WBGU

German Advisory Council on Global Change

Summary

World in Transition

Governing the Marine Heritage

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(as on 28 February 2013)

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This publication summarizes the report "World in Transition: Governing the Marine Heritage" which will be published in the autumn of 2013 and will be available free of charge at the Secretariat.

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Summary

Living with the sea forces us to think differently: to think in a new way and to act differently.
Elisabeth Mann Borgese, 1918-2002, marine conservation pioneer

Rethinking the oceans

For a long time humanity thought of the sea as something inexhaustible. Given the sheer size of the oceans, it seemed inconceivable that humans might be able to exert any appreciable influence on the 'blue continent'.

Changes caused by humans take place gradually, and even today they are very difficult to detect or measure. It therefore took a long time before it was discovered that the impact of humankind on the sea grew ever stronger as our society became more industrialized, finally reaching disturbing dimensions: marine fish stocks are in a poor state due to overfishing, so that almost two-thirds of stocks need time to recover; a fifth of the species-rich coral reefs have already disappeared and three-quarters are at risk; and not least, our societies use the oceans as a rubbish dump, threatening species and ecosystems with nutrients, toxins and plastic. Man-made hazards also include CO_2 emissions from fossil fuels, which are increasingly acidifying the oceans and thus endangering marine ecosystems. The acid concentration has already risen by almost a third since industrialization began, and this can have considerable effects on marine ecosystems and fishery.

Further examples of humanity's huge impact include cases of large-scale pollution (like after the disastrous accident involving the Deepwater Horizon oil rig in April 2010), the sudden collapse in the early 1990s of the once seemingly inexhaustible stocks of cod off Newfoundland, and the rising temperature of the world's oceans, which has already led to a dramatic reduction in the size of the Arctic sea ice. Overall, the oceans are in an unsatisfactory state. This largely still undiscovered 'blue continent' is proving to be fragile, and in parts it is already irreversibly damaged. For these reasons, the oceans – their treasures and the threats they face – repeatedly find themselves at the focus of public attention.

Human influence grows with technological development. Today, new ways of using the seas promise great opportunities, but they can also put new pressure on the oceans and their ecosystems. Using the huge potential of offshore wind power can contribute to a climate-friendly energy supply. On the other hand, unprecedented and unquantifiable risks are involved in the extraction of fossil oil and gas resources from the deep sea and the Arctic, and in mining methane hydrates – all of which are now becoming technically feasible. Similarly, the increasingly effective methods being used to detect and catch fish in remote areas of the high seas and at ever-greater depths are increasing pressure on fish stocks and marine ecosystems.

Humankind is dependent on the seas, their ecosystem services and their biological diversity – for food, energy generation, medical products, tourism, climate-regulating functions and the oceans' absorption of CO_2. Against the background of humanity's influence on the seas – which is already big today and could potentially become much larger in the future – and in view of the seas' key importance for our societies, the WBGU asks how humanity might best go about the task of developing a sustainable stewardship of the oceans.

What condition will the oceans be in when we hand them over to coming generations in the middle of this century? Are we now going to take on responsibility and embark on the path of sustainability in the real world and not merely on paper? Much will depend on how marine conservation and ocean uses are organized, in other words on ocean governance. This report therefore focuses on the global, regional and national rules governing the conservation and sustainable use of the oceans, and above all on how we can ensure that these rules are implemented, which has been a huge problem in the past.

The WBGU puts the debate on the seas into the context of the 'Great Transformation' towards a low-carbon, sustainable society – the subject of its 2011 flagship report 'A Social Contract for Sustainability'. Here, the

WBGU argued that if greenhouse-gas emissions continued growing unabated, the Earth system would breach planetary guard rails within a few decades and enter domains that would be incompatible with sustainable development. The WBGU is convinced that nothing short of a new industrial revolution can prevent this. For that to happen, the world will have to phase out not only fossil power generation, but also energy-intensive urbanization and emissions-intensive land use within the next few decades. The WBGU believes the seas should be fully incorporated into this transformation towards a low-carbon, sustainable society, in particular because of the irreversibility of some of the processes involved. The oceans have the potential to give the transformation massive support; in turn, the transformation is necessary for the long-term conservation of the marine ecosystems.

The WBGU already focused on the seas in its 2006 special report 'The Future Oceans – Warming Up, Rising High, Turning Sour'. In particular it took a closer look at the interface between greenhouse-gas emissions and the oceans (e.g. warming, sea-level rise, ocean acidification). In the present report the WBGU examines the examples of food and energy, which were already at the centre of its 2011 flagship report on transformation. It studies the sustainable management of fish stocks, sustainable aquaculture and the development of marine renewable-energy systems. It also shows how the oceans can make a substantial contribution to the transformation. At the same time, the seas and their ecosystems are threatened by the effects of climate change and ocean acidification.

The WBGU shows that the conservation and sustainable use of the oceans are urgently necessary, that a transformation towards low-carbon, sustainable development is possible including the oceans, and that it can yield substantial advantages worldwide for sustainable energy supplies and food security.

Guiding principles for future ocean governance

Future ocean governance – i. e. how to develop a sustainable stewardship of the oceans – will play a crucial role if mankind is to reverse the present trend and manage the seas in a sustainable way. The current situation is quite favourable as a starting point: the world already has a comprehensive international treaty – the United Nations Convention on the Law of the Sea, or UNCLOS – which, together with accompanying agreements, functions as a kind of 'constitution of the seas'. However, UNCLOS was adopted in 1982, so that more recent insights are either absent altogether or given inadequate attention. In particular, it has meanwhile become increasingly accepted that humanity is a dominant factor in the entire Earth system. Humankind's new shaping impact is expressed by the term 'Anthropocene' to describe our present era. In the Anthropocene, humanity should take on responsibility for the stewardship of the natural environment. This also applies to the seas.

The existing system of ocean governance has failed in several areas, not only because the intergovernmental regulations that have been agreed are insufficient, but primarily because these regulations are not resolutely implemented and misconduct is hardly ever prevented by sanctions.

Given these challenges, the WBGU recommends basing our interaction with the oceans on three guiding principles. They are crucial for designing a regime for protecting and sustainably using the oceans which, in combination with ten criteria for sustainable ocean governance (Box 1), can ensure the long-term conservation of ecosystem services, biodiversity, and yields from the sustainable use of the sea. The starting point is a fundamental change of position and perspective applying the following three principles:

1. *The oceans as a common heritage of mankind:* The oceans are a global public good for which no clearly defined, sustainability-based conservation obligations or rights of use exist. The idea that the oceans are a 'common heritage of mankind' was put forward as early as the 1960s by Arvid Pardo and Elisabeth Mann Borgese in the negotiations on UNCLOS. Although it was not enforced as a principle of international law for the oceans as a whole, it was codified for the mineral resources of the seabed beyond national jurisdiction ('the Area'). In the WBGU's view, it follows from the common heritage of mankind principle that global public goods must be accessible to all people and not be fully at the disposal of any state, individual or company. The conservation and sustainable use of the common heritage of mankind requires stewards, a management regime for conservation and sustainable use, and rules on sharing to ensure that the costs and benefits of the regime are distributed fairly. From a political perspective this results in a system of shared sovereignty between states which is based on a global regulatory framework geared towards sustainability goals. The marine public goods are to be conserved and their short-term exploitation and overexploitation avoided, thus also enabling future generations to use them.
2. *The systemic approach:* The sectoral approach, which is widely prevalent in ocean governance at present, is characterized by a narrow view of the different forms of use (e.g. fishing, oil extraction,

conservation) and does not do justice to the systemic requirements of sustainability. The WBGU proposes the introduction of a systemic approach in order to integrate both the different levels of the system and the interactions between the natural and social systems that should be taken into account when dealing with the oceans. The approach comprises the following levels: *First*, marine ecosystems are themselves complex systems which should be protected and used according to the 'ecosystem approach'. The ecosystem approach was developed in the context of the Convention on Biological Diversity and is now widely recognized by governments. *Second,* the systemic approach should go far beyond the uses of the marine ecosystems and also take land/sea interactions into account – after all, many of the risks to the oceans are caused by economic activities on land. For example, industrial production can damage the oceans when plastic products or long-lived pollutants find their way into the sea via the atmosphere or rivers. Regulating industrial production can therefore also contribute to marine conservation. Last, but not least, agriculture too is responsible for considerable input of nutrients and sediments into the oceans. *Third*, in the era of the Anthropocene, linkages in the Earth system should also be taken into account – e.g. CO_2 emissions from fossil fuels, which damage marine ecosystems both indirectly – via climate change by raising temperatures – and directly by acidifying the seawater. *Fourth*, on all these levels it must be taken into account that there are complex and dynamic interactions between society and nature. The WBGU therefore regards the integrated observation of these interactions between marine ecosystems and societies as indispensable to a comprehensive systemic approach.

3. *The precautionary principle:* According to the precautionary principle, steps based on the state of the art in science and technology are taken to prevent possible environmental damage, even when there is no full scientific certainty on how likely it is that there actually will be any damage or how much it might cost. The application of the precautionary principle is particularly important in complex systems – to which marine ecosystems and their land/sea interactions definitely belong – because their reactions to influences or disturbances are difficult to predict. It is therefore important to allow enough scope for decisions to be flexible and reversible. Although the precautionary principle is reflected in many regulations and decisions on ocean governance, it is rarely strictly applied in practice.

