



**Universiteit Utrecht**



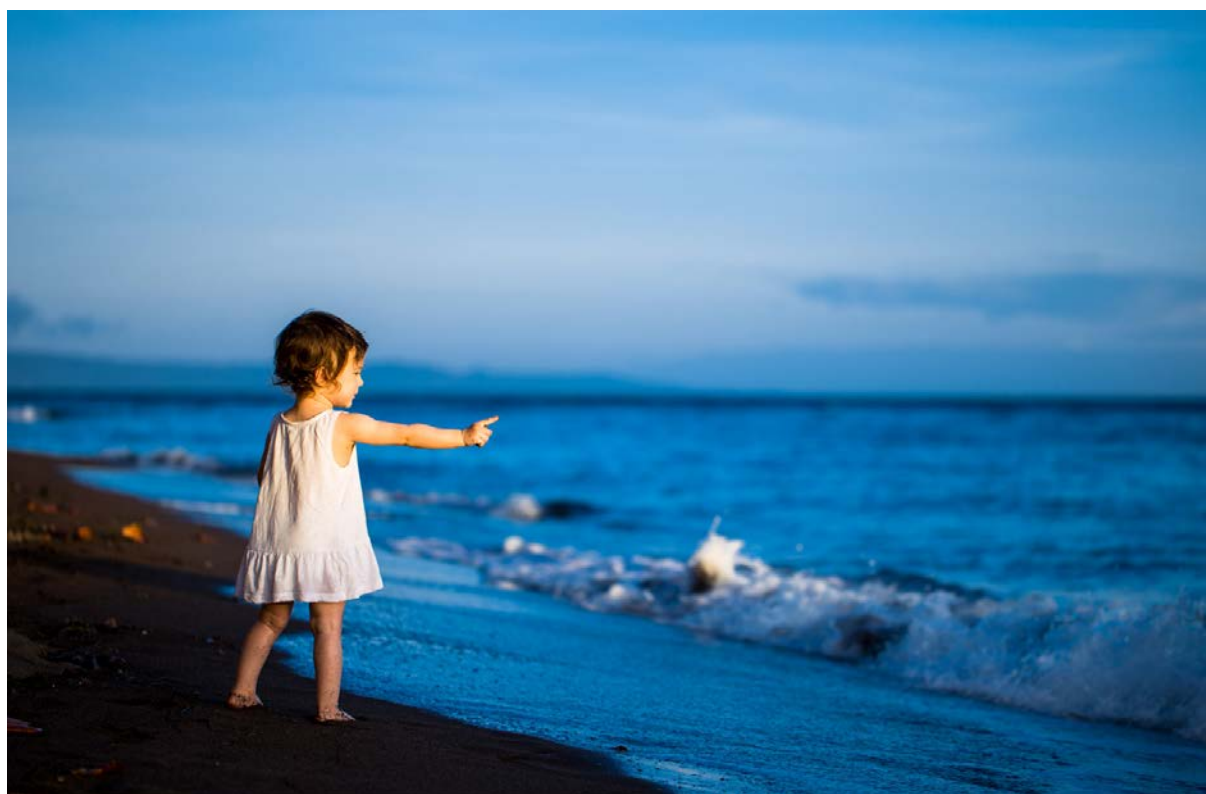
**Seas, Oceans & Public  
Health in Europe**  
Linking oceans and health research



## **Seas, Oceans and Public Health**

An extensive analysis of the potential of innovations in Europe and South-East Asia

*By N. Pellens*



Date: 18 July 2019

Master's thesis

Research MSc Sustainable Development

Track International Development

Faculty of Geosciences

Utrecht University

Submitted by: Noortje Pellens  
Student number – 6300936  
[n.pellens@students.uu.nl](mailto:n.pellens@students.uu.nl)

Supervisor: Dr. Ajay Bailey  
Assistant Professor  
Department of Human Geography and Planning  
Faculty of Geosciences, Utrecht University  
[a.bailey@uu.nl](mailto:a.bailey@uu.nl)

Second reader: Dr. Maggi Leung  
Associate Professor  
Department of Human Geography and Planning  
Faculty of Geosciences, Utrecht University  
[w.h.m.leung@uu.nl](mailto:w.h.m.leung@uu.nl)

Deltares contact: Dr Eline Boelee  
Senior researcher Water, Environment and Health  
Ecology and Water Quality  
[Eline.boelee@deltares.nl](mailto:Eline.boelee@deltares.nl)

Dr. Anouk Blauw  
Project manager SOPHIE  
Marine and Coastal Systems  
[Anouk.blauw@deltares.nl](mailto:Anouk.blauw@deltares.nl)

*Cover photo: A child speaking to the ocean. Photo taken by Dragos Dumitrescu, Romania.*

## Table of Contents

Summary .....	5
List of abbreviations .....	6
Figures and tables .....	7
Acknowledgements .....	9
1. Introduction.....	10
1.1. SOPHIE: Seas, Oceans and Public Health in Europe .....	10
1.2. Research objective and questions .....	12
2. Background on oceans and human health relations .....	13
2.1 Oceans and human health .....	13
2.1.1. Impacts of oceans on human health .....	13
2.1.2. Impact of humans on oceans.....	14
2.2. Sustainable Development Goals .....	15
2.3. Oceans and human health in Europe.....	16
2.3.1. Impacts of humans on oceans .....	17
2.3.2. Impact of oceans on human health.....	18
2.3.3. The SDGs on the European agenda .....	19
2.4. Oceans and human health in South-East Asia.....	21
2.4.1. Impacts of humans on oceans .....	22
2.4.2. Impact of oceans on human health.....	23
2.4.3. The SDGs on the South East Asian agenda .....	24
3. Theoretical Framework .....	27
3.1. Drivers, Pressures, State, Impact, Response (DPSIR) in OHH.....	27
3.2. How does this research build on existing theory?.....	28
4. Methodology .....	29
4.1. Scientific and societal relevance .....	29
4.2. Research strategy .....	30
4.2.1. Study design.....	30
4.2.2. Selection of participants.....	32
4.2.3. Data collection .....	33
4.2.4. Data analysis .....	39
5. Results.....	43
5.1. Description of innovations .....	43
5.1.1. Environmental issues addressed by innovations .....	47
5.1.2. Ecosystem services provided by innovations.....	48
5.1.3. Contribution of innovations to SDG targets.....	50
5.2. DPSIR Analysis .....	51

5.2.1. DPSI categories of innovations by environmental issues .....	53
5.2.2. DPSI categories of innovations by ecosystem services .....	54
5.3. Comparative analysis with South-East Asia .....	55
5.3.1. Environmental issues addressed by innovations .....	56
5.3.2. Ecosystem services provided by innovations.....	58
5.3.3. Contribution of innovations to SDG targets.....	61
5.3.4. DPSIR Analysis .....	62
5.4. Expert view on the role of innovations .....	65
5.4.1. The role of innovations in Europe.....	65
5.4.2. The role of innovations in South-East Asia .....	67
6. Discussion .....	70
6.1. Potential of innovations as tools for enhancing human health.....	70
6.2. Challenges, opportunities and limitations .....	71
7. Conclusion .....	73
8. Recommendations.....	75
References.....	76
Appendices.....	81
Appendix A – State of the art.....	81
State of the art in Europe.....	81
State of the art in South-East Asia .....	82
Appendix B – Background of the DPSIR Framework.....	83
Appendix C – Interactive map .....	85
Appendix D – SOPHIE Online Form .....	88
Appendix E – Interview questions .....	90
Appendix E1 .....	90
Appendix E2 .....	91
Appendix E3 .....	92
Appendix E4 .....	93
Appendix F – Coding scheme .....	94
Appendix G – List of innovations arranged by DPSI .....	97
Appendix H – More details of OHH innovations .....	107
Stakeholders .....	107
Distribution over DPSI categories .....	108
SDGs per DPSI .....	109
Appendix I - Expanding the research network.....	110
Appendix J – Evaluation letter host organization .....	112
Appendix K – Academic article.....	114

Appendix L – Intermediate steps of analysis .....	115
Drivers.....	118
Pressures .....	120
State.....	124
Impact .....	128

## Summary

Interactions between humans and the ocean can have strong beneficial effects on human health as well as a positive impact on the marine environment. This thesis research analyzes the potential of innovations in Oceans and Human Health (OHH) interactions for enhancing human health in Europe and South-East Asia. It is key to understand how human health benefits can be increased and negative impacts on the marine environment can be reduced. This research therefore addresses the question: *How can (social) innovations in OHH interactions enhance human health in Europe and South East Asia?* Research on OHH relations in Europe is still in the early stages, complicating the process of effective OHH policymaking. The purpose of this research is to contribute to the body of knowledge on OHH relations.

The research makes use of mixed methods and a combined case study and survey approach. Innovations were identified and inventoried using content analysis of websites and were then compiled into a database. Data were analyzed according to the DPSIR framework, considering the impact on environmental issues, ecosystem services and the contribution to Sustainable Development Goal (SDG) targets. In-depth interviews with experts gave additional insights in the potential role of innovations in improving oceans and human health. The results show a positive impact on oceans and human health through increasing food provision, water quality and tourism opportunities as well as combating environmental issues such as commercial fish stock depletion, pollution and climate change. Innovations contribute to various targets of SDG 3, 13 and 14. To increase impact, experts recommend innovations to be upscaled internationally, through collaborations and networks. Innovations can further spread knowledge and awareness on OHH relations and hence complement OHH policymaking.

This research concludes that innovations contribute to enhancing human health, through providing ecosystem services and direct ocean interactions. This research has led to an improved understanding of oceans and human health interactions and the potential and characteristics of innovations. This research gives an overview of what types of innovations are available to enhance OHH interactions. By expanding on the use of *Responses*, the commonly applied measures by innovations for solving environmental issues and generating health benefits is understood. This research recommends increasing the impact of innovations by upscaling, while taking into account the local circumstances. The Strategic Research Agenda could conduct further research on quantifying the impact of innovations and developing a platform via which social innovators can find each other.

Key words: *Innovation, Oceans and Human Health, DPSIR, Sustainable Development Goals*

## List of abbreviations

ASEAN – Association of South-East Asian Nations

DPSIR – Drivers, Pressures, State, Impact, Responses

EU – European Union

GHG – Greenhouse Gases

ICM – Integrated Coastal Management

OHH – Oceans and Human Health

PEMSEA – Partnerships in Environmental Management for the Seas of East Asia

SDG – Sustainable Development Goal

SDS-SEA – Sustainable Development Strategy for the Seas of East Asia

SEA – South-East Asia

SOPHIE – Seas, Oceans and Public Health In Europe

SRA – Strategic Research Agenda

UN – United Nations

UNESCAP – United Nations Economic and Social Commission for Asia and the Pacific

US – United States

## Figures and tables

Figure 1 The SOPHIE partnership, with associated fields of expertise and links to the SOPHIE Work Packages (Fleming, 2017).....	11
Figure 2 Risks, benefits and opportunities of oceans and human health (Fleming et al. 2014).....	13
Figure 3 Overview of progress towards the SDGs in an EU context (Eurostat 2018).....	21
Figure 4 Progress towards SDGs in ASEAN up to 2018 (UNESCAP, 2018).....	25
Figure 5 Expected achievements targets SDG 3 in South-East Asia .....	25
Figure 6 Expected achievements targets SDG 13 in South-East Asia .....	25
Figure 7 Expected achievements targets SDG 14 in South-East Asia .....	26
Figure 8 Conceptual Framework.....	28
Figure 9 Research Framework.....	32
Figure 10 Map of Research Network.....	36
Figure 11 Research Area in Europe. (Please note that The Canary Islands are included in this research, although not displayed in this map) .....	46
Figure 12 The geographical distribution of innovations over the European sea basins.....	47
Figure 13 Environmental issues addressed by innovations.....	47
Figure 14 Ecosystem services provided by innovations .....	49
Figure 15 Contribution of innovations to SDG targets .....	50
Figure 16 DPSI categories of innovations by Environmental issues in Europe (n=221).....	53
Figure 17 DPSI categories of innovations by Ecosystem Services in Europe (n=218) .....	54
Figure 18 Research Area in South-East Asia. (Please note that Papua New Guinea is included in this research, although not displayed in this map).....	55
Figure 19 Environmental issues addressed by innovations in Europe.....	56
Figure 20 Environmental issues addressed by innovations in South-East Asia.....	56
Figure 21 Examples of seaweed packaging by Evoware .....	58
Figure 22 Ecosystem services provided by innovations in Europe.....	59
Figure 23 Ecosystem services provided by innovations in South-East Asia .....	59
Figure 24 Contribution of innovations to SDG targets .....	61
Figure 25 DPSI categories of innovations by Environmental issues in Europe (n=221).....	63
Figure 26 DPSI categories of innovations by Environmental issues in South-East Asia (n=94) .....	63
Figure 27 DPSI categories of innovations by Ecosystem Services in Europe (n=218) .....	64
Figure 28 DPSI categories of innovations by Ecosystem Services in South-East Asia (n=69).....	64
Figure 29 Stakeholders of innovations in Europe .....	107
Figure 30 Stakeholders of innovations in South-East Asia.....	107
Figure 31 Distribution over DPSI categories of innovations in Europe .....	108
Figure 32 Distribution over DPSI categories of innovations in South-East Asia .....	108
Figure 33 Contribution to SDG targets per DPSI category of innovations in Europe .....	109



Figure 34 Contribution to SDG targets per DPSI category of innovations in South-East Asia.....	109
--	-----

Table 1 Overview of SDG targets relevant to Oceans and Human Health.....	15
Table 2 Data collection and interviews.....	36
Table 3 Data collection and interviews.....	36
Table 4 List of Experts Interviewed.....	36
Table 5 Overview of stakeholders .....	40
Table 6 Examples of innovations.....	43
Table 7 Key concepts of the DPSIR framework.....	52
Table 8 Interview guide Europe - experts.....	90
Table 9 Interview guide Europe – Key informants.....	91
Table 10 Interview guide South-East Asia – Experts .....	92
Table 11 Interview guide South-East Asia – Key informants.....	93
Table 12 List of innovations arranged by DPSI in Europe .....	97
Table 13 List of innovations arranged by DPSI in South-East Asia.....	105

## Acknowledgements

During this research, I was lucky enough to have the unconditional support of many people around me. Therefore, I would like to dedicate a special word of thanks to these people.

First of all, I want to thank my academic supervisor Ajay Bailey for the countless meetings, the continuous support and confidence in my research skills and the constructive feedback that helped me during the research process.

Second, I want to thank Eline Boelee for her supervision during my full-time internship at Deltares. I have been astonished by her patience and confidence. It is hard to describe how much I appreciated all the laughs, the guidance in a to me new organization, as well as the opportunities along the way and the chance to learn from her experiences as a researcher and professional in the field of water and health. Also, I want to say thank you to Anouk Blauw for her trust in me from the beginning onwards and allowing me to take up important tasks within the SOPHIE project that she leads for Deltares.

Furthermore, I want to express my gratitude to the SOPHIE project partners for inviting me to the 4-day annual expert meeting, for their constructive feedback, advice and additional literature. I am grateful for their appreciation of my input and their encouragement to make the best of this research. In particular, I am grateful for the experts who were willing to dedicate their time to participate in my interviews and those who supported me to even publish my results in an academic journal.

Additionally, I would like to thank my colleagues within Deltares for making my internship a valuable, but above all enjoyable learning experience and who made me feel an appreciated colleague. Thanks to Deltares for being such an accommodating host organization. Special thanks to Michelle Jeuken for her help with statistical programs during the data processing and analysis and Matthijs Schaap for his work in designing an interactive map to visualize the data of this research.

Ultimately, I want to thank my family and friends, who have stood by me during my entire study career, of which this thesis represents an end. Major thanks to all those people who have supported me during the past years to explore new cities and cultures and meet new people and who made this academic journey worthwhile.

## 1. Introduction

### 1.1. SOPHIE: Seas, Oceans and Public Health in Europe

Human health implications are becoming more important as human activities in coastal areas increase. As a maritime continent, research in this area is of high importance for Europe, as well as its people and oceans. Over the last twenty years, the importance of research within oceans and human health has been recognized primarily by the US (Fleming et al. 2014). Far less is known about this topic in Europe, which faces its own characteristic set of challenges and opportunities concerning OHH interactions. Europe has not yet managed to develop an integrated, collaborative, international research framework on a continental scale (Fleming et al. 2014).

SOPHIE is the research program of the European Commission that aims to protect the state of the ocean, strengthen its human health benefits and reduce risks to society. It is part of the Horizon2020 research and innovation program of the European Commission that is designed to promote breakthroughs and discoveries (“What is Horizon 2020?” n.d.). Within this program, many research projects are funded as an investment in the future of Europe and to create smart, sustainable and inclusive growth. Being one of these projects, SOPHIE connects scientists and other experts from the medical and social field to the marine and environmental field. It proposes an integrated approach towards complicated Oceans and Human Health (OHH) issues (SOPHIE2020). Furthermore, SOPHIE provides a network of people and organizations active within OHH relations that investigate the potential role of marine ecotourism and citizen science in this area of research. The data used in the project originate from many different sources: citizens, research, data repositories and existing European policies.

The SOPHIE consortium consists of 8 project partners that are located in England, Ireland, The Netherlands, Belgium and Spain and all carry out research in different fields of expertise. The final outcome of SOPHIE will be a clear, evidence-based Oceans and Human Health Strategic Research Agenda (SRA) applicable to the European context. This SRA is developed with active involvement of various stakeholders and experts (Fleming, 2017). This SRA makes recommendations for the future of Oceans and Health Science in Europe. It will serve as an effort to bring together relevant research entities to further continue with OHH research in a consistent and coordinated manner. The SRA will formulate short, medium- and long-term goals and advocate how to align these with European policymaking. Furthermore, the SRA advises how to implement, coordinate and communicate oceans and human health research across Europe. The client for this master's thesis is research institute Deltares. As is depicted in the diagram below (Figure 1), Deltares is responsible for the identification of innovative solutions within OHH interactions, hence this will be the focus area for this research.

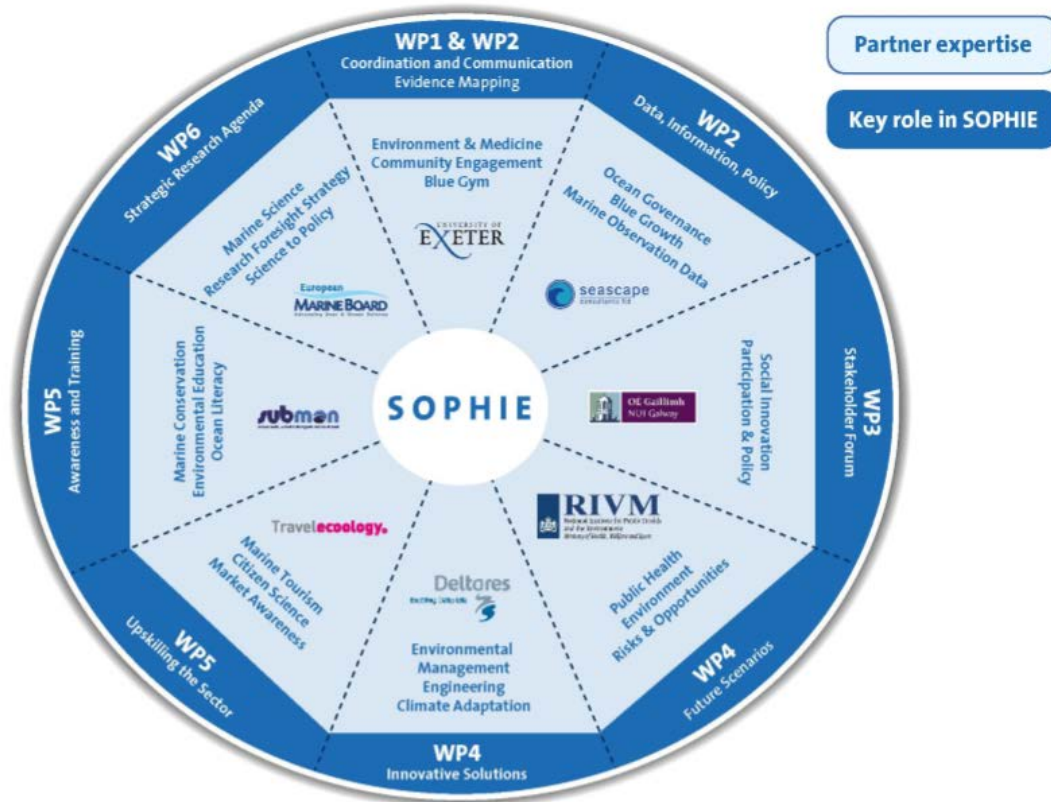


Figure 1 The SOPHIE partnership, with associated fields of expertise and links to the SOPHIE Work Packages (Fleming, 2017)

Innovative solutions or innovations in this research are defined as initiatives or case studies that directly or indirectly promote the benefits of healthy oceans to human health and well-being. Although the innovations in this research also encompass technical and environmental innovations, most of them are part of what is in theory referred to as social innovation. Social innovation can be defined as the creation of “long-lasting outcomes that aim to address societal needs by fundamentally changing the relationships, positions and rules between the involved stakeholders, through an open process of participation, exchange and collaboration with relevant stakeholders, including end users, thereby crossing organizational boundaries and jurisdictions” (Voorberg et al. 2015, p.2). Social innovation is particularly important in this research as it highlights the importance of alternative responses (i.e. non-policy and regulation) towards the public issues of oceans and human health and demonstrates how people themselves have combined efforts to address these issues. Participation of end users, in this case citizens, is referred to as co-creation. End users are mobilized to be actively involved in various stages of the production process of innovations (Voorberg et al. 2015).

Innovative ways of organizing can break patterns in geographical, cultural and political traditions and address long-standing global problems such as poverty, hunger, conflict or sustainability issues (Moulaert F, MacCallum, Mehmood & Hamdouch (Eds.). 2013). “These innovative forms of organization represent an emerging type of social behavior that has no historical precedent” (Moulaert et al. 2013, p.13). The innovations selected for this research address sustainability issues in oceans and seas. Social innovations always include a concern about human conditions, for example to overcome social exclusion, to improve the quality of services or to improve the quality of human life and well-being. Innovations in this research combine environmental sustainability with improving human conditions in terms of health and well-being. These innovations are collaborations of various stakeholders with various beneficiaries (Table 5). They aim to solve OHH issues and challenges by

actively involving different parts of civil society, bypassing policy, regulation and organizational structures.

## 1.2. Research objective and questions

The objective of this research is to identify how innovations can enhance human health benefits that derive from marine ecosystems. It contributes to a better understanding of how an integrated approach of public health and marine ecosystem health can stimulate beneficial OHH interactions. The potential of innovations in promoting and organizing positive interactions is explored, as well as their applicability throughout Europe. Additionally, successful innovations in South-East Asia are identified and compared to the best practices in Europe, in order to assess the potential for exchange of best practices.

### Research question

*How can (social) innovations in OHH interactions enhance human health in Europe and South-East Asia?*

### Sub-questions

- 1) *How do oceans influence human health and vice versa?*
- 2) *How do current practices and policy address OHH interactions in Europe?*
- 3) *What types of (social) innovations can be identified in Europe and South-East Asia?*
  - a. *In what ways and to what extent do innovations respond to Drivers, Pressures, State or Impact? (We apply DPSIR framework in chapter 4.)*
  - b. *How are environmental issues and human health impacted by innovations?*
  - c. *In what ways do they contribute to the SDG targets?*
  - d. *How do social innovators perceive upscaling perspectives for OHH initiatives?*
- 4) *What types of (social) innovations are commonly observed and which are not?*
- 5) *In what ways do innovative responses in Europe and South-East Asia differ and to what extent can innovative practices in both regions be exchanged and applied?*

## 2. Background on oceans and human health relations

### 2.1 Oceans and human health

From early history onwards, humans have depended on coastal areas worldwide (Bowen et al. 2014; Fleming et al. 2014). Oceans are linked to human health as they provide eco-system services, but they can also pose risks such as floods (Moore et al. 2013; Depledge et al 2013). Also, humans have an impact on the oceans, either through exploitation and pollution, or by protection and conservation efforts (Figure 2). This section explains these OHH relations and their risks and benefits.

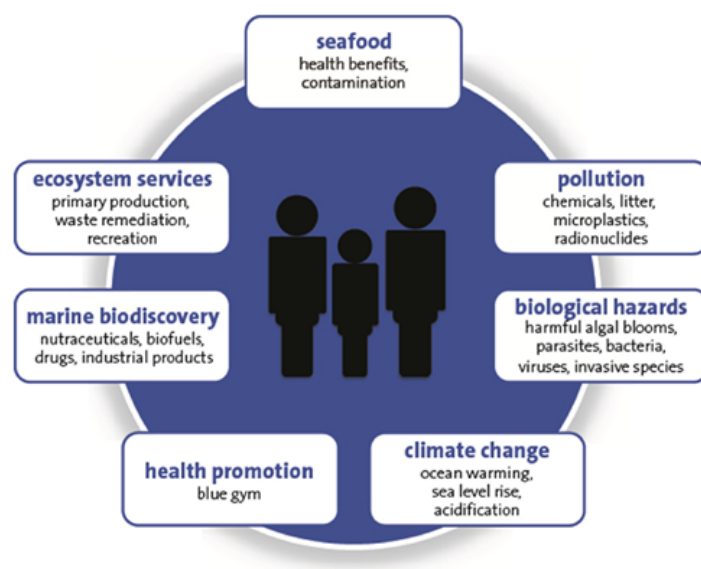


Figure 2 Risks, benefits and opportunities of oceans and human health (Fleming et al. 2014)

#### 2.1.1. Impacts of oceans on human health

Oceans provide food and livelihoods and offer connections to humans in other parts of the world (Bowen 2014; Fleming et al. 2014; Moore et al 2013). Over one billion people worldwide are dependent on seafood as their primary source for their protein intake (Bowen 2014). “In some low-income, food-deficient countries, fish proteins are absolutely essential to food security as they comprise a significant share of a low level of animal protein consumption” (Moore et al. 2013, p.892). Seafood is of high importance as a source of protein, vitamins and minerals and compared to other types of food, it is richest in concentrations of omega-3 fatty acids (European Marine Board 2013; Moore et al. 2013). “Omega-3 fatty acids improve heart health, benefit brain health and development and protect against the development of certain cancers. Fish intake is also associated with health outcomes such as reduced depression symptoms in adults and fewer asthmatic and respiratory allergies in children” (European Marine Board 2013, p.2). Furthermore, the oceans are an important source of compounds for pharmaceutical products. There are seven marine-derived medicines in clinical use currently (EMB and CEFAS n.d.) and many more compounds are still being explored as treatments for diseases such as cancer and Alzheimer.

Moreover, the discovery of marine life has contributed to understanding the human physiology (EMB and CEFAS n.d.). Not only have oceans impacted humans on a physical level, positive effects also become apparent in their mental well-being. Coastal areas stimulate outdoor activity and consequentially help to reduce obese related diseases, as well as depression and psychological illnesses (Depledge et al. 2013). Already in the 18<sup>th</sup> century, people were aware of the healing functions of the seas and coastal environment. Initially, the focus was on the physical health benefits that seawater could offer to people. Later the focus shifted to include the mental health effects that the maritime environment

provides (Bowen et al. 2014). People connect feelings of revitalization, destressing and relaxation to time spent in coastal areas. Moreover, psychological well-being in turn benefits physical well-being. It is found that stress, anxiety and pain directly influence the physical state of the human body in terms of weakening the immune system and increasing the risk of cardiovascular diseases and diabetes (Bowen et al. 2014). The ecological state of the ocean and coast is an important factor in the magnitude of these benefits, as it appears that benefits to the psychological human health are less when the visited area is polluted than a clean area.

Coastal areas are immensely popular for recreation and tourism. As mentioned above, the benefits on their mental health and well-being that people experience when spending time at coastal environments, results in the popularity of coastal and maritime areas (European Marine Board 2013). Since the 1960 and 1970s, global welfare has increased, leading to an increased interest in tourism and recreation opportunities (Bowen et al. 2014). This trend has been evident in coastal and marine environments in specific. The most rapidly growing sector within present-day tourism is marine and coastal tourism (Bowen et al. 2014). Although tourism and recreation offer health and well-being impacts and economic benefits, they also put pressure on natural resources due to e.g. overdevelopment in coastal areas or trampling.

