Summary of the First Global Integrated Marine Assessment

I. Introduction[1]

Let us consider how dependent on the ocean we are. The ocean is vast: it covers seven tenths of the planet, is on average about 4,000 metres deep and contains 1.3 billion cubic kilometres of water (97 per cent of all the water on the surface of the Earth). There are, however, 7 billion people on Earth. This means that each one of us has just one fifth of a cubic kilometre of ocean as our portion to provide us with all the services that we get from the ocean. That small, one fifth of a cubic kilometre portion generates half of the annual production of the oxygen that each of us breathes, and all of the sea fish and other seafood that each of us eats. It is the ultimate source of all the freshwater that each of us will drink in our lifetimes.

The ocean is a highway for ships that carry the goods that we produce and consume.

created submarine canyons, glacial troughs, sills, fans and escarpments. Around the ocean basins, there are marginal seas, more or less separated from the main ocean basins by islands, archipelagos or peninsulas, or bounded by submarine ridges and formed by various processes.[6]

The water of the ocean mixes and circulates within those geological structures. Although the proportion of the different chemical components dissolved in seawater is essentially constant over time, that water is not uniform: there are very important physical and chemical variations within the seawater. Salinity varies according to the relative balance between inputs of freshwater and evaporation. Differences in salinity and temperature of water masses can cause seawater to be stratified into separate layers. Such stratification can lead to variations in the distribution of both oxygen and nutrients, with an obvious variety of consequences in both cases for the biotas sensitive to those factors. A further variation is in the penetration of light, which controls where the photosynthesis on which nearly all ocean life depends can take place. Below a few tens of metres at the coastal level or a few hundred meters in the clearer open ocean, the ocean becomes dark and there is no photosynthesis.[7]

Superimposed on all this is a change in the acidity of the ocean. The ocean absorbs annually about 26 per cent of the anthropogenic carbon dioxide emitted into the atmosphere. That gas reacts with the seawater to form carbonic acid, which is making the ocean more acid.

The ocean is strongly coupled with the atmosphere, mutually transferring substances (mostly gases), heat and momentum at its surface, forming a single coupled system. That system is influenced by the seasonal changes caused by the Earth's tilted rotation with respect to the sun. Variations in sea-surface temperature among different parts of the ocean are important in creating winds, areas of high and low air pressure and storms (including the highly damaging hurricanes, typhoons and cyclones). In their turn, winds help to shape the surface currents of the ocean, which transport heat from the tropics towards the poles. The ocean surface water arriving in the cold polar regions partly freezes, rendering the remainder more saline and thus heavier. That more saline water sinks to the bottom and flows towards the equator, starting a return flow to the tropics: the meridional overturning circulation, also called the thermohaline circe y1(n)-111.8(e)2-19.3(h currents carry that production is also high. Some of those areas of dense living marine resources are also areas of high biological diversity. The general level of biological diversity in the ocean is also high. For example, just under half of the world's animal phyla are found only in the ocean, compared to one single phylum found only on land.

Human uses of the ocean are shaped not only by the complex patterns of the physical components, sectors and environmental, social and economic aspects, has to cover. The members of the Pool have been nominated by States through the chairs of the regional groups within the Assembly and are allocated tasks by the Bureau on the r

declining biological resources with important implications for food security and biodiversity.[14]

Theme C

With regard to the cross-cutting issue of food security and food safety (part IV), fish products are the major source of animal protein for a significant fraction of the world's population, particularly in countries where hunger is widespread. Globally, the current mix of the global capture fisheries is near the ocean's productive capacity, with catches on the order of 80 million tons. Ending overfishing (including illegal, unreported and unregulated fishing) and rebuilding depleted resources could result in a potential increase of as much as 20 per cent in yield, but this would require addressing the transitional costs (especially the social and economic costs) of rebuilding depleted stocks. In some areas, pollution and dead zones are also depressing the production of food from the sea. Small-scale fisheries are often also a critical source of livelihoods, as well as of food, for many poor residents in coastal areas. Rebuilding the resources on which they depend and moving to sustainable exploitation will potentially have important benefits for food large quantities of marine debris in the ocean, and negative impacts on marine life and on the aesthetic aspects of many ocean areas, and thus consequent socioeconomic effects.[18]

Theme G

Adverse impacts on marine ecosystems come from the cumulative impacts of a number of human activities. Ecosystems, and their biodiversity, that might be resilient to one form or intensity of impact can be much more severely affected by a combination of impacts: the total impact of several pressures on the same ecosystem often being much larger than the sum of the individual impacts. Where biodiversity has been altered, the resilience of ecosystems to other impacts, including climate change, is often reduced.

