Human health and EU maritime policy

Closing the loop

Seas, Oceans & Public Health in Europe

Linking oceans and health research

Human health and EU maritime policy
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SOPHIE Project Policy Brief Report

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The SOPHIE project

Seas, Oceans and Public Health in Europe (SOPHIE) is a pan-European project working towards protecting both human health and the health of the marine environment.

Funded by the European Union's Horizon 2020 programme, to help establish a new research capacity for the emerging scientific discipline of Oceans and Human Health, SOPHIE brings together different communities (i.e. marine scientists, medical and social scientists, experts from the public health and other fields) and creates a platform for these communities to work together to understand the complex interactions between the marine environment and human health and wellbeing.

Whilst the ocean can benefit human health and boost wellbeing via activities like recreation and relaxation, it can also pose risks to human health – through factors such as flooding and pollution.

This complex mix of threats and opportunities interact in ways we don't fully understand. As a maritime continent, conducting research in this area is important for Europe, its inhabitants and its ocean.

SOPHIE is addressing this need by gathering information from many different sources: from citizens; from societal stakeholders; from research findings; from data repositories; and from existing European policies. The project is creating a network of people and organisations interested in the links between ocean and human health and exploring how marine tourism and citizen science can contribute to this growing discipline. The ultimate aim of the project is to produce a Strategic Research Agenda – a roadmap which sets out the priorities for Oceans and Human Health research over the coming decade.

The SOPHIE project is being led by the University of Exeter, for more information contact: **sophie2020@exeter.ac.uk** or visit our website: **https://sophie2020.eu/**.

Sign up to the Ocean and Human Health Community Platform **www.sophie2020.eu/activities/community-platform**.

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Executive summary

The relationships between marine environmental health and human health are highly complex and multi-faceted. The integrated metadiscipline of Oceans and Human Health has sought to unravel these complex linkages which encompass both risks and benefits to human health.

With the establishment of the EU Integrated Maritime Policy[1] in 2007, Europe took a significant step forward in terms of integrating its approach to maritime policy. Moving away from the previously disjointed and sectorally-oriented policy framework, the Integrated Maritime Policy recognized that coastal seas and oceans are one system and that pressures and impacts in one location will potentially lead to impacts in other locations. Likewise, human activities in the marine environment impact on each other and on marine ecosystems in ways that may cause conflict and lead to marine environmental degradation.

While we have legislated widely to regulate the impacts of human activities on the marine environment, and devised mechanisms to monitor and measure these impacts, we have not fully considered, in turn, the impacts of the marine environment (and marine environmental degradation) on human health. From a policy perspective, Oceans and Human Health seeks to deliver new knowledge and understanding that can help us to close this loop.

A high level of health protection should be ensured in the definition and implementation of all EU policies and activities, according to the Amsterdam Treaty. The 'Health in All Policies' approach is a horizontal cross-policy approach to strengthen the links between health and other policies.

The EU's Integrated Maritime Policy should facilitate blue growth in a sustainable way that protects ecosystem health and, by default, that of the human component of the ecosystem. However, if the human health element is to be more fully considered within a maritime context, then we need to be able to identify Ocean and Human Health interactions that can be measured and monitored in a meaningful way.

This report examines a number of legislative instruments and strategies linked to the EU Integrated Maritime Policy. Taking account of the Health in All Policies goal, consideration is given to what extent, if any, key EU maritime policies or actions, can or should encompass a focus on human health. The following recommendations are made on mechanisms and tools that can be used to achieve co-beneficial outcomes for marine environmental health and human health.

- Promote and support the development of a 'health in all policies' (HiAP) approach in marine and maritime policies and their implementation.
- Embed the marine environmental component in the study and practice of environment and health.
- Design and implement dedicated Oceans and Human Health management tools and actions.
- Optimise existing data streams to support evidence-based management. Build an integrated architecture for health data in Europe as has been achieved for marine data.
- Increase the support for Oceans and Human Health in research, sectoral and regional cooperation programmes.

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[1] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52007DC0575&from=EN

2

Introduction

The relationships between marine environmental health and human health are highly complex and multi-faceted. The integrated metadiscipline of Oceans and Human Health has sought to unravel these complex linkages which encompass both risks and benefits to human health. However, considerable knowledge gaps remain, which limit our capacity to put in place effective policies and management actions to reduce the burden of disease and optimize opportunities for health promotion[2].

With the establishment of the EU Integrated Maritime Policy[3] in 2007, Europe took a significant step forward in terms of integrating its approach to maritime policy. Moving away from the previously disjointed and sectorally-oriented policy framework, the Integrated Maritime Policy recognized that coastal seas and oceans are one system and that pressures and impacts in one location will potentially lead to impacts in other locations. Likewise, human activities in the marine environment impact on each other and on marine ecosystems in ways that may cause conflict and lead to marine environmental degradation.

Since 2008, the EU has made substantial progress by establishing specific instruments, implementing actions and strategies, including the Marine Strategy Framework Directive[4] (marine environment), Marine Knowledge 2020[5] (marine data), the Maritime Spatial Planning Directive[6] (spatial planning), and the Blue Growth Strategy[7] (economy). Some of these strategies and legislative instruments make reference to human health. However, while we have legislated widely to regulate the impacts of human activities on the marine environment, and devised mechanisms to monitor and measure these impacts, we have not fully considered, in turn, the impacts of the marine environment (and marine environmental degradation) on human health. From a policy perspective, Oceans and Human Health seeks to deliver new knowledge and understanding that can help us to close this loop.

This report examines where Oceans and Human Health sits in the policy landscape in Europe. It is not designed to provide an exhaustive analysis of EU policy in this area, which is exceptionally complex. An inventory compiled during the SOPHIE project, details some policy, strategy and legislative instruments that could be relevant in an Oceans and Human Health context, and highlights the complexity of this area. This report focuses on a selection of these instruments that have arisen from the 2007 Integrated Maritime Policy and identifies their relevance to human health and wellbeing. It identifies the challenges and opportunities associated with developing a fully integrated policy approach that takes account of Ocean and Human Health interactions. Finally, some critical knowledge gaps are identified that, if addressed, can help to underpin progress towards fully integrated ocean and human health policies. Specifically, this report:

- Highlights the limited consideration of human health within marine policies and the potential opportunities to address this.
- Aims to raise the profile of the marine component of the environment in the already well established field of environment and human health.
- Advises that an ecosystem based approach to management, with recognition of the human component as part of the ecosystem, should, if fully implemented, naturally support healthier environments and healthier populations.
- Highlights the deficit of any generalised indicators linking the marine environment to human health, thereby inhibiting the establishment of long-term surveillance opportunities.
- Makes recommendations for co-beneficial actions that align protection of marine environmental health with the protection and promotion of human health.

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[2] European Marine Board (2013). Linking Oceans and Human Health: A Strategic Research Priority for Europe. Position paper 19 of the European Marine Board, Ostend, Belgium.
[3] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52007DC0575&from=EN
[4] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0056
[5] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52010DC0461
[6] https://www.eea.europa.eu/policy-documents/directive-2014–89-eu-maritime
[7] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52012DC0494

This report, which will form the basis for a SOPHIE Policy Brief, is primarily intended for EU and national policy makers and practitioners in the fields of environment, marine, human and public health. It is also targeted at research funders at EU and national level as several critical knowledge gaps are identified that require a research response. Finally, it should be of interest to the growing Oceans and Human Health community in Europe, and the broad spectrum of SOPHIE project stakeholders.
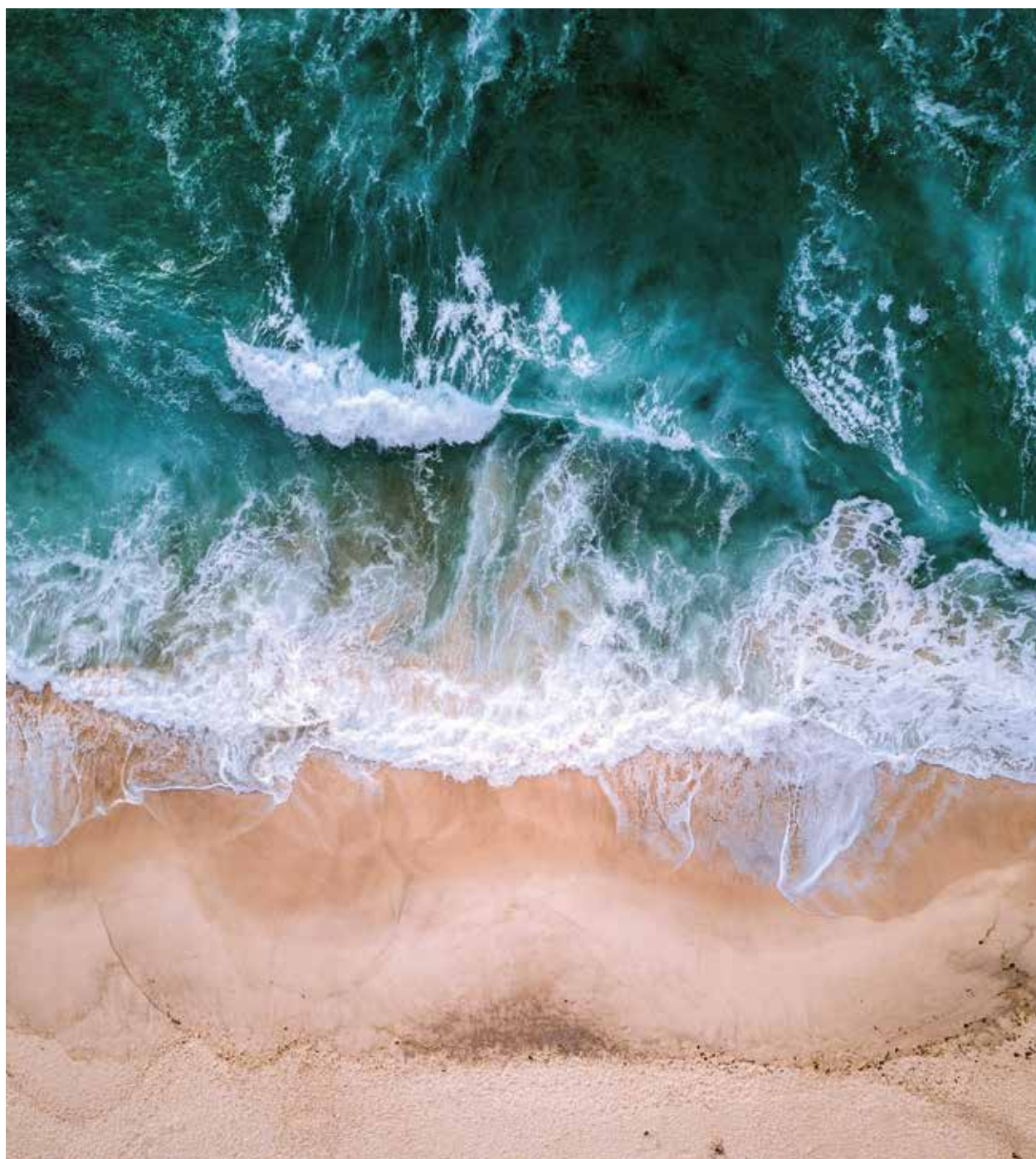
2.1   Environment and health

