likely to steer SWM (Stem *et al.,* 2003; Krüger, 2005; Clements *et al.,* 2010; Mendoza-Ramos & Prideaux, 2017), but only when benefits are culturally-appropriate and equitably distributed (Bookbinder *et al.,* 1998; Naidoo & Adamowicz, 2005; He *et al.,* 2008), land tenure is secured (Charnley, 2005; Haller *et al.,* 2008; Bluwstein, 2017), the social and political justice aspirations of IPLCs are respected (Stronza & Gordillo, 2008; Coria & Calfucura, 2012), and the value conflicts introduced by tourism development are fully addressed (Lai & Nepal, 2006; Waylen *et al.,* 2010).

Although financial benefits to sustain SWM have often been prioritized (Tisdell, 2004; Ogra & Badola, 2008), incentives to engage IPLCs in SWM can also include education, empowerment and opportunities for capacity development (Nabane & Matzke, 1997; Brooks *et al.,* 2009), social services and infrastructure (Spiteri & Nepal, 2006), as well as devolution of IPLC rights to manage, and benefit from, wildlife conservation (Lindsey *et al.,* 2009; Western *et al.,* 2015; Nilsson *et al.,* 2016). Moreover, engaging women in SWM as direct beneficiaries and key stewards of wildlife can help bridging the agendas of gender equality and SWM, particularly within the framework of the SDG (Nabane & Matzke, 1997; Espinosa, 2010; Staples & Natcher, 2015; FAO, 2016; UNEP, 2016; Leisher *et al.,* 2016; Lelelit *et al.,* 2017). Gender mainstreaming approaches are crucial for the success of community-based SWM (Ogra, 2012; Meola, 2013; UNESCO, 2016; Davies *et al.,* 2018).

Manage invasive alien species through multiple policy instruments

There are more than 40 international legal instruments dealing with the issue of invasive alien species (IAS), including CITES and the Ramsar Convention on Wetlands, as well numerous national laws. However, there are many legal, institutional and social barriers to effective invasive species management, including information management challenges, resourcing, risk perception and lack of public support, and definitional and jurisdictional issues that can generate a lack of coherent, systemic and community-partnered approach to IAS management. This is particularly the case in urban and peri-urban areas where rapid urban growth and sprawl occurs (Martin *et al.,* 2016; Le Gal, 2017; Riley, 2012; Vane and Runhaar, 2016). Further, low economic incentives to engage private landowners can undermine the effectiveness of the frameworks for IAS management and biodiversity protection (Martin *et al.,* 2016). Developing and implementing IAS management strategies in collaboration with IPLCs has been suggested as an effective means to enhance local capacity to prevent, detect and eradicate IAS in areas inhabited or managed by IPLCs, although the evidence still lies on weak empirical footing, with only a few case-based studies available (e.g., Hall, 2009; Dobbs *et al.,* 2015). It is well established that social, political and economic values, as well as cultural worldviews have been shown to underlie the perception of IAS, as well as preferences over management options (O'Brien, 2006; Warren, 2007; Hall, 2009; Crowley *et al.,* 2017). In view of this, direct inclusion of IPLCs on deliberations over IAS management decisions can help to identify the most strategic and effective measures for IAS control, as well as to anticipate conflict and foster dialogue over different values in inclusive ways (Robinson *et al.,* 2005; Bhattacharyya *et al.,* 2014).

Potential solutions include treating IAS as a collective action problem rather than a private landowner problem (Martin *et al.,* 2016; Graham *et al.,* 2016; Graham, 2013; Howard *et al.,* 2016), implementing projects for removal of IAS through direct payments (Bax *et al.,* 2003; McAlpine at al., 2007; Rumlerova *et al.,* 2016; Brown *et al.,* 2016), through tax incentives combined with restoration work and tradeable permits (see examples in Supplementary Materials 6.2.4).

6.3.2.4 Expanding ecosystem restoration projects and policies

Ecological restoration is *the process of assisting the recovery of an ecosystem that has been degraded, damaged,* or destroyed (SER, 2004) and reforestation can have potential positive impacts to help ecosystems adjust to climate change, such as through restoring altered hydrological cycles, extending habitat for species threatened by climate change, or protecting coastal areas from storms and sea level rise (Locatelli *et al.,* 2015). For instance, the UN is committed to restoration through projects such as reforestation for carbon sequestration (e.g. REDD+) (Nellemann & Corcoran, 2010; Watson *et al.,* 2000; Munasinghe & Swart, 2005) or restoring wetlands for flood protection. There is wide agreement on the importance of expanding restoration efforts, including the CBD Aichi Target 15 that commits to restoration of at least 15% of degraded ecosystems by 2020, the European Union Biodiversity Strategy Target 2, and the Bonn Challenge to restore 150 and 350 million hectares of the world's deforested and degraded lands by 2020 and 2030, respectively. Restoration and reforestation of 12 million ha of forests by 2030 are also key elements of the implementation of the Brazilian Nationally Determined Commitments (NDC) of the Paris Agreement.

Restoration projects make use of both regulatory and market instruments in policy mixes, such as public financing, mitigation banking or offsetting, tax incentives, and performance bonds (Hallwood, 2006; Reiss *et al.,* 2009; Robertson, 2004; Ruhl *et al.,* 2009). Tax incentives for set-asides for restoration work, such as Landcare & Bushcare policies (in Australia), are farmer voluntary policies that encourage community-based strategic restoration projects (Compton and Beeton, 2012), including bush set-asides for recovery from grazing and grants to replant and fence off bushland. Farmers pay for at least half the restoration costs, which can be reclaimed through tax incentives (Abensperg-Traun *et al.,* 2004). The Working for Water Program in South Africa is an example of an approach that combines IAS removal and restoration through targeted employment and payments to poorer participants. The project has been credited with success in native vegetation species recovery (Beater *et al.,* 2008; van Wilgen & Wannenburgh, 2016) and increasing water yields (Le Maitre *et al.,* 2000, 2002; Dye & Jarmain, 2004). Lessons from the South Africa program include the need for continuous monitoring and frequent follow-up, the need to train personnel, and the need for active restoration (and replanting) of native tree species on cleared plots. Another national example of integrating restoration objectives into specific policies is that of the Rural Environmental Registry (CAR), which supports the implementation of the new Forest Law in Brazil (see section on Monitoring and regulating forest use above).

Contextual and historical legacies often shape restoration practices. Therefore, there is increasing recognition that restoration projects need to be seen as part of larger social-ecological systems (Dunham *et al.,* 2018; Zingraff-Hamed, 2017), also considering social goals in the planning, decision-making, implementation and success evaluation of such projects (Junker, 2008; Hallett *et al.,* 2013; Higgs, 2005; Burke & Mitchell, 2007; Woolsey *et al.,* 2005;

2007). It is for example increasingly recognised that it is beneficial to involve all relevant stakeholder groups to gain acceptance (Junker *et al.,* 2007) and to promote social and environmental learning (Pahl Wostl, 2006; Restore, 2013; Petts, 2006). One example is the 're-wilding' approach in the US (Swart *et al.,* 2001; Hall, 2010) to restore to pre-European settlement ecosystems, which contrasts with the cultural landscape approach in Germany (Westphal *et al.,* 2010). The importance of community culture and normative values in shaping social acceptance of restoration projects has often been neglected (Ostergren *et al.,* 2008; Waylen *et al.,* 2009), with acceptance depending on whether restoration builds upon the emotional or cultural attachments that communities have to a place or supports traditional patterns of use (Baker *et al.,* 2014; Buijs, 2009; Drenthen, 2009; Lejon, 2009; Shackelford *et al.,* 2013). Participation, such as through community reforestation, is seen to reduce the risk of conflict (Eden and Tunstall, 2006; Gobster and Barro, 2000; Higgs, 2003) and promises more equitable outcomes, such as access to ecosystem services. This opens restoration as a tool for poverty alleviation. However, there is a knowledge gap in defining measures for social-economic attributes, although this has recently received attention (Baker & Eckerberg, 2016). Overall, there is a need for more research into the realized social and economic outcomes or impacts of restoration (see Supplementary Materials 6.2.4).

Revitalizing ILK and restoring IPLC institutions

Evidence shows that indigenous and local knowledge (ILK) is rapidly changing and eroding in many parts of the world (Cox *et al.,* 2000; Brodt, 2001; Godoy *et al.,* 2005; Brosi *et al.,* 2007; Turner & Turner, 2008; Reyes-García *et al.,* 2007, 2013, 2014; Tang & Gavin, 2016; Aswani *et al.,* 2018). While ILK is inherently dynamic (Berkes, 1999; Gómez-Baggethun & Reyes-García, 2013; Reyes-García, *et al.*, 2016), it has been shown that at least some dimensions of the social-ecological memory of IPLCs are becoming substantially eroded (Ford *et al.,* 2006, 2010; Turvey *et al.,* 2010; Fernández-Llamazares *et al.,* 2015). Rapid social and cultural changes create discontinuity in the transmission of ecological knowledge (Singh *et al.,* 2010; Etiendem *et al.,* 2011; Reyes-García *et al.,* 2010, 2014; Turvey *et al.,* 2010; Shen *et al.,* 2012; Guèze *et al.,* 2015; Luz *et al.,* 2015, 2017), impact the functioning of collective institutions, many of which have supported sustainable resource management and diverse biocultural landscapes for long periods of time (Agrawal, 2001; Oldekop *et al.,* 2013; Fernández-Llamazares *et al.,* 2016, 2018; Sirén, 2017).

Policies focused at revitalizing language and local ecological knowledge also contribute to recognizing and, in some cases, restoring IPLCs' customary institutions for ecosystem management, which have been weakened or eroded (Aikenhead, 2001; McCarter *et al.,* 2014; McCarter & Gavin, 2014; Tang & Gavin, 2016). For example, in contexts where environmental degradation is linked to the loss of cultural values, ILK revitalization efforts have been successfully linked to ecological restoration projects, also providing cultural incentives (Anderson,1996; Long *et al.,* 2003; López-Maldonado & Berkes, 2017; Reyes-García *et al.,* 2018). Some customary education programs have also integrated ILK in school curricula, contributing to strengthen networks of ILK transmission (Kimmerer, 2002; Reyes-García *et al.,* 2010; Ruiz-Mallén *et al.,* 2010; McCarter & Gavin, 2011, 2014; Hamlin, 2013; Abah *et al.,* 2015). Similarly, it has been shown that ILK revitalization efforts are most effective when controlled and managed by the communities involved (Singh *et al.,* 2010; McCarter *et al.,* 2014; Fernández-Llamazares & Cabeza, 2017; Sterling *et al.,* 2017). Moreover, it is important that revitalization efforts consider the gendered nature of knowledge and the crucial role of women in knowledge transmission (Iniesta-Arandia *et al.,* 2015; Díaz-Reviriego *et al.,* 2016).

6.3.2.5 Improving financing for conservation and sustainable development

Financing is a critical determinant of the success or failure of conservation outcomes, as acknowledged in the CBD and SDG which call for increased financing and aid, and Aichi Target 3, which calls for the promotion of positive incentives for the conservation and sustainable use of biodiversity by 2020. These economic tools for biodiversity can include instruments such as biodiversity-relevant taxes, charges and fees; tradable permit schemes; and subsidies that aim to reflect the inherent values of biodiversity in their actual use, which have raised billions in recent years (OECD, 2010b; OECD, 2013). Currently, finance mobilized to promote biodiversity has been estimated at about US$ 52 billion globally (Parker *et al.,* 2012; Miller, 2014), while estimates of the financing necessary to reach international targets range from US$ 76-440 billion per year (CBD, 2012; McCarthy *et al.,* 2012). An estimated 80 percent of biodiversity conservation funding across low and middle income countries is derived from international aid (ODA), with the remaining 20 percent coming from domestic, private and other sources (Hein *et al.,* 2013; Waldron *et al.,* 2013). Other forms of financing besides ODA include direct payments to those who conserve biodiversity through various transfer mechanisms, including PES (see section on *Improving REDD+ and PES,* above), eco-compensation policies, or ecological fiscal transfers (see Supplementary Materials 6.2.4 for details on the latter two). Other financing mechanisms can include tradable permits, in which markets, auctions or other schemes allow those causing biodiversity loss or pollution to compensate their environmental impacts in other locations (see Supplementary Materials 6.2.4).

Though uncertainty exists on overall funding levels (Tittensor *et al.,* 2014), there is widespread agreement that resources are well below needs (James *et al.,* 1999; McCarthy *et al.,* 2012; Waldron *et al.,* 2013) and have failed to meet donor commitments (Miller *et al.,* 2013). Developing country capacity to finance conservation and sustainable use is increasing (Vincent *et al.,* 2014), and initiatives such as the UNDP BIOFIN project (www.biodiversityfinance.net) have assisted countries with identifying options, but ODA is likely to remain the major finance source for now. Existing flows have generally been well-targeted to countries with greater conservation need (Miller *et al.,* 2013), but there is inconclusive evidence about whether these resources have resulted in conservation success. New trust fund and collective fund approaches have been used in recent projects, such as the Amazon Fund to combat deforestation in Brazil (see Supplementary Materials 6.2.4). However, few if any peer-reviewed studies explicitly examine the impact of specific biodiversity financing projects using robust program evaluation methods. Bare *et al.* (2015) find higher rates of forest loss correlated with aid (concluding not that aid caused loss, but that aid was insufficient to halt existing drivers), while Waldron *et al.* (2017) found that conservation funding —much of it is ODA—did reduce biodiversity loss by an average of 29%. There is a paucity of impact evaluations in the conservation sector that examine socio-economic impacts of financing (Börner *et al.,* 2016; Puri *et al.,* 2016). Finally, there is a major gap in assessing the long-term impacts of conservation aid (Miller *et al.,* 2017) (see also Supplementary Materials 6.2.4). All of these gaps suggest a strong need for better systems of tracking and assessing the impacts of different types of financing; in other words, not just more financing is needed, but better understanding of the mechanisms for success.

6.3.3 Integrated Approaches for Sustainable Marine and Coastal Governance

Marine and coastal areas, covering 70% of the Earth's surface, include the High Seas or areas beyond national jurisdiction (ABNJ) which cover nearly half of the Earth's surface (Harris & Whiteway, 2009) and territorial waters from the baseline to national territorial limits. Adding river catchments affecting coastal areas means that much of the Earth's surface is directly connected to marine and coastal biodiversity and ecosystem services. Policy instruments for coastal biodiversity and ecosystem management span the scale of institutions from global and intergovernmental to local communities, and concern many different sectoral, thematic and cultural stakeholder and rights-holder groups. The United Nations Convention on the Law of the Sea (UNCLOS) includes provisions for coastal States to exercise national jurisdictions within 200 nautical miles from the baseline and to meet responsibilities for their Flag vessels on the High Seas.

Most Aichi Biodiversity Targets are relevant to marine and coastal biodiversity, but Targets 6, 7, 10, and 11 are explicit in their coverage of fisheries sustainability and ecosystem-based management (Target 6), sustainable aquaculture (Target 7), and coral reefs subject to anthropogenic pressures and impacted by climate change and ocean acidification (Target 10), and protected areas (Target 11). The ambitious target dates of 2015 (Target 10) and 2020 (Target 6, 7 and 11) have not or will not be met globally by 2020. For the SDG, Goal 14 (life below water) is most explicitly relevant to marine and coastal biodiversity, but most other Goals are also relevant.

At the frontier between land and seas, coastal areas support dense human populations, are undergoing rapid economic development and have been heavily transformed e.g., into cities, ports, tourist facilities and aquatic farms, with profound consequences for biodiversity and ecosystem services such as wildlife habitats and clean water. Downstream of terrestrial material flows, deltas and estuary systems receive nutrient, sediment, sewage, waste and pollution loads from distant regions. On land and sea margins, climate and other hazards are often more severe than inland (United Nations World Ocean Assessment, 2017). Coastal rehabilitation offers some opportunities to partially restore some ecosystem functions after their initial transformation or destruction for human use.

Climate change and pollution caused by land and sea-based carbon emissions and waste disposal are impacting the High Seas and coastal areas. Direct human exploitation of the High Seas is also increasing from fishing, shipping, oil and gas extraction, seabed mining, ocean energy production and aquaculture. Consequently, biodiversity conservation is a key issue in the High Seas (World Ocean Assessment, 2017; Ingels *et al.,* 2017). High Seas biodiversity is experiencing predominantly negative impacts, e.g., Census of Marine Life (Ausabel *et al.,* 2010), including in the abundance and diversity of fauna and in the status of sensitive and unique habitats such as seamounts (Koslow *et al.,* 2017), hydro-thermal vents (LeBris *et al.,* 2017) and deep-sea corals (Cordes *et al.,* 2017).

The use and management of coastal and marine areas are divided among many individual and corporate players whose activities impact the oceans. Unless action is based on sound shared knowledge, the players may fail to act in the interests of conservation (World Ocean Assessment, 2017), e.g., when coastal reclamation projects proceed in ignorance of the potential destruction of ecosystem services. In addition, the rights of different players may be unequal. For example, IPLCs are often long-established inhabitants and users of the coastal environment, but their access and ownership often are not secured against larger economic activities.

Following the Rio 1992 Earth Summit, conservation groups, governments and researchers increased attention to fisheries and other coastal industries impacting biodiversity and ecosystem services (Spalding *et al.,* 2013; Garcia *et al.,* 2014). Despite the raised awareness, action has been slow. For example, despite the ocean's importance in climate, oceans will be a major priority only in the 6th assessment cycle of the IPCC, due for completion in 2022. After ten years of discussion, in 2017, the UN General Assembly resolved (Resolution 72/249) to convene a conference to develop an international legally binding instrument under UNCLOS in order to address the conservation and sustainable use of marine biodiversity of ABNJ and marine genetic resources benefits sharing.

Governance of marine conservation still faces major challenges including a lack of proper international and regional legal framework for emerging challenges such as the impact of climate change on marine biodiversity. Another major problem is non-implementation of existing legal instruments in international, regional and national levels. Cases that illustrate these problems have been exposed in the IPBES regional assessments. For instance, the regional assessment for Europe and Central Asia highlights that, although the Regional Seas Conventions are playing an important role in joint management of marine areas, the performance is uneven and application not consistent with modern conservation principles and capacity of the region (IPBES, 2018a). The regional assessment for Asia and the Pacific highlights the absence of regional seas conventions or other binding legal instruments for promoting regional joint governance of marine areas (chapter 6, pp. 520-525).

This section presents both short and long-term policy options contributing to integrated approaches to marine and coastal governance. This ranges from identifying governance gaps, including in legal frameworks, and conditions that may facilitate the implementation of available policies in response to immediate needs **(Table 6.4)**.

Table 6 4 **Options for integrated approaches for marine and coastal governance.**

Short-term options	Long-term options (in the context of transformative change)	Key obstacles, potential risks, spillover, unintended consequences, trade-offs	Major decision maker(s)	Main level(s) of governance	Main targeted indirect driver(s)
Global marine and coastal					
Implementing global marine environment agreements for shipping		• Industry resistance due to competitive pressures, lack of awareness and lack of commitment • Practical weaknesses undermining the agreement effectiveness, e.g., flag state enforcement of MARPOL • More enterprises operating outside legal regimes	• International (e.g., IMO) • Regional (inter-) governmental organisations, • national, sub-national and local governments, including government linked authorities, e.g., port management • Shipping and logistics industry	International, regional, national, local	Economic, institutions
	Mainstreaming climate change adaptation and mitigation into marine and coastal governance regimes	• Lack of scientific knowledge to design practical measures • Lack of funding, industry and government support • Risk of resource declines, loss of human living space, food Lack of governance mechanisms to coordinate responses on necessary scales	• International inter-governmental agencies, • International and regional funding bodies • Regional and national sectoral agencies • Conservation-directed public-private financiers • Science and educational agencies • Donor agencies • IPLCs	International, regional, national, local	Economic, institutions, governance, technological

Short-term options	Long-term options (in the context of transformative change)	Key obstacles, potential risks, spillover, unintended consequences, trade-offs	Major decision maker(s)	Main level(s) of governance	Main targeted indirect driver(s)
	Mobilising conservation funding for the oceans	• Lack of private sector funding and very high reliance on public funds • Lack of investment assurance • Need for innovative financing mechanisms	• Maritime industries • International and national, governments	International, national	Economic, institutions, governance
International waters: High Seas (ABNJ) and regional waters					
Improving shared governance		• Maritime territory disputes • Ocean grabbing and failure to fully incorporate human dimension in conservation and resource governance • Differences in legal regimes of adjacent regions	International, regional, national and local governments	International, regional, national, local	Economic, institutions, governance, regional conflicts
Mainstreaming nature and its contributions to people		• Low national priority to biodiversity conservation • Current sectoral conservation efforts often need scaling up • Enforcement costs high, but electronic methods offer new options • Conservation and sectoral agency efforts need greater coherence	• International, regional and national governments, management agencies, NGOs, industry, IPLCs, Consumers	International, regional, national	Economic, institutions, technological, governance
	High Seas convention	• No legally binding international law for comprehensive protection of biodiversity	• International and national governments, • Non-governmental agencies, • Private sector	International, national	Economic, institutions, governance
Coastal waters					
Promote integrated management		• Long time frame and planning often stronger than implementation; • High transactions costs or fixed trade-offs can make system slow to respond to changing pressures or needs of coastal communities	• National central, sectoral agencies, NGOs, local and sub- national agencies, private sector specific to context, IPLCs	National, local	Economic, institutions, technological, governance
Mainstreaming nature conservation in sectoral management, with an emphasis on fisheries		• Widespread overfishing, pollution and habitat destruction, subsidies, IUU, market incentives • Weak progress in implementing existing fisheries governance framework • Solutions are context specific	• National governments, private sector management options, regional and international organisations, NGOs, industries and fishers organisations	International, regional, national	Economic, patterns of production, supply and consumption, governance, technological
Scaling up from sub-national project pilots		• Local conservation needs often precede national policies, but scaling up local solutions enables cooperation across local jurisdictions • Locally developed solutions may not be fully transferrable to other local situations	• National and local governments, IPLCs, Citizen groups	National, local	Economic, institutions, governance

Short-term options	Long-term options (in the context of transformative change)	Key obstacles, potential risks, spillover, unintended consequences, trade-offs	Major decision maker(s)	Main level(s) of governance	Main targeted indirect driver(s)
Building ecological functionality into coastal infrastructure		• Ineffective planning and approval processes for development • Insufficient financial and human resources for monitoring	• National and local governments, private sector	National, local	Economic, institutions, governance
Engaging stakeholders to achieve common ecological and social good outcomes		• Stakeholders not working together on solutions	• International and national NGOs, private sector governments, scientists and educationists, IPLCs	International, national, local	Economic, institutions, governance, cultural

6.3.3.1 Global Marine and Coastal

Overarching global policies and processes, including and beyond climate change-related agreements have had major impacts on action to protect marine and coastal biodiversity and ecosystem services (chapter 2.1 and 3). In the present section, we focus on key global agreements that need to be integrated into policy for marine and coastal biodiversity and ecosystem services.

6.3.3.1.1 Implementing global marine environment agreements for shipping

History shows that global agreements regarding shipping are challenging to negotiate, and, once agreed and ratified, challenging to implement, and in motivating government, industry and community stakeholders to act. The existing conventions and protocols on vessel-sourced pollution, including exotic and potentially invasive species from ships' hull fouling and ballast water, are important examples as shipping grows (World Ocean Assessment 2017, chapter 17).

Several international maritime agreements on the environment pre-dated UNCLOS, notably the International Maritime Organization (IMO) International Convention for the Prevention of Pollution from Ships, 1973 – MARPOL (Karim, 2015). UNCLOS was critical, however, as it introduced the regulatory framework of duties and jurisdiction of states addressing the main sources of ocean pollution, the success of which heavily depends on detailed regulations and their enforcement by international, regional and national institutions. Despite wide convergence of shipping issues and participation of most of the countries as well as the considerable success of IMO Conventions, worldwide uniform enforcement, monitoring and control still need development (Karim, 2015). Enforcement, monitoring and control relied greatly on flag state enforcement (Mattson, 2006) but in addition, port-state enforcement is being applied in some maritime agreements, such as the Food and Agriculture Organization Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (2009). This combined with new satellite and information technologies are being applied in efforts to track compliance, but enforcement is still weak (Petrossian, 2015). Enforcement and implementation are lacking both within and beyond national jurisdiction (Karim, 2015, 2018), but regional cooperative arrangements may improve regulatory capacity and should be further strengthened. In addition, a coordinated and widespread initiative for capacity building to strengthen understanding of and capacity for flag state responsibility in the global regulatory apparatus is needed to combat pollution in the areas beyond national jurisdiction (World Ocean Assessment, 2017).