Sea-level rise

It is very likely that extreme sea-level maxima have already increased globally since the 1970s, mainly as a result of global mean sea-level rise. That rise is due in part to anthropogenic warming, causing ocean thermal expansion and the melting of glaciers and of the polar continental ice sheets. Globally averaged sea level has thus risen by 3.2 mm a year for the past two decades, of which about a third is derived from thermal expansion. Some of the remainder is due to fluxes of freshwater from the continents, which have increased as a result of the melting of continental glaciers and ice sheets.

Finally, regional and local sea-ao2a.3.fe31av alisl1rnrhisdb0.7(is)-3nisg.5(by)27-421(m)-b7eh-2.3(h03n)-13 mixing also impact the amount of nutrients brought up from lower levels into the zone that sunlight penetrates, with consequent reductions in ecosystem productivity.[27]

Ocean circulation

The intensified study of the ocean as part of the study of climate change has led to a much clearer understanding of the mechanisms of ocean circulation and its annual and decadal variations. As a result of changes in-14(ti18.1(o9(al)2.9( )--7.8(h)(s)8.3()22.4(t)m6(843 s)22(l)-)-2 dominated by crustacea. Even in the open ocean, climate warming will increase ocean stratification in some broad areas, reduce primary production and/or result in a shift in productivity to smaller species (from diatoms of 2-200 microns to picoplankton of 0.2-2 microns) of phytoplankton. This has the effect of changing the efficiency of the transfer concert for the various species. Increasing water temperatures will also increase metabolic rates and, in some cases, the range and productivity of some stocks. The vulnerable to sea-level rise in concert with other effects of climate change, such as changes in storm patterns.[38]

Coral reefs

Corals are subject to “bleaching” when the seawater temperature is too high: they lose the symbiotic algae that give coral its colour and part of its nutrients. Coral bleaching was a relatively unknown phenomenon until the early 1980s, when a series of local bleaching events occurred, principally in the eastern tropical Pacific and Wider Caribb4( )12.1(l)-2.6cit.r7.5(i)-1(l)-8.4(i).8( )]TJ-0.0o7(1 Tw T*[(-4.4(a)-)]TJ-i)-1(l2.1(16-0.6( )-2.1(16-9.2(h)3)-

planetary warming means that there are increasing possibilities for shipping traffic between the Atlantic and Pacific Oceans around the north of the American and Eurasian continents during the northern summer. The movement of species between the Pacific and the Atlantic demonstrates the scale of the potential impact. Those routes are shorter and may be more economic, but shipping brings with it increased risks of marine pollution both from acute disasters and chronic pollution and the potential introduction of invasive non-native species. The very low rate at which bacteria can break down spilled oil in polar conditions and the general low recovery rate of polar ecosystems mean that damage from such pollution would be very serious. Furthermore, the response and clear-up infrastructure found in other ocean basins is largely lacking today around the Arctic Ocean. Those factors would make such problems even worse. Over time, the increased commercial shipping traffic through the Arctic Ocean and the noise disturbance it creates may also displace marine mammals away from critical habitats.[42]

B. Higher mortality and less successful reproduction of marine biotas

Impacts of changes in breeding and nursery areas

Changes in breeding and nursery areas are best documented for the larger marine predators. For seabirds, globally, the greatest pressure is caused by invasive species (mainly rats and other predators acting at breeding sites). That pressure potentially affects 73 threatened seabird species — 75 per cent of the total and nearly twice as many as any other single threat. The remaining most significant pressures are fairly evenly divided between those faced mainly at breeding sites, n6(e)-157(t)]TJ(a)0.5(i)-14(n)-0.6(l)-.4(e)t bss changes driven by climate change. Even in the open ocean, evidence is increasing for

The scale at which a fish-community structure is determined and its variation is documented can be even more local, because some important drivers of change in coastal fish communities are themselves very local in scale, such as coastal infrastructure development. Other obvious patterns are recurrent, such as increasing mortality rates (whether from exploitation or coastal pollution) leading both to fish communities with fewer large 52

was left for their traditional fishing activities. Whether or not their activities were actually restricted, their slogan drew attention to a challenge faced all around the world as increasing demands are made for space for ocean-based activities.

