Urbanization of Coastal and Shelf Seas

Karen Helen Wiltshire

Abstract: Increasing pressure on and utilization of coastal and shelf seas in combination with global issues such as those related to climate change presents as a serious challenge to the management of future oceans. Associated challenges include sea level rise and safety of equity, healthy aquaculture, high-level tourism, transport/shipping and sustainable ecosystems. In this paper the global complexity and extent of human use of coastal seas is illuminated and the urgent need globally for new terms of coordinative management highlighted. The term urbanization in the context of the human expansion into coastal and shelf seas is introduced. On a world-wide basis five major direct human usages/interests in coastal and shelf seas which are identified in terms of urbanization are: Fisheries and aquaculture, artificial structures and coastal armouring and transport and anthropogenic pollutants and tourism. It is shown that Urbanization of the sea is a given. Future human health, economies and industry are dependent on the integrity and function of coastal and shelf seas. We urgently need scientific research into new marine "ecostructures" and engineering for sustainable marine infrastructures. We need to implement new technologies and stations for observing and monitoring our coastal systems. We need to manage and plan human requirements. We need to accept the urbanization of the seas and oceans as a fact. Humans need this space. Only this acceptance will allow us take on this major challenge as policy makers and coastal sea managers order to deal with it wisely and in a holistic integrative manner.

1 Introduction

The propagated statistics for distribution of the world´s population in the next 50-100 Years estimates that between 50 and 70% of the population will be living at a coastal sea (0) (UNEP 2016). This implies increasing pressure on and utilization of coastal and shelf seas. In combination with global issues such as those related to climate change, this presents as a serious challenge to the management of future oceans. Associated challenges include sea level rise and safety of equity, healthy aquaculture, high-level tourism, transport/shipping and sustainable ecosystems. Increasingly, these topics mostly singly, are subject to studies in the context of sustainable coastal zone management, e.g. (1) Jackson et al. 2001, (2) Pauly et al. 2003, (3)

Tõnisson et al. 2011, (4) Vandenbruwaene et al 2011, (5) Lusher et al. 2013. However, in order to avoid conflicts of interest and sustained multifaceted use, multidimensional and international cooperation as well as resource studies, ending in globally useful legislature, are urgently required (6) European Environment Agency (EEA) 2006, (7) EEA 2013, (8) Liquete et al. 2013.

Global seas are becoming urban and we need to accept that the urbanization of the sea is intrinsically linked to human future. (Definition of urbanize: "to take on urban characteristics" whereby an urban area is "an area were humans live and carry out work"; (9) Merriam Webster 2016).

Globally speaking, the development and use of coasts and shelf seas generally, and with more or less rigor, falls within national terrestrial land use and land management regulations. These are often dealt with in a similar legislative manner as terrestrial land and resource management and planning questions. However, outside the 12 nautical mile boundary, and especially further offshore in the Exclusive Economic Zone (EEZ), legislation becomes more fuzzy and spatial planning is a challenge. (For an excellent depiction of the situation, which can considered a precursor to all future global coastal situations, see page 81, EEA report, „The changing faces of Europe's coastal areas" 2006, (7))

The European Union has notably been addressing this problem for some time (10) European Union (EU) 2000, and after a long lead up the European Parliament and the Council adopted legislation for a common framework for maritime spatial planning. (11) EU 2014. (See future perspectives below)

Human beings have been living, adapting to, and more or less managing the terrestrial margins (coasts) since the beginning of record. Interestingly, it is only in approximately the last 1000 years that humans have really started to really dominate the ocean realm and shelf seas in particular.

Starting with the use of estuaries and coastal seas as a source of food, as a means for transporting goods and for travel, through to the building of protective structures such as harbours and dikes, humans have increasingly tried to utilize/tame the sea. (12) Charlier et al. 2005, (13) Knottnerus 2005, (14) Reise 2015. As long as their numbers were low and their distribution was bundled into small units, the influence of humans on coastal and shelf seas was relatively contained.

The only areas where humans, already early on, facilitated great changes on a regional basis were example in travelling (e.g. Vikings in their conquests), fishing (e.g. Herring fisheries in North and Baltic Seas) and land reclamation (e.g. The Netherlands); (15) Pye 2014, (14) Reise 2016.