Ways toward a future form of ocean governance

The need for a radical turnaround in the use of the oceans is well known, as is what needs to change. And although this is already enshrined to some extent in the existing system of ocean governance, in practice governments do not implement or follow the corresponding regulations strictly enough. Not least, there are loopholes in the existing international law of the sea. In this report, therefore, the WBGU has scrutinized UNCLOS from the perspective of the three guiding principles and ten criteria. The future system of ocean governance should not only correspond to these principles and criteria, it should also establish suitable mechanisms for ensuring compliance with, and the enforcement of, the rules and for sanctioning misconduct.

The regulatory framework that needs to be observed is defined by shared responsibility for conserving the oceans according to the common heritage of mankind principle. The players should be able to move as freely and autonomously as possible within this framework. Ultimately, however, all users need to fundamentally rethink the way they interact with the oceans at all levels of governance. Humanity must stop the way in which the seas are predominantly managed today, which is often geared to short-term profits. The focus should be on marine conservation for the benefit of present and future generations, including the conservation of biodiversity and marine ecosystem services.

The WBGU is convinced that profound changes in the governance of the oceans are necessary and appropriate in order to create a suitable institutional and political framework for a sustainable stewardship of the oceans. However, resolute implementation of the proposed guiding principles would require major changes to UNCLOS. In the WBGU's view, such an initiative currently has little chance of implementation, because the gap between the changes in ocean governance that are necessary from the sustainability perspective and political feasibility seems too deep at present.

Against this background, the WBGU has decided to focus attention on two paths, each with a different ambition and speed. *First*, the WBGU outlines the vision of a fundamental reform of the existing law of the sea – irrespective of the current chances of implementing it – offering orientation on how best to address the challenges of marine conservation and the sustainable use of the oceans. *Second*, the WBGU develops recommendations for action which link up with ongoing political processes, are easier to implement, and are therefore suitable as steps towards the vision without requiring a reform of UNCLOS.

Box 1

Ten criteria for a future system of ocean governance

In this report the WBGU has developed ten criteria for analysing the existing system of ocean governance at various levels, from local to global, which should simultaneously guide measures aimed at redesigning the ocean governance of the future.

1. *Adaptive management* aims to continuously improve the knowledge base for governance and to promptly use it for improving the conservation and sustainable use of the oceans. Adaptive management increases our knowledge of the structure and dynamics of ecosystems via a learning process and thus iteratively improves the protection and management of the seas.
2. *Incentives for innovation* encouraging a sustainable, low-risk use of the oceans reward players who develop long-term, sustainable business models on the use and conservation of the seas instead of seeking short-term profit maximization.
3. A *clear assignment of rights of use* is necessary to prevent the overexploitation of the sea, which is a common good. This makes it possible to exclude certain users and thus to coordinate use – either via markets or by negotiation. Furthermore, the societal costs of use can be charged to the users according to the *polluter pays* principle, so that the external costs are internalized.
4. Neither the conservation nor the sustainable use of the oceans as a global public good is possible without an unprecedented level of global cooperation and *global cooperation mechanisms*. Global cooperation forms the foundation for the development of international treaties on marine conservation and use, and for the joint implementation of these treaties.
5. *Subsidiary decision-making structures* – i.e. assigning decision-making powers primarily to decentralized decision-makers at the regional or local level, and secondarily to central international agencies – are crucial for the acceptance of global and national regulations. Moreover, such an interpretation of subsidiarity makes regulations easier to enforce efficiently.
6. *Transparent information* ensures that all players have access to the relevant data.
7. *Participatory decision-making structures* make it possible to reveal interests; they lead to decisions that all stakeholders can understand.
8. *Fair distribution mechanisms* aim to ensure an equitable distribution both of the benefits of marine resource use and of the costs – e.g. of conservation, monitoring, surveillance and sanctions. This applies to the sharing of costs and benefits between countries and between different levels of a country's government.
9. *Conflict-resolution mechanisms* are necessary in order to coordinate the many and complex use interests of different stakeholders (e.g. governments and individuals).
10. *Sanction mechanisms* at the different governance levels are key instruments for enforcing compliance with regulations on use.

As a basis for its vision of a reformed law of the sea, the WBGU recommends extending the common heritage of mankind principle as a binding guiding principle to cover all uses of all marine biological and mineral resources – but varying in specificity across the maritime zones seaward of the territorial sea (exclusive economic zone (EEZ), continental shelf, high seas and the Area). The vision also outlines the institutional design of a corresponding regime of conservation and use. A World Oceans Organization (WOO) would be set up as a global steward of the common heritage of mankind. According to the subsidiarity principle, the sustainable management of the sea as a common good should as far as possible be decentralized and left to regional and national institutions according to the principles of a reformed UNCLOS. On the high seas, newly established Regional Marine Management Organizations (RMMOs) would shape ocean conservation and use. The coastal states, as stewards, should be accountable to the international community as regards the sustainability of the management of the marine zones entrusted to them, by meeting strict reporting obligations.

This vision, which the WBGU considers necessary and appropriate, is evidently very ambitious in view of the lengthy negotiations required, the complexity of global marine conservation, and conflicts over the use of marine resources. It is therefore highly unlikely to be politically implemented any time soon. Nevertheless, the WBGU is outlining this ambitious vision of ocean governance, as recent experience has shown that political feasibility is difficult to predict. Numerous political events and crises of recent contemporary history – such as Germany's phasing out of nuclear power after Fukushima or the euro crisis – show that, given urgent challenges or events, reforms can become possible which are so radical that they were previously considered totally unrealistic. In the same way, far-reaching opportunities for marine policy that are unforeseeable today might open up one day. Such reforms should be well thought through and discussed beforehand. The WBGU's aim with this vision is to contribute to this discussion.

In order to get closer to the vision's long-term objective, the WBGU also makes policy recommendations that link up with ongoing or envisaged political processes that do not require any changes to UNCLOS and are therefore suitable as steps along the road towards the more ambitious vision. Overall, the report aims to serve as a compass to give long-term orientation for reforms on conservation and the use of the oceans.

The focal themes

In this report on the oceans, the WBGU focuses on the examples of food and energy, as in its previous report entitled 'A Social Contract for Sustainability'. These are key issues in the Great Transformation towards a low-carbon, sustainable society, to which the oceans can make a significant contribution. In this context the WBGU analyses the sustainable use of fish stocks and aquacultures as well as marine renewable energy technologies, and outlines a reform of ocean governance based on these examples.

- *Fishing: stopping overexploitation and raising long-term revenue.* Food from the sea can help ensure food security for a growing world population and thus to some extent ease the rising pressure on land use. In this way fishing and aquaculture based on sustainability can make an important contribution to the transformation towards a climate-friendly society. It is becoming increasingly clear that overfishing is not only inflicting environmental damage worldwide, but that it is also economically inefficient. The depletion of fish stocks must therefore be stopped so that the seas can be used sustainably. A good foundation under international and 'soft law' for the modern, sustainable management of fish stocks has already been laid by the UN Fish Stocks Agreement, the FAO Code of Conduct for Responsible Fisheries, the goals of the Rio follow-up process and the decisions of the Biodiversity Convention. Yet these regulations and decisions are poorly implemented in practice. So a transformation towards sustainability and an end to overfishing would be doubly worthwhile: marine ecosystems and their biodiversity would be spared, and incomes would actually rise as the fishing pressure declined and stocks recovered.
- *Marine energy: momentum for the energy-system transformation.* In order to succeed with the transformation towards a climate-friendly society, the energy systems, which are currently dominated by fossil energy carriers, should be converted to renewable energy generation. The huge potential of offshore wind power and the use of other marine renewable energy technologies could make a significant contribution to an emission-free future in a decarbonized energy system. The important thing now is to accelerate the already developing momentum by providing targeted government support for innovations. To ensure sustainability, the environmental compatibility of marine renewable-energy technologies must already be a key development criterion at very early phases of technological development. The expansion of renewable energy also brings the phasing out of fossil offshore oil and gas exploitation closer and makes it easier to avoid even starting the extraction of climate-damaging methane hydrates.
- *Arctic: the race for resources.* The WBGU complements the two above-mentioned thematic perspectives by adding a regional focus on the Arctic (Box 2). Here, in addition to other valuable resources, access to both energy and fish stocks plays an essential role and currently involves considerable potential for conflict. In the Arctic, the race to exploit marine resources in general, and oil and gas reserves in particular, is becoming increasingly noticeable. Responsibility for protecting the common heritage of mankind around the North Pole, with its valuable but extremely fragile polar ecosystems, is being increasingly eclipsed by the expected short-term profits. This highly risky expansion will lengthen the climate-damaging fossil energy path; national interests are threatening to gain the upper hand over the common heritage of mankind and the interests of future generations. This could be counteracted by a comprehensive, cross-border marine protected area for the Arctic (Box 2).