### 2.1.2. Impact of humans on oceans

Unsustainable behavior of the global human population threatens the health of oceans around the world. Firstly, pressure on coastal areas increases rapidly due to population growth, construction work in coastal sites and mass tourism (Depledge et al. 2013). Second, pollution of the environment, be it chemical or microbial, through agricultural and industrial runoff, disposal of sewage and solid waste in the seas severely impacts ocean life. The seas are the final destination for most of the human produced litter and traces thereof can be found in all different parts of the world and marine systems (European Marine Board 2013; Fleming et al. 2015). Plastics account for 60-80 percent of all litter in the oceans and is equal to around 5 billion tons in weight. The number of species affected by marine litter is high; 45 percent of all mammal species and 21 percent of all seabird species are affected through ingestion or entanglement, most of which caused by plastic waste (EMB and CEFAS n.d.). Additionally, plastic waste slowly fragmentates into microplastics that end up in marine organisms and the food chain (Fleming et al. 2015; Fleming, Maycock, White, & Depledge 2019; EMB and CEFAS n.d.). Furthermore, overfishing, pollution and extractive practices lead to disturbances in the ecosystems and destruction of natural habitats (Fleming et al. 2015).

“The ocean plays a vital role in climate via its capacity to store and transport heat around the globe. Ocean currents and atmospheric winds together produce the climate as we know it” (Fleming et al. 2006). Nonetheless, over the last few decades the climate has changed drastically, altering the ocean’s capacity for climate regulation and increasing the health risks of the coastal population. Firstly, sea levels and temperatures of the oceans rise due to global warming (Fleming 2006; “The Ocean and Climate Change”, 2017). This causes coral reefs to disappear and habitats to alter, disturbing the natural ecosystems and forcing many species to migrate (“The Ocean and Climate Change”, 2017; EMB and CEFAS n.d.; Fleming et al. 2019). Second, climate change causes vital ecosystem services such as carbon storage and oxygen generation to decrease. Furthermore, due to the increased absorption of greenhouse gases (GHG) acidification of the water body takes place (“The Ocean and Climate Change”, 2017). Humans are indirectly affected by these actions themselves. Food security reduces as oceans become less productive and natural protection diminishes, leading to increased vulnerability of the coastal population (“The Ocean and Climate Change”, 2017; European Marine Board 2013; EMB and CEFAS n.d.). “Natural events (such as hurricanes, severe storms and tsunamis) can have devastating impacts on coastal populations, while pollution of the seas by pathogens, harmful algal blooms and




toxic waste can cause illness and death” (Moore et al. 2013, p.889). Some of these risks even become greater due to climate change (Fleming et al. 2006; Depledge et al. 2017). Health effects on humans from climate change impacts vary from drowning, injury and mental health issues such as depression, due to for example floods, forced migration or economic impacts (Fleming et al. 2006; Bowen et al. 2014; Depledge et al. 2017; Fleming et al. 2019). Sources of pollution such as the spill of chemical contaminants, fecal waste and plastics also pose a great danger to human health as they end up in the food chain (Depledge et al. 2017; Fleming et al. 2019). Additionally, the release of antibiotics into the environment promotes antimicrobial resistant bacteria which in turn pose a threat to human health (Fleming et al. 2015). Moreover, opportunities for finding potential medical compounds diminish due to the deterioration of marine ecosystems (Fleming et al. 2015).

Climate change, pollution and deterioration of marine ecosystems affect all oceanic areas throughout the world, hence their consequences are of universal importance. Action to combat climate change therefore requires transnational cooperation and decision-making. The people suffering most directly from climate change induced oceanic impacts are coastal communities (“The Ocean and Climate Change”, 2017; Fleming et al. 2019). It is key that risks to these people are reduced and that by protection of the marine environment, oceanic benefits are enhanced. These issues and benefits relate directly to the targets of the SDGs and demonstrate the urgency to increase coastal resilience, ocean conservation and improve human health and well-being.

## 2.2. Sustainable Development Goals



Ocean conservation as well as human health and well-being are high on the global agenda, which is demonstrated by the ‘Sustainable Development Goals’ (SDGs) that are set up by the United Nations (UN) in 2015. The SDGs are a set of 17 global goals that aim to guide the world towards a sustainable way of living, by reducing inequality, eradicating poverty and hunger as well as increasing health and well-being, preserving natural resources and combating climate change (United Nations – Sustainable Development Goals). Of these sustainable development goals, three are directly related to oceans and health and are core for this research, notably, SDG 3: Good Health and Well-being, SDG 13: Climate Action and SDG 14: Life below Water (Table 1). Oceans and human health interactions indirectly impact other SDGs; however, these are not discussed in this research. Oceanic issues are not limited to one region either and can lead to different consequences in different areas. It is therefore interesting to draw a comparison between two different areas in the world with both much interaction with oceans: Europe and South-East Asia, that face different challenges and how they respond to these challenges.

*Table 1 Overview of SDG targets relevant to Oceans and Human Health<sup>1</sup>*

SDG	Target	Description
	3.3	By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases
	3.4	By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being
	3.9	By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination

<sup>1</sup>Source: Website UN



	3.D	Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks
	13.1	Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries
	13.3	Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning
	14.1	By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution
	14.2	By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans
	14.3	Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels
	14.4	By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics
	14.A	Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries

### 2.3. Oceans and human health in Europe

“Surrounded by four seas and two ocean basins, and with a coastline of 89,000km, Europe is a truly maritime continent. Approximately 43% of the EU population (over 218 million people) live in coastal regions, including in 194 coastal cities” (Fleming 2017, p.6). Of the 28-member states of the European Union, 22 have a coastline and two thirds of the European frontiers are coasts (Fleming et al. 2006). The interactions between humans and oceans determine to a great extent the state of the marine and coastal environment as well as human health. Accordingly, it is of great importance to understand the dynamics of OHH interactions to ensure socio-economic and environmental well-being throughout the continent. Sustainable use of and interactions with the maritime environment can help to enhance human health and create an overall motive for preserving ocean ecosystems. Extensive research on OHH interactions and innovation are key for developing a strategy to make use of the possible interactions to increase well-being, reduce overall health-risks and pressure on healthcare. The European continent can be divided into 5 maritime regions, notably the Baltic, North Sea, Mediterranean, Black Sea, and Atlantic (Fleming, 2017). Although located around the same continent, these regions differ highly in terms of natural, social, cultural and economic circumstances.

### 2.3.1. Impacts of humans on oceans

One of the greatest harms to the European marine environment is overfishing (European Marine Board 2013). While targeting commercial fish and shellfish, other marine life, so-called bycatch, is unintentionally killed, leading to huge losses in biodiversity (EEA 2018). Ecosystems where intensive and unsustainable fishing activities take place are severely damaged and altered (Fleming et al. 2015). European fish stocks have greatly declined as a result of unsustainable fisheries. In 2018, in the Mediterranean and Black sea, 88 percent of the assessed stocks were overfished (EEA 2018). Also, alterations in sea floor habitats occur as a result of human economic activity in the marine environment. These alterations influence the functioning of seabed habitats and affect the sea floor integrity. The state of the seabed is a key area of concern in Europe (“Our Oceans, Seas and Coasts”, 2019). Harmful human activities causing this are related to obtaining natural resources that can vary from bottom trawling and aggregate extraction to energy production and coastal infrastructure (EEA 2018).

Non-indigenous or alien species are introduced into the European seas as a consequence of globalization and international trade (EEA 2018). Their numbers increased drastically between the 1960s and 1980s, especially in the Mediterranean (Depledge et al. 2013). Although these newly introduced species often settle in the new ecosystem without problems, some become invasive species and have a harmful impact on the environment (Bowen et al. 2014). “When this happens, major ecological, economic or social effects threaten biodiversity and ecosystem services. Records show that more than 1 350 marine alien species have been introduced into European seas since the 1950s” (EEA 2018).

Climate change has a major impact on the state of the oceans, due to rising temperatures and increased levels of greenhouse gases in the atmosphere and ocean. The most visible effect of climate change with regards to the marine environment and human health is extreme weather events (European Marine Board 2013; Fleming et al. 2015). “The health impacts of such major events can be acute (e.g. trauma, drowning, starvation, water-borne and vector-borne diseases) and are often followed by more chronic issues such as mental illness, malnutrition and population migration, which can last for years” (European Marine Board 2013, p.23). Sea level rise and rising water temperatures are two other effects of climate change that impact ocean life and life on land. Due to salt water intrusion with sea level rise, fresh water supplies are contaminated, posing a direct threat to coastal communities (Bowen et al. 2014; European Marine Board). Rising water temperatures cause fish to migrate and harmful algal blooms to occur more often, reducing coastal food provision and leading to health threats (Fleming et al. 2015).

Marine pollution is a major issue in Europe’s oceans and seas. Microbial contamination, chemical contamination and solid waste cause a range of consequences to marine life and human health, such as contaminated food and water and biological hazards (Fleming et al. 2015; European Marine Board 2013). Contaminants can be found across the marine environment in water, sediments or animals (Fleming et al. 2015; European Marine Board 2013). Partly, contamination is caused by natural factors, often in low concentrations, whereas others are released by humans. Contaminants can travel through the food chain, ending up in fish and shellfish for example, which are consumed by humans (Fleming et al. 2015; Depledge et al. 2017). “Evidence shows that regulatory levels for certain contaminants in seafood have been exceeded in European seas, exposing humans to contaminants through consumption” (EEA, 2018). The main sources of contamination are, agricultural, industrial and domestic run-off, port and shipping activities, aquaculture and energy production. Aside from these activities, unsustainable lifestyles and overconsumption are sources of pollution, producing increasingly large amounts of litter that end up in the ocean (EEA, 2018).

### 2.3.2. Impact of oceans on human health

The most important benefits that are generated by the ocean in Europe are related to food provision, pharmaceuticals and recreational spaces (European Marine Board 2013; Fleming et al. 2006). These are beneficial for both physical human health as well as mental health and well-being. The global demand for seafood in 2010-2012 was 19 kg per person, whereas currently in the European Union, average seafood consumption is 23 kg per person per year (EMB and CEFAS n.d.). Aquaculture is increasingly important as a source of nutrients for the world population as well as crucial in providing employment and income for low income countries. In the European Union, aquaculture is responsible for around 20 percent of the total EU fish production (European Marine Board 2013). Over the past 20-30 years, an active research process has been started by researchers to actively search for biomedical compounds in the oceans that can be used for curing diseases such as cancer and AIDS. This has furthermore been important due to issues related to increasing antibiotic resistance of human pathogens (European Marine Board 2013; Fleming et al. 2015). “For example, more than 50% of the current anticancer drugs are natural products or derived from a natural origin, many of these originally from marine organisms” (European Marine Board 2013, p.57). Considering the fact that less than 10 percent of marine species have been described, any of the other species could be crucial in finding the next disease cure (EMB and CEFAS n.d.; Depledge et al. 2013).

Coastal and maritime tourism in Europe employs over 3 million people and accounts for over one third of the maritime economy (“coastal and maritime tourism”, n.d.). It is a key area for the European Blue Growth Strategy considering its potential for sustainable economic growth and job creation. The sector is expected to grow around 2-3 percent by 2020 and thus offers great potential for employment opportunities and revenue (“coastal and maritime tourism”, n.d.). Crucial to promotion of tourism in this sector is the quality of the ocean's waters as well as coastal surroundings (European Marine Board 2013). Nevertheless, tourism also highly impacts the health of maritime ecosystems by increased pressure on natural areas and can therefore reduce water quality and degrade coastal areas.

Already in the Victorian era and before the 1940s, spa's and coastal treatments were highly popular and widespread in Europe to promote human health and well-being (European Marine Board 2013; Fleming et al. 2015). With the development of antibiotics in the 1940s, these types of treatments dropped in popularity. However, current complexity in human health issues and the decrease in performance of some pharmaceutical treatments have caused a renewed interest in the value of marine ecosystems for public health (European Marine Board 2013). Projects such as the ‘Blue Gym’ demonstrate this renewed popularity (European Marine Board 2013; Depledge et al. 2013). Research and experiments indicate that people prefer environments that contain aquatic components and perceive marine and other aquatic environments to be among the most restorative (White et al. 2010; Wheeler et al. 2015; Korpela et al. 2010). Mental health benefits such as feelings of calmness and revitalization are found to be stronger in coastal environments than urban green spaces or the countryside (European Marine Board 2013). This becomes clear in behavioral choices e.g. where people show willingness to pay more for houses and hotel rooms with views of water (White et al. 2010; Bowen et al. 2014). Britton, Kindermann, Domegan, & Carlin (2018) carried out a systematic study of the effect of blue space interventions on mental health. They found among others that there were benefits in terms of self-esteem, social confidence and resilience, as well as environmental connectedness (Britton et al. 2018). Environmental connectedness is associated with capacity for psychological restoration. Furthermore, there are strong potential health and well-being benefits for children who take part in Blue Exercise. White et al. (2016) conclude from a case study examination of a surfing program that engagement of children improved fitness, self-reported satisfaction with body appearance and friendship. Furthermore, it was understood to have benefitted their social skills and motivation.

An increasing interest in Europe is noticeable with regards to the interconnectivity of blue spaces and human health and its benefits. Whereas in the past, hardly any research was conducted on these connections, recent developments in research have moved towards this area. As part of the Horizon2020 program, several research projects that investigate the link between blue areas and health on the European level have been initiated, such as the Blue Health, Blue Gym, Blue Mind and INHERIT projects. These look more deeply into the relations and interactions between oceans and human health in Europe, linkages between environment, climate and health as well as perception and awareness about the impact of oceans on human health. For more information on the State of the Art, see Appendix A. Although research projects are going on, there are still gaps in knowledge that need to be addressed with regards to oceans and health in Europe. This research builds on previous research and contributes to filling these gaps, as it helps to understand the specific relations with the marine environment. This research in specific goes beyond the scope of the previously mentioned collection of good practices in environment and health, as it collects in depth information on innovative practices in the marine domain and how their benefits can be maximized throughout the European continent.

### 2.3.3. The SDGs on the European agenda

Based on the data since 2015, the European Union in general has advanced with regards to almost all SDGs (Figure 3) (European union 2018). “Over this five-year period progress appears to have been strongest towards SDG 3 ‘good health and well-being’, followed by SDG 4 ‘quality education’ and SDG 7 ‘affordable and clean energy’” (European union 2018, p.2). The EU-27 Member States score on average the lowest on SDG 12 (Ensure sustainable consumption and production patterns), and on SDG 14 (Conserve and sustainably use the oceans, seas and marine resources for sustainable development) (European Commission reflection paper 2019). For SDG 14 as well as SDG 13 ‘climate action’, trends cannot be calculated, due to insufficient data. Interesting to note is that the some of the biggest challenges for health and well-being are climate change, environmental risks and unhealthy habits. Public spending on healthcare prevention is rather low, whereas the costs for non-communicable diseases are high. The link between these SDGs is therefore highly interesting.

A key trend in health and well-being in the EU is<sup>2</sup> that life expectancy continues to go up. “Nevertheless, tobacco and excessive alcohol consumption, being overweight, lack of physical activity, mental health issues such as depression and suicide, alongside communicable diseases continue to adversely affect health and, together with demographic and social changes, they create additional burdens on the EU healthcare systems” (European Commission reflection paper 2019, p.74). Unhealthy lifestyles have negative consequences on human health, public spending on human health and the overall productivity of the population. Half of the adult population in the EU in 2014 was overweight and although non-communicable diseases make up for 80 percent of the healthcare costs, only 3 percent of health budgets is spent on prevention (European Commission reflection paper 2019). Some of the biggest threats to public health in the coming years are climate change, environmental risks and unhealthy habits. What is needed in the coming years is a system that stresses the importance of the prevention of diseases as well as the promotion of health.

With regards to climate action, total greenhouse gas emissions decreased by 22 percent during the period of 1990-2017 (European Commission reflection paper 2019). Nevertheless, “fossil fuel subsidies remain high. Approximately EUR 112 billion are estimated to have been allocated annually to the production and consumption of fossil fuels between 2014 and 2016” (European Commission reflection paper 2019, p.104). “In the period 1980-2016, weather and climate-related losses accounted for a total

---

<sup>2</sup> More key trends and challenges, see [https://ec.europa.eu/commission/sites/beta-political/files/rp\\_sustainable\\_europe\\_30-01\\_en\\_web.pdf](https://ec.europa.eu/commission/sites/beta-political/files/rp_sustainable_europe_30-01_en_web.pdf)

of EUR 410 billion in losses at 2016 values for Member States” (European Commission reflection paper 2019, p.104). Over the last 5 years, the amount of EU member states that have developed a national adaptation strategy has grown from 15 to 25. The European Union argues that local authorities play a key role in combatting climate change as they are in closest touch with the European citizens. “The EU Covenant of Mayors for climate & energy brings together thousands of local governments voluntarily committed to implementing EU climate and energy objectives. It has also contributed significantly to raising awareness at the local level on the need to prepare for the impacts of climate change, with local action for adaptation and resilience playing a crucial role in protecting people and their assets” (European Commission reflection paper 2019, p.106).

Some of the key trends and challenges in life below water relate to marine protected areas, sustainable fisheries and pollution. The European Union is taking efforts to increase the amount of protected marine areas and has increased the coverage of these areas from 6 percent to almost 11 percent between 2012 and 2016 (European Commission reflection paper 2019). Sustainability in the fishing industry has improved and commercial fishing within sustainable boundaries has increased. Nevertheless, fisheries in the Mediterranean and the Black sea are falling behind with more than 80 percent of their fish stocks being overfished. In the future, all forms of marine pollution will continue to be problematic. These include noise pollution and plastics as well as chemical and microbial pollution from land-based activities (“Our Oceans, Seas and Coasts”, 2019). Although plastic pollution is expected to become less in the future, current levels of plastic waste are expected to continue causing problems (European Commission reflection paper 2019). Some of the most important factors that pose a threat to the European seas are environmental degradation and climate change, pollution, irresponsible tourism and overfishing and illegal fishing. European coastal waters are measured to be of very high bathing quality, but organic and chemical pollutants from human activities as well as marine litter continue to pose a serious threat to Europe’s marine ecosystems.

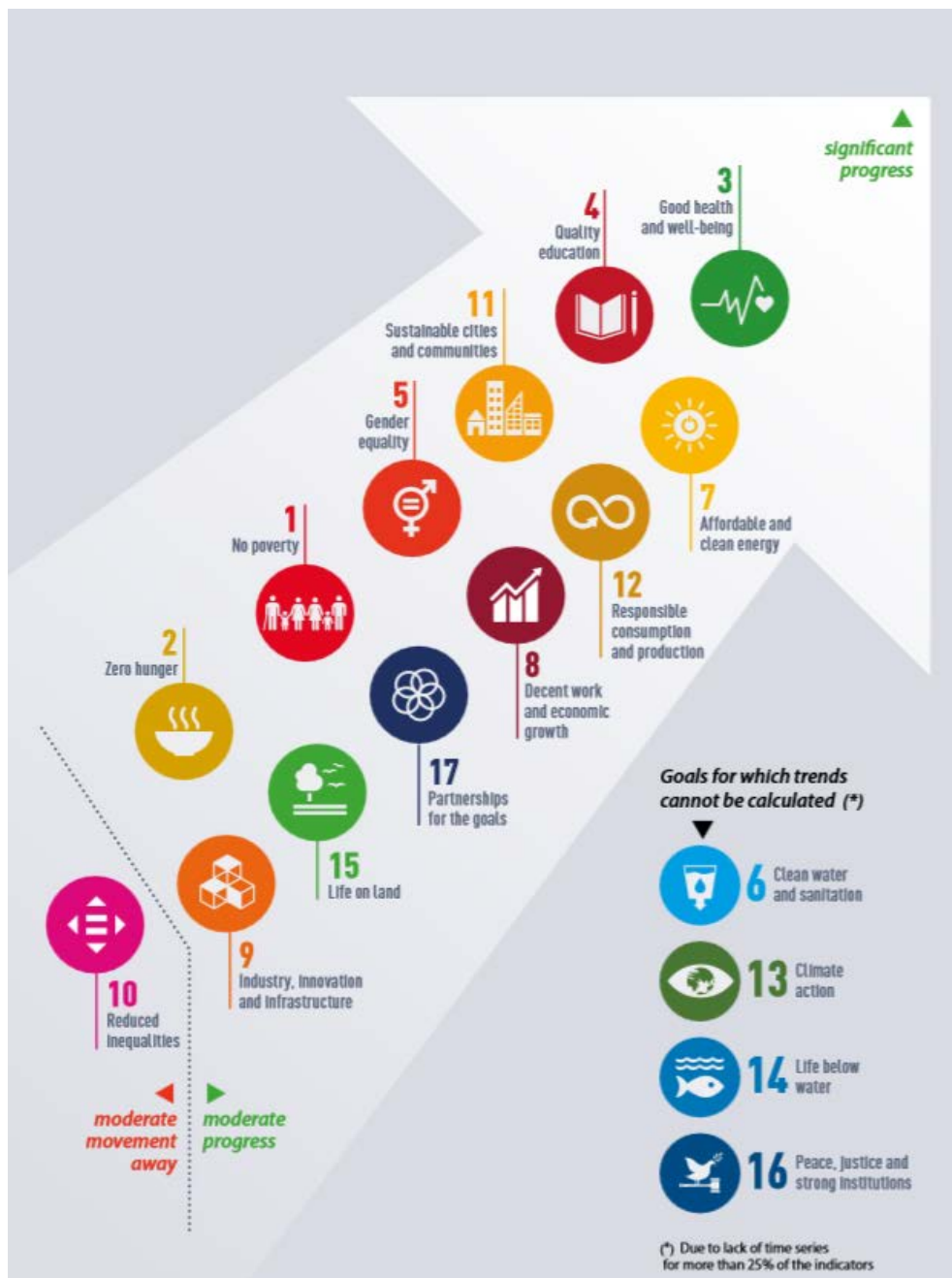


Figure 3 Overview of progress towards the SDGs in an EU context (Eurostat 2018)

## 2.4. Oceans and human health in South-East Asia

South-East Asia (SEA) has a population of around 625 million people, who greatly depend on a healthy ocean, even more than other regions worldwide. In this research, South-East Asia is defined as the member countries of ASEAN, notably Brunei, Burma (Myanmar), Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand and Vietnam. Over 70% of South-East Asia's human population lives in coastal areas (Todd et al. 2010). This part of the population is most prone to natural disasters and highly vulnerable due to their socio-economic state (Neumann, Vafeidis, Zimmermann & Nicholls 2015; Fifth ASEAN State of the Environment report 2017). The seas and oceans of the South-East Asian region account for three times the size of the land. A large part of the GDP in this region is descendent from fishing and tourism and in lesser amounts from aquaculture (Spalding 2017).



#### 2.4.1. Impacts of humans on oceans

The oceans of South-East Asia face severe threats, most of which are caused by human behavior. These threats impact the health of the South-East Asian environment, leading to a deterioration of the water quality and ecosystems. In turn, deterioration of the ocean as a resource impacts the livelihoods and health of the large coastal population. The ASEAN region is home to the so-called Coral Triangle, which is an area immensely rich in biodiversity and with high ecological value. The area covers a marine area of six million square kilometer and is home to among others 6 of the 7 species of sea turtles and over 2000 species of fish. “All told, the region hosts 15% of worldwide fish production, 33% of seagrass meadows, 34% of coral reef cover and 35% of the world’s mangrove acreage” (Spalding, 2017). However, over 80 percent of South-East Asia’s reefs are at risk (Todd et al. 2010). The main threats to the ocean in this region are marine pollution, coastal over-development, overfishing and destructive fishing practices, destructive coastal tourism and climate change (Fifth ASEAN State of the environment report 2017; Spalding 2017). One of the key challenges in the ASEAN region is the lack of enforcement of laws and regulations with regards to ocean protection and conservation.

Pollution from socio-economic activities in these areas is one of the major threats to ocean life. Both pollution from land-based as well as sea-based activities are part of the problem and the types of pollution range from sediment, to marine litter, toxics and sewage (Burke, Selig, & Spalding, 2002; PEMSEA 2018). As a result of sediment and sewage pollution, other marine issues occur, such as eutrophication, harmful algal blooms and habitat loss. The problems caused by pollution are getting worse as activities become more intense. Increased maritime traffic and fishing practices, intensive agriculture and aquaculture, dredging and mining activities, high urbanization and industrialization rates and deforestation and coastal development are adding to the problems (Burke et al. 2002; Todd et al 2010). “Marine-based activities that threaten coral reefs include pollution from ports, oil spills, ballast and bilge discharge, garbage and solid waste dumping from ships, and direct physical impacts from groundings and anchor damage” (Burke et al. 2002, p.22).

SEA experiences a rapidly growing, urbanizing and industrializing coastal population. This trend, combined with ever-increasing coastal tourism, requires more infrastructure in coastal areas, putting more pressure on coastal development (Burke et al. 2002; Todd et al. 2010). Effects of intensified coastal development or overdevelopment are increased runoff of sediments and nutrients, which deteriorate the water quality and restrict photosynthesis processes, leading to coral bleaching and death. The removal of natural areas such as mangroves or seagrasses for development worsens this problem (Burke et al. 2002; Todd et al. 2010). Irresponsible and destructive tourism practices enlarge problems of pollution and overdevelopment by adding to garbage disposal, sewage runoff, and alterations in land-use. Furthermore, tourists pose a direct threat to marine life by reef trampling and taking coral (Burke et al. 2002). In order to maintain the pristine areas that tourists come to see in the first place, the tourism sector needs to develop sustainably. Tourism in SEA can offer a great opportunity for marine conservation, however it can also pose a direct threat to marine life.

Moreover, major threats to marine life in ASEAN seas are overfishing and destructive fishing (Spalding, 2017; PEMSEA 2018). “Fishers in Southeast Asia have adapted to market demands by using specialized, often destructive, fishing techniques such as poison fishing and blast fishing. Each of these methods contributes to overfishing of economically important fish and may cause the unintended exploitation of countless other species, fundamentally changing the marine ecology of the region” (Burke et al. 2002, p.28). The ecosystem balance is interrupted when certain fish populations experience great declines in size. The species change their behavior and with that alter the rest of the ecosystem, posing consequences for other aspects of the ecosystems. Furthermore, destructive fishing practices

eliminate large areas of habitat, forcing populations of marine life to move and reducing the natural value of the environment.

Climate change impacts the marine environment in a variety of ways. Due to global warming, water temperatures rise, leading to coral bleaching and major habitat loss (Burke et al. 2002; Fifth ASEAN state of the environment report 2017; PEMSEA 2018). Furthermore, because of melting sea ice, sea levels rise and pose a threat to coastal populations in SEA in specific. A big part of the coastal areas in SEA lies at low elevation, being more vulnerable to flooding events (Fifth ASEAN state of the environment report 2017). This trend, combined with high subsidence rates that are present in many of the SEA coastal areas, and the large coastal populations, demonstrates the risk of climate change on coastal areas and life on land.

#### 2.4.2. Impact of oceans on human health

The fisheries in the coral reefs are crucial for food provision and employment (Burke et al. 2002). Aside from coral reefs, food provision in the Coral Triangle is also dependent on the presence of seagrass meadows. These marine environments provide at least 50 percent of the fish-based food, which is of high importance in the diet of the local communities as it makes up for about 54 to 99 percent of their daily protein consumption (Fifth ASEAN state of the environment report 2017).

Other benefits that derive from coral reef ecosystem services are for example tourism, biomedical substances and natural protection. “Their beauty draws millions of tourists from around the world each year. Corals themselves possess a yet untold value as biochemical material for pharmaceuticals and other products. Reefs also facilitate the growth of mangroves and seagrasses, provide sheltering habitat essential to a variety of marine species, and help prevent shoreline erosion” (Burke et al. 2002, p.9). The people of South-East Asia have lived in close contact with the seas from ancient history onwards. The large coastal population depends on the coast and its coral reefs for local livelihoods. Furthermore, the marine environment is historically and culturally of high importance to coastal communities in this region.