Now that the world´s population has grown to 7.5 billion, humans are utilizing the seas with escalating needs. Because of their accessibility, coastal and shelf seas are the focus of use and globally considered, these are actually poorly managed overall. Usage ranges from the capture fisheries, establishment of large aquaculture ventures, energy production, transport and tourism through to the establishment of marine protected areas. Marine spatial planning becomes ever more important the greater the pressure of usage. (7) EEA 2006.

In this paper the global complexity and extent of human use of coastal seas is illuminated and the urgent need globally for new terms of coordinative management highlighted. Examples are illustrative and do not pertain to be exhaustive. The term urbanization in the context of the human expansion into coastal and shelf seas is introduced.

2 Current usage of coastal seas

On a world-wide basis five major direct human usages/interests in coastal and shelf seas which are identified here as:

1) Fisheries and aquaculture
2) Artificial structures and coastal armouring
3) Transport
4) anthropogenic pollutants and
5) tourism

Additionally, increasingly coastal seas are used for energy production and as marine protected areas. The impact of these usages on ecosystems is not subject of this paper and thus in all discussion of human use, reader is referred to the referenced papers separately.

2.1 Fisheries and aquaculture

As over 790 million people currently suffer from malnourishment, it is expected that the world´s fisheries and aquaculture will provide alleviating food and protein in the future. (16 &17) FAO, 2014, 2016. Indeed, the apparent fish consumption (per capita) has increased from of 9.9 kg in the 1960s to a current estimate of 20 kg per capita (16) FAO, (2016). The global total capture fishery in 2014 amounted to 93.4 million tonnes, whereby 81.5 million tonnes and 11.9 million tonnes came from marine and inland waters, respectively. ((17) FAO, 2016). The world trade in fish was US$148 billion (export value) in 2014. Thus, the net-export value of fisheries in developing countries is higher than the total of rice, coffee, sugar and tea together.

As the world's populations grow most at the coast 12% of the population currently relies on fisheries and aquaculture for their livelihoods, with increasing tendency.

The vast majority of capture fishing is carried out in coastal and shelf seas. This is because it is at these interfaces of land and ocean, often with upwelling waters, where the waters are most dynamic, nutrient rich and productive. They also allow easy accessibility. The capture fishing efforts can be subdivided into subsistence, recreational or commercial, fishing efforts. Accordingly, the capture fishing involves all sorts of different effort and gear, ranging from hand net and small boat fisheries, deployed from land, through to highly commercialized offshore ventures (17) FAO 2016. The fisheries are both pelagic and benthic resources and include both capture fisheries and aquaculture.

Examples of subsistence fisheries and recreational fisheries are found in Africa and the Caribbean. Large fishing effort can be exemplified by whaling in Fjords around Svalbard, Anchoveta fishing, trawling in the North Sea and Mediterranean (17) FAO 2016. Generally fishing vessels are small in size, with 85 % of the motorized fishing vessels in the world being less than12 m in length, implying coastal and shelf sea fishing ranges.

Coastal fisheries and their habitats are not in *status quo*, but rather maximally utilized and thus, subject to great human interference and resultant changes. Capture fisheries can seriously damage the sea floor, in trawling, for example, by abrasion or selective extraction of benthos.

For example, in the German North Sea, tiny areas, even within marine protected areas (3^2 nautical miles) are estimated to annually fished with an effort of up to 150 to 400 hours of large beam trawling, resulting in a "man-made" habitat on the sea floor. (7) EEA 2006.

As habitats are changed to artificial habitats and resources (species) become scarce, commercial resource interests shift to other species. This has resulted in the situation known as fishing down the food chain (2) Pauly et al. 2003, whereby the commercially useful fishes have moved from for example Sturgeon/Cod in the North sea. (Fig. 1.) in the past, down to sand eel in the present.

Wild fisheries are often used with a "free for all mentality". The sea floor is "out of sight" and thus "out of mind". The land based analog to this type of resource use is perhaps the opportunistic and indiscriminate harvesting of natural rain forests. At some point, when the main resource is decimated to a point where it is no longer commercially useful, one turns to the culture of organisms (monoculture). In the ocean aquaculture is the natural next step.

Figure 1: Sturgeon market in Hamburg-St. Pauli mid- 1880ies,
Source: LLUL Schleswig Holstein

Aquaculture is the world´s main source of fish. The pelagic environment in coastal areas can be considered an *in situ* "fish incubator" and it is akin to agricultural animal husbandry in terrestrial systems. Aquaculture is a farming industry in the ocean. The sea is merely a holding medium harnessed for food production purposes. Aquaculture in coastal areas of China at is the largest in the world a huge industry mostly situated inland.