The fundamental change in general cargo shipping (from loose bulk to containerized) has also produced a total change in the nature of the ports that act as terminals for that traffic, as large areas of flat land are needed for handling containers, both on departure and arrival. That land has, in many cases, been provided by means of land reclamation. As shipping traffic continues to grow, further substantial areas of land will be required. Dredging to create ports and to maintain navigation channels produces large amounts of dredged material that has to be disposed of. Most of that material is dumped at sea, where it smothers any biota on the seabed.[67]

Submarine cables and pipelines

The vital role that submarine cables now play in all forms of communication through the Internet — whether for academic, commercial, governmental or recreational purposes — means that there will continue to be a demand for more capacity, and hence for more submarine cables. Although submarine cables (and any protective corridors around them) cover only very narrow strips of seabed, they introduce a line break across the seabed that prevents other activities from spreading across it. Submarine cables will therefore continue to neutralize increasing segments of the seabed for any purpose that impinges on the seabed. Submarine pipelines are unlikely ever to venture into the open-ocean areas where many submarine cables have to be laid, but they have a growing role for transporting oil and gas through coastal zones and between continents and their adjacent islands. In some ways, therefore, their increased demand marine-based renewable energy require ocean space, and wind farms already cover significant areas in the coastal North Sea. Wave and tidal energy will make equal, if not larger, demands. The location of wind, wave and tidal installations can have significant effects on marine biotas. Special care is needed in siting installations that can affect migration routes or feeding, breeding or nursery areas. This is therefore a field in which the requirements of the new energy sources for ocean space could be important competitors with other, longer-established uses or with the need to conserve marine biodiversity.[70]

F. Increasing inputs of harmful material

Land-based inputs

The agricultural and industrial achievements of the past two centuries in feeding, clothing and housing the world's population have been at the price of seriously degrading important parts of the planet, including much of the marine environment, especially near the coast. Urban growth, unaccompanied in much of the world by adequate disposal of human bodily wastes, has also imposed major pressures on the current scale. In the past, industrial production had been dominated by the countries around the North Atlantic basin and its adjacent seas, as well as Japan. Over the past 25 years, the rapid growth of industries along the rest of the western Pacific rim and around the Indian Ocean has dramatically changed that situation. The world's industrial production and the associated waste discharges are rapidly growing in the South Atlantic, the Indian Ocean and the western Pacific. Even if the best practicable means are used to deal with heavy metals and hazardous substances in the waste streams from those growing industries, the growth in output and consequent discharges will increase the inputs of heavy metals and other hazardous substances into the ocean. It is therefore urgent to apply new less-polluting technologies, where they exist, and means of removing heavy metals and other hazardous substances from discharges, if the level of contamination of the ocean, particularly in coastal areas, is not to increase.

Frameworks have also emerged at the international level for addressing some of the problems caused by heavy metals and hazardous substances. In particular, the Stockholm Convention on Persistent Organic Pollutants[76] and the Minamata Convention on Mercury[77] provide agreed international frameworks for the States party to them to address the issues that they cover. Implementing them, however, will require much capacity-building.[78]

Oil

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degraded. This seriously affects the maritime economy, both for fishermen and, where tourism depends on the attractiveness of the ecosystem (for example, around coral reefs), for the tourist industry. Social consequences are then easy to see, both through the economic effects on the fishing and tourist industries and in depriving the local that the highest concentrations (more than 200,000 pieces per square kilometre) occurred in the convergence zones between two or more ocean currents. Computer model simulations, based on data from about 12,000 satellite-tracked floats deployed since the early 1990s as part of the Global Ocean Drifter Program, confirm that debris will be transported by ocean currents and will tend to accumulate in a limited number of subtropical convergence zones or gyres.