Although in general health benefits from oceans can be substantial, as described in the previous chapter, in South-East Asia the local population does not always receive these. Poverty is widespread in coastal areas in the ASEAN region. The rural coastal population of six ASEAN member states experiences high rates of infant mortality and malnutrition amongst children. The coastal and marine resources as well as the opportunities that are offered in this environment are crucial assets to the livelihoods of the poor coastal population. These high poverty rates have a severe impact on the state of the coast and oceans in the ASEAN region (Fifth ASEAN state of the environment report 2017, p.162). There are plenty of marine activities and residences that can be of benefit to human health, such as diving excursions and beach resorts, however they are commonly experienced by tourists and not by the local population. The oceans are mainly used by the local people as a working domain for fishing and tourism related activities (Burke et al. 2002; Fifth ASEAN state of the environment report 2017). To the local South-East Asian population, it is not necessarily the benefits of the ocean that influence their health, but the risks they are exposed to, living at the coast. It is therefore key to focus on the major health risks that come from the oceans and in what ways these can be reduced to improve overall health.

Deterioration of the South East Asian coast poses great risks to the health of the coastal population. Due to a decline in mangrove forests and coral reefs, there is less natural protection during extreme weather events. As a result, the impacts of extreme weather events are much more severe. Due to climate change and sea level rise, extreme weather events will occur more frequently. Considering the continuously growing population and urbanization rates, there will also be more people at risk (Fifth ASEAN state of the environment report 2017). Furthermore, with a decline in fish populations, food security reduces,



as well as one of the major sources of income disappears. Moreover, one of the main sources of income in this region, marine tourism, will decline as the natural beauty and diversity of ocean life drastically reduces.

Another severe risk that is often indirectly caused by humans is the consumption of contaminated seafood (Fifth ASEAN State of the environment report 2017). As a result of (plastic) pollution in the marine environment, microplastics and chemicals end up in the ocean. These microplastics are consumed by small organisms, which are then consumed by others, hence travelling through the food chain eventually into the human diet. Chemical contamination of parts of the food chain end up in human bodies as well.

To achieve sustainable use of marine resources and ocean conservation, it is necessary for ASEAN to take action. To do so, it is key that education and awareness of the importance of oceans in SEA improves and the general attitude towards the marine environment changes (Clark 2018). Regional conservation and research efforts stress the timeliness of the topic, although they are only at a beginning stage. It is therefore crucial that more research is carried out in this area. For more information on the State of the Art, see Appendix A.

#### 2.4.3. The SDGs on the South East Asian agenda

The way in which the region of South-East Asia is moving towards sustainable development distinguishes itself from other regions, as it is guided by two highly similar agendas, notably the United Nations 2030 agenda for sustainable development as well as the ASEAN community vision 2025. These agendas were both ratified shortly after another in 2015 by ASEAN member states. In an attempt to create one coherent vision and plan for sustainable development in the region, ASEAN plans on converging the ASEAN vision 2025 agenda and the SDGs of the 2030 agenda. “The ASEAN Vision 2025 document emphasizes complementarity of its goals to the SDGs. This complementarity is quite evident and comes in various forms. The first is in their respective overall people-centric goals, which were founded on the desire to end poverty and all forms of inequalities and translated in their respective battle cries” (United Nations 2017, p.28). Moreover, “11 of 14 Vision 2025 Goals are aligned with SDG 17” (United Nations 2017, p.30), acknowledging the importance of international partnerships.

PEMSEA, Partnerships in Environmental Management for the Seas of East Asia, is a regional body that plays an important role in the regional management and conservation of the seas and oceans in East Asia. In their Sustainable Development Strategy for the Seas of East Asia (SDS-SEA) they among others highlight the importance of SDG 13 and 14 for conservation of the seas. It “encourages initiatives to address them. The SDS-SEA strategy to “adapt” focuses on such management and disaster risk reduction, recognizing that preparation is now a critical part of ICM [Integrated Coastal Management], especially in vulnerable coastal areas” (PEMSEA 2017, p.24). With regards to SDG 14, it aims to ““preserve” endangered marine species and threatened resources, and to “sustain” biodiversity and fisheries in the EAS. It is a bottom-up approach to ecosystem management that applies ICM in its broadest sense, beginning in small coastal communities and municipalities, and bringing in local, national, and regional leadership for lawmaking” (PEMSEA 2017, p. 24).

The United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) has collected data on the progress towards the SDGs in South-East Asia and ASEAN member states. The results in the ASEAN countries regarding progress towards SDG 3, 13 and 14 is visualized in Figure 4. Moderate progress is made in Good Health and Well-being, there is a regression in Climate Action and only little progress combined with insufficient data for Life Below Water since 2000 (Data UNESCAP, 2018). “The main challenges for ASEAN in implementing the SDGs are ‘financing, technology, trade, systemic issues and data, monitoring and accountability’” (United Nations 2017).



Figure 4 Progress towards SDGs in ASEAN up to 2018 (UNESCAP, 2018)

The UNESCAP has made an overview of the expected achievements by ASEAN member states with regards to achieving the SDG targets in 2030. The expectations follow up on the trend in progress that has been made thus far. Positive trends are indicated using the color green, accelerate progress with yellow and negative trends are indicated with red. Grey represents a lack of data for measuring the target. Most progress is expected for SDG 3, although it differs for each of the targets. Expected progress for the targets of these goals is positive for 3.9, 3.D and accelerate for 3.3 and 3.4, as shown in Figure 5.

Goal 3	3.1 Maternal mortality	3.2 Neonatal & child mortality	3.9 Health impact of pollution	3.d Risk management capacity	3.b R&D of medicines	3.3 Communicable diseases
	3.c Health financing	3.4 NCD & mental health	3.7 Sexual & reproductive health	3.6 Road traffic accident	3.5 Substance abuse	3.8 Health coverage
	3.a Tobacco Control					

Figure 5 Expected achievements targets SDG 3 in South-East Asia

Figure 6 demonstrates that there is insufficient data for measuring the targets 13.1 and 13.3. Environmental protection, sustainable communities and enhanced capacity for responding to disasters and climate change however are important features of the Vision2025 agenda and do resemble with some targets of SDG 13 (United Nations 2017).

Goal 13	13.2 Climate change policies (national)	13.1 Resilience & adaptive capacity	13.3 Climate change awareness	13.a Needs of developing countries	13.b Capacity for planning & management

Figure 6 Expected achievements targets SDG 13 in South-East Asia

For target 14.2 a negative trend is expected, meaning a reverse trend to achieve the target and there is insufficient data on 14.1, 14.3, 14.4, 14.A (Figure 7). With regards to coastal resilience, extreme events, health and livelihoods of the coastal population of South-East Asia, it is crucial to gain positive results in these targets and measure them accordingly.

Goal 14	14.5 Conservation of coastal areas	14.2 Marine & coastal ecosystem	14.1 Marine pollution	14.3 Ocean acidification	14.4 Destructive fishing	14.6 Fisheries subsidies
	14.7 Marine resources in SIDS	14.a Research capacity & marine technology	14.b Small-scale artisanal fishers	14.c Implementing international law		

*Figure 7 Expected achievements targets SDG 14 in South-East Asia*

### 3. Theoretical Framework

#### 3.1. Drivers, Pressures, State, Impact, Response (DPSIR) in OHH

For an overarching theoretical framework, DPSIR - *Driving forces (Drivers), Pressures, State, Impact, Response*, is used. In Appendix B, more background is provided on the DPSIR framework. In this thesis, the OHH innovations are considered as *Responses*.

Responses are measures that are taken to either change *Drivers*, reduce *Pressures*, act to preserve the *Environmental* or *Human State* or minimize negative and increase positive *Impacts*. *Responses* are traditionally policy and regulatory interventions, but in this research, they are characterized as innovations. An innovation in this context is a measure to reduce risks to humans from natural disasters as well as enhance human health from ecosystem services and improve the ecological state via OHH interactions. Each innovation is a responding mechanism to either a *Driver*, *Pressure*, *State* or *Impact* in OHH interactions. Below, these components are further explained. In the conceptual framework, the connections between the different components are visualized schematically. To fully grasp all aspects of the interactions, this research distinguishes between ‘*Environmental Pressures*’ and ‘*Human Pressures*’ as well as ‘*Environmental State*’ and ‘*Human State*’ (Figure 8).

##### *Driving forces in OHH*

*Drivers* refer to the socio-economic structures and activities that steer human behavior. *Drivers* exist to organize society in such a way that the basic needs of the population are met, and that good living conditions and good health are provided. In the context of this research, relevant *Drivers* are policies and regulations that are concerned with the marine environment, public health, related industrial sectors and emissions. They form the basis for pressures to develop and are a determining factor in the eventual state of environment and human health.

##### *Pressures in OHH*

*Human Pressures* represent the human behavior as a consequence of the socio-economic structure of *Drivers* that influence the environment (Gabrielsen and Bosch 2003; Borja et al. 2006). They are determined by lifestyle choices regarding e.g. consumption, transportation and housing. Examples of human behavior that affect the state of the ocean are either positively through conservation efforts, or negatively through contamination of the waters and coast. *Environmental Pressures* are linked to emissions, pollution and extractive disturbances. “*Environmental Pressures* may include discharges of chemical, physical, or biological agents, land-use changes, direct contact uses through extraction or physical damage to ecological resources, as well as actions that improve environmental conditions” (Yee et al. 2012, p.416).

##### *State in OHH*

The *State* originally represents the natural systems, concerning the quantity and quality of physical, biological and chemical phenomena (Gabrielsen and Bosch 2003). Nevertheless, in DPSIR frameworks focusing on environment and human interactions, there is a need to define the *Human State* and *Environmental State* separately in order to investigate mutual impacts. In this research, the *Environmental State* refers to the ecosystem health of the marine environment. The *Human State* on the other hand refers to physical and mental health and well-being. Both the *Environmental* and *Human State* are influenced by *Pressures* and in their turn have impact on each other.

##### *Impact in OHH*

Fluctuations in *Environmental* or *Human State* influence the *Impact* of oceans on humans, i.e. ecosystem services, as well as consequences for human well-being (Yee et al. 2012; Borja et al. 2006). The *State* of the marine environment greatly determines the ecosystem services of *Impact* for humans, such as safe seafood, recreational spaces and climate regulation. Nevertheless, a deteriorated *Environmental State* reduces ecosystem services and can generate negative impacts to human health and well-being through contaminated water and food and natural disasters and threats. Use of the ocean for improving the *Human State* can impact the *Environmental State*, both positively through restorative practices and negatively through e.g. damage caused during recreation.

Figure 8 shows the conceptual framework, demonstrating how innovations as responses, intervene in all components of DPSI. Their interventions are indicated by the green arrows. Following the framework insight is retrieved that is necessary for answering RQ 3a and b (1.2).

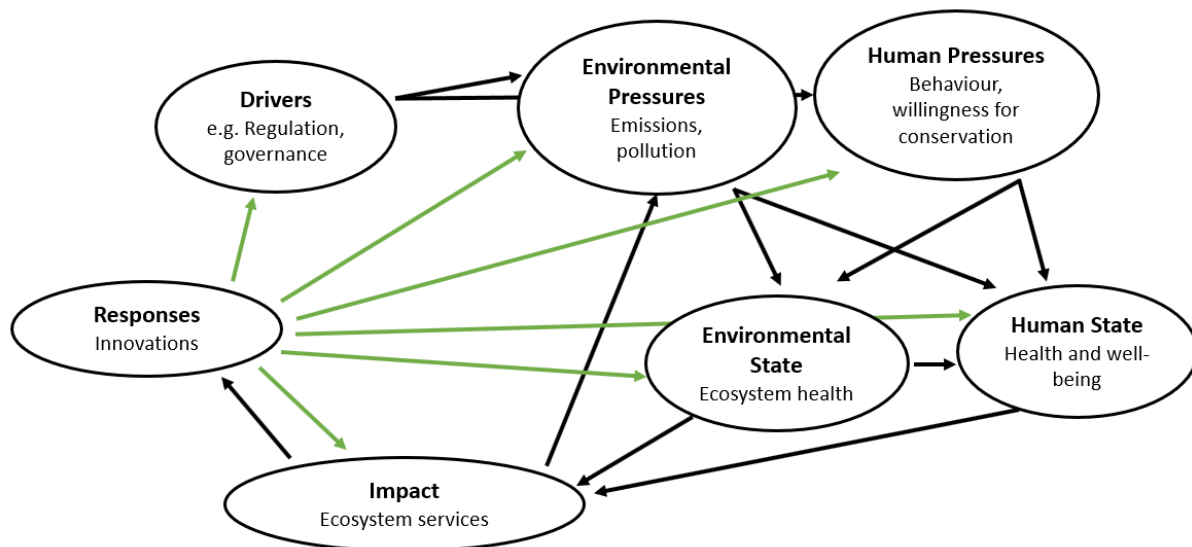


Figure 8 Conceptual Framework

### 3.2. How does this research build on existing theory?

As was mentioned by Lewison et al. (2016), “a key area for development focuses on the R in DPSIR” (p.116). Most of the papers that were reviewed by Lewison et al. used DPSIR to “develop policy responses, but the *Responses* included in DPSIR frameworks are rather limited and focused largely on traditional governance and legislative approaches. It would be useful for future DPSIR research to consider a wide range of potential *Responses*, ranging from those that alter rules and payoffs thereby shaping behavior, to direct investments, to initiatives that might alter human values and preferences that influence consumption and production choices underlying *Drivers* and *Pressures* in the DPSIR framework” (Lewison et al. 2016, 116).

This research contributes to filling this gap in research by attributing the main focus to *Responses* in the application of DPSIR. By doing so, it stands out from previously conducted research using DPSIR, as it goes further than the traditional interpretation of governance and legislative *Responses*. It adds to new interpretations of *Responses* that can be used in DPSIR analyses, by demonstrating the commissioning of initiatives or innovative practices (Lewison et al. 2016). An extensive analysis will present how innovations as *Responses* influence *Drivers*, *Pressures*, *State* and *Impact* and alter human behavior and conservation efforts within OHH interactions. With that, it connects the two separate domains in an integrated approach that is needed for OHH management and policymaking in Europe and South-East Asia.

## 4. Methodology

### 4.1. Scientific and societal relevance

#### *Scientific relevance*

Potential benefits of the relations between oceans and human health in Europe are largely unknown, therefore more in-depth research is crucial (Fleming et al. 2014; 2017). No research has yet been conducted on the effects of pragmatic, innovative OHH initiatives in Europe and the potential benefits that can be generated through them. An inventory of these initiatives could help to connect research on OHH interactions with regional policymaking, governance and management. This study is the first to provide an overview of the impacts of innovations, the environmental issues that are addressed by them as well as the ecosystem services that they provide. Moreover, these innovations are visualized geographically in the form of an interactive presentation tool that serves for information and inspiration throughout Europe.

Additionally, this study applies the DPSIR framework in a novel way. It extends the interpretations of actors of the ‘responses’ component of the framework, going beyond traditional interpretations (Lewison et al. 2016). By doing so, it adds to the understanding of how DPSIR can be applied in environment and health research. Whereas DPSIR is known as a useful framework to understand environmental and social dynamics, this is the first time DPSIR is deployed to study the interactions between oceans and human health. This research makes an interdisciplinary contribution by connecting the until presently often disconnected concepts of public health and marine environment. It therefore contributes to the field of oceans and human health research in Europe. The results of this research are furthermore used as input for the formulation of the European Strategic Research Agenda to further explore the link between oceans and human health.

Although the main impact of this research is concentrated on the European context, making a comparative analysis with South-East Asia, allows it to also contribute to the body of knowledge on OHH relations in that region. Little is known about OHH relations in South-East Asia, but research programs, such as Blue Communities, are gradually being initiated. This research offers an explorative preliminary review to outline innovative and pragmatic examples in SEA and investigate how these fit into the regional context.

#### *Societal relevance*

Europe is a maritime continent with an extensive coastline. It depends greatly on the seas for various purposes and interaction between humans and oceans is essential. Due to these strong interactions, risks and benefits from the oceans to humans and vice versa are crucial. This research demonstrates that risks to human health that are generated through interaction with the seas can be reduced, whereas benefits to humans from the oceans can be increased. It is key that the state of the oceans and seas is protected to enhance human health and sustainably use the oceans. By providing insight in innovative OHH solutions and their potential health and environmental benefits, this research demonstrates its societal relevance. The same applies to South-East Asia; where a large part of the population is vulnerable to risks from ocean interactions, information on how to optimize benefits from OHH interactions and reduce risks will enhance the resilience of coastal communities in this region. Global societal relevance of the research furthermore becomes apparent in specific SDG targets (Table 1) that are addressed, notably: Targets 3.3, 3.4, 3.9 and 3D, on water-borne diseases, water pollution and contamination, early warning and risk reduction. Targets 13.1 and 13.3, on resilience to climate-related hazards and natural disasters, education and awareness-raising. Targets 14.1, 14.2, 14.3, 14.4 and 14.A on marine pollution, protection of marine and coastal ecosystems, ocean resilience, restoration and scientific cooperation at all levels.



## 4.2. Research strategy

The main research question of this research is: *How can (social) innovations in OHH interactions enhance human health in Europe and South-East Asia?* In order to answer this question, the sub-questions are answered in four phases (Figure 9). An overview of the research methods and data collection is presented below. The different steps within the research phases are demonstrated in the research framework. This section is built up of four parts, notably the study design, the selection of participants, data collection and data analysis (Azevedo et al. 2011). Limitations and ethical considerations are also discussed in this chapter.

### 4.2.1. Study design

This research aims to increase understanding of how innovations can enhance human health through OHH innovations in Europe and South-East Asia. It is characterized by a mixed method design in quantitative and qualitative methods as well as a combined case-study and survey design. “Although these strategies can be found as independent major forms of research in handbooks about methodology, in practice a mix of these strategies can be used” (Verschuren and Doorewaard 2010, p.161). This research has done that deliberately, as neither one of the approaches is sufficient to conduct the analysis that is necessary for this research. Therefore, elements are taken from both strategies and combined into one approach. The overall study design has most elements in common with the case study approach, although it also contains various crucial characteristics of the survey design. Following the survey method, many research units<sup>3</sup> are needed for the range of innovations that are investigated, therefore requiring extensive data generation. These provide more breadth than depth and are collected by remote, closed data generation (Verschuren and Doorewaard 2010). The case study approach does not allow for such large samples. The results are quantitative and are analyzed correspondingly, giving insight in the range of impacts innovations have on both oceans and human health.

Unlike the survey approach, research units (innovations) are collected using a strategic or purposive sampling method, limiting the sample to innovative practices in OHH interactions in Europe and SEA only (Azevedo et al. 2011; Kothari 2004). Furthermore, additional information about a selection of units is gathered through semi-structured interviews with key informants linked to the research units. These qualitative research methods are characteristic to the case study approach, which is desired in this research as it allows for more in-depth insight in the data. The type of case study analysis applied is most comparable to the hierarchical case study, in which research units are examined in two stages. First, a separate examination of the units collected in the context of the DPSIR framework. Second, a comparative analysis of the units that are collected in Europe and South-East Asia, in which the focus lies on interpreting the results (Verschuren and Doorewaard 2010; Kothari 2004). During the examination of the units in stage one of the case study analysis, aspects of the reductionist type of survey method are applied. In this stage, “reality is reduced to a set of research units (first reduction), and the latter to a set of variables (second reduction)” (Verschuren and Doorewaard 2010, 163). The innovations of this research capture fragments of reality and are perceived as research units. The analysis following the DPSIR framework then further investigates the corresponding variables.

The research units are all interventional in essence as they intervene in oceans and human health interactions. Therefore, the nature of this research is interventional, however, in line with empirical or observational studies, the researcher does not have control over the interventions as these were already existing research units (Kothari 2004; Azevedo et al. 2011). Subsequently, no randomization procedures

---

<sup>3</sup> A large number in this context is understood as 150-200 research units. According to Verschuren and Doorewaard, dependent on the context, a large number can be understood to be at least between 50-80 units. Depending on the desired breadth of the research project, units could easily range between 5000-50.000 (Verschuren and Doorewaard 162).

were implemented. Research methods applied were aimed at describing the possible associations between research units, rather than test hypotheses on causal relations (Azevedo et al. 2011). Therefore, the research methods can best be categorized as descriptive, including comparative and correlational methods (Kothari 2004).

### Phase I

As explained in the research area and focus, the scope of this research is on innovative European OHH initiatives and a comparative study with South-East Asia. The research has taken place between November 2018 and July 2019. This phase was dedicated to understanding the context of oceans and human health in Europe and South-East Asia and identifying the gaps in knowledge, answering question 1 and 2 (section 1.2.). Accordingly, a suitable framework for analysis, DPSIR, was selected and research strategies and methods were determined to help close the knowledge gaps.

### Phase II

During phase two, data collection took place. The design of the sampling methods, participant criteria and recruitment methods were determined prior to data collection. Innovations in OHH in Europe and South-East Asia were identified through websites, social media, an online form, semi-structured interviews and informal conversation. This background information and overview of innovations partially answers the third sub-question of this research and forms the basis for analysis in phase III (section 1.2.). In-depth interviews with experts and innovators are used to gain understanding of the current practices regarding OHH interactions and their perspectives on the potential of upscaling innovations.

### Phase III

Data analysis programs SPSS and NVivo are selected for processing the data retrieved in the previous phase. DPSIR is used as a tool to investigate the potential of innovations and their effect on environmental and human health benefits, the SDGs and their scope of impact. This analysis of innovations demonstrates how OHH interactions can help to enhance human health and environment. The data from the interviews help to embed these results in the context of OHH in Europe and SEA and further understand the potential of innovations. During this phase, sub-question three and four are discussed in depth (section 1.2.).

### Phase IV

Resulting from data analysis in phase III, common practices are evaluated, and their potential for enhancing OHH is discussed. Key focus areas for OHH policymaking based on innovative case studies are identified and presented. Furthermore, the possibilities for intercontinental exchange of OHH knowledge and innovative practices between Europe and South-East Asia are presented during this phase. This phase aims to answer sub-question five and provides overall conclusions that answer the main research question (1.2.). Ultimately, final recommendations for the European Strategic Research Agenda are made, pointing out where further research is still needed.



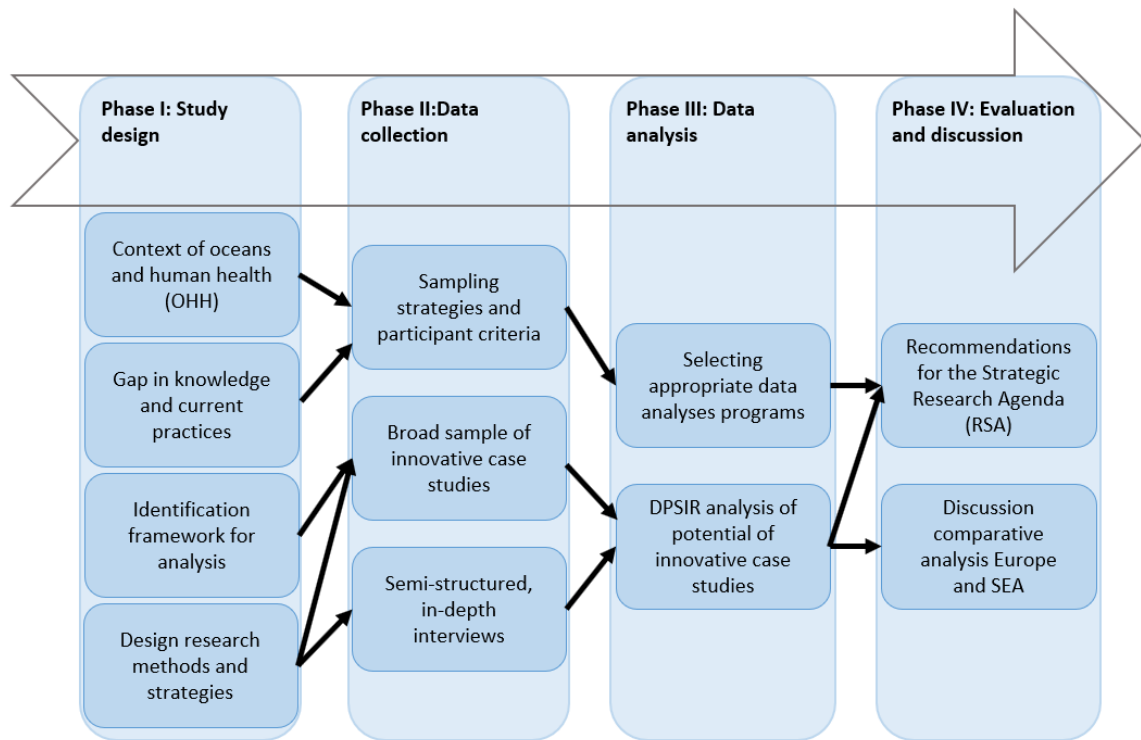


Figure 9 Research Framework

#### 4.2.2. Selection of participants

##### *Participant criteria*

Participants and innovations were selected based on inclusion and exclusion criteria. The criteria used for research units to a large extent defined the potential participants for qualitative data collection. These units consisted of innovative case studies that cover oceans and human health within Europe or South-East Asia, excluding current practices in oceans and human health or innovative cases in other areas. Innovative cases are understood to not yet be institutionalized or formalized on a large scale and make use of OHH interactions in a creative way. Social innovators or key informants (Table 4) were selected for interviews from the innovations according to a wide range of topics. Criteria were that participants either have founded or are actively involved in an innovative case and speak either English, Dutch or Spanish<sup>4</sup>.

Experts (Table 4) were selected for in-depth interviews to enhance understanding of OHH research and context, policymaking in Europe and current practices. Based on their field of expertise, candidates were selected during a multi-day expert meeting. The expertise of these candidates was in OHH research, European OHH policymaking and current practices. Furthermore, they had in-depth knowledge of the regional socio-economic, cultural, environmental and geographical context. Both key informants and experts were selected regardless of gender, age or background.

##### *Sampling methods*

Interview candidates were identified according to selection from the database of innovative case studies based on the criteria above. The target population was clearly identified, and the applied sampling methods correspond with deliberate sampling, also known as purposive or non-probability sampling (Azevedo et al. 2011; Kothari 2004). This sampling method was not used with the idea of obtaining a representative sample of the target population, but rather for covering a wide range of interventions.

<sup>4</sup> Due to further language restrictions of researcher

For the selection of experts, judgement sampling as component of deliberate sampling was used. Judgement sampling is not meant to make generalizations, but to further develop hypotheses, in this case about potential of innovations in OHH interactions.

#### *Recruitment process*

As the key focus of this research lies on the inventory of innovations within the European domain, the SOPHIE online form<sup>5</sup> (Appendix D) and meetings are oriented towards this region. Gathering data on South-East Asia for comparative analysis involves inventing other strategies, making use of a more extensive network.

Four categories of participants can be distinguished, notably key informants (social innovators) in Europe, key informants in SEA, OHH experts in Europe and regional experts on South-East Asia (Table 4). Key informants in Europe were identified by means of the database with initiatives and websites. A few social innovators managed to find and fill in the online SOPHIE form and left their contact details. For the innovations collected by the researcher, key informants were selected using the initiative's website. They were contacted via email and asked to participate in a 15-20-minute telephone interview. The response rate was 14 out of 24 and of the responses (none refused to participate, but some were unavailable). The key informants in South-East Asia were selected from websites of innovations and through personal contacts. Meetings and conversations with experts during the multi-day expert meeting of the SOPHIE project in Oostende (Appendix I) as well as Deltares meetings, introduced the researcher to various local expert networks and through this snowball sampling strategy, key informants in South-East Asia were contacted. The response rate was 6 out of 8, of whom 5 eventually participated in interviews. Non-respondents with available phone number and one-time respondents received a polite reminder in an attempt to increase the response rate. This led to new email contact, but due to busy schedules not always to interview responses. This challenge was solved by contacting sufficient new candidates.

Most experts were recruited for interviews during the multi-day expert meeting, where acquaintance was made during informal conversations. After the meeting, experts were contacted via email and asked to participate in a 45-60-minute interview. The response rate was 5 out of 7, with 1 out of 7 refusing to participate. The motivation for refusal was a perceived lack of experience, being a first year PhD candidate. Non-respondents and additional experts received a reminder and invitation to participate by a mutual contact, which led to interesting new interviews. Furthermore, the researcher was introduced to experts within the host organization that had in depth knowledge of the research topic or the region under study. Three experts from the organization with living and work experience in the region of South-East Asia were interviewed as well as one expert on European marine policymaking. For South-East Asia, two external experts were also contacted, whom however did not respond to the inquiry.