In coastal areas China and Norway produce roughly the same tonnage of organisms at 1200 thousand tonnes per annum. This industrial farming type of aquaculture requires large amounts of infrastructure in terms of nets and floating platforms and support infrastructure. The aquaculture Industry generally weighs heavily on the marine environment. The coastal environments in which aquaculture is carried out, can for example be ancient mangroves (e.g. Indonesia) and sensitive fjord ecosystems (e.g, Norway and Chile). (17) FAO 2016.

Although globally the fishing industry is regulated, the coastal oceans are unequivocally part of a human industry. Ecosystems have changed radically due to species shifts and habitat loss. Regulation and environmental measures function to a limited degree and even in areas where fishing is purportedly well managed and the coastal environments and fisheries are supposedly managed, we are a long way off a sustainable situation, overall. Fig 2.

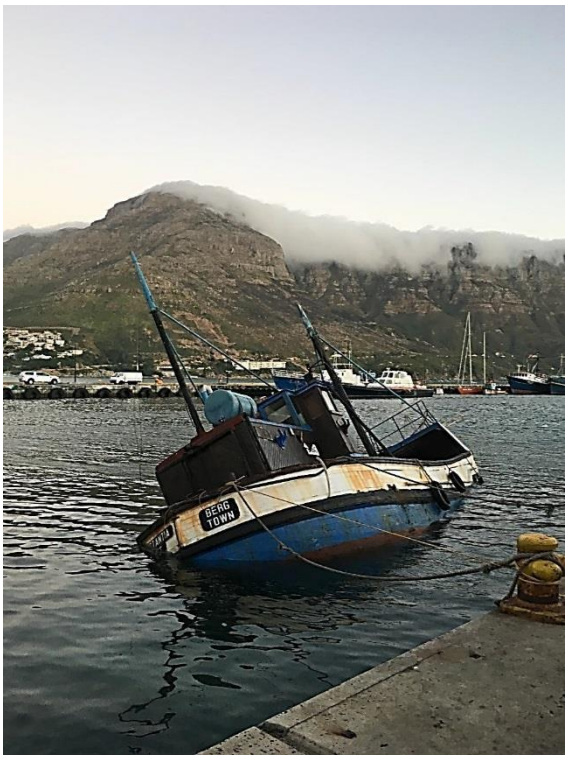

Figure 2: Fishing harbour, Hout Bay, South Africa

In summary: using an illustrative quote made by the Director General of the FAO, J. da Silva ((16) FAO 2014): The challenges for the fisheries and aquaculture sector and particularly at the Coast "range from the scourge of illegal, unreported and unregulated (IUU) fishing to harmful fishing practices, to wastage, to poor governance. They can all be overcome with greater political will, strategic partnerships and fuller engagement with civil society and the private sector. We need to foster good governance by ensuring the uptake and application of international instruments such as the Port State Measures Agreement, and we need to spur innovative solutions with business and industry. We all have a role to play in order to enable fisheries and aquaculture to thrive responsibly and sustainably for present and future generations".

Coastal fisheries and especially the aquaculture industry, including the catchment wastes produced by inland fisheries are and urban management issue of global proportions. Sustainability of these habitats needs urgent re-thinking and rigorous joint governance to deal with the many conflicts of interests.

2.2 Artificial structures and coastal armouring

Humankind has lived close to coasts and estuaries/ river mouths from the point in history where livelihoods and food supply were linked to the ocean (12) Charlier et al. 2005, (13) Knottnerus 2005. The downside of permanent settlement was, and is, the danger of inundation. With settlement, defense against the sea became important.

Archeological evidence shows that coastal defense structures probably started with, for example, simple redirection of channels, building of earthen protective hummocks and e.g. brushwork sediment traps (12) Charlier et al. 2005 and land reclamation. In the meantime after devastating sea inundation in the previous and last centuries (18) TeBrake 2002; (19) Schenk 2009 human s in for example Europe learned that they had to work with the sea differently. This ultimately resulted in massive engineering works such as the flood gate systems across the delta of the river Scheldt, Meuse and Rhine "Delta works" in The Netherlands (http://www.deltawerken.com/en/10.html?setlanguage=en) and the new highly integrative and stakeholder oriented 100 year dike programs of Northern Germany and the Waddensea UNESCO heritage area (20) Schleswig Holstein 2015.