Plastics are by far the most prevalent debris item recorded, contributing an estimated 60 to 80 per cent of all marine debris. Plastic debris continues to accumulate in the effective enforcement of the MARPOL requirements, particularly in western Europe. The changes in arrangements for reparation for any damage caused by oil pollution from ships have improved the economic position of those affected.

In spite of all that progress, oil discharges from ships remain an environmental problem, for example, around the southern tip of Africa and in the North-West Atlantic. Off the coast of Argentina, however, a solution to the impact of those discharges on penguin colonies seems to have been found by rerouting coastal shipping. The likely opening of shipping routes through the Arctic between the Atlantic and the Pacific risks introducing that form of pollution into a sea area where response infrastructure is lacking, oil recovery in freezing conditions is difficult and the icy water temperature inhibits the microbial breakdown of the oil.[89]

Pollution from cargoes of hazardous and noxious substances appears to be a much smaller problem, even though there are clearly problems with misdescriptions of the contents of containers. Losses of containers, however, appear to be relatively small: in 2011, the losses were estimated at 650 containers out of about 100 million carried in that year.

Sewage pollution from ships is mainly a problem with cruise ships: with up to 7,000 passengers and crew, they are the equivalent of a small town and can contribute to local eutrophication problems. The local conditions around the ship are significant for the impact of any sewage discharges. The increased requirements under MARPOL on the discharges of ship sewage near the shore are likely to reduce the problems, but the identification of the cases where ships have contributed to eutrophication problems will remain difficult.

The dumping of garbage from ships is a serious element of the problem of marine debris. In 2013, new, more stringent controls under MARPOL came into force. Steps are being taken to improve the enforcement of those requirements. For example, the World Bank has helped several small Caribbean States to set up port waste-reception facilities, which has made it possible for the Wider Caribbean to be declared a special area under annex V of the Convention, under which stricter requirements apply. Other States (for example the Member States of the European Union) have introduced requirements for the delivery of waste ashore before a ship leaves port and have removed economic incentives to avoid doing so. It is, however, too early to judge how far those various developments have succeeded in reducing the problem.[90]

Offshore hydrocarbon industries

Major disasters in the offshore oil and gas industry have a global, historical recurrence of one about every 17 years. The most recent is the Deepwater Horizon blowout of 2010, which spilled 4.4 million barrels (about 600,000 tons) of oil into the Gulf of Mexico. The other main harmful inputs from that sector are drilling cuttings (contaminated with drilling muds) resulting from the drilling of exploration and production wells, "produced water" (the water contaminated with hydrocarbons that comes up from wells, either of natural origin or through having been injected to enhance hydrocarbon recovery), and various chemicals that are used and discharged offshore in the course of exploration and exploitation.

Produced water, in particular, increases in quantity with the age of the field being exploited.[91]

Offshore mining

The environmental impacts of near-shore mining are similar to those of dredging operations. They include the destruction of the benthic environment, increased turbidity, changes in hydrodynamic processes, underwater noise and the potential for marine fauna to collide with vessels or become entangled in operating gear.[92]

Implications for human well-being and biodiversity

Human health, food security and food safety

Marine biotas are under many different pressures from hazardous substances on reproductive success. Dead zones and low-oxygen zones resulting from eutrophication and climate change can lead to systematic changes in the species structure at established fishing grounds. Either can reduce the extent to which fish and other species used as seafood will continue to reproduce at their historical rates. When those effects are combined with those of excessive fishing on specific stocks, there are risks that the traditional levels of the provision of food from the sea will not be maintained.