#### **4.2.3. Data collection**

The methods used in this research are mixed methods of qualitative and quantitative data collection. The **quantitative data** account for the basis of the research and are selected from the internet and collected into an online form by the application of content analysis (Krippendorff 2004). During the search for innovations, the researcher made use of search engines to find websites, social media channels (Facebook, Twitter and LinkedIn) and online newspaper articles. The internet holds an important record of texts that users can obtain and use and content analyses of web pages have become more common (Krippendorff 2004). The complexity and richness of the web and the access to mixed

---

<sup>5</sup> Online list of questions designed by the host organization for describing innovations.

media provide many opportunities for the researcher to apply content analysis to web pages (Kim and Kuljis 2010). In order to compile the database of innovations, information is collected in the SOPHIE online form. Additional to content analysis of websites and social media, this form has been filled in by either initiators or participants of innovations. During the search for innovations, a range of textual attributes is used to find appropriate results and retrieved texts are judged for their relevance by the researcher (Krippendorff 2004). The content analysis of web pages allows the researcher to identify and use relevant data in a convenient manner (Kim and Kuljis 2010). The population of relevant texts, that represent the phenomena of interest, that is then collected forms the basis of the inventory. In line with content analysis they are further distinguished, categorized and cross-tabulated using the SOPHIE online form and SPSS.

The strategy of collecting innovations furthermore complies with the reductionist strategy of the survey approach. “The use of closed questions (questionnaires and structured interviews), and closed observation categories, to be used in systematic observation and content analysis of written and audio-visual documents and contents of media” (Verschuren en Doorewaard 2010, 163). As a result, an extensive overview of existing innovations in Europe is gathered and categorized as to how they operate within OHH interactions, what environmental issues they cover, what health benefits they generate and where they are located. In total 150 innovative case studies are listed as a purposive sample to obtain a range of cases from which information can be retrieved (Table 2 and Table 3). For South-East Asia, the same collection strategies were used, but the cases were collected in a separate excel document. The desired number of cases for SEA in this research is 50. The same overview is then made for these cases, using the program SPSS. This part of data collection gives insight in information necessary for answering question 1, 3b and 5 (1.2.).

The SOPHIE online form was designed by the host organization at the early stages of the SOPHIE project. The program used for the design of the form is Formdesk, in which the data are also collected. Data can be downloaded from Formdesk into an excel file, which is then imported in the data analysis program SPSS. The initial idea of the online form was that people involved in an innovation would fill it in, providing information about their initiative. Though this online form was spread among a large network of ocean and health specialists; i.e. the project partners of SOPHIE and their networks, as well as the audience of an oceans and human health meeting in Stockholm, only a few responses were collected. It was not clear if this low response rate was caused by inefficient targeting of audience, lack of visibility to audience, lack of willingness by audience or the complexity of the form. In order to collect data on innovations, an internal researcher at Deltares, who is also involved in the SOPHIE project started the collection process. From the beginning of November onwards, the collection of innovative case studies was included as a part of this thesis research.

During content analysis of web sources, it quickly became apparent that for some topics, many initiatives were available, such as plastic pollution and recreation. Innovations for other topics such as biotechnology and eutrophication were more difficult to encounter. Geographically, the Black Sea appeared to be most difficult in finding cases, probably partly due to a language barrier. When a gap was identified in a topic or geographical area, extra effort was put into searching for cases there, to ensure minimal bias. In this way, relevant insight was collected for question 4 (1.2.). Social media was strategically used, particularly for its interconnectivity and timeliness of information. Initiatives with similar interests and missions are often linked via their social media pages. Websites were used for collecting information about innovations, whereas social media was used to find other cases.

**Qualitative data** on the other hand are collected via two approaches: First, semi-structured, in-depth interviews are conducted with key informants (social innovators) across the European continent. This

was done in order to get access to more local innovations in countries that due to a language barrier or the scale of the innovation cannot be found through desk research. Also, this was used to gain insight in the perspectives of social innovators on the potential of innovation in OHH relations and suggestions for expansion of OHH innovations in Europe. To gather information on innovations in South-East Asia, regional experts from Deltares and their local network were contacted, as well as external experts from the SOPHIE project (Figure 10).

Key informants were selected from the collected case studies: A selection of 24 initiatives covering a range of different environmental issues and ecosystem services ensured a diverse representation of the types of initiatives. The contact persons of these initiatives were either encountered via the website, social media or occasionally through the SOPHIE online form and were contacted for a 15–20-minute telephone (or skype) interview. Considering the fact that this part of data collection took place mostly in a developed region with limited time, telephone interviews were highly desirable (Kothari 2004). Similarly, for data collection in SEA, this method was preferred as it is more flexible in comparison to mailing methods and is a quick way of obtaining information (Kothari 2004). Via these interviews, new initiatives were suggested as well as new possible contact persons. Furthermore, these interviews gave insights in the perspectives for upscaling by highlighting missing structures and important measures for upscaling. Interviews were conducted in three languages, notably English, Spanish and Dutch. In a few exceptions, the interview questionnaires were sent via email to the participants that due to time constraints were not available over the phone. The data collected using these methods provided crucial information for question 3b, 3d and 5 (1.2.).

Second, semi-structured, in-depth interviews with external experts were conducted to gather information on the context of OHH in Europe and contributed to increased understanding of the research background. The respondents are project partners of SOPHIE that are engaged in oceans and health research and European policy-making and regulations. These interviews were highly important for enhancing the understanding of the European context additional to the literature review. Moreover, they are necessary to place the innovations and focus of this research into the broader context of oceans and human health in Europe. The project partners are experts in the field and have given new insights that could not yet be encountered in literature. Much of their research forms the basis of the most recent knowledge on OHH and is sometimes still captured in working documents. Therefore, the interviews provided new insights to this research and have added crucial information. Moreover, this information has been key to identify the gaps in policy-making and further explore the potential of innovations with regards to these gaps. The information collected in this stage of data collection forms an important part of the answers to question 1, 2 and 3d (1.2.). In addition, in-depth interviews were held with experts on South-East Asia, in order to gain more insight in the current state of affairs in the region concerning oceans and health. The input from these interviews further helped to gain insight in question 1,2 and 5 (1.2.).

Prior to conducting the semi-structured and in-depth interviews, questionnaires were designed by the researcher and adapted various times, to meet the needs of the research and adjust to the schedule and expertise of the interviewees. The interviews were recorded, transcribed in Excel and coded in NVivo. The list of interviewees is presented in Table 4 and the interview questionnaires are listed in Appendix E)

## Europe

Table 2 Data collection and interviews

Data collection method	Number of respondents
Online form	150
Semi-structured, in-depth interviews	11 key informants
Semi-structured, in-depth interviews	5 experts

## South-East Asia

Table 3 Data collection and interviews

Data collection method	Number of respondents
Online form	50
Semi-structured, in-depth interviews	5 key informants
Semi-structured, in-depth interviews	3 experts

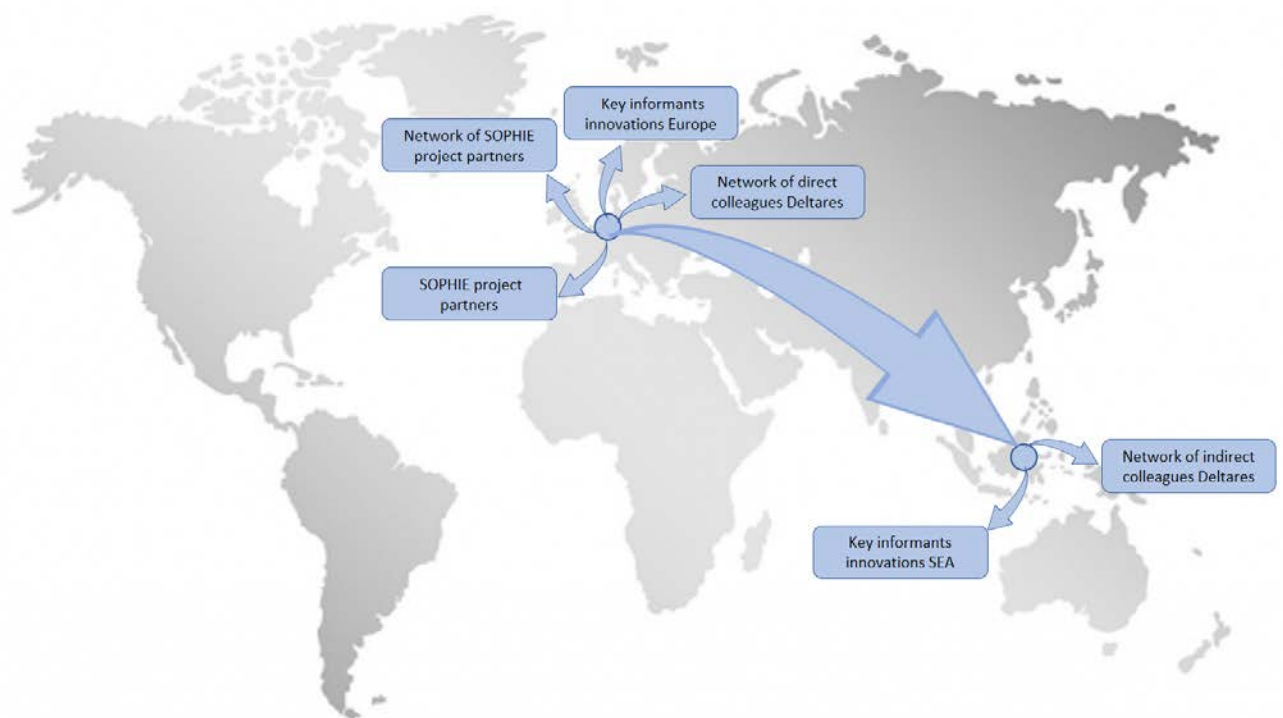


Figure 10 Map of Research Network

Table 4 List of Experts Interviewed

<i>Europe</i>			
Social innovators	Organization	Country	Topic/Expertise
1	KostaSYSTEM	Spain	Videometry tools for beach management and coastal risks
2	SUP-Kids	Worldwide	SUP, water safety and environmental education

3	Safe Haven Ireland	Ireland	Sail training opportunities for integration and youth empowerment
4	The Wave Project	UK	Surf therapy and emotional health
5	Vies Braves	Spain	Open water swimming, recreation and awareness
6	Adria Experience	Croatia	Sailing for mental well-being, fitness and happiness
7	Exxpedition	UK	Citizenscience, water quality and gender equality
8	Healthy Seas	Greece, The Netherlands, UK and Italy	Prevent and remove fish nets from polluting the seas
9	Scott Haldane Foundation	The Netherlands	Diving and hyperbaric medicine
10	Swim Guide	France, Ireland, Denmark	Water quality, awareness and citizen-science
11	Waddenwier	The Netherlands	Sustainable seaweed production
<b>Experts</b>	<b>Institution</b>	<b>Country</b>	<b>Topic/Expertise</b>
12	Think tank in marine science policy	Belgium	European marine science policymaking and regulation
13	Knowledge institute	The Netherlands	Coastal and marine systems and European policymaking
14	Higher education	England	Ecotoxicology, environment and human health. Research on oceans and human health.
15	Higher education	England	Epidemiology, environment and human health. Research on oceans and human health.
16	Higher education	England	Environmental psychology, health and well-being. Research on oceans and human health.
<i>South-East Asia</i>			
<b>Social innovators</b>	<b>Organization</b>	<b>Country</b>	<b>Topic/Expertise</b>
17	The Pink Nose Revolution	Papua New Guinea	Surfing for women empowerment and mental health
18	Surf + Social Good Summit	Indonesia	Surfing, collaboration and social change
19	Biorock	Indonesia	Artificial reefs for biodiversity and ecotourism
20	Greeneration	Indonesia	Waste management and ecofriendly behavior

<b>21</b>	Watertrek – Paddle and Plant	Myanmar	SUP, environmental education, conservation and research
<b>Experts</b>	<b>Institution</b>	<b>Country</b>	<b>Topic/Expertise</b>
<b>22</b>	Knowledge institute	The Netherlands – Singapore	Marine and coastal ecology
<b>23</b>	Knowledge institute	The Netherlands – The Philippines	Research and project development in South and East Asia
<b>24</b>	Knowledge institute	The Netherlands – The Philippines	Landscape ecology and public health

#### Data management and quality

Complications with data collection for this research were that the database used in this research is a self-compiled database that had to be created from the beginning. Cases collected in the database were selected based on expert judgement by the researcher. Steps that were taken to ensure minimal bias, ethical conduct and transparency are presented below:

The first step was to formulate criteria for collection of innovations. Since this research is looking for innovative solutions in oceans and human health interactions, it excludes initiatives that already exist on a large scale or have existed for quite a while. Case studies are considered innovative when they are not yet institutionalized or formalized on a large scale and that make creative use of interactions between oceans and human health in a way that is not common and that build on current practices. Based on aforementioned criteria, expert judgement decided which case studies were considered innovative and therefore included and which ones were not.

Second, in order to cover a wide range of international web-sites, the researcher made use of 5 languages (English, Dutch, Spanish, Portuguese and French) to search for innovations in areas of which researcher possesses language skills. However, as this research has collected data from innovations throughout Europe and South-East Asia, there are limitations to the research with regards to language barriers. Since many of the innovations are local initiatives, they often operate within their own network and language, making it difficult for an outsider to encounter them. Furthermore, these small-scale innovations often do not have a website or social media channel, making it even more complicated to trace them via internet. Hence, the network of social innovators that is contacted in this research is key for detecting such innovations.

One strategy applied by the researcher to detect initiatives that were difficult to find online, was to inquire after other examples of innovations in the country or region during interviews with key informants. This often proved very successful as it led to new contacts and initiatives that, prior to the interview, were not known to the researcher. Additional to these interviews, regional contacts from Deltares were approached by the researcher to find new cases or sources of information to contact in the region where data were lacking. This was done for the Black Sea basin, where due to a.o. language barriers few innovations were found. Although the regional experts did not know of any examples, they did refer to new platforms on the internet for more information. This allowed the researcher to encounter more initiatives for the region.

As a means to ensure minimal bias, continuous reflection on research progress and evaluation of results was performed in search of gaps. Attention was then paid to filling these gaps and investigating if these occurred due to insufficient effort or not. Notable is that the data collection and creation of the database was not fully done by the researcher; the host organization played a significant role in designing the



framework of the database and adding some innovations to it. The approach of the people involved in this process differed from the researcher's and may have influenced the style of input in the database. These components of the data collection process are characteristic to handling a new database rather than an existing one.

Characteristic to doing research, there are limitations to the methodology that need to be considered. An overall limitation to this research is that it is restricted to innovations that were successfully working. Innovations that failed could not be found on the internet and could not be considered in the analysis. It went beyond the scope of this research to investigate the reasons for failure of initiatives, hence the researcher decided to only focus on successful innovations and their impact. The mixed-methods character of this research makes for various strategies to complement each other and make use of the different strengths of all methods. However, some important potential limitations are a consequence of this strategy. The research consists for a large part of qualitative data, which means that analysis is based partly on the researcher's interpretation. The quantitative data that is collected for this research on the other hand is highly useful for identifying trends, but due to the unique, innovative nature of all cases collected as well as the size of the sample, it is almost impossible to derive generalized conclusions from the analysis. Because this is the first, almost entirely self-compiled database, it only represents a first inventory of the innovations that exist in Oceans and Human Health and encourages further investigation of their potential.

The ethical conduct of the qualitative methods of this research was based on the three core principles of ethical research set out by Hennink, Hutter, & Bailey (2011), notably respect of persons, beneficence and justice. This research made use of informed consent and self-determination, meaning that interview candidates were well-informed about the research and could choose to participate or refuse. The researcher ensured that participating in interviews would not cause any harm to participants. It was taken into account that interviewees were highly respected researchers or entrepreneurs who had very busy schedules and that their participation was not rewarded with any financial means. The researcher tried to ensure that the interviews would not require any more time than was agreed upon beforehand. In some cases, the interviewees themselves indicated they preferred some more time, which was always accepted and appreciated by the researcher. Although not in financial sense, the research does give interviewees back an increased insight in a new domain of OHH. With the completion of this research as well as the interactive map new insights are given as to what other types of innovations exist aside from the ones interviewed, in which all participants were very interested. Interviews were recorded with permission of the interviewees and they were assured that the records would be kept confidential. Participants are only known to the researcher and remain anonymous in the thesis.

#### 4.2.4. Data analysis

Qualitative data were recorded, transcribed and analyzed by use of coding in the NVivo program, ensuring that interpretations are grounded in the data (Hennink et al. 2011). Coding software such as NVivo is beneficial to the researcher as it allows for more effective and efficient coding, locating and moving of data (McLafferty and Farley 2006). All 24 interviews were coded, by means of inductive and deductive coding. This method implies that codes were formulated both by the topics of the interview guide as well as issues raised by participants directly deriving from the data (Appendix F). Whilst rereading the transcripts, data was annotated to later develop and refine codes. In a later stage, analytical reading was applied to the texts, to consider the underlying context of the interviews. This was a means to better understand the data than when merely annotating (Hennink et al. 2011). The quality of analysis of the qualitative data depends to a large extent on the precision of the coding. Therefore, the data is coded carefully, and the amount of codes was determined when researcher decided that a point of saturation was reached (Hennink et al. 2011).



Quantitative data were collected in a database of the program Formdesk while interpretations and comparisons were done using the data analysis tool SPSS and Excel. A crucial aspect of data analysis was to get familiarized with the data and the data analysis tool. Analysis of quantitative data has taken place in multiple phases. In the first phase, the research units (innovations) are listed, followed by the second reduction, notably the investigation of their variables. After that, they are “processed and analyzed in a quantitative way based on statistical principles and procedures” (Verschuren and Doorewaard 2010, 162-163). Taking analysis one step further, this survey approach is combined with a case study approach that allows for comparative analysis. In conclusion, the innovations are first studied independently from each other, using the DPSIR framework. After that, their variables were investigated, i.e. their impact on environmental issues, ecosystem services and SDGs, followed by a comparative analysis between Europe and SEA (Verschuren and Doorewaard 2010; Kothari 2004). Spider diagrams have been found to be useful tool to visualize the application of the DPSIR framework to environmental issues and ecosystem services in an integrated manner. They help to see how measures are rated based on various components and have among others been applied by Ericksen (2008) and Nachtergaele et al. (2010) in socio-environmental research to link environmental quality and ecosystem services to social well-fare.

Additional to the variables of the online form, an analysis of the stakeholders involved in innovations was conducted (Appendix H). As was also done for the DPSI categories and SDG targets, new variables were added in SPSS to include stakeholders. A categorization of stakeholders was developed and finetuned by researcher and supervisors, which includes both beneficiaries and actors involved. For each innovation it was decided to which stakeholders it was applicable. Again, multiple answers were possible.

*Table 5 Overview of stakeholders*

<b>Stakeholders</b>	<b>Definition</b>
NGO	A non-profit organization that operates independently of any government and aims to address social, environmental or political issues (Lexico).
Business	A commercial organization selling or producing goods or services.
Public health	“The science and art of preventing disease, prolonging life and promoting human health through organized efforts and informed choices of society, organizations, public and private communities and individuals” (Acheson, 1988; WHO in “Public health services”, n.d.). Public health takes into account physical, social and mental well-being and promotes health while preventing and treating diseases.
Personal health	Centered on the patient and provided anytime, anywhere, inside and outside the institutional points of care (IGI Global).
Fishing community	Group of people involved in the fishing industry, including the catchment, sales and lobby.

Environmentalists	Group of people concerned about protecting the state of the environment.
Scientific community	Scientists or scientific institutions that conduct research and provide expert knowledge.
Art community	Group of people involved in creative activities.
Governmental body	Any form and level of governance from municipalities to national governments, to international governing institutions.
Educational community	One or more educational institutions or a group of teachers.

Source: Compiled by the researcher.

### Reflection

During the data collection and analysis some difficulties appeared with regards to the categorization that is used in the SOPHIE online form. For each innovation that was collected, three types of categorization, i.e. environmental issues, ecosystem services and type of action, were expected to be selected in the online form, of which multiple answers were possible. This had complicated the process of analysis, as the answers given to the questions were not recognized as multiple answers by SPSS. In practical terms, this has meant that the multiple-choice answers from the online form had to be recoded into new variables with values '0' and '1', corresponding to which of the answers were selected.

Since the SOPHIE online form was designed before the start of this research and was not open to adaptations, there were important features missing. Hence, also content wise, some extra steps were added to be able to conduct the necessary analysis in SPSS. In an early attempt to solve inconsistencies in the SOPHIE online form with regards to the content of this research, new categories were introduced by the researcher that were an agglomeration of two SOPHIE online form categories, notably environmental issues and ecosystem services. Nevertheless, after extensive practicing, puzzling and familiarization with the data and the data analysis tool and negotiations with two supervisors, it was decided to maintain the initial categories and instead add a new structuring mechanism that would be used for analysis: The DPSIR framework.

This research decided to structure the innovations according to the DPSIR framework, therefore, all innovations had to be re-evaluated and categorized according to DPSIR. In this process, each of the innovations was assigned to one dominant component of DPSIR. Moreover, it was of high relevance to this research to investigate the correspondence of all innovations to the SDGs. By means of expert judgement and evaluation of each individual innovation description was decided which SDG targets were relevant. A list of the definitions of SDG targets and DPSIR operational concepts was also maintained during this matchmaking process, ensuring its accuracy. These steps of analysis have been crucial in formulating an answer to research question 3a and c (1.2.). Consequently, more variables were added in SPSS with the relevant SDG targets, which values again were demonstrated by '0' and '1'. The determination of the corresponding SDG targets was done manually for all innovations separately; a lengthy process. Shortly before the preliminary analysis of 100 results, a formula was used in Microsoft excel that allowed the process of assigning '0' and '1' to the innovations to be carried out more easily in all categories.

With regards to the comparative analysis, the scope of the research was adapted a few times. At the start of the research, the research area was restricted to Europe, however considering the timeliness and international relevance of the research topic, the scope was extended to include a comparative analysis with another region. The scope however needed to be adjusted various times, first, from a broad

comparative analysis between Europe and South-East Asia to a more focused comparison between innovations in Europe and Indonesia to make the research more feasible. However, new insights lead to a re-adjustment, notably comparing trends in the selection of research units in Europe to a selection of units found in ASEAN countries. This last adjustment enables the research to properly compare cases in various countries that exist in different regional contexts to each other to find differences and similarities in trends. Furthermore, it offers the opportunity to conduct analysis and give recommendations for two supranational governing domains, notably the European Union and the Association of South-East Asian Nations.

#### Presentation of data

As a means to present the data, the researcher assisted in the creation of an interactive map (Appendix C) as a visualization tool for the innovations. A geographical and thematic overview of the collected innovations is presented in this interactive map, that allows users to select and structure according to topics covered by innovations, notably environmental issues and ecosystem services. Various meetings with a cartographer were scheduled to discuss the design of the map. The collected data needed to be rewritten into a suitable format for the mapping design tool. The researcher was responsible in the design process for the collection of latitude/longitude coordinates and the selection of colors and symbols representing the various environmental issues and ecosystem services. The cartographer translated this data into a map using the program GeoJson.

The map allows for visualization of geographical and thematic distribution of innovations. It demonstrates areas for further research and helps to see where gaps exist. It allows for selection of thematic layers that can be activated or de-activated and combined to see what gaps might occur and what the dominant issues and proposed solutions in different areas are. It is a tool to present the data in a way that provides more insight than is done by graphs or tables. The map can be used for supplementary insights when answering sub-question 3 and 4 (section 1.2.). Furthermore, the map functions as a preliminary setup of what can later develop into an interactive platform where social innovators can connect to each other. It is of use to the researcher, the project partners of SOPHIE and social innovators as well as for the Strategic Research Agenda of the European Union and dissemination to the public through the SOPHIE website.



## 5. Results





In the first part of this chapter, the observations of innovations in Europe are presented and discussed in terms of environmental issues (5.1.1.), ecosystem services (5.1.2.) and sustainable development goals (5.1.3.). In the second part (section 5.2.), innovations have been categorized and conceptualized using the DPSIR framework, analyzing how these relate to the environmental issues addressed and ecosystem services delivered. Third, a comparative analysis with South-East Asia is conducted to understand the operations of OHH innovations in different settings worldwide (5.3.). At the end of the chapter in 5.4. experts share their view on the potential role of innovations in both Europe and South-East Asia.

### 5.1. Description of innovations





The collected innovations are very diverse but have one thing in common: they enhance human health and well-being and improve the state of the marine environment. The approaches for achieving this are different for various innovations tackling different environmental issues as well as generating various ecosystem services. Innovations contribute to, among others, increased scientific knowledge and research on ocean health, pollution and biodiversity and help to maintain healthy fish stocks. Or they facilitate access to coastal areas and inclusive recreational activities that strengthen the physical and mental state of people. Others set protected areas, spread awareness on climate change and environmentally friendly behavior and optimize technologies for using oceanic resources. The wide diversity of innovations is illustrated with examples of groups of innovations in Table 6.

Table 6 Examples of innovations

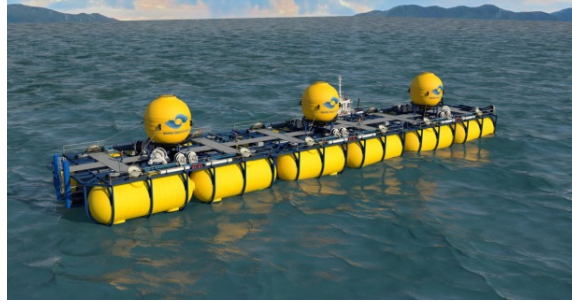
Examples (groups) of innovations	Illustration	Action
Early warning systems	 <p>❖ <i>Environmental Agency - Bathing Water Quality Forecasting System</i></p>	Early warning systems are applied in forecasting, for example targeted at bathing water quality, to reduce the risk of ingesting contaminated water or exposure to harmful substances during bathing activities.
Citizen-science	 <p>❖ <i>Community Seagrass Initiative</i></p>	Citizen-science initiatives are typically research projects in which citizens can participate to monitor issues varying from coverage of seagrasses and coral bleaching to water quality, microplastics and biodiversity.

<p><b>Sustainable food provision</b></p>	 <p>❖ <i>Pesce Ritrovato</i></p>	<p>Sustainable food provision includes sustainable fishing practices, that reduce pressures on species that are overexploited and instead focus on alternative species for consumption, as well as alternatives food sources from the ocean such as the cultivation of seaweed.</p>
<p><b>Conservation, and restoration</b></p>	 <p>❖ <i>EDMAKTUB – Drones for Cetacean Research</i></p>	<p>Conservation and restoration innovations address the state of the environment by enhancing biodiversity, restoring coral reefs, mangroves and other marine habitats, setting protected areas and applying new technologies such as artificial reefs. Often these projects have a recreational component to them, where volunteers can help with replanting or monitoring in the field.</p>
<p><b>Ecotourism</b></p>	 <p>❖ <i>Biorock Indonesia</i></p>	<p>Ecotourism initiatives offer an alternative to mainstream or mass tourism in coastal areas. An example is a whale watching certificate that protects the animals as well as human safety. Other ecotourism activities are sustainable sailing expeditions and coastal wellness retreats or a combination with citizen-science, such as tracking wildlife observations during excursions.</p>
<p><b>Environmental education</b></p>	 <p>❖ <i>SUP-Kids</i></p>	<p>Environmental education programs promote environmentally friendly behavior and enhance ocean literacy. These can take place in the shape of environmental classes in schools, as well as interactive outdoor activities and awareness campaigns. Examples are SUP and education programs, film competitions and art programs.</p>



<b>Plastic clean up and recycling</b>	 <p>❖ <i>Recycled Park</i></p>	<p>Clean up and recycling projects include both the prevention of waste disposal in the marine environment as well as the removal thereof and the re-use of plastic waste as a resource for new products with recreational value. Examples are 3D printed coastal recreational spaces and benches, surfboards, clothes or eco-bricks for sustainable housing.</p>
<b>Biotechnology</b>	 <p>❖ <i>Coral Biome</i></p>	<p>Research projects investigate the potential of biomedical compounds in the marine environment that can be used in the treatment of diseases such as cancer, diabetes and Alzheimer. Moreover, with increasing antimicrobial resistance, there is a need for novel medical substances.</p>
<b>Mental health</b>	 <p>❖ <i>Sailing into wellness</i></p>	<p>Initiatives that use the restorative effect of the ocean in interactions with the ocean for people suffering from mental health issues like depression, anxiety, stress and ptsd. Types of activities are sailing, surfing and meditation at sea for improving mental well-being. Adaptive programs are also created to include people with physical or mental disabilities.</p>
<b>Adaptive rescue services</b>	 <p>❖ <i>Surfing Medicine International</i></p>	<p>Threats to human health from spending time or living at the coast occur through floods or accidents in water sports and activities. Innovations provide among others medical training for rescuing surfers, hyperbaric medicine and post-flood rescuing resources.</p>

## Renewable energy production



❖ WaveSub

Innovative technologies can enable renewable energy production from waves or tides. These are local solutions, that can drastically reduce the dependency on fossil fuels, reduce CO2 emissions and are sometimes used in combination with spaces for recreation and enhancing biodiversity.

