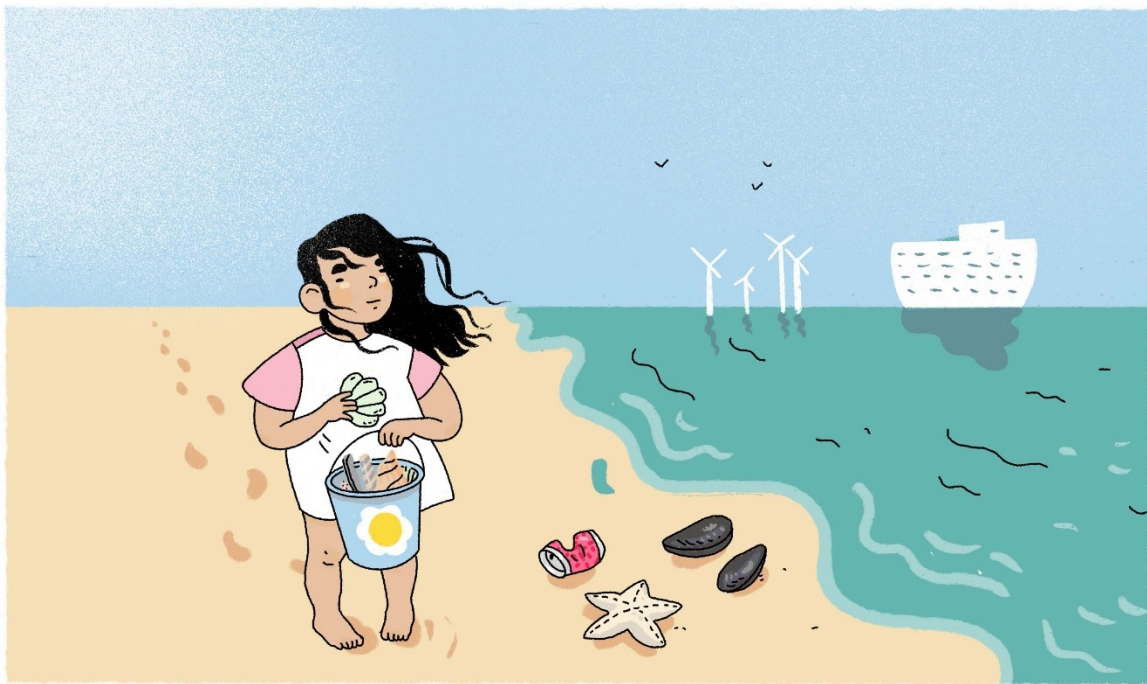


# Health and well-being from the sea: Future trends and possible solutions for Europe

## 1. Introduction

Spending a day at sea is a dear childhood memory for many of us. Being with friends and family, breathing fresh sea air, enjoying the sun... Not only does it feel good, but research has also shown that it is good for your mental and physical health. Furthermore, the sea is an essential source for our daily food and also becomes more and more a resource for the production of new medication. The sea is important for our health in many ways. To preserve our seas and oceans for future generations, they need to be well managed and protected. We need citizens, stakeholders, experts and authorities to achieve this.



Future trends, such as climate change, migration, an ageing population, pollution and technology, will have big impact on societies in Europe. So far, the impacts of these trends have only been studied at a continental or national level, and policy development is often based on such high-level studies.

Promoted by the Ocean Decade and the recent IPCC Ocean report, oceans get more and more attention at the international level. However, the implications of global trends on health at a local level are barely understood so far. Local authorities and citizens need to understand the link between Oceans and Human Health in order to anticipate on the impacts of future trends and take action to keep their citizens healthy and safe.

In this narrative, we describe how Ocean and Human Health issues are currently dealt with at a local level, which trends are already anticipated on and which promising approaches are available to respond to the challenges and opportunities arising. This narrative has been drafted within the

Horizon2020 project Seas, Oceans and Public Health in Europe (SOPHIE)<sup>1</sup>. The project explores the complex interactions between the health of the marine environment and human health.