Research in the context of transformation

Research has a key role to play in the transformation towards a sustainable stewardship of the oceans. It must examine the role of the oceans in the Earth system, the impact of human activity and the repercussions of changes on human societies. At the same time it should think ahead and develop visions of a sustainable stewardship of the seas, study specific possibilities of sustainable use and draft political strategies for achieving them. Such research, which the WBGU terms 'transformative', promotes transformation by generating sustainable innovations in relevant sectors and supporting their dissemination. In addition, 'transformation research' is needed for the analysis of societal transformation. It should investigate the overall conditions and key factors affecting overarching societal transformation processes in the fields of ocean conservation and use – as well as their interactions with technical systems and ecosystems – in order to develop alternative transformation paths and make recommendations on how to shape them politically. However, transformation research is hardly established to date in German marine research. It seems essential for the use of the oceans as the common heritage of mankind.

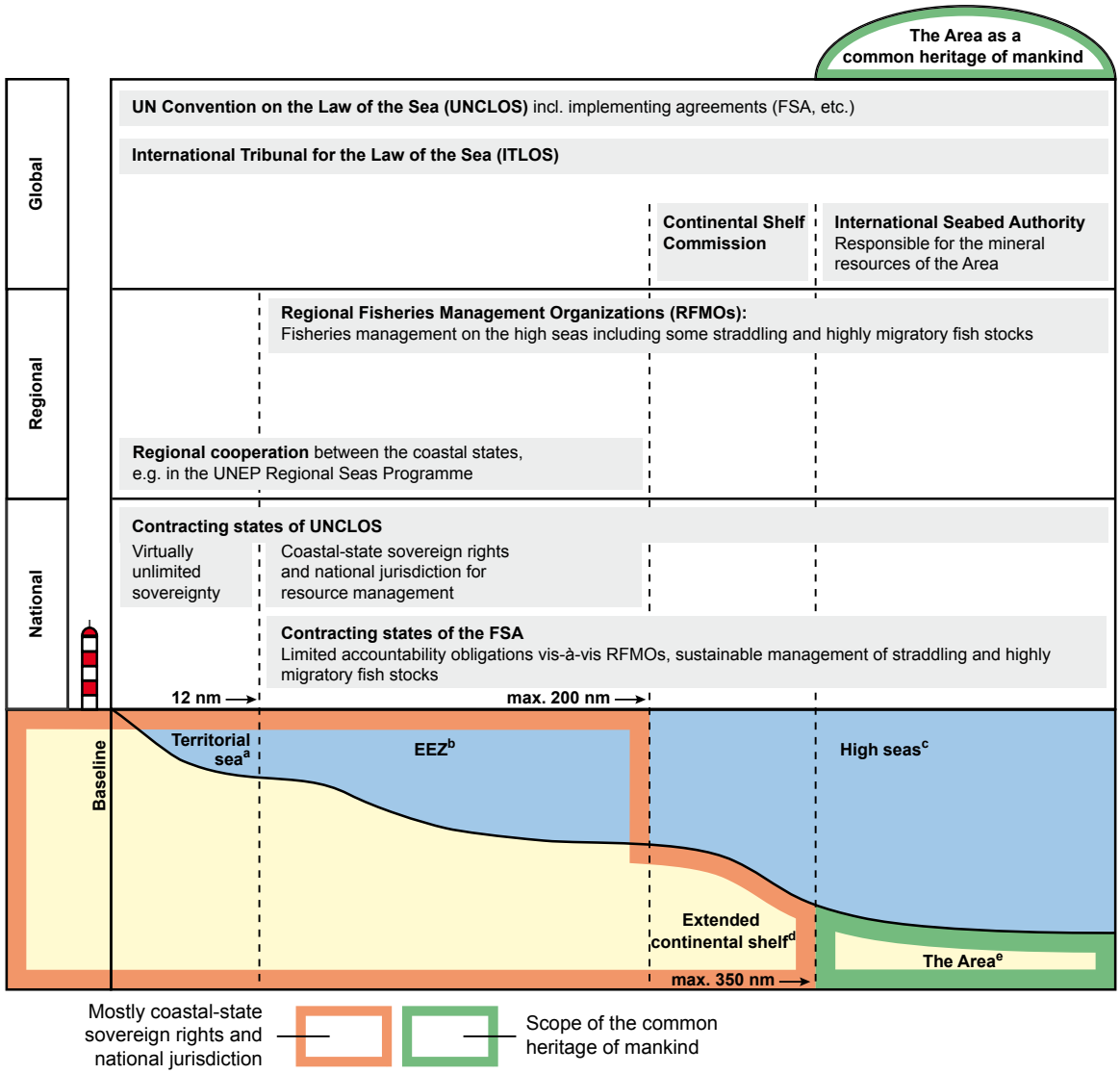

Figure 1: Status quo of ocean governance, simplified diagram.
The common heritage of mankind is today limited to the mineral resources of the seabed seaward of national jurisdiction ('the Area'). These resources are administered by the International Seabed Authority. The UN Convention on the Law of the Sea (UNCLOS), together with its implementing agreements (primarily the UN Fish Stocks Agreement, FSA), defines the framework of ocean governance. The Regional Fisheries Management Organizations (RFMOs) organize the management of fish stocks on the high seas and of the straddling and highly migratory fish stocks in the exclusive economic zones (EEZs). The coastal states have far-reaching sovereign rights to use all resources in their EEZ and the mineral resources of the continental shelf. Regional cooperation between coastal states is organized through programmes and agreements (especially UNEP Regional Seas Programmes).

a The territorial sea extends up to 12 nautical miles (nm) from the baseline. It comprises, inter alia, the seabed and its subsoil. The coastal state has territorial sovereignty in the territorial sea.
b The EEZ covers the marine area seaward of the territorial sea, extending for a maximum of 200 nm measured from the baseline. The EEZ comprises the water column as well as the seabed and its subsoil.
c The high seas begin seaward of the EEZ and are limited to the water column. They are not subject to any national sovereignty; freedom of navigation, fishery, research, etc. applies here.
d The continental shelf comprises the seabed and its subsoil seaward of the territorial sea. The continental shelf regularly overlaps with the EEZ and has no separate importance. The continental shelf can, however, extend further than the seaward boundary of the EEZ (‚extended continental shelf'). The outer limit of the continental shelf may not be more than 350 nm from the baseline (or 100 nm from the 2,500 m isobath).
e The Area comprises the seabed and its subsoil seaward of national jurisdiction.
Source: WBGU