Oceans and Human Health is a subset of the broader field of Environment and Health. The World Health Organisation (WHO) defined Environment and Health in 1993 as comprising *'those aspects of human health, including quality of life, that are determined by physical, chemical, biological, social, and psycho-social factors in the environment. Environmental health issues transcend national boundaries, and thus are global concerns.'* In terms of outcomes, Environment and Health is targeted towards preventing disease and creating health-supportive environments. According to the WHO Regional Office for Europe, Environment and Health includes both the direct pathological effects of chemicals, radiation and some biological agents, and the effects (often indirect) on health and wellbeing of the broad physical, psychological, social and cultural environment (Novice, 1999). The importance of environmental factors as determinants of health cannot be underestimated. The WHO has estimated that, globally, 12.6 million deaths are caused annually by environmental determinants, equating to 25% of all deaths (the equivalent figure for Europe is 20%)[9].

A comprehensive surveillance system and a robust policy framework is in place at global and European level to reduce and manage environmental threats to human health. In addition to dealing with the established threats to health posed by air pollution, noise pollution and exposure to hazardous chemicals and biological pathogens, the health impacts of climate change and loss of biodiversity are gaining prominence as priority issues for action. The WHO has been coordinating its Environment and Health Process since the 1980s, with Ministerial conferences being held approximately every five years since 1989 to evaluate and guide European policies and actions on human health. The 2017 Ostrava Declaration[10] places the need for further cooperation and coordination in Environment and Health firmly in the context of the UN 2020 Agenda for Sustainable Development and the Paris Climate Agreement. Meanwhile a broad range of EU policies address specific Environment and Health challenges including the Clean Air Policy Package for Europe[11], the Environmental Noise Directive[12], and the regulation of chemicals under the REACH Directive[13].

While Environment and Health addresses the quality of drinking and bathing water, by and large its application is restricted to the built environment and natural terrestrial and atmospheric environments including inland waters and groundwater. The role and relationship between the marine environment (coastal waters, seas and oceans) has not generally been addressed by Environment and Health. Yet, there are, unquestionably, health risks and benefits arising from human interactions with aquatic environments, including the marine environment (Bowen *et al.*, 2014; European Marine Board, 2013). It has been estimated, for example, that 250 million cases of gastroenteritis occur worldwide each year, and 50,000–100,000 people die annually from infectious hepatitis as a result of bathing in contaminated water. The overall global burden of human disease caused by microbial sewage pollution alone of coastal waters has been estimated at 4 million lost person-years annually – translated into an economic loss of approximately USD$ 16 billion per year (Van De Guchte, 2014; Depledge, 2013).

While the evidence base remains limited, there is a clear need to understand and manage better the implications for human and public health of our interactions with the marine environment. The implications for public health of climate change are unavoidable and already being encountered at different levels in different parts of the world. The recent IPCC Special Report on Oceans, Cryosphere and Climate Change reaffirmed earlier projections that sea-level rise is on track to rise by between 0.5m and 1m by the end of this century (IPCC, 2019). Residents of low-lying coastal cities and small island developing states are increasingly vulnerable to sea-level rise, coastal flooding and extreme weather. So any discussion on the importance of the link between climate change and human health must take account of the critical role of the ocean as a buffer of climate change (through carbon sequestration from the atmosphere) and also the impacts of climate change on the ocean itself. In addition, the importance of the marine environment towards mitigating climate change, providing resources that could support sustainable supplies of food and energy to a growing human population and in providing a health-promoting environment are increasingly recognised.

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[9] https://apps.who.int/iris/bitstream/handle/10665/204585/9789241565196_eng.pdf;jsessionid=465C7FF4B2E525EC2D26538915BA668C?sequence=1
[10] http://www.euro.who.int/__data/assets/pdf_file/0007/341944/OstravaDeclaration_SIGNED.pdf?ua=1
[11] https://ec.europa.eu/environment/air/clean_air/index.htm
[12] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32002L0049
[13] https://ec.europa.eu/environment/chemicals/reach/reach_en.htm

2.2 What is Oceans and Human Health?

There is increasing evidence that human health and wellbeing are linked to, and impacted by, the seas and oceans that cover 70% of the earth's surface. The impacts of human activities on the marine environment have increased substantially over the last half century. Human actions including greenhouse gas emissions, pollution and overfishing have led to warming ocean temperatures, ocean acidification and deoxygenation, degraded marine ecosystems and loss of biodiversity. Damage to marine and coastal environments has the potential to significantly influence our future health and wellbeing and even our very survival. While the risks to health are considerable and serious, there are also multiple potential benefits to human interactions with marine or 'blue' environments. The benefits to both physical and mental health of time spent in coastal settings has been documented for centuries (Depledge *et al.*, 2019; Bowen *et al.*, 2014; White *et al.*, 2013; Wheeler *et al.*, 2012). This complex, circular relationship (Figure 1) between the state of our marine environment, our health and our activities is the basis of a growing scientific meta-discipline called Oceans and Human Health (Sandifer *et al.*, 2013).

The range of interconnections between the ocean and human health is broad and multi-faceted, encompassing both risks and benefits (see Figure 2 from Fleming *et al.,* 2014). Evaluation and management of the health of marine ecosystems and human health are largely the preserve of entirely different disciplines with little interaction (European Marine Board, 2013). This leads to critical knowledge gaps that inhibit the potential for effective policies with co-beneficial outcomes for both marine environmental health and human health. To address the complex interactions of humans and the oceans, Oceans and Human Health has emerged as a truly interdisciplinary and integrated meta-discipline. Oceans and Human Health brings together traditional marine scientific disciplines such as physical and biological oceanography, marine biology and marine chemistry with the disciplines of public health, medicine, psychology, geography, economics and sociology, as well as law, humanities, business, and the arts (Fleming *et al.*, 2015). A key additional feature of Oceans and Human Health is the engagement of diverse stakeholder communities (including fishers, recreational users, private enterprise and policy makers), ensuring co-design and impact of research actions.
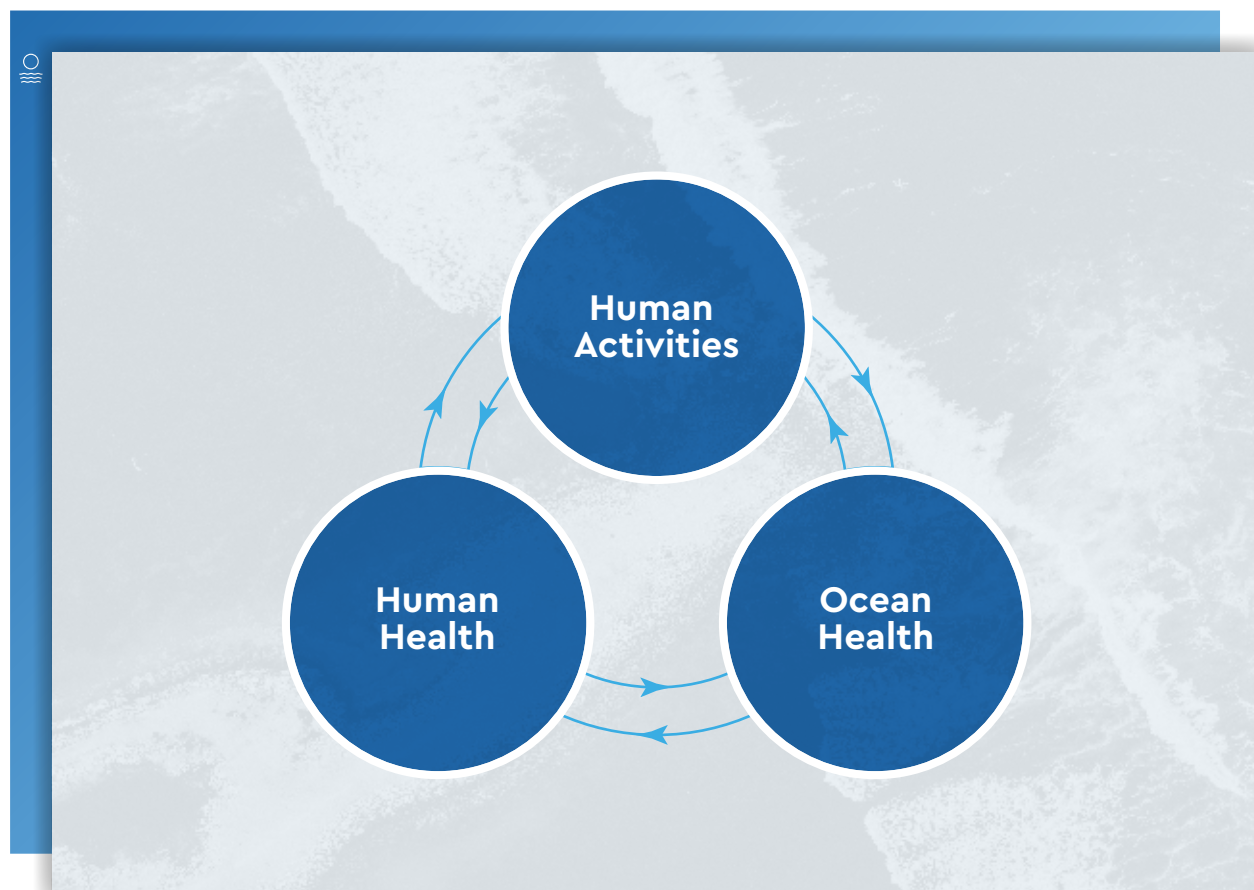