Uncertainty about future developments and trends is inherently a part of future outlook studies. Currently, Europe and the rest of the world are responding to the novel coronavirus outbreak. The possible consequences of the coronavirus pandemic for future (local) policymaking are beyond the scope of this study. All local workshops and policy document analyses were carried out before January 2020.

## 2. Trends and current issues

The seas and oceans in Europe all have their characteristics and issues, and people living at their coastlines have their own views on what is at stake and what should be improved or protected. Furthermore, global trends like climate change and the increase of tourism, may have different impacts for local communities. To collect information on local perspectives, a participatory approach has been developed to identify challenges at a local level arising from global trends. During interactive workshops with regard to the North Sea, the Baltic Sea, the Atlantic Ocean and the Mediterranean Sea, diverse groups of local stakeholders discussed (1) current priority issues, (2) the relevance and impact of global trends in their local area, and (3) the research gaps that need to be addressed regarding these trends. The results of the workshops have been used as input for a European strategic research agenda on oceans and health.



### Current issues

In the current situation, there are both similarities and differences between the relevant issues for each of the sea basins regarding oceans and health. For instance, both positive and negative views exist regarding the different roles of tourism (tourism as an important economic contributor versus pollution e.g. by cruise ships). Other differences concern economic dependencies on the sea, the

<sup>1</sup> This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 774567.

possibilities of aquaculture, sources of pollution and more specific aspects related to the cultural heritage of the region such as food from the sea. Ageing of the population, with different demands for recreation at sea, increasing use of medicines and the impact on the environment, and concerns regarding the protection of vulnerable ecosystems, were also brought forward during the workshops. Table 1 presents the relevant issues identified during the four stakeholder workshops.

*Table 1 Current situation and issues identified in the four stakeholder workshops.*

Themes*	Atlantic Ocean (San Sebastián)	Baltic Sea (Helsinki)	Mediterranean Sea (Malaga)	North Sea (Eastern Scheldt)
<b>Demography</b>	Population slightly growing, increasing ageing	Population slightly growing, increasing ageing	Ageing population and increasing life expectancy	Local population is shrinking, strong increase in summer due to tourism. This sets pressure on various facilities.
<b>Economy</b>	Relatively high economic growth	High local production, mainly services sector, fishing declining, High digital connectivity, smart city, living lab	BlueMed Initiative: for a healthy, productive and resilient Mediterranean Sea, High unemployment figures after the 2007 economic crisis	Highly valued area with multiple - sometimes conflicting - functions: recreation, shipping, ecology, flood protection, fishery & aquaculture, energy supply.
<b>Fishery and aquaculture</b>	Fishing sector declining, Aquaculture limited due to waves and currents	Living with the sea (peninsular nature), Eating much seafood as part of cultural heritage, No offshore fish farming (severe winter)	Importance of seafood for cultural identity	Strong fishing sector (mussels)
<b>Tourism</b>	Welcome to visitors but avoid mass tourism	Busy harbour for passengers and trade	Cruise ship sector provides employment and economic growth but is also an important source of contamination.	Tourism: beaches nature; water recreation
<b>Ecology</b>		Issues with nutrients in the Baltic Sea		Concerns on increased use of pharmaceuticals
<b>Climate change</b>	Increase of flooding and development of storms and currents	Storm water and flooding strategy needed	Increase of storms with heavy rainfall and flooding, heatwaves and severe droughts	Unprecedented rate of climate change. Increase of flooding and droughts
<b>Ocean and human health interactions</b>				The relationship between water and health is identified, but not yet fully understood.
<b>Policy development</b>		Baltic Sea Action Plan	MPAs (Marine Protection Areas) to protect sensitive species and sustainable use	A long-term vision connecting ocean and human health, is lacking.

\*Not all categories came forward explicitly during each of the stakeholder workshops.