European coasts are fortresses of concrete and engineering, protecting humans from the sea and at the same time allowing easy access and exploitation of its resources. Globally coastal margins are experiencing rapid growth in population including the construction of increased artificial surfaces. This irreversible change in land cover, often from natural to urban and maritime infrastructure development, in a quasi-random and user-lobby dominated manner, can be seen as one of the main threats coastal system integrity and sustainability. In Europe alone, artificial surfaces increased at a rate of 190 km2 per year between 1990 and 2000. (7) EEA 2006.

Valuable equity, fortressed in steel and concrete, is often placed perilously close to/in areas subject to sea level rise and storm inundation. Apart from the danger of loss of property, poorly-planned construction on a shore can cause, for example, erosion and habitat loss in the intertidal zone. This is a major issue globally and increasingly is resulting in new management and engineering ideas for coastal construction. For example, because of the increased building interests Florida legislature has set up a "Coastal Construction Control Line Program" which aims to protect the Florida coastal system "from improperly sited and designed structures which can destabilize or destroy the beach and dune system". (21) Florida administrative code 2012. In contrast eastern US coasts (e.g. Outer Banks) often have limited defence. Coastal property and equity is often constructed in a "disposable manner" and on stilts- allowing water to flow underneath and quick replacement upon destruction due to storms (22) Dolan & Lins 2000. Construction directly on the foreshore, for example, as is the case with Miami, US, can result in the long term necessitation of retreat from shoreline property or in the need reengineering of property due to sea level rise (23) Tomkins & Deconcini 2014.

A great coastal environmental problem is the armouring of the shorelines with e.g. harbours, artificial beaches and other artificial constructions such as dams, dikes or sea walls. This has become especially important along the Mediterranean coast (over 8 %) and in the North Sea (16 % of the coast) with countries with relatively short coastlines (e.g. the Netherlands, Germany, Belgium and Slovenia) having the highest amount of shoreline conversion to man-made surfaces. Such coastal armouring is often closely related to coastal erosion process affecting the stability of coasts in question. Twenty five percent of the European coastline is affected by erosion, with one fifth of the EU coastline currently severely affected by erosion.

European coastlines are retreating on average by 0.5– 3m and up to 15 m per year. Current data show that about 25 % of European coastlines experience erosion. (7) EEA 2013.

Coastal armouring can have many offshore consequences such as redirection of hydrography and sediments such as the destabilization of sand barriers and island building processes. As a result of such issues German UNESCO Wadden Sea Heritage is part of an innovative 100 year coastal plan ensuring its sustainability. (20) Schleswig Holstein 2015.

The extraction of sand and gravel (mining) to counteract coastal erosion, for beach nourishment and for use as building material in the construction industry in coastal waters is of increasing importance globally. This, as well as the deepening of river catchments has the potential to also disturb the hydrography of coastal seas and restructure the benthic environment.

Perhaps one of the greatest questions facing the energy industry is what to do when structures such as oil installations have come to the end of their lives. The "OSPAR Convention" ((24) See OSPAR 2009) regulates the requirement for removal of all artificial structures from the ocean at the end of their lives. There are 184 rigs in the North Sea, of which 150 are likely to be decommissioned in the coming years. The energy industry has to find many different ways of dealing with this. The global oil and gas industry has taken on this enormous task and is assessing any environmental implications associated with decommissioning. The questions needing answers are manifold and include the potential of structures which have been in place for many years to have become artificial reefs for marine organisms (25) Soldal et al. 2002 with "Rigs to Reef" programmes, as in the Gulf of Mexico, through dealing with pollutants under rigs and to governance and advocacy issues (26) Schroeder & Love 2004; (27) Jørgensen 2012. The energy companies need to encourage the design of future facilities to incorporate decommissioning features. Unfortunately, the renewable energy industry, which is currently increasingly replacing the oil industry offshore, especially in Europe, has made little use of the lessons learned by the oil and gas industry. As the first of these renewable energy infrastructures come to the end of their lives, decommissioning is a huge issue both in terms of costs and the fact that some of the materials built into the structures, which were deemed harmless on building may no longer be accepted as harmless. (28) Kaiser & Snyder 2011.