Figure 1 The circular relationship between human health, human activities in the marine environment and ocean health
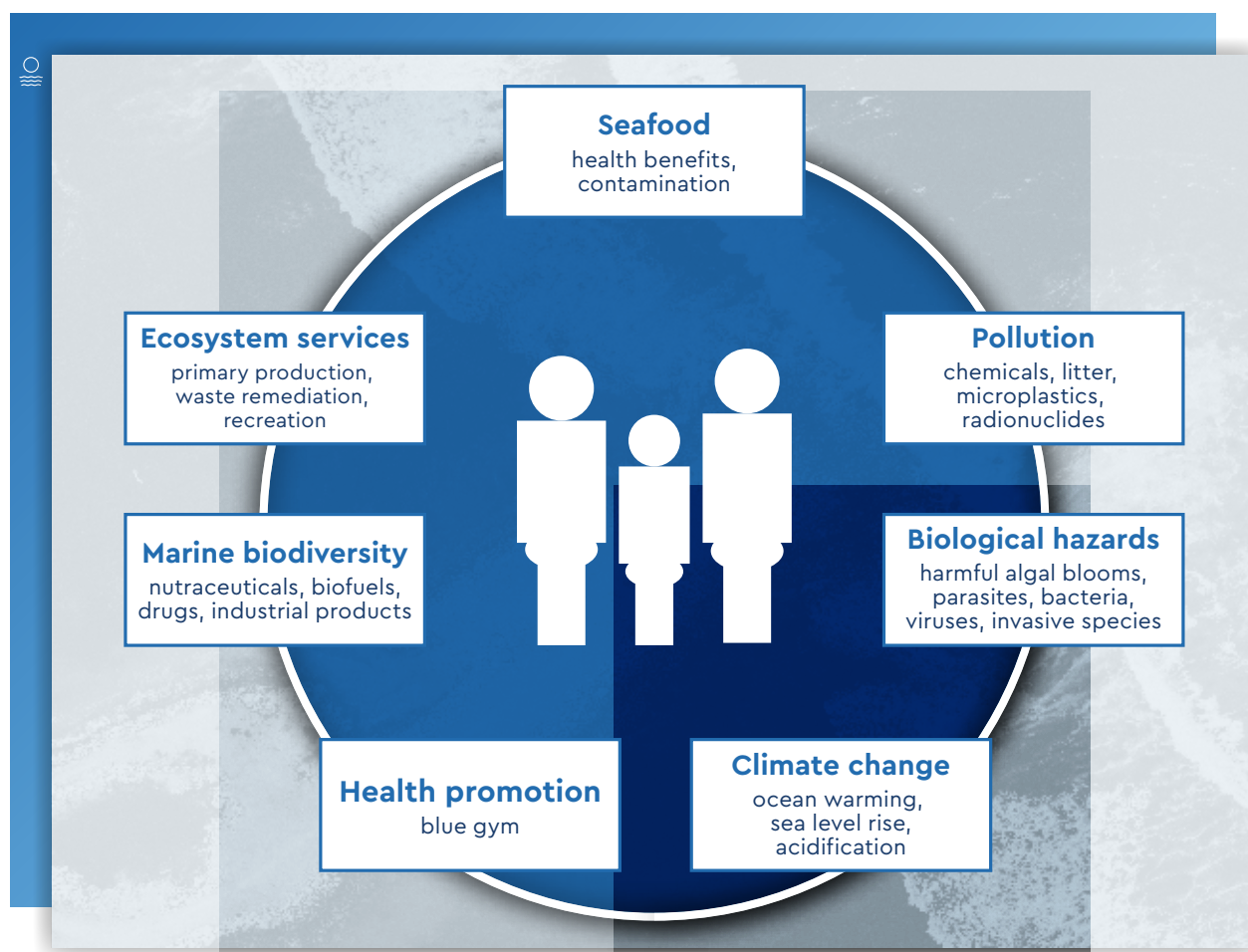
Figure 2 Key benefits (left) and risks (right) for human health and wellbeing from the marine environment (from Fleming *et al.*, 2014).

Conceptually, it is not difficult to understand the rationale for promoting integrated and interdisciplinary research as key to addressing complex ocean-human health interactions. However, translating such knowledge into real-life policy and management practices is much more challenging. So just how and why should marine environmental policy take account of human health and wellbeing? Perhaps a good – if rather unexpected – place to start, is the treaty which founded to the modern-day European Union: The Maastricht Treaty.

2.3 Integrating health in all policies

The Treaty on European Union[14] (Maastricht Treaty, 1992) lists *'the attainment of a high level of health protection'* as one of the common policies or activities that the Community should implement in order to achieve its aims. Article 129 (Public Health)

further details that the Community should contribute towards achieving this high level of public health through cooperation between Member States and by supporting Member State actions, if necessary. It further notes that, *'Health protection requirements shall form a constituent part of the Community's other policies'* and that also *'the Community and the Member States shall foster cooperation with third countries and the competent international organizations in the sphere of public health.'*

The Treaty of Amsterdam (1997) goes a step further requiring that *'A high level of human health protection shall be ensured in the definition and implementation of all the Union's policies and activities'* (Article 152 Public Health).

This legal obligation provided the rationale for the concept of Health in All Policies (HiAP) and was the main health theme of the Finnish European Union (EU) presidency in 2006. HiAP was proposed as *'a horizontal cross-policy approach to strengthen the*

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[14] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM%3Axy0026

links between health and other policies' (Ståhl *et al.*, 2006). The strategy recognises that health is also influenced by factors that fall outside of the health sector and thus other sectoral policies can influence health outcomes. It recognised further there was significant potential to improve human health by considering the impacts on determinants of human health during the planning and implementation of other policies. Crucially, it also notes that health in turn can have implications for the policy goals and outcomes of other sectoral policies (Ståhl *et al.*, 2006).

In the EU, Member States maintain primary responsibility for health, for defining their health policy and for the organisation and delivery of health services and medical care. The role of the EU being to complement national policies for the protection and improvement of human health (Treaty on the Functioning of the EU)[15] through ensuring that all policies protect and promote human health. The EU can adopt health legislation and has done so in certain areas, such as directives and regulations on pharmaceuticals and tobacco, amongst others[16]. The EU can also address recommendations on public health to EU member states, such as for example the Council Recommendation on smoke free environments[17].

Whilst the EU's role in health is limited, it has an important role to play in promoting cooperation and supporting Member State health systems to operate more effectively, such as through the following priority actions identified for the period 2016–2020[18]:

- Achieving greater cost-effectiveness;
- Competitiveness together with safety;
- Tackling emerging global threats such as antimicrobial resistance;
- Evidence-based policy making;
- Addressing the risk factors of non-communicable diseases;
- Promoting vaccination.

Beyond Europe, DG SANTE (the European Commission's Directorate for Health and Food Safety) works with stakeholders such as the WHO and OECD (Organisation for Economic Co-operation and Development)[19] to promote EU values and standards globally. The EU's integrated and cooperative approach to health, together with its influence on other non-EU European countries, was highlighted as playing an important role for the implementation of Health 2020[20], a European policy framework to support action across government and society for health and wellbeing.

The EC key priorities for multilateral cooperation in health are Anti-Microbial Resistance (AMR), health security, tobacco control and pharmaceuticals. Currently DG SANTE is working with the OECD and the European Observatory on Health Systems and Policies on the *'State of the Health in the EU'*, a continuous two-year cycle initiative[21] to compile and make available data on health and health systems in EU countries, providing country profiles and *'at a glance'* EU health information.