Source: Compiled by the researcher

In the collection of innovations and the compilation of the database, researcher ensured minimal bias by actively searching across all regions in Europe (4.2.3.). Based on the selection criteria as discussed in the methods section, a total of 150 innovations has been collected, categorized and analyzed. The geographical distribution of the innovations is shown in Figure 11 and Figure 12. Figure 11 demonstrates in blue the European countries in which innovative cases have been identified. Selection was based on European countries with a coastline of which has been made use by OHH innovations as location for one or more activities. Although Europe is usually subdivided into 5 major sea basins, notably the Baltic sea, the North Sea, the Atlantic Ocean, the Mediterranean and the Black sea, this research also includes the Celtic Sea as a separate sea basin. The geographical distribution of the innovations across the European sea basins is considerably unequal (Figure 12). Most cases were found in the North East Atlantic, North Sea and Mediterranean Sea, whereas least cases were identified in the Black Sea. All 6 sea basins under study have very different characteristics in terms of natural environment, climate, culture and socio-economic structures, which is why some types of innovations function better under specific circumstances and are therefore more prevalent in some areas than others.



Figure 11 Research Area in Europe. (Please note that The Canary Islands are included in this research, although not displayed in this map)



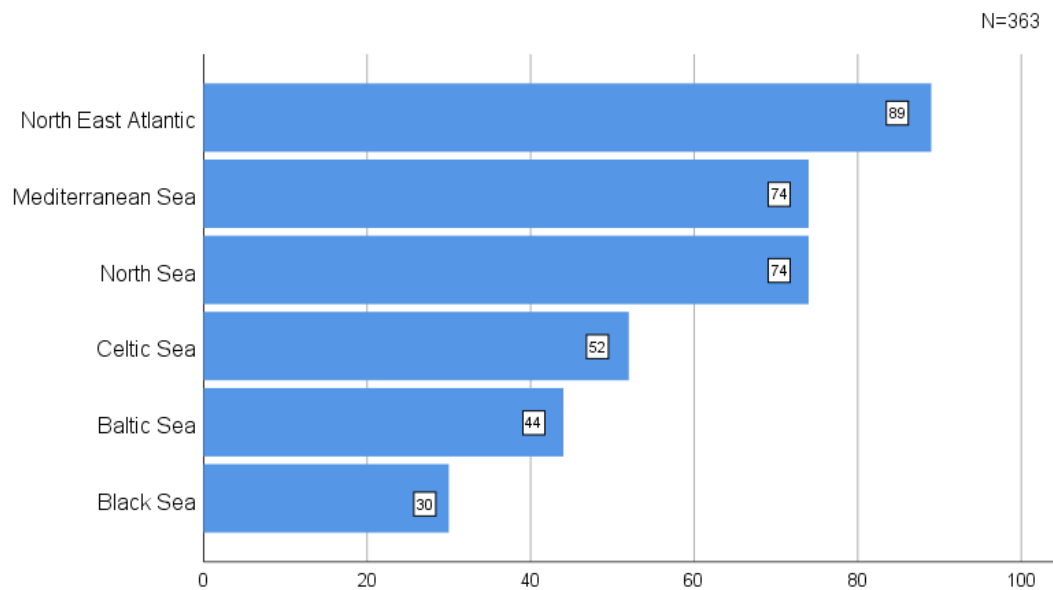


Figure 12 The geographical distribution of innovations over the European sea basins.

### 5.1.1. Environmental issues addressed by innovations

In order to understand the impact of innovations on the environmental state of the oceans, for each innovation is indicated to what environmental issues it responds, with multiple answers possible. The results are depicted in Figure 13 to illustrate which topics are commonly addressed by innovations and which are not. Regarding environmental issues, the innovations mostly address loss of biodiversity, plastic pollution, commercial fish stock depletion and climate change/ocean acidification, whereas little attention is paid to eutrophication and harmful algae blooms.

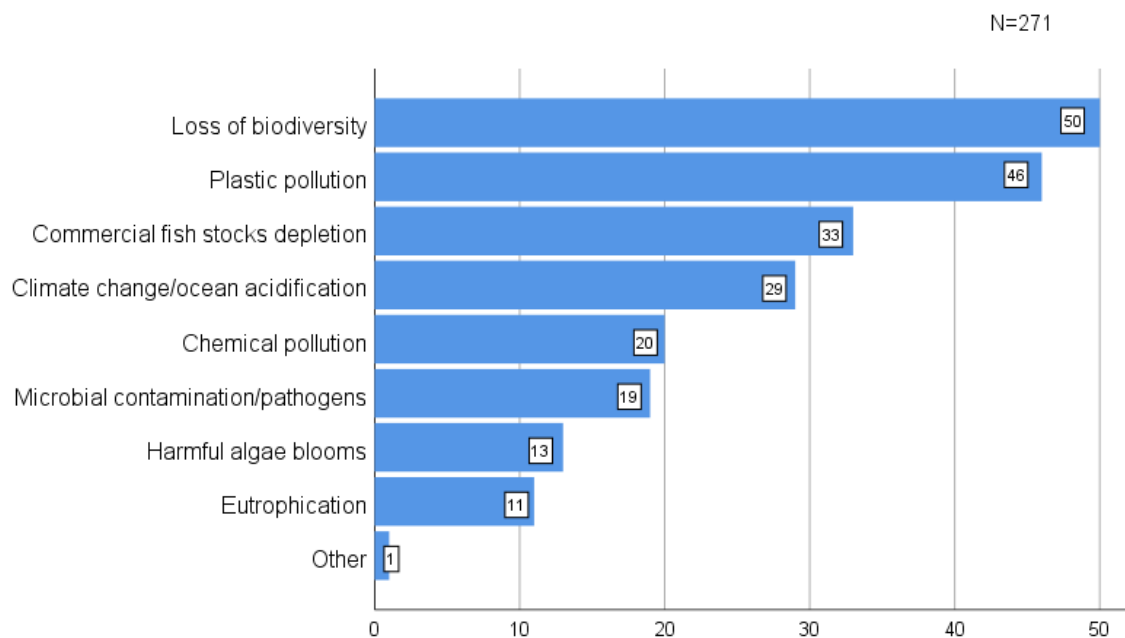


Figure 13 Environmental issues addressed by innovations

### Environmental impact according to social innovators

In addition to the inventory of innovations, the environmental impact was also addressed more in-depth during interviews with social innovators. Their impact on clean coasts and seas is noticeable in a variety of ways. Some innovations contribute to a cleaner marine environment through clean up actions on the

beach and in the water, but also to maintaining clean coasts and waters in the long term. An example is Healthy Seas, an initiative committed to removing often toxic ghost nets from the water and recycling these.

*“The nets collected by Healthy Seas are not sent into landfills or burned. Instead, they are recycled in order to create high-quality consumer products, like carpets, socks and swimwear. In the first 6 years of operation, more than 453 tons of ghost nets have been collected and sent for recycling, the equivalent of 3 blue whales”. – Healthy Seas.*

Their actions help to improve the water quality and give waste a new value and function.

Other innovations are active in educating communities about their ocean responsibility. They help to promote environmentally friendly behavior, often based on the idea that people understand the value of their environment when they are connected to it<sup>6</sup>. An example of such an initiative is SUP-Kids, an outdoor educational and recreational program that brings children out to the water for SUP activities, through which they learn about their environment and water safety.

*“Having kids realize that adventure is right on the doorstep and closer than they think, makes them see nature as a playground and lean more towards the environment”. – SUP-Kids.*

Innovations such as SUP-Kids connect people to the ocean in a fun and responsible manner, which helps to develop awareness and environmentally friendly attitudes.

Due to their often-local nature, innovations can take care of a very local issue with specific characteristics. One such positive local impact is the creation of marine protected areas. Innovations help to set protected areas or no-go zones that exclude harmful activities and instead promote innovative environmentally friendly use. One innovation that carries out this idea is Vies Braves. They design open water swimming itineraries along the coast of Catalonia, creating safe recreational spaces while excluding harmful activities in these spaces. During an interview, a key informant of View Braves described their environmental impact as follows:

*“The main environmental impact is to get and do more kilometers of itineraries. Protecting pieces of coast during the season, the tourism impact reduces as ships and boats can't go here and let loose their anchor. Posidonia recovers as the seafloor remains intact. Fish and organisms can then live in the plant as it promotes marine life”. – Vies Braves.*

This sketches an example of how innovations can help to restore marine environments, boost biodiversity and develop sustainable coastal management.

An indirect environmental impact of innovations is their contribution to the scientific body of knowledge about the state of the oceans. Innovations doing research are for example citizen-science projects such as Community Seagrass Initiative. They report on their website that they are active in monitoring the coverage of the seafloor with seagrass around the coast of South-West England. In other cases, they can be large-scale interdisciplinary research projects or lab experiments, ranging in topic from microplastics and contaminants to biodiversity, ecosystem health and climate change effects.

### 5.1.2. Ecosystem services provided by innovations

In order to understand the impact of innovations on human health, for each innovation is indicated which ecosystem services it helps to provide, with multiple answers possible (Figure 14). The results are depicted in the following graph. The most common ecosystem services that innovations provide are

---

<sup>6</sup> Author's interview with participant 2

tourism, recreation and well-being, water quality and food provision, whereas few cover biotechnology or marine renewable energy.

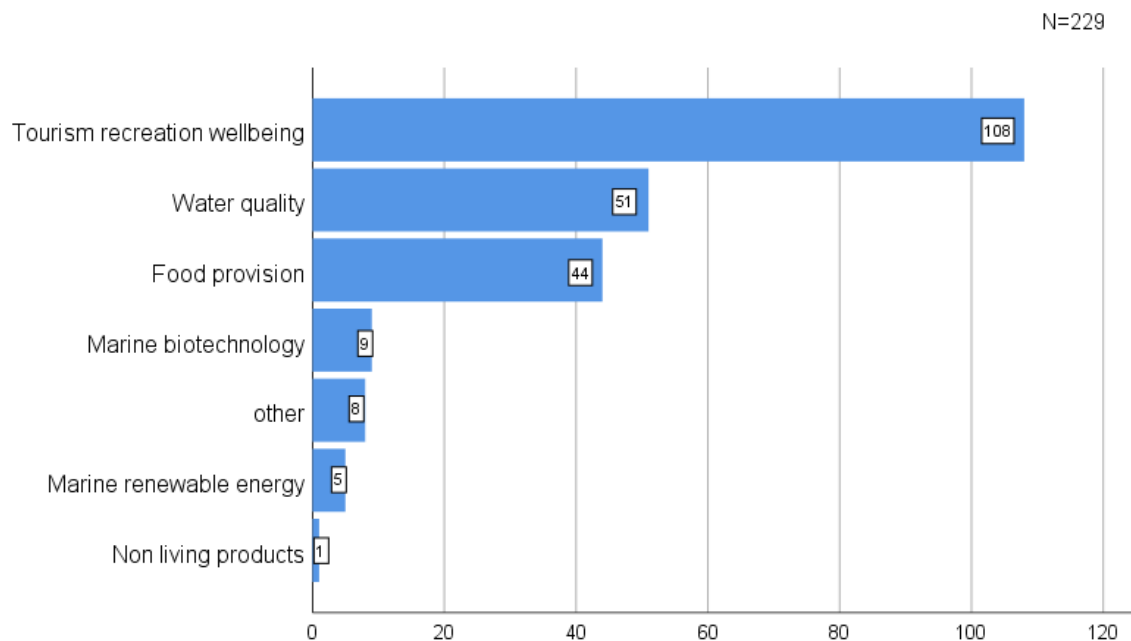


Figure 14 Ecosystem services provided by innovations

The ecosystem services that innovations provide form the link to human health. Ecosystem services indicate how innovations foster environmental services and how these translate into health benefits. In addition, social innovators were asked to describe how they think their innovations create health benefits. Their responses give more insight in how innovations create tangible health benefits of ecosystem services.

#### *Health impact according to social innovators*

Social innovators describe their impact on human health in various ways. Firstly, as innovations spread awareness on health risks, people become more knowledgeable of their own health and safety. This links to the prevention of health issues that occur due to e.g. water quality, accidents in physical water activities and other threats. Swim Guide is an initiative committed to collecting data and spreading knowledge on water quality.

*“People love to swim, and they love their waterbodies and they want to know whether they can swim and what the water quality is, so that question basically everyone that calls us asks the same and we want to help them with this information.” – Swim guide.*

Ensuring that people are well-informed about the safety of their waterbodies for e.g. swimming reduces the risk of illness from polluted water spaces. Other innovations address the risks of accidents in recreational water activities. Surfing Medicine International presents on its website how it improves the medical qualifications through teaching medical and rescuing skills for surfers by surfers. Another example is the Scott Haldane Foundation, which provides additional training for doctors about diving and hyperbaric medicine.

Innovations also play an active role in the promotion of health, both mental and physical. Mental health is improved by reduction of depression and anxiety, boosting self-confidence, and improving self-esteem<sup>7</sup>. A representative of The Wave Project explained during an interview:

*“Children that are unhappy are often isolated. Depression and anxiety are made worse or caused by isolation. Breaking this isolation is a big part of the therapy.” – The Wave Project.*

These innovations make use of the calming and relaxing effect of the ocean and particularly focus on vulnerable people such as victims of war, people with trauma’s and mental/physical disorders, people with autism or people struggling with an addiction. The physical health is promoted through providing exercises and being outdoors in fresh air<sup>8</sup>, where people are encouraged to be active and reduce risks of overweight. Additionally, physical health is promoted through the provision of healthy seafoods, such as the sustainable seaweed production by Waddenwier.

Other types of innovations increase safety around coastal waters through early warning, continuous monitoring and research. An example of such an innovation is KOSTASystem, which monitors the currents and waves along the Bay of Biscay and helps to detect and warn for dangerous currents in time. Also, innovations contribute to improving scientific knowledge on the health risks posed by pollutants as well as engage and empower women in doing OHH research and taking care of their health. One innovation that stands at the forefront of these developments is Exxpedition, an all-women’s scientific voyage in which the female sailing crew researches microplastics in the ocean’s as well as the impact of microplastics on human (women’s) health.

### 5.1.3. Contribution of innovations to SDG targets

Understanding the impact of innovations on environmental issues and ecosystem services gives insight in how they improve social and environmental conditions, however for translating that impact into concrete environmental and human health benefits, additional instruments for analysis are required. The Sustainable Development Goals are very suitable for this purpose, as specific SDG targets make their impact on health and environment tangible (Table 1.). Moreover, the SDGs have high societal relevance as guiding principles towards a sustainable global future.

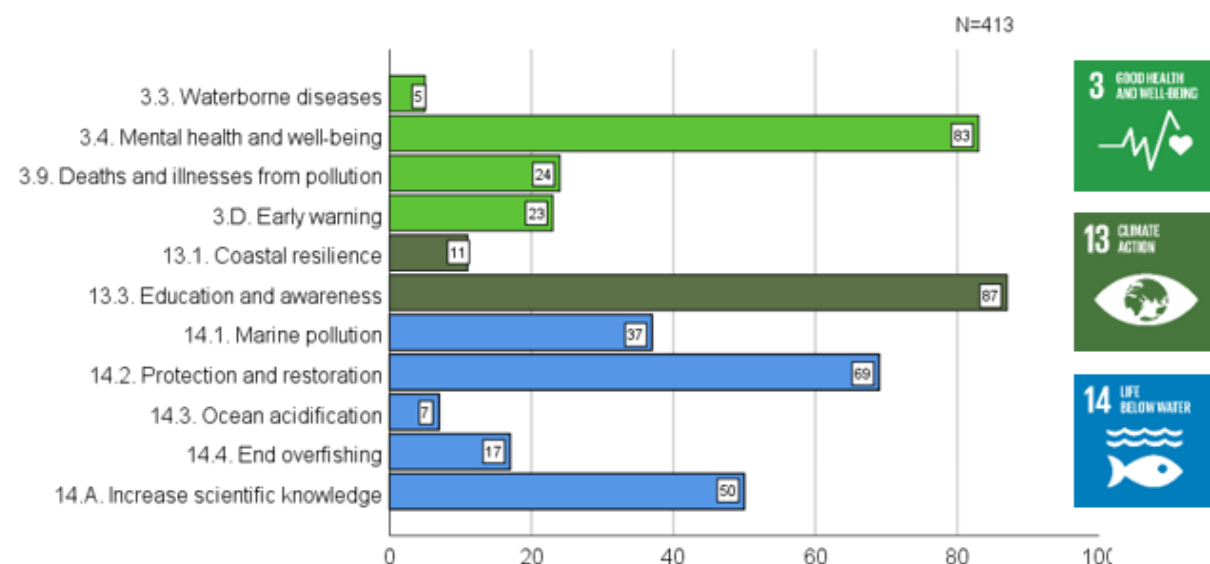


Figure 15 Contribution of innovations to SDG targets

<sup>7</sup> Author’s interview with participant 3, 4, 6

<sup>8</sup> Author’s interview with participant 4, 5,

The analysis of SDGs on the European agenda as presented in section 2.3.3. show most attention and progress on SDG 3. Striking is that on average, EU member states score lowest on SDG 14 and that a lack of data makes progress towards SDG 13 and 14 difficult to measure. This, whilst some of the most important health challenges occur as a result of environmental risk and climate change (European Commission reflection paper 2019). Other prominent health challenges are unhealthy lifestyles and mental health issues. Due to climate change, overfishing and pollution, the state of the marine environment deteriorates, posing increasing health risks to coastal populations. The European Union also stresses the importance of local action among others to increase resilience and awareness on climate change. Innovations contribute to achieving SDG targets that are currently important focus points of the EU. They also provide responses to their biggest health and environmental challenges, where at the moment insufficient measures are taken. These are to focus on the promotion of physical and mental health, to increase awareness and resilience on climate change and to reduce marine issues such as pollution and overfishing.

The results of this research show particularly great correspondence to SDG targets ‘promotion of mental health and well-being’ (3.4), ‘education and awareness on climate issues’ (13.3), ‘protection and restoration of marine ecosystems’ (14.2) and ‘increasing scientific knowledge’ (14.A) (Figure 15). Furthermore, some impact is generated with regards to reduction of marine pollution and deaths and illnesses that derive from it (14.1. and 3.9.). Least affected by innovations on the other hand are waterborne diseases (3.3), coastal resilience (13.1) and ocean acidification (14.3).

Having understood the wide range of kinds of innovations as well as the most common topics they address in section 5.1., the next section will conceptualize and categorize these using the DPSIR framework (Figure 8). In line with this framework, Responses – in this case innovations – target one component of DPSI as a way to categorize the type of action they undertake. For the conceptualization of innovations, the concepts of Table 7 below have been operationalized, which formed the basis for the categorization for the types of responses corresponding to DPSI. This clustering and classifying of innovations allows the researcher to identify trends and correlations between DPSI and the subjects. This can be used to get insight in how categories of innovations are applied when addressing environmental or health challenges.

## 5.2. DPSIR Analysis

Going one step further than describing the impact of innovations on environmental issues and ecosystem services, this section will analyze how the impact of innovations differs per DPSI category. Using the DPSIR framework as presented in Figure 8, innovations (*Responses*) have been assigned to the DPSI categories that they respond to. The following analysis demonstrates how innovations for *Drivers*, *Environmental Pressures*, *Human Pressures*, *Environmental State*, *Human State* and *Impact*, relate to the ‘environmental issues’ and ‘ecosystem services’ (3.1.).

Table 7 gives an overview of the key concepts of each DPSI category, indicating what type of innovations can be expected in this category. The DPSIR framework relates to OHH innovations in the sense that it encompasses the trade-offs between (marine) environment and human health and shows how these link to types of responses. This categorization allows for better understanding of the various ways in which innovations operate and how that corresponds to environmental and human impact. It gives an idea of how types of responses are applied to achieve targets or make certain improvements. The dataset for Europe consists of 150 innovations that have each been assigned to one dominant DPSI category, by means of expert judgement, operationalizing the concepts of Table 7. This research distinguishes 14 innovations responding to *Drivers*, 5 innovations responding to *Environmental Pressures*, 45 innovations responding to *Environmental State*, 24 innovations responding to *Human*

*Pressures*, 33 innovations responding to *Human State* and 29 innovations responding to *Impact* (Figure 31).

Table 7 Key concepts of the DPSIR framework

DPSIR	Key concepts
Drivers	
• Socio-economic	Coastal construction, tourism, agriculture, industrial activity, fishing industry, transportation, fossil resource extraction, population growth, governance, equity
• Natural	Natural ecosystem fluctuations, weather conditions
Pressures	
• Environmental	Atmospheric emissions, microbial and chemical pollution, solid waste, extractive disturbances
• Human	Consumption patterns, choice of housing, willingness for conservation
State	
• Marine ecosystem	Climate, pollutants, biodiversity, ecosystem health, water quality
• Human health and well-being	Demographics. Physical health. Mental health and well-being
Impact	
• Ecosystem services	Water quality and quantity, provision of seafood, opportunities for recreation and tourism, climate regulation
• Human health benefits	Mental and physical health and well-being, economic benefits, social and cultural benefits
• Trade off drivers	Tourism and recreation, transportation, fishing, resource extraction and pharmaceutical products
Responses	
• Driver level	Marine industry policies, transportation and emission policies
• Pressure level	Resource management, coastal planning, disposal limitations
• State level	Restoration, conservation, monitoring
• Impact level	Mitigation, compensation, indicators of human health and well-being, assessment, education and awareness

OHH innovations addressing *Drivers* and *Environmental Pressures* represent types of actions that are directly linked to policy and regulation, which is typically done by governmental bodies and institutions. These are studied in other work packages of the SOPHIE project and were not targeted in this study. Nevertheless, some cases were encountered, albeit not a sample that allows for proper analysis. Therefore, the key focus of this analysis is on the other DPSI categories. This section will explore prominent issues, services and SDGs and link these to DPSI concepts and observations. This research builds on the existing literature by integrating the DPSIR framework with OHH components in spider diagrams to visualize the link with DPSI concepts. These diagrams cannot be interpreted as an attempt to give a representative overview (4.2.2.). Instead, these diagrams are meant to help identify trends in a wide range of cases and understand which types of innovations are most commonly applied with regards to OHH. The full list of innovations arranged by DPSI can be found in Appendix G.

### 5.2.1. DPSI categories of innovations by environmental issues

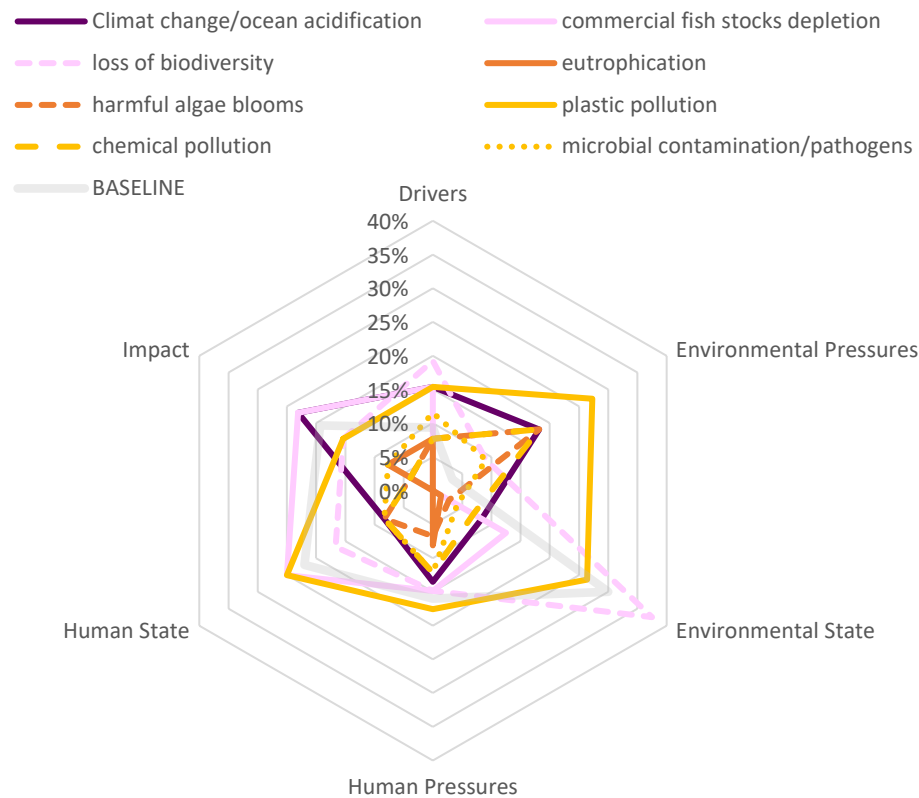


Figure 16 DPSI categories of innovations by Environmental issues in Europe (n=221)

Figure 16 visualizes the environmental issues and their division among the DPSI categories. It becomes clear that some environmental issues correspond well with certain types of DPSI innovations. This implies that innovations targeting a certain type of environmental issues address some categories of DPSI more (or less) than others. The grey “baseline” shows the division of the 150 OHH innovations over the DPSI categories. Values that differ from this baseline indicate an over- or underrepresentation. The most targeted issues ‘loss of biodiversity’, ‘plastic pollution’, ‘commercial fish stock depletion’ and ‘climate change’, address different types of DPSI responses, as discussed below.

Actions to reduce the loss of biodiversity particularly target the *Environmental State*. These are efforts to restore, conserve and protect marine ecosystems and their biodiversity, which logically follows from the key concepts in Table 7. When addressing plastic pollution, innovations respond to *Human State*, *Environmental State* and *Environmental Pressures*. This means that the issue of plastic waste can be addressed using three different end goals. Firstly, removing plastic pollution from the ocean improves the *Environmental State*. Second, preventing plastic pollution from being disposed into the (marine) environment responds to *Environmental Pressures*. Third, removing and reducing plastic waste prevents it from harming human health (*State*). Commercial fish stock depletion innovations mainly address *Human State* and *Impact*, as well as *Drivers*. They for example do so by taking efforts to restore ecosystem services (*Impact*). Furthermore, they are aimed at enhancing the *Human State* by offering sustainably caught fish or alternative healthy seafoods. Moreover, they support regulations and policymaking (*Drivers*) that ensure sustainable management of fish stocks on a drivers’ level and prevent overexploitation. In addressing climate change, innovations respond mainly to *Environmental Pressures* and *Human Pressures*. They reduce *Environmental Pressures* through prevention of atmospheric emissions and extractive practices by innovating in renewable marine energy.



Additionally, they respond to *Human Pressures* by stimulating environmentally friendly behavior and lifestyle through education and awareness on climate issues. Most issues are addressed by multiple types of innovations. Although in total few OHH innovations respond to *Environmental Pressures* (the ‘dent’ in the grey baseline), relatively more environmental issues (‘peaks’ in the graph) are linked to this type of action.