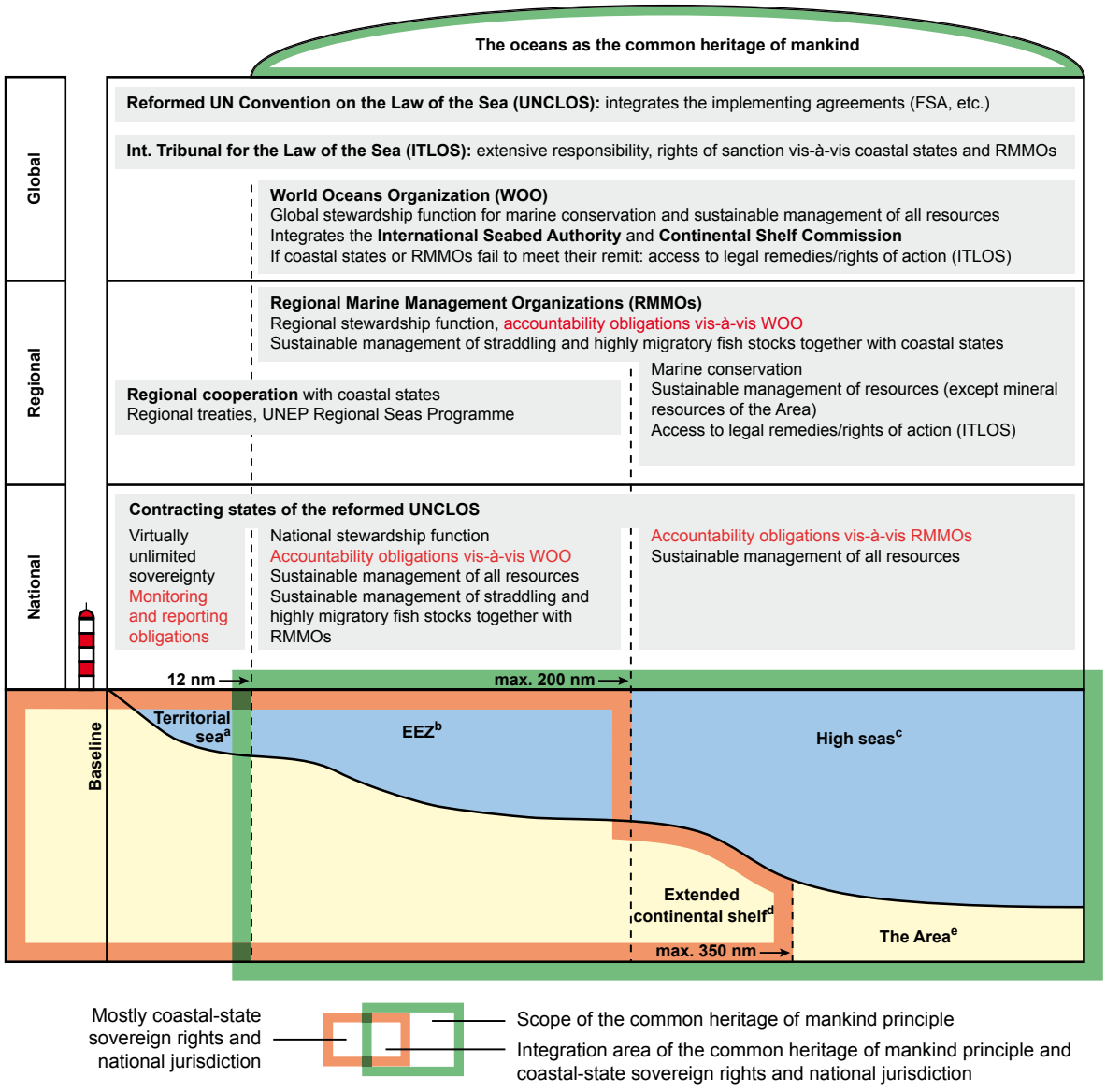

Figure 2: Vision for a future system of ocean governance, simplified diagram.
All marine areas, with the exception of the coastal waters, are given ‚common heritage of mankind' status. This includes all resources seaward of the territorial sea, including mineral and biological resources. The coastal states retain their rights of use over the resources in the exclusive economic zone (EEZ) and the mineral resources of the continental shelf. As stewards of the marine environment within the EEZ, the coastal states have an obligation to use these resources sustainably. The rights of use therefore also involve accountability obligations vis-à-vis the new World Oceans Organization (WOO). The International Seabed Authority and Continental Shelf Commission are integrated into the WOO. The Regional Fisheries Management Organizations (RFMOs) are integrated into the Regional Marine Management Organizations (RMMOs) which organize the sustainable management of all resources on the high seas. They also organize the management of straddling and highly migratory fish stocks in cooperation with the coastal states. The WOO takes on the role of the oceans' global steward and monitors compliance with rules on their conservation and sustainable use. It has access to legal remedies, especially rights of action, at the International Tribunal for the Law of the Sea (ITLOS). Regional cooperation between the coastal states under programmes and agreements continues.
Red text: Accountability obligations vis-à-vis higher levels of governance.
a-e: See Fig. 1 for explanations
Source: WBGU

A social contract for the seas

Agreement on a virtual, global 'social contract for the seas' is the prerequisite for sustainable stewardship of the oceans. It would also make a reformed system of ocean governance more effective and legitimate. Such a social contract for the seas would effectively be part of the social contract for a great transformation towards a low-carbon, sustainable society. In this way humanity should above all take responsibility for the permanent conservation of healthy, productive and resilient marine ecosystems for present and future generations and translate this responsibility into political action. In addition, accepting responsibility for the common heritage of mankind involves sharing marine resources in a responsible and fair manner, as is already laid down in the law of the sea. This requires 'proactive states', particularly coastal states that commit themselves to the sustainable management of the oceans and enforce internationally agreed regulations. Designing the social contract for the sea is an open process in which the participation of civil societies should be a key element. This participation is based on involvement, transparency and monitoring decisions made by the proactive states on the oceans. Change agents have a key role to play in the sustainable stewardship of the oceans: supported by proactive states, they drive the transformation process forward by developing and testing new technologies and modes of behaviour – starting in niches. They then disseminate them using opportunities which they create themselves or which become available in other ways.

The WBGU's vision of a comprehensive reform of the international law of the sea

The following sections present in detail the vision, the recommended steps for a comprehensive reform of the law of the sea, and the WBGU's research recommendations.

The WBGU recommends placing the use of the oceans on a new foundation which not only takes account of the realities of ocean use and the needs of ocean protection, but also ensures the long-term conservation of ecosystem services and yields from sustainable use of the sea for both present and future generations. For this purpose, the WBGU is formulating a new, overarching vision of future ocean governance based on the conviction that the sea should be understood as a common heritage of mankind. This vision is outlined below.

- *Establish the 'common heritage of mankind' principle, the systemic approach and the precautionary principle:* The WBGU recommends enshrining in international law these three guiding principles – the common heritage of mankind, the systemic approach and the precautionary principle – for all uses of the sea as a global public good by reforming UNCLOS. The regime for marine conservation and use based on the common heritage of mankind principle should apply in differentiated forms to the maritime zones seaward of the territorial sea (EEZ, continental shelf, high seas, Area) and include all their resources.
- *Form a World Oceans Organization:* An international organization should be formed to function as a global steward of the marine environment and its resources in accordance with the extended scope and powers of UNCLOS. The aim of this World Oceans Organization (WOO) is not to be a 'super-authority for marine matters'; rather, it should only intervene if the management and monitoring tasks assigned to the parties to the convention (EEZ and continental shelf) or RMMOs (high seas) are not being properly carried out. Accordingly, the WOO would be equipped with the right to sue countries or agencies before the International Tribunal for the Law of the Sea (ITLOS). Furthermore, the WOO would also be given the authority to set standards. The International Seabed Authority and the Commission on the Limits of the Continental Shelf set up under the existing UNCLOS would be integrated as independent entities into the WOO's new organizational structure and retain their areas of jurisdiction.
- *Set up Regional Marine Management Organizations:* Regional Marine Management Organizations (RMMOs) should be set up under regional intergovernmental agreements to organize the conservation and sustainable use of the regional resources of the high seas (e.g. fish stocks, marine energy, genetic resources). They would also be responsible for marine protected areas and for implementing a system of marine spatial planning on the high seas. Their remit would furthermore include equitably distributing the yield from the use of the sea, by either selling or auctioning rights of use to the member states. Some of the proceeds could be used to finance marine conservation, monitoring and capacity building in developing countries. As regional stewards the RMMOs would be accountable to the WOO, particularly in matters relating to the sustainability of use. Each should cover a marine region, so that the entire area covered by the high seas could be administered without overlap.
- *Extend the jurisdiction of ITLOS:* The International Tribunal for the Law of the Sea (ITLOS) should be strengthened to create a judicial reference in the field of the law of the sea and international environmental law. In future, disputes over the interpreta-

tion of the law of the sea and international environmental law, and actions to prosecute cases of marine pollution, should be assigned first to ITLOS. The interpretation of UNCLOS would also remain the responsibility of ITLOS as the 'guardian of the treaties'. The new WOO should be equipped with the right to bring actions before ITLOS. Furthermore, selected and recognized non-governmental organizations should be granted class action rights.

- *Conservation and sustainable use of the high seas:* The WBGU recommends declaring the high seas as part of the common heritage of mankind. In future, marine biological resources (e.g. fish stocks, genetic resources) should also be sustainably managed in line with the common heritage of mankind principle, and the benefits generated by this management should be fairly distributed – as under the regulations on seabed mineral resources. The UN Fish Stocks Agreement (FSA) would become part of the reformed UNCLOS. In line with the subsidiarity principle, the management of high-seas marine resources should be decentralized and transferred to the RMMOs. Financial advantages resulting from the use of marine resources on the high seas should benefit all humankind, focusing in particular on the interests of developing countries.
- *Conservation and sustainable use of the EEZ:* The common heritage of mankind principle should be extended to the exclusive economic zone (EEZ). The trusteeship for the management of the common heritage of mankind in the EEZs and on the continental shelf would be transferred to the respective coastal states. Violations of the common heritage of mankind principle would have to be sanctionable in order to achieve a sustainable use of the sea. The coastal states would maintain their customary, far-reaching rights of use within the EEZ which have already been assigned to them under the existing UNCLOS. They would, however, be under an obligation to the international community to protect the common heritage of mankind and to use it in a sustainable way; they would be accountable to the WOO in this respect.
- *Introduce rights of action and sanctions:* It should be possible for the WOO and parties to the reformed UNCLOS to sue those parties that fail to meet their reporting or conservation obligations at ITLOS, and for ITLOS to subsequently impose sanctions. These sanctions might include export or import restrictions on illegally sourced resources. Furthermore, a country that is in breach of the treaty could be excluded from participating in licence auctions for the resources of the high seas. As a last resort ITLOS should have the power to restrict a state's sovereign rights in the EEZ if it has abused its powers.
- *Set up a stricter liability regime:* A much more effective international liability regime should be created covering all activities across all sectors involving a potential risk to the seas (absolute liability with residual state liability).
- *Strengthen civil-society engagement:* Civil society, especially non-governmental organizations committed to marine conservation, should be given access to ocean-specific information, be informed about planning and approval processes relating to law of the sea and international environmental law, and be given corresponding rights of participation and legal action.
- *Expand marine protected areas and establish spatial planning:* An ecologically representative and effectively managed system of marine protected areas should cover at least 20-30% of the area of marine ecosystems. Furthermore, using graded zones allowing different intensity of use, this system of marine protected areas should be a core component of a marine spatial planning system to be set up and established as an instrument at the national, regional and global levels of ocean governance. On the high seas the WOO would take on the coordination and supervision of protected areas and spatial planning, while the RMMOs would carry out planning and management.
- *Provide for environmental impact assessment:* Interventions by planned activities in the oceans should only be allowed if the dangers they present for existing ecosystems are evaluated in advance and weighed up against the benefits of the intervention; this process should be obligatory. Accordingly, a strategic environmental assessment is recommended for plans and programmes relating to the oceans. A 'marine impact assessment' should be established for land-based activities. In this way the authorization process for land-based industrial production plants could already ensure that the only substances and products that can reach the oceans are those that have no harmful effects.