Coastal seas are not only influenced by the introduction of artificial structures on an ecosystem level but as discussed above, they are also increasingly are becoming man-made in terms of their sedimentary processes and geology. As a result of this urban usage of the coastal area, all kinds of new ways to decrease the need for artificial surfaces (such as: controlled inundation and retreat, new engineering materials and structures, structure recycling) are currently being considered and must be subject to increased research (7) EEA 2013, (13) Reise 2015.

2.3 Transport

The intensity of global maritime transport has been increasing steadily. The United Nations Conference on Trade And Development (29) UNSTAD 2015 estimated that shipping increased by 3,4 % in 2014, with a total shipping of 9,84 billion tons shipped worldwide. The major shipping product is crude oil and thereafter coal and petroleum and derivatives. (30) UNSTAD 2015.

The pressure of shipping on European coastal waters is so great that the EU is propagating a concept known as Motorways of the Sea EU 2013) (31). This is set up to become a common

transport policy forming the basis for the development of trans-European networks, which also includes short–sea shipping. The short-sea shipping indicator of the EU deals with the shipping pressure of the transport of goods between European destinations. In 1991 and 2001 this indicator grew by a third to approximately 1270 billion tonne-km. This makes it comparable with road transport volumes in Europe, which are already totally overstretched in Europe and desperately in need of respite. The concept "Motorways of the Sea" is aimed alleviating the pressure on land and at improving market access throughout Europe via the movement of goods across maritime transport corridors. Four corridors for shipping are proposed: One linking the Baltic States to the North Sea, ones for Western Europe, south Eastern Europe and south Western Europe. See Fig. 3 ((32) EU 2016). On the long run it is hoped this should alleviate road pressure on land, rather than just add another transport dimension.

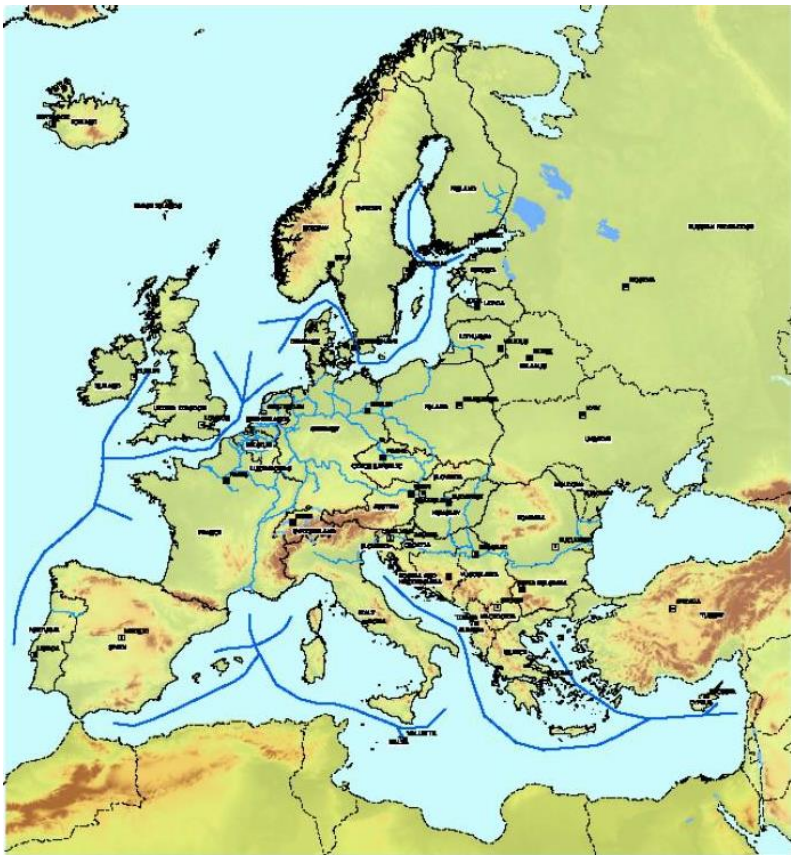

Figure 3: Motorways of the sea EU 2016

Globally the need for less grid-locked transport routes via the ocean result in the repeated discussion of the widening and opening of new canals (e.g. Suez, Kra Isthmus of Thailand etc). In particular the future of Arctic coasts in the advent of ice-free northern waters presents as a major coastal and shelf sea issue. Apart from regional shifts, the opening of new routes can make existing coastal infrastructure geared to shipping obsolete and thus potentially result in coastal industrial wastelands. The future global maritime transport policy will have to address the sustainability of marine transport, look at future routes and the impact on coasts and coastal seas on a global scale. This requires integrated global spatial planning for coastal and shelf seas taking global climate shifts, environment, economies, and interconnectivity of ports and nations into consideration. (30) UNSTAD 2015.