### 5.2.2. DPSI categories of innovations by ecosystem services

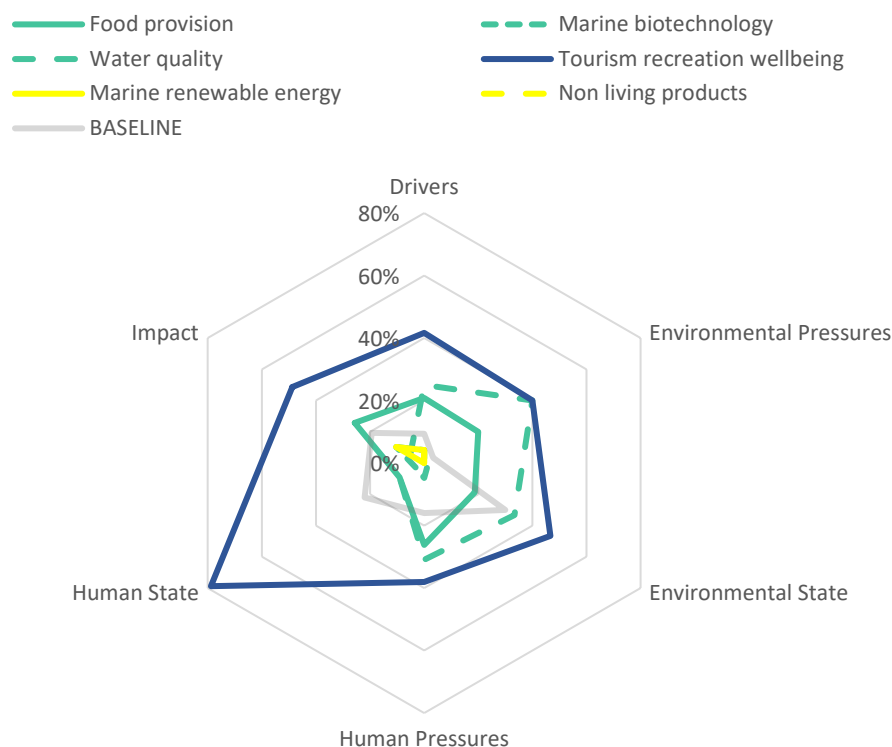


Figure 17 DPSI categories of innovations by Ecosystem Services in Europe (n=218)

Figure 17 presents the ecosystem services in relation to DPSI. The most frequent ecosystem service is ‘tourism, recreation and well-being’ (Figure 14), followed by ‘water quality’ and ‘food provision’. Innovations that are related to tourism, recreation and well-being typically respond to the *Human State*. These innovations provide recreational spaces and activities that boost people’s physical and mental health. However, it is also true that all DPSI categories of innovations can create tourism, recreation and well-being as an ecosystem service. Innovations that improve water quality generally address *Environmental Pressures*. These imply efforts to address sources of contamination, be it chemical, microbial or plastic pollution. Furthermore, water quality is improved by innovations responding to the *Environmental State*, by removing pollutants from the marine environment. Innovations that are aimed at improving food provision mostly address *Impact* and *Human Pressures*. By responding to *Impact*, innovations enhance ecosystem services and improve food provision. Furthermore, by responding to *Human Pressures*, innovations stimulate responsible consumption patterns and a lifestyle that help to sustain seafood supplies.

### 5.3. Comparative analysis with South-East Asia

This section compares the dynamics of (social) innovations in OHH in Europe with those in South-East Asia. A comparative analysis between regions has not been performed thus far. As the state of the oceans, human health issues and the SDGs are of global concern, it is desirable to expand the scope of research. For the full list of innovations in SEA arranged by DPSI see Appendix G. The comparative analysis focusses on trends instead of numbers, as the units of analysis are not equal in size. The map in Figure 18 demonstrates in blue the countries in SEA in which case studies have been identified. Selection was based on South-East Asian countries, with a primary focus on member states of ASEAN, that have a coastline of which has been made use by OHH innovations as location for one or more activities. This research will compare innovative cases from Europe to a range of cases in South-East Asia. Accordingly, trends for each region are identified and best practices from European countries are compared to best practices in South-East Asia.



Figure 18 Research Area in South-East Asia. (Please note that Papua New Guinea is included in this research, although not displayed in this map)

### 5.3.1. Environmental issues addressed by innovations

In general, both regions show some of the same trends. Similar to Europe (Figure 19), the most frequently addressed environmental issues in SEA are loss of biodiversity and plastic pollution, followed by climate change/ocean acidification and commercial fish stock depletion (Figure 20). Considering the geographical location of South-East Asia, encompassing the coral triangle, it is not surprising that loss of biodiversity is a commonly addressed issue. Furthermore, plastic pollution is an issue that is clearly visible along the coast of South-East Asia and that touches many people, which might make it a more obvious topic to mobilize people. Very few innovations address harmful algal blooms, eutrophication and other sources of pollution.

#### *Europe*

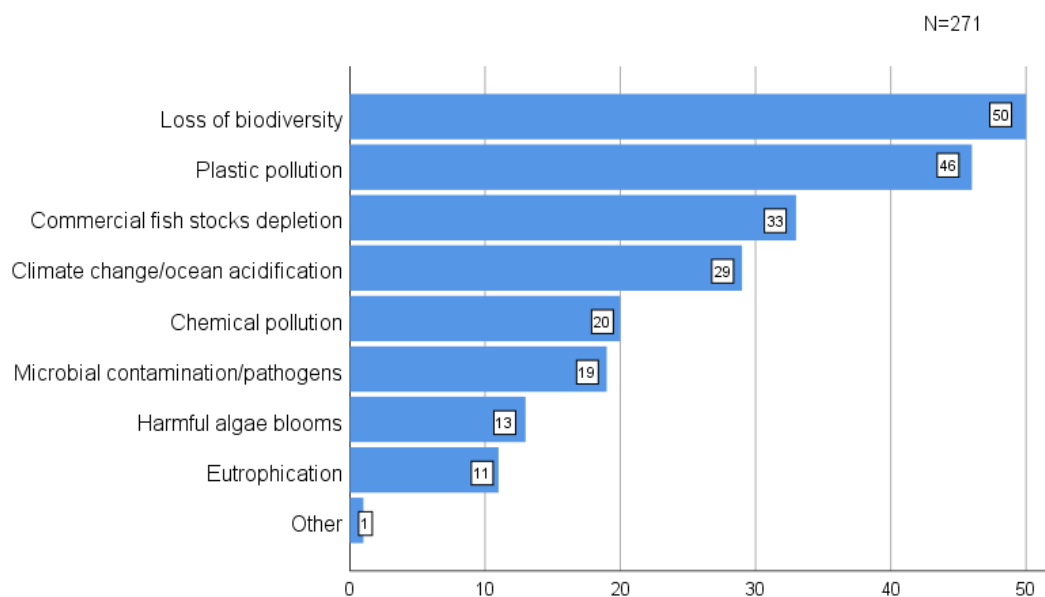


Figure 19 Environmental issues addressed by innovations in Europe

#### *South-East Asia*

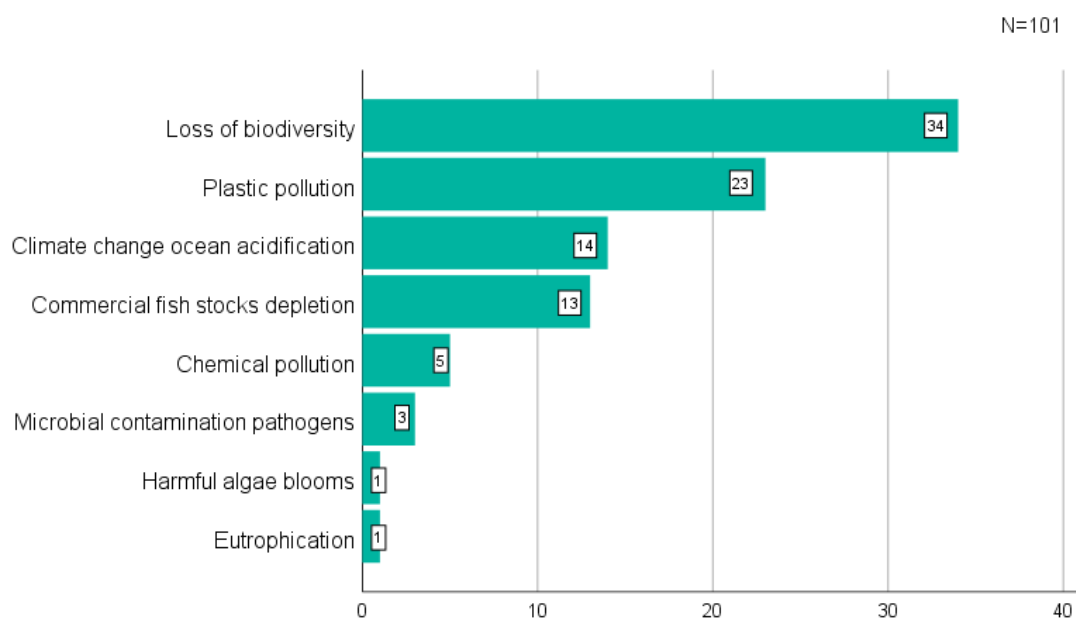


Figure 20 Environmental issues addressed by innovations in South-East Asia

### *Environmental impact according to social innovators*

Innovations have environmental impact in a variety of ways, notably through raising awareness and promoting environmentally friendly behavior. Taking part in innovative initiatives makes people appreciate and enjoy the marine environment, which triggers more responsible behavior<sup>9</sup>. Ocean literacy can be promoted in a creative and innovative way as was done by the Surf and Social Good Summit in Indonesia. A key informant explains how enjoying the sea space can help to make environmental impact.

*“Changing access and experience of the sea space through something like surfing is introducing this kind of novel new experience that is quite playful and encourages social connection, changes people's relationship and attitude towards the natural environment. It sort of naturally makes people want to take part in more pro-environmental behavior to clean their beach so a sense of ownership and responsibility for the beach had changed, because it is now associated as a place, a space for enjoyment”. – Surf and Social Good Summit.*

The OHH innovations in South-East Asia also contribute to ecosystem restoration, e.g. coral and mangrove restoration by Biorock Indonesia and Watertrek. These initiatives reduce pressures on ecosystems by protection measures and stimulating a shift towards alternative livelihoods such as tourism. Biorock Indonesia is an initiative that rebuilds coral reefs by using underwater art. It stimulates a sustainable form of tourism instead of the previous livelihoods which included destructive fishing practices. During an interview, a representative gave an example of how their environmental impact has become visible in the local community.

*“So, because most of the fishermen have already started to work or have businesses in tourism, they don't work in the fisheries anymore. Little bit as fishermen, but not like 20 years ago. They are actually aware that coral reefs will affect their lives, more in tourism than as a fisherman”. – Biorock Indonesia.*

Innovations have also led to increased protected areas, such as the eco-resort Misool in Indonesia. As explained on the website, Misool created a marine protected area, where former poachers are trained and paid to become rangers and protectors of the area. Other examples strive for clean marine environments by improving local waste management, clean ups and recycling. An example of an innovative waste prevention initiative is Evoware, specialized in using seaweed for packaging, while safeguarding livelihoods of seaweed farmers (Figure 21).

---

<sup>9</sup> Author's interview with participant 17, 21.



Figure 21 Examples of seaweed packaging by Evoware<sup>10</sup>

### 5.3.2. Ecosystem services provided by innovations

One thing that immediately stands out when comparing the ecosystem services for innovations in Europe and SEA is the correspondence to the category ‘other’ (Figure 22; Figure 23). This category is relatively much higher in SEA than it is in Europe, possibly because the categories had been designed for Europe. In Europe most OHH innovations in this category address ‘mental health’, whereas in SEA they are mostly aimed at ‘community resilience’ and ‘(women) empowerment’. ‘Other’ in SEA is even more frequently applicable than water quality and food provision. Another striking finding is that the OHH innovations found in SEA do not cover marine biotechnology and non-living products. The two regions have in common that tourism, recreation and well-being are the most common ecosystem services provided by the innovations.

<sup>10</sup> Source: <http://www.evoware.id/>

## Europe

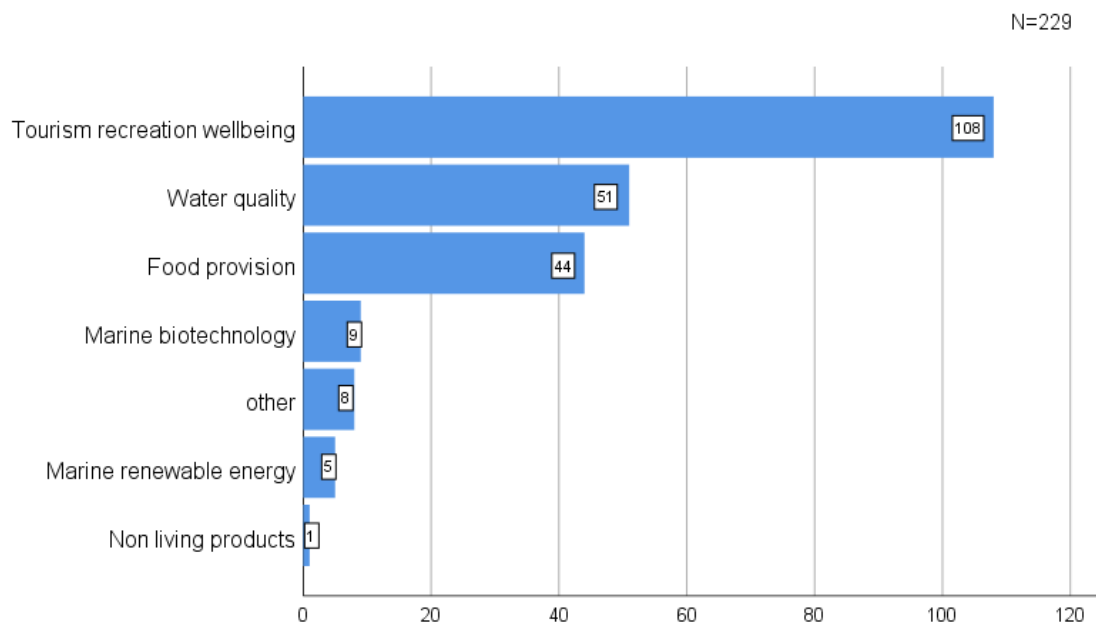


Figure 22 Ecosystem services provided by innovations in Europe

## South-East Asia

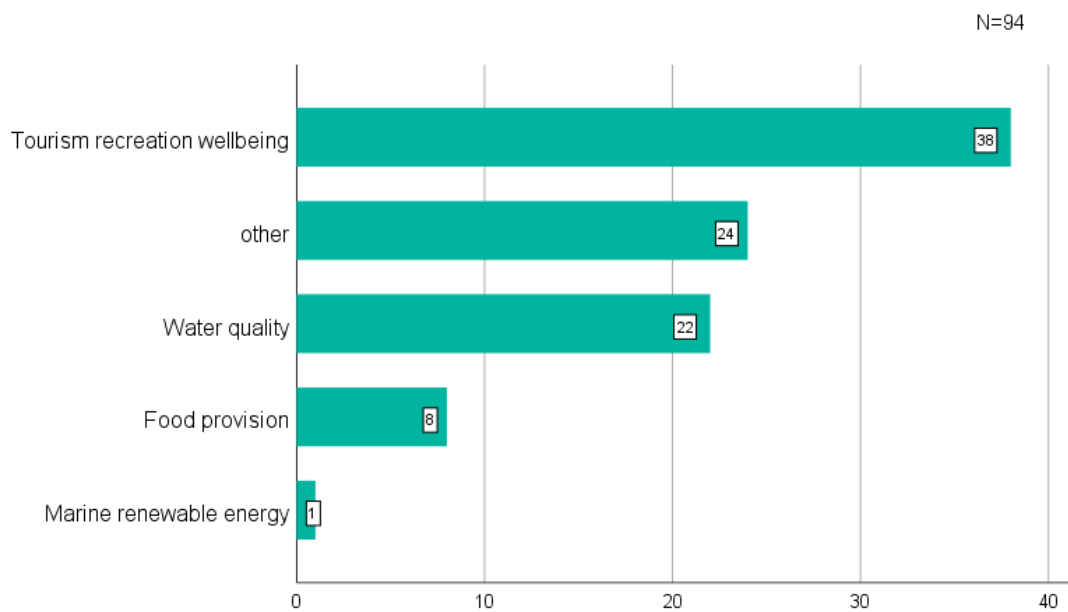


Figure 23 Ecosystem services provided by innovations in South-East Asia

As was also done in Europe, social innovators in South-East Asia were asked during interviews to give more insight into tangible health benefits of ecosystem services. Their responses supplement the graphs above.

### *Health impact according to social innovators*

Innovations can improve access to the ocean and ensure inclusive participation in activities such as surfing. The Pink Nose Revolution in Papua New Guinea is one of them and encourages social connection, promotes women empowerment and creates physical and recreational activity, in particular to people who are otherwise excluded.

*“It is creates access and experience of the seas for surfing for greater health and well-being benefits and overall I suppose senses of empowerment and engagement of women in sport in their cultural setting where that doesn't really happen”. – The Pink Nose Revolution.*

It is an example of how such an innovative initiative can empower women and take this impact beyond the marine and coastal area to their daily lives and even larger socio-economic processes.

Furthermore, innovations have improved the safety of the coastal population through improved housing options and implementation of safety measures for fishing activities<sup>11</sup>. One innovative initiative that enables sustainable, safe housing options is Ecobrick, where (plastic) waste is collected by fishermen and recycled into building materials. Another example is NEVHouse, whose website shows how they recycle waste into building materials for e.g. schools, houses and hospitals. A representative of Greeneration explained how they impact the safety of fisherfolk.

*“They said they didn't use the safety vest because they felt like they could swim and they didn't feel comfortable using it. We explain to them the urgency of that. Not only to them, also the family. The change that happened is that previously they didn't use the safety vest but now they use it more often”. – Greeneration (Plastic Catch Operations).*

Moreover, innovative solutions can help to improve water quality in various locations by combating pollution of the water bodies. On the website of the International Marine Organization (IMO), MarPol is explained as an international mechanism to set regulations to prevent pollution from ships. Research-oriented innovations contribute to increasing knowledge on the relations between oceans and human health. An example of such an international, interdisciplinary research project is Blue Communities, who explain on their website their aims to e.g. promote empowerment and resilience of local communities and increase the benefits of ecosystem services to the coastal population.

---

<sup>11</sup> Author's interview with participant 20



### 5.3.3. Contribution of innovations to SDG targets

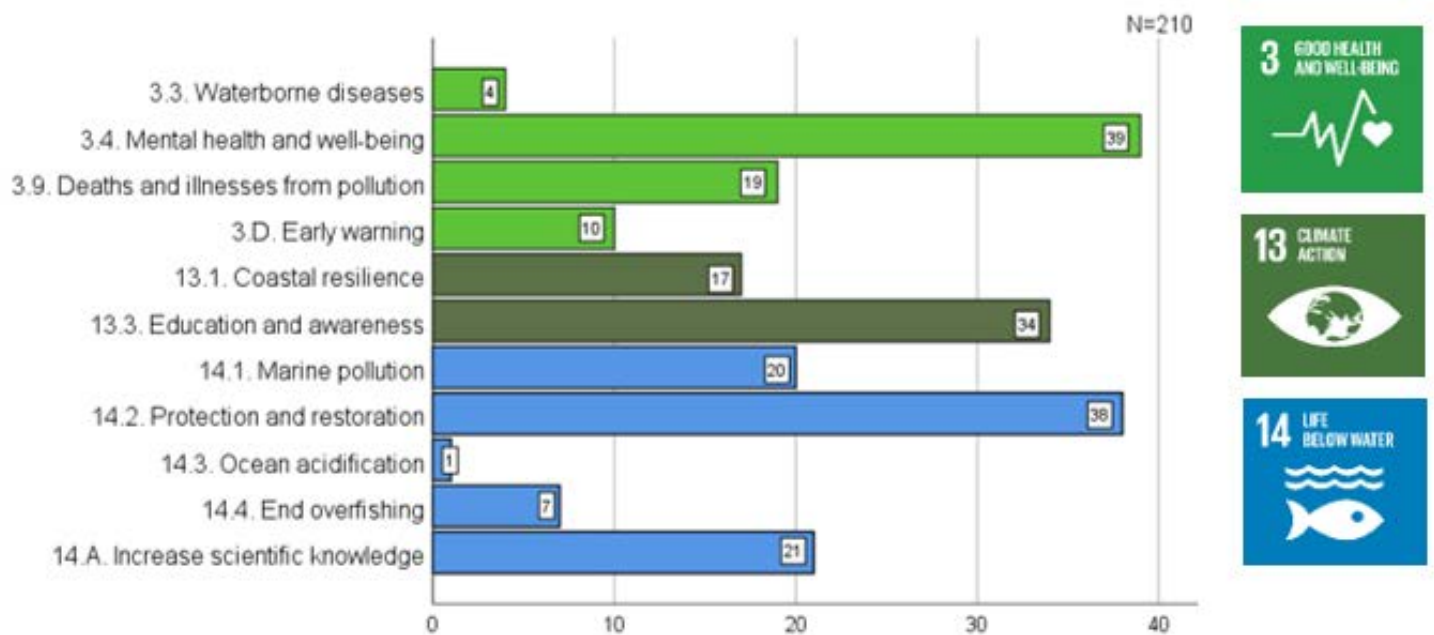


Figure 24 Contribution of innovations to SDG targets

The analysis in paragraph 2.4.3. indicates the projected progress for SDGs in ASEAN. Moderate progress is expected for SDG 3, whereas expectations for SDG 13 are negative and very little progress is expected towards SDG 14. Considering the fact that a major threat to health for the increasingly large coastal population of ASEAN is climate change, these figures are alarming. Expected progress for the corresponding SDG targets is positive for 3.9 and 3.D and accelerate for 3.3. and 3.4. For the Vision2025 agenda of ASEAN, environmental protection, resilience and climate change are important features, however there are insufficient data to measure targets 13.1 and 13.3. The same problem complicates the measurements of targets 14.1, 14.3, 14.4 and 14.A. It is predicted however that target 14.2 will experience a negative trend. It is crucial for achieving coastal resilience, protecting the marine environment and safeguarding the health of the coastal population that positive results are obtained in these targets and that they are properly measured. The results from this analysis show that innovations have a positive impact on in particular the promotion of mental health and well-being (3.4), protection and restoration of marine ecosystems (14.2) and increasing education and awareness 13.3 (Figure 24). This is comparable to the contribution of OHH innovations to the SDGs in Europe (Figure 15). Furthermore, scientific knowledge is increased (14.A), marine pollution is reduced (14.1) and this results in reduced deaths and illnesses from pollution (3.9). Hence OHH innovations can contribute to filling the shortcomings in the efforts of ASEAN in achieving the SDG targets.

#### 5.3.4. DPSIR Analysis

Applying the same categorization of DPSI on innovations in South-East Asia may identify substantial differences in the types of actions applied in these different regions and how these are deployed for creating environmental and health benefits. For South-East Asia, most innovations responded to the *Environmental State* (Figure 32). Although the environmental state was the most frequently addressed DPSI category in Europe too, the relative distribution over DPSI categories was rather different. In South-East Asia innovations responded to *Drivers*, 2 innovations to *Environmental Pressures*, 23 innovations to *Environmental State*, 5 innovations to *Human Pressures*, 7 innovations to *Human State* and 10 innovations to *Impact* (Figure 32).

This section will cover the mostly addressed environmental issues: plastic pollution, loss of biodiversity and commercial fish stock depletion. What predominantly stands out for environmental issues is that in South-East Asia, the innovations targeting plastic pollution respond less to the *Environmental State* and more to *Environmental Pressures* and *Human Pressures* than in Europe (Figure 26). Loss of biodiversity in Europe is addressed by innovations responding to the *Environmental State* more than anything else (Figure 25). In South-East Asia on the other hand, this issue is addressed almost equally by innovations responding to *Drivers*, *Human State* and *Environmental State*. Fish stock depletion in Europe is an issue that is tackled by innovations concerning *Human State*, *Human Pressures* and *Impact*. In South-East Asia, this is an issue that is predominantly addressed by innovations targeting *Drivers*.

This section will cover the mostly addressed ecosystem services: Tourism, recreation and well-being, water quality and food provision and how these are linked to innovations targeting the *Human State*, *environmental state* and *impact*. The ways in which these issues relate to DPSI categories of innovations is highly different from Europe (Figure 28). These innovations often combine for example tourism and recreational activities with conservation or restoration efforts. For Europe however, most innovations providing tourism, recreation and well-being effects respond to the human state (Figure 27). Innovations aimed at improving the water quality commonly respond to environmental pressures in South-East Asia, whereas in Europe the type of response is more diverse. Food provision corresponds most to innovations targeting drivers, which again in Europe receives a more diverse response.

## Europe

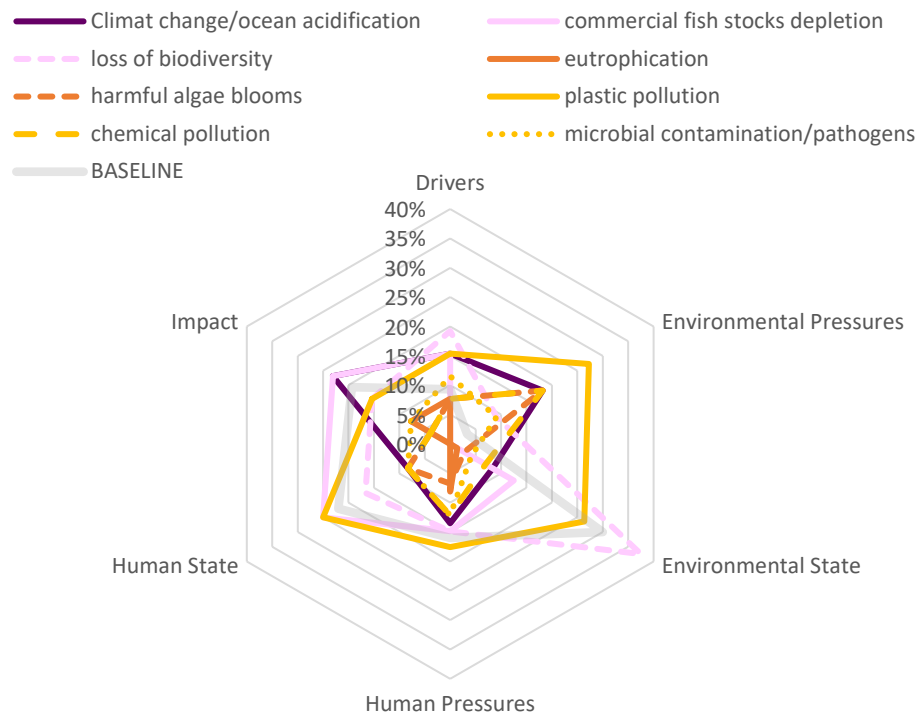


Figure 25 DPSI categories of innovations by Environmental issues in Europe (n=221)

## South-East Asia

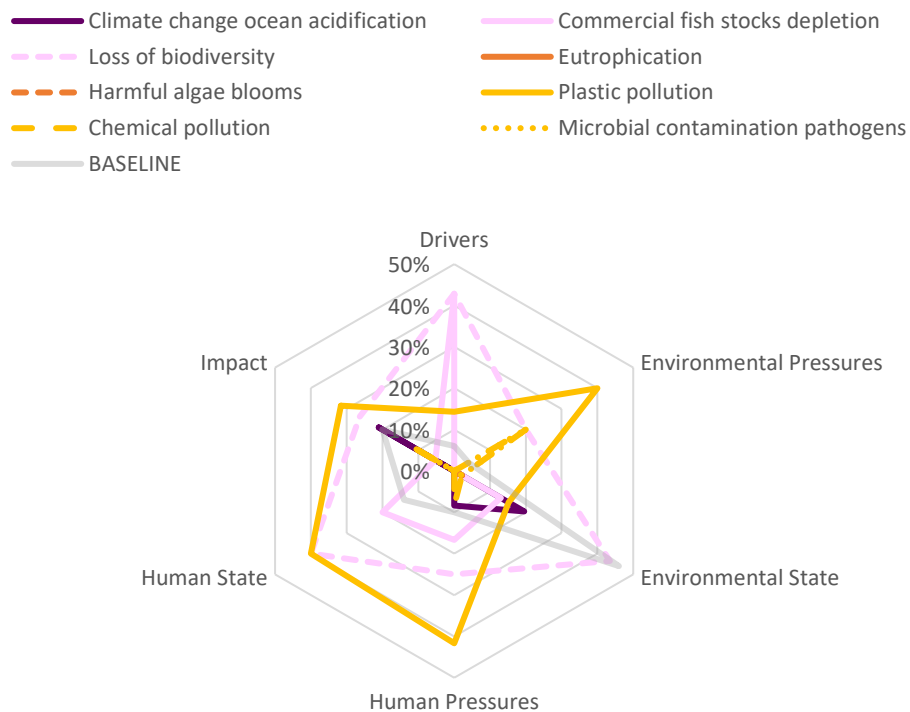


Figure 26 DPSI categories of innovations by Environmental issues in South-East Asia (n=94)

## Europe

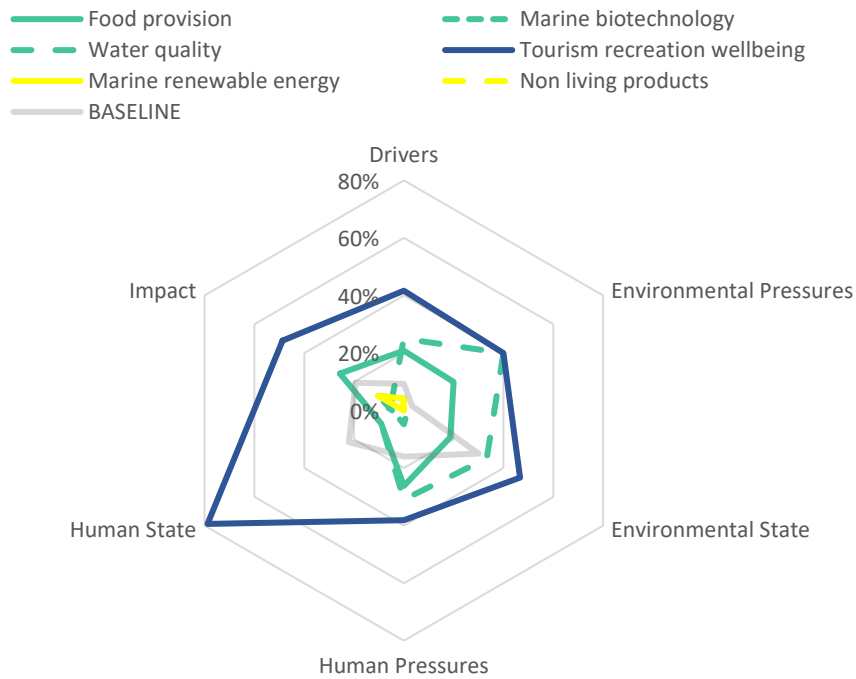


Figure 27 DPSI categories of innovations by Ecosystem Services in Europe (n=218)

## South-East Asia

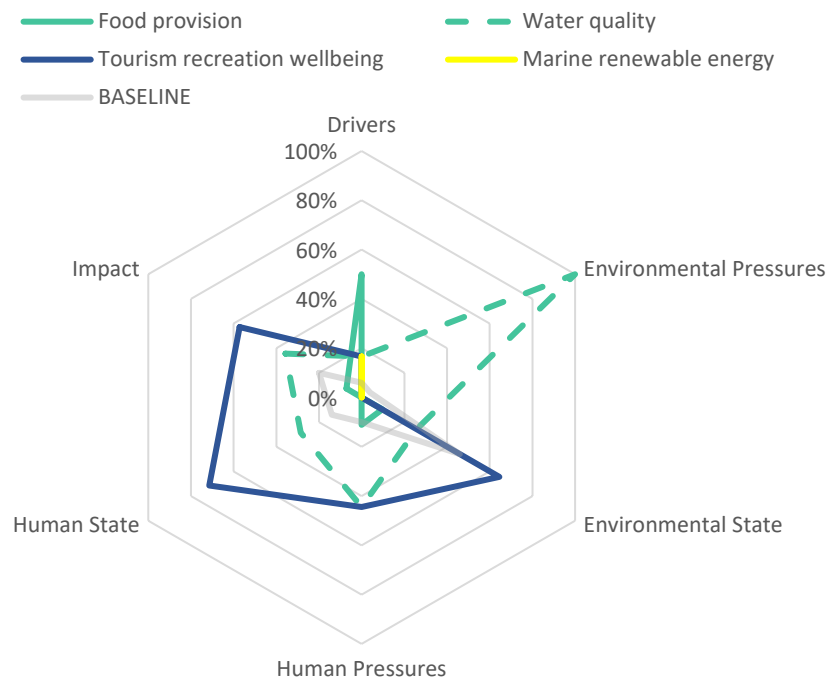


Figure 28 DPSI categories of innovations by Ecosystem Services in South-East Asia (n=69)

## 5.4. Expert view on the role of innovations

Having understood the effects of innovations on oceans and human health in both Europe and South-East Asia, this section presents the expert opinion on the potential role that innovations can play in society. The interviewed experts (Table 4) have knowledge of current practices in society and the gaps that exist. During these interviews, experts explained the current state of affairs in policy and research and how OHH innovations could contribute to improving these. They also give their view on the perspectives for upscaling of innovations.