The road to a comprehensive reform of the law of the sea: recommendations for action

Bearing in mind the likely need for lengthy negotiations, the complexity of marine conservation, and the conflicts of interest about marine resources and their use, it is evident that the WBGU's vision is very ambitious and unlikely to be politically implemented in the near future. In order to get closer to the vision's long-term objective, the WBGU has drawn up recommendations for action that can link up with ongoing or envi-

saged political processes, do not require any changes to UNCLOS, and therefore seem more politically feasible.

Ocean governance

The following recommendations are designed in such a way that they could open the door for further reforms. They are thus the first steps recommended by the WBGU for realizing a sustainable form of ocean governance as outlined in its vision of an ambitious reform of the law of the sea.

- *Strengthen the knowledge and action base of ocean governance:* In order to improve the scientific basis, the WBGU recommends the rapid enhancement of a global monitoring system for the oceans. The existing activities (e.g. IOC, FAO, WMO, WCMC) should be extended, better coordinated and combined. Monitoring activities should go hand in hand with the further development and supervision of policy objectives for the oceans. Moreover, scientific knowledge should be processed in an integrated way for policy-makers to give them a reliable overview of the current state of knowledge and the possibilities for action on the oceans. To this purpose the UN General Assembly decided in 2005 to have a regular global report drawn up on the state of the marine environment ('Regular Process'), which takes into account both scientific and socio-economic aspects and is comparable to the IPCC's reports. The Regular Process is relatively unknown among German marine scientists. The WBGU recommends giving the project much stronger support and integrating it into the existing scientific infrastructure. In addition, an international, consensus-oriented, multi-stakeholder process should be initiated to build a knowledge-based foundation for action and develop guidelines for humanity's future stewardship of the oceans (perhaps along the lines of the World Commission on Dams or the International Assessment of Agricultural Knowledge, Science and Technology for Development, IAASTD). The 'Ocean Advisory Group' announced in the Oceans Compact could become the starting point for this process.
- *Create the necessary conditions for sustainable, long-term management:* At present, ocean management is often largely focused on short-term profit. A suitable institutional and political framework is urgently needed to put an end to this state of affairs and move towards long-term and sustainable business models. Ecosystem services should be evaluated and priced; these prices should be taken into consideration in decisions on state investment and development projects and incorporated into marine users' economic decision-making processes. Harmful subsidies in the fishing sector should be cut back and funding provided for sustainable-use infrastructures and research and development work on sustainable management (capacity building).
- *Develop strategies for sustainable ocean governance:* The Oceans Compact initiated in 2012 by UN Secretary General Ban Ki-moon should be promoted and used to establish a strategic vision of the United Nations on the conservation and sustainable use of the oceans. The Oceans Compact should be further developed into an 'Integrated World Oceans Strategy' incorporating a new sustainable and systemic form of ocean governance, as outlined in this report. In line with the Millennium Development Goals (MDGs) or the yet-to-be-developed Sustainable Development Goals (SDG), it should be equipped with a list of objectives for the seas ('Oceans MDGs' and 'Oceans SDGs') and passed by the UN General Assembly. Such a global strategy for the oceans recalls the Rio Declaration of 1992 and should bring together the principles, guidelines, development paths and goals that are fundamental to the conservation and sustainable use of the oceans. They should be taken up and implemented at the regional, national and local levels. To promote a coherent transformation policy, the proposed guiding principles and goals should also be enshrined in regional and national marine strategies. Germany and the EU should also forge alliances with like-minded states and become pioneers of subglobal ocean governance. Such alliances should support efforts to implement the Oceans Compact.
- *Improve accession to and implementation of UNCLOS:* The WBGU regards UNCLOS as the basis for a social contract for the seas and recommends developing the convention further. The parties to UNCLOS should intensify their diplomatic efforts to persuade the remaining non-member states to join, and improve the implementation of the agreed political objectives.
- *Support an implementing agreement on biological diversity on the high seas:* There are above all three specific regulatory gaps on the high seas which are supposed to be closed by the planned implementing agreement to UNCLOS: the use of marine genetic resources, marine protected areas and environmental impact assessments. The WBGU recommends holding detailed negotiations on this new implementing agreement as soon as possible. In addition, the agreement should be equipped with a funding mechanism.
- *Advance the UN Fish Stocks Agreement and RFMOs:* The ratification of the UN Fish Stocks Agreement (FSA) with its precaution-oriented and knowledge-based approach should be promoted via diplomatic channels. In the longer term, the FSA should be extended by adding the common heritage of man-

kind principle. Its jurisdiction should be expanded to cover all species fished on the high seas. Urgent action is required to encourage the Regional Fisheries Management Organizations (RFMOs) to manage their fish stocks in a sustainable manner. Positive case examples should be taken up here. The provisions of the FSA and the FAO Code of Conduct for Responsible Fisheries should be incorporated into the RFMOs' regional agreements, and regular and transparent performance reviews should be conducted. There should be a globally accessible register for all fishing vessels that want to operate on the high seas in RFMO areas, and compulsory licensing to make illegal, unreported and unregulated (IUU) fishing more difficult. The RFMOs should make full use of their rights under UNCLOS and the FSA to make it difficult or impossible for ships based in non-cooperating states to use RFMO stocks.

- *Strengthen and extend regional ocean governance:* In the context of the UNEP Regional Seas Programme, Germany's Federal Government and the EU should encourage the development of regional agreements for all marine regions covering as much of the global ocean as possible. The WBGU recommends upgrading the programme and integrating it into the Oceans Compact. Moreover, greater efforts should be made to implement the existing regional seas agreements, e.g. by agreeing ambitious protocols and action plans. The WBGU also recommends more institutionalization, for instance by delegating more tasks to commissions (e.g. HELCOM); these should regionally pool knowledge and skills, among other tasks
- *Improve dovetailing in regional ocean governance:* Cooperation should be deepened between adjacent marine conservation agreements and, in the case of fisheries, between adjacent RFMOs. The existing inter-regional collaborations should be based on the common heritage of mankind principle, the systemic approach and the precautionary principle. Significantly improved cooperation and coordination between stakeholders is also recommended within individual marine regions, e.g. between regional agreements, RFMOs and the UNEP Regional Seas Programme, to speed up the harmonization of objectives and measures.
- *Boost international financing for conservation and the sustainable use of the seas:* Following the equality principle, all states should take part in financing marine conservation; the size of payments by the individual states should be based on their economic strength. According to rough estimates, reorienting ocean management towards sustainability is likely to cause one-off costs of at least US$ 200-300 billion worldwide – plus annual costs of at least US$ 20-40 billion. In view of such sums, existing funding mechanisms are clearly totally inadequate. The WBGU recommends setting up two additional international funds: one (subsidiary) fund to support measures for the protection and sustainable use of the oceans within the EEZs, and one to finance the conservation of the high seas. The money should come from user charges, among other sources.
- *Create investment incentives for the conservation and sustainable use of the seas:* Targeted positive and negative economic incentives – such as user charges, payments for ecosystem services or temporary subsidies – should be used to support sustainable long-term uses. Via public financing mechanisms, potential users and investors should also be provided with low-interest loan capital and instruments for hedging the risks of investing in the sustainable use of the seas.
- *Strengthen and expand private governance:* In recent years private players have developed forms of governance relating to the conservation and sustainable use of the oceans that are not prescribed by state rules. The main ones are private certification initiatives aiming to encourage the sustainable use of the oceans (e.g. Marine Stewardship Council, Friend of the Sea, Aquaculture Stewardship Council). The number of fisheries certified by such programmes and the number of labelled fish and seafood products has increased considerably in recent years, involving the risk of standards weakening and the credibility of certifications dwindling. The WBGU recommends laying down minimum requirements within Europe on private sustainability standards for wild fishery products. Furthermore, the conformity of voluntary – both private and public – sustainability standards with applicable international commercial law should be clarified in the context of the WTO negotiations.
- *Considerably expand marine protected areas:* The Biodiversity Convention (CBD) aims to designate 10% of the oceans as marine protected areas by 2020; this does not seem ambitious enough. The WBGU recommends that at least 20-30% of the area of marine ecosystems be included in an ecologically representative and effectively managed system of protected areas. However, in view of the current global extent of marine protected areas (only 1.6%), it seems even more urgent to accelerate the knowledge-based implementation of existing objectives. The successes at the regional level (OSPAR Commission) should be continued and transferred to other regions wherever possible. Furthermore, the German Federal Government should continue giving a high priority to overcoming political blockades against an agreement on protected areas in the high seas.

Box 2

Regional focus on the Arctic: Comprehensive conservation of a unique natural environment

Unlike the Antarctic, which is an ice-covered continent surrounded by the sea, the Arctic is a sea, much of which has hitherto been covered by ice all year round; it is surrounded by land. According to the WBGU's vision, the Arctic Ocean should be assigned to the common heritage of mankind. At the same time the Arctic, with its marine and terrestrial ecosystems, is a unique natural environment that is particularly worth protecting. Its use should be subject to very strict conservation requirements. The Arctic ecosystems are much more fragile and sensitive than those at lower latitudes. The Arctic also fulfils an important function in marine food production. The effects of the Anthropocene in general, and climate change in particular, are revealed especially clearly there.

Access to such Arctic resources as oil, gas, gold, zinc, rare earths and fish stocks, and the passage of shipping through Arctic waters have been made easier by continuous technological development and the retreat of the Arctic ice. Greater use would cause substantial risks to the fragile polar ecosystems from pollution and accidents, involving the danger of irreversible damage.