In addition, heavy metals and other hazardous substances represent a direct threat to human health, particularly through the ingestion of contaminatik5.8(d)-0.6( )12.4(d)-0.7(o)-1025(f)-6.7

have thus been linked to impaired immune systems. Likewise, improvements in a fish-health index in the same area in the 2000s have been attributed to reductions in the local concentr exacerbate anthropogenic impacts and compromise deep-sea ecosystem structures and functions, and ultimately its benefits to human welfare.[98]

Those multiple pressures interact in ways that are poorly understood but that can amplify the effects expected from each pressure separately. The North Atlantic has been, comparatively, the subject of much scientific research. It has many long-term ocean-monitoring programmes and a scientific organization that has functioned for over a century to promote and coordinate scientific and technical cooperation among the countries around the North Atlantic. Even there, however, experts are commonly unable to disentangle consistently the causation of unsustainable uses of, and impacts on, marine biodiversity. This may initially seem to be discouraging. Nevertheless, well-documented examples exist of the benefits that can follow from actions to address past unsustainable practices, even if other perturbations are also occurring in the same area.[99]

Marine mammals, marine reptiles, seabirds, sharks, tuna and billfish

Cumulative effects are comparatively well documented for species groups of the top predators in the ocean, including marine mammals, seabirds and marine reptiles. Many of those species tend to be highly mobile and some migrate across multiple ecosystems and even entire ocean basins, so that they can be exposed to many threats in their annual cycle. Se1(d)1(s) m oh Tc 0.0I.7(g)-17(IB(h)-0.6(ri.3(np12.4(e)-4.1)-8.4(i)-14b)-0.6(i)-2.3(r)-2.3(rC)

Tourism and aesthetic, cultural, religious and spiritual marine ecosystem services

The changes in marine biodiversity can have consequential effects on the ecosystem services that humans obtain from the ocean. Particularly important is the link between the health of warm-water corals and tourism. Warm-water corals represent a major component of the attractiveness of many tourist resorts in the Caribbean, the Red Sea, the Indian Ocean and South-East Asia, and that attractiveness will be seriously undermined if tourists can no longer enjoy the corals. The same applies to other resorts

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consumption per capita varies considerably, from Africa an production in value, with a total export value of 129 billion dollars, of which 70 billion dollars (58 per cent) was exports by developing countries.[113]

Aquaculture is responsible for the bulk of the production of seaweeds. Worldwide, reports show that 24.9 million tons was produced in 2012, valued at about 6 billion partnership with them. This makes the tracking of the distribution of benefits from this sector, other than direct employment in extraction and processing, very difficult.[116]

Developments in offshore mining

There is limited information about the value of the offshore mining industry and the number of people it employs, but it is unlikely to be significant at present in comparison with terrestrial mining. For example, in the United Kingdom, which is the world's largest producer of marine aggregates, the industry directly employs approximately 400 people.[117]

Developments in tourism

Tourism has generally been increasing fairly steadily for the past 40 years (with occasional setbacks or slowing down during global recessions). In 2012, international tourism expenditure exceeded 1 billion dollars for the first time. Total expenditure on tourism, domestic as well as international, is several times that amount. The direct turnover of tourism contributed 2.9 per cent of gross world product in 2013, rising to 8.9 per cent when the multiplier effect on the rest of the economy is taken into account. The Middle East is the region where tourism plays the smallest part in the economy (6.4 per cent of GDP, including the multiplier effect), and the Caribbean is the region where it plays the largest part (13.9 per cent of GDP, including the multiplier effect).

Most reports of tourism revenues do not differentiate revenues from tourism directly related to the sea and the coast from other types of tourism. Even where tourism in the coastal zone can be separated from tourism inland, it may be generated by the attractions of the sea and coast or its maritime history, as it may be based on other attractions not linked to the marine environment. Consequently, the value of ocean-related tourism is a matter of inference. However, coastal tourism is a major component of tourism everywhere. In small island and coastal States, coastal tourism is usually predominant because it can only take place in the coastal zone in those countries. Particularly noteworthy is the way in which international tourism is increasing in Asia and the Pacific, both in absolute terms and as a proportion of world tourism. This

Satellite national accounts

Information on the distribution of economic benefits from the ocean is hard to compile from current information sources. The work of the United Nations Statistics Division in developing a System of Environmental-Economic Accounting and an Experimental Ecosystem Accounting System seems likely to help to fill that information gap. In the same way, national satellite accounts dealing with tourism and fisheries should help to fill information gaps in those fields.[120]