### Future trends

Based on their local knowledge, the participants in the stakeholder workshops identified what trends they consider relevant for their sea basin and local situation (see Table 2). Energy transition, further loss of biodiversity and climate change was brought forward as relevant for (almost) all sea basins. Other trends were only relevant in one or two of the sea basins. This possibly reflects significant differences in relevant issues between the various regional sea basins. Alternatively, the results may be influenced by the backgrounds of the stakeholders participating in the workshops. Different stakeholder groups may, therefore, identify other relevant trends. These results therefore give a first indication of trends of concern in different areas.



### Local impacts of relevant trends

The joint discussion on different trends enabled the identification of cross-sectoral issues, impacts and research gaps. It highlighted the potential to create co-benefits with other sectors, e.g. regarding social inequalities, health and well-being and education. The value was shown of inclusion of elderly in education activities to emphasise the importance of the sea. Ocean fronts in cities can also create a sense of place and pride to citizens.

Some highlights from the discussions on cross-sectoral issues, impacts and co-benefits:

- The recreational use of blue spaces may lead to improved mental and physical health for all, but also requires management of litter, pollution (noise, air, water) and impacts on local infrastructure, risk awareness, the importance of the local heritage for different groups, and the protection of biodiversity (benthic communities) (*Atlantic Ocean, San Sebastián*).
- The impacts of climate change are highly uncertain, yet alterations take place at an unprecedented rate (*North Sea, Eastern Scheldt*).
- The push for marine renewables (energy transition) may have negative impacts on ecology. Further loss of biodiversity might add to the current policy discussions for the Baltic Sea as a 'lost cause' but also serve as an incentive to create co-benefits for ecology. It may result in local extinctions of species, an increase of invasive species, an increase of blue algae and the



weak adaptation of fish etc. and may add to a changing ecosystem and thus have an impact on food webs (*Baltic Sea, Helsinki*).

- Increased flooding and erosion risks at coastal areas may arise due to climate change. The possible effects on the ecosystem may lead to regime changes that cannot be reversed anymore. Loss of biodiversity and other ecological impacts are different across Mediterranean Sea basin (*Mediterranean Sea, Malaga*).



**Table 2** Overview of most relevant trends for oceans and health for different sea basins from the four stakeholder workshops.

Most relevant trends	Short description	Atlantic Ocean (San Sebastián)	Baltic Sea (Helsinki)	Mediterranean Sea (Malaga)	North Sea (Eastern Scheldt)
<b>Towards a circular economy</b>	Substantial development towards a circular economy, with less use of fossil fuels and replacement by renewables. <i>The development of newer, less-harmful chemicals and substances.</i>	X	X		
<b>Energy transition</b>	Development of new energy sources: tidal, wave, blue, solar & wind energy generation	X	X		X
<b>Aquaculture</b>	Increased utilisation of coastal areas for aquaculture; more activities and businesses catering to the increased demand.				X
<b>Healthcare transition</b>	Increasing costs and cost-management of healthcare, as well as alternative methods of financing & management systems.	X			
<b>Changes in income distribution</b>	Income inequality is expected to rise further. <i>Income inequalities can cause health and social problems.</i>	X			
<b>Increasing overweight/obesity</b>	An increasing proportion of people who are either overweight or obese.				X
<b>More recreational use of blue spaces</b>	Recreational use of blue spaces will increase, under influence of tourism and popularity of water-related activities in urban areas.	X		X	
<b>Technology development in industry</b>	Technological improvements in food production systems, fishery technology, waste collection, processing, shipping etc. <i>Furthermore, emission reduction technology as well as new substances being used.</i>		X		X
<b>Further loss of biodiversity</b>	The ecological impacts due to human activities (loss of biodiversity, pollution (plastics, oil, chemical substances), depletion of natural resources) will increase.	X	X	X	X
<b>Climate change</b>	Climate change will further induce weather extremes (storms), higher temperatures, more droughts, more floods and sea-level rise. Coastal erosion. Acidification. Warmer seawater.		X	X	X
<b>Changing institutional and governance structures</b>	Decision-making is changing from government to multi-actor governance, including the involvement of citizens. This trend differs from country to country.		X		