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[15] https://eur-lex.europa.eu/resource.html?uri=cellar:41f89a28–1fc6–4c92-b1c8–03327d1b1ecc.0007.02/DOC_1&format=PDF
[16] DIRECTIVE 2001/83/EC on medicinal products for human use, Directive 2001/83/EC, Regulation on procedures for the authorization and supervision of medicinal products and establishing a European Medicines Agency Regulation (EC) No 726/2004 , Tobacco Products Directive DIRECTIVE 2014/40/EU
[17] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32009H1205(01)
[18] https://ec.europa.eu/info/sites/info/files/strategic-plan-2016–2020-dg-sante_en_0.pdf
[19] https://www.oecd.org/ https://www.oecd.org/
[20] Health 2020 A European policy framework and strategy for the 21st century, WHO Regional Office for Europe © World Health Organization 2013 http://www.euro.who.int/en/publications/abstracts/health-2020.-a-european-policy-framework-and-strategy-for-the-21st-century-2013
[21] https://ec.europa.eu/health/state/summary_en

2.4 Scope of this report

In 2014, the European Marine Board and the European Centre for Environment and Human Health (University of Exeter, UK) organised a joint workshop on Oceans and Human Health (OHH). Following this, the EMB issued a 'Message From Bedruthan'[22] to capture and highlight the workshop's key recommendations towards achieving a more 'coordinated, transnational and interdisciplinary Oceans and Human Health research programme in Europe'. One of the recommendations was the following:

'Goal 5 - Policy Assessment and Support: Analyse the current EU policy framework, identifying policy gaps and making recommendations in support of evidence-based policy which takes account of marine environment and human health interactions.'

Policies are powerful tools, if used in the right way and for the right goals. Over the last 12 years, the EU has established a robust and integrated marine/ maritime policy framework, ensuring coherent and coordinated Member State action to sustainably protect, monitor and conserve the marine environment, ideally in cross-border cooperation with neighbouring Member States and third countries (reaching sea-basin level). There is no question that enormous progress has been made in the last decade towards a more integrated maritime policy framework in the EU. However, human health and wellbeing are not yet well integrated into maritime policy.

This report examines a number of legislative instruments and strategies linked to the EU Integrated Maritime Policy. Taking account of the Health in All Policies goal, consideration is given to what extent, if any, key EU maritime policies or actions, can or should encompass a focus on human health. Recommendations are made on mechanisms and tools that can be used to achieve co-beneficial outcomes for marine environmental health and human health.

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[22] http://www.marineboard.eu/publication/message-bedruthan

3
EU maritime policy and human health

Surrounded by four seas and two ocean basins; and with a coastline measuring 70,000km (EU coastal states only), Europe is truly a maritime continent. Europe's total population is estimated to be *circa* 747.3m people[23], of which about 513.5m are living in the EU. Almost 45% of the EU population (i.e. 214 million people) live in coastal regions (EU Blue Economy Report 2019)[24]. The EU Blue Economy Report (2019) estimates that in 2018 the established sectors of the EU Blue Economy directly employed over 4 million people, generated €658 billion of turnover and €180 billion of gross value added in 2017.

Until relatively recently, EU policies related to the conservation and use of Europe's seas and oceans were disconnected and sectorally-driven. That changed when the EU launched its Integrated Maritime Policy (IMP) in October 2007[25]. The IMP was not designed to replace existing policies, rather to introduce a much greater level of coherence and coordination between different areas of maritime policy. It focuses, in particular, on issues that affect multiple maritime sectors and require coordination across diverse maritime actors or stakeholders. Although broader in focus, the IMP has followed five specific areas of action:

• Blue Growth;
• Marine Data and Knowledge;
• Maritime Spatial Planning;
• Maritime Surveillance;
• Sea Basin Strategies.

Since the launch of the IMP, the Commission has advanced progress in the above areas with a range of strategic actions and legislative instruments

including the Blue Growth Strategy (2012), the Marine Knowledge 2020 Strategy (2012), and the Maritime Spatial Planning Directive (2014), all of which are addressed in more detail below. Maritime surveillance has led to the establishment of the Common Information Sharing Environment (Maritime CISE)[26] and there are now regional strategies in place for the Baltic Sea, the North Sea, the European Arctic Ocean, the Atlantic, the Ionian and Adriatic Seas and the Black Sea.

So does the Integrated Maritime Policy take a Health in all Policies approach? The opening paragraph of the Integrated Maritime Policy or 'Blue Book' which was adopted in 2007 states the following:

'The seas are Europe's lifeblood. Europe's maritime spaces and its coasts are central to its wellbeing and prosperity – they are Europe's trade routes, climate regulator, sources of food, energy and resources, and a favoured site for its citizens' residence and recreation.'

Reading this statement it is easy to imagine that human health and wellbeing is a central consideration of the IMP. However, the IMP is primarily focused on supporting the development of Europe's maritime economy, with an emphasis on regional or sea basin scale cooperation. Other priorities do feature, such as marine environmental health and security, but human health and wellbeing are not of primary concern. Below, we examine in a little more detail three flagship maritime strategies and legal instruments that have either emerged directly from the IMP process (MSP and Blue Growth), or are linked (MSFD). The data component (Marine Knowledge) is addressed in Section 4.

[23] https://www.worldometers.info/world-population/europe-population/
[24] https://op.europa.eu/en/publication-detail/-/publication/676bbd4a-7dd9-11e9-9f05-01aa75ed71a1/language-en/
[25] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52007DC0575
[26] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2014:0451:FIN

3.1 The Marine Strategy Framework Directive

The EU Marine Strategy Framework Directive (MSFD) [Directive 2008/56/EC][27], came into force on 17 June 2008. While it is not one of the specific actions of the Integrated Maritime Policy, and its implementation is the responsibility of DG Environment, it has long been considered the environmental pillar of the IMP. The primary goal of the MSFD is for Member States to work, through a common legislative framework, to achieve Good Environmental Status (GES) of their marine waters by 2020. GES is described in the Directive as:

'The environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive within their intrinsic conditions, and the use of the marine environment is at a level that is sustainable, thus safeguarding the potential for uses and activities by current and future generations'.

The MSFD is the first comprehensive piece of European legislation aimed at protection of the marine environment and the marine resources upon which human economic and social activities depend. Since its introduction Member States have been required to follow five key steps leading to implementation: initial assessment of their marine waters; determination of good environmental status of their marine waters; setting of environmental targets; establishment and implementation of monitoring programmes; and identification of measures of actions to achieve or maintain GES. The Ecosystem Approach to Management of human activities is integral to the MSFD, recognising that humans benefit from marine ecosystem goods and services and that social and biological systems are highly interconnected.

It is important to note that when the MSFD was first introduced in 2008, a substantial amount of legislation and regulation related to marine environmental protection was already in place at EU and Member State level. Member States were already actively implementing Habitats[28], and Birds[29], Directives, the Common Fisheries Policy[30], the Bathing Waters Directive[31] the Shellfish Waters Directive[32], the Water Framework Directive[33], to name but a few. However, the MSFD required that Member States achieve a much greater coordination in the implementation of existing nature, water and fisheries legislation and introduce new measures where gaps existed. The European Commission estimates that approximately 25% of the measures being implemented at Member State level under the MSFD are additional to measures that are required or were already in place under other EU legislative instruments.

The MSFD sets out 11 qualitative descriptors of Good Environmental Status that represent key elements of marine environmental health including, for example, biodiversity, marine litter and contaminants. The Descriptors effectively detail in very general terms what GES will look like. To enable Member States to determine the good environmental status of their waters and to guide their assessment of that status, the Commission established a set of detailed criteria and methodological standards through Commission Decision 2010/477/EU (2). These were revised and updated in 2017 through Commission Decision 2017/848/EU.

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[27] https://eur-lex.europa.eu/eli/dir/2008/56/oj
[28] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31992L0043
[29] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0147
[30] https://ec.europa.eu/fisheries/cfp_en
[31] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32006L0007
[32] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM%3Al28177
[33] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM%3Al28177

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3.1.1 How is the MSFD linked to human health and wellbeing?

The MSFD is specifically focused on protecting and restoring Europe's marine environment and resources. Good Environmental status as defined by the directive pertains to characteristics that reflect the health of the marine environment. The relevance of MSFD to human health is explicitly referenced in the original Directive. Article 1 (General Provisions) states that Member States will be required to put in place marine strategies that:

(a) protect and preserve the marine environment, prevent its deterioration or, where practicable, restore marine ecosystems in areas where they have been adversely affected;

*(b) prevent and reduce inputs in the marine environment, with a view to phasing out pollution as defined in Article 3(8), so as to ensure that there are no significant impacts on or risks to marine biodiversity, marine ecosystems, **human health** or legitimate uses of the sea.*

Of note, therefore, is that human health is referenced as a key factor and there is a clear recognition in this text of the link between human health and wellbeing and healthy marine environment (in particular with respect to alleviating anthropogenic pollution).

The term 'human health' appears twice in the original text of the Directive and in both cases it refers to the direct implications of pollution of the marine environment to human health. Hence, while the MSFD does recognise a connection between marine environmental health and human health, this is restricted to the narrow interpretation of this relationship related only to the effects of marine pollution. However, even a cursory analysis of the 11 descriptors of good environmental status reveals multiple and complex interconnections between GES and human health (Table 1). Depending on the descriptor, these interconnections are either indirect (e.g. biodiversity) or direct (e.g. contaminants in seafood).