I. Integrated management of human activities affecting the ocean

The Regular Process is to provide an assessment of all the aspects of the marine environment relevant to sustainable development: environmental, economic and social. Even though the marine environment covers seven tenths of the planet, it is still only one component of the overall Earth system. As far as environmental aspects are concerned, major drivers of the pressures producing change in the ocean are to be found outside the marine environment. In particular, most of the major drivers of anthropogenic climate change are land-based. Likewise, the main drivers of increased pressures on marine biodiversity and marine environmental quality include the demand for food for terrestrial populations, international trade in products from land-based agriculture and industries and coastal degradation from land-based development and land-based sources.

Thus, as far as social and economic aspects of the marine environment are concerned, many of the most significant drivers are outside the scope of the present Assessment. For example, the levels of cargo shipping are driven mainly by world trade h(a)-11.3(A9)-12(d)19(t)-1 identities are readily found, but the marine component is not easily separated. Even white pigments found in many waste streams) have been shown to react with the ultraviolet component of sunlight and to kill phytoplankton;[124] A

(c) Although much is being done to reduce pollution from ships, there is scope for more attention to the routes that ships choose and the effects of those routes in terms of a)

However, many other threats derive from problems that are more local and constitute global problems simply because the same type of problem and threat occurs in many places. For most of those problems, techniques have been developed that can successfully address them. Implementing them successfully is then a question of building the capacities in infrastructure resources, organizational arrangements and technical skills.

Problems of that kind that can be addressed include:

(a) Reducing inputs of hazardous substances, waterborne pathogens and nutrients;[129]

(b) Preventing maritime disasters due to the collision, foundering and sinking of ships, and implementing and enforcing international agreements on preventing adverse environmental impacts from ships;[130]

(c) Improving fishery management;[131]

(d) Managing aquaculture;[132]

(e) Controlling tourism development(a)-h(i)dngf21.30 Tc 0.5(f21()r7(n)14a)-100.018 Tc 0.270

im>DCuT14[7792(3)-015.86 ironmental ed193 southern hemisphere and, again in general, the North Atlantic and its adjacent seas are probably the most thoroughly studied — and even there major gaps remain.[137]

Physical structure of the ocean

Plankton are fundamental to life in the ocean. Information on their diversity and abundance is important for many purposes. Such information has been collected for over 70 years in some parts of the ocean (such as the North Atlantic) through continuous plankton recorder surveys. Nine organizations currently collaborate in extending such surveys, but the desirable comprehensive global coverage has not yet been achieved.

As well as information on biodiversity in the ocean and the number and distribution of the many marine species, information is also highly desirable on the health and reproductive success of separate populations. Many species contain separate populations that have limited interconnections. It is therefore important to understand how the local influences specific to each population are affecting them. As the regional surveys in part VI show, much is already known about the population health and reproductive success of many species, but there are also large gaps in knowledge, particularly in the southern hemisphere.[141]

Fish stock assessments are essential to the proper management of fisheries. A good proportion of the fish stocks fished in large-scale fisheries are the object of regular stock assessments. However, many important fish stocks of that kind are still not regularly assessed. More significantly, stocks important for small-scale fisheries are often not assessed, which has adverse effects in ensuring the continued availability of fish for such fisheries. This is an important knowledge gap to fill. Likewise, there are gaps in information about the interactions between large-scale and small-scale fisheries for stocks over which their interests overlap, and between recreational fishing and other fisheries for some species, such as some trophy fish (marlins, sailfish and others) and other smaller species.[142]

The present Assessment sets out the main specific issues for which there are gaps in our knowledge of marine biotas, in particular of all the species and habitats that have been scientifically identified as threatened, declining or otherwise in need of special attention or protection. Those species include, with some indications of important issues identified in part VI: marine mammals, sea turtles, seabirds (particularly migration routes), sharks and other elasmobranchs (especially the lesser-known species and certain tropical areas), tuna and billfish (particularly the non-principally marketed species), cold-water corals (especially where they are found in the Indian Ocean), warm-water corals (particularly at locations in deeper water), estuaries and deltas (particularly integrated assessments of them), high-latitude ice, hydrothermal vents (especially the extent to which they are found in the Indian Ocean), kelp forests and seagrass beds (especially the degree of loss of kelp and the pathology of the diseases affecting them), mangroves (especially the taxonomy of associated species and their interactions with salt marshes), salt marshes (especially the ecosystem services that they provide) and the Sargasso Sea (especially the links with distant ecosystems).[143]