6.3.3.1.2 Mainstreaming climate change adaptation and mitigation into marine and coastal governance regimes

Coordinated measures are needed to combat climate-related stressors on marine biodiversity, e.g., ocean acidification, ocean warming and deoxygenation (Bijma *et al.,* 2013; Pörtner, 2014; Levin *et al.,* 2018), as these stressors have sectoral effects, such as on stable fisheries agreements (Brandt & Kronbak, 2010; Galaz *et al.,* 2012). In fact, the Paris Agreement is now the first climate agreement to explicitly consider the ocean. International and regional legal instruments and mechanisms for climate change, oceans, fisheries and the environment are relevant for these challenges, but they remain inadequate (Galland *et al.,* 2012; Herr *et al.,* 2014; IPCC, 2017). At the least, sectoral and general ocean governance will have to mainstream major climate issues in governance regimes at international, regional and national levels. This mainstreaming will help sectoral management adapt and mitigate emissions. If linked to climate actions, this may also help reduce some of the knowledge gaps on climate and the ocean, and gaps between scientific and government attention to climate change (Magnan *et al.,* 2016; Gallo *et al.,* 2017). Achieving policy coherence over such complex issues also requires significant new knowledge on the oceans and climate which can feed back into climate science. In the case of proposed climate solutions such as geoengineering to capture carbon from the atmosphere, the IPCC warns that the impacts on marine ecosystems "remain unresolved and are not, therefore, ready for near-term application" (http://www.ipcc.ch/ipccreports/tar/wg3/index.php?idp=25).

Many impacts of global changes are highly unbalanced, because telecouplings affect people who have not caused the problems. Sea level rise is eroding the living space of many marginal coastal people in developing countries, e.g., on low-lying Pacific islands and coastal mangroves in Asia. Funds set up to address these transfer issues, e.g., the Green Climate Fund and other multilateral instruments will not have their intended effects unless greater priority is given to developing countries (Friends of the Earth and Institute for Policy Studies, 2017), and these funds need to specialize and cooperate effectively to provide coherent support (Amerasinghe *et al.,* 2017).

6.3.3.1.3 Mobilising conservation funding for the oceans

According to some estimates, the oceans provide trillions of USD annually in goods and services to society (Costanza *et al.,* 1997). Policies and incentives towards the sustainable use of the oceans – from controlling overfishing and pollution to promoting new technologies for energy and carbon sequestration to incentives for sustainable tourism – have economic and social impact across sectors of society and regions, benefiting private and public economies, and local communities. However, innovative solutions are needed for improving financing for conservation action for the ocean. Some estimates suggest that that market-based mechanisms could, for example, deliver up to 50% of the finance for coral reefs (Parker *et al.,* 2012), including for instance cap-and-trade programs such as the Ocean Appreciation Program (Ocean Recovery Alliance, 2016), green bonds (Thiele, 2015a), and blue carbon sequestration to benefit biodiversity (Maldonado & Barrera, 2014; Murray *et al.,* 2011; Thiele & Gerber, 2017). On the High Seas, the financial mechanisms to support conservation are not well established and new institutional financial structures, including financial solutions that allow for private funds to be invested in conservation, such as from international markets, are increasingly recognized as essential (Madsbjerg, 2016).

The majority of current biodiversity funding is from public finance (e.g., GEF) (Huwyler *et al.*, 2014) and is affected by the short-term time horizons of political agendas and public opinions. Following models used in climate (Buchner *et al.,* 2015) and development finance (Gutmann & Davidson, 2007), growing attention is given to the potential use of market-based mechanisms used in terrestrial systems for the High Seas, such as payments for ecosystem services and biodiversity offsets (Gjertsen *et al.,* 2014).

Clean, renewable ocean-derived energy has the potential to reduce carbon emissions and meet 10 percent of EU demand by 2050 (Ocean Energy Europe, 2015). Technologies of this magnitude, however, are impeded by high initial investments and risks. These barriers may be overcome through public-private collaboration and require careful planning and environmental impact assessment (Economist Intelligence Unit 2015). There is potential for increased research and infrastructure support for wave and tidal energy technology, which have been slow in terms of technological advancements (REN21, 2018; Bruckner *et al.,* 2014).

A portion of the profits from ocean-based goods and services could be directed into conservation research, monitoring, and enforcement. For example, ocean tourism, managed with respect for, with and by local communities, can yield successful results if earning from tourism are funneled into supporting sustainable management (Cisneros-Montemayor *et al.,* 2013; Hess, 2015); and appropriate incentives in fishing could help change current practices such as derelict gear that threaten habitats and natural capital stocks (Grafton *et al.,* 2006; Grafton *et al.,* 2008).

Global cooperation is needed to develop innovative mechanisms to conserve the ocean, just as global collaboration is needed to address air quality and atmospheric emissions. Ocean conservation projects may be funded by a proposed Ocean Bank for Sustainability and Development and trust funds. The Ocean Bank concept has been supported by several NGOs that argue current development banks and structures are not sufficient for the largest ecosystem (WWF, 2015). Proponents envision that this new institution arrangement could be funded by states and private investors, providing knowledge, project development, training, and financing (Cicin *et al.,* 2016). Trust funds can offer long-term financial assistance and have already been applied to marine conservation management (MAR Fund, 2014; MRAG, 2016), e.g., a fund for a protected area in Kiribati compensates the government for license profits forgone (MRAG, 2016).

In the last 20 years, conservation organisations – international, national and local – e.g., IUCN, WWF, CI, TNC, WCS and their local chapters – have developed major coastal conservation programs, supported by funding from (mainly) US based philanthropic foundations (Packard, Walton, Pew, etc.) and often giving particular attention to charismatic ecosystems, e.g., coral reefs, and mega-fauna, e.g., whale shark, cetaceans and other marine mammals, and penguins. However, as the foundations turn more to Blue Economy issues such as fishing and food security, their future efforts may not be so focused on biodiversity conservation, calling attention to the importance of diversifying funding mechanisms supporting marine and ocean conservation and sustainable use.

6.3.3.2 International waters: High Seas (ABNJ) and regional waters

Significant areas of the ocean are outside settled national jurisdictions, although certain activities may be under the controls of regional bodies or of global agreements. Some disputes over precise jurisdictions remain. A few countries, including the USA, have not signed the United Nations Convention on the Law of the Sea (UNCLOS), but largely abide by its provisions. The High Seas sustain global-scale ecosystem functions and provide essential benefits to humans (Rogers *et al.,* 2014) but are subject to three increasing trends (World Ocean Assessment, 2017). First, human needs are increasingly met from the ocean, some directly, e.g., food from fisheries, aquaculture and ranching (Ferreria *et al.,* 2017; APEC, 2016), and some indirectly, e.g., greater shipping of commodities in an increasingly globalized world (Simcock & Tamara, 2017; Simcock, 2017). Second, direct drivers affecting the High Seas are expected to increase, including fishing, aquaculture, mining, energy and defence activities, sound pollution from transportation, and chemical and biological pollution from increased use of the sea and coastal living. Third, as efforts to increase the sustainability of ocean uses within national jurisdiction increase (FAO, 2016; CBD, 2017), some of the effort is moving offshore (Merrie *et al.,* 2014; Gjerde *et al.,* 2013). These three trends have major impacts on nature and its contributions to people, including the challenge of managing rapidly emerging industries such as mining, undersea communications and energy. Improving shared governance, mainstreaming nature, and a new High Seas convention are proposed as options.

6.3.3.2.1 Improving shared governance

Supporting and expanding existing conservation cooperation mechanisms represent a promising short-term option for protecting High Seas biodiversity. Some of these institutions are expanding their initiatives into areas beyond national jurisdiction, e.g., through fisheries observer programs, anti-IUU (illegal, unreported and unregulated) fishing measures. Regional organisations, particularly, the Regional Seas Programmes, Regional Fisheries Management Bodies and their conventions, and GEF Large Marine Ecosystems (LME) programmes can also play an important role in combating land-based marine pollution.

A common first step in establishing international coastal cooperation is a transboundary programme of technical cooperation, such as the Regional Seas Programmes and Conventions and the GEF initiated LME projects. Many of these programmes have helped create effective environment agreements among countries.

Territorial disputes may impede conservation, to the extent that in contentious areas, multilateral cooperation has been limited to technical cooperation among a subset of countries rather than active management (Williams, 2013). Where maritime territory disputes remain, countries are urged to settle these through the UNCLOS legal routes. UNCLOS offers four options for dispute settlement and by finding the means that best suits, states have settled many disputes. However, instances where some of the large powers have opted not to resort to UNCLOS dispute settlement system may jeopardize the effectiveness of the forum (Klein, 2014; Gates, 2017).

“Ocean grabbing” is a term used to describe an emerging concern over the dispossession or appropriation of ocean space or resources from prior users, rights holders or inhabitants resulting from governance processes with power asymmetries among participants. More broadly, the issue of accumulation by dispossession is both an issue that can impede conservation and be used by conservation interests to obtain a foothold over community lands (Harvey, 2003; Hall, 2013; Benjaminsen & Bryceson, 2012). If the needs of local communities and ecosystems are not fully taken into account, allocation of access rights to ocean space or resources may undermine human security and impair biodiversity components. Conservation allocations such as marine protected areas, and rights-based approaches such as individual fisheries quotas may be conducted in ways that do not undermine human security and ecological functions (Bennett *et al.,* 2015).

Thinning and disappearing sea ice, melting permafrost, and circumpolar climate change, however locally and regionally varied, are commonly identified as playing their part in rapidly unsettling the geographies of Arctic governance (Overland & Wang, 2013; Smith & Stephenson, 2013; Hussey *et al.,* 2016; Stephenson, 2018). Strategies are being sought that will promote renewed international cooperation and reduce the risks of discord in the Arctic, as the region undergoes new jurisdictional conflicts and increasingly severe clashes over the extraction of natural resources in a region that is critical to the prevision of globally important NCPs (Berkman & Young, 2009; Young, 2010; Keil, 2015; Hussey *et al.,* 2016; Harris *et al.,* 2018).

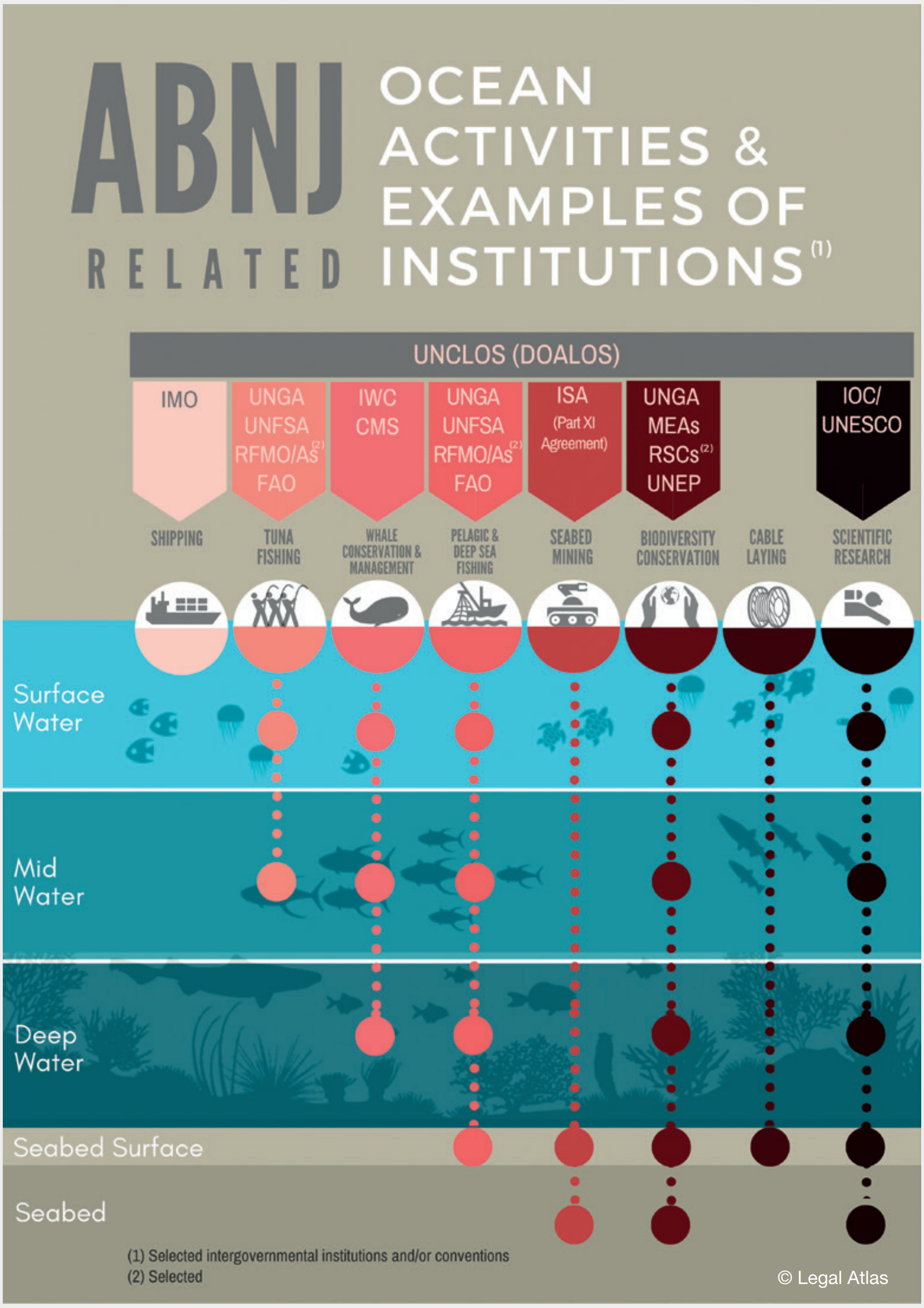

Figure 6 3 **Multiple ocean uses and examples of institutions related to areas beyond national jurisdiction illustrating the different ocean depths relevant to the activities and institutions.**

Source: UNEP-WCMC (2017).

Several organizations have advocated for the negotiation of a harder law regime for the Arctic (Kankaanpää & Young, 2012), including firmer institutional, financial and regulatory foundations for the Arctic Council (Berkman & Young, 2006) and improved transboundary conservation planning (Greenpeace, 2014; Hussey *et al.,* 2016; Edwards & Evans, 2017; Harris *et al.,* 2018).

6.3.3.2.2 Mainstreaming nature and its contributions to people

Recognising the rising pressures on biodiversity on the High Seas, most sectoral regulatory agencies are recognizing the need to mainstream biodiversity conservation into their approaches to policy and management (CBD, 2016). Responding to growing public pressure from NGOs and international agencies, measures are being introduced. For instance, Regional Fisheries Management Organisations (RFMOs) are implementing UNGA Resolution 61/105 to protect deep sea Vulnerable Marine Ecosystems (VMEs) from bottom trawling (Rice *et al.,* 2017). Similarly, sectoral agencies such as the International Seabed Authority for deep-sea mining (Anton, 2011) and International Maritime Organisation for shipping are adopting, or urged to, additional policies and measures to manage and mitigate the pressures of these sectors on High Seas biodiversity and their habitats.

The effectiveness of conservation policies for the High Seas depend crucially on how well they are implemented, a challenge that sectoral regulatory agencies have been grappling with for decades. In some areas, there is a need for substantive scaling up resources and prioritizing areas of rising pressure, e.g., for tuna fisheries (Juan-Jorda *et al.,* 2017). A major obstacle is the lack of priority that countries give to international arrangements for nature conservation. The latter highlight the role of regional management bodies and their secretariats in mobilizing action, and that of NGOs that advocate action through campaigns engaging public attention and presenting submissions to management bodies.

The experience of RFMOs in protecting VMEs from deep sea fishing shows that a strong science foundation is crucial as the knowledge basis (MacDonald *et al.,* 2016), in addition to guidance on suitable conservation management measures (FAO, 2009). As little of the seabed is mapped, however, the knowledge base is generally poor. Protection is still feasible using responsive mechanisms based on existing knowledge, e.g., real-time move-on (cease-fishing) rules triggered when the presence of a VME is identified through bycatch indicator taxa; and great progress on identifying VMEs and Ecologically and Biologically Significant Marine Areas, even with incomplete information (Dunn *et al.,* 2014).

For RFMOs and other sectoral agencies, member States need to provide costly surveillance and enforcement (Rice *et al.,* 2014). These functions present a greater challenge on the High Seas than within national jurisdictions, but additional policy interventions have enhanced the effectiveness of existing policies, e.g., the FAO Port State Measures Agreement (2009, in force 2016) increased the effectiveness of other measures to deter IUU fishing (FAO, 2017). Sectoral management agencies, including fisheries, and NGOs such as Global Fishing Watch, are now testing new technologies such as satellite monitoring of electronic fisheries operations, onboard CCTV monitoring of catch and bycatch, and real-time data entry (Hosken *et al.,* 2016). These technologies can lead to better monitoring, control and surveillance.

Greater efforts are needed to achieve coherence between the efforts of sectoral management agencies and the efforts of biodiversity conservation agencies, including those led by intergovernmental organizations such as the CBD, e.g., program for identifying Ecologically or Biologically Significant Areas (EBSAs – Johnson *et al.,* 2018), and by NGOs, e.g., Birdlife International. In fisheries, poor coherence leads to low returns on conservation and management investments (Garcia *et al.,* 2014a). The obstacles to improving coherence are high because it requires governance processes with convening power to bring the agencies together, the duty to cooperate both in selecting policies and measures that work synergistically and implementation strategies that encourage cooperation (Garcia at al., 2014b).

6.3.3.2.3 Pathways to protect nature in the High Seas

The need for coherence poses the greatest challenge, and greatest opportunity, for changing the trends of loss in High Seas biodiversity. The limitations of UNCLOS to deal effectively with nature conservation in the High Seas biodiversity was recognized over a decade ago. Open Ended Working Groups of the UNGA (http://www.un.org/depts/los/biodiversityworkinggroup/biodiversityworkinggroup.htm) prioritized three themes: the ability to apply spatial management tools, including High Seas Marine Protected Areas (MPA) binding on all marine industry sectors; marine spatial planning across sectoral agencies; access and benefits sharing to marine genetic resources; environment impact assessment, technology transfer and capacity building.

UNGA has initiated in 2017 an intergovernmental conference on an international legally binding instrument under UNCLOS on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (General Assembly Resolution 72/249); with expected conclusion in 2020. These negotiations will be a major factor in the future trajectories of High Seas biodiversity. An eventual future instrument is likely to include provisions for area-based management including MPA, environmental impact assessment and marine genetic resources. National government are encouraged to support the timely agreement of an effective instrument for marine protection and then implement the provisions with regard to key sectors, e.g., fishing, seabed mining, coastal oil and gas, geoengineering and waste disposal.

6.3.3.3 Coastal Waters

National governments play a major role in determining the balance of coastal protection and resource use, and global codes and conventions can help promote national action, e.g., SDG 14 (life below water). Governments face the challenges of harmonising and coordinating responsible agencies and interests, setting national policies and priorities, coordinating and integrating planning, resourcing, implementing, monitoring and reporting. Locally led initiatives can also feed up into national policies (see 6.3.3.3.3).

6.3.3.3.1 Promoting integrated management

Since the 1980s integrated coastal environment management concepts have been a focus of academic attention (Merrie & Olsson, 2014). Conservation, international and national organisations also have promoted, developed and piloted several related forms of integrated marine and coastal management, especially Integrated Coastal Management (ICM) and Sustainable Development in Coastal Areas (ICM/SDCA – http://www.pemsea.org/our-work/integrated-coastal-management/SDCA-framework), MPA, Marine Spatial Planning (MSP) (Ehler & Douvere, 2009) and Ecosystem Based Management (EBM) (Agardy *et al.,* 2011). MSP and MPA illustrate the challenges.

MPA have been applied most commonly to fisheries and special area conservation. Their effectiveness depends on the economic conditions, governance and institutional contexts in which in which they are applied (Agardy *et al.,* 2011; Ban *et al.,* 2013; IPBES, 2018c), their location (Mouillot *et al.,* 2015), and local livelihood activities that are displaced by the MPA must be addressed (Cudney-Bueno *et al.,* 2009; Bennett & Dearden, 2014; IPBES, 2018d).

Conversely, when MPA management incorporates biophysical, economic, and social characteristics of the system, more sustainable fishing practices may result (Cinti *et al.,* 2010; Sciberras *et al.,* 2015; Gill *et al.,* 2017).

MPA and systems of interconnected MPA offer conservation management options for both the short and long term, for governments, private, NGO, and IPLC actors. The social and economic benefits of MPA can improve community well-being via increased income from fisheries or tourism (McCook *et al.,* 2010), and IPLCs can engage in stakeholder processes so that MPA benefit both people and nature (Bennett & Deardan, 2014). The private sector can contribute innovative financing for implementing and enforcing MPA (Theile & Gerber, 2017). Rights-based approaches to MPA management and ocean governance offer a promising option to strengthen MPA and MPA Networks implementation (Bender, 2018). NGOs have an important role to play in implementing MPA, through assisting community engagement and capacity building, monitoring and evaluation, and developing and implementing economic incentives to support MPA (Mascia *et al.,* 2009).

Marine spatial planning (MSP) is a comprehensive "public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objective *that are usually specified through a political process."* (IOC-UNESCO Marine Spatial Planning Programme – http://msp.ioc-unesco.org/). It evolved together with MPA developments (Katsanevakis *et al.,* 2011), bringing together multiple users of the ocean – energy, industry, government, conservation and recreation. Not an end in itself, intent of MSP is a coordinated and sustainable approach to ocean use. Policy-relevant guidebooks have been developed to support implementation (e.g., Ehler & Douve, 2009). Despite good pilot cases and some success, a 2012 review concluded that: "Comprehensive MSP initiatives are relatively new and thus largely untested. In those that are underway, there appears to be greater emphasis on planning than on post-plan implementation" (Secretariat for the CBD and GEF, 2012, p.32). Furthermore, the requirements of cross-sectoral decision-making can be seen by line ministries as onerous and undesirable (Secretariat for the CBD and GEF 2012), although this is clearly very important in implementing the mainstreaming requirements of the CBD. A further challenge is that the adaptable nature of MSP must continually maintain a balance of ecosystem conservation and economic and social aims (Merrie & Olsson, 2014), making frequent updates and adaptive responses necessary. National capacity to implement integrated environmental stewardship can be affected also by the relative powers of the ministries. In some governments, environment ministries are newer and weaker compared to economic and central ministries (Jordan *et al.,* 2010).

Overall, the obstacles to implementation, longer time frame for success, complexity of the integrated solutions, and need to be responsive to changing externalities (e.g., climate change, new trade agreements, changing markets for traditional products, etc.) all mandate that governance arrangements focus also on shorter term responsive action, including sectoral in cases, to address the most immediate problems in a step by step approach. Nevertheless, sectoral or local actions need to be nested with higher level institutions adjudicating on cross-sectoral trade-offs resulting from specific actions, such as those competing for coastal space: ports, urban development, fisheries, tourism, and conservation.

Integrated management at the national and local levels: National governments, pivotal to integrating management across scales and to negotiate international and regional agreements. Typically, an international agreement is the catalyst for national action, however avoiding piecemeal solutions is difficult since local and national levels actors are continuously responding to accelerate social and environmental changes. On the other hand, localized solutions can be effective. For instance, while a global instrument against plastic pollution will take time, national and sub-national actions are contributing to address the problem (Niaounakis 2017). National and state governments, for instance, can impose restrictions on the sale and use of single-use plastic bags, for instance as did Chile in 2017 in restricting such items particularly in coastal villages and towns.

Decentralizing policies to sub-national and local governance have a direct impact on the type of coastal and marine management. In the last three decades, coastal and marine management has been affected by the opportunities and challenges caused by national re-organisations associated with the devolution and decentralisation of government powers to state, province or local government and community levels, requiring rapid capacity building at sub-national levels. In Southeast Asia (e.g., Indonesia, Philippines and Vietnam) devolution models were embraced with varying results. Indonesia has received major World Bank development and conservation support for community and local government-based empowerment, and the local outcomes covered the spectrum from responsible leadership, to elite capture, patronage networks, and outright corruption (Warren & Visser, 2016). Another example of diverse outcomes of local level management is the coastal cities in the Great Buenos Aires conurbation (Argentina), comprising ten different jurisdictions at national, provincial and municipal government level. Responding to local politics and globalization pressures on competitive industries, decades of decentralization or federation efforts were resolved essentially in favour of decentralisation rather than metropolitan integration (Dadon & Oldani, 2017).

Successful short and medium-term sub-national interventions can include small scale actions and projects at sectoral or cross-sectoral level, as for this scale, sectoral boundaries may not be so rigidly delineated. Technical projects, research institutes (as entry points for diagnosis, finding solutions, monitoring status) and community, including youth, engagement, are critical elements to the success of grassroots conservation.