### 5.4.1. The role of innovations in Europe

Policymaking remains sectorial; the policy domains of oceans and of health are disconnected<sup>12</sup>. In order to manage these two domains, there is a need for more overarching, integrated policies<sup>13</sup>. Politicians tend to work in their own silos, and the medical and environmental community have trouble reaching out to each other<sup>14</sup>.

*“The fact is that policymaking still remains very sectorial. You have marine policies, freshwater policies. The European Commission has already pointed towards the need to have more integrated, cross-cutting policies which is a challenge of course. So, I think currently this is a gap”. – Expert 15 (Higher education).*

Furthermore, policymaking with regards to health is still mostly related to reducing disease, for most policymakers<sup>15</sup>, rather than the broader definition of health as physical, mental and social well-being.

*“For policymakers today, it is a journey for them to realize. As soon as you talk about health in this country, all they talk about is disease. They have no concept about health, no concept about the environment having anything to do with health”. – Expert 14 (Higher education).*

Marine policies on the other hand are too general, where the same regulations are applied in different areas throughout Europe. There may be a need for separate policies and regulations adjusted to local or regional circumstances. Currently, there is no plan or vision of what the relationship between people and the oceans should be like. This is a crucial aspect in the development of policies. More attention to characterizing coastal communities around Europe and how these are likely to change could support this. Furthermore, attention needs to be paid to the kind of coastal environments there are around Europe and how these will be used for different purposes, i.e. the preservation of species, enhancing biodiversity, tourism or economy<sup>16</sup>.

*“Quite often it comes from the conservation point of view that we had a beautiful coastal environment, people moved in, they did stuff, damaged it, let's restore it to what it was. But I think that's a pretty bankrupt idea to be honest now, because it's all changed so much anyway” – Expert 14 (Higher education).*

Scientists too have a tendency to work within their own silos. Convincing case studies are needed to show that the link between oceans and human health is real and considerable. Evidence is important to demonstrate the beneficial effects that people believe there to be. This evidence then needs to be translated into concrete health effects such as public health benefits or impacts on certain medical

---

<sup>12</sup> Author's interview with participant 12, 14, 15.

<sup>13</sup> Author's interview with participant 12, 15.

<sup>14</sup> Author's interview with participant 15, 16.

<sup>15</sup> Author's interview with participant 12, 14, 16.

<sup>16</sup> Author's interview with participant 14

conditions. This can contribute to the understanding that there are psychological benefits, or perhaps specific benefits on for instance ischemic heart disease, diabetes, or cancer. Such research, evidence and work need to be coordinated across countries; not just in Europe, but globally<sup>17</sup>. This is congruent with the literature by Fleming et al. (2014), which confirms this lack of integrated scientific research and states that required expertise from different fields to solve OHH challenges is disconnected. This lack of research makes that Europe has not yet been able to formulate corresponding OHH policies (Fleming et al. 2014). Convincing case studies can be scaled up across Europe or beyond<sup>18</sup>. By doing this and translating research and scientific evidence into planning, the biggest public health challenges could be improved.

Experts described how OHH innovations could contribute to fill gaps in knowledge and policies. On an individual level people are aware of the possible benefits of oceans for their well-being, but they have not thought of doing anything about it at a policy level. Innovations could help to spread awareness, as a source of inspiration or as a way of storytelling<sup>19</sup>.

*“I think that that is actually the most compelling way of engaging people to understand the issues. We have to really convince government advisory groups which are often made up of academics of different disciplines of the evidence that taking some intervention, really really really works and they are so skeptical”. – Expert 14 (Higher education).*

Innovations are hopeful tales on various levels, which could also help to shift the focus that has so far been mainly on the threats of the ocean to human health, towards the potential benefits that oceans can generate.

*“I think the innovative solutions are really interesting because they are almost a way not to bypass policy but work ahead of policy. I think they are sort of complementary to policy and they don't have to necessarily wait for the politicians to act.” – Expert 12 (Think tank).*

Innovations are a way to work ahead of policy. Furthermore, it is a way to test on a small scale what works and what does not, rather than immediately try to roll it out across Europe. A platform of innovations can help to fill the gap in policymaking by for example indicating the need for new research that is necessary for policy implementation<sup>20</sup>. In that way, they can feed the policymaking.

There is no one size fits all approach for OHH in Europe. Some OHH innovations are suitable for upscaling and others are not. In all cases, if innovations are to be scaled up, they need to be adapted to the local circumstances<sup>21</sup>. Although upscaling requires more resources, it can increase effectiveness of OHH innovations to scale up and expand to places with similar issues as well as to inspire people<sup>22</sup>.

*“You could potentially have bigger impact by working out which organizations are doing similar things to you in different areas and collaborate in that way. You'll be able to scale much faster and create much more effective impact.” - Exxpedition*

---

<sup>17</sup> Author's interview with participant 14, 13, 16.

<sup>18</sup> Author's interview with participant 13, 16.

<sup>19</sup> Author's interview with participant 14, 15.

<sup>20</sup> Author's interview with participant 12,13.

<sup>21</sup> Author's interview with participant 1, 5, 6, 15.

<sup>22</sup> Author's interview with participant 1, 2, 7, 10, 12, 15.

Upscaling can prevent duplicating efforts in other places<sup>23</sup>. One way of upscaling is to set up collaborations and partnerships, which make use of the local resources in another location but share knowledge and experiences across locations<sup>24</sup>.

Another viewpoint on the upscaling of innovations was given by an expert of a think tank in marine science policy, who said:

*“I think the innovations have a benefit that they don't have to be upscaled. So, what works in one area, so what's suitable for the people living in a specific area, with a specific environment and specific conditions, might not necessarily translate elsewhere. And I think that's also the benefit that they don't have to upscale, that they can be very much a local solution for a local problem, rather than sort of trying to make blanket approaches which don't really work for everyone” – Expert 12 (Think tank).*

This statement emphasizes the strength of innovations in offering a solution for local issues, which is also recognized by the social innovators above. The majority of the interviewees however agrees that as long as innovations adapt to local circumstances, make use of local resources, collaborate and share knowledge, upscaling is a good way to increase their impact.

#### 5.4.2. The role of innovations in South-East Asia

Some international efforts to link oceans and health have been made, initiated by ASEAN and PEMSEA about e.g. international guidelines on pollution, however these are still developing and formulating measures takes time<sup>25</sup>. This is hindered by the political reality of short-term policymaking, which complicates the process of formulating sustainable integrated policy strategies<sup>26</sup>. Policymaking with regards to the marine environment is generally not directly aimed at improving health, but indirectly through addressing ecosystem services.

*“Policymakers will know about the link between the environment and health, but there is no governmental program that stimulates it in that sense. However, there is the link with improving the ecosystem so that later there will be more fish and that people can make use of those ecosystem services again. But then it's more food security with in the background it being good for health, but not purely for health if that's what you mean.” – Expert 24 (Knowledge institute).*<sup>27</sup>

Problematic for effective policy on oceans and health is that most attention is paid to megacities rather than coastal communities. There is hence no equal attention for the entire coastal population<sup>28</sup>. Besides, there are many governmental bodies (federal or local) that have their own programs and often lack financial capital, which makes overall implementation very ineffective<sup>29</sup>.

Innovations can play a role in creating local awareness of healthy ecosystems and healthy communities, rather than being incorporated into national policy<sup>30</sup>. The PEMSEA annual report 2017 acknowledges the importance of local action and praises a local government network that develops among others

---

<sup>23</sup> Author's interview with participant 3, 7,

<sup>24</sup> Author's interview with participant 1, 3, 7, 10, 12,

<sup>25</sup> Author's interview with participant 22.

<sup>26</sup> Author's interview with participant 22.

<sup>27</sup> Translated from Dutch

<sup>28</sup> Author's interview with participant 23.

<sup>29</sup> Author's interview with participant 19, 20.

<sup>30</sup> Author's interview with participant 22.



environment-related initiatives. These are similar to some of the innovations collected in this research, considering they cover issues such as conservation, biodiversity protection, climate change, pollution and resilient communities (PEMSEA, 2017). They can function as an example and inspire others, which are mentioned as important qualities by a representative of Watertrek.

*“We impulse a momentum, we impulse awareness. We talk to people who are in the field, we give them tools, we do our expeditions, we collect data. It's the power of example. The power of starting something”. - Watertrek*

By being in the field, talking to people, collecting data, the innovators create visibility<sup>31</sup>. OHH innovations will be successful if local people are involved and if actions are envisaged for the long term. However, as long as actions are small-scale, the impact will remain small. In order to have big impact, it should be upscaled and linked to livelihoods<sup>32</sup>.

*“So I think if you can scale it up, it will be effective, but it will only be effective if people can earn something with it, if they get some interest in it. If it is just a project of planting and leaving, it simply won't stay. There needs to be some minor business or incentive connected to it, otherwise it won't have any effect”. – Expert 24 (Knowledge institute)<sup>33</sup>.*

If there are direct, tangible benefits, it will most likely be sustainable. Governmental bodies can play a role in enforcement, to complement these innovations<sup>34</sup>. However, as long as the impact on health is not made clear or measured, it will not be recognized by governments as a direct tool to improve human health<sup>35</sup>.

Most interviewees took a positive stance towards the idea of upscaling. They agreed however that it is important to consider local issues, circumstances, cultural differences and attitudes towards the marine environment in order to be able to pursue similar activities and projects in other areas<sup>36</sup>. It would be helpful to create a network of support for collaborations and bringing together small projects to create something bigger<sup>37</sup>.

*“Create that network of support, so people wouldn't feel so isolated with what they are doing. Everyone is repeating the same efforts, trying to overcome the same challenges that maybe someone has solved over here”*

*“I think what's important and what is happening are these networks and knowledge in collaborations. So a network like the ISTO (International Surf Therapy Organization) is starting to unpack best practices, which they are mentoring. They have been working in surf therapy for a long time, as compared to these new smaller projects that are popping up, which want to know how to do the same thing for a community. I think that is probably a really healthy way of doing it, instead of thinking ‘okay this is what we did in Sri Lanka, let's role this out across South-East Asia.’ I am afraid that just won't work because of the cultural context and setting”. – Surf and Social Good Summit*

---

<sup>31</sup> Author's interview with participant 17, 21.

<sup>32</sup> Author's interview with participant 22, 24.

<sup>33</sup> Translated from Dutch

<sup>34</sup> Author's interview with participant 24.

<sup>35</sup> Author's interview with participant 22.

<sup>36</sup> Author's interview with participant 18, 20, 21, 22.

<sup>37</sup> Author's interview with participant 18, 24.

One expert was rather skeptical of what the role of innovations could be in improving health across the region and explained:

*“The results thereof are hard to get a hold on and it has as an effect that the government will not recognize that these innovations as such could be useful tools to influence human health. I also think that speaking of priorities, there would be other quick wins that have a bigger impact on human health. So, this would be too indirect to be a solution”- Expert 22 (Knowledge institute)<sup>38</sup>*

The impact of innovations on health can be indirect as they translate often into benefits from ecosystem services. If innovations are to be successfully upscaled for impact, then it has to start at an early stage<sup>39</sup>. Aside from bringing social innovators together, upscaling can also form the basis for setting national standards, for example with regards to waste management<sup>40</sup>.

---

<sup>38</sup> Translated from Dutch

<sup>39</sup> Author's interview with participant 20, 24.

<sup>40</sup> Author's interview with participant 20.

## 6. Discussion

### 6.1. Potential of innovations as tools for enhancing human health

The results of this research show how innovations can generate health and environmental benefits from OHH interactions and how they reduce health risks. Furthermore, they show that innovations can be used as a tool for raising public awareness and involving people in OHH interactions. The results of this research are unique in the sense that they are the first to give insight in how innovations can do that. They build on and add to existing literature and fill knowledge gaps indicated by other studies. The position paper of the European Marine Board (2013) emphasizes the importance of better understanding the potential health benefits from marine and coastal ecosystems, reducing human health impact of environmental threats and anticipate future threats to public health. It indicates key areas of action of which one is to improve communication to and participation by the general public and raise awareness about OHH relations (European Marine Board 2013). Furthermore, as this research investigates the impacts of OHH interactions on human health as a whole, it adds to the literature of Britton et al (2018) on the effect of Blue Space Interventions for improving mental health. Their research also stresses the relevance of understanding the health benefits of OHH interactions.

OHH innovations influence environmental issues, ecosystem services and sustainable development goals in many different ways and to different extents (5.1.). Possible explanations are that certain issues appeal more to people to take action than others; e.g. plastic pollution and loss of biodiversity are rather visible and easy to grasp, whereas harmful algae blooms and microbial pollution may be less so. Furthermore, some issues might need to be addressed by the government instead of social innovators, as they might require strict regulations and policy. Low coverage of certain topics by innovations may have a few implications. On the one hand, it might mean that they either do not pose that much of a problem or that there are already larger efforts in place to address them. On the other hand, these topics might require extra attention, because they have not received much yet. The topics that are very well-covered by innovations can also be interpreted in two ways. On the one hand, many efforts are taken by different actors (Figure 29; Figure 30) to address them, therefore, there would be no need for any further action on these topics. Social innovators are already taking efforts to improve the situation; therefore, there would be no need for the government to interfere. On the other hand, the fact that these topics receive many responses might stress a certain urgency and serve as an indication for key areas that need attention. Visualizing the coverage of innovations in a map helps to indicate what topics require attention and in which locations. The urgency for attention towards these topics is also stressed by Fleming et al. (2014). This paper confirms the opportunities that OHH interactions generate with regards to health and well-being, but also expresses concern about the developments of “future interactions between climate change, ocean acidification, microbial and chemical pollution and their impact on ecosystem services” (Fleming et al. 2014, p.18).

Categorization of innovations according to the DPSIR framework has resulted in a deeper understanding of the type of actions applied by social innovators when solving environmental issues or providing health benefits (5.2.), and where the innovations have most effects. These results are congruent with the established and potential interconnections and expected positive impacts of OHH interactions mentioned by Fleming et al. (2015). In their article, they advocate for research on these potential interconnections, which is partly realized by this study (Fleming et al. 2015). The DPSIR framework as applied in this research advocates for an integrated approach towards solving OHH challenges. Existing literature by Ford, Graham, & White (2015) and Fleming et al. (2014) emphasizes the need to integrate the ecosystem health and public health. The value of such integrated analysis is demonstrated in this research by exploring the benefits in both oceans and human health domains. The DPSIR framework was then used to identify measures to solve integrated OHH problems. Identifying

the most commonly applied measures for different issues, helps to understand why these actions are preferred. Lewison et al. (2016) emphasize a key element for development in the Responses component of DPSIR. Instead of the usual focus on traditional responses (policy and regulation), they advise to investigate alternative responses such as initiatives that influence human behavior and choices. This research has presented the effect of innovations as responses to OHH issues and benefits in society. Enhancing insight in and understanding of the most commonly applied and most suitable measures, the results have proven relevance to OHH developments. Furthermore, building on previous socio-environmental research by Ericksen (2008) and Nachtergaele (2010), spider diagrams were found to be an accurate tool for visualizing the integration of oceans and human health.

Although there are regional characteristics and geographical, socio-economic and cultural differences between Europe and South-East Asia, both regions experience challenges regarding OHH. The results, with a total of 200 OHH innovations, demonstrates that in both regions, many social innovators are indeed inspired to take action in OHH issues to enhance human health benefits and improve marine environmental conditions. The importance of local action and initiatives is acknowledged by PEMSEA's Annual Report 2017 and the European Commission's reflection paper (2019). Social innovators in Europe and South-East Asia indicated that they are interested in learning from others and sharing experiences. It is hence relevant to make these innovations known amongst social innovators, so that knowledge, ideas and tools can be exchanged and applied in different circumstances. Region-specific approaches can function as a source of inspiration when exchanged. For example, in Europe there is a strong focus on mental health and well-being aspects of recreational activities. In SEA tourism and recreation is an important aspect of innovations, however, it's not always self-evident that the local population will benefit from those activities aside from a source of income and livelihood. Recreational use of the ocean for coastal communities in South-East Asia could be an area where health benefits could derive from in the future.

The current gap in research and policymaking, pointed out by Fleming et al. (2014) and (2015), requires an integrated understanding of complex OHH interactions. This creates room and opportunity for innovations to fill that gap in knowledge and action (section 5.4.). Impact is achieved by complementing policy through non-traditional, innovative responses to OHH issues. There is still a lack of coherent, holistic vision for the future of seas and oceans and the interactions with humans. "Better understanding and management of these interactions are a global priority that require a global political focus and worldwide participation" (Fleming et al. 2019, p.4). The impact of innovations will in general be small-scale, but upscaling or creating collaborations and networks will help to increase their impact. Furthermore, they can indicate key areas for action, and function as small scale tests and success stories of what works and what does not, which can help to accelerate OHH policymaking. Designing a platform through which social innovators can find others, develop networks, share knowledge and expertise will help to realize upscaling efforts. Social innovators can inspire others to participate or do similar things, prevent the duplication of efforts and in that way expand their reach and potential.

## 6.2. Challenges, opportunities and limitations

An important research challenge has been that due to the novel nature of the topic of this research, academic literature on the topic is scarce. At the same time, this offered the unique opportunity of contributing to an important knowledge gap. This research used the most recent literature, some of which was published during this research. Furthermore, scientific experts in the field of research were interviewed, which helped to place the new topic of innovations in the context of Oceans and Human Health in Europe and South-East Asia. As a result, this research managed to deliver a valuable contribution to the current knowledge on the topic. This research has provided the first database and

analysis of innovations in OHH interactions. More research is needed, for instance into the effectiveness of innovative solutions, the exact impact on human health and on the links to policymaking. In addition to the challenges, this research has thus brought many opportunities. It gave the researcher the opportunity to compile the first database of oceans and human health innovations and meet experts in the field. It offered the chance to be part of and get an inside perspective of activities and operations within a Horizon2020 program. Furthermore, it provided the opportunity to work as an academic in a research organization and experience how expert knowledge is applied to actual societal and environmental challenges.

The research applied purposive sampling to reach the desired range of innovations. The main methodological limitations were dependence on online availability of innovations, language restrictions and examples of success stories only (see section Data management and quality). These limitations created a bias of cases that were reachable, of whom representatives were willing to participate and that fell within the limits of the languages. These limitations are also advantages as the innovations selected are ones that people are enthusiastic about, available on the internet and likely to inspire. The selection of webpages and content analysis, though carried out with much accuracy, allowed some degree of interpretation, which could create some bias. The researcher has been aware of the limitations and challenges of the research and has continuously strived to obtain accurate data for reliable and valid results.

## 7. Conclusion

This thesis has addressed the socially, environmentally and scientifically relevant question of how innovative solutions in oceans and human health interactions can enhance human health and well-being (section 1.2.). The main research question was answered through the compilation of a database, representing the first inventory of innovations in OHH interactions in Europe and SEA. The research was guided by a theoretical framework that allowed to conceptualize and categorize the innovations. An in-depth analysis investigated the potential role of innovations.

To get insight in the way in which innovations can contribute to improving OHH benefits, this research covered the influence of oceans on humans and vice versa as well as current practices in research and policy. Oceans provide ecosystem services such as food, medicine, recreational spaces and climate regulation, which are of great benefit to human health, but can also threaten health through e.g. floods. On the other hand, humans influence the state of the ocean through pollution of the water, either chemical, plastic or microbial contamination, but also threaten the ocean with climate change and overexploitation of its resources. At the same time, humans play a key role in protection and conservation efforts, which improve the state of the ocean and in turn enhance the ecosystem services. Oceans and human health are disconnected in current practices of research and policy. There is limited research and policymaking that integrate the two domains, while the interface can be used to address main health issues in Europe, reduce risks and solve marine environmental issues. The thesis showed that innovations are a promising approach with the potential of improving both human health benefits as well as the conditions of the marine environment.

The inventory of innovations and the interviews with social innovators and experts were analyzed as to how innovations help to solve environmental issues, provide ecosystem services that generate health benefits and contribute to achieving the sustainable development goals. The environmental impact is primarily made by addressing loss of biodiversity, plastic pollution, climate change and commercial fish stock depletion. Health benefits on the other hand are generated through the provision of ecosystem services such as tourism, recreation and well-being, food provision and water quality. The corresponding SDG targets that innovations are mostly contributing to are mental health and well-being (3.4), education and awareness (13.3), conservation and protection (14.2) and increased scientific research (14.A). Innovations cover some of the least addressed SDG targets.

To understand the types of actions applied, the innovations have been analyzed according to the DPSIR framework. Putting this categorization in relation to the topics mentioned before, helps to give insight in what types of measures are most commonly applied to create certain environmental and health benefits. This analysis explained how innovations responded to a.o. socio-economic structures, emissions, human behavior, the mental and physical state of people or ecosystem health. From the analysis, it appeared that some topics were more commonly addressed than others. *Drivers* and *Environmental Pressures* were not common types of action for innovations as these refer to governmental and legislative actions, which were largely excluded from this research (section 5.2.). Issues that were barely addressed by innovations included HAB, eutrophication, microbial pollution and chemical pollution. The ecosystem services non-living products, renewable energy and marine biotechnology were hardly targeted by the innovations. Reasons for this could be that either these topics do not appeal to people to take action, or the issues around them are not exceptionally big, or other actors such as governments should solve these issues.

In general, the environmental issues, ecosystem services and SDG targets targeted by innovations are rather similar in Europe and South-East Asia. In both regions, social innovators are inspired to take action in OHH interactions. What stands out is that for ecosystem services, mental health is an important

component in Europe, which is hardly found for innovations in South-East Asia, whereas community resilience and empowerment is much more important in this region. Social innovators were positive towards exchanging knowledge and practices internationally, as they stated in the interviews. Furthermore, experts argued that innovations have a potential role in working ahead of and alongside policy. They address locally important issues and can help to create awareness on oceans and human health relations. They can also be used for accelerating OHH policymaking by working as a way of storytelling and demonstrating success stories on the benefits of OHH interactions. In order to increase their impact and prevent ineffective and unnecessary duplication of efforts by social innovators internationally, upscaling is encouraged and recommended by innovators and experts. However, it is important that the innovations match the local context, have access to local resources and preferably take a collaborative and network approach, in which knowledge and experiences are shared among innovations.

This is the first database and extensive research on the role of innovations in OHH interactions. It contributes to filling a knowledge gap and is therefore not only of societal, but also of scientific relevance. This thesis research has been a step in the right direction towards understanding how to use oceans and human health interactions for enhancing human health.



## 8. Recommendations

This research has listed various items that deserve further attention relevant to the European Strategic Research Agenda. Key recommendations for further research include quantitative research on impact of OHH innovations. Other follow-up research on OHH innovations could cover the relation between innovations and behavioral change; and look for a deeper understanding of the (gaps in) thematic coverage of innovations.

This research has touched upon mental health as a strong potential benefit from innovations in OHH interactions. This merits more attention to and a deeper understanding of the impact of the ocean on mental health and the so-called ‘blue mind’, as also mentioned in expert interview and stressed by Britton et al. (2018). The prevalence of mental health issues in Europe makes the search for remedies considered a priority area for research to enhance public health.

Other managerial and policy implications could be based on this thesis. For instance, the European Union and ASEAN could develop a platform to maximize the potential of innovations in Europe and around the world. Providing a platform for social innovators to exchange innovative practices helps to solve OHH issues on a larger scale by building networks, sharing knowledge and establishing collaborations. Such a platform would be a key resource for finding successful innovative solutions, inspiring effective regional or continental OHH policies. The interactive map that illustrates the distribution of innovations across Europe (Appendix C) will be used at the SOPHIE website and could serve as a first inspiration to the development of a platform.

Investments in an overall basic level of awareness on OHH relations in Europe and South-East Asia can serve as a foundation for effective OHH policy implementation and enforcement. The previously mentioned platform could advance this. Another key element for achieving sustainable, inclusive and accessible OHH interactions is improved infrastructure to encourage care of the coastal zones and marine environment. Examples are improved waste management in these areas and enhancing safe, public access for all. To do so, policymaking needs to embrace the integration of the marine environment and public health domains.

## References

Azevedo, L.F. et al. (2011). How to write a scientific paper - Writing the methods section. *Revista Portuguesa de Pneumologia*, 17(5), 232-238.