A key question arises: how can the measures applied to implementation of MSFD, an instrument dedicated to achieving a healthy marine environment, be extended to deliver tangible and measurable benefits to human health and wellbeing? The concept of marine ecosystem goods and services may provide at least part of the answer. Marine ecosystem services are the services provided by the processes,

Table 1 The 11 qualitative descriptors of the Marine Strategy Framework Directive and their direct and indirect connections to human health and wellbeing

Descriptor N°.	Topic	MSFD characteristics of Good Environmental Status	Relevance or connection to Human Health and Wellbeing
1	Biological Diversity	Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.	Linked to ecosystem resilience and provision of ecosystem goods, benefits and services critical to human health (e.g. climate regulation, food provision, waste bioremediation, cultural and recreational benefits).
2	Non-indigenous Species	Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems.	Threat of non-indigenous species to displacement of indigenous species and to ecosystem functioning affecting ecosystem goods, benefits and services critical to human health.
3	Commercial Fish and Shellfish	Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.	Critical for provision of food and feed for human and animal consumption; provision, through human consumption of seafood, of nutrients of importance for human health; support for jobs and economic prosperity in peripheral coastal regions.
4	Food Webs	All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.	Linked to ecosystem resilience and provision of ecosystem goods, benefits and services critical to human health (e.g. climate regulation, food provision, waste bioremediation, cultural and recreational benefits).
5	Eutro-phication	Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.	Deleterious effects on marine ecosystem health and areas affected which compromises provision of marine ecosystem benefits, goods and services. Direct impacts on human health through consumption of seafood (primarily filter-feeding shellfish) contaminated with toxins harmful to human health (e.g. paralytic, neurotoxic and diarrhoeic shellfish poisoning). Socio-economic impacts also potentially affect human health and wellbeing.
6	Sea-floor Integrity	Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.	Linked to ecosystem functioning and provision of ecosystem goods, benefits and services critical to human health.
7	Hydro-graphical Conditions	Permanent alteration of hydro-graphical conditions does not adversely affect marine ecosystems.	Linked to ecosystem functioning and provision of ecosystem goods, benefits and services critical to human health.
8	Contaminants	Concentrations of contaminants are at levels not giving rise to pollution effects.	Direct human health impacts arising from exposure to chemical and biological contaminants in the marine environment (bathing).Indirect impacts on marine environmental benefits, goods and services linked to effects of contaminants on marine life
9	Contaminants in Seafood	Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards.	Direct impacts to human health and wellbeing of consuming seafood contaminated with toxins (biological in nature) or toxicants (chemical or physical in nature).
10	Marine Litter	Properties and quantities of marine litter do not cause harm to the coastal and marine environment.	Marine and coastal environmental degradation caused by marine litter (e.g. plastics) adversely affects 'cultural ecosystem services' linked to human wellbeing (recreation, tourism, beauty, spiritual etc.) and impacts on economic development and jobs (marine and coastal tourism).
11	Energy (incl. Underwater Noise)	Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.	Linked to ecosystem functioning and provision of ecosystem goods, benefits and services critical to human health.

functions and structure of the marine environment that directly or indirectly contribute to societal welfare, health and economic activities. (Norton, *et al.,* 2018). Marine ecosystem services represent a common thread connecting all MSFD descriptors and human wellbeing, with each descriptor either underpinning or contributing to the provision of ecosystem benefits, goods and services.

Quantitative metrics such as monetary value or health value can be used to value ecosystem goods and benefits, whereas qualitative, non-monetary approaches will usually have some consideration of health, socio-cultural or conservation value (Legat *et al.,* 2016). There has been a substantial amount of research and policy guidance around the development of valuation frameworks for ecosystem services and benefits. However, until a common framework is in place, the value of ecosystem services will continue to be externalised in decision-making regarding human activities in the marine environment.

Key questions include:

- How can MSFD, as currently applied, better link to human health across the 11 descriptors of Good Environmental Status?
- Can a suite of indicators be developed that link marine environmental health and human health?
- Can programmes of measures as applied at Member State level include a subset of measures designed to take account of human health impacts?

3.2   The Blue Growth Strategy

The EU Blue Growth Strategy[34] is a long-term strategy to support sustainable growth in the maritime economy. Recognising the potential of Europe's seas and coasts as drivers of economic growth, the Strategy was adopted in 2012 as Europe was still in the early stages of recovery from the 2008 financial crisis. As the maritime component of the Europe 2020 Strategy for smart, sustainable and inclusive growth, the Blue Growth Strategy was proposed to 'offer new and innovative ways to help steer the EU out of its current economic crisis.'

The Blue Growth strategy, with its focus on converting marine resource potential into jobs and economic growth, could be seen as primarily an economically-motivated policy response. However, it also clearly called for the sustainable use of marine resources and recognised the importance of safeguarding the marine environment and its biodiversity to maintain the provision of essential ecosystem services. The obligatory reporting by Member States under the MSFD would provide a means of monitoring how compatible Blue Growth is with marine environmental protection goals. In this respect it is worth noting also that the Blue Growth Strategy originally emerged from the wider concept of Green Growth, defined by the OECD as follows:

'Green growth means fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our wellbeing relies.'

While recognising that the blue economy encompassed many diverse sectors, the Blue Growth Strategy initially focused on five sectoral areas or 'value chains' that had the potential to deliver sustainable jobs and growth, and which could benefit from targeted policy intervention. These were chosen based on their job-creation potential as well as the potential for research and development to deliver technological improvements and innovation together with the need for action at EU level. The five priority areas identified were: marine renewable energy, aquaculture, marine and coastal tourism, blue biotechnology and marine mineral resources.

The Blue Growth strategy also recognised regional differences, and that blue growth opportunities and challenges faced by Atlantic sea basin stakeholders were very different from those in the Baltic sea region. Dedicated 'sea-basin strategies'[35] were established to foster regional cooperation, including with third countries (where appropriate) and to allow for tailored measures to capitalize on regional and geographical opportunities and address their specific challenges.

Cross-cutting all aspects of the blue economy, three key enabling components were recognised as necessary to provide the required knowledge, legal certainty and security to grow the blue economy, namely: improved access to marine data and information (Marine Knowledge 2020 strategy); maritime spatial planning to support sustainable and effective management of human maritime activities (later regulated under the 2014 Maritime Spatial Planning Directive); and integrated maritime surveillance through the development of a Common Information Sharing Environment[36] (CISE) for the maritime domain, to support the relevant authorities in their surveillance activities through the sharing of sensitive information.

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[34] https://ec.europa.eu/maritimeaffairs/sites/maritimeaffairs/files/docs/body/com_2012_494_en.pdf
[35] https://ec.europa.eu/maritimeaffairs/policy/sea_basins_en
[36] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52010DC0584

3.2.1 Blue growth and human health and wellbeing

While human health and wellbeing may not have been primary drivers behind the Blue Growth strategy, it is interesting to note that a 2012 EC-commissioned study entitled 'Blue Growth: Scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts' began from the perspective of six global maritime functions (Figure 3), noting that each had wider socio-economic relevance.

Figure 3 Six global maritime functions as identified by the Ecorys 2010 Blue Growth Study (adapted from Ecorys, 2012)

Connections to health can be ascribed across all six of these maritime functions, while 'Food, Nutrition, Health and Ecosystem Services', specifically references human health. These functions did not form part of the eventual Blue Growth scheme but illustrate that the links between sustainable use of marine resources and human health were already recognised.

Of the five priority areas identified in the blue growth strategy, clearly 'aquaculture' as a source of sustainable food to feed a growing population and 'marine and coastal tourism' with its inherent recreational and leisure opportunities have direct relevance for human health and wellbeing. All areas, however, could be considered to directly or more indirectly have impact for human health and wellbeing, either positively (provision of energy, medicines, nutritional products) or negatively, (adverse environmental impact leading to biodiversity loss or ecosystem destruction). Below we take a closer look at the three areas with most relevance to human health.

Aquaculture

Under the EU Blue Growth Strategy, aquaculture is identified as a key sector for growth to ensure a

sustainable supply of seafood, generally of high nutritional value and high economic value. Aquaculture is regulated at Member State level but its sectoral development is managed under the EU Common Fisheries Policy. The 2013 EU Communication, Strategic Guidelines for the development of EU aquaculture[37], provides a framework to guide Member States in the development of aquaculture in coastal, transitional and inland waters. As a commercial maritime activity, aquaculture is a good example of the need for integrated maritime policy making, given that it depends on healthy and productive waters (Water Framework Directive; Marine Strategy Framework Directive) a robust planning and governance system (Marine Spatial Planning Directive), and specific legislation necessary to ensure high production standards and to protect human health (e.g. Shellfish Waters Directive;).

While at global level, aquaculture production (both marine and freshwater) now equates approximately in tonnage to wild capture fisheries landings (FAO, 2018), in Europe, aquaculture production accounts only for some 20% of EU fish production. The EC-commissioned 2017 SAPEA (Science Advice for Policy by European Academies) report on Food from the Oceans, provides a number of evidence-based policy recommendations on increasing the amount of food harvested from the ocean while maintaining healthy marine and coastal ecosystems. The report states that marine aquaculture (mariculture) has the greatest potential for expansion to meet the needs of a rapidly expanding human population (SAPEA, 2017).

Marine Biotechnology

Human health is explicitly referenced in the 2012 Communication on Blue Growth in terms of the potential of blue biotechnology and marine natural products discovery for the *'health, cosmetic and industrial biomaterials sectors'*. Less explicitly, it further stresses how ocean resources can be used to *'deliver human necessities such as food and energy in a way that is more sustainable.'* Marine biotechnology capitalises on the genetic diversity of marine organisms, many of which are adapted to extreme environments and have developed interesting mechanisms of action that can be harnessed to generate new medicines, food products, or enzymes for cleaner and more efficient industrial processes.