Indigenous Peoples and Local Communities are central to sub-national marine conservation action but vary significantly in terms of their capacities and needs to manage marine resources under different types of pressures. Across the world, the position and contribution of IPLCs to coastal management vary significantly from areas where communities retain full control to various types of mixed arrangements, to complete deprivation of rights. Evidence demonstrates that local customary institutions can be more effective than formal external ones in promoting management. In Indonesia, continuous traditional marine management such as *sasi laut* and *pangalima laut* were more potent and likely to be obeyed than more modern proclamations, e.g., of Marine Protected Areas (Harkes & Novaczek, 2002; Wiadnya *et al.,* 2011). In Sumatra with well-conceived external support, even cases of corrupt devolved authority could be turned around into local community advantage (Warren & Visser, 2016).

6.3.3.3.2 Mainstreaming nature conservation in sectoral management, with an emphasis on fisheries

National resource managers of coastal waters, private sector enterprises, citizens and consumers can all play a role to help prevent environmental damage, including by protecting vulnerable areas, changing damaging manufacturing practices, sensitive land development, waste disposal and consumption patterns. Collectively, these mainstreaming approaches are now being referred to as ecosystem-based approaches to management within specific sectors. Sectoral activities and policy often determine the conservation approaches but focus on components of nature most closely linked to their sectoral activities. For example, fisheries experts have been early to diagnose environmental problems such as fish stock overexploitation and bycatch, but less likely to focus on a seabird colony finding insufficient food because of a fishery harvest. Effective governance is needed to ensure sectors do not prioritize resource uses to a level that risks unsustainable practices.

In addition to risk of overharvesting, the IPBES regional assessments for Africa, the Americas, Asia and Pacific, Europe and Central Asia found that fisheries conservation is threatened also by other external threats, including many types of pollution, habitat destruction for industries and human living space, invasive alien species from sources including ballast water introductions, nutrient driven hypoxia, jelly-fish blooms, and climate change. These problems call for the joint effort of governance institutions from local, to national, and regional, and even global.

Managing the impacts of fishing and fish supply chains to conserve the target stocks and the environment has become a recognized environment priority, e.g., SDG target 14.4 and Aichi target 6. One-third of marine fish stocks (including invertebrates) are fished at biologically unsustainable levels, 60% at sustainable levels, and 7% underfished (FAO, 2018a). However, many marine fish stocks are of unknown status, suggesting that estimates about sustainable fisheries management may be over-optimistic (FAO, 2018a). Positively, there is evidence that stock rebuilding is occurring in countries including USA, Australia, Namibia, Canada, and the European Union (FAO, 2018a). However, evidence on ending overfishing and rebuilding depleted stocks suggests that the successful recovery of depleted marine resources depends possibly more on management of infrastructure and socio-economic contexts than on having accurate stock assessments alone, especially if management measures that are suited to data-poor fish stocks are used (e.g. IPBES, 2018c; Brodziak *et al.,* 2008; Rosenberg *et al.,* 2006; Caddy & Agnew, 2004; Garcia *et al.,* 2018).

Despite evidence for the need to address overexploitation from fishing, many countries and RFMOs have not fully implemented the extensive international legal framework, including both hard and soft law instrument, referred to as the Code of Conduct for Responsible Fisheries and its instruments (FAO, 2012). The World Ocean Assessment (United Nations, 2017) proposed the following options: ending overfishing and rebuilding depleted stocks; eliminating IUU fishing; reducing the broader ecosystem impacts of fishing including habitat modification and effects on the food web; reducing the adverse impacts of pollution; and reducing the adverse impacts of perverse subsidies.

A major challenge is that the options are highly context specific and need to be purpose built, albeit lessons can be learned from practice elsewhere and locally specific solutions involve opportunities for co-management. Developed countries may use complex, data rich ecological-economic models (Nielsen *et al.,* 2018), but the models, management institutions and methods, e.g., catch shares, individual transferable quotas (ITQs), may not suit developing country and small-scale fisheries. Specific cultural and ecological contexts are important for successful community-based fisheries management, making any model hard to upscale (Poepoe *et al.,* 2007), although local leaders, social capital and incentives were found to be important (Gutiérrez *et al.,* 2011).

Communities making a living from small-scale fishing and coastal resources have often been ignored in national and international policy, despite their strong dependency on the resources (García-Quijano *et al.,* 2015). Furthermore, assessments, including the present one, generally neglect to consider women's role in this sector and thereby ignore major unrecorded fish catches (Gopal *et al.,* 2017). As well as women, policies need to consider the rights and concerns of Indigenous Peoples with respect to livelihoods, equity and rights, participating and contributing knowledge to fisheries and coastal ecosystem management (Capistrano & Charles, 2012; Fisher *et al.,* 2015). The 2015 Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (SSF-VG) were developed to overcome the neglect of local communities, indigenous and non-indigenous. Countries are encouraged to implement the SSF-VG, which incorporates comprehensive environmental as well as human rights and equity principles.

"Balanced harvest" (Garcia *et al.,* 2016) has been debated as a possible approach to increase food from the sea while maintaining sustainable fisheries but evidence on its effectiveness is lacking as it has not yet been implemented.

To address sustainability through eliminating IUU fishing, countries and Regional Fishery Bodies should not only exercise effective fisheries management, but also implement strong surveillance capacities, e.g., Petrossian, 2015, (see 6.3.3.2.1 and 6.3.3.1.1) and adequately invest in research and technical capacity, for instance improving recognition of illegal landing species and sizes (e.g., Romeo *et al.,* 2014).

Customized options to reduce and eliminate bycatch and discards are essential to minimize ecosystem impacts of fishing (Hall *et al.,* 2017; Gladics *et al.,* 2017; Gilman *et al.,* 2016, Little *et al.,* 2015; Broadhurst *et al.,* 2012). National measures to reduce the direct impacts of fishing on marine mammals, sea turtles and seabirds have proven successful (Grafton *et al.,* 2010). In fisheries for migratory species and in remote ocean areas like those in the Southern Ocean, international inter-organizational collaboration is needed (Osterblom & Bodin, 2012). In addition to managing bycatch and discards, reducing the broader ecosystem impacts of fishing depends on establishing new and implementing current MPA, and restoring critically endangered ecosystems (e.g., Kennelly & Broadhurst, 2002; Fourzai *et al.,* 2012). Adoption of the ecosystem approach to fisheries across countries has, according to FAO, been slow but has consistently moved forward (FAO, 2018b).

Fishery subsidy reforms, which includes elimination of harmful subsidies, decoupling subsidies from fishing effort, re-orienting subsidies to management and technological improvements, conditioning subsidies on fishery performance, and substitution of ongoing subsides for buyback schemes (Cisneros-Montemayor, 2016; Tipping, 2016) are innovative attempts to redress current failures in the interest of resource protection and sustainability.

Seafood certification and ecolabelling are economic instruments designed to change consumer seafood demand for well-defined target species or fisheries whose sustainability is under threat, direct them to better environmental choices, create market access, and provide incentives to improve fishing practices through price premiums to producers (FAO 2018b). The uptake of these schemes has been much greater in developed countries and is considered to have had the most important non-State positive impact on fisheries sustainability, but more efforts are needed to increase its uptake and the lower barriers to entry for developing country and small-scale fisheries (Gutierriz *et al.,* 2016; FAO, 2018b). In view of the diversity of ecolabelling and certification schemes have developed, for which FAO has established a Global Benchmark Tool. To date, only three fisheries and one aquaculture scheme have been benchmarked. Several schemes are now addressing social standards but as yet these lack agreed performance norms (FAO, 2018b). As precursors to certification, fisheries improvement programs (FIPs) are important stepping stones towards sustainability (https://fisheryprogress.org/).

Certification and ecolabelling have had a major positive impact on improving fisheries sustainability and, for developed counties, may be the most important recent non-government fisheries management initiative. Evidence shows that support of governments and other fisheries actors are essential for fisheries certification (Gutierrez *et al.,* 2016). Controversy over certificate standards and questions over accountability for the certification machinery and decisions have arisen (Miller & Bush, 2015; Gulbrandson & Auld, 2016). In addition, certification has had only modest success so far in including developing countries and small-scale fishers and producers. A further challenge is that only some consumers are yet willing to pay more for certified seafood (FAO, 2018b).

6.3.3.3.3 Scaling up from sub-national project pilots

National agencies, including government science and management agencies, play key roles identifying, diagnosing, researching and developing technical projects and pilots on marine biodiversity conservation, often following specific sub-national cases, such as Australian efforts to sustainably manage competing uses of the Great Barrier Reef Marine Park (Merrie & Olsson (2014).

Scaling up is the challenge for sub-national initiatives. In Asia, the PEMSEA partnership has demonstrated the feasibility of building on small scale local success. For example, in Batangas, Philippines, efforts spread from five local authorities to 34, covering the watershed and coastal areas of the whole province (http://www.pemsea.org/our-work/integrated-coastal-management/ICM-sites). By 2021, ICM is expected to reach 25% of the East Asia region's coastline using the PEMSEA model that has performed well in East Asia, as national governments collaborate towards a regional strategy. The work starts at the local government level, rather than relying on national policy to initiate action. Like other integrated approached, ICM relies on networks of experts reaching out to interested local actors, having also attracted attention from international donors.

Successful examples of local governance, albeit with external support in most cases, are described in the IPBES regional assessments. For instance, since 2005 in the Pacific region, locally managed marine areas have grown in number; in Madagascar, the NGO Blue Ventures is piloting payment schemes for blue carbon; and in West Africa, mangrove conservation has progressed in a six-country development project with local partners.

6.3.3.3.4 Building ecological functionality into coastal infrastructure

Given the inevitability of future coastal infrastructure development, it is vital that decision makers consider the ecological functions of coastal ecosystems from the start (Daffron *et al.,* 2015). Altered and damaged ecosystems are difficult to restore or rehabilitate, or not politically or economically feasible. Maintaining and managing natural system by removing stressors such as pollutants may be a fraction of the costs of restoration (Elliot *et al.*, 2007). In some cases, however, created ecosystems may even be culturally preferred. With the rapid increase in created coastlines, especially around urban areas, ecosystem rehabilitation, increasing attention has been paid to remediation and multi-purposing coastal structures such as breakwaters and marinas.

6.3.3.3.5 Engaging NGOs, industry and scientists as stakeholders to achieve common ecological and social good outcomes

Across countries, interpretations and awareness of the importance of conserving nature and its contributions to people in the oceans are diverse and dynamic, although a growing degree of convergence is emerging as a result of local social movements, global environment conventions and agreements, scientific efforts, and environmental advocacy. New national and local environmental NGO are emerging, creating greater and more distributed demands for conservation action. For instance, large international NGO have set up national branches and joint ventures in many countries, bringing their own concepts and values and adapting them to local circumstances and channels of influence. Although the translations do not always work, with time and experience, the short-term actions can mature to more appropriate forms for local ecosystems and species, values and knowledge, e.g., national versions of seafood consumption guides.

Powerful industry players may obstruct and even capture the political processes, e.g., port infrastructure, shipping, industrial fishing, tourism and real estate (Jenkins & Schröder, 2013; Bavinck *et al.*, 2017), but industry actors are also highly relevant to finding solutions. Options to involve private interests include corporate social responsibility, market-based instruments such as certification (e.g., seafood certification, 6.3.3.3.2) and best practice in fisheries and aquaculture production methods (Jenkins & Schröder, 2013). In the case of coastal hypoxia caused by nutrient loading, more attention is needed to engage sectors responsible for the largest point-source nutrient emissions (farmers, intensive livestock producers, agricultural chemical and fertilizers companies) in policy decision-making, remedial action, educational programmes and training sessions (STAP, 2011).

Marine assessment processes provide opportunities for management agencies, research institutes, NGO and other citizen groups to assess and report the status of nature and its contributions to people, to identify issues and suggest solutions. International collaboration on assessments and standards can enable national status reports to be shared and information to be aggregated and compared regionally and globally. In addition to international government organization assessments, such as the World Ocean Assessment, NGO and privately funded systems can contribute to collaborative efforts such as the Ocean Health Index (http://www.oceanhealthindex.org/).

6.3.4 Integrated Approaches for Sustainable Freshwater

Freshwater ecosystems include rivers, lakes, reservoirs, wetlands and groundwater systems. The options for decision makers discussed under this section are based on SDG6 (clean water and sanitation) and several Aichi Biodiversity Targets (ABTs). Population growth, climate change, increasing demand for water, institutional policies, and land-use change – all interact to determine available water supply and use (Liu *et al.*, 2013). Short and long-term options to manage water need integrated and adaptive governance that reduce pressures on water, encourage nature-based solutions and green infrastructure, and promote integrated water resource management as well as considerations of water-energy-food nexus (WWAP/UN-Water, 2018). Adaptive measures include rainwater harvesting, improved pasture management, water reuse, desalinations and more efficient management of soil and irrigation water, among others (Jiménez *et al.,* 2014). Inclusive and informed approaches to water governance open up opportunities for stakeholders with diverse interests to be involved in making decisions that are integrated, adaptive, resilient, innovative and responsive (WWAP, 2018; Ison & Wallis, 2017; Razzaque, 2009; Pahl-Wostl, 2007). Transformational change requires a move away from the business as usual approach and puts emphasis on the recognition and integration of multiple values, including intrinsic and relational values, in water management (WWAP/UN-Water, 2018; Bartel *et al.,* 2018).

The complexity of water resources is reflected in its status as an economic good as well as a public good (CESCR, 2003; Griffin *et al.,* 2013; Whittington *et al.,* 2013). It is well established that challenges to water management are aggravated as there are ambiguities in relation to the status and scope of legal rights governing access to water (McCaffrey, 2016; Murthy, 2013). It is critical to understand the combination of options and instruments that can be designed to meet policy objectives and allocations arrangements (WWAP, 2015; OECD, 2015). In the short-term, a clear legal status needs to be in place for all types of water, such as surface water, groundwater and wastewater along with a clear indication of the ownership and user rights and polluter duties. Such a legal regime will enable the responsible authority/ies to determine the level of access to be given to various users, monitor the losses in water distribution, impose sanctions such as fines or penalties, and determine the response measures in cases of exceptional circumstance, such as drought and severe pollution (Ring *et al.,* 2018; Acosta *et al.,* 2018; Stringer *et al.,* 2018; Scarano *et al.,* 2018; WWAP, 2015).

In many countries, environmental flow allocations continue to be used as a surrogate for the protection of Indigenous Peoples and Local Communities' interests in water management (e.g., NWI, 2004; DoW, 2006), with little or no consideration for IPLC customary rights of freshwater resources in water allocation decisions (Finn & Jackson, 2011; Bark *et al.,* 2012; Jiménez *et al.,* 2015). Low representation of IPLCs in water resource decision-making has often led to conflicts and disagreements over values and management priorities, which have often been aggravated by clashes between market-based instruments and local customary rights (Boelens & Doornbos, 2001; Boelens & Hoogendam, 2001; Trawick, 2003; Jiménez *et al.,* 2015) (Also see Supplementary Materials 6.3).

This section presents both short and long-term options for decision makers that contribute to integrated approaches to freshwater governance **(Table 6.5)**.

6.3.4.1 Improving water quality

Setting clear water quality standards**:** Improved water quality standards are essential to protect both nature and human health, by eliminating, minimizing and significantly reducing different streams of pollution into water bodies (SDG6) including river basins **(Figure 6.4)**. Command and control regulations such as end-of-pipe control, quality standards and discharge permits have a significant role to play to reduce point source pollution (e.g., wastewater from households, commercial establishments and industries) (Kubota & Yoshiteru, 2010; UNEP, 2016; OECD, 2017; WWAP, 2017; WWAP, 2012). A strong and transparent implementing authority with necessary technical and managerial capacity as well as provisions on access to information that benefits implementation and enforcement processes would benefit such regulatory measure (UN-Water 2015b). In addition, mitigation of the impacts of pollution from non-point or diffuse sources (e.g., run-off from urban and agricultural land) requires ecological responses,

Table 6 5 Options for integrated approaches for freshwater governance.

Short-term options	Long-term options	Key obstacles, potential risks, spill-over, unintended consequences, trade offs	Major decision maker(s)	Main level(s) of governance	Main targeted indirect driver(s)
Improving water quality					
Setting clear water quality standards; data gathering & monitoring		• Identification of non-point sources • Lack of managerial and technical capacity	National sub-national and local government, private sector, IPLCs, civil society	National, sub-national, local	Institutions, governance, technological
Collaborative initiatives and IPLC monitoring		• Lack of adequate monitoring; • Lack of adequate or effective remedial action	Global, regional, national government, private sector, IPLCs, civil society, donor agencies, science and education organisations	All	Institutions, governance
Technological advances		• Lack of quality standards • Lack of institutional and financial capacity	Regional, national government, private sector, donor agencies, science and education organisations	All	Economic, technological
Strengthening standards for corporate sector		• Lack of compliance monitoring • Lack of enforcement	Global, regional, national government, private sector, donor agencies, NGOs	All	Economic, institutions, governance
Managing water scarcity					
Water abstraction charge		• Abstraction charge may not reflect the environmental cost and vulnerability of local population	National sub-national, local government; IPLCs, private sector, citizens (households, consumers), community groups, farmers	National, sub-national, local	Institutions, economic, governance, demographic
Restrict groundwater abstraction		• Lack of management plan for groundwater • Lack of (or weak) ownership right of groundwater • Lack of monitoring of data • Lack of policies harmonising groundwater with energy, agriculture and urban development policies	National, sub-national, local, private sector, IPLCs, citizens (households, consumers), community groups, farmers	National, sub-national, local	Economic, institutions, governance. demographic
Water efficient agricultural practices		• Lack of access to water efficient technologies for agriculture and optimized irrigation systems • Lack of technical assistance and finance	National, sub-national, local, private sector, farmers, IPLCs	National, sub-national, local	Technological, institutions, governance, economic
Engaging stakeholders					
Integrated, rights based, and participatory approach to water management		• Weak (or lack of) transparent process to identify relevant stakeholders • Weak provisions to access information by stakeholders • Ineffective participation of all stakeholders including IPLCs • Weak (or lack of) a right based approach to protect water resource • Inadequate regulatory framework to support custodianship and open access	National, sub-national, local government; private sector, civil society, IPLCs, donor agencies, science and education organisations	National, sub-national, local	Institutions, governance, cultural

Short-term options	Long-term options	Key obstacles, potential risks, spill-over, unintended consequences, trade offs	Major decision maker(s)	Main level(s) of governance	Main targeted indirect driver(s)
Use of economic instruments					
Payment for water ecosystem services		• Lack of quantifiable environmental objectives at the watershed level • Lack of evaluation of environmental additionality • Lack of monitoring of ecosystem services outcomes	National, sub-national, local government, civil society, IPLCs, private sectors, donor agencies	National, sub-national, local	Economic, institutions, governance
Improving investment and financing					
Public private partnership		• Ineffective regulation, monitoring • Lack of consideration of ILK and IPLC cultural values	National and local governments; civil society including communities, small farmers, workers, women, and IPLCs. Agribusiness, mining companies, finance capital, and international financial institutions	All	Economic, institutions, governance
Promoting Integrated Water Resource Management					
Fostering polycentric governance		• Fragmentation of instruments and institutions • Complexity of issues • Reluctance to move beyond traditional methods	National and local governments, IPLCs, Civil Society, private sectors	Regional, national, sub-national, local	Economic, governance, institutions
Facilitating integration across sectors		• Acknowledge water-food-energy nexus • Broadening the knowledge base	National and local governments, IPLCs, Civil Society, private sectors	Regional, national, sub-national, local	Economic, governance, institutions, technological
Harness international normative framework		• Lack of compliance and implementation	National and sub-national government	Regional, national, sub-national, local	Economic, governance, institutions
Encouraging transboundary water management					
Implementing international law norms and basin treaties		• Lack of political will • Fragmentation • Lack of funding • Lack of implementing mechanisms and institutions	• Treaty Secretariats • National and Supra-national governments • Non-state actors such as NGOs, private sectors, individuals	Global, international, national	Economic, institutions, governance, regional conflicts
Addressing fragmentation		• Lack of political will • Lack of implementing institutions	Treaty secretariats, National supra-national governments	Global, regional, national	Governance, institutions
Strengthening participatory tools		• Lack of information • Lack of effective consultation and participation; • Weak institutions to promote co-decisions • Lack of monitoring	Treaty secretariats, national and supra-national governments	Global, regional, national	Governance, institutions

and education and awareness programmes (OECD, 2017). A basin wide programme can play a positive role in reducing run-off from agriculture (UNEP 2016; GEO6 Freshwater). Moreover, nature-based measures on water purification, soil erosion, urban stormwater run-off, flood control can effectively promote green infrastructure (WWAP/UN Water 2018; Also see section 6.3.5.3).

***Collaborative initiatives*:** The countries with shared water may develop and enforce water quality standards through international or inter-state agreements (GEO-6 Freshwater, 2017). Agreements managing transboundary water can identify highly contaminated sites, develop and implement remedial action and monitoring, and contribute to measurable improvements in the water quality (GEO-6,

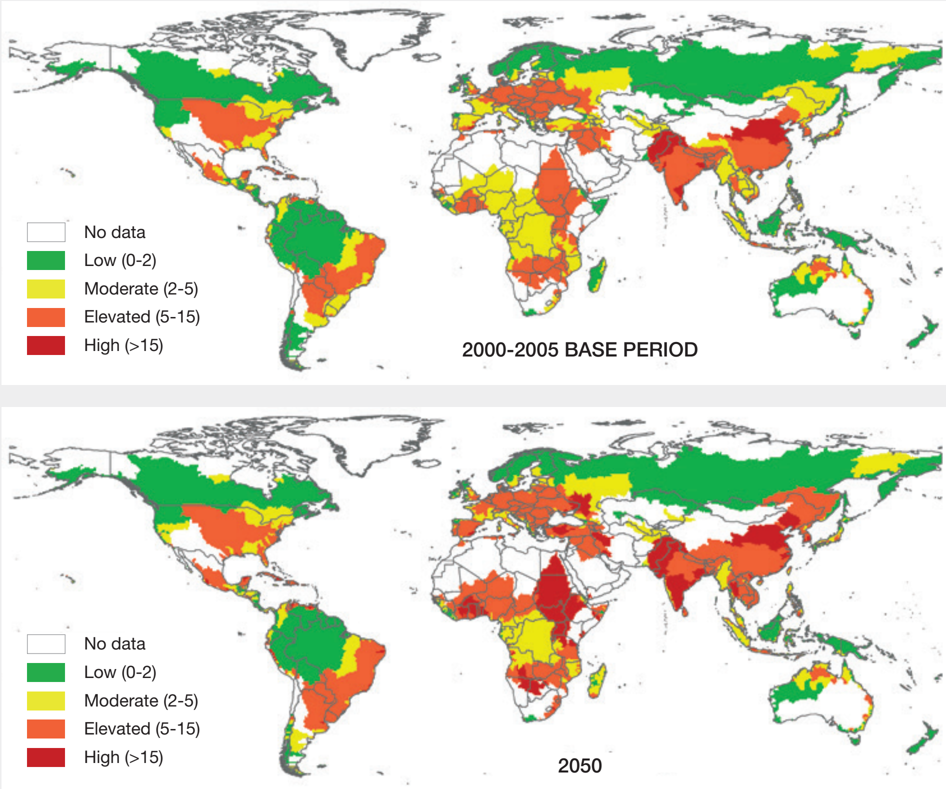

Figure 6 4 **Water quality risk indices for major river basins.**

Water quality risk indices for major river basins during the base period (2000-2005) compared to 2050 (Veolia & IPFRI, 2015, fig.3, p.9).

Freshwater; UNEP, 2016). Well-defined and collaborative international commissions (e.g., Rhine Action programme) or national institutions (e.g., London River Action Plan, 2009) can reduce fragmentation of water management and provide a valuable platform for all relevant actors within the river basin (UNEP, 2016). Such international (e.g., Danube river, Black Sea) and national as well as local collaboration (e.g., 'River Chief' system in China, Wang *et al.,* 2017) to set water quality standards can help ensure that financial resources are spent in the most effective way (UNEP, 2016; WWAP, 2017).

IPLC monitoring: The intimate connection that IPLCs maintain with their freshwater bodies, through intergenerational transmission of knowledge and practices, puts them in a privileged position to closely monitor water quality (Sardarli, 2013; Bradford *et al.,* 2017; see chapter 2.2). In many IPLC worldviews, water is a spiritual resource (e.g., the lifeblood of Mother Earth) that must be respected and kept clean (Mascarenhas, 2007; Collings, 2012; Basdeo & Bharadwaj, 2013; Weir *et al.,* 2013; Morrison *et al.,* 2015). Given that pollution poses important threats to many IPLC livelihoods and cultures (e.g., Orta-Martínez *et al.,* 2007, 2017; Kelly *et al.,* 2010; Harper *et al.,* 2011; Huseman & Short,2012; Nilsson *et al.,* 2013; Jiménez *et al.,* 2015; Bradford *et al.,* 2017) different IPLC groups are engaging, or even initiating community-based monitoring of freshwater quality (Deutsch *et al.,* 2001; Benyei *et al.,* 2017), although evidence on the effectiveness of these initiatives is still largely lacking.