### 3. Looking for future proof solutions

#### **Experiences with Ocean and Human Health in practice: the case of the Eastern Scheldt**

Zooming in on a specific case study area fosters a better understanding of current issues and future challenges. Through a desk study and interviews with representatives of key organisations, we explored in more detail what ocean and human health issues are relevant, how they are currently dealt with and which trends and knowledge gaps are most important in this area.

The Eastern Scheldt is a former estuary in the province of Zeeland in the Netherlands. After a North Sea flood in 1953, it was decided to build a permeable storm surge barrier to close off the Eastern Scheldt during storm periods. In 2002, the entire area was declared a national park including marine waters, mudflats, meadows and shoals. The area supports economic activity through mussel and oyster farming, tourism and recreation. The national park is popular for sailing, fishing, diving, cycling and bird watching and hosts an abundance of sea life.

#### *Current frameworks for managing bathing water and food safety*

The European directives and regulations for bathing water and food safety target the reduction of the exposure of consumers to microbial and chemical contamination through bathing water and shellfish consumption. Both microbial and chemical contamination are managed by regulating maximum concentration levels of specific contaminants and through regular monitoring these threshold levels. When maximum concentration levels are exceeded, further exposure (through bathing or shellfish consumption) is prevented as much as possible. If threshold levels of contamination are violated on a regular basis, measures to improve water quality are required, or the use of the water for bathing or shellfish production should be stopped. Next to strategies for bathing water and food safety, a local jellyfish protocol has been developed, and ocean literacy is enhanced through information campaigns.

Other European directives aim at prevention of harmful substances entering the environment. The REACH directive requires producers to provide information on toxicity for humans and the environment in order to judge whether chemical substances should be allowed to be produced and used. The Urban Waste Water Directive prescribes levels of wastewater treatment needed for different situations. The Habitats Directive, Water Framework Directive and Marine Strategy Framework Directive aim to preserve a good ecological status of coastal and marine waters. The Marine Spatial Planning Directive and the National Environment and Planning Act require local stakeholders to balance interests between economic developments, ecological status and human health and well-being. The European Flood Risk Directive furthermore aims to protect human health against flood risks.

Additionally, there are several national and local initiatives to develop joint overarching visions and strategies that cover all these subjects, including flood risks and climate change effects. In these initiatives, the interests of human health are indirectly represented by the recreation sector and actors representing environmental health, but the health sector is not directly involved.

#### *Stakeholder concerns regarding emerging contaminants*

There are concerns among stakeholders about the growing number of emerging contaminants, including pharmaceuticals, antimicrobial resistant bacteria and micro-plastics. Not only are there too many substances to be monitored but the combined effect of various mixes of contaminants is largely unknown as well. We demonstrated with the use of models how the understanding of land-based sources of contaminants could help to gain information on the concentrations of contaminants in the

Easter Scheldt that are not monitored. This modelling approach ‘from-source-to-sea’ can also help to estimate pollution risk in areas and times without monitoring data.



### The potential of local innovative solutions for ocean and human health

We explored the potential contribution of innovative approaches developed by citizens and local stakeholders, for enhancing ocean and human health. Local initiatives most commonly promote tourism, recreation and well-being while targeting mainly loss of biodiversity and the reduction of plastic pollution. The collection of innovative initiatives is available for inspiration through an interactive map (see Figure 2).