The definition of "Motorways of the Sea" are the signature of the urbanization of the ocean.

2.4 Anthropogenic pollutants

Eutrophication and human effluent input has been globally recognized over many years as one of the most important problems coastal waters. The quality of water directly associated with urban coastal areas is easily recognized as a potential health issue and thus, has been subject to scrutiny and more rapid alleviation, than other forms of pollution.

In general, nitrogen and phosphorus loads in coastal waters have been decreasing, and globally speaking wastewater treatment has improved significantly. However, the atmospheric deposition of nitrogen compounds into the coastal ocean is still significant and needs to be addressed. It has for example been estimated that 30/ 25 % the total nitrogen discharges occur from the atmosphere in the North Sea/Baltic Sea respectively (6) EEA 2006. The shipping sector is one of the main sources of NOx emissions in coastal seas and especially so, when ships are not at anchor but in waiting modes. For example estimation for the Baltic Sea shows that approximately 16 000 tonnes per annum of nitrogen are deposited indirectly into the Baltic Sea from ships. Shipping emissions of NOx are predicted to continue increasing as long nitrogen emissions are not extensively regulated in the shipping sector.

Globally, the input budgets of pollutants to coastal seas remain largely unclear. Estimation by the (33) UNDP, 2003, suggests that, every year, 5.9 trillion gallons of sewage are discharged into coastal waters. The deoxygenation of coastal waters has increased and the numbers of dead zones in coastal waters have doubled since 1990. These areas may be small and are found coastal bays and entrainments, but also can be up to 70 000 km2 in dimension (34) United Nations Environment Programme (UNEP) 2011. It is also estimated that 160,000 factories discharge between 41,000 to 57,000 tons of toxic organic chemicals and 68,000 tons of toxic metals into coastal seas. The role which coastal cities need to play in the mitigation of this industrial dumping into coastal waters is abundantly clear.

Heavy metals and persistent organic pollutants, although getting less, are still an issue and the occurrence of new substances such as PCPs and hexachlorobutadiene in coastal waters is an ongoing problem and seriously needs to be controlled (35) UNEP 2015. Globally and especially in the EU, oil discharges from refineries and offshore installations into coastal seas have been decreasing since the 1980s, although there has been an increase industrial activity. However, though reduced they are still a cause for concern. The new accessibility of the Arctic due reduced ice coverage leaves a lot of scope for the oil industry in the future, in difficult to regulate areas. Also even if the industry moves to deeper waters offshore, all spills do ultimately end up in coastal seas.

Another huge source of visual pollution in coastal seas and with uncertain food chain effects is the input of plastics (5) Lusher et al. 2013. Simple observations on plastic occurrence in beaches and entrained areas shows that with the amount of plastic litter present in our coastal seas, we will need a global clean-up plan akin to litter clean-up plans in terrestrial environments.

Coastal waters currently function as urban dumping grounds, requiring urgent clean up and management attention.

2.5 Tourism

Tourism is the world's largest industry in terms of the number of people involved and the economic gain. It is the largest individual sector, worldwide, driving coastal economies ((37) UNEP 2009). It is estimated that 63% of European tourists (36) EU 2013 prefer the coast over mountains, cities and countryside. In the (37) UNEP, 2009, study it was identified that tourism in the maritime industry sector has the greatest potential to increase and foster the quality and sustainability of coastal waters. Coastal and maritime tourism ("coastal" here meaning: land-based activities and "maritime" meaning: using coastal waters) are very dependent on the quality and coherence of physical, environmental, cultural and socio-economic features of the receiving coastal environment (37) UNEP 2009. Poor infrastructure and poor environmental quality are deleterious to tourism.

The EU has identified the coastal and maritime tourism sector as an area with "special potential to foster a smart, sustainable and inclusive Europe" (36) EU 2013. European tourism is the biggest maritime sector in terms of gross value and employment. This sector is expected to grow by 2-3% by 2020.

Tourism is growing steadily in Europe with the Mediterranean expanding the most. For example, in 2001, tourism represented 43 % of the jobs in coastal regions in France whereby it was worth four times the added value of all sea products and maritime transportation. However, with political unrest in the area around the Mediterranean regions such as Turkey, Egypt and Tunisia are experiencing sharp declines in coastal and Maritime tourism.