The use of bioresources (including marine) for research and development is now regulated under

a 2014 regulation[38] to implement the Nagoya Protocol in the EU. The Nagoya Protocol itself provides the legal framework for the implementation of one of the three pillars of the Convention on Biological Diversity, namely access to biodiversity and the fair and equitable sharing of benefits arising from their use (ABS). Whilst the tenets of the Nagoya Protocol are laudable, there have been increasing concerns from the scientific community that its implementation can hinder research and development where the sharing and transfer of biological samples has long been routine and necessary. A recent bulletin[39] from the World Health Organisation, highlights the potentially detrimental effects of the Nagoya Protocol on international research on infectious diseases and calls for simplified measures for non-commercial research. Since most biological resources enter the value chain via basic research activities (Rabone *et al.*, 2019), distinguishing between commercial and non-commercial activities had long been a stumbling block in the negotiations for the Nagoya Protocol and the development of the EU regulation to implement it. So while on the one hand, the economic potential of marine biodiversity as a potential source of new medicines, biomass, industrial enzymes and high value added products is a maritime policy goal in the EU, on the other hand increasing regulation is impinging on research and development in this area[40].

Relevant to marine bioresources, discussions on access and benefit-sharing in relation to biodiversity from areas beyond national jurisdiction (not regulated under the Nagoya Protocol) are ongoing, as one of a number of measures in a proposed new legally binding instrument under the United Nations Convention on the Law of the Sea (UNCLOS) on the conservation and sustainable use of marine biodiversity of areas beyond national jurisdiction. Given that the ABS discussions in relation to marine biodiversity

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[37] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013DC0229&from=EN
[38] Regulation (EU) No 511/2014 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014R0511
[39] Bull World Health Organ 2019;97:379 | doi: http://dx.doi.org/10.2471/BLT.19.23217
[40] The Marine Biodiscovery Pipeline: From Cruise to Commercialisation https://www.abdn.ac.uk/ncs/documents/BBNJ%20Papers%2007%20The%20Marine%20Biodiscovery%20Pipeline%202018.pdf

from beyond national jurisdiction have pivoted around the principle of 'common heritage of mankind' and how to deal with intellectual property rights and patents (Blasiak *et al.,* 2018), Health 2020 notes that one of the causes of the high price of medicines are the intellectual property rights granted to promote scientific innovation. They also advise that countries should promote research on those diseases for which no treatment exist, as well as those which disproportionally affect people on low incomes[41].

Marine Tourism

Coastal tourism has been estimated to employ around 2.2 million people in the EU with gross value added (GVA) generated by the sector amounting to €65.1 billion[42]. In 2014, the EC adopted a Communication on 'A European Strategy for more Growth and Jobs in Coastal and Maritime Tourism'[43]. The associated communication outlined 14 actions to help grow the sector in a sustainable way. Member States were invited to *'Develop cultural heritage based tourism, underwater archaeological parks (based on work done by UNESCO), and nature and health tourism in coastal destinations.'* Clearly, marine and coastal tourism can bring many benefits to coastal com-munities, indeed many depend on it for their livelihoods. However, it can also have detrimental effects on these communities if not managed sustainably, in terms of pollution, in its many forms, and overdevelopment. This can, in turn, result in a loss of revenue. Recognising this, the communication also stresses that *'tourism depends on a healthy environment and the sustainable use of natural capital.'* It further highlights the many pieces of EU legislation that require Member States to protect and preserve their marine and coastal environments (e.g. Marine Strategy Framework, Shellfish Waters Directive, Water Framework Directive,

Bathing Waters Directive) and stresses the role of integrated coastal zone management and maritime spatial planning for appropriate planning. The strategy also supported the promotion of 'ecotourism' which would allow the coastal tourism sector to measure and monitor its own sustainability via various mechanisms, such as the European Eco-Management and Audit Scheme[44] and EU Ecolabel indicators.

Given the importance of marine and coastal tourism for employment, particularly in peripheral areas, it is worth noting that studies have consistently shown that unemployment has a large negative effect on how individuals think and feel about their lives – their 'subjective wellbeing' (Dolan *et al.,* 2008). Marine and coastal tourism is an extremely important area in the context of Oceans and Human Health, existing as it does at the interface between the health of the marine environment and human health. It represents an opportunity for positive actions to be implemented in support of both.

In summary, the EUs Integrated Maritime Policy should facilitate blue growth in a sustainable way that protects ecosystem health and, by default, that of the human component of the ecosystem. Eikeset *et al.,* (2018), in a review of the wider concept of blue growth, noted that we still lack a good understanding of possible mechanisms for the implementation of these integrated policies. The need for methods to both characterise and quantify inter-sectoral interactions, as well as appropriate decision-support tools to enable sustainable blue growth has also been highlighted (Klinger *et al.,* 2018).

If the human health element is to be more fully considered within a maritime context, then we need

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41 Health 2020 A European policy framework and strategy for the 21st century, WHO Regional Office for Europe © World Health Organization 2013
  http://www.euro.who.int/en/publications/abstracts/health-2020.-a-european-policy-framework-and-strategy-for-the-21st-century-2013
42 https://op.europa.eu/en/publication-detail/-/publication/676bbd4a-7dd9–11e9–9f05–01aa75ed71a1/language-en/
43 https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1479224038190&uri=CELEX:52014DC0086
44 https://ec.europa.eu/environment/emas/index_en.htm

to be able to identify Ocean and Human Health interactions that can be measured and monitored in a meaningful way. There is already an abundance of publicly available, marine environmental and maritime data and information, and this resource is growing thanks to the Marine Knowledge 2020 strategy.

3.3 The Maritime Spatial Planning Directive

Balancing the expansion of multiple and sometimes conflicting maritime human activities – which often bring much-needed jobs to coastal zones and peripheral regions (e.g. aquaculture and tourism) – can prove challenging, in terms of the activities themselves but also their impact on ecosystem services and natural capital which contribute to human wellbeing. Achieving this requires effective planning of the use of our marine spaces.

The EU Directive on Maritime Spatial Planning was adopted on 24 July 2014. According to the Directive, Maritime Spatial Planning or MSP[45], is a process by which the relevant Member State authorities analyse and organise human activities in marine areas to achieve ecological, economic and social objectives.

The EU MSP Directive was adopted in 2014 and establishes a framework for MSP, *'aimed at promoting the sustainable growth of maritime economies, the sustainable development of marine areas and the sustainable use of marine resources.'* Under the MSP Directive, the EU 23 coastal Member States are obliged to develop a national maritime spatial plan at the latest by 31 March 2021. These Member States are currently in different phases of the MSP process, with plans either in preparation, adopted or in review.

At a global level, the EU is leading the development of MSP, with 46% of all MSP initiatives currently taking place in the EU. In 2011, the European Commission published a non-binding set of MSP guidelines, with the intention of encouraging the nascent development of MSP in Member States along a consistent pathway. The introduction by the European Union of the MSP Directive in 2014 was timely as some Member States were already developing their own MSP frameworks and associated legislation. The Directive, which

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[45] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32014L0089

Member States were required to transpose into national legislation by 2016, ensures that MSP will be developed across all EU coastal states according to a coherent EU framework. This becomes especially important in light of the need for transboundary cooperation and cooperation with third countries. The consistent implementation of MSP at sea basin level is especially important and emphasised as a priority in the Directive.

Other key issues for MSP identified in the Directive include: land-sea interactions; the ecosystem-based approach; coherence between MSP and other processes such as integrated coastal management; the involvement of stakeholders; and the use of best available data.

3.3.1 How is the Maritime Spatial Planning Directive linked to human health and wellbeing?

The text of the original 2014 MSP Directive makes no direct reference to human health or wellbeing. The role of the MSP in promoting and preserving marine environmental health, however, and in this way linking directly to implementation of the Marine Strategy Framework Directive (MSFD), is a central tenet of the Directive. As with MSFD, the Directive makes specific reference to the key role of the Ecosystem-Based Management of human activities in the marine environment which embodies the understanding that humans are an integral part of the ecosystem.

Table 2 Some of the environmental, economic and social benefits of MSP
(from Ehler, C. & Douvere, F, 2009).

Environmental / Ecological Benefits	Identification of biological and ecological important areas
	Biodiversity objectives incorporated into planned decision-making
	Identification and reduction of conflicts between human use and nature
	Allocation of space for biodiversity and nature conservation
	Establish context for planning a network of marine protected areas
	Identification and reduction of the cumulative effects of human activities on marine ecosystems
Economic Benefits	Greater certainty of access to desirable areas for new private sector investments, frequently amortized over 20-30 years
	Identification of compatible uses within the same area of development
	Reduction of conflicts between incompatible uses
	Improved capacity to plan for new and changing human activities, including emerging technologies and their associated effects
	Better safety during operation of human activities
	Promotion of the efficient use of resources and space
	Streamlining and transparency in permit and licensing procedures
Social Benefits	Social Benefits Improved opportunities for community and citizen participation
	Identification of impacts of decisions on the allocation of ocean space (e.g., closure areas for certain uses, protected areas) for communities and economies onshore (e.g., employment, distribution of income)
	Identification and improved protection of cultural heritage
	Identification and preservation of social and spiritual values related to ocean use (e.g., the ocean as an open space)

Table 2, taken from Ehler and Douvere (2009), illustrates some of the key benefits of MSP. These in turn help to identify how MSP and its successful implementation can link to human health and wellbeing. For example, protection of biodiversity and ecosystems through identification and allocation of maritime space for biodiversity and nature conservation (e.g. Marine Protected Areas) ensures protection of ecosystem goods and services important for human health and wellbeing (such as climate regulation, food provision, waste remediation, etc.). By improving the basis for sustainable and coherent planning and decision-making around commercial activities in the marine environment, MSP also supports sustainable Blue Growth and the creation and protection of jobs in peripheral coastal communities. Finally, improved opportunities for community and citizen participation in managing human activities in the marine environment, empower people in the protection and use of marine resources

and the cultural and recreational services they provide, which are linked to human wellbeing. Therefore, the MSP, and by extension the EU MSP Directive, has relevance to the protection and promotion of human health and wellbeing in an Ocean and Human Health context.