***Technological advances*:** Options targeting the treatment of wastewater and water reuse include pollution prevention at the source (e.g., industries, agriculture), treatment of polluted water, safe reuse of wastewater, and the restoration and protection of ecosystems (UNEP, 2016; WWAP, 2017; WWAP, 2012). The discharge of untreated wastewater can have severe impacts on human and environmental health, including outbreaks of food-, water- and vector-borne diseases, as well as pollution and the loss of biological diversity and ecosystem services (WWAP, 2017). The collection of wastewater and applying appropriate levels of treatment for other uses or discharge into the environment can be improved with quality standards and regulations for incoming wastewater streams and outgoing treated wastewater (WWAP, 2017; OECD, 2017). In addition, it is well established that sufficient institutional capacity and financing are required to build wastewater treatment plants in developing countries and emerging markets (WWAP, 2017).

Data gathering and monitoring: Although there are attempts to gather water related global monitoring data (WWAP, 2017; WWAP, 2012), it is well established that there is a lack of data relating to water quality and wastewater management, particularly in developing countries (UN-Water 2015a) and most notably, in areas inhabited by IPLCs (Nilson *et al.,* 2013; Bradford *et al.,* 2017). Policies that promote holistic assessment of water including gathering of data on water quality and cycle can inform decision-making and increase understanding on how to manage water and ecosystem services sustainably (UNEP, 2016; WWAP, 2012; WWAP, 2015).

Strengthening standards for the corporate sector: There will always be trade-offs between business needs and targets. Better understanding is needed between long-term approaches to meet global goals and short-term approaches chosen by companies. There is opportunity to develop and strengthen voluntary standards that comply with international best practices (e.g., CEO Water Mandate's Integrity Guidelines and Framework, International Water Stewardship Standard, European Water Stewardship Standard), IFC Performance Standards on Environmental and Social Sustainability and SDG6. These voluntary standards aim to enable business and their supply chains to comply with the voluntary standards. Recently, the global corporate reporting standards for water have been revised to measure water consumption and withdrawal in water stressed areas more efficiently (GRI 303: Water, 2018). Such reporting standards aim to enable the corporate decision makers to assess the impacts of their activities on water and how to sustainably manage the resource. Increasing trade of 'virtual water' has led to competition with local water users and exacerbated the need for inclusive and informed water governance (Sojamo *et al.* 2012; Sojamo & Archer 2012). Indeed, several certification schemes include water use and water pollution related issues (e.g., GlobalGap, MPS-ABC, the Rainforest Alliance, IFOAM, Alliance for Water Stewardship). These certification schemes are not without criticisms such as lack of transparency, exclusion of stakeholders, negligible environmental benefits, and poor monitoring. The challenge is to ensure that the certification schemes do not create unequal allocation of water between export-oriented companies and local water users' communities and respect local and customary water rights.

6.3.4.2 Managing water scarcity

Water scarcity is common throughout West Asia and Asia Pacific regions, and in arid parts of Africa and the Americas (GEO-6 Freshwater, 2017). Water scarcity leads to droughts, soil degradation, excessive extraction of groundwater and loss of wetlands with negative impacts on nature and NCP (WWAP/UN Water, 2018; CBD, 2015; Wetlands International, 2010). In the short-term, one option for policy makers is to put water rationing measures to reduce freshwater usage. Water authorities and government may decide to promote water rationing as an emergency measure or as part of a legal water right (GEO6 Freshwater 2017). Option such as water abstraction charge (or water resource management charges) commonly targets industrial users, agriculture, hydropower producers, domestic users and energy production (OECD, 2015), but the charges may not lower water consumption (Finney, 2013; Kraemer, 2003a). To mitigate the negative impacts of any water allocation reform, the decision makers may need to find a balance among divergent interests (Finney, 2013; Rogers, 2002). Abstraction charges for large scale usage of surface and groundwater can be an option to allocate and use water more efficiently. However, such abstraction charge needs to reflect the environmental cost and vulnerability of the local population (Finney, 2013; OECD, 2017b; Kraemer *et al.,* 2003a).

In addition, coherent policy across sectors such as water, energy, climate change and agriculture is needed so that policy reform in one sector does not encourage over-consumption of water resources (FAO, 2014; Bazilian *et al.,* 2011; Olsson, 2013; Benson *et al.,* 2015). In the short-term, e.g., modifications in the land use policy may encourage conservation of water through the use of water efficient agricultural practices, optimized irrigation systems, improved crop varieties, rainwater harvesting and floodwater storage, and discourage agricultural runoff and water loss in the regions with water scarcity (Reddy *et al.,* 2018; OECD, 2015). Greater policy coherence will play a crucial role to reduce negative economic, social and environmental externalities; however, such coherence is vital for better coordination among decision makers and increased collaboration among stakeholders (Rasul, 2016; FAO, 2014; Hussey & Pittock, 2012; Benson *et al.,* 2015).

Option such as desalination of water is used in arid west Asian countries and US (e.g., California) and resulted in increased investment in new desalinization plants (West Asia Regional GEO-6, 2017; North America GEO-6, 2017). Solar desalinization is an alternative that is being applied in several small island states (GEO-6 Freshwater, 2017). There are trade-offs involved as desalination projects require large amounts of energy and 'produces highly concentrated brine' (OECD, 2017) which can negatively affect coastal ecosystems (WWAP, 2017). Thus, the efficiency of the desalinization projects is contested and inconclusive.

Restrict groundwater abstraction: Groundwater abstraction has risen sharply over the last 50 years (Shah *et al.,* 2007) and groundwater pollution has degraded groundwater dependent ecosystems (FAO, 2016a, b; Wada, 2010; Foster, 2013). Surface water and groundwater are closely linked and should be managed conjunctively

(Foster, 2011). It is well established that there is a need for better data regarding existing groundwater resources including their recharge, use and discharge rates (UNEP, 2012; Pandey *et al.,* 2011). As for options, *first*, in the short-term, a management plan on groundwater or both surface and groundwater may clearly set out a framework for groundwater allocation and may contain water quality and salinity management plan (OECD, 2017b; OECD, 2015). *Second*, another short-term approach would be to adopt the rights-based approach to manage water (including groundwater) that may strengthen the provisions on ownership of water, user rights and customary rights, rules related to pollution control and roles and responsibilities of competent authorities (WWAP, 2015; Winkler, 2012; Misiedjan & Gupta, 2014; Mechlem *et al.*, 2016). *Third*, collection and monitoring of data are even more crucial for groundwater management due to the interconnected nature of surface and groundwater and the need for monitoring groundwater abstraction is well established (Custodio, 2002; Konikow, 2005; Shah *et al.,* 2000; FAO, 2016). However, such monitoring will require installation of water meter and tracking of water usage and consumption and monitoring aquifers is technologically demanding and costly (OECD, 2017b; Van Geer, 2006). *Fourth*, groundwater allocation needs to be coherent with policies in other sectors such as energy, agriculture and urban development so that subsidies in one sector do not lead to overconsumption of groundwater (Varady, 2016; Hussey & Pittock, 2012; Alley *et al.,* 2016).

6.3.4.3 Engaging stakeholders

Engagement of stakeholder includes integrated and participatory approach to freshwater management and helps the decision makers to identify innovative and equitable solutions (Varady, 2016). For river basins and water catchments management, multi-level collaborations of government bodies, multi-stakeholder engagement and partnership of various water users at the local level remain crucial (Megdal *et al.,* 2017). Instead of 'top down' policies, it is well established that 'bottom up' policies connecting decision makers and water users promote informed decisions, enhance effectiveness of decisions, and reduce conflicts among water users (Varady, 2016; UNEP, 2016; WWAP, 2017). For example, comprehensive treatment of wastewater is generally undertaken at the local level. Therefore, stakeholder engagement (e.g., through communication, consultation, participation, representation, partnership, co-decision) and motivation for compliance remain crucial for any local policy measure (Akhmouch & Clavreul, 2016). In addition, any such local measure will need to be adapted to economic inequalities, local circumstances, ecosystem needs, competing uses of water and culturally acceptable practices (WWAP, 2017). To increase the use of treated wastewater at the national level, quality standards along with financial or legal incentives can be integrated into national water supply schemes (WWAP, 2017; Hanjra *et al.,* 2015). Consulting with various water users and engaging them in monitoring and performance assessment can help the decision makers to decide the preferred reform options for water management, recognise multiple values and gain a better understanding of the preferences of different waters users (Megdal *et al.,* 2017).

Greater engagement of IPLCs in water governing bodies such as through negotiated agreements (Jackson & Barber, 2015) can serve a purpose in incorporating IPLC social, spiritual and customary values in water management (King & Brown, 2010; Finn & Jackson, 2011; Barber & Jackson, 2012), as well as local ecological knowledge (Weir *et al.,* 2013; Escott *et al.,* 2015). For example, native title law in Australia recognizes Aboriginal rights and cultural values of water, requiring environmental flow requirements for indigenous values in water plans (Jackson & Morrison, 2004; Jackson & Langton, 2011; Jackson *et al.,* 2014). More specifically, adaptive water management regimes have been shown to be effective in accommodating IPLC water entitlements and greater participation of IPLCs in multi-stakeholder water governance (Bark *et al.,* 2012), which may include greater roles of IPLCs in market-based water trading and management mechanisms, where they currently play a minor role (Jackson & Langton, 2011).

Non-governmental organisations can play a role in the formulation of river trusts to protect certain species or pollution event and manage the water catchment (e.g., Severn Rivers Trust in the UK). Success of this type of arrangement depends on the voluntary participation of communities to reach local solutions. Such trust, as a custodian of the waterways, can work with its partners and volunteers to look after the heritage and wildlife on the canals and rivers for present and future generations (e.g., UK Canal and River Trust, 2015).

Along these lines, there is a growing trend towards the recognition of the rights of rivers, as part of a broader movement promoting the rights of nature (Pacheco, 2014; Akchurin, 2015; Díaz *et al.,* 2015; Borràs, 2016; Demos, 2015; Humphreys, 2016). For instance, by granting legal personality to the Whanganui River, the Government of New Zealand found an innovative way to honor and respect the Maori traditional worldviews that see the river as "an indivisible and living whole", as well as the its associated traditional customary institutions for river governance (*Te Awa Tupua (Whanganui River Claims Settlement Act,* 2017; Archer, 2013; Strack, 2017). The legislation recognizes the river as a "living entity" and establishes a co-management regime for collaborative water governance with the Whanganui River Iwi, an indigenous community with cultural ties to the river (Hutchison, 2014; Tanasescu, 2015).

6.3.4.4 Use of economic instruments

There are a range of economic instruments that guide the water sector including tradeable quotas, abstraction charges, payment for ecosystem services (PES), license fees, biodiversity offsets, and subsidies (UNEP 2007; Grafton 2011).

Currently, Latin America is the region that counts with more cases of implementation of PES dealing with the protection of watershed services (Brauman *et al.*, 2007; Brouwer *et al.*, 2011; Grima *et al.*, 2017; Martin-Ortega 2013; Stanton *et al.*, 2010). State-led programs constitute the majority of these schemes. Studies assessing the effects of the PES on water flows or quality are basically non-existent, in part due to the methodological difficulties and costs that entail to carry out such type of analyses (Alam 2018; Salzman 2018). Most of PES dealing with water-related ecosystem services are based on empirically untested assumptions about the relationship between land use and the condition and flow of water resources. However, such relationships are complex, and generalizations are difficult to hold (Scott *et al.*, 2004; Sun *et al.*, 2017). Reviews on PES in watersheds have found that most of them are unable to demonstrate impacts on water-related ecosystem services (Brouwer *et al.*, 2011; Yan *et al.*, 2018). In general, the lack of evaluation of environmental additionality is a pervasive problem in PES (Pattanayak *et al.*, 2010), though there have been recent advancements (Jayachandran *et al.*, 2017). The lack of enforcement of conditionality, monitoring of ecosystem services outcomes and evaluation of impacts are reported as recurrent caveats of PES design (Ezzine-de-Blas *et al.*, 2016).

Considerable knowledge gaps still remain with regards to several subjects in PES schemes implemented in watersheds: (a) How to address the uncertainties associated with the relationship between land use and the provision of hydrological services; (b) The extent to which PES schemes are inducing additional effects not only in land use practices but also on the conditions of water resources; (c) How different payment modalities influence rules about the management of common pool resources, such as water; and (d) The long-term relational and behavioural implications of the payments among the involved stakeholders, particularly relations between agents along the watersheds. In addition, the next generation of studies should pay more attention to how to deal with the trade-offs that arise between pursuing ideal design principles, on one hand, and transaction costs and the need to reconcile different policy goals, on the other. Attention should be also given to the profile of PES participants, which has important implications for impact assessment (Grillos 2017; Jack & Jayachandran 2018).

Since the effects of PES schemes on water-related ecosystem services remain largely uncertain, the issue of what can decision makers do to make these interventions effective remain a critical one. *First*, as stated above, impact evaluation systems (and their costs) should be considered in the design of schemes. The establishment of an impact evaluation system should be considered as an inherent part of PES design. Win-win outcomes from PES should not be taken for granted. Indeed, over-reliance on payments as win-win solutions may lead to disappointed results (Muradian *et al.*, 2013). *Second*, in order to enhance legitimacy, the possibility of the existence of multiple values should be acknowledged in the design, implementation and evaluation of PES schemes. The socioeconomic outcomes of the payments might have different meanings to different social groups. *Third*, the assumptions about the relationship between land use and the provision water-related ecosystem services should be derived from empirical evidence. *Fourth*, the management of the scheme should follow adaptive and dynamic principles, based on knowledge generation and incorporation into the design and implementation. Any social-ecological system is dynamic, and the effectiveness of interventions is dependent on the capacity of managers to follow and be responsive to changes.

6.3.4.5 Improving investment and financing

The targets of SDG 6 and the related Aichi Biodiversity Targets (2, 7, 8, 11, 14, 15) require investment in hard infrastructure, such as water- and wastewater- treatment plants, reservoirs, pipes, and sewers; and investment in service systems, including enforceable legal rights, democratic accountability, research and support for local communities and small farmers. The key decision makers for these public goods can be categorized as (A) national and local governments elected by the people of the country; (B) organisations including indigenous and local communities, small farmers, workers, women, and ethnic groups. In parallel there are others pursuing private or market goods, including (C) agribusiness, mining companies, finance capital, and international financial institutions. There are conflicts of interest between these groups in relation to choices for financing investment.

It is well established that investment in wastewater treatment needs to be combined with regulation, monitoring and enforcement (WWAP 2017; OECD 2017a). Leaving ownership and investment to market mechanisms leads to land and water 'grabs', (Woodhouse 2012; Mehta *et al.* 2013), and to price hikes for water and sanitation services (Chong *et al.*, 2006). Thus, business and international financial institutions (group C) have advocated the use of private finance, reinforced by international public sector agencies, to select suitable projects for commercial viability, with public benefits emerging as externalities (Serageldin 1995; Marin 2009; McKinsey 2009). This includes the consistent promotion of Public Private Partnerships (PPPs) as a vehicle for financing investment required for the SDG. PPPs can help incentivize and even co-finance the wastewater sector and promote small- and medium-scale entrepreneurs (WWAP 2017; Murray *et al.*, 2011). However, benefits arising from PPP projects in the water sector are contested and the need to integrate social and environmental considerations in the PPP is well established (Martin 2009; Stringer *et al.* 2018). Sustainable financing for water pollution may benefit from a mix of economic policy instruments that promote an efficient allocation and use of water and reduce water pollution (UNEP 2016)

Actual private investment in water, wastewater and other infrastructure has failed to meet expectations, and has been almost negligible in lowest income countries (Clarke Annez 2006; Foster & Briceño-Garmendia 2010; Gleick 2014; Hall & Lobina 2006). Public sector investment, financed by both tax revenues and utility surpluses, has been the key to development of water infrastructure both in high income countries, including France, and in developing countries, where the MDG for drinking water was met ahead of target (Foss-Mollan 2001; Pezon 2009; Hall & Lobina 2012). For governments and civil society (groups A and B), public finance is more susceptible to democratic accountability and control. Formal techniques, such as cost-benefit analysis, have been used for many decades to evaluate government decisions on investment in water resources, water supply and sanitation (Haveman 1965; Gunter & Fink 2010).

Investment by small farmers, especially with public sector support, can result in more sustainable and biodiversity sensitive investment in irrigation (Xie *et al.*, 2014; Woodhouse *et al.*, 2017; Fraiture & Giordano 2014) and public sector investment in irrigation can successfully reflect economic and resource factors (Rosegrant & Pasandaran 2016), whereas the use of market mechanisms by raising prices impacts farmers' income without improving efficiency (Varela-Ortega *et al.*, 1998). Meanwhile, Natural Capital Accounting could provide an option for the efficient use of scarce natural resources. The WAVES partnership, for example, has supported Botswana, Madagascar and Rwanda to develop accounting methods which include natural capital (Waves Partnership 2013; Stringer *et al.* 2018).

IPLCs have often expressed that engagement in water management is generally limited to consultative capacity through ineffective representative processes (Behrendt & Thompson 2004; Hunt *et al.*, 2009). The development of partnerships optimizing IPLC participation offers substantial opportunities for greater IPLC engagement in water management (Tinoco *et al.*, 2014; Escott *et al.*, 2015; Jackson & Barber 2015). Capacity building relevant to water resources management (Jackson & Altman 2009; Hoverman & Ayre 2012), financial support to allow for participation (Jackson *et al.*, 2009; Escott *et al.*, 2015) and greater consideration of ILK and IPLC cultural values (Mooney & Tan 2012; Nikolakis *et al.*, 2013; Maclean & The Bana Yarralji Bubu Inc. 2015) have been deemed as key enabling factors for fostering effective IPLC participation in water governance (Escott *et al.*, 2015).

6.3.4.6 Promoting Integrated Water Resource Management

Fostering polycentric governance: Particular institutional challenges of catchment-level governance are the reluctance of existing power structures to devolve authority (Jager *et al.*, 2016; Moss 2012; Ring *et al.* 2018) and to move beyond specific pollutants to more systematic governance. Implementation of the Water Framework Directive (WFD) illustrates how many member states have maintained existing structures and procedures while resisting the transfer of power to new river basin authorities (Jager *et al.*, 2016; Ring *et al.* 2018). Failure to implement plans also often compromises the delivery of WFD objectives (Voulvoulis *et al.*, 2017). Implementing polycentric governance remains a key option. For example, the South African National Water Act (1994) aims to adopt a system of polycentric governance at the level of 19 Catchment Management Authorities. While the approach has seen some of the challenges of devolution discussed above, it has been successful in addressing cross-sectoral integration (Muller 2012; Stringer *et al.* 2018).

***Facilitating integration across sectors*:** IWRM enables decision makers to move beyond single-issue policies. Linking land-use and water planning for example has resulted in large urban populations gaining access to water and sanitation (GEO6 H20 chapter; PanEurope GEO6; North American GEO6; LAC GEO6). Understanding telecouplings between distant natural and human systems are an important option for holistic approaches to managing complex socio-ecological systems (Liu 2013; Liu 2015). Consideration of the Water-Food- Energy nexus contributes to taking telecoupling between distant and local drivers of change into account when implementing IWRM (e.g., Stringer *et al.* 2018). In addition, such integration would benefit from the application of social science research to enable greater inclusion of knowledge from policy and political science and public administration and provide important insights into watershed governance (Sabatier *et al.*, 2005; McDonnell 2008; Cook & Spray 2012; Lubell & Edelenbos 2013).

Harness international normative framework: Adoption of integrated watershed, catchment and river basin management strategies is emphasized as one option to maintain, restore or improve the quality and supply of inland water resources (CBD COP Decision IV/4 (1998)). The UNECE Water Convention on the Protection and Use of Transboundary Watercourses and International Lakes (1992) requires parties to take "all appropriate measures" to conserve and restore ecosystems (Article 2). These include the establishment of water quality objectives and criteria, conservation and restoration of ecosystems, and development of concerted action programmes for the reduction of pollution. The Ramsar Convention on Wetlands (e.g., Resolution VIII.16, 2002) also emphasizes the importance of restoration and the inclusion of multiple actors including private landowners, NGOs, and IPLCs in wetland restoration planning and implementation (WWAP-UN Water 2018). A key option for riparian governments and NGOs is to harness the international normative framework to implement national and watershed scale measures. This includes the development of legal instruments and policies for controlling alien species and wetlands restoration – e.g., the Working for Water (WfW) programme pays actors to remove invasive alien species in South Africa while enhancing the capacity and commitment to solve invasive species issues (https://www.environment.gov.za/projectsprogrammes/wfw). (See section 6.3.2.5 for ecosystem restoration).

6.3.4.7 Encouraging transboundary water management

The IWRM options (section 6.3.4.6) are also applicable to the transboundary context. In addition, further options are set out below.

Implementing international law norms and basin treaties: Existing international obligations provide the normative framework and a level playing field for basin level implementation at national and transboundary levels. For example, the UN Watercourses Convention's process-based norms offer options for interpreting and implementing the convention and implementing an effective system at the national level (Rieu-Clarke & Lopez 2013). In addition, basin level treaties can offer effective mechanisms for managing transboundary basins and preventing the escalation or emergence of transboundary disputes (Brochmann & Hensel 2009; Tir & Stinnett 2012; Dinar *et al.*, 2015). The content and design of such treaties need particular consideration (Dombrowsky 2007). For instance, options for securing compliance include strong mechanisms for dispute resolution (UNEP 2002; Lim 2014) and recognition of non-state parties (Jacobson & Brown-Weiss 1998). On the other hand, sanctions are the least effective in terms of implementation across national borders (Brunée 2007).

Addressing fragmentation: Regime fragmentation is a key obstacle of the law of transboundary watercourses (Zawahri 2011; Rieu-Clarke & Pegram 2013) as there is a common trend to adopt bilateral agreements within multilateral river basins (Song & Whittington 2004). The second assessment of the implementation of the UN Watercourses Convention emphasizes the importance of integrating sectorial policies to avoid perverse outcomes (European Commission for Europe 2011). The UN Watercourses Convention and the UNECE Water Convention are the two main international Conventions governing the management of transboundary water resources. Both are in force, open to all countries and mutually reinforcing (McCaffrey 2014). Rieu-Clarke and Kinna (2014) therefore recommend a 'package approach' and three institutional options for States to address fragmentation while simultaneously implementing both Conventions. The first option suggests that the UNECE Secretariat would be responsible for servicing both Conventions. The second envisages two parallel institutional frameworks where each Convention has its own Secretariat. The final option is to maintain the *status quo* where contracting states would not need to make any amendments to the two existing Conventions.

Strengthening participatory tools: Data sharing provisions within transboundary agreements is an important option for enhancing effective transboundary water resource management. Even where data is shared, concerns often remain over their veracity (Turton *et al.*, 2003; Timmerman & Langaas 2004; Grossmann 2006; Armitage *et al.*, 2015; Gerlak *et al.*, 2011). Conversely, data and information can facilitate transparency and trust which in turn enhances compliance (Young 1994; Burton & Molden 2005; Gerlak *et al.*, 2011). In addition, improved stakeholder engagement and enhanced capacity for integrated problem solving are key components of the success of the transboundary endeavor (Dore *et al.*, 2012; Lim 2014). Where stakeholders perceive particular rules to have emerged from a legitimate process, they are more likely to comply with their commitments (Franck 1998; Jacobson & Brown Weiss 1998; Breitmeir *et al.*, 2006; Brondizio & Le Tourneau 2016; Diaz *et al.*, 2018).

6.3.5 Integrated Approaches for Sustainable Cities

Urbanization is one of the most forceful drivers of ecological change (Seto 2013), with more than two thirds of the world's population expected to live in cities by 2050 (United Nations 2010). The most significant growth in urbanization during the 21st century will occur in the developing world, particularly Africa and India, which combined will add more than 1 billion *new* urban residents by 2040 (UNDESA 2014). In urban areas human populations and human built infrastructure are the most dense (Grimm *et al.*, 2008), and can drive significant impacts on local, regional, and global nature and its sustained contributions to people's quality of life if not managed properly (McPhearson *et al.*, 2018). More than half the global urban population lives in settlements of less than one million, and attention is needed across the urban hierarchy, from global cities to towns and small villages (UN Habitat and United Nations ESCAP 2015).

Globally, urban land cover is projected to increase by 1.2 million square kilometers by 2030. This could result in considerable loss of habitats in key biodiversity hotspots, including the Guinean forests of West Africa, the tropical Andes, the Western Ghats of India, and Sri Lanka (Seto *et al.*, 2012), and of Mediterranean habitat types (Elmqvist 2013). Yet despite major changes to ecological properties, critical NCPs are still present in urban settings (Gomez 2013a, Gomez 2013b). An array of options for the protection, adaptive management and restoration of nature in cities are thus critical to maintain a supply of nature's contributions to urban populations and are essential to engender more sustainable futures for city inhabitants (McDonald 2013; McPhearson *et al.*, 2014).