It was estimated that by 2020, half of the Mediterranean coastline will be built up, with much of the development linked to tourism. Indiscriminate and rampant construction in coastal areas is counteractive to tourism needs. The increase of artificial surfaces on coastal land and underwater can be linked to declines /changes in biodiversity and of natural habitats. Artificial surfaces on coastal land become problematic if infrastructure is left unused or falls into disrepair. Resultant concrete coasts with derelict buildings and underwater infrastructure represent a significant form of pollution and have negative sociocultural impacts (desolation). Underwater structures are more complicated as, if left undisturbed, they may become reefs and new habitats and must be considered in terms of their new worth overall to the system. The (37) UNEP, 2009, study shows clearly the need for Integrated Coastal Zone Management (ICZM) in order react to the global requirements for recreational space and tourism. It was clearly shown that the human needs, in terms of tourism, in coastal areas, include pristine natural environments, innovative, effective infrastructure and accessibility. These needs can only be met globally on the long term with careful planning and governance, and if conflicts of use and interests are dealt with in an integrative manner.

Population growth and urbanization on land, towards larger and larger cities, mostly close to coasts, has resulted in a greater need for recreation, especially close to/ on the sea. This is associated with increased infrastructure on coasts and in coastal waters. This in itself is urbanization and this rather defeats the purpose of recreation in order to get away from an urban zone. Thus, in the interest of human welfare it is increasingly clear that we need new management of coastal and shelf sea zones, maybe taking the EU initiative on Maritime Spatial Planning and Integrated Coastal management as exemplary (see (38) European Commission 1999 and (31) EU 2013.

3 Future Perspectives and Conclusions

The human population on Earth continues to grow and is concentrated near coastal seas. Consequently, coastal systems (marine and terrestrial) are becoming increasingly urbanized and significantly less "natural". The major agents for this are the maritime industry particularly related to fisheries and aquaculture, transport (motorways of the sea), increased infrastructure with artificial surfaces, and tourism.

At the same time, the human need for recreational and "wild spaces" in natural environments is growing rapidly and increasingly takes the form of coastal and marine tourism. Human recreation and especially tourism requires a paradoxical mix of good infrastructure in non-degraded coastal and marine environments. Degradation of "natural" coastal and marine systems involves loss and change of habitat, shifts and reduction in biodiversity, eutrophication, contamination, erosion. However, what humans perceive as a natural recreational environment has everything to do with suggestion and what they are used too. Diked landscapes and polder landscapes are attractive to the northern Germans and the Dutch.

The preservation/repair of coastal Mangrove belts verses the expensive construction of artificial structures, to combat coastal erosion and inundation as a result of sea-level rise has only recently been recognized in for example in Thailand and Bangladesh. This was in part due to the experience that areas with Mangroves were more robust compared to those artificial structures with regard to Tsunamis.

The question of decommissioning of oil rigs into artificial "habitats" and fish attractants takes on an interesting dimension in overfished shelf seas and is considered to be of different relative importance in the regulations for the Gulf of Mexico as opposed to those for the North Sea. How new offshore energy infrastructure will be built regarding its habitat-building properties and future decommissioning is a major construction and financial issue, dependent on different governance.

Humans are increasingly spreading into Earth´s coastal shelf seas. We are using them both for economic reasons and in order to upgrade our quality of life. As a result, the pressure on even the smallest of areas can be enormous. The German Bight is a case in point, whereby zonation and planning in order to manage the system has resulted in an urban marine area interspersed with natural areas "parks". (Fig. 4 courtesy of (39) BSH 2009). There was no choice in this small marine area, too many parties had too many interests. Just as in terrestrial systems human needs outweigh the space/resources available. Just as we currently are working on Motorways of the Sea for transport of goods, it is perceivable that in order to retain species of value to man and the marine ecosystem, we may soon have to devise interlocking corridors for the linkage of marine protected areas in the ocean.