A comprehensive, cross-border marine protected area covering both the Arctic areas of the high seas and the adjacent EEZs and precluding resource extraction and fishing would be the most likely to meet conservation requirements. Until such a protected area has been established, the following recommendations represent steps in the desired direction:

- *Arctic protected area for the High Arctic:* The High Arctic should be declared a protected area. Protected-area status involves restrictions on rights of use.
- *Extend and promote the existing protected areas in the Arctic:* In 2004 a working group of the Arctic Council drafted a Marine Strategic Plan which aims to promote networking between existing protected areas. The German Federal Government should support the efforts of the working group. There are already a number of marine protected areas within the territories of various countries bordering the Arctic, e.g. in Canada, Norway and Greenland. These efforts should also be acknowledged and encouraged.
- *Institutionalize the sustainable use of the Arctic:* The WBGU recommends that the international community and the states bordering the Arctic should agree to maintain the ecological balance of the Arctic Ocean as part of the common heritage of mankind. Within the EEZs, too, the Arctic Ocean should only be used sustainably. Uses – especially the offshore production of oil and gas – should be allowed only according to strict safety and environmental-protection standards.
- *Implement a binding Polar Code:* Germany should support the efforts of the European Commission to develop a binding code of conduct (Polar Code) on shipping in the region to be administered by the IMO. The aim here is to counter the environmental risks from rising shipping traffic in the Arctic; corresponding safety measures should be agreed.
- *Establish a liability regime:* To date there is no liability regime that applies in the event of environmental damage in the Arctic Ocean. Such a liability regime should be agreed. It should centre on the principle that states are responsible for taking precautions and provide a clear framework for action with liability provisions for individual user groups and causers.

- *Set up marine spatial planning:* The WBGU recommends a multilateral system of marine spatial planning that ensures cross-national coordination in order to realize large-scale environmentally friendly uses across zones. In the EU the instrument of marine spatial planning should be made a permanent and obligatory part of integrated marine policy. Germany should play a pioneering role in this and organize a European exchange of experience. A comprehensive system of marine protected areas is an essential component of marine spatial planning systems.
- *Promote the harmonization of existing liability regimes:* The current law on liability has gaps and deficits. The WBGU therefore supports the European Commission's intention to standardize the law on liability for offshore activities.

Focus: food from the sea

In many developing countries fish plays an important role for food security, income generation and health care. However, most fish stocks are still poorly managed today worldwide, both ecologically and economically. Overexploitation of fish stocks poses one of the most serious threats to marine ecosystems. At the same time, the demand for fish and seafood is on the increase – and with it the pressure on fish stocks. Despite ever greater efforts by fisheries, global yields are now declining. The depletion of fish stocks must be stopped if sustainable ocean stewardship is to succeed. Such a transformation towards sustainability has already begun in some countries: stocks are recovering, they are being managed sustainably, and marine ecosystems are being protected. Thus future catch volumes could even be permanently higher than they are today in the long term. However, for this to happen the fishing pressure and the overcapacity of fishing fleets would have to be reduced. This would involve political, social and economic costs for a transitional period. The potentially larger yields once fish stocks have recovered won't materialize for years or even decades.

In view of the unsatisfactory state of many fish stocks and the growing demand for fish, many people's hopes are directed towards aquaculture. However, the

currently prevalent form of marine aquaculture cannot meet the expectations of rising sustainable fish production. Breeding focuses primarily on carnivore fish species whose feed is largely produced from forage fish; the latter are in turn caught by conventional fishing. Depending on the species of fish, several kilograms of forage fish are required to produce every kilo of bred fish. These problems can for the most part be avoided by other forms of aquaculture, i.e. breeding herbivorous freshwater species or mussels. A form of sustainable aquaculture should therefore be promoted that operates in a socially acceptable and environmentally responsible way.

Important preconditions have already been met for the transformation of fisheries. For example, ambitious international regulations and political objectives are in place to stop overfishing by 2015; this was reaffirmed at the Rio+20 Conference in 2012. The overall legal framework and incentive systems are important starting points for implementation. At present they often still offer misguided incentives, such as subsidies for expanding fishing capacity or for fuel. Ecological damage is not internalized. There are also recommendations for responsible aquaculture that have been agreed at the international level. The technical instruments and management options for sustainable fisheries and aquaculture are already known or are being developed. What is primarily needed now is the effective implementation and enforcement of agreed rules and targets. Then overfishing can be stopped, yields could rise, and the contribution to food security for a growing world population would be guaranteed. In order to achieve this, the WBGU recommends the following:

- The ecosystem approach and the precautionary principle should be rigorously applied. Furthermore, scientifically based, sustainable yield limits should be fixed for fish stocks and applied as broadly as possible. The maximum sustainable yield (MSY) should not be regarded as a target, but as the absolute upper limit of catches: actual production should remain well below it for environmental reasons. This new role of the MSY should be enshrined in fishery governance at all levels. On this basis, ecosystem-based management plans covering several years should be drawn up and adhered to. It is crucial here to effectively monitor compliance with rights of use and access and to apply corresponding sanctions.
- The capacities of fishing fleets should be reduced worldwide as a matter of urgency. The decisive factor in this context is to phase out subsidies which up to now have encouraged overfishing and fleet overcapacity. The WBGU recommends pushing hard for the abolition of subsidies in the corresponding WTO negotiations.
- Urgent steps should be taken to reduce the ecological risks and side effects of marine capture fisheries. Destructive or wasteful fishing methods should be prohibited and environment-friendly methods that reduce bycatch made mandatory. The WBGU recommends compulsory landing for bycatch.
- Illegal, unreported and unregulated (IUU) fishing will only be stopped by better treaties with strict controls and sanctions. Widespread acceptance of the UN Fish Stocks Agreement and resolute reforms to the Regional Fisheries Management Organizations (RFMOs) would make IUU fishing on the high seas much more difficult. International cooperation should be greatly improved in order to generate a large enough pool of data about the high seas. The FAO International Plan of Action against IUU Fishing deserves stronger support. Monitoring the port states is regarded as particularly effective; it is therefore important that the FAO Port State Agreement comes into force and is implemented quickly. In the European Union, an IUU fishing regulation has already come into effect, although its effectiveness cannot yet be finally assessed.
- Fisheries in the EU are in a poor condition, although the situation is improving slowly. The reforms to the EU's Common Fisheries Policy proposed by the European Commission should be adopted and resolutely enforced, otherwise the internationally agreed objective of sustainable fisheries by 2015 cannot be reached. Similarly, the Fisheries Partnership Agreements with developing countries must be fundamentally reformed in order to meet environmental, economic and social sustainability criteria. Since the EU is the largest importer of fish in the world, it should take advantage of all available commercial-policy options to strengthen sustainable management in the exporting countries.
- The EU and Germany should do more to help developing countries build up a sustainable system of fisheries management and corresponding value chains. Greater emphasis in global and national policies should especially be placed on the concerns of small-scale fishermen and on securing their participation. Low-income groups who cover a large proportion of their animal protein intake from fish and seafood should be reimbursed for losses of yield in the course of the transition to sustainable fisheries.
- Fishing for forage fish for aquaculture operations focusing on carnivorous fish should be replaced as quickly as possible by alternatives; in this way aquaculture might be able to ease the pressure on wild fish stocks. Instead, the forage fish stocks should be used as far as possible for direct human consumption. Instead of breeding predators, sustainable

aquaculture should rely more on omnivorous and herbivorous species of freshwater fish and crab, as well as clams, snails and algae, to reduce the need for input from wild fisheries (fish meal, fish oil or fry).

- The ecosystem and precautionary approaches should also be a basic principle of management in aquaculture. The regulations of the FAO Code of Conduct for Responsible Fisheries that are relevant for aquaculture should be stipulated by states as binding national law and implemented by means of suitable political, institutional and economic conditions and control instruments – and enforced by inspections and sanctions.
- Development cooperation should focus on increasing support for small and medium-sized aquaculture operations in developing and newly industrializing countries and on promoting sustainable production there. In particular they should help stop the further destruction of mangrove forests by shrimp farms.
- In the EU and in the international arena, the German Federal Government should seek to improve, harmonize and expand certification schemes for sustainable aquaculture. Retailers should stock more aquaculture products that are certified according to sustainability criteria. Consumers should, for example, be provided with more information to encourage them to buy more products that are sustainably produced.
- The technological development of sustainable aquaculture systems should be supported. Above all, integrated, poly- and multitrophic and closed production systems could help reduce the environmental impact. The development of responsibly produced substitutes for fish meal and oil should be promoted. Studies should also be conducted to examine to what extent sustainable – preferably multitrophic – offshore aquaculture operations, possibly in combination with offshore wind farms, might reduce competition for land use in coastal areas.

Focus: energy from the sea

Energy systems have a key role to play in the transformation towards a low-carbon, sustainable society. A low-carbon energy supply requires a corresponding national energy policy. An international energy policy is also beneficial. Use of marine energy is currently dominated by oil and gas production, and mining and transport accidents can have catastrophic consequences for marine ecosystems. At the same time, emissions of methane and carbon dioxide during extraction, accidents and use are contributory factors to climate change. A climate-friendly energy policy therefore also requires a climate-friendly form of offshore energy generation, which is characterized by the deployment of offshore wind- and marine-energy technologies. The long-term goal is to phase out the offshore extraction of fossil fuels. Since some of the low-carbon marine-energy technologies are still at an early stage of development and show considerable potential, they should be supported by a targeted innovation policy. At the same time, a legal framework should be designed that ensures the protection of the marine ecosystems and a sustainable use of the seas.