Planning for the impacts of climate change on urban settlements is also a core challenge for our urban future, as highlighted by the inaugural IPCC Conference on Cities and Climate Change in early 2018. Cities consume 75% of the world's energy use and produce more than 76% of all carbon, and are therefore major contributors to climate change, but are also highly vulnerable to risks, especially in coastal locations (Bai *et al.*, 2016). Reducing the impact of climate change will require a more integrated approach to urban design, planning and construction; urban ecosystems; and transport, energy, water and urban governance (Rosenzweig *et al.*, 2016). It will also require implementation by all levels of government – both national urban policy and state and local strategies and actions (OECD 2010), yet many barriers exist that prevent integrated urban approaches, ranging from financial challenges to lack of information to sectoral fragmentation (Runhaar *et al.*, 2018)

The good news is that urban planning and policy in cities around the world are already developing novel approaches, methods, and tools for developing sustainable cities, including in developing countries (Norman 2016, McEvoy *et al.*, 2013, Measham *et al.*, 2011). This section reviews options in the short and longer-term to enable sustainability transitions in cities, while recognizing that the challenges, and thereby the options, differ in the global South and North (Nagendra *et al.*, 2018). The section focuses on the main groups of options for sustainable cities: urban planning for sustainability; nature-based solutions and green infrastructure; reducing the impact of cities; and enhancing access to urban services for a good quality of life (see for an overview **Table 6.6**).

Table 6 6 **Options for sustainable cities.**

Short-term options (both incremental and transformative)	Long-term options	Key obstacles, potential risks, spill- over, unintended consequences, trade-offs	Major decision maker(s)	Main level(s) of governance	Main targeted indirect driver(s)
Urban planning for sustainability					
Bioregional planning		Traditional urban planning that focuses only on development	National & local government, civil society	National, regional, local	Economic, demographic, Institutions, governance
Nature-friendly urban development		Lack of understanding of habitat needs of animals and plants	National & local government	National, regional; local	Institutions, governance
Increasing green space		Trade-offs between densification and green space, increasing land prices	Local government	Local	-
Protecting land for urban agriculture and food security		Zoning that limits urban food production, increasing land prices	Local government, civil society	Local	Cultural
Nature-based solutions and green infrastructure					
Promoting or requiring green roofs to counterbalance temperature effects		Resistance to requiring GI by law, increases in maintenance costs, lack of incentives	National and local government	National, local	-

Short-term options (both incremental and transformative)	Long-term options	Key obstacles, potential risks, spill- over, unintended consequences, trade-offs	Major decision maker(s)	Main level(s) of governance	Main targeted indirect driver(s)
Planting trees to reduce air pollution, mitigate climate change and storm-water control		Trade-offs between densification and green space, concerns about liability and building damage, costs of maintenance	Local government, civil society	Local	-
Protecting watersheds and wetlands for habitat conservation, clean water supply and storm-water control		Trade-offs with other land uses, pressures for development of coastal areas	Regional and local governments	Regional, local	Health
Protecting, creating or restoring wetlands, tidal marches or mangroves for flood protection		Trade-offs with other land uses, pressures for development of coastal areas	Governments	Regional, local	-
Reducing the impacts of cities					
Encouraging articulated density to enable public and active transportation (e.g walking, bicycles)		Trade-offs between densification and green space; changes in lifestyle needed	Regional and local governments	Regional, local	Economic, demographic, cultural, Institutions, governance
Reduce transport energy use through road-use pricing, promoting public transportation		Changes in lifestyle needed, political will to increase taxes on externalities	Governments	National, regional, local	Cultural
Mitigating building energy use by energy-efficient building codes		Resistance to requiring codes by law, costs of retrofitting	Industry, governments	Local	Technological
Addressing urban consumption by encouraging alternative business models		Change in lifestyle needed, planning for circular economy needed	Governments, industry, civil society	All	Economic, Cultural, institutions, governance
Enhancing access to urban services for good quality of life					
Enhancing access to clean water and sanitation, through SUWM, partnerships, investment, etc.		High costs for water infrastructure, concerns about private sector involvement, sectoral siloing	Governments, industry, civil society, private sector	Local, regional	Economic, governance
Improving management of solid waste through incentives & other programs		Difficult to reach informal settlements	Local government, civil society	Local	Economic
Improving access to transportation by investing in public and active transportation		High cost; major shift of focus needed in transportation planning	Governments	National, regional, local	Economic
Encourage participatory planning approaches		Challenges entrenched interests and authorities	Local governments	Local	Governance

6.3.5.1 Urban planning for sustainability

The SDG, UN Habitat (Quito 2016) and the World Urban Forum (Kuala Lumpur 2018) have all collectively reaffirmed the positive contribution integrated strategic urban planning can make in protecting nature within and around cities (Folke *et al.* 2002; Norman, 2018). Over the past few decades, "ecocities" and "green cities" theories began to emphasize the importance of ecosystems within cities and in linked rural areas (Yang 2013). Sustainable urban design seeks to maximize the quality of the built environment and minimize impacts on the natural environment (McLennan 2004). Innovative urban planning theories have emerged, such as Ecological Design (Rottle & Yocom 2011), New Urbanism, Sustainable Urbanism (Farr 2008), Ecological Urbanism (Mostafavi & Doherty 2010), Agricultural Urbanism (De La Salle and Holland 2010), Landscape Urbanism (Waldheim 2007), Green Urbanism (beatley 2000), Biophilic Urbanism (Beatley 2009), Ecocities (Register 2006), and Ecopolises (Ignatieva *et al.*, 2010). These approaches emphasize ecological restoration and connected multifunctional green infrastructure, prioritize walkable and mixed land uses (Register 2006).

Options for sustainable urban planning include: bioregional planning; nature-friendly urban development; increasing green space in cities; and protecting land for urban agriculture (see Supplementary Materials 6.4.1 for a detailed discussion).

- *Bioregional planning:* Inter- and transdisciplinary, collaborative, and strategic urban planning and design that integrates with surrounding regions can offer numerous benefits to water, renewable energy, and air quality (Breuste *et al.*, 2008; Raudsepp-Hearne *et al.*, 2010; Beatley 2011; Colding 2011; Novotny *et al.*, 2010; McDonald & Marcotullio 2011; Pauleit *et al.*, 2011; Ignatieva *et al.*, 2010; Ahren 2013; Carmen *et al.*, 2013; Alexandra *et al.*, 2017).

- *Nature-friendly urban development:* Ecosystems are often highly fragmented in urban areas, which can alter the genetic diversity and threaten long-term survival of sensitive species. To ensure viable urban populations, urban planners need to understand species' needs for habitat quality and connectivity (Kabisch *et al.*, 2017; Braaker *et al.*, 2014; Colding 2011). Ecologically progressive urban planning and policy are already demonstrating how biodiversity conservation and management to enhance local ecosystem services production can be part of urban transitions and transformations for sustainability (Kabisch *et al.*, 2017).

- *Increasing green space and greenbelts throughout cities*: GIS and other holistic spatial planning tools and technologies can be used to create new green spaces and improve and connect existing ones using (Pickett & Cadenasso 2008; Vergnes 2012).

- *Protecting land for urban agriculture and food security*: Urban and peri-urban agriculture, in the form of private gardens, vegetated rooftops, or vertical gardens can both increase food security and conserve biodiversity. Demonstrating that urban agriculture reduces environmental deterioration, increases food security, produces jobs, and connects communities can support rezoning efforts and integration with climate adaptation and flood mitigation policies (Smit 1996; Resource Centers on Urban Agriculture and Food Security).

6.3.5.2 Nature-based solutions and green infrastructure

Increased use of green infrastructure and other ecosystem-based approaches can help advance sustainable urban development while reinforcing climate mitigation and enhancing the quality and quantity of urban NCP (RUAF 2014; Ecologic Institute 2011; Georgescu *et al.*, 2014). The European Commission defines green infrastructure (GI) as "a strategically planned network of natural and semi-natural areas with other environmental features designed and managed so as to deliver a wide range of ecosystem services" (European Commission 2015). Yet, agreement on what exactly constitutes GI is elusive since the term is often used to refer to interventions across a variety of scales including large national ecological networks, wetland restorations, storm-water projects, public green space, allotments, green corridors, street trees, green roofs and walls, permeable pavements and even private gardens (Cameron *et al.*, 2012; Cohen-Shacham *et al.*, 2016).

Green infrastructure can be a critical source for security and improving human wellbeing in urban areas (Gill *et al.*, 2007; Foster *et al.*, 2011; Depietri *et al.*, 2011). Different types of GI can play a role in providing nature's contributions to urban residents such as storm water management and flood protection, temperature regulation, cleaner air and water, urban food production, recreation, and health benefits, as well as contributing to habitat creation and restoration, connectivity of ecological networks, and increasing urban biodiversity (Andersson *et al.*, 2014; Garmendia *et al.*, 2016). GI is also thought to present the most cost effective and synergistic solution for ensuring local climate change adaptation, and promoting low carbon cities (Fink 2016). For example, incorporating green infrastructure in urban design, especially in warmer climates, can potentially reduce the use of air conditioning, increase significant energy savings, and therefore indirectly reduce GHG emissions (Alexandri & Jones 2008; Georgescu *et al.*, 2014).

Specific options for using GI approaches to address urban problems include the following (see Supplementary Materials 6.4.2 for a detailed discussion).

- *GI to counterbalance temperature effects*: The role of some types of GI (trees, green roofs and green walls, parks, ponds) in regulating temperature, including reducing the effects of urban heat islands, is well established.

- *GI for reducing air pollution*: Vegetation can remove or reduce certain pollutants from the atmosphere, including greenhouse gas emissions through carbon sequestration, and trees act as carbon sinks in urban settings (McPherson 1998; McPherson & Simpson 1998).

- *GI to provide clean water supplies*: Provisioning of water is a critical nature contribution to people (NCP) provided by ecosystems and protecting watersheds and wetlands within cities and in the region is crucial. This will also support other regulating NCP including flood alleviation, nutrient cycling, and habitat conservation.

- *GI for storm-water management*: The benefits and cost-effectiveness of GI for storm water and flood control in urban areas are well established (Kabisch *et al.*, 2016).

- *GI for storm and flood control:* A growing number of cases are demonstrating the effectiveness of ecosystems as nature-based solutions to buffer the impacts of climatological, hydro-meteorological and even some geophysical hazards such as landslides (Renaud *et al.*, 2016; McPhearson *et al.*, 2018). The creation or restoration of wetlands, tidal marshes, or mangroves provide water retention and protect coastal cities from storm surge flooding and shoreline erosion during storms (Haddad *et al.*, 2015; Gittman *et al.*, 2014; Kaplan *et al.*, 2009). Similarly, "sponge cities" in China, defined as urban development that takes into account flood control and water conservation through infrastructure planning and ecosystem-based protection, are using GI to combat persistent and significant urban flooding challenges (Li *et al.*, 2017).

Notwithstanding the substantial evidence for the benefits of GI as nature-based solutions, some concerns remain relating to trade-offs, protection of biodiversity, and governance and equity issues. Further research is needed to better understand the synergies and trade-offs between the different benefits offered by GI (Haase, 2015). Promotion of GI at present seems to be focused on opportunities for economic growth, enhancing durability of infrastructure, and cost reduction (Garmendia *et al.*, 2016). GI initiatives would benefit from more explicitly incorporating nature conservation objectives, as well as assessing and safeguarding the impacts of GI projects on biodiversity (Eggermont *et al.*, 2015; Garmendia *et al.*, 2016). A recent EU publication noted the need for habitat suitability and mapping of nature's contributions as part of GI approaches (EEA 2014). In addition, it is also necessary to evaluate the degree of transferability and uptake of GI research within the developing world context, since most research originates in developed countries (Shackleton 2012). Barriers to GI implementation often include a lack of incentives, little institutional support, and concerns about increased maintenance costs (Zhang *et al.*, 2012).

Mainstreaming of GI, and nature-based solutions in general, may include several options. First, meaningful participation from multiple stakeholders is essential in order to identify commonalities and differences between stakeholder preferences (Hansen & Pauleit 2014), and to encourage co-production of initiatives to ensure ownership and stewardship (Nesshöver *et al.*, 2017). Secondly, long-term guardianship of urban areas may require recognition and institutional support for diverse forms of property rights arrangements such as Urban Green Commons (e.g. collectively managed parks, community gardens, allotments) (Colding & Barthel 2013), as well as the empowerment of grass roots initiatives that match solutions to demand (Brink *et al.*, 2016). Lastly, urban planning decision-making processes could benefit from incorporating the concept of the insurance value of ecosystems. This refers to placing importance on the role of nature in conferring resilience that secures the long-term conditions necessary to sustain a good quality of life for humans (Green *et al.*, 2016). This can be applied in an urban planning context to help target investments for GI and urban nature restoration, and might even require involving insurance industry sectors as key investors in GI and nature restoration efforts (European Commission 2015). However, despite the recognition of nature-based approaches as "low regret" measures for climate change adaptation and disaster risk reduction at both local (Kabisch *et al.*, 2017) and global levels (UNISDR 2005, 2015; IPCC 2012), such approaches still remain the most disregarded component of urban plans and strategies (Renaud *et al.*, 2013; Matthews *et al.*, 2015).

6.3.5.3 Reducing the impacts of cities

With global populations urbanizing, the environmental impacts of cities have become increasingly large, such as increasing demand for materials to create infrastructure, vehicles and buildings (IRP 2018). Within this context it is necessary to look at the 'solution space' for cities, noting that some directions for alleviating urban environmental impact are at a national or societal level, and international city-peer organisations such as ICLEI or the C40 collective are sharing experiences among cities on reducing impacts.

The literature on resource efficiency indicates that key issues of concern for urban areas are limited reserves, recycling, and reducing consumption, and from this a systems perspective and circular economy ideas of industrial ecology have emerged (Miatto *et al.*, 2016; Heinz Schandl *et al.*, 2016; Schandl *et al.*, 2015; UNEP 2016). It is worth noting that although thousands of cities report on their (usually only direct) GHG emissions, monitoring of the whole urban metabolism of cities is more rare, but increasing (Kennedy *et al.*, 2011; Huang *et al.*, 2015). Research agencies and NGO are beginning to gather data at the national and international scale, and research indicates that network system modeling approaches, global life-cycle perspectives, and multi-criteria assessments can be key tools (Beloin-Saint-Pierre *et al.,* 2017). Urban environmental assessments will need to become as much a part of planning as housing, transport and economics if we are to measure progress in the resource efficiency of cities. The urban literature points to changes in urban density and form, efficient transport, and how people build, consume, and live in cities as key components to increasing efficiency and reducing impacts (Reid Ewing & Cervero 2010; Reid Ewing & Rong 2008; Weisz & Steinberger 2010).

Specific options for reducing the impacts of cities include the following (see Supplementary Materials 6.4.3 for a detailed discussion).

- *Encouraging density and in-filling:* Sprawling cities generally require more energy for transport per capita (Newman & Kenworthy 1989), more car travel, less travel by public transit (Kenworthy & Laube 1999) and accommodate larger floor area in buildings, which consume more electricity (Kennedy *et al.*, 2015). To be an effective intervention for socio-economic and environmental benefit, density must be implemented at key transport nodes, surrounding and linking between activity centres (Suzuki *et al.*, 2013).

- *Planning urban form and transport:* Planners and industry need to create neighborhoods of mixed land use and diverse housing options that pre-empt the need for citizens to travel across the city (Cervero & Guerra 2011; Ewing *et al.*, 2008; Grubler *et al.*, 2012; Marshall 2008). Other options to reduce transport energy use include internalization of external costs (e.g. congestion pricing), making public transport more attractive, and not extending the road network (Grubler *et al.*, 2012).

- *Mitigating building energy use and emissions*: Buildings are the single largest energy use sector within cities world-wide (Weisz & Steinberger 2010). Significant operational savings can be achieved from implementing energy efficient building codes (Pauliuk, Sjöstrand, & Müller 2013) and with new urbanization and replacement of existing stock, there is an opportunity to decouple energy needs from urban growth (UN Environment and International Energy Agency 2017).

- *Addressing urban consumption:* Reducing the indirect impact of urban consumers can be achieved by promoting the selling of services instead of consumer goods that provide the service. Implemented through the 'circular economy', this collectively can help separate material needs from consumption (IRP 2018) (see further discussion in section 6.4 on sustainable economies).

- *Transformative urban governance:* Engaging citizens in planning, including participatory budgets, is an important role for (local) governments (Grubler *et al.*, 2012; IRP 2018).

6.3.5.4 Enhancing access to urban services for good quality of life

One of the main targets of SDG 11 (sustainable cities and communities) is to ensure access for all to basic services. This is especially urgent in cities in the global South, where inhabitants of informal settlements, or slums, have access to few or no services (Nagendra *et al.,* 2018). Reducing informal settlements was one of the Millenium Development Goals, and more steps can be taken to address these targets to enhance the quality of life for the quarter of the world's population that live in informal settlements (UN-Habitat 2015, Richards 2006). Options include increasing access to clean water and sanitation; improving management of solid waste; increasing access to transportation and green spaces; and transforming governance approaches (see Supplementary Materials 6.4.4 for a detailed discussion).

- *Improving access to clean water and sanitation:* Increasing access to sanitation and clean water by fostering partnerships between all actors to encourage a bottom-up, participatory approach, including recognition of where the informal sector provision of water is working, could increase effectiveness and socio-economic benefits (Ahlers *et al.*, 2014; Annamalai 2016; Bonnardeaux 2012; McFarlane 2008). Sustainable urban water management (SUWM) is the umbrella term for adaptive, integrated, participatory delivery of water, and in most cases, barriers to SUWM are not technical, but institutional (Brown & Farrelly 2009; Marlow *et al.,* 2013). In some cases, public-private partnerships may work, while in others not (Koppenjan & Enserink 2009; Zhong *et al.*, 2008). As noted in section 6.3.4, investing in natural ecosystems such as wetlands can also help to conserve biodiversity while helping communities manage their own water supplies (Postel 2005).

- *Improving management of solid waste:* A top-down approach to improve solid waste management could be integrated sustainable solid waste management (ISSWM) policy, which provides a legal framework to enforce effectiveness (Shekdar 2009). Less costly approaches could be incentive programs and tiered trash collection (pay-as-you-throw) which could significantly reduce the amount of solid waste produced and increase the amount of materials recycled (Dahlen 2010; Folz & Giles 2002) and composting or waste-to-energy programs in place (Sharholy 2008).

- *Improving access to transportation:* Access to safe, affordable, accessible, and sustainable public transportation systems helps communities to thrive socially and economically (Litman 2013; Kenworthy 2006; Litman 2006; Newman 2006; Banister 2001; Deakin 2001; Newman 1999; Cervero 1996; Crane 1996). Other options include promotion of low-cost alternative transportation, such as bicycles or ride sharing.

- *Improve access to green space:* As noted previously, green spaces in cities can contribute to NCP provisioning and biodiversity protection, among other advantages such as increasing GQL, promoting healthy physical and mental well-being (Nadja Kabisch *et al.*, 2017; van den Bosch & Sang 2017; Dennis 2016; Gomez 2013; Lee & Maheswaran 2011), and decreasing crime (Bogar 2016; Donovan 2012; Troy 2011; Kuo 2001).

- *Improving participatory planning and governance for inclusion*: One of the targets of SDG 11 is to enhance and expand on participatory and integrated planning at all levels of governance (UN-SDG 11), which can help contribute to GQL. Participatory planning offers views that may otherwise have been neglected (Innes & Booher 2010).

6.3.6 Integrated Approaches for Sustainable Energy and Infrastructure

It is well established that the energy supply sector based on fossil-fuel energy systems is the largest contributor to greenhouse gas (GHG) emissions (IPCC 2014; Bruckner *et al.*, 2014; Van der Voet 2012; McDaniel & Borton 2002). Extraction, storage, transformation and use of energy sources (i.e. the energy, mining and infrastructure sectors) have considerable negative impact on biodiversity and ecosystem services via degrading, fragmenting, polluting and over-exploiting species and habitats, introducing invasive alien species, and contributing to climate change (CBD/SBSTTA/21/5, Jones *et al.*, 2015; McDonald *et al.*, 2009; chapter 2.1). The transition from a fossil-fuel energy based system to renewables has been identified as a necessary action for a sustainable future. This is reflected by SDG 7 (affordable and clean energy), aiming to ensure access to affordable, reliable, sustainable and modern energy for all, as well as to increase the share of renewables in the global energy mix (UNDP 2016; CBD 2016; CBD 2017). Nevertheless, to ensure the sustainability of an energy transition, impacts of renewables on other SDG (Nerini *et al.*, 2017) as well as on nature and NCPs – especially trade-offs between renewable energy oriented land uses and nature conservation, also covered by the Aichi Targets – has to be equally taken into account (Santangeli *et al.*, 2016a, b; for relevant SDG and Aichi Targets see chapter 3) (See Supplementary Materials 6.5 for discussion on associated challenges).

As **Figure 6.5** indicates, expansion of energy oriented biomass (biofuel) production has more serious impacts on nature and NCP than solar and wind energy, although regional differences across the globe are significant. Therefore, in this section, biofuels related issues are assessed in more detail while other renewable energy sources (including solar, wind, hydropower and their mixes) are discussed throughout.

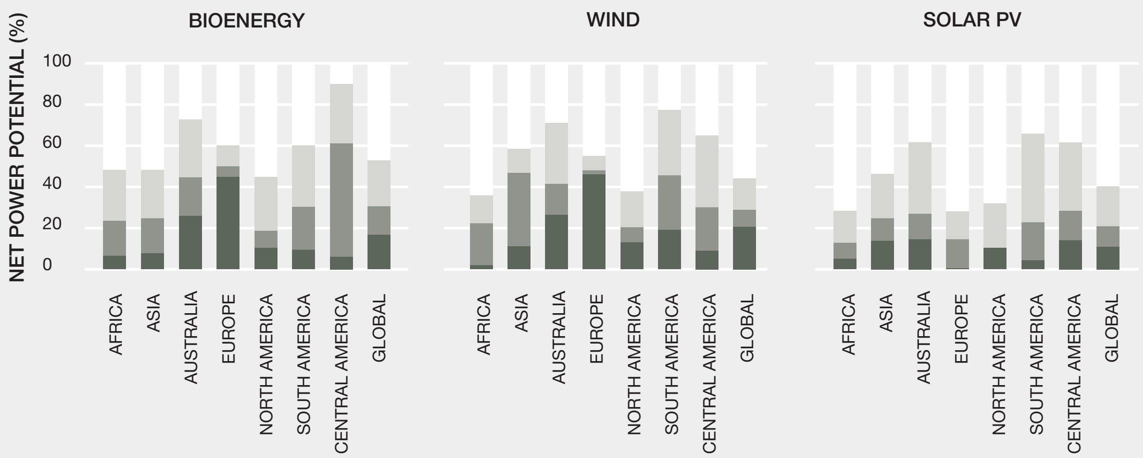

Figure 6 5 **Trade-offs between renewable energy potential and protected areas (Santangeli *et al.*, 2016b).**

Percentage (relative to the total potential of each source) of unrestricted power generation potential available for bioenergy (in the form of *Miscanthus × giganteus*), wind energy and solar photovoltaic summarized by continents and globally. The bars show generation potential within current PAs (Protected Areas; black section of each bar), top ranked areas for 17% PA expansion (dark grey), 17–30% highest ranked areas (light grey) and for the remaining 70% of the landscape (white).

Key governance challenges are the acknowledgement of multiple values in relation to the impacts of current and planned energy use on nature, NCP and GQL, as well as managing trade-offs and telecouplings. Energy use is closely linked to a whole range of political, social and economic interests (Hall *et al.*, 2013; Huber 2013; Mitchell 2011). Institutional interplay across levels – e.g., the course of national borders, the setup of electricity markets, the distribution of property rights, regulations and decision-making processes – defines who owns resources needed for the generation of energy, who gains access to energy, and who bears the burdens (Heindl 2014).

The ways in which energy, mining and infrastructure projects are carried out and implemented trigger conflicts between worldviews and values, raise implementation problems, and often affect IPLC rights to land and water, as illustrated by an increasing number of social-environmental conflicts throughout the world (Arsel & Angel 2012; Rival 2009; Islar 2012; Jordà-Capdevila & Rodríguez-Labajos 2014; Martinez-Allier 2014; Ehara *et al.*, 2016; Spice 2018). At least 40% of all the 2,588 socio-environmental conflicts documented globally happen to involve IPLCs (EJAtlas 2018). Similarly, from the 501 land and environmental defenders that have been assassinated worldwide (2014-2016), almost 40% were IPLCs (Global Witness 2015, 2016, 2017). Disputes over land ownership are an underlying factor in most of these conflicts (Oxfam *et al.*, 2016; Dell'Angelo *et al.*, 2017a, 2017b; RRI 2017). In general, large-scale energy development projects, either renewable or non-renewable, often trigger trade-offs between climate change mitigation, energy provision, social development and nature conservation objectives (e.g., Humpenöder *et al.*, 2018).