As discussed above, the ecosystem approach to management is one of the key mechanisms through which the human component (social, economic, health and wellbeing) of the ecosystem can be protected and promoted in policy, planning and management. The ecosystem approach makes explicit the link between the status of natural resource systems and ecosystem services that support human wellbeing. Figure 4, below, provides a conceptual framework to illustrate how the MSFD, Blue Growth and MSP link to human health and wellbeing through the provision and protection of ecosystem services.
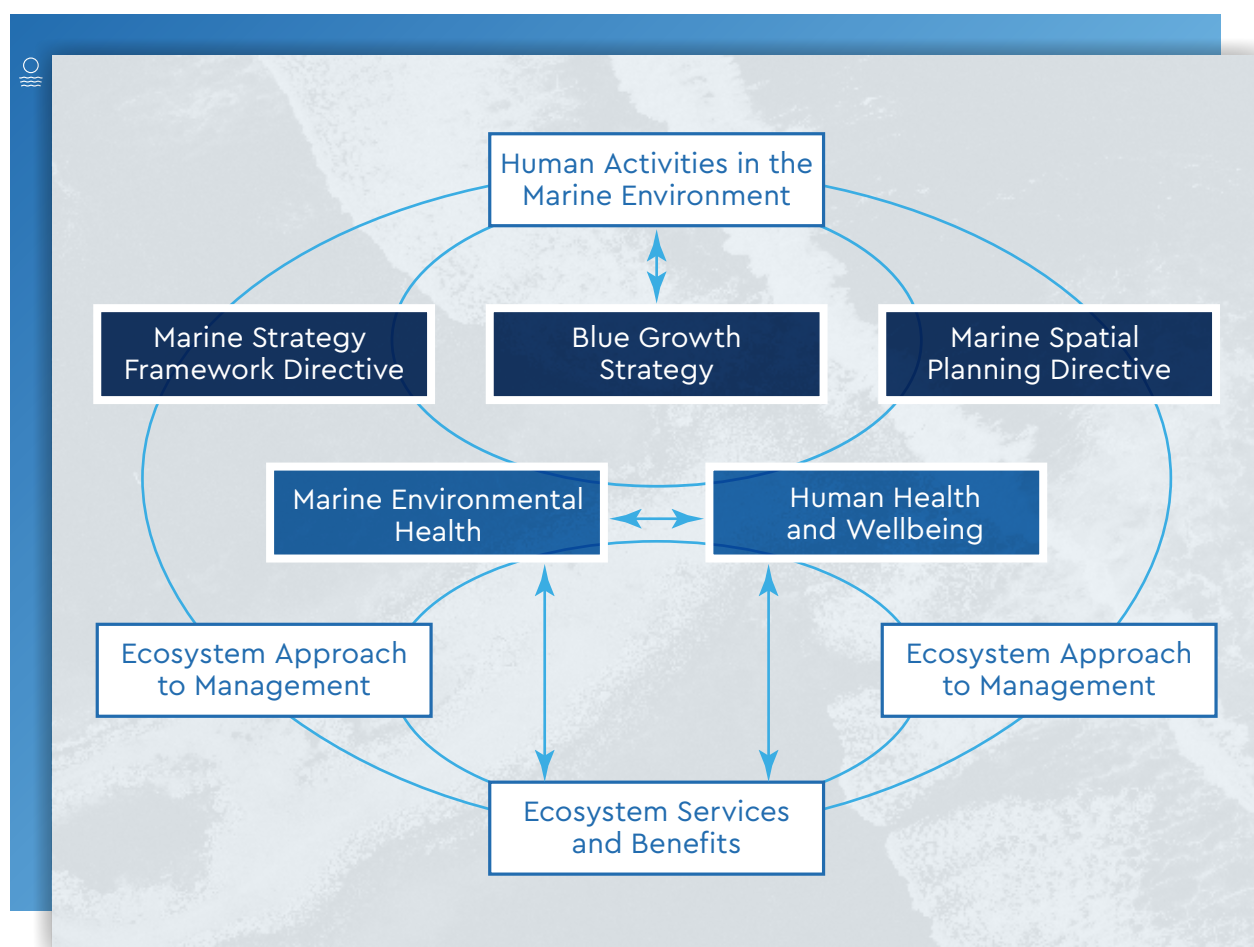

Figure 4 A conceptual framework illustrating the linkages between primary EU marine/maritime policy instruments, management tools and environmental and human health. Ecosystem services are considered the link between ecosystems and human health

4
Closing the policy loop
Data information and knowledge

It is evident that there has been little collaborative work between the health sectors and those sectors involved in maritime activities or marine environmental management and protection (Fleming *et al.*, 2006, Fleming *et al.*, 2019). A non-exhaustive inventory of European and international policies, strategies and legislative instruments that could be considered in the context of Oceans and Human Health was compiled in the framework of the SOPHIE Project[46] and indicates that the complexity of the policy landscape governing the tangled web of Oceans and Human Health interactions (Fleming *et al.*, 2019) is equally labyrinthine and reflects both the opportunities and the challenges inherent in developing cross sectoral approaches.

A study by Wear (2019) highlights the irony of the lack of collaboration between the health and environmental conservation sectors in that often these distinct sectors are facing a common challenge. Wear examined the impact of sewage on the health of coastal communities and coral reefs by identifying the threats to both from contaminated water. Of the 17 threats identified, 9 were found to affect both humans and coral reefs, and in almost every case of a shared threat, they were being independently addressed by both conservation sectors and the health sectors. The authors suggest that combining these efforts should result in positive outcomes for both human and coral health.

Extrapolating from coral reefs, the Oceans and Human Health research community has highlighted numerous interactions where collaborative action could achieve greater 'win-win' scenarios for the distinct sectors. However, as Wear (2019) also notes, in order to inspire decision makers to cultivate cross

sectoral collaborations, there is a need for ample evidence.

In 2002 a group of US researchers explored the use of indicators to link changes in the marine environment to human health outcomes (Knap *et al.*, 2002). They highlighted the following:

'Monitoring systems that include the rapid assessment of contaminants in the ecosystem and subsequent risk to human populations, with appropriate internationally distributed databases, need to be developed and validated. Such tools would provide early detection of potential environmental threats and enhance the ability to prevent human illness.'

To achieve this, they argued for the need to develop a research and monitoring framework programme across geographic and disciplinary boundaries based on 'models' that could be extrapolated to different environments. The success of these models would be largely dependent on establishing a comprehensive set of Oceans and Human Health relevant biomarkers (indicators) with sufficient sensitivity and specificity to detect environmental changes that affect human health.

In the EU, regulatory obligations such as the MSFD and the Water Framework Directive (WFD), led to the elaboration of indicators for (marine) environmental health. Data on these are continually being gathered and increasingly, thanks to Open Data policies, being made publicly available. Whilst many indicators for marine ecosystem health exist (Rombauts *et al.*, 2013), few consider the human component of the

[46] https://sophie2020.eu/wp/wp-content/uploads/2018/05/Policy-review-inventory.pdf

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ecosystem, other than in terms of its impacts on the marine environment. Studies to incorporate the human health and wellbeing dimension in ecosystem-based management note that existing indicators and data are very limited (Cole *et al.*, 1998; Breslow *et al.*, 2017). The WHO's Global Health Observatory (GHO) provides a gateway to health-related statistics for more than 1000 indicators, some of which could be useful in an Oceans and Human Health context.

'Big Data' analytics provide another opportunity to link changes in environmental health status to human health status (appropriate human health indicators) or vice versa. Some of the ways in which Big Data could be used in an environment and human health context were identified by Fleming *et al.*, 2017 as:

- *'Rapid identification of population or ecosystem vulnerability hot spots for targeted prevention, interventions, or research';*
- *Providing healthcare practitioners and public health planners with relevant information for improving services for locations and populations identified as being at risk;*
- *Tracking interactions between different ecosystems and populations over time;*
- *Development of early warning systems to prevent and anticipate environmental impacts on health and wellbeing;*
- *Initiate and evaluate natural experiments and even formal interventions in different places and among different ecosystems and populations of humans and other animals;*
- *Promote more effective stakeholder engagement and information exchange through citizen science, scenario building, and shared decision making with the research community, policymakers, and civil society.'*

An example of how Big Data analytics and online visualisation could be used to improve forecasting and public health planning was demonstrated in a study by Cherrie *et al.,* (2018). The authors compared weather patterns to human infectious disease pathogen time series data to explore the relationship between weather and pathogen incidence.

Fleming *et al.,* (2017), stress that 'environment' and 'health' represent very different areas with different research cultures, ethos, languages, and expertise, making the task of linking these data types extremely difficult. Many of the inherent challenges identified in relation to facilitating interoperability between health data and environmental data (including the diversity of cultures, language, lack of standardisation, harmonisation and availability of data) have all been tackled very successfully in the marine domain.