Ways in which humans interact with the ocean

Some of the issues relating to the ocean and to the ocean biotas (for example, ocean acidification and fish stock assessments) are linked to the way in which humans affect some aspects of the ocean (for example, through carbon-dioxide emissions or fisheries). However, there are many more areas in which we do not yet know enough about human activities that affect or interact with the ocean to enable us to manage those activities sustainably.

For shipping, much information is available about where ships go, their cargo and the economics of their operations. However, important gaps remain in our knowledge about social aspects of shipping: in particular, little is known about the levels of death and injury of seafarers, an issue recently raised by the Secretary-General of the International Maritime Organization.[144]

Land-based inputs to the ocean have serious implications for both human health and the proper functioning of marine ecosystems. In some parts of the world, those have information on the origin, fate and effects of plastic microparticles and nanoparticles is highly desirable. Likewise, because of their potential effects on phytoplankton, there is a gap in knowledge about titanium dioxide nanoparticles.[148]

Many aspects of integrated coastal zone management still present important knowledge gaps. Those responsible for managing coastal areas need information on, at least, coastal erosion, land reclamation from the sea, changes in sedimentation as a result of coastal works and changes in river regimes (such as damming rivers or increased water abstraction), the ways in which the local ports are working and dredging is taking place information currently available, it is impossible to say what gaps currently exist in arrangements to build such capacities. Conclusions on where the capacity-building gaps exist could only be reached by conducting a survey, country by country, of the capacity-building arrangements that currently exist and of how suitable they are for each country's needs. The preliminary inventory of capacity-building for assessments

The capacity to manage fisheries effectively requires ships, equipment and skills to monitor and assess fish stocks. Based on those assessments, capacities are then required to develop, apply and enforce appropriate fishery management policies. Such capacities are likely to include fishery protection vessels to monitor what is happening at sea, access to satellite data to monitor the movements of fishing vessels through transponders, institutional structures to regulate markets in fish and other seafood (including their freedom from contaminants and pathogens) and the necessary enforcement mechanisms at all stages from ocean to table.

Ways in which humans interact with the ocean

Many human activities affecting the oceans are carried out by commercial enterprises. Those can be expected to develop the capacities to generate the knowledge and infrastructure that they need to run their businesses and to comply with relevant regulations. For public authorities, however, capacities will be needed to ensure that they can create appropriate regulati1.4(y c)5.3(o).9(a)1 a-14(TCe)-4.1(s a)0.5(f9.3(9(r)11.7(e8.4(a)-11.3rd content of heavy metals and other hazardous substances, to remove waterborne pathogens where they could pollute bathing waters and contaminate seafood and to prevent excessive nutrient discharges;

(j) Promote the proper handling of agricultural waste and slurry and the proper use of agricultural fertilizers and pesticides;

(k) Deliver the organization, equipment and skills to monitor and control other human activities that impact on the marine environment;

(l) Manage the coastal zone in an integrated way. Where tourism is significant, those capacities need to include the ability to monitor and regulate tourist developments and activities, so as to keep them within acceptable limits in relation to the carrying capacities of the local ecosystems.

A general gap exists in capacities for an integrated assessment of the marine environment. An integrated assessment needs to bring together: (a) environmental, social and economic aspects; (b) all the relevant sectors of human activities; and (c) all the components (fixed and living) of the relevant ecosystems. The idea of an integrated assessment in that sense is relatively recent. It presents a challenging requirement, which requires specialists in many different fields to work together.

In building capacities for integrated assessments, it is necessary to think further about the concept of an integrated marine assessment. The present assessment is the first global integrated assessment of the marine environment. The Group of Experts who are collectively responsible for it are convinced that the further development and refinement of techniques for making integrated assessments are needed.