Energy production and use are connected by telecouplings to many other ecosystems and resource uses at multiple scales and sectors, raising concerns over biodiversity (e.g., the impact of climate change from energy-related GHG emissions), human health (e.g., the impact of indoor pollution due to inefficient energy technologies), water use and fisheries (e.g., the impact of hydropower), agriculture and forestry (e.g., bio-energy as replacement for fossil fuels), and mining (e.g., rare earth, cobalt, lithium etc. extraction for storage) (Doria *et al.*, 2017).

This section focuses on options for sustainable energy systems exist for various decision makers, including the development of sustainable biofuels strategies, encouraging comprehensive environmental impact assessment, ensuring compensation and innovative financing for environmental and social impacts, ensuring access to energy for all by promoting community-led initiatives, promoting inclusive governance, and promoting sustainable infrastructure **(Table 6.7)**.

Table 6 7 **Options for integrated approaches for sustainable energy and infrastructure.**

Short-term options	Long-term options	Key obstacles, potential risks, spillovers, trade-offs and unintended consequences	Major decision maker(s)	Main level(s) of governance	Main targeted indirect driver(s)
Biofuels strategies					
	Develop sustainable biofuels strategies	• Lack of cross-sectoral policy frameworks • Fragmentation and the lack of coordination between different institutions and sectors • Trade-offs between low GHG energy production and biodiversity	Global institutions, Regional bodies, National and local governments, Private sector, IPLCs	All	Technological, economic
Environmental Impact Assessment					
Improve environmental impact assessment		• Dominance of economic valuation and technical knowledge • Lack of institutional capacity	International bodies, National and local governments, IPLCs	All	Patterns of production and supply

Short-term options	Long-term options	Key obstacles, potential risks, spillovers, trade-offs and unintended consequences	Major decision maker(s)	Main level(s) of governance	Main targeted indirect driver(s)
Compensation and financing					
Strengthen biodiversity compensation policies for development and infrastructure losses		• Compensation does not address root causes of overdevelopment • Difficulties in raising funds in developing countries • Risk for negative impacts on livelihoods by shifting conservation away impacted areas • Ambiguous guidance to developers • Limited capacity for implementation • Inadequate monitoring and enforcement	National, sub-national and local governments, Private sector, IPLCs, Civil society, Landowners and other ecosystem services beneficiaries	National, local	Economic, governance
Promote innovative financing for sustainable infrastructure		• Lack of understanding of novel financial tools (e.g. green bonds and performance bonds) • Concerns about returns of investment • Potential for 'greenwashing'	Global financial institutions National and subnational governments Private corporations	Global, national, subnational	Economic
Community-led initiatives					
Promote community-led initiatives		• Technical and social lock-ins hindering energy independency • Controversial political and economic interests • Energy oligopolies	National governments, Local governments and municipalities, NGOs and cooperatives, Private sector, Citizen and IPLCs	Local, regional, national	Patterns of production and consumption, technological
Inclusive governance					
Promote inclusive governance		• Inappropriate siting of energy infrastructure harming IPLCs • Lack of free, prior and informed consent of IPLCs • Economic interests overruling other aspects	International bodies, National and local governments, Private sector, IPLCs	All	Governance, cultural
Sustainable infrastructure					
	Promote sustainable infrastruc-ture & technology	• Lack of institutional capacity • Lack of economic power • Lack of political will	National and local governments, Universities, Private Sector	All	Technological Patterns of production, supply and consumption

6.3.6.1 Development of sustainable biofuels strategies

Some international organizations (see e.g., IPCC 2014; Searchinger *et al.*, 2017; IRENA 2017), regional organizations (EC 2009) and country governments view biofuel as a clean energy source that support climate mitigation strategies (REN21 2018). Sixty-four countries are in the process of mandating or increasing mandated blending of biodiesel or ethanol in motor fuels, being Brazil, EU, Argentina, Canada and China the largest markets (Edenhofer *et al.*, 2011; IPCC 2014; UN General Assembly 2015; IEA & OECD 2013; Gota *et al.*, 2015; Malins 2015). Favourable taxation and export levies are applied by several countries (e.g., Brazil and Indonesia). Global subsidies for liquid biofuels exceeded US$20 billion in 2014 (Worldwatch Institute 2014). The adoption of biofuel policies has decelerated worldwide but current policies still tend to underestimate risks of biofuels (Goetz *et al.*, 2017; Le Bouthillier *et al.*, 2016; De Man & German 2017; Oliveira *et al.*, 2017; Fargione *et al.*, 2008 – see Supplementary Materials 6.5.1).

At the international and national level, incorporating sustainability criteria in renewable energy laws can recognize the interlinkages between energy use and production, and its impacts on biodiversity (Le Bouthillier *et al.*, 2016; Fritsche & Iriarte 2014; Lin 2012; Frank *et al.*, 2013). For example, the EU Renewable Energy Directive (EU 2009) sets a mandatory 10% minimum target for the share of biofuels in transport petrol and diesel consumption by 2020 to be achieved by all Member States, but to mitigate telecoupling effects it also requires biofuel production to fulfil several sustainability criteria. Options for national governments to mitigate risks of land use change and biodiversity loss related to the expansion of bioenergy production include monitoring and reporting with a focus on potential regulation (e.g., water competition in South Africa), as well as corrective action (e.g., adjustment of the volume of renewable fuels mandated such as in the US and EU). Creating country-wide zoning (e.g., Brazil, Mozambique) can serve as basis of selecting "marginal" or "waste lands" for biofuel production (e.g., India, MNRE 2009), although this is contested in literature (Goetz *et al.*, 2017; Montefrio & Dressler 2016; Baka 2013), especially because such categories, many of which are inherited from colonial occupation, represent rich ecosystems that provide multiple NCP, locally and regionally (Ahmed *et al.*, 2017). Sector-specific zoning (e.g., Brazil's Agroecological Zoning for Sugarcane) and regulation is another option to improve sustainable energy use, which can be interlinked with infrastructure policies. Private sector recently used to implement codes of conduct (e.g., Brazil's Agro-environmental Protocol of the Sugar-based Ethanol Sector) and certification systems (e.g., Indonesian Sustainable Palm Oil), as well as environmental impact assessment and management procedures. However, the current performance of such certifications remains poor, due to the proliferation of low-quality ecolabels and the low market share of certified crops; but also, because ecosystem services and broader cross-sector repercussions of biofuels production and use are not part of such schemes (Gasparatos *et al.*, 2018; German *et al.*, 2017).

Second and third generation biofuels (non-edible plant biomass and unicellular photosynthetic microorganisms, respectively) are promoted as possible alternatives to edible plant based biofuels (Ravindran *et al.*, 2016; Lackner 2015; Mohr & Raman 2013). However, assessments about their effects and associated risks are largely theoretical and premature until these technologies are applied widely (Goetz *et al.*, 2018; Ravindran *et al.*, 2016; Lackner 2015; Mohr & Raman 2013). Second generation biofuels are confronted with sustainability problems similar to those of the first generation (Mohr & Raman 2013). Third generation biofuels (e.g., microalgae) seem to employ significantly less land resources for their production, but their production is very energy intensive and economically unviable today. Technological innovation aims to improve processing technologies as well as microorganisms, pointing to additional risks in form of genetic engineering (Ravindran *et al.*, 2016; Lackner 2015).

For any generation of biofuels to be sustainable, global demand would have to be reduced, and opportunity costs compared to other technologies considered (e.g., photovoltaic, Searchinger *et al.*, 2017). Several governments plan to replace gasoline powered engines by electric ones in the near future to achieve the targets set in the Paris Climate Agreement, which could massively reduce the demand for ethanol and biodiesel. However, advancing e-mobility would amplify other problems, e.g., the production of lithium and other metals and rare earths (Xiong *et al.*, 2018), and expanding it to shipping and air transport (including military) is questionable. Reducing transport volumes, e.g., by shorter supply chains, local production and better public transport, is another option, which would however require far-reaching reforms of the taxation and subsidy system.

6.3.6.2 Encouraging comprehensive environmental impact assessment (EIA)

In the context of energy, the purpose of an environmental impact assessment (EIA) is to assess how the project might cause harm to the environment and to the people and their livelihoods through extraction and infrastructure development. EIA in the mining sector is encouraged worldwide by national laws and international financing organizations (IFC 2012; Equator Principles 2013). While EIA is integrated within the national laws of countries around the world (Morgan 2012; UNEP 2018), case studies demonstrate that social and ecological impacts, IPLC participation, mitigation measures as well as post-monitoring of renewable energy projects may not be adequately addressed in the EIA (Fearnside 2014; Larsen *et al.*, 2018; Schumacher 2017) and weak implementation of EIAs remains a challenge (European Commission 2013). Numerous well established impact assessment methods can be considered helpful for incorporating diverse value systems in the EIA process concerning energy. For example, biodiversity-inclusive EIA offers opportunities for effective participatory mechanisms engaging those who depend the most on nature and its contributions, such as Indigenous Peoples and Local Communities (Akwé: Kon Guidelines 2004; IFC 2012, Standard 7); however, there are associated challenges particularly in developing countries (Craik 2017; Quintero 2012). EIA may also serve as background for "no net loss" and "net gains" biodiversity policies (IFC 2012, Standard 6) using compensatory mechanisms (e.g., offsets), in response to impacts identified in the EIA.

Different options exist to improve EIA practice for energy, mining and infrastructure. Applying the precautionary principle to EIA requires decision makers to identify areas of uncertainty and to consider the implications of knowledge gaps (CBD EIA Guidelines, para. 42). Another option is to incorporate adaptive management into EIA instruments via requirement for ex-post monitoring and follow-up measures (CBD EIA Guidelines, para. 44). Integrating ecosystem services into EIA helps managing trade-offs if implemented in a context-specific manner, by providing a basis to prioritize certain functions and benefits and to identify a wider range of stakeholders affected by potential changes to ecosystem services (OECD 2008; Landsberg 2011; Baker *et al.*, 2013). Such approaches are emerging in EIA practice (European Commission 2013; IFC 2012, Standard 6), but different environmental assessment contexts, resource availability, local capacity and accessible information are likely to drive such integration of ecosystem services (Baker *et al.*, 2013).

Strategic environmental assessment (SEA) has been introduced to expand the scope of impacts by looking at the cumulative effects from programmatic or other spatially related actions (Abaza *et al.*, 2004; UNEP 2018). Challenges aside, widening the scope is possible by incorporating ecosystem services (Slootweg *et al.*, 2010; Geneletti 2013; Landsberg *et al.*, 2013; European Commission 2013; Baker *et al.*, 2013) or integrating Health Impact Assessment with SEA. At present, there is very limited consideration of health in SEA (e.g., in Scotland, Douglas *et al.*, 2011), although good examples exist, e.g., the assessment of health impacts of wind power (Knopper & Ollson 2011; Van den Berg 2003; Pedersen *et al.*, 2004), and the use of the Integrated Environmental Health Impact Assessment approach (Briggs 2008; http://www.integrated-assessment.eu/). See Supplementary Materials 6.5.2 for a detailed discussion on IEA.

6.3.6.3 Ensuring compensation and innovative financing for environmental and social impacts

Compensation approaches have been developed as an instrument to deal with environmental and social effects that cannot be fully avoided or mitigated in energy, mining and infrastructure projects (Koh *et al.*, 2017). Since the 1970's, several countries developed laws and regulations to apply compensatory measures as a requirement for environmental licensing (Rundcrantz & Skärbäck 2003; ten Kate *et al.*, 2004; Rundcrantz 2006). Many compensation approaches are driven by requirements for 'no net loss' of biodiversity – applied now in more than 80 countries – but goals are often challenged by unclear definitions of the baseline reference for 'no net loss' (Maron *et al.*, 2018). Compensation can take form of measures to reduce environmental impacts, to improve social conditions, or monetary payments to offset ecological losses (Villarroya & Puig 2010; Gastineau & Taugourdeau 2014). Recent trends include projects for compensatory mitigation, biodiversity offsets, mitigation banking, habitat banking, species banking, and wetlands mitigation (OECD 2016) (see Supplementary Materials 6.5.3 for a detailed discussion).

There are potential positive effects of compensation schemes, e.g., making new financial resources available for conservation (estimated at several billions per year), reducing the costs of environmental compliance, and supporting the social and economic development of local populations (ten Kate *et al.*, 2004). International experience suggests that no net loss policies combined with biodiversity offsetting and banking can be effective at involving the private sector in conservation, especially relative to widespread uncompensated losses of biodiversity from development projects (ten Kate *et al.*, 2014; OECD 2016; Vaissière *et al.*, 2016). However, there is little comparable data about the amount of compensatory measures and resources allocated for this approach (Villarroya & Puig 2010; Xie *et al.*, 2013). They are intended to be a 'last resort' option, but critiques note that offsets do not address the root causes of overdevelopment of energy, mining and infrastructure projects leading to nature deterioration, and scarcity can create value in markets and banks (Spash 2015). Only a handful of studies have investigated the local impacts of offset projects on IPLCs, which remains a research gap (Bidauda *et al.*, 2017), given that developers who buy offsets tend to be more powerful actors than impacted IPLCs (Apostolopoulou & Adams 2017) and some localized and site-specific biodiversity losses can be irreplaceable (ICMM & IUCN 2012) There is also little literature on the effective use of resources, which makes the results of improving social and economic conditions within project areas inconclusive.

Risks and challenges (see Supplementary Materials 6.5.3) must be addressed for offsetting to deliver on its promise, including the lack of clear policy requirements that offer unambiguous guidance to developers and offset providers (e.g., Quétier *et al.*, 2014), inadequate monitoring and enforcement and lack of political will to require and enforce best practice in offsetting (IUCN 2014; ten Kate & Crowe 2014). More participatory processes of offset definitions and politics have been proposed to address these challenges (Mann 2015).

Standards and obligations for environmental performance or liability in infrastructure and development can mobilize significant amounts of private capital. Innovative mechanisms like performance bonds (whereby a sum of money commensurate with the estimated cost of site rehabilitation is held by a banking or insurance institution to be relinquished upon satisfactory end of the project) are recommended to encourage biodiversity protection during resource extraction, and to ensure sufficient financial sources to restoration after resource extraction activities end (ICMM 2003, 2008). Another new mode of private financing are green bonds, a US$694bn market in 2016, with notably increased use in Asia (Climate Bond Initiative 2017; Clapp 2018). Green bonds raise capital to finance climate-friendly projects in key sectors like transport, energy, building and industry, and water (Croce *et al.*, 2011). Institutional investors are expected to be the dominant buyer of green bonds, and they are touted to provide returns comparable to conventional non-green bonds.

6.3.6.4 Ensuring access to energy for all by promoting community-led initiatives

Energy poverty exists both in developing and developed countries and is embedded in the wider socio-cultural, economic and political context, therefore reflects significant inequalities within and across nations (Brunner *et al.*, 2018; Monyei *et al.*, 2018; Sadath *et al.*, 2017). Citizen's inclusion to renewable energy production and distribution provides more affordable and just energy access, contributes to behavioural change towards more sustainable energy consumption and helps to reduce the adverse impacts of energy use on nature and NCP (Schreuer & Weismeier-Sammer 2010; Rijpens *et al.*, 2013; Kunze & Becker 2015; Islar & Busch 2016). Different types of community-led energy initiatives have emerged all over the world, providing access to clean, reliable and affordable energy. Energy autonomy, realized through decentralized renewable energy production and consumption in local communities and often driven by social and technological innovation to match demand and supply, has been targeted by sustainable and local low-carbon communities in Europe and beyond (Rae & Bradley 2012; Yalçin-Riollet *et al.*, 2014; Hobson *et al.*, 2014; Lee *et al.*, 2014; Hoicka & MacArthur 2018).

Low-carbon communities can take various organizational forms and renewable energy cooperatives (REC) represent a major type which builds on the democratic governance of renewables and provides economic payback to members who join RECs and invest in renewables (Herbes *et al.*, 2017; Hentschel *et al.*, 2018; Heras-Saizarbitoria *et al.*, 2018). Major technological solutions to provide accessible energy to communities in isolated regions include, among others, small-scale photovoltaics (Menconi *et al.*, 2016; Monyei *et al.*, 2018), run-off river hydropower (Egre & Milewski 2002; Wazed & Ahmed 2008), and mixes of different renewable energy sources (Kaldellis *et al.*, 2012). Off-grid, micro-grid and hybrid solutions, applied together with smart technologies, are efficient ways of producing, storing and sharing renewable energy within communities (Menconi *et al.*, 2016). Financing such developments and system transitions may build on public financing and incentives to increase citizen investment (e.g., feed-in tariffs) (Curtin *et al.*, 2017), market based investments (Linnenluecke *et al.*, 2018), and alternative financial models like co-operatives or crowd-funding (Gezahegn *et al.*, 2018; Hall *et al.*, 2018; Vasileiadou *et al.*, 2016). Realizing the urgency of providing modern energy technology and services has also prompted development institutions, such as World Bank and UNDP, to support renewable energy facilities led by communities (UNDP 2012).

Although community-based renewables tend to be less detrimental than large-scale energy development projects as induced land use change is of lower scale and intensity, they might have adverse effects on nature and society (see e.g., Castán Broto *et al.*, 2018; Islar 2012; Aksungur *et al.*, 2011), which has to be mitigated. Overcoming the financial, infrastructural, institutional, socio-cultural barriers of community based renewables is possible if supporting policy is combined with transformation management (Goddard & Farelly 2018), and if governance engages actors from different decision-making levels (Markantoni 2016; Goldthau 2014) and vulnerable groups like women and IPLCs (UNDP 2012) (See Supplementary Materials 6.5.4).

6.3.6.5 Promoting inclusive governance in planning and implementation of energy and infrastructure projects

Excluding local inhabitants from planning energy, mining and infrastructure development projects often leads to socio-environmental conflicts (Finer *et al.*, 2008, 2015; Filho 2009; Kumpula *et al.*, 2011; RAISG 2016; Wilson & Stammler 2016) and legal disputes, coming with severe financial and reputational risks for both states and corporations (Nielsen 2013; Greenspan *et al.*, 2014; Wilson & Stammler 2016). Large-scale infrastructures are often planned and implemented without the Free, Prior and Informed Consent (FPIC) of IPLCs (Hope 2016; Dunlap 2017; MacInnes *et al.*, 2017; Fernández-Llamazares *et al.*, 2018), generally resulting in habitat and biodiversity loss and threatening local livelihoods and good quality of life (Muradian *et al.*, 2003; Escobar 2006; Finley-Brook 2007; Araujo *et al.*, 2009; Finer & Jenkins 2012; Athayde 2014; Laurance & Burgués-Arrea 2017). For example, the rights of Indigenous Peoples in voluntary isolation and initial contact are under assault from infrastructure expansion (Finer *et al.*, 2008; Martin 2008; IACHR 2013; Pringle 2014; Kesler & Walker 2015).

Increased public scrutiny of the social-environmental impacts of extractive activities has led industry to adopt a diverse set of voluntary CSR instruments, including the Extractive Industries Transparency Initiative, the UN Guiding Principles on Business and Human Rights, the Free Prior and Informed Consent, or the Social License to Operate (SLO) (Prno & Slocombe 2012; Business Council of British Colombia 2015; Moffat *et al.*, 2016; Bice 2014). SLO refers to the outcome of engagement processes between industry and communities to establish acceptance of extractive activities (Nielsen 2013; Boutilier & Tgompson 2011), and become central in defining what levels and kinds of social and environmental harm are acceptable, what actions for compensation or restoration are appropriate, and how responsibilities for these actions are distributed (Meesters & Behagel 2017; Idemudia 2007). The concept, however, does not indicate when a SLO is in place, nor does it necessarily imply consent, legitimacy or responsibility of mining activities (Owen & Kemp 2013; Boutilier 2014).

Environmental justice movements, including different forms of IPLC activism, are gaining prominence in response to the expansion of infrastructure development and extraction activities onto IPLC territories (Martínez-Alier *et al.*, 2010, 2014, 2016; Petherick 2011; Athayde 2014; Spice 2018). Mainly through global citizen action, social mobilization and capitalizing on modern technologies, the local social-ecological struggles of IPLCs become matters of global concern (Earle & Pratt 2009; Lorenzo 2011; Temper & Martínez-Alier 2013; Pearce *et al.*, 2015; Januchowski-Hartely *et al.*, 2016). International human rights law protects the right of IPLCs to give or withhold their Free Prior and Informed Consent in relation to resource extraction, infrastructure or energy development projects in their territories (Cariño 2005; Edwards *et al.*, 2011; Ward 2011; MacInnes *et al.*, 2017). Such principle is best understood as an expression of the right to self-determination of IPLCs (Charters & Stavenhagen 2009; Hanna & Vanclay 2013; Doyle 2015) and is enshrined in the UN Declaration on the Rights of Indigenous Peoples, ILO Convention 169, and the Nagoya Protocol on Access and Benefit Sharing, as well as in several national laws (Ward 2011; MacInnes *et al.*, 2017). Although the implementation of FPIC faces several challenges on the ground (Anaya 2005; Perreault 2015; Pham *et al.*, 2015; Dehm 2016), its legal significance is gaining global recognition and lays a solid foundation for simultaneously supporting nature conservation and human well-being (Page 2004; Magraw & Baker 2006; FPP *et al.*, 2016). Increasing engagement of IPLCs in project planning, consultation or social impact assessment is likely to be best served by the adoption of standards and policies such as the Equator Principles, the Global Reporting Initiative, or the UNEP's Policy on Environmental Defenders (Lane *et al.*, 2003; FPP 2007; Yakovleva *et al.*, 2011; UNEP 2018) and binding instruments such as the Escazú Agreement on environmental rights in Latin America and the Caribbean (ECLAC 2018).

A convergence of demand-driven leverage is likely to improve the regulatory stringency and enforcement in countries supplying key mineral resources. For example, in the conflict between IPLCs in Orissa State, India, and the bauxite mining operations of Vedanta Resources (Razzaque 2013), environmental activism, human rights protests and court cases remained ineffective for years, until important shareholders (e.g., the Church of England and the Norwegian government) decided to disinvest in the company, and the government withdrawn the clearances of the mining project (Goodman *et al.*, 2014; Iyer 2015). This case also highlights the possible role of shareholder activism in promoting inclusive governance for energy, mining and infrastructure development (Cundill *et al.*, 2017; Goranova & Ryan 2014). See Supplementary Materials 6.5.5.

6.3.6.6 Promoting sustainable infrastructure

Due to an unprecedented explosion of infrastructure development, extensive areas of the planet are being opened to new environmental pressures (van Dijck 2008; Balmford *et al.*, 2016; Johansson *et al.*, 2016; Gallice *et al.*, 2017; Kleinscroth & Healey 2017) as part of massive infrastructure-expansion schemes—such as China's One Belt One Road initiative (Laurance & Burgues 2017; Lechner *et al.*, 2018) and the IIRSA program in South America (Laurance *et al.*, 2001; Killeen 2007). These new "development corridors", including roads, highways, hydroelectric dams and oil and gas pipelines come with high environmental and social costs, including deforestation (Barber *et al.*, 2014; Fernández-Llamazares *et al.*, 2018), biodiversity loss (Laurance *et al.*, 2001, 2006, 2008; Pfaff *et al.*, 2009; Benítez-López *et al.*, 2010; Sloan *et al.*, 2017), land grabbing (Toledo *et al.*, 2015; Alamgir *et al.,* 2017), social disruption (Mäki *et al.*, 2011; Baraloto *et al.*, 2015) and violation of IPLC customary rights (Fernández-Llamazares & Rocha 2015; Martínez-Alier *et al.*, 2016; Delgado 2017).

The total length of paved roads is projected to increase globally by 25 million kilometres in 2050 (Dulac 2013), with nine-tenths of all road construction occurring in developing countries (Laurance *et al.*, 2014). Given that new roads generate large ecological footprint (e.g., Laurance *et al.*, 2002, 2009), a viable and cost-effective way to avoid habitat loss in areas of high conservation value, also including protected areas, is to keep them road-free by "avoiding the first cut" (Caro *et al.*, 2014; Laurance *et al.*, 2014, 2015; Alamgir *et al.*, 2017; Sloan *et al.*, 2017; Fernández-Llamazares *et al.*, 2018). Another vital tactic is to use large-scale, proactive land-use planning. Approaches such as the "Global Roadmap" scheme (Laurance & Balmford 2013; Laurance *et al.*, 2014) or SEA (Fischer 2007) have been successfully used to evaluate the relative costs and benefits of infrastructure projects, and to spatially prioritize land uses to optimize human benefits while limiting new infrastructure in areas of intact or critical habitats (e.g., Laurence *et al.*, 2018; Laurance *et al.*, 2015; Balmford *et al.*, 2016; Sloan *et al.*, 2018).With many roads becoming rapidly dysfunctional, investing in maintenance represents a more sustainable option than road expansion (Wilkie *et al.*, 2000; Burningham & Stankevich 2005; Luburic *et al.*, 2012; Alamgir *et al.*, 2017).