In fossil-fuel prospecting far from the coast, a trend is emerging to work at ever greater depths. Floating platforms, underwater robots and horizontal drilling systems make it possible to operate even at great depths and in difficult-to-access marine areas such as the Arctic. It must be feared that the offshore extraction of fossil fuels will expand further, given that deposits are expected to be large and the global demand for energy is likely to rise. In addition, further technological developments could turn the mining of marine methane hydrates into an attractive business. However, the risks involved are still largely unknown at present. Marine methane hydrates are not needed either for a future low-carbon global energy supply or to cover the phase of converting the energy systems. Existing reserves and resources of conventional gas are more than sufficient for energy-system transformation. From the point of view of climate and marine policy, the WBGU advocates abandoning efforts to mine marine methane hydrates. The WBGU also recommends applying stricter environmental requirements when issuing drilling permits, and establishing an international liability regime for companies operating offshore oil and gas installations, as well as for marine mining. Moreover, humanity is only likely to have a fair chance of limiting anthropogenic climate change to 2°C if the total amount of anthropogenic CO_2 emissions remains restricted during this century. Therefore, only a small percentage of known fossil fuel deposits should be used.

So policy-makers should promote the expansion and development of offshore wind power and other sustainable marine energy technologies, as well as transnational offshore power grids. Some countries are already successfully operating offshore wind farms, while others are still in the test phase. Stronger and more stable winds prevail at sea than on land, so that offshore wind energy can reach a higher level of capacity utilization and consistency. Using floating structures, offshore wind farms could potentially be operated in deeper waters and further away from the coast. The more renewable-energy technologies can be transferred to the ocean, the less energy has to be generated

on land. The risks posed by renewable-energy technologies at sea are considerably lower than those of marine oil and gas extraction. Even so, here too there are potential dangers for marine ecosystems and species, for example from turning rotors, noise during the construction phase and electromagnetic fields created during the transport of electricity. This must be taken into account when building offshore grids and in future technological developments.

In the future it will also be possible to use the sea for other forms of renewable energy production. Although offshore bioenergy production – using algae for example – is still in its infancy, it seems to have considerable potential. So-called multi-use platforms could offer economic and ecological advantages for the global marine energy system of the future, since they not only generate, but also store sustainable energy. However, this requires an offshore energy-transmission system which is integrated into corresponding transport systems on land. In addition to oil and gas pipelines, other networks will be needed in the future to transport electricity and CO_2. Some of these transmission technologies could be combined. The WBGU's detailed recommendations are as follows:

- *Develop national energy strategies:* National energy strategies should be agreed all over the world, with development targets for renewable-energy technologies and therefore also for offshore-wind or sustainable marine-energy technologies. In addition, marine spatial planning and approval processes should be developed for offshore technical installations, as well as liability regimes. The WBGU recommends that the German Federal Government should conduct intensive scientific accompanying research. This could provide a source of recommendations for statutory requirements on the design, construction and operation of offshore wind farms and marine energy technologies.
- *Use marine spatial planning:* Since offshore wind and other marine renewable energy systems require space and compete both with existing uses of the oceans and with ocean and coastal conservation, the WBGU particularly recommends the application and further development of marine spatial planning. In view of the cross-border effects of marine technical systems on ecosystems and shipping, marine spatial planning should be coordinated at the level of regional seas agreements such as OSPAR or HELCOM.
- *Strengthen the regulatory framework:* Especially for gas and oil production, the WBGU recommends strengthening the regulatory framework, both in European waters and worldwide, in order to reduce the risk of accidents, improve damage-repair capabilities and regulate liability. For the European Union, the WBGU recommends stricter environmental regulations when issuing drilling permits. The existing EU liability regime for the operation of offshore oil and gas facilities should be extended in scope to the Member States' EEZ and the continental shelf. To this extent the Federal Government should push for swift adoption of the draft regulation which already exists.
- *Support innovation:* Innovation should be supported to send the right political signals to potential investors, as most marine technologies in the field of renewable energy generation are still far from mature. The WBGU recommends that the Federal Government should politically support the development of the relevant technologies and market integration and ensure that this is done in a participatory way. In international cooperation it should also encourage research into the environmental risks of marine technologies, develop new regulations and standards, and agree international treaties on environmental protection.
- *Build an offshore supergrid:* An offshore power grid interconnecting the various marine power-generating plants and different countries makes it easier to integrate fluctuating power generators by smoothing the generated output. This would reduce the need for storage facilities. The WBGU therefore recommends that the Federal Government should construct an offshore grid in the North Sea as soon as possible, as announced in the Energy Concept and the Development Plan for the Sea. The vision and planning of an integrated, transnational offshore power grid in Europe should in particular be fully coordinated with the national plans of the relevant countries bordering on the North Sea.
- *Refrain from marine methane hydrate mining:* Mining of marine methane hydrates is associated with a number of environmental risks that have not yet been quantified. At this stage, therefore, the WBGU recommends against it. Nevertheless, research should continue on the deposits, their stability and the environmental risks. However, since some countries, e. g. Japan, could start commercially exploiting methane hydrates within the next few years, the WBGU reiterates its recommendation from the 2006 special report on 'The Future Oceans' to carefully review the risks of methane hydrate mining in each individual case. The International Seabed Authority is responsible for methane hydrate deposits in the Area. Here too, the WBGU argues in favour of a ban on the mining of methane hydrates based on the common heritage of mankind principle, the systemic approach and the precautionary principle. Moreover, this fossil fuel is not needed for the sustainable and low-carbon global energy supply of the future.

Given the likelihood that methane hydrates will soon be mined, the WBGU recommends, as a minimum solution, that the signatories to UNCLOS agree on international standards for the marine mining of methane hydrates; the Seabed Authority could then make these a requirement for licensing.

- *Develop regulations for sub-seabed CCS:* The WBGU does not regard the injection of CO_2 into ocean water as a sustainable option due to uncontrollable risks and the insufficient retention period. The WBGU's assessment of the storage of CO_2 in stores under the seabed, however, is that it is less risky than storage in land-based locations; it therefore recommends focusing research on this form of use. Doubts about retention capacity should be carefully examined. CCS technology should not be used on a large scale until it can be proved in scientific studies that the required retention period of at least 10,000 years can be guaranteed. Furthermore, it should be clarified prior to use how long-term monitoring can be implemented. An (international) legal framework should be developed regulating not only liability for the escape of CO_2 over several decades, but also the climate-relevant question of long-term escape over thousands of years.

Research recommendations

Research has a key role to play in the necessary transformation towards a low-carbon, sustainable society. The transformation is a societal search process that should be supported by research. The aims of research should be to develop visions of sustainable ocean stewardship, describe different paths of development, and develop sustainable technological and social innovations in collaboration with politics, business and society. Scientific marine research in Germany is very well positioned by international comparison. However, greater cooperation between the natural, social and engineering sciences is essential if humanity is to interact with the oceans in a sustainable way. To develop the research landscape, the WBGU distinguishes between transformation research and transformative research.

Transformation research seeks to understand transformation processes in order to accelerate future transformations and improve their governance. It involves the interdisciplinary, scientific analysis of societal transformation processes as such, in order to explain factors and causal relations and identify the 'conditions of possibility' (Immanuel Kant) of social and technological innovation, including their potential effects on ecosystems. Transformation research also specifically addresses the forthcoming task of designing and governing the transformation by outlining visions and possible paths of transformation, identifying possible negative effects on the environment, and developing proposals for policy-making. The main areas of marine transformation research include the following: research on appropriate ocean governance in view of multiple uses of the sea; the significance of the oceans in the context of world society; intercultural research on ocean stewardship; radical changes in the use of the sea before and during industrialization, including interactions with ecosystems; and visions of future ocean use and assessing the different paths that might lead there. The WBGU recommends creating interdisciplinary research institutions and programmes to take up the issues outlined.

Transformative research encompasses all scientific activities that can generate the decisive innovations in the sectors relevant for a transformation towards sustainable ocean use – thus enabling the transformation in the first place. The WBGU particularly emphasizes the following research topics, which are all directly interconnected in the context of sustainable ocean stewardship: global change research provides the problem diagnosis and the fundamental system understanding that is essential for good ocean governance; governance research provides frameworks for institutions and policies and in this way enables targeted political action. Global change research and governance research together stimulate research in the particular fields of action. Food and energy are key issues of the Great Transformation towards a low-carbon, sustainable society, to which the oceans can make an essential contribution. In this report the WBGU focuses on these two key aspects – food and energy – and makes exemplary research recommendations for sustainable problem solutions, uses and specific governance mechanisms in these fields.

The following recommendations should also be supported by existing research institutions and programmes.