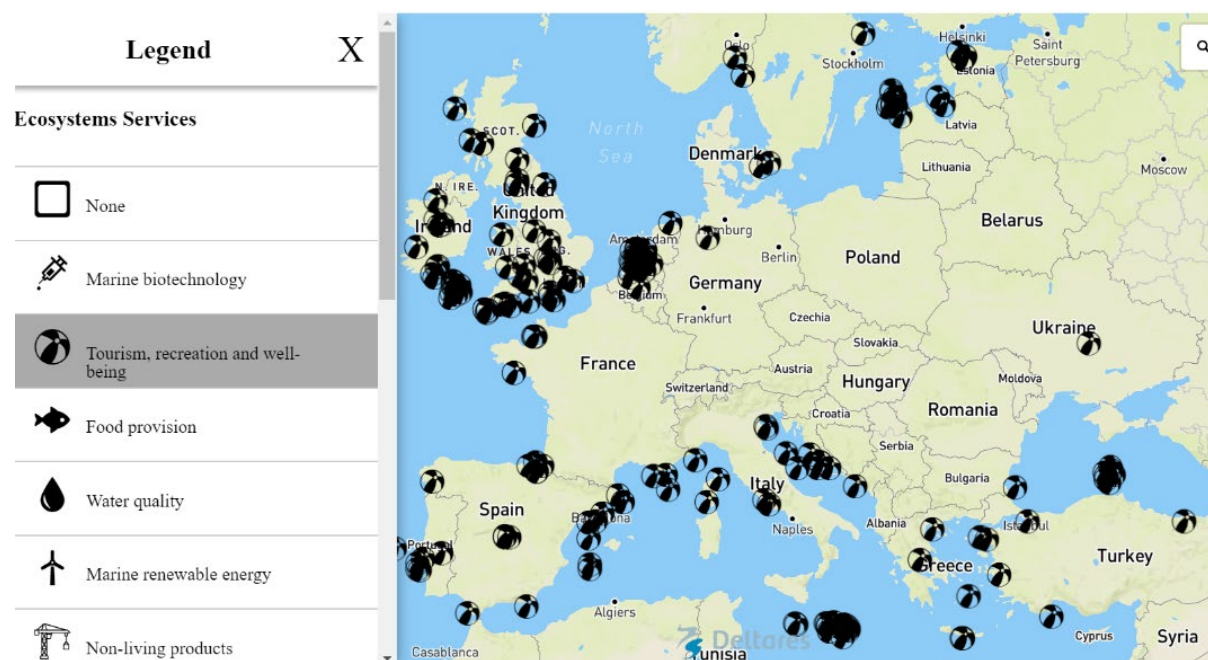


Figure 2- Local innovative solutions for ocean and human health in Europe and South-East Asia: an interactive map ([http://v-web002.deltares.nl/sophie/Initiative\\_map/](http://v-web002.deltares.nl/sophie/Initiative_map/)).

These innovative approaches may complement traditional top-down approaches by governments. Examples include initiatives to reduce plastic pollution, clean-up of beaches and re-use of collected plastics for new products. There are also many citizen science initiatives and initiatives to enhance human health through marine ecotourism and therapies involving exercise at sea. A total of 200 innovative initiatives in Europe and Southeast Asia have been collected covering an extensive range