Infrastructure development related to renewable energy sources can adversely affect nature and humans, decreasing the net benefits and sustainability of renewables (Drewitt *et al.*, 2006; Cohen *et al.*, 2014; Lang *et al.*, 2014; Drecshler *et al.*, 2017). Life cycle assessment can help decision makers choose the best renewable energy source for specific purpose. Along with

EIA or SEA, a landscape approach using geographical information systems can be applied to compare the impacts of different energy scenarios on nature and NCP, by integrating various types of data (Benedek *et al.*, 2018; European Commission 2014; Jones *et al.*, 2015). Resource extraction (e.g., rare earth, cobalt, lithium) for assembling electrical components of renewable energy production, especially batteries and photovoltaics, will further increase and affect the environment (Fthenakis 2009; Larcher & Tarascon 2015). Sustainable mineral sourcing could be improved via global governance which sets and monitors international targets (Ali *et al.*, 2017). Geological exploration plans considering the overlap between protected areas and the prevalence of mineral resources (e.g., the MiBiD index) could further decrease the impact of mining on nature (Kobayashi *et al.*, 2014). Similarly, the negative impacts of energy-related infrastructure can be mitigated through the use of land-use zoning to identify sensitive areas (e.g., Laurance *et al.*, 2015; Balmford *et al.*, 2016; Sloan *et al.*, 2018) or through sensitive operating practices – e.g., turning off wind turbines when large numbers of soaring migratory birds are passing (Hüppop *et al.*, 2006; Allinson 2017).

Dams – producing hydropower, improving navigation or providing secure water supply (Nilsson *et al.*, 2005) – also have largescale landscape impacts (e.g., Belo Monte Dam in Brazil, Lees *et al.*, 2016). More than 50,000 dams above 15 m height exist worldwide (Lejon *et al.*, 2009), and several examples point the significant negative impacts they have on nature and society (Tullos 2009; Finer & Jenkins 2012; Fearnside 2016; Dudgeon 2010; chapter 4; Doria *et al.*, 2017; Beck *et al.*, 2012), which are often not well mitigated (Zarfl *et al.*, 2015; Poff & Schmidt 2016; Winemiller *et al.*, 2016; Latrubesse *et al.*, 2017).

Despite their negative environmental and social impacts, dams may generate new benefits (Menzie *et al.*, 2012), such as create habitat for protected species, or function as a refuge under climate change, making it difficult to consider biodiversity trade-offs associated with decisions about dam removal (Lejon *et al.*, 2009; Beatty *et al.*, 2017). While many studies show positive effects of dam removal on biodiversity (e.g., O'Connor *et al.*, 2015), others highlight unintended risks and consequences, such as dispersal of invasive fish (Lejon *et al.*, 2009), colonization of non-native plants (Tullos *et al.*, 2016) or spread of accumulated contaminants (O'Connor *et al.*, 2015). Case studies also show that deliberations about dam removal tend to create situations where locals become divided between environmental, economic, and cultural losses and gains (Reily & Adamowski 2017). In sum, the complex consequences of dam-removal are unresolved, and studies are typically not framed to inform management concerns that are context-specific (Tullos *et al.*, 2016). See Supplementary Materials 6.5.6.

6.4 TRANSFORMATIONS TOWARDS SUSTAINABLE ECONOMIES

The publication of the *IPCC special report on global warming of 1.5°C* made clear that under current development trajectories global warming will exceed 1.5°C during the coming two decades (IPCC 2018). Similarly, it has become evident (this report; UN 2018) that achieving the internationally-agreed 2030 Sustainable Development Goals and the 2050 Vision for Biodiversity will require transformative change towards sustainable economies. This is the context within which progress towards sustainable landscapes, marine and ocean systems, freshwater management, urban systems, and energy and infrastructure are subsumed, and for which they represent vital parts of the solution.

A plethora of definitions for a sustainable economy have been suggested (e.g., King & Slesser 1994; Bartelmus 1999; Pearce & Barbier 2000; Urhammer & Røpke 2013; Pullinger 2014; Martin 2016). In the IPBES context it can be defined as an economy that does not produce the indirect and direct drivers impinging on nature, nature's contributions to people, and a good quality of life, and account for the important role that telecoupling, trade, supply chains, and producer-consumer interactions now play in our global system. This requires that economic, social and technological indirect drivers and the patterns of production, supply, and consumption that make up the economy respect ecological limitations and ecosystem integrity (Raworth 2015; Bengtsson *et al.*, 2018).

A sustainable economy must also provide more equitable access to the fruits of development and quality of life (O'Neill *et al.*, 2018). Some impacts on nature can be caused by poorer households forced to exploit natural resources due to a lack of other economic options, although the poor are often well aware of their dependence on nature and protect biodiversity (Martinez-Alier 2002). Other data suggests that it is inequality in particular that may lead to negative impacts on the environment as wealth concentrates among people who are not willing to pay for the provisioning of public goods (Boyce 1994; Kashwan 2017). Policies aimed at reducing poverty and inequality thus have the potential to be linked up with priorities for NCP conservation (Johnson 1973). Rethinking what makes an economy sustainable thus will need to focus not only on incorporating pluralistic values of nature, as this report has noted, but also rethinking what it means to have a good quality of life, and how it links to nature and its contributions (Naeem *et al.*, 2016). The concept of an "adequate standard of living" as a human right derives from the Universal Declaration of Human Rights (UN 1948). Policies to achieve a "social protection floor" to protect this right include measures and institutional reforms to achieve both basic income security and universal access to essential, affordable social services (UN 2018). These aims could be combined with more nature-specific measures and attention in the 21st century, such as including ideas about access to NCP as part of social protection measures.

Further, a sustainable economy must be one in which climate change causes and impacts are addressed, to ensure that carbon emissions do not remain an environmental externality, that globalization does not exacerbate the impacts of climate change, and that communities have sufficient financial means to reduce vulnerability and adapt to forecasted changes (O'Brien

Table 6 8 **Options for transformation to sustainable economies.**

Short-term options	Long-term options	Key obstacles, potential risks, spill- over, unintended consequences, trade-offs	Major decision maker(s)	Main level(s) of governance	Main targeted indirect driver(s)
Reforming Subsidies					
Assess impacts of all subsidies policies (e.g. energy, fisheries, agriculture, water); removal of cost ineffective subsidies	Long-term removal of all environmentally-unsound subsidies	Vested interests opposed; political challenges: beneficiaries of subsidy policies protest their removal; welfare impacts of subsidy removal for some communities	National; sub-national; and local governments; research & education organizations	National and sub-national	Economic, institutions
Address over and under consumption					
'Nudges' to consumers; product labelling; local reuse or fix-up initiatives; corporate or NGO led initiatives to discourage overbuying; taxes on consumption; consumer reduced-consumption movements	Expansion of sharing economy; transition towns; sufficiency orientation of consumers; design for sustainability for products and services	Beliefs in rationality of markets; dogma of consumer sovereignty; lack of policies that address leakage & telecoupling; political risks for tax increases; potentials for consumer backlashes	Citizens; private sector; national governments; NGOs; scientific groups	National and local	Economic, cultural
Reducing unsustainable production					
Taxes on resource consumption and degradation; circular economy models; use of LCA as policy tool; corporate social responsibility (CSR)	Circular economy; change production systems based on LCA; capping of resource consumption	Lack of data and research on efficacy; market forces promoting growing production; insufficient consumer interest	National, sub-national and local governments; private sector; NGOs	National and local	Economic, cultural
Reforming trade regimes and financial systems					
Changes in trading rules; stricter regulation of commodity futures markets	Reforming trade system & WTO; future regulation on environmental derivatives	Vested interests opposed; complexity and opaqueness of information	National governments; intergovernmental institutions	All	Economic, institutions
Reforming models of economic growth					
Use of alternative measures of economic welfare and Natural Capital Accounting	Move toward steady state economics paradigm and degrowth agenda	Mostly academic exercises so far; lack of clarity on how to achieve steady-state or degrowth; political risks of not supporting economic growth at all costs; initial welfare impact of recession or degrowth; need to reallocate large sector of economy	Global institutions; national governments; private sector	All	Economic, governance, institutions

& Leichenko 2000; Stern 2006; Betzold & Weiler 2017). Failure to act now on reducing emissions is likely to impose severe economic risks to economies around the globe (Stern 2006; Hsiang *et al.*, 2017), yet recent modelling notes the particular challenges of holding warming to 1.5 degrees given strong economic inequality, high dependence on fossil fuels for global trade and transport, and inadequate climate policies (Rogelj *et al.*, 2018). While many policies have as their stated goal a nexus of nature protection, climate mitigation or adaptation, and poverty reduction, successes in this area are still difficult to find (Boyd *et al.,* 2007, Reynolds 2012, Caplow *et al.,* 2011, Lowlor *et al.,* 2013).

This transformation of the global financial and economic system towards sustainability is both necessary and possible, as the current system increasingly reflects dominant power and geopolitical interests rather than a commitment to sustainability and equity. Aichi Biodiversity Target 4 calls for governments, business and stakeholders at all levels to take steps towards "sustainable production and consumption", as does SDG 12 (responsible consumption and production) (Bengtsson *et al.*, 2018) (section 6.4.2 and 6.4.3). International systems of trade and national systems of positive and negative subsidies are also tools for achieving more sustainable ends (section 6.4.1 and 6.4.4). Finally, there are alternative models of the economy (including green growth and degrowth) to achieve a good quality of life without contributing to degradation of nature and nature's contributions to people (see section 6.4.5). There are a number of possible options for decision makers to begin to transform our economic system into a more sustainable one, ranging from immediate short-term options and longer-term options that may take decades or more to implement. Given the size and scope of the global economy, encompassing all levels from local economic output of firms to global trade between nations, different options can be applied at different scales, from individual consumers up to international institutions. This section provides a review of these options **(Table 6.8)**.

6.4.1 Reforming environmentally harmful subsidy and tax policies

Aichi Target 3 calls for the elimination, phasing-out or reform of incentives, including subsidies, that are harmful to biodiversity. It is estimated that financial support to agriculture that is potentially environmentally harmful amounted to USD 100 billion in OECD countries in 2015, and that fossil fuel subsidies account for USD 345 billion globally (OECD 2017a). The amount of finance mobilized to promote biodiversity is therefore conservatively estimated to be outweighed by potentially environmentally harmful subsidies by a factor of 10. Other potentially environmentally harmful subsidies that may also adversely affect biodiversity and ecosystems include those that encourage overcapacity in the fishing and forestry sector, subsidies that encourage urban sprawl, and the over-consumption of water.

Given the magnitude of these harmful subsidies, governments should consider the fiscal and environmental implications of their policies and work to identify and assess both their direct and indirect impacts on terrestrial and marine ecosystems. Many of these support policies were put in place for other reasons, such as to maintain the economic viability of rural areas, but such objectives can be achieved with policies that promote public goods, rather than the over-exploitation of natural resources. Reducing harmful subsidies and increasing positive environmental subsidies allows countries to compensate for the cost of adopting environmentally friendly production and consumption behaviour and by so doing, encourage such behaviour. Examples of positive subsidies with outcomes on biodiversity include grants to farmers who construct contour bunds on steep slopes, which is a policy within both the US Conservation Reserve program and the EU CAP (see **Box 6.5**).

Agricultural subsidy policy reform has already taken place with success in some countries; agricultural subsidies were reformed in Switzerland and New Zealand, and pesticide

Box 6 5 **Positive Subsidies.**

The EU Common Agricultural Policy (CAP) has long tried to use generally voluntary schemes aiming at providing incentives to farmers to conserve and better provision ecosystem services on their individual farmlands and prevent agricultural land degradation (e.g. overuse of pesticides or tillage). Under CAP, farmers are required to make a five-year obligation to use environmentally friendly farming practices (for example, conservation set-asides, organic agriculture, low-intensity systems, integrated farm management; preservation of landscape of high-value habitats and biodiversity, etc. (CDB 2015), and they receive payments to cover the cost of these enhancements or income lost from doing so. However, the agri-environmental payments of the CAP in particular are reported to have only a moderate positive impact on biodiversity (e.g., Capitanio *et al.*, 2016; Overmars *et al.*, 2013; Whittingham 2011; Kleijn *et al.*, 2006; Primdahl *et al.*, 2003) (see Ring *et al.,* 2018, section 6.5.2).

subsidies were removed in Indonesia (OECD 2017c). Subsidy reform can be combined with other measures, for example removing harmful subsidies from livestock production, imposing taxes, and internalizing social and environmental externalities in food production costs (Stoll-Kleemann & Schmidt 2017). However, the full impact of removal of subsidies on biodiversity and nature is not well understood, given the long time-lags necessary to judge such impacts.

In another example, removal of inappropriate subsidies to fossil fuel energy will help reduce carbon emissions. Estimates of the global costs of subsidizing fuels from 2012 to 2015 range between US$300-680 billion per year depending on accounting methods (Franks *et al.*, 2018). G7 countries alone provided at least $100 billion annually in subsidies for the production and consumption of oil, gas and coal, despite pledges from these countries to reduce them (Whitley *et al.*, 2018). Reducing energy subsidies and spending these funds instead on SDG would allow many countries to go a long way towards meeting their domestic financing needs. For example, Vietnam has annual per-capita fuel subsidies of US$35, which would cover an estimated one quarter of funding needed to meet their SDG commitments (Franks *et al.*, 2018) (see **Figure 6.6**). India, Indonesia, and Mexico recently reduced their subsidies for transport fuels, and major reforms of fuel or electricity prices are taking place in Argentina, Egypt, Iran, the Gulf Co-operation States, and Morocco (OECD 2017a; Rosas-Flores *et al.*, 2017; Wesseh *et al.*, 2016; Bhattacharyya *et al.*, 2017). Iran was able to end ecologically undesirable fuel subsidies by instituting a universal dividend while phasing out subsidies (Tabatabai 2012), and subsidy removal can result in opportunities for conservation and potential energy savings, as shown in in Malaysia (Yusoff & Bekhet *et al.*, 2016). China has also recently removed some energy subsidies (Jiang *et al.*, 2015; Lin *et al.*, 2014; Lin & Li. 2012) reporting both economic and environmental gains (Hong *et al.*, 2013). The starting point for energy subsidy reform from these cases points to the need to clearly define the policy objectives, understand the distribution of the costs and benefits of subsidies, assess economic as well as social and environmental impacts, actively promote the dissemination of information to stakeholders, and engage with all relevant parties (Barg *et al.*, 2006).

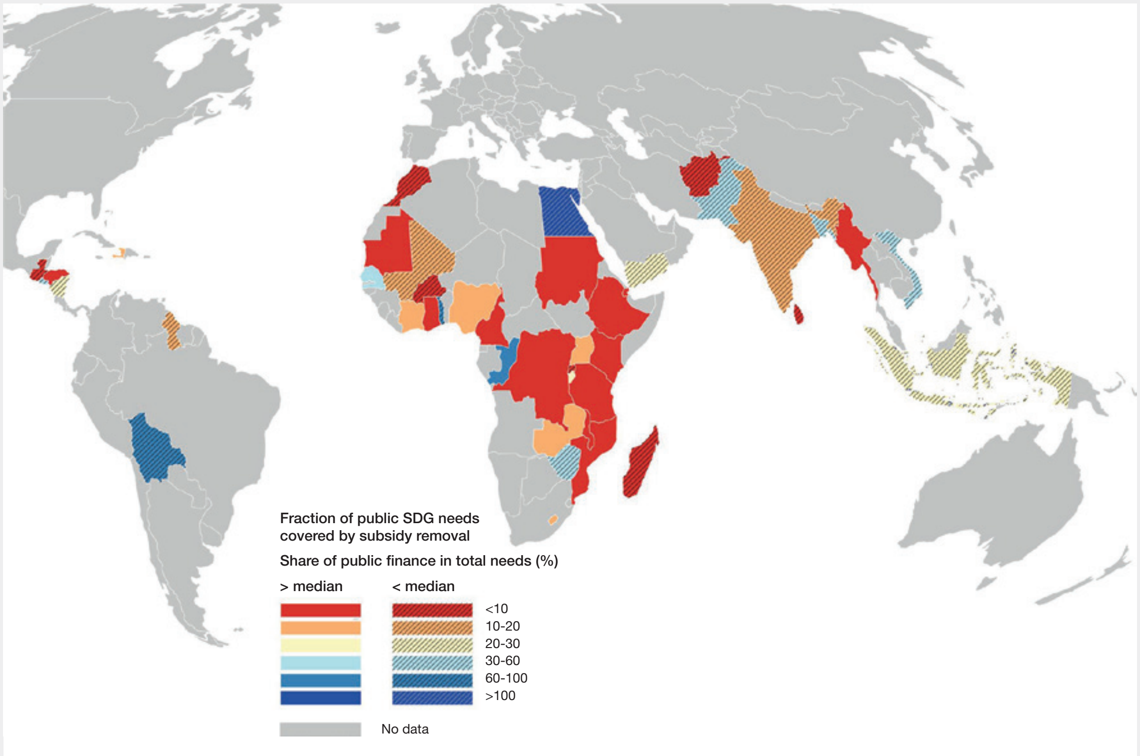

Figure 6 6 **Fraction of the national public investment need for the SDG agenda that could be financed by freeing up funds that are used at present for subsidizing fossil fuels.**

Source: Franks *et al.* (2018).

In the fisheries sector, subsidies have been estimated to be at least 13 billion per year (OECD, 2017b; Sala *et al.,* 2018). Many governments subsidize fishing by national fleets, often exceeding the net economic benefit. Fisheries subsidy reform took place in Iceland, New Zealand and Norway in the 1990s in attempts to reduce pressure on fishing stocks but remains a problem in many other countries and in particular in High Seas fishing. A recent review of High Seas fishing found that without subsidies and low wages (often slave level labor), "more than half of the currently fished high-seas fishing grounds would be unprofitable at present exploitation rates" (Sala *et al.*, 2018) (also see section 6.3.3.3.2).

International action can help countries become motivated to tackle subsidy reform, such as through "informal international law" (Pawley *et al.*, 2012). They include declarations by the leaders of the Group of Twenty (G20), the Group of Seven (G7), and the Asia-Pacific Economic Cooperation (APEC) countries. SDG target 14.6 calls on countries to prohibit certain forms of fisheries subsidies that contribute to overcapacity and overfishing, and Target 12.C makes a similar appeal to phase out "inefficient fossil fuel subsidies". The WTO has more stringent rules, or "hard law" on controlling subsidies in general, and the Agreement on Agriculture has stewarded a gradual reduction in the most trade-distorting support to the farming sector, but none of these address environmental effects specifically. At the global level, there are calls for streamlining positive renewable energy subsidies as well as involving global institutions like the WTO and the UNFCCC in the energy subsidy reform (Cosbey & Mavroidis 2014; Rubini 2012; De Bièvre 2017; van Asselt & Kulovesi 2017; Van de Graaf & van Asselt 2017).

Commonly cited obstacles for subsidy reform include concerns regarding impacts on competitiveness and distributional impacts, including employment. However, ex-post empirical analysis has found little evidence in this regard (OECD 2017c). Vested interests and political acceptability can also present barriers to subsidy reform. Political economy insights from successful biodiversity policy reform can shed light on how this transition can be achieved in practice (OECD 2017c). These suggest the need to: act quickly when presented with windows of opportunity that may be outside the influence of domestic policy makers and unrelated to the environment (for example, human health); build alliances between economic and environmental interests (e.g., when there are common interests between certain groups, even though the motivations may not be); devise targeted measures to address potential impacts on competitiveness and income distribution; build a robust evidence base on the social costs and benefits of reform; and encourage broad stakeholder engagement (OECD 2017c; 2011).

Finally, ensuring compliance with fair tax policies can help ensure funding for biodiversity and nature as well. Tax havens reduce the amount of financing available to governments for global public goods provisioning and provide bad actors with opportunities to avoid financial scrutiny, reducing the impact of policies such as certification or supply chain monitoring (also see section 6.3.2). A recent study of tax havens found that 70% of known fishing vessels implicated in illegal fishing are flagged in a tax haven, and that nearly 70% of foreign capital to the largest companies raising soy and beef in the Amazon, prime drivers of deforestation, was channeled through tax havens (Galaz *et al.*, 2018).

6.4.2 Addressing Over- and Under-consumption

Over-consumption by households is a major driver of resource use and depletion, primarily in housing, mobility and nutrition (Spangenberg & Lorek, 2002). Involuntary under-consumption is synonymous with poverty and a lack of options, while overconsumption results from unsustainable choices and practices. Overconsumption plays a major role in driving NCP loss and is associated with higher carbon footprints (Ivanova *et al.*, 2017). Reduced consumption is thus also an imperative to meet the Paris Agreement climate targets, which are unlikely to be met with resource efficiency or alternative energy sources alone (Alfredsson *et al.*, 2018). Patterns of over-consumption, however, vary greatly within and across global regions, with involuntary under-consumption and poverty representing the reality of a significant portion of the world population.

One basic misperception is that a better life is held to emerge from more consumption opportunities. Instead, studies show human needs are limited and mostly non-material; they can be satisfied with less resource consumption than usual in the affluent countries (Steinberge & Roberts, 2010) if suitable satisfiers are chosen (Max-Neef *et al.*, 1989). Satisfaction with GQL has been shown not to increase above a certain income threshold (Max-Neef 1995) and to be decoupled from income and thus consumption thereafter (Layard 2005; Hoffman & Lee 2016) (although the rich seem to be happier than the poor in most societies (Veenhoven 2010)).

Consumption-focused policies have a significant opportunity to complement other nature conservation efforts (Igoe 2013; Isenhour 2014) with a resource conservation potential of demand-side measures potentially matching supply side options (Cruetzig *et al.*, 2016; Lazarus *et al.*, 2011), in particular when combined with policies to compensate for rebound effects (the phenomenon where increased efficiency leads consumers to take that additional money and increase consumption elsewhere) (Jackson 2005; Lorek & Spangenberg 2014). We here review options for consumers, governments and the corporate sector.

Consumers' action options: Grassroots and civil society organizations have advocated a wide range of lifestyle modifications and shifts in consumer behaviours, often focusing on information and education initiatives for affluent and environmentally conscious consumers, such as generating pressures on corporations and governments by mobilizing the social norms of affluent consumers (Conroy 2001) and engaging in the co-designing of products and services (Fuad-Luke 2008). Critics point out that these successes are often short lived and have done little to challenge dominant consumption logics or practices. Furthermore, studies indicate that changing the composition of consumption has limited effects on the overall environmental impact (Røpke 2001) and that it is reducing the level of resource consumption that reduces drivers of environmental damage (Lorek 2010; di Giulio & Fuchs 2014; Lorek & Spangenberg 2014).

Already a number of consumers have chosen to reduce their consumption by practicing 'voluntary simplicity', often motivated more by lifestyle choices rather than concerns about sustainability (McDonald 2015) and in conjunction with reducing their income and increasing their leisure time and thus avoiding rebound effects (Freire-González *et al.*, 2017). As such changes are not easy in the current consumer society (Speck & Hasselkuss 2015), dedicated policies are called for to make a resource-light, good life easier (Schneidewind & Zahrnt 2014; Heindl & Kanschik 2016).

Government policy options supporting consumers: To influence *conscious decisions,* awareness-raising and information campaigns are viable options. However, the literature on their effectiveness is unclear, particularly for the average consumer who may not share strong environmental norms (Stern 2000; Spaargaren *et al.*, 2013). An option to influence *spontaneous decisions* is the choice architecture approach including nudging, i.e. offering pre-set default options which in some cases had a strong influence on consumers' propensity to make desirable choices (Gsottbauer & van den Bergh 2011). Nudges can include tailored messaging or offer peer comparisons, provide disclosures or warnings, create default rules, or use social norms (Sunstein 2015; Lehner *et al.*, 2015; Halker 2013; Olander & Thorgersen 2014). However, nudging has been effective only if the required change of everyday life routines and the effort required were not too onerous (Keller *et al.*, 2016). There is also very little evidence that non-regulatory measures used in isolation, including nudges, are effective for biodiversity conservation (Newton *et al.*, 2013; Hobson 2013). *Legislation and norms* have the advantage of binding all consumers for all kinds of decisions to the same standards, and to be implementable in relatively short time. They range from broad ecological tax reforms to bans of single-use disposable products, disincentives for travel or meat consumption, and public investments in product service agreements or collaborative consumption networks. Many consumers favor the removal of dangerous products from the market and a stronger role for governmental agencies in protecting consumers over more choice (Isenhour 2011).

Taxing consumption: Many taxes on activities or products exerting negative (and often indirect) effects on ecosystems and biodiversity rely either on the polluter-pay principle or on the user-pay principle (Ekins 1999). Examples of these "green" taxes and levies can include:

- Pesticide taxes, e.g. France, Denmark, Norway, Sweden, United States (OECD 2017a; Hogg *et al.*, 2014). However, moderate increases in the tax rate alone appear not to be sufficient to reduce use (Sainteny 2011; Jacquet *et al.*, 2011).