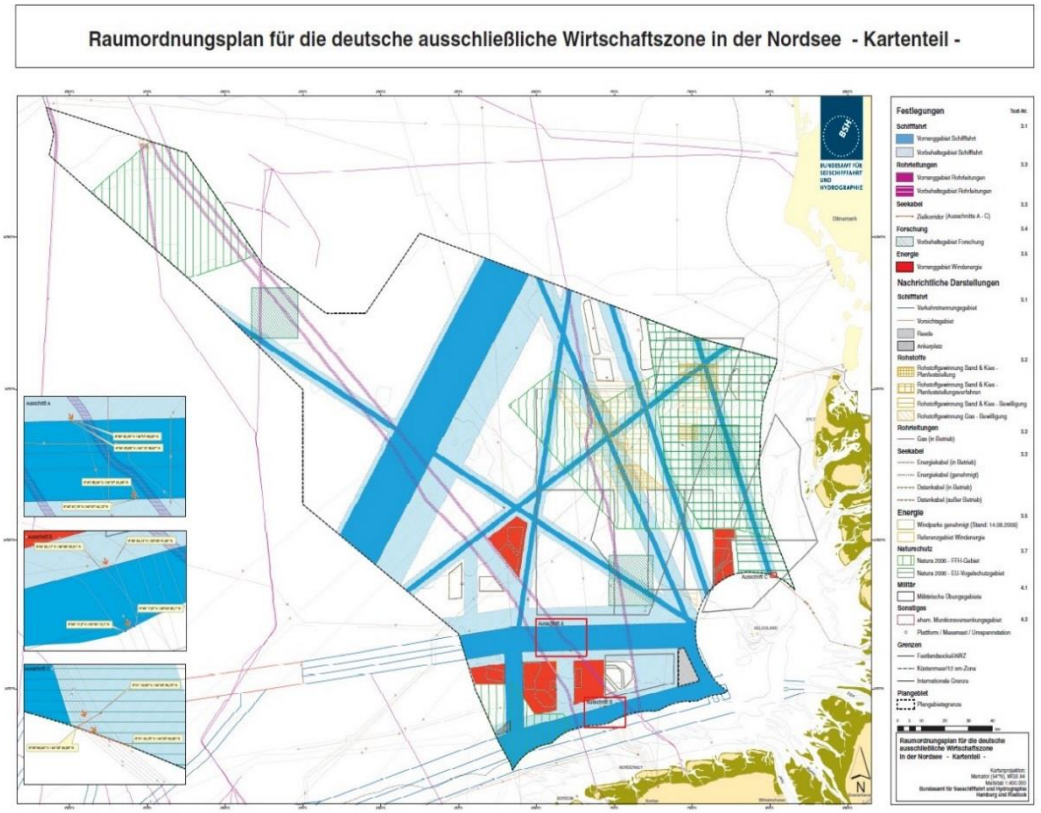

Figure 4: Zonation of the German Bight, North Sea, BSH 2009. Motorways of the Sea in blue, Offshore Wind Farms in Red, Nature reserves in Green.

Urbanization of the sea is a given. All the FAO, UN, EU etc. (cited as above) studies on maritime human future show this explicitly. Future human health, economies and industry are dependent on the integrity and function of coastal and shelf seas. We urgently need scientific research into new marine "ecostructures" and engineering for sustainable marine infrastructures. We need to implement new technologies and stations for observing and monitoring our coastal systems. We need to manage and plan human requirements.

Simply it is this: we need to accept the urbanization of the seas and oceans as a fact. Humans need this space. Only this acceptance will allow us take on this major challenge as policy makers and coastal sea managers order to deal with it wisely and in a holistic integrative manner.

Zonation of the German Bight, North Sea, BSH 2009. Motorways of the Sea in blue, Offshore Wind Farms in Red, Nature reserves in Green.

Acknowledgements

I wrote this paper on "urbanization of the sea" in the knowing that I have merely been a manager of the Coastal Sciences for the past 20 years. My colleagues and many experts with whom I have worked with, as well as the general Public with whom my family and I share two highly armoured Islands in the North Sea for living and working space, have helped me immensely with my views on ICZM and coastal science. For this I am grateful.

As I write these words, a wonderful ocean scientist, Graham Shimmield, with whom I have discussed issues like these many times, has sadly passed away. Thus, sadly the topic of "Urbanization of the Sea", will remain an undiscussed joint topic. I am sure we would have had a good "natter".

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Author

Karen Helen Wiltshire
Alfred Wegener Institute
Helmholtz Center for Polar and Marine Research
Biologische Anstalt Helgoland & Waddensea Station
Hafenstraße 43
25992 List/Sylt
Germany
e-mail: karen.wiltshire@awi.de