The EU's Marine Knowledge 2020 Strategy has been instrumental in establishing Europe's leadership in the collection, analyses and sharing of diverse marine and maritime data and derived information. Its aim was to unlock the wealth of marine data that were already being collected throughout Europe by a myriad of actors, and make these harmonised data freely available. By establishing a collaborative European Network, EMODnet (European Marine Observation and Data Network), data from diverse sources (oceanography, marine biodiversity, marine pollution, geological substrates, seabed habitat types, bathymetry, and maritime human activities) have been collated, processed according to international standards and made freely available as interoperable data layers and data products (e.g. maps on marine litter, oil and gas installations, eutrophication and species distribution). In addition to EMODnet, the Copernicus Marine Environmental and Monitoring Programme (CMEMS) provide state-of-the-art analyses and marine forecasts daily, allowing us to observe, understand and anticipate marine environment events.

The availability of these data and analysed data products support scientific research, environmental management, industry operations and education, across borders. They provide opportunities for innovation and help reduce risks associated with our seas and coasts.

The situation for transnational, publicly available health data is quite different. Health data are generally collected and stored at national level, with various restrictions on availability. Data that is publicly available is often collected via different mechanisms and stored in different formats, limiting its re-use for purposes other than that for which it was taken. Human health data also comes with its own unique challenges in terms of confidentiality and ethics, especially in a GDPR-compliant[48] EU.

The 'State of the Health in the EU' cyclical reports gather health data from various official sources. The most recent, 'Health at a Glance: Europe 2018'[49] report cites data sources as joint questionnaires administered by the OECD, Eurostat and WHO, together with data from European surveys co-ordinated by Eurostat, as well as from the European Centre for Disease Prevention and Control (ECDC), the European Commission's Joint Research Centre (JRC), and other sources.

Work is ongoing to address the difficulties in accessing interoperable, cross-border health data. In 2018, as part of the wider Digital Single Market Strategy,[50] the EC published a Staff Working Document and a Communication on 'Digital Transformation of Health and Care in the Digital Single Market (eHealth)'[51]. These policy documents outline the direction of EU activities in this field, focusing on three priorities:

- Citizens' secure access to their health data, also across borders;
- Personalised medicine through a shared European data infrastructure;
- Citizen empowerment with digital tools for user feedback and person-centred care.

The proposed shared European data infrastructure will allow *'researchers and other professionals to pool resources (data, expertise, computing processing and storage capacities) across the EU'[51]* and build on the promise of Big Data. The eHealth communication further details that pilot actions will be launched, pooling data and resources across the EU to demonstrate the benefits for advancing research and disease prevention, amongst others, and that funds will be mobilised to support these and other initiatives as well as the exchange of innovative and best practices. These commitments represent a real opportunity to advance the interoperability and availability of health data. In relation to Oceans and Human Health it raises some interesting questions and opportunities:

[48] General Data Protection Regulation (EU) 2016/679 https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1532348683434&uri=CELEX:02016R0679–20160504

[49] https://ec.europa.eu/health/sites/health/files/state/docs/2018_healthatglance_rep_en.pdf

[50] The Digital Single Market strategy aims to open up digital opportunities for people and business and enhance Europe's position as a world leader in the digital economy. https://ec.europa.eu/digital-single-market

[51] Staff Working Document [SWD(2018) 126] 'Digital Transformation of Health and Care in the Digital Single Market (eHealth)' https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD:2018:126:FIN, Communication on 'Digital Transformation of Health and Care in the Digital Single Market (eHealth)' [COM(2018)233] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018%3A233%3AFIN

- What health data that is already being collected could be most useful in an oceans and human health context, and what is required to aggregate these at EU level and improve interoperability (as has been achieved for marine data)?

- What data (marine, maritime or health) are missing? What data are not yet being captured that could be particularly relevant in an Oceans and Human Health context for improved forecasting and management of public health and marine environmental health.

- What role can civil society e.g. (coastal communities), maritime sectors (e.g marine tourism operators) and innovative technologies play in monitoring and providing data on oceans and human health interactions?

- How can Europe leverage its capacity in marine data management and sharing (including on human activities), building also on the cross-border and multidisciplinary open innovation environment of the European Open Science Cloud, to advance our knowledge of the circular relationship between the health of our marine environment and human health? What training opportunities exist that can maximise this potential?

- What cost-savings could be achieved in terms of improved public health management and marine environmental management, through access to accurate and adequate data on these relationships?

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5
Marine environment and human health interactions
Moving from policy to practice

Oceans and Human Health (OHH) is a meta-discipline with applications across several EU policy areas, the most obvious being environment, maritime affairs, public health, and research and innovation. However, a deeper analysis indicates that it has relevance across many of the currently listed 286 EU policy areas[52]. Given that the European Union started out as an economic community, it is not surprising that development of a sustainable maritime economy is clearly a priority for the EU Integrated Maritime Policy. However, the scope of European cooperation has broadened since the early days of the EEC. This is clearly evident in the text of the 1992 Maastricht Treaty, Article 3 of which states that among the goals of the new European Union is *'peace, its values and the wellbeing of its people.'*

Whilst this report has largely focused on EU maritime policies, Oceans and Human Health (OHH) interactions and effects are not confined to the marine and coastal arena. Many of our land based activities impact the ocean (agricultural run-off, plastic and other pollution, transport) and the ecosystem goods and services that benefit human health and wellbeing have beneficial impacts far inland (e.g. climate regulation and resource provision).

Ståhl (2018) argues that in order to properly consider the role of all sectors in health and wellbeing and health equity, there is a need to increase the level of 'health literacy' among the public, policymakers, media and civil servants. Improving the public's ocean literacy has been high on the maritime policy agenda in the EU, particularly in regard to its international ocean governance agenda. Ocean literacy is key to helping people know and understand their influence on the ocean and the ocean's influence on them. In this context, human health and wellbeing should be central to promoting ocean literacy. Put simply, raising the profile of OHH can help ensure that EU maritime policy is implemented in a way that promotes both the health of the Ocean and human health.

[52] https://ec.europa.eu/info/policies_en

5.1   Recommendations

1. **Promote and support the development of a 'Health in All Policies' (HiAP) approach in marine and maritime policies.**

    In accordance with the high priority placed on health and wellbeing in the Maastricht Treaty, ensure that health is embedded as a horizontal goal in future maritime policy developments. Community level action (in this case focusing on coastal communities) and public participation are key to HiAP capacity building, raising awareness of health threats and developing community actions for health. Consideration should also be given to the HiAP approach at regional level (e.g. Regional Sea Conventions and EU sea basin strategies).

2. **Embed the marine environmental component in the study and practice of Environment and Health.**

    The field of Oceans and Human Health is effectively a subset of the broader field of Environment and Health. While this has been established in the scientific world, greater action is needed for its translation into policy and practice. A powerful message of support, delivered through the platform of the World Health Organisation (WHO) European Environment and Health process, would provide impetus for greater action in this field both in Europe and internationally.

3. **Design and implement dedicated Oceans and Human Health management tools and actions.**

    Marine policy and health policy in Europe are highly complex, implemented at multiple geographical scales, and almost entirely unconnected. While it is not reasonable to propose substantial integration of health and marine policies, an opportunity exists to develop management tools that operate at the interface between these policy domains. In support of this, a suite of Oceans and Human Health indicators should be developed to allow greater capacity to measure and monitor Oceans and Human Health interactions, supporting the co-beneficial objectives of both marine environmental and human health.

4. **Optimise existing data streams to support evidence-based management in an Oceans and Human Health context.**

    Monitoring programmes are implemented at Member State level to support the effective implementation of EU Directives such as the Marine Strategy Framework Directive, the Water Framework Directive, the Bathing Water Directive and the Maritime Spatial Planning Directive. Substantial data holdings are made openly available through national data centres and at European level through e-infrastructures such as EMODnet. Given limited resources to develop new dedicated monitoring programmes, where possible, existing data streams should be leveraged for Oceans and Human Health applications, for example to identify and minimize threats to public health associated with marine environmental causes. 'Big Data' analytics can also play a role in elucidating marine environmental trends and linking these to health impacts.

5. **Build an integrated architecture for health data in Europe.**

    The development of a pan-European integrated data architecture under the Marine Knowledge 2020 strategy (including cross-border and cross-sectoral data access, integration, interoperability, analyses and e-infrastructures) is a major achievement of the EU Integrated Maritime Policy. While there are particular challenges to making health data openly available and interoperable, the progress in marine data coordination should be used as an exemplar to address challenges for building a new EU health data architecture; collating, harmonizing and providing access, as appropriate, to public health data, in line with the recent EU Communication on Digital Health and Care. This can ultimately enable better integration of health and marine data to support Environment and Health objectives.

6. **Increase the support for Oceans and Human Health in research, sectoral and regional cooperation programmes.**

    Ensure future support at EU and national level for research & innovation in the field of Oceans and Human Health to promote transdisciplinary collaboration and training and, continuing existing efforts to build a community of practice to address key knowledge gaps in support of evidence-based policy. In particular, develop priority actions and funding supports in the Horizon Europe programme, EU Territorial Cooperation programmes, the Life+ programme, and future sea basin strategies.

6
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Acronyms

DG ENV	Directorate General for Environment
DG MARE	Directorate General for Maritime Affairs and Fisheries
EC	European Commission
EU	European Union
GES	Good Environmental Status
MSFD	Marine Strategy Framework Directive
MSP	Marine Spatial Planning
OHH	Oceans and Human Health
SOPHIE	Seas Oceans and Public Health in Europe
WFD	Water Framework Directive
WHO	World Health Organisation

Seas, Oceans & Public
Health in Europe

Linking oceans and health research