- Fee-based licenses for logging, fishing and hunting are price mechanisms to limit certain detrimental mechanisms (Fisher *et al.*, 2008).

- Taxes on luxury and consumer goods have shown some success in reducing excess consumption and raising money for other initiatives (Schor 2005).

- Road and congestion charges, often in large cities like London and Stockholm, have been shown to reduce transportation by single occupancy vehicles and lower carbon emissions (Newberry 2005).

- Carbon/energy/fuel taxes with the main motivation to mitigate climate change also reduce environmental risks and threats to ecosystems (Ekins 1999).

- Eco-VAT. In Brazil, an ecological value added tax is paid to municipal governments (Farley and Costanza 2010).

However, while these targeted fees and taxes, and VAT more generally, dampen consumption, very few direct consumption taxes have been designed specifically in order to preserve nature and NCP. Taxes can be combined with other economic instruments for these ends; for example, revenues from taxes may be used to finance other biodiversity-conserving activities, like protected areas (Farley and Costanza 2010; Raes *et al.*, 2016). As no global assessment of the effectiveness of these kinds of taxes is found in the literature, the evidence remains inconclusive (Hogg *et al.*, 2014). More empirical work on the experimental use of different taxation schemes and their environmental outcomes is recommended.

Local and regional governments across the world are also investing in a wide range of programs to encourage more resource-light consumption including elements of sufficiency such as hosting repair cafes, materials exchanges/swaps, and innovating 'collaborative consumption' events like tool lending libraries. Authorities have also indirect influences on consumption patterns and levels: public transport planning can enhance the accessibility without car use, with positive environmental and quality of life outcomes. Additionally, in most countries, public procurement is the single largest purchaser of goods and services. This gives public authorities from the local to international level the opportunity to strengthen sustainable suppliers and nudge others towards greening their offers, by stimulating the demand for energy saving buildings, recycled products or organic food, reducing the consumption of materials, energy and land and thus mitigating several direct and indirect drivers of nature deterioration (Brammer & Walker 2011; Lutz 2009).

Corporate action reducing consumption: Corporations and industry associations have responded to consumer demand through sustainable sourcing practices and consumer awareness campaigns in the interest of both resource protection and building brand loyalty. However, Williamson *et al.* (2006) found that such voluntary approaches will not alter the behaviour of manufacturing enterprises significantly unless they have a positive effect on the bottom line, e.g. by reducing resource or labor cost, ensuring employee morale (Jacobsen & Dulsrud 2007) or avoiding regulation by pre-empting measures (Marsden & Flynn 2000). The research on such Corporate Social Responsibility (CSR) programs tends to conceptual rather than empirical, except for some labelling and certification programs (Carlson *et al.*, 2018). See Supplementary Materials 6.6.1 for a detailed discussion on addressing overconsumption.

6.4.3 Reducing unsustainable production

Several studies have shown that production systems focused on economic growth correlate with increasing environmental impacts, both on micro/household and on macro/cross-national levels (Hayden & Shandra 2009; Rosnick & Weisbrot 2007; EEA 2014; Ward *et al.*, 2016). Policy options include the setting of resource caps and taxes, transitioning to a circular economy, corporate social responsibility, and using life cycle analysis as a policy support tool.

Resource caps and taxes: Resource caps and taxes are a way to limit the volume of resources used or produced in production processes. Examples with positive environmental effects include water extraction charges or energy sector charges (McDonald *et al.*, 2012), e.g., car fleet gasoline consumption limits as an obligation to manufacturers and public procurement. Caps and taxes support transformative change as reducing supply modifies the competition rules in a market economy, requiring companies to redesign products and business models by taking resource limitations (and implicitly biodiversity aspects) into account alongside economic considerations throughout the supply chain (Ayres 1989). A large number of studies have shown that avoidance costs tend to be lower than damage and repair costs (Aslaksen *et al.*, 2013; Gee *et al.*, 2013; Simberloff 2014, EEA 2017).

As one example, carbon pricing is currently in discussion as a possible way to spur development of non-fossil fuel energy sources and reduce carbon emissions (Essl & Mauerhofer 2018); a recent study found that while the potential to raise revenue from carbon pricing is highly variable depending on country's emission intensity and economic activity, many low income countries could finance much of their needs to implement the SDG with a carbon pricing scheme starting at $40/ton (Franks *et al.*, 2018). To avoid disproportionate negative effects on producers and resulting rises in prices, resource caps and taxes can be complemented with compensatory measures, such as carbon dividends and subsidies to low income energy users.

Transitioning to a circular economy: The major aim of the Circular Economy (CE) is to decouple economic growth and the deterioration of the environment (Ghisellini *et al.*, 2016), suggesting that economic prosperity and improved environmental quality can be achieved together at the same time (Kirchherr *et al.*, 2017) through technological, economic and social innovations (Jesus & Mendonça 2017). There are many competing definitions about what the circular economy is and how far it can be implemented at the micro (e.g. company, consumer), meso (e.g. industrial park) or the macro (regional, national, global) level (Kirchherr *et al.*, 2017). According to a frequently cited definition, CE is "an industrial system that is restorative or regenerative by intention and design. It replaces the ‹end-of-life› concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and within this, business models." (Ellen MacArthur Foundation 2013: p7). Most discussions about CE recognize that it may not be possible to make the economy fully circular. For example, **Figure 6.7** offers a representation of the CE that allows for raw materials input and residual waste outputs.

CE is promoted in various countries worldwide (for examples, see Supplementary Materials 6.6.2). Nevertheless, consensus is still lacking on how far the global economy is progressing towards a CE. Cooper *et al.* (2017) estimated that potential savings of energy used for economic activities worldwide could reach 6-11%, while Haas *et al.* (2015) carried out a material flows analysis on data from 2005 and estimated that the recycling within the economy as share of processed material reached 6%

Figure 6 7 **Depiction of the circular economy.**

Source: https://www.europarl.europa.eu/ireland/en/news-press/circular-economy-meps-call-for-“systemic-change”-to-address-resource-scarcity.

globally and 13% in the EU. Reasons for these relatively low numbers are thought to be the large proportion of non-recyclable fossil fuel and biomass material throughput (Haas *et al.*, 2015), and the accelerating production due to the rebound effect (Zink & Geyer 2017). Other factors include policy and enforcement failures, consumer preferences, costs, and infrastructure deficits (for details, see Supplementary Materials 6.6.2).

Corporate social responsibility (CSR): CSR initiatives are voluntary efforts by companies to address social and environmental concerns arising from business activities (Robinson 2011; European Commission 2011, Dyllick & Hockerts 2002; Baumgartner 2014; O'Connor & Spangenberg 2008). CSR is used by sectors that are directly affected by the degradation of local ecosystems and habitat loss (e.g. fisheries, agriculture, forestry, tourism) (Boiral & Heras-Saizarbitoria 2017; Hastings & Botsford 2003; Pickering & Hill 2007) as well as sectors that are indirectly affected through their globalized supply chains (Robinson 2011). The idea of CSR is that companies have the potential and responsibility to make a substantial contribution to arresting declines in biodiversity and ecosystems services (Armsworth 2010; Lambooy 2011; Athanas 2005; 'Biodiversity in Good Company' Initiative https://www.business-and-biodiversity.de/en/about-us/). The ultimate role of companies should be to identify, to be transparent and accountable for their impacts (ISO 26000) (ISO 2010), and to develop strategies to reduce negative and to maximize positive impacts. However, since the inception of the CBD in 1992, little progress has been achieved in terms of involving the business community in protecting biological diversity worldwide (Overbeek *et al.*, 2013). For instance, most of the Fortune 500 companies do not systematically record their activities regarding biodiversity and ecosystems service management (Bhattacharya, 2013); a recent study found only 5 companies in the Fortune 100 had specific and measurable commitments to biodiversity (Addison *et al.*, 2018). However, research suggests that business profits and good condition of biodiversity are often correlated (Tilman *et al.*, 2006; Worm & Barbier

2006; Bishop *et al.*, 2008; Lambooy 2011) (see also Supplementary Materials 6.6.2).

Using life cycle analysis as a policy support tool: Life cycle assessment (LCA) offers a method for quantitatively assessing and evaluating the inputs, outputs, and potential environmental impacts of a product system throughout its life cycle (ISO 2006a). It is widely applied by companies (Frankl & Rubik 2000; Clift & Druckman 2015) to inform consumers (Del Borghi 2013) and for public policy making (Owsianiak *et al.*, 2018). However, the inclusion of biodiversity in LCA has been limited to specific species or has related factors such as climate change or land use (Verones *et al.*, 2017; Goedkeep *et al.*, 2013; deBaan *et al.*, 2013; Schenk 2001; Penman *et al.*, 2010; Curran *et al.*, 2011; Koellner *et al.*, 2013; Souza *et al.*, 2015; Winter *et al.*, 2017; Chaundhary *et al.*, 2015; see Supplementary Materials 6.6.2). Several authors have discussed options to incorporate ecosystem services into LCA (Zhang *et al.*, 2010 a, b; Bakshi & Small 2011; Koellner & Geyer 2011; Cao *et al.*, 2015; Othoniel *et al.*, 2016; Blanco *et al.*, 2017; Bruel *et al.*, 2016) but so far with little progress. LCA approaches have a number of limitations, as they present many choices and assumptions, are complex and require sufficient and standardized data, provide a snapshot at a specific point in time which may be outdated by innovation or modified supply chains by the time the data is used, and focus on reducing the impacts per unit of consumption, not on reducing consumption levels themselves (Pré Consultants 2006; Finkbeiner 2014; Galatola & Pant 2014).

6.4.4 Reforming trade regimes to address disparities and distortions

Key global commodities with negative impacts on nature are among the major items traded internationally and subject to rules through the WTO and other regional and bilateral trade deals. There is growing evidence that these trading rules often encourage overproduction or unsustainable production, and that future markets can create pressures for expansion of production in unsustainable ways (Pace & Gephart 2017; Bruckner *et al.*, 2015). While challenging, it is increasingly acknowledged that reforming trade systems and financial markets is essential to controlling the impact of global economic drivers on nature.

Reforming the trade system: There are general concerns that trade liberalization contains considerable risks for nature and the environment. For example, tensions have been identified between WTO regulations, particularly the General Agreement on Tariffs and Trade (GATT) and environmental concerns. Documented cases focus on efforts to ban tuna from fisheries operations and nations that do not implement dolphin conservation measures (Waincymer 1998) or, similarly, to ban shrimp from fisheries operations and nations that do not implement turtle conservation measures (Benson 2003). Other examples include domestic support for multifunctional agriculture (see also 6.3.2) (Dibsen *et al.*, 2009; Hasund 2013, Potter & Burney 2002; Potter & Tilzey 2007). Tensions have also been identified between the GATT and biosecurity issues related to preventing diseases and invasive species from entering (Maye *et al.*, 2012).

A different issue identified in literature is related to the WTO Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) (Brand & Görg 2003). While the potential of WTO and other free trade agreements and WTO regulations to contribute to conservation and sustainability is criticized (Waincymer 1998; Brand & Görg 2003), some suggest that the inclusion of environmental provisions in TRIPS can prevent negative environmental impacts and even promote conservation and good environmental practices (Neumayer 2000; Ivanova & Angeles 2006). Opportunities within WTO have been identified in the Technical Barriers to Trade (TBT) agreements and in Preferential Trade Agreements (Charnovitz 2007). Also, the Geographical Indications (GI), part of TRIPS, can provide opportunities for conservation and sustainability, but only if nature and biodiversity friendly practices are embedded in the GI specification (Garcia *et al.*, 2007).

While other regional or bilateral free trade agreements such as NAFTA include environmental provisions, these have mostly been implemented in a narrow way and have not resulted in significantly raised levels of environmental protection (Sanchez 2002). At the global level, WTO has started to discuss environmental provisions as part of the Doha negotiations since 2001, but negotiations were not successful and ended in 2016. Since then, bilateral trade agreements have increased in importance, as have the intensification of 'trade wars'. The consequences of this situation for international cooperation, as well as for nature, its contributions and the quality of life are yet to be determined.

Reforming derivative and futures markets: The increasing trade in futures and derivatives over the past decade have been associated with outcomes that affect biodiversity. Futures and comparable financial products such as derivatives are essentially contracts between buyers and sellers of commodities that stipulate volumes, price and delivery date (Pollard *et al.*, 2008). Derivatives and futures turn variability into a credit risk that can be hedged against, traded, and speculated on, and signal the ongoing commodification of new forms of nature (Smith 2007; Cooper 2010). For example, climate and weather derivatives have emerged, seen as a flexible and cost-effective way for companies to reduce risk and become more creditworthy (Pryke 2007; Cooper 2010). While futures and derivatives contracts can offer potential income stability and protection against risks, they are also an opportunity for speculation and hedging on price movements which can lead to turbulence and price volatility (Cooper 2010). This means that, when unregulated, these markets can pose a potential threat to sustainability and contribute to social crises (Heltberg *et al.*, 2012).

In the United States, home to the largest commodity futures markets, financial regulations designed to prevent excessive levels of speculation by financial investors were in place for much of the 20th century. These rules included reporting requirements as well as ‘position limits’ that restricted the number of commodity futures contracts purely financial investors (also referred to as ‘non-commercial operators’) could hold at any given time. Over the course of the 1980s to early 2000s, these regulations were gradually relaxed (Clapp & Helleiner 2012). Following the deregulation of the US futures markets, speculative investment in agricultural commodities increased from US$ 65 billion in 2006 to US$ 126 billion in 2011 (Worthy 2011). It has been suggested that this contributed in part to the 2007-2008 food crisis, as a number of observers noted that food prices were rising more quickly and sharply than was warranted by the underlying fundamentals of supply and demand for those crops at the time (e.g., FAO 2008). Analysts identified speculative financial investment, including commodity index products marketed to large institutional investors, as a potential factor in driving up food prices (Masters 2008; Ghosh 2010) with severe impacts on the quality of life in many countries (Ivanic & Martin 2008; Bellemare 2015). Although there is debate over the extent to which financial speculators were responsible (see, for example, Sanders & Irwin 2010), several international organizations have noted that financial speculation in agricultural commodity markets can make food price trends more volatile (BIS 2011; UNCTAD 2011). Higher and more volatile food prices matter for biodiversity because when food prices rise, investment in agricultural production also typically rises, influencing land-use trends. At the height of food price volatility in the 2008-2013 period, there was a rush to increase production, especially of cereal crops such as wheat, maize and rice, as well as oil crops such as soy (FAO 2017).

As commodity exchanges around the world, including in developing countries, develop to include more sophisticated financial and investment products, it is important for them to consider adopting regulations that seek to limit excessive financial speculation on those markets that can affect biodiversity outcomes (FAO *et al.*, 2011): for example, by putting limits on the number of contracts per trader in each market (Ghosh *et al.*, 2012) and by enhancing market transparency (Clapp 2009; Minot 2014). In the wake of the 2008 financial crisis, governments around the world sought to tighten regulations on commodities futures markets with a view to reining in speculative financial investments that could affect prices and destabilize markets (Helleiner 2018). In the United States, the Dodd-Frank Wall Street Reform and Consumer Protection Act authorized the adoption of new rules to strengthen the position limits and reporting requirements to restrain excessive speculation. However, the substance of these rules has been weakened and their implementation has been delayed following extensive lobbying and court challenges from the financial industry. The European Union also developed more stringent regulations known as Mifid II, but these rules were also weakened in the face of the financial industry. It is unclear whether the new regulations in the US and EU, once fully implemented, will achieve their intended effect, and their subsequent impact on agricultural outcomes that affect biodiversity.

6.4.5 New models for a sustainable economy

In recent decades, many have questioned the economic growth paradigm and its compatibility not only with environmental sustainability but also achieving a good quality of life for all. The challenges of climate change and biodiversity loss, in particular, underline that the scale of economic activity has already pushed society out of the safe operating space of the planet (Rockström *et al.*, 2009; IPCC 2018). By detaching mainstream paradigms of unending economic growth from economic and social relations, alternative ways of understanding human and societal well-being have been proposed (Costanza *et al.*, 2014; Cattaneo 2014; O’Neill 2012). A central idea in these approaches is to decouple growth of the economy and enhancement of human well-being from resource use and extraction. The most prominent models are the Green Economy (also called Green Growth or Inclusive Green Growth, promoted by the OECD, UNEP and EU), which builds upon earlier discussion on ecological modernization (Mol & Spaargaren 2000), and the model of (physical) Degrowth leading to a steady state economy (Daly 1974; Denaria *et al.*, 2013).

The core assumption of the Green Economy model is that increasing economic activity as well as the generation of income and jobs can be achieved without becoming unsustainable. Key strategies in this endeavor include increasing the efficiency of resource use by means of technological and social innovations (York & Rosa 2003) and transitioning towards more sustainable patterns of consumption (UNEP 2002). Other discussions highlight the possibilities of substituting natural capital for human capital and human made capital (Pearce *et al.*, 1989; Pearce & Barbier 2000), while protecting a critical level of natural capital (Deutsch *et al.*, 2003; Ekins 2003).

The toolbox used in green economy policies typically includes a mix of regulatory (laws, voluntary agreements), economic or market based (green taxes, credits, certification, subsidies, offsetting, PES, circular economy) and informational instruments (labeling, consumer campaigns), with an emphasis on the latter two. On the consumption side, Green Economy strategies call for (voluntary) changes in consumption patterns towards the growth in production and consumption of non-material or non-resource intensive goods and services. There are however strong criticisms to this Green Economy concept arguing that the suggested measures may indeed be indispensable, but not sufficient in the long term and that more fundamental change is necessary (Victor 2008; Jackson 2009).

Degrowth, including the older idea of a steady state economy (Daly 1974), contests the necessity of economic growth as a condition of human well-being and good quality of life. Foremost amongst these is that for an economy to remain within ecological bounds, it must possess a constant stock of physical capital at a level that can be maintained by material flows remaining within the regenerative capacity of the ecosystem (Daly 1974). Only if economic output could be decoupled from resource use, growth in Gross Domestic Product (GDP) would be consistent with sustainability. Models of degrowth go beyond the physical steady state and advocate "an equitable downscaling of production and consumption that increases human well-being and enhances ecological conditions at the local and global levels, in the short and long-terms" (Schneider *et al.*, 2010:512). This implies reduced growth in the physical part of the economy and as a result in the monetary or financial side (Spangenberg 2010). On the consumption side, degrowth goes beyond greener consumption patterns by advocating for reduced consumption levels overall.

Strategies for degrowth include limits on resource extraction, new social security guarantees and work-sharing (reduced work hours); universal basic income and income caps (see Supplementary Materials 6.6.3); consumption sufficiency, and resource taxes with affordability safeguards; redistribution of wealth, support of innovative models of "local living"; commercial and commerce free zones; new forms of money; high reserve requirements for banks; ethical banking; green investments; cooperative property and cooperative firms (Eckersley Ro 2006; Jackson 2009; Korten 2008; Latouche 2009; Spangenberg 2010; Klitgaard & Krall 2012; Heikkurinen 2016; Samerski 2016). Already existing practices that adopt these models or parts include eco-communities and villages, cooperatives, community currencies, time banking or urban gardening (e.g., Cattaneo & Gavaldà 2010; Nierling 2012; 2010; Dittmer 2013; Xue 2014; LeBlanc 2017; McGuirk 2017). In a degrowth strategy, these practices are integrated with selected instruments from the green economy toolbox, like green taxes or consumer campaigns (Kallis *et al.*, 2012; Rigon 2017), but not others such as biodiversity banking due to reservations against the commodification of nature (Gómez-Baggethun & Ruiz-Pérez 2011).

Evidence of the effectiveness of alternative models of the economy, including associated strategies and practices, is inconclusive. Yet, existing evidence shows that current strategies and practices have not accomplished a decoupling of economic growth from energy and materials consumption over an extended time span (chapter 2). Without an adjustment of orientations and priorities, including an effective instrumentation of such policies, a sustainable economy is not going to be achieved. These alternative models and associated strategies and practices offer opportunities to promote nature and its contributions, recognize value pluralism (Pascual *et al.*, 2017), and enhance inclusiveness as recognized in the SDG. An example of such a value pluralist approach is the concept of Good Living ("Buen Vivir"), which means material, social and spiritual well-being of people who live not at the cost of others or nature (Brand *et al.*, 2017; Beling *et al.*, 2018). This concept of Good Living has been adopted in the Bolivian constitution, calling for recognition of the rights of nature and holistic understanding (IPBES 2016; Pacheco 2014a, b), albeit with limited impact on the country's neo-extractivist policy (Beling *et al.*, 2018). Other examples include the broad discussion on the transition to an "ecological civilization" in China (Yan & Spangenberg 2018).

Since the GDP does not capture the state of the environment, biodiversity nature and its contributions, and is not a measure of welfare in itself, the discussion of alternative models of the economy has extended to the development of alternative measures to represent human well-being and good quality of life (see chapter 2). Some, like the Index of Sustainable Economic Welfare (ISEW) (Daly & Cobb 1989) and the Genuine Progress Indicator (GPI) (Cobb *et al.*, 1995), are based on GDP calculation; subtracting the "bads" like environmental degradation and biodiversity loss in monetary terms and adding the "goods" not included in the GDP such as the value of unpaid work. A comprehensive set of indicators for short and longer-term development has been suggested by the Stiglitz-Sen-Fitoussi Commission set up by the French government (Stiglitz *et al.*, 2010). Another prominent measure is the Gross National Happiness Index, introduced by the Bhutanese Government. This measure focuses on equitable social development, cultural preservation and conservation of the environment (Verma *et al.*, 2017). Recently, local, regional and national governments, including different States in the US (see Talberth & Weisdorf 2017 for an overview), and Belgium (Bleys 2013) have shown interest in these measures.

Further innovations have been proposed in accounting systems to incorporate environment and ecosystems. To this end, UN Statistics extended the international statistical system by satellite accounts of physical flows and environmental goods, and in its latest version the value of ecosystems and their services (https://seea.un.org/). This includes amongst others Material Flow Accounting (MFA) and Material and Energy Flow Accounting (MEFA) (Bringezu *et al.*, 1997; Haberl *et al.*, 2004) and Natural Capital (NC) assessment and accounting (Natural Capital Coalition 2017). There is a wide variety in methods and approaches. Some of these focus on only one ecosystem service or form of capital (for example carbon), some use formal accounting methods and involve monetization, and again others use non-monetary units to quantify and express environmental stocks and flows (Day 2013; Faccoli *et al.*, 2016; Bateman *et al.*, 2011; Donnely *et al.*, 2016; Agrawala *et al.*, 2014; Robèrt 2002; Schmidt-Bleek 2008; Spangenberg *et al.*, 1998; Dittrich *et al.*, 2012; Ulgiati *et al.*, 2011, Ayres *et al.*, 1996; Steen-Olsen *et al.*, 2012; Giampietro *et al.*, 2014; Lomas & Giampietro 2017; ten Brink 2012; UNU-UHDP and IHDP 2014) (see Supplementary Materials 6.6.3).

There is as yet no evidence of the effectiveness of the use of environmental accounting approaches. As an information instrument, its effectiveness is based on the premise that more information will result in better decision-making (Guerry *et al.*, 2015; Mace *et al.*, 2015) – a premise that is largely unsupported (Caceres *et al.*, 2016; Turnhout *et al.*, 2013; Wesselink *et al.*, 2013). Yet, as has been shown for other information tools such as models or indicators (Turnhout *et al.*, 2007; Van Egmond & Zeiss 2010; see Section 6.2.2), environmental accounting may be helpful as a tool for the facilitation of dialogue on the diverse values of nature and biodiversity. However, in order to enable this role, it is important that it uses a broad perspective that includes non-economic values and that it employs a participatory approach so that relevant stakeholders can contribute to the definition and identification of indicators for nature, ecosystem services, environmental assets, and natural capital (Turnhout *et al.*, 2007; Raymond *et al.*, 2009).

6.4.6 Conclusions

The existing economic system of capital-intensive exploitation of nature, extensive international trade and their telecouplings, and wide-ranging inequality between countries and between peoples within countries, is not a system that is natural or to which there is no alternative. To the contrary, such an economic system has evolved over time due to human interventions, institutions, policy choices and options, and as such, can be transformed just as it was created. The problem is often one of both recognizing the scope of the problem through sharing information, implementing more inclusive and realistic economic accounting, as well as tackling reforms to the system through gradual incremental changes like changing consumer behaviour, incentivizing different economic pathways, reducing production impacts, and reforming trade, subsidies and markets or various kinds. More transformative options like creating circular economies, moving to degrowth and steady-state economic paradigms, tackling inequality, and revamping the way we finance and prioritize conservation of nature and biodiversity will require concerted efforts from a range of decision makers, with national governments, private corporations and international institutions leading the way. Designing such an integrated world economy that values nature and its contributions in pluralistic ways, recognizes their long-term importance to human quality of life, and rightfully prioritizes them as public goods above private profit is a long-term vision that will require innovative, imaginative and adaptive ways to transform our current economic and governance systems.

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