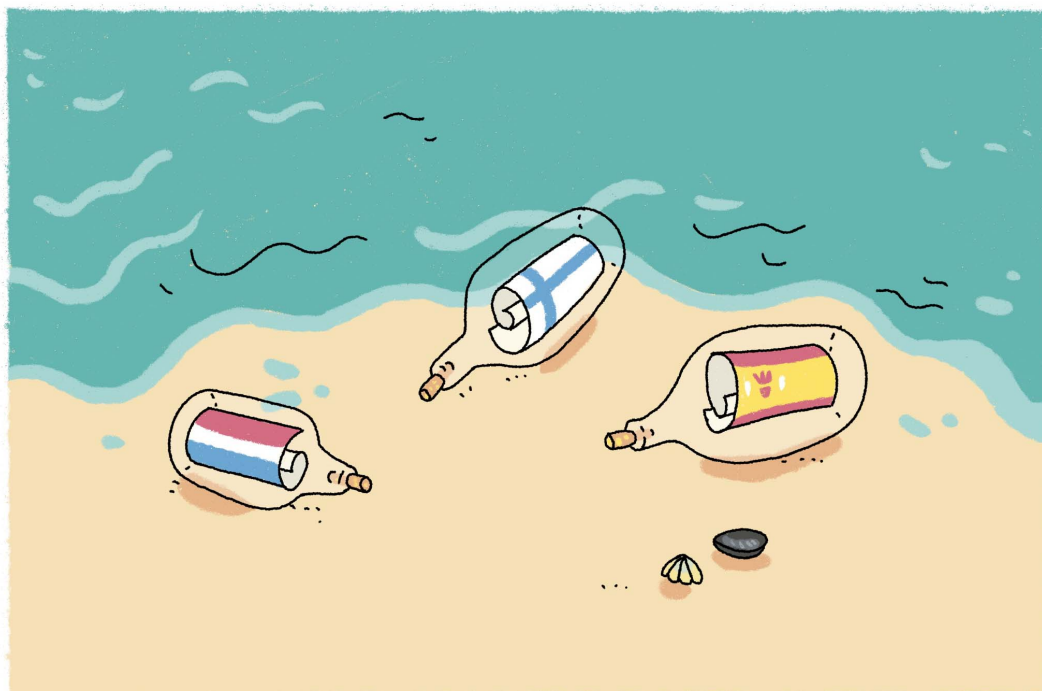
of approaches aiming to address environmental issues and protect and restore ecosystem services. These innovative approaches have a potential to make a significant contribution to enhancing ocean and human health and support adapting to the local impacts of global trends (see Table 2). This is particularly important for issues that are hard to resolve through top-down policy approaches. For example, these initiatives can raise awareness and understanding of citizens and stakeholder groups on the importance of ocean health. And in addition, they support human well-being by promoting recreation near or at sea.

#### 4. Knowledge gaps

What are the risks and benefits of coastal areas on human health and well-being, and how can these risks and benefits be balanced to serve health promotion? In our analysis, several research gaps were identified that should be explored further:

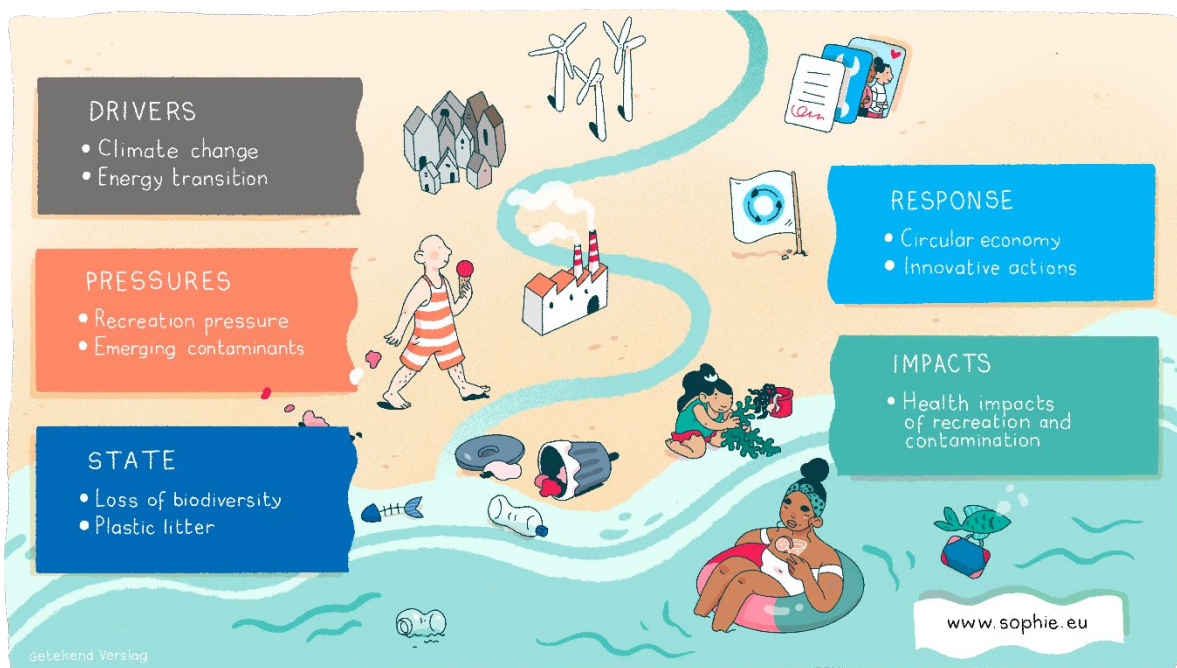
- The role of the local context in the promotion of ocean and health benefits**  
 During our stakeholder workshops, the importance of the local context was highlighted. Some research gaps are relevant for multiple sea basins, such as the introduction of cross-sectoral planning and implementation strategies across institutional levels and geographical scales for ocean and human health and the need for awareness-raising and behavioural change ('cleaner habits', perceptions of risks). Other research gaps have a specific local focus, e.g. the local impact of climate change and pollution on bathing water quality, biodiversity and the marine food web and the sustainable recreation capacity of an geographical area.