Global change research

Global change research focuses largely on physical and biogeochemical environmental changes that can be either natural or caused by humans. It increasingly also analyses the effects of the changes on societies and the options for combining economic and societal development with a reduction in harmful environmental impacts. A central theme of marine global change research is the interaction between climate change and the oceans: although seawater warming, changes in ocean currents and rising sea levels are recognized as problems and justify preventive action according to the

precautionary principle, the upstream and downstream processes are only partially understood, and future projections and risk assessments still involve great uncertainty. This also applies to the receding sea-ice cover and the effects of ocean warming on the continental ice. Profound but insufficiently understood changes in ocean chemistry, such as acidification or the spread of oxygen-deficient zones in the world's oceans, are further issues that need more consideration. More intensive research is also needed into the effects on marine ecosystems of multiple stress factors such as warming, acidification, pollution and overfishing. Our understanding of the processes that are taking place is currently not keeping up with the pace of changes in the oceans. Even so, there is sufficient knowledge in many problem areas and action fields to take decisive action now and to tackle the reform of the existing ocean governance system in the manner proposed by the WBGU.

Research on ocean governance

Research should develop visionary plans for new, ocean governance structures that meet the challenges of the Anthropocene. Simultaneously there is a need for greater cooperation between global governance research – which focuses mainly on the social sciences and jurisprudential disciplines – and the natural and engineering sciences, in order to develop suitable governance patterns based on a better understanding of the interaction between the ecological, socio-economic and technical systems. Emphasis should, for example, be placed on the theoretical foundation and conceptual development of global guiding principles – such as the World Heritage principle – and their institutional and material design.

To enable corresponding steps towards transformation to be taken, governance research should contribute to a cross-sectoral and coherent analysis and assessment of governance structures, and to legal and economic conditions and requirements relating to the current and future use of the oceans. The focus here should be on the importance of the oceans as a global public good; on the institutional fragmentation of global ocean governance; on ways of steering and shaping new forms of ocean use (e.g. renewable marine energy, offshore aquaculture); and on improving interaction between regional and global governance.

In order to develop a polycentric form of global governance in the multi-level system, a further priority area for research should be the comparative analysis of mechanisms and institutions at the regional and national level, the aim being to identify examples of best practice and to draw practical conclusions on the fragmentation of ocean governance and possible ways of improving cooperation and coherence. Here, too, it is important to determine – through cooperation with the natural sciences – the effects the solutions might have on the ecosystems and whether they are appropriate with regard to real-life environmental problems.

Research should also be stepped up into policy instruments that do justice to the depth of human interference in the Anthropocene, e.g. research on marine spatial planning, user charges and the development of a global evaluation system for the marine environment (status and target indicators). It is necessary to study how such instruments can be designed and institutionally embedded into systemic multi-level governance.

Research on food from the sea

- *Sustainable fisheries:* Research on the sustainable management of fish stocks should concentrate in particular on the technical fine-tuning of fishing equipment to avoid by-catch and to catch the respective target species more selectively. Research should also aim to improve indicators of ecosystem linkages. In addition, there is a demand for methods that make it possible to estimate the maximum sustainable yield (MSY) even if little data is available. There is also a need for research on the use of marine protected areas as an instrument of fisheries management. As a contribution to food security there should also be research on how fish species which have hitherto only been used as forage fish can be used directly for human consumption. In addition, it would be useful for fishery governance if socio-economic research were conducted on the overall conditions and incentive structures for sustainable fisheries management. In this context Germany should emphasize research into sustainable EU fishing in third countries. Research on the economic assessment of biodiversity and marine ecosystem services, among other things, offers a starting point in this context. Further important research aspects include the fight against illegal, unreported and unregulated (IUU) fishing, as well as regulatory and implementation gaps in governance – and solutions for closing those gaps. Finally, a scientific consensus should be sought on the governance mechanisms that can be particularly recommended for promoting sustainable small-scale fisheries (e.g. value-chain optimization, social security for small-scale fishermen).
- *Sustainable aquaculture:* Research on developing environmentally friendly, integrated, multitrophic

and closed aquaculture systems should be given priority support using the ecosystem approach as a basis. Research on offshore aquaculture should also cover synergies with other offshore installations such as wind farms. In view of initial successes and applications, research on substituting fish meal and oil in feeds should be further intensified; the possible repercussions of increased plant-based feed substitution on land use should also be studied in this context. There should be intensified research into the potential yields of sustainable aquaculture and on their contribution to food security and poverty reduction. In particular, information is needed on the global yield potential of different aquaculture scenarios. Furthermore, different governance approaches should be examined together with their potential for supporting an environmentally and socially responsible development of aquaculture. National and international research cooperation to promote aquaculture research should be strengthened, particularly with and in developing countries.

Research on energy from the sea

Key technologies should be further developed for sustainable marine energy generation – including floating multi-use platforms that can integrate different power-generation technologies as well as algae cultivation. Also important is the development of ocean-based storage applications, such as deep-sea stores, the electrolytic production of hydrogen, and the transport of methane in the form of artificial methane hydrate. The further development of high-voltage direct-current transmission is a necessary prerequisite for setting up an offshore supergrid. As a general rule, the WBGU also recommends more research into risks and environmental hazards relating in particular to the cumulative and long-term effects of extracting fossil fuels, to storing CO_2 beneath the ocean floor, and to renewable energy-generation technologies. Special attention should be given to research into the interactions between magnetic fields and marine ecosystems and on reducing noise emissions during the construction of marine renewable-energy technologies.

Research policy

With regard to research policy the WBGU stresses the following recommendations:

- *Greater integration of interdisciplinary marine research into research programmes:* The WBGU recommends integrating sustainable marine research more closely into existing research programmes, with the social sciences interacting more closely with the natural sciences. At the EU level, a programme for sustainable marine infrastructures should be established at the European Academies Scientific Advisory Council (EASAC); calls for research-project proposals on the conservation and sustainable use of the oceans should be developed within the 8th EU Framework Programme for Research and Innovation ('Horizon 2020'). A cross-cutting subject on the conservation and sustainable use of the oceans – similar to the existing cross-cutting theme on sustainable land management – should also be integrated into the BMBF's Framework Programme Research for Sustainable Development (FONA).
- *Greater institutionalization of interdisciplinary marine research:* The WBGU recommends strengthening the institutional basis for interdisciplinary research relating to the conservation and sustainable use of the seas. The German Marine Research Consortium would seem a suitable nucleus for a corresponding strategic development of German marine research and should be strengthened in its role as a platform for coordination and communication. Possible ideas for strengthening the institutional base of interdisciplinary marine research include promoting networks; integrating missing disciplines into existing research institutions; setting up a new research institute that incorporates elements from the fields of economic, social and cultural sciences; and creating a new interdisciplinary institute. In addition, the WBGU recommends the establishment of an experimental alternative programme as a DFG Collaborative Research Centre whose approval criteria should combine interdisciplinarity, societal problem relevance and a connection with the conservation and sustainable use of the oceans. Because of the growing relevance of marine and polar policy in the context of security, environmental and science policy, the WBGU also recommends setting up a research centre for marine and polar policy.
- *Greater integration of science, politics and civil society:* When implementing technology-policy measures relating to the use of the oceans, the WBGU recommends integrating more research perspectives that deal with marine ecosystems and their protection, as well as technology assessment. Another recommendation is to develop proposals for an innovative marine science-policy interface. With a view to improving future collaborations between science and politics, the WBGU recommends analysing the experience gained from the Joint Initiative for Research and Innovation to encourage greater cooperation between science, politics, business and society. Sustainability should be at the centre of atten-

tion in this context. In addition, the WBGU recommends more involvement from civil society when it comes to setting the agenda and designing programmes of marine research, as well as awarding public research funds for this purpose. The WBGU recommends information and education campaigns to increase public knowledge about the ecological condition of the oceans and the scale of the threat to them. In addition, existing civil-society initiatives for the protection of the marine environment should be specifically supported by the government.

Epilogue

At the end of this report, the question remains as to how its many recommendations can be implemented at the local, national and international level. Experience shows that such processes take many years, and fundamental changes – or system changes – are often made possible by unforeseeable, new developments or events, as was shown by the German *Energiewende* (energy-system transformation) after the nuclear disaster in Fukushima. Even so, the oceans could be actively brought more into the public eye, and there are already signs of a trend in this direction: the United Nations declared 1998 the Year of the Oceans; World Oceans Day has been celebrated every year since 2009; and the oceans were high on the agenda at the Rio+20 Conference. This shows that there is a growing public awareness of the blue continent's problems. This growing attention could condense into a consensus on the conservation and sustainable use of the oceans in the form of a 'marine social contract'. This would be a major boost to the further development of a sustainable marine policy. As Elisabeth Mann Borgese put it, the issue is "to live with the sea". This report endeavours to make a contribution in this regard.

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The German Advisory Council on Global Change

(Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen – WBGU)

The WBGU is an independent, scientific advisory body to the German Federal Government set up in 1992 in the run-up to the Rio Earth Summit. The Council has nine members appointed for a term of four years by the German Federal Cabinet. The Council is supported by an interministerial committee comprising representatives of all ministries and the German Federal Chancellery. The Council's principal task is to provide scientifically-based policy advice on global change issues. The Council:

- analyses global environment and development problems and reports on these,
- reviews and evaluates national and international research in the field of global change,
- provides early warning of new issue areas,
- identifies gaps in research and initiates new research,
- monitors and assesses national and international policies for the achievement of sustainable development,
- elaborates recommendations for action, and
- raises public awareness and heightens the media profile of global change issues.

The WBGU publishes flagship reports every two years, making its own choice of focal themes. In addition, the German government can commission the Council to prepare special reports and policy papers.

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