Future planning requires the inclusion of the local context in the research design. What are the risks and benefits for local coastal areas regarding human health and well-being? How can these risks and benefits be balanced well and serve health promotion? How can climate adaptation serve both safety, ecosystem preservation and human health?



- Strategies for managing health risks of emerging contaminants more effectively**

To address this knowledge gap, a better understanding of the combined effects of contaminants is needed. This is called 'mixture toxicity effects'. Alternative, integrative approaches need to be developed to assess, reduce and mitigate human and ecological health risks of a wide range of potentially harmful activities, including discharges of pharmaceuticals and micro-plastics to the sea. Novel 'source-to-sea' modelling approaches, innovative monitoring methods and proxies for groups of substances are promising developments to support such integrative approaches. Also, integration across sectors (e.g. production and prescription of pharmaceuticals and their distribution and effects in the environment) and integration between land and sea domains are critical for successful solutions and require further study on how to achieve this.



- Enhancing the impact of citizens' and stakeholders' initiatives on ocean and human health in their environment**

The impact of initiatives by citizens and stakeholders could be further enhanced by creating extensive communities based on local initiatives: internet platforms to connect people; conferences for inspiration and exchange of best practices, tools and experiences. There are already a few networks based on local initiatives that apply a specific approach in different locations. The facilitation of collaboration in networks and sharing best practices could enhance the dissemination and strengthen the impact of local initiatives. The interactive map with collected initiatives during this study can be used as a first step to foster this network and share best practices. The effectiveness of such upscaling approaches is yet to be supported by more scientific evidence.

## 5. Take-home messages

Based on our project results, the following take-home messages are relevant when developing plans for coastal and marine areas. This holds especially for the response to major trends such as climate change, further loss of biodiversity, increasing recreation and the nutrition, health and well-being of increasing human populations.

- **Local context and communities shape opportunities.** Although many trends act at global scales, their local impacts and local values and ambitions can be different between regions. Therefore, solutions need to be developed based on the interests of local stakeholders and communities. This will strengthen the effectiveness of actions to improve ocean and human health.
- **Include health aspects in coastal and marine policy plans.** In general, the importance of the environment to public health is understood but more scientific evidence is required on the impact of design, ecological status and use of marine areas on public health, both on global and local scales.
- **Use an intersectoral and interdisciplinary approach.** Policymaking for healthy humans and oceans involves a wide range of policy issues, from demographic changes to public health, water governance, biodiversity, social inequalities and economic development. An intersectoral approach is needed to realise health benefits. For instance, a joint management of emerging contaminants using a source-to-sea approach can be much more effective than strategies that address individual substances.

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