“Blue Communities” (2019). Retrieved from: <http://www.blue-communities.org/Home>

Boelee, E., Geerling, G., Zaan, B. van der, Blauw, A. & Vethaak, D (2019). Water and health: From environmental pressures to integrated responses. *Acta Tropica*, 193, 217-226.

Borja, Á. et al. (2006). The European Water Framework Directive and the DPSIR, a methodological approach to assess the risk of failing to achieve good ecological status. *Estuarine, Coastal and Shelf Science*, 66(1), 84-96.

Bowen, R.E. et al (Eds.). (2014). *Oceans and Human Health: Implications for Society and Well-Being*. New Jersey: John Wiley and Sons.

Britton, E., Kindermann, G., Domegan, C., & Carlin, C. (2018). Blue care: a systematic review of blue space interventions for health and wellbeing. *Health Promotion International*, 1-20.

Burke, L., Selig, E., & Spalding, M. (2002). Reefs at Risk in Southeast Asia. *World Resources Institute*. Retrieved from [https://wriorg.s3.amazonaws.com/s3fs-public/pdf/rreasia\\_full.pdf?\\_ga=2.179483302.305514043.1549458062-2132060995.1541776212](https://wriorg.s3.amazonaws.com/s3fs-public/pdf/rreasia_full.pdf?_ga=2.179483302.305514043.1549458062-2132060995.1541776212)

Clark, T. (2018, January 23). How can ASEAN help Southeast Asian's Oceans? *Asia-Pacific Forum on Environment and Development*. Retrieved from <https://www.apfed.net/asean-can-help-southeast-asias-oceans/>

Coastal and Maritime Tourism (n.d.). *European commission*. Retrieved from: [https://ec.europa.eu/maritimeaffairs/policy/coastal\\_tourism\\_en](https://ec.europa.eu/maritimeaffairs/policy/coastal_tourism_en)

Depledge et al (2013). Changing Views of the Interconnections Between the Oceans and Human Health in Europe. *Microbial Ecology*, 65(4), 852-859.

Depledge et al. (2017). Future of the Sea: Health and Well-being of Coastal Communities. *Foresight, Governance office for science*, 4-21.

Depledge, M.H. & Bird, W. J (2009). The Blue Gym: Health and Well-being from our Coasts. *Marine Pollution Bulletin*, 58(7), 947-948.

Dumitrescu, D. [A child speaking to the ocean.] [photograph]. Retrieved from: <https://www.unworldoceansday.org/world-oceans-day-photo-competition>

Eriksen, P.J. (2008). Conceptualizing food systems for global environmental change research. *Global Environmental Change*, 18, 234-245.

European Commission (2019). *Reflection Paper: Towards a Sustainable Europe by 2030*. Retrieved from [https://ec.europa.eu/commission/sites/beta-political/files/rp\\_sustainable\\_europe\\_30-01\\_en\\_web.pdf](https://ec.europa.eu/commission/sites/beta-political/files/rp_sustainable_europe_30-01_en_web.pdf)

European Environmental Agency (2018). Marine Environmental Pressures. Retrieved from <https://www.eea.europa.eu/themes/water/europes-seas-and-coasts/marine-environmental-pressures>

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

European Marine Board (EMB) & Centre for Environment Fisheries and Aquaculture Science (CEFAS) (n.d.). *Human Health and the Ocean: What's the Connection?* [Factsheet]. Retrieved from <http://www.marineboard.eu/sites/marineboard.eu/files/public/publication/OHH%20Fact%20sheet%20set.pdf>

European Union (2018). *Sustainable development in the European Union Overview of progress towards the SDGs in an EU context*. European Commission. Luxembourg: Publications office of the European Union.

Fleming et al. (2006). Oceans and Human Health: Emerging Public Health Risks in the Marine Environment. *Marine Pollution Bulletin*, 53(10-12), 545-560.

Fleming et al. (2014). Oceans and Human Health: A Rising Tide of Challenges and Opportunities for Europe. *Marine Environmental Research*, 99, 16-19.

Fleming et al. (2015). The Oceans and Human Health. Oxford University Press: The Oxford Encyclopedia of Environmental Science, Environment and Human Health.

Fleming, LE. (2017). Seas, Oceans and Public Health in Europe (SOPHIE): A Strategic Research Agenda for Europe and Beyond. Proposal number: 774567. Call: H2020-BG-2016-2017.

Fleming LE, Maycock B, White MP, & Depledge MH (2019). Fostering human health through ocean sustainability in the 21<sup>st</sup> century. *People and Nature*, 00, 1-8.

Ford A.E.S, Graham, H., & White, P.C.L. (2015). Integrating Human and Ecosystem Health Through Ecosystem Services Frameworks. *EcoHealth*, 12, 660-671.

Gabrielsen, P. & Bosch, P. (2003). Environmental Indicators: Typology and Use in Reporting. *European Environment Agency*. Retrieved from [http://www.brahmatwinn.uni-jena.de/fileadmin/Geoinformatik/projekte/brahmatwinn/Workshops/FEEM/Indicators/EEA\\_Working\\_paper\\_DPSIR.pdf](http://www.brahmatwinn.uni-jena.de/fileadmin/Geoinformatik/projekte/brahmatwinn/Workshops/FEEM/Indicators/EEA_Working_paper_DPSIR.pdf)

Grellier et al. (2017). BlueHealth: a study programme protocol for mapping and quantifying the potential benefits to public health and well-being from Europe's blue spaces. *BMJ Open*, 7, 1-8.

Hennink, M., Hutter, I., & Bailey, A. (2011). *Qualitative Research Methods*. London, UK: SAGE publications.

“Principles” (n.d.). *INHERIT*. Retrieved from <https://www.inherit.eu/>

Kim, I. & Kuljis, J. (2010). Applying Content Analysis to Web-based Content. *Journal of Computing and Information Technology*, 4, 369-375.

Korpela, K., Ylén, M., Tyrväinen, L., & Silvennoinen, H. (2010). Favorite green, waterside and urban environments, restorative experiences and perceived health in Finland. *Health Promotion International*, 25.2, 200-209.

Kothari, C.R (2004). *Research Methodology: Methods and Techniques*. New Delhi, India: New Age International (P) Limited Publishers.

Krippendorff, K. (2004). *Content analysis: an introduction to its methodology* (2<sup>nd</sup> ed.). Thousand Oaks, CA: Sage Publications.

Lewison et al. (2016). How the DPSIR framework can be used for structuring problems and facilitating empirical research in coastal systems. *Environmental Science and Policy*, 56, 110-119.

Livni, E. (2018, August 5). Blue Mind science proves the health benefits of being by water. *Quartz*. Retrieved from <https://qz.com/1347904/blue-mind-science-proves-the-health-benefits-of-being-by-water/>

Mangi S.C., Roberts C.M. & Rodwell, L.D. (2007). Reef fisheries management in Kenya: Preliminary approach using the driver–pressure–state–impacts–response (DPSIR) scheme of indicators. *Ocean and Coastal Management*, 50(5-6), 463-480.

McLafferty, E. & Farley, A. (2006) Analysing qualitative research data using computer software. *Nursing Times*, 102 (24), 34–36.

Moore et al. (2013). Oceans and Human Health (OHH): a European Perspective from the Marine Board of the European Science Foundation (Marine Board-ESF). *Microbial Ecology*, 65, 889-900.

Moulaert F., MacCallum, D., Mehmood, A. & Hamdouch, A. (Eds.). (2013). *The International Handbook on Social Innovation: Collective Action, Social learning and transdisciplinary research*. Cheltenham, UK: Edward Elgar Publishing Limited.

Nachtergaele, F., Biancalani, R., Bunning, S. & George H. (2010). Land Degradation Assessment: The LADA approach. *Research Gate*, 72-75.

Neumann, B., Vafeidis, A.T., Zimmermann, J. & Nicholls, R.J. (2015). Future Coastal Population Growth and Exposure to Sea-Level Rise and Coastal Flooding - A Global Assessment. *PLOS ONE*, 10(6), 1-34.

“NGO” (n.d.). In *Lexico dictionaries*. Retrieved from <https://www.lexico.com/en/definition/ngo>

Nichols, W. J. (2014). *Blue Mind: How Water Makes You Happier, More Connected and Better at What You Do*. London, UK: Little, Brown.

“Fifth ASEAN state of the environment report” (2017). *Association of South East Asian Nations*. Retrieved from: <https://environment.asean.org/wp-content/uploads/2018/01/SOER5.pdf>

“The Ocean and Climate Change” (2017). *IUCN*. Retrieved from <https://www.iucn.org/resources/issues-briefs/ocean-and-climate-change>

Our Oceans, Seas and Coasts. (11-03-2019). *European Commission*. Retrieved from:

[http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/implementation/index\\_en.htm](http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/implementation/index_en.htm)

PEMSEA (2017). Because the Sea is Life: PEMSEA Annual Report 2017. *Partnerships in Environmental Management for the Seas of East Asia (PEMSEA)*, 1-64. [http://pemsea.org/sites/default/files/PEMSEA%20Annual%20Report%202017%20\(20180716\).pdf](http://pemsea.org/sites/default/files/PEMSEA%20Annual%20Report%202017%20(20180716).pdf)

PEMSEA (2018). State of the Oceans and Coasts 2018: Blue Economic Growth in the East Asian Seas Region. *Partnerships in Environmental Management for the Seas of East Asia (PEMSEA)*. Retrieved from <http://pemsea.org/publications/reports/state-oceans-and-coasts-2018-blue-economy-growth-east-asian-region>

“Personal healthcare” (n.d.). In *IGI Global Dictionary*. Retrieved from <https://www.igi-global.com/dictionary/exploring-personal-healthcare-help-two/22474>

“Public health services” (n.d.). In *World Health Organization*. Retrieved from <http://www.euro.who.int/en/health-topics/Health-systems/public-health-services>

Seas Oceans and Public Health in Europe (n.d.). Retrieved from <https://sophie2020.eu/activities/innovative-solutions/>

Spalding, M.J. (2017, February 10). The Association of Southeast Asian Nations’ Role in Ocean Issues. *The Ocean Foundation*. Retrieved from <https://www.oceanfdn.org/blog/association-southeast-asian-nations-role-ocean-issues>

Sustainable Development Goals (n.d.). *Sustainable Development Goals Knowledge Platform*. Retrieved from <https://sustainabledevelopment.un.org/sdgs>

UNESCAP (2018). SDG Progress Assessment. Retrieved from <http://data.unescap.org/#progress>

United Nations (2017). Southeast Asia Subregion Challenges and Priorities for SDG Implementation. *United Nations Economic and Social Commission for Asia and the Pacific*. Retrieved from <https://www.unescap.org/resources/southeast-asia-subregion-challenges-and-priorities-sdg-implementation>

Verschuren, P. & Doorewaard, H. (2010). *Designing a Research Project*. The Hague: Eleven International Publishing.

What is Horizon 2020? (n.d.). *European commission*. Retrieved from <https://ec.europa.eu/programmes/horizon2020/what-horizon-2020>

Wheeler et al. (2015). Beyond greenspace: an ecological study of population general health and indicators of natural environment type and quality. *International Journal of Health Geographics*, 14(17), 1-17.

White et al. (2010). Blue Space: The importance of water for preference, affect and restorativeness ratings of natural and built scenes. *Journal of Environmental Psychology*, 30(4), 482-493.

White et al. (2016). The health benefits of blue exercise in the UK. In Barton, J., Bragg, R., Wood, C. & Pretty, J. (Eds). *Green Exercise: Linking Nature, health and well-being*. Abingdon, UK: Routledge. 69-77.

Voorberg, W. H., Bekkers, V. J. J. M. & Tummers, L. G. (2015) A Systematic Review of Co-Creation and Co-Production: Embarking on the social innovation journey, *Public Management Review*, 17(9), 1333-1357.

Yee et al. (2012). Integrating Human Health and Environmental Health into the DPSIR Framework: A Tool to Identify Research Opportunities for Sustainable and Healthy Communities. *EcoHealth*, 9(4), 411-426.

## Appendices

### Appendix A – State of the art

#### State of the art in Europe

The ‘Blue Health’ project is part of the European Horizon2020 program, and it has been running since 2016 (Grellier et al. 2017). It aims to understand the effects of water-based environments on health and well-being and looks at the climate, environment and health nexus in the European context. By doing so, Blue Health wants “to map and quantify the public health impacts of changes to both natural blue spaces and associated urban infrastructure in Europe, and to provide evidence-based information to policymakers on how to maximize health benefits associated with interventions in and around aquatic environments” (Grellier et al. 2017, p.1). One major objective of Blue Health is to gather evidence that will form the basis for recommendations on how to enhance human health and well-being by effectively adapting blue infrastructure and human behavior in urban areas.

As a follow-up of the Green Gym project that has existed in the UK for 10 years, the Blue Gym was initiated (Depledge and Bird, 2009). The Green Gym uses land-based nature conservation as a mechanism to improve outdoor physical activity and boost human health and well-being. The Blue Gym investigates the benefits that can be gained from coastal environments in the UK. The objective is to create a network of Blue Gym activities that in particular promote the mental and physical benefits that can be obtained by exercising near an aquatic environment. In this way it will contribute to connecting more people to blue spaces, both coastal and inland.

Another research that connects the blue environment and health is Blue Mind, initiated by Wallace Nichols. It builds on the philosophy that water bodies have a therapeutic effect on people’s minds. The blue mind acknowledges that the brain gets a break from daily experienced stress in the fast-moving society. When in contact with the ocean, the state of mind becomes calm and peaceful (Nichols 2014). It is the counterpart of a red mind: stressed, anxious and processing too much information (Livni, 2018). Being in or near water forces people to disconnect from society and reconnect with nature. It is linking the medical world with natural therapy. Although the Blue Mind research started in the US, its underlying ideology is also used in European OHH research projects. This is part of the emerging research field that is called neuroconservation (Nichols 2014).

INHERIT (Inter-sectoral Health and Environment Research for InnovaTion) is a 4-year project that is part of the Horizon2020 program and has as a core activity to identify life and consumption patterns that play part in environmental protection and the promotion of overall health and health equity. INHERIT addresses issues regarding the health and environment interface as well as health inequity (“principles”, n.d.). It stimulates policy making, current practices and innovations to tackle these issues. The project emphasizes the interconnectedness of environment and health and the importance of preserving the environment for health and well-being. It takes into account the role of the consumer and insists on behavioral change towards more sustainable consumption patterns. “It aims to make more explicit, the links between the environment, health, well-being, health equity, and our lifestyles and behaviors” (“principles”, n.d.). INHERIT collects good practices in Europe that encourage people to change their behavior in a sustainable way that stimulate environmental well-being and better health and health equity.

Though extensively adding to the current body of literature and existing knowledge on blue spaces, environment, and human health and well-being, these research programs have a general focus and do not look into the specific benefits of the marine environment for human health. Furthermore, they largely focus on urban areas, hence excluding large coastal environments. Blue Health is beneficial to research and policy as it gives insights in how urban spaces can be organized to enhance human health



benefits from blue spaces. Furthermore, through other Horizon2020 programs, the link between the environment and human health is currently extensively researched and it is advocated how to use these relations to enhance health. These programs form a good base for this branch of research, however, more research is needed for more specific environments. For the relation between the marine environment and human health and well-being, there are no other pan-European research programs yet besides SOPHIE, demonstrating that this field of research is even more innovative and that a gap in research still exists here.

### State of the art in South-East Asia

Some regional efforts have already been made in the region, aimed at adapting to and reducing future risks, managing marine litter, protecting marine environments, regional management of fisheries, coasts and the marine environment and preserving key marine species (Fifth ASEAN state of the environment report 2017). Marine management and conservation is crucial to sustain ecosystem services and can be done by creating marine protected areas, improving fishing methods, ecotourism and the enforcement of regulations and laws.

Recently efforts have been made in particular to set up a regional research program called 'Blue Communities' that aims to protect the marine environment and enhances human health benefits. This program started in 2017 and is active in The Philippines, Indonesia, Malaysia and Vietnam. 'Blue communities' is a collaborative research capacity-building program of 4 years that responds to risk reduction in coastal areas in South-East Asia. It is a joint program of UK research partners and SE Asian partners and it is built up of twelve interconnected research projects (Blue-Communities.org). In this way, it strives to tackle threats to the marine environment as well as enhance ecosystem services that are generated by the oceans. Most prominently, these are climate change, sustainable harvesting, good health and well-being, opportunities for growth and implementation of regional marine management.

Five out of these twelve projects are directly aimed at increased understanding of the impact of oceans on human health and vice versa, notably: impacts on ecosystem services and values; marine renewable energy; small-scale coastal tuna fisheries management; well-being benefits and risks of coastal living; and earth observation approaches. This program and its timeliness indicate that there is an interest by the UK and SEA to improve oceans and human health and well-being in the region and that there is not yet enough knowledge on the topic. This research program is the first of its kind in South-East Asia but is still in the early stages. Beyond the scope of this research program, there is much more that needs to be investigated regarding OHH in SEA. Research in this area is relevant for improvement of sustainable interactions and human health. The components highlighted by this project demonstrate the priority or key areas in which research is needed. 'Blue communities' addresses SDG 1 (No Poverty), 2 (Zero Hunger), 3 (Good Health and Well-being) and 14 (Life below Water), once again highlighting the importance and relevance of the sustainable development goals in the region of SEA and their interconnectedness in OHH research.

## Appendix B – Background of the DPSIR Framework

DPSIR represents a conceptual framework that is used to demonstrate the relation between society and the state of the environment, and it helps to connect social and environmental risks to human health (Gabrielsen and Bosch 2003; Yee et al. 2012). DPSIR functions as a tool to connect scientific knowledge to policymaking by generating a wide scale of linkages between the key aspects of sustainability: Economy, society, environment and public health (Borja et al. 2006; Yee et al. 2012). Being “one of the most widely applied environmental frameworks, the Driving force–Pressure–State–Impact–Response (DPSIR) framework, is favored for its simplicity and transparency, focus on causal relationships, and ability to integrate socio-economic factors, biological and physical sciences, and decision science” (Yee et al. 2012, p. 412).

DPSIR is used in environmental assessments for describing environmental issues that follow a causal chain of environmental indicators. It derives from the Canadian STRESS model that described environmental issues using *Pressures*, *State* and *Responses* and was later adopted by the OECD as the OECD Pressure State Response (PSR) model (Gabrielsen and Bosch 2003). To also consider social and economic aspects, other dimensions, notably *Drivers* and *Impacts* were added. The European Environmental Agency uses the DPSIR framework for environmental assessments. “During these twenty years of history, the framework has developed from a tool to describe natural ecosystems under stress to a framework for describing human - environment interactions and the related information flows” (Gabrielsen and Bosch 2003, p.7). Hence it serves as a tool to extract information, structure research and knowledge and consider alternative responses to sustainability issues (Yee et al. 2012).
















It has been used over time by among others Gabrielsen and Bosch (2003), Borja et al. (2006), Mangi, Roberts & Rodwell (2007), Yee et al. (2012), Boelee, Geerling, Zaan, Blauw & Vethaak (2019) and Lewison et al. (2016) in various ways to analyze socio-environmental issues. For instance, Gabrielsen and Bosch started using the DPSIR framework for the European Environmental Agency for environmental issues. Borja et al. used the DPSIR framework to assess the pressures and risk of failing the ecological good state of water bodies applied to a case study of the Basque estuarine and coastal waters. Mangi et al. on the other hand focused on reef fisheries management in Kenya, in which it identifies factors that lead to overfishing and what policy measures can be applied. Yee et al. connect human health and environmental health and used the DPSIR framework as a tool to integrate socio-cultural and economic components of environmental health and public health into one framework. Boelee et al. (2019) use the DPSIR framework to investigate the potential of integral water management to improve human health, with water management as *Responses*. Lewison et al. (2016) applied DPSIR to research and policymaking on sustainability in coastal SES (social-ecological systems). The DPSIR framework has been used over time to connect environmental and social factors to identify (policy) measures to solve integrated societal problems.

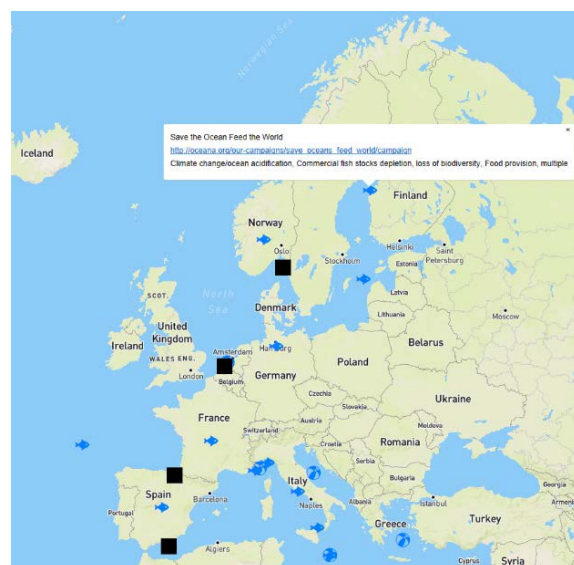
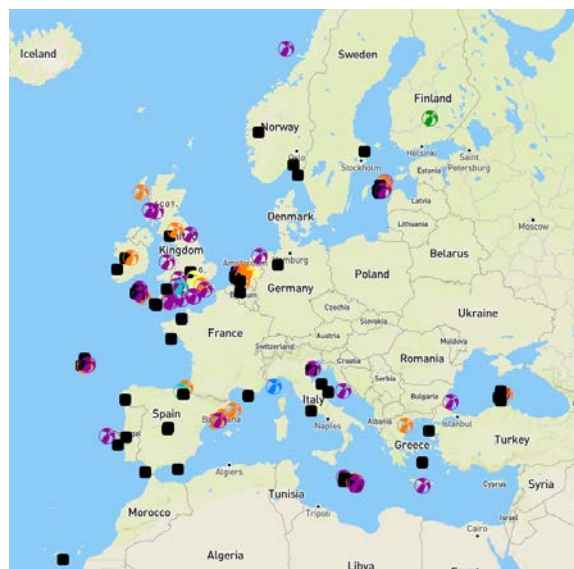
Various modifications have been made to the DPSIR framework in recent years, which among others created DPSEEA (Drivers, Pressures, State, Exposure/Experience, Effect and Action), modified mDPSEEA and recently eDPSEEA (Reis et al. 2015). In 2015, eDPSEEA was proposed by Reis et al, which established an ecosystem enriched DPSEEA. Their article extended the use of the framework to “include a platform for assessments of impact of environmental pressures on human health and well-being as well as ecosystem health and the resulting ecosystem services provided” (Reis et al. 2015, 1386).

In the current study the aim is to study the effects and benefits of *Responses* in specific, therefore the traditional DPSIR framework has purposively been selected for analysis. It does however deliberately make a distinction between human and environmental sides of DPSIR. Furthermore, in line with

eDPSEEA, it aims to include ecosystem services that go beyond the *Environmental State* (Reis et al. 2015). To do so, ecosystem services, tradeoffs and health benefits are understood as part of *Impact*. In 2016 DPSIR was used by Lewison et al. in coastal and social-ecological systems research; forming a good basis for the use of DPSIR in this research. In the context of SOPHIE, the framework is useful as a supporting mechanism to demonstrate all aspects that play a role in OHH relations. The theory and the concepts are used in exploring the value of an integrated approach, i.e. involving public health and marine ecosystems, for improving OHH interactions in Europe. The overview of innovations regarding OHH interactions that is provided is structured according to the components of the DPSIR model. In this way, the theory and concepts will help to demonstrate the potential of OHH innovation for improving public health and marine conservation.

## Appendix C – Interactive map

Legend	X
<b>Ecosystems Services</b>	
	none
	Marine biotechnology
	Tourism, recreation and well-being
	Food provision
	Water quality
	marine renewable energy
<b>Environmental issues</b>	
	multiple
	Climate change/ocean acidification
	harmful algae blooms
	microbial contamination and pathogens
	Commercial fish stocks depletion
	plastic pollution
	eutrophication
	loss of biodiversity
	chemical pollution



## Overview required data

File	Home	Insert	Page Layout	Formulas	Data	Review	View	Help	Tell me what you want to do
B319									
	A	B	C	D	E	F	G	H	
1	id	name	url	locationname	location_lat	location_lon			
2	000	Scott Haldane Foundation	<a href="https://www.scotthaldane.nl/nl/">https://www.scotthaldane.nl/nl/</a>	The Netherlands	52.105883	5.240813			
3	001	PRIMROSE	<a href="https://www.atlanticarea.eu/project/2/">https://www.atlanticarea.eu/project/2/</a>	Ireland; Scotland, England, Spain, Portugal and France.	53.412390	-8.243890			
4	001	PRIMROSE	<a href="https://www.atlanticarea.eu/project/2/">https://www.atlanticarea.eu/project/2/</a>	Ireland; Scotland, England, Spain, Portugal and France.	56.496638	-4.220445			
5	001	PRIMROSE	<a href="https://www.atlanticarea.eu/project/2/">https://www.atlanticarea.eu/project/2/</a>	Ireland; Scotland, England, Spain, Portugal and France.	56.227638	-2.21749			
6	001	PRIMROSE	<a href="https://www.atlanticarea.eu/project/2/">https://www.atlanticarea.eu/project/2/</a>	Ireland; Scotland, England, Spain, Portugal and France.	54.063669	-3.743220			
7	001	PRIMROSE	<a href="https://www.atlanticarea.eu/project/2/">https://www.atlanticarea.eu/project/2/</a>	Ireland; Scotland, England, Spain, Portugal and France.	52.355518	-11.74320			
8	001	PRIMROSE	<a href="https://www.atlanticarea.eu/project/2/">https://www.atlanticarea.eu/project/2/</a>	Ireland; Scotland, England, Spain, Portugal and France.	56.580715	-8.135860			
9	002	CEPES	<a href="https://www.cepes.eu/">https://www.cepes.eu/</a>	Hamburg, Germany	53.551086	9.893382			
10	003	Seafarers Hospital Society	<a href="https://seahospital.org.uk/">https://seahospital.org.uk/</a>	London, UK	51.48169	-0.00869			
11	004	The mission to seafarers	<a href="https://www.missiontoseafarers.org/">https://www.missiontoseafarers.org/</a>	London, UK	51.51139	-0.08226			
12	004	The mission to seafarers	<a href="https://www.missiontoseafarers.org/">https://www.missiontoseafarers.org/</a>	London, UK	55.39324	-2.62203			
13	005	Mater Muroso	<a href="https://www.matermuroso.com/">https://www.matermuroso.com/</a>	Spain	43.2258	-1.93238			
14	006	Co-development of Climate Services for Adaptation to Changing Marine	<a href="https://www.codcme.eu/">https://www.codcme.eu/</a>	Irish Atlantic, French Atlantic, Baltic Sea, Black Sea, Mediterranean Sea, North	35.971601	16.416732	Mediterranean		
15	006	Co-development of Climate Services for Adaptation to Changing Marine	<a href="https://www.codcme.eu/">https://www.codcme.eu/</a>	Irish Atlantic, French Atlantic, Baltic Sea, Black Sea, Mediterranean Sea, North	58.054165	20.443380	Baltic		
16	006	Co-development of Climate Services for Adaptation to Changing Marine	<a href="https://www.codcme.eu/">https://www.codcme.eu/</a>	Irish Atlantic, French Atlantic, Baltic Sea, Black Sea, Mediterranean Sea, North	45.892455	-12.237205	Atlantic		
17	006	Co-development of Climate Services for Adaptation to Changing Marine	<a href="https://www.codcme.eu/">https://www.codcme.eu/</a>	Irish Atlantic, French Atlantic, Baltic Sea, Black Sea, Mediterranean Sea, North	43.174037	34.109343	Black Sea		
18	006	Co-development of Climate Services for Adaptation to Changing Marine	<a href="https://www.codcme.eu/">https://www.codcme.eu/</a>	Atlantic, Baltic Sea, Black Sea, Mediterranean Sea, North	52.323163	4.178320	North sea		
19	006	Co-development of Climate Services for Adaptation to Changing Marine	<a href="https://www.codcme.eu/">https://www.codcme.eu/</a>	Atlantic, Baltic Sea, Black Sea, Mediterranean Sea, North	51.039735	-7.132920	Celtic Sea		
20	007	CoolRoute	<a href="https://www.sailcoolroute.eu/">https://www.sailcoolroute.eu/</a>	UK and Scandinavia	51.896893	-8.486316			
21	008	The Plastic Soup Foundation	<a href="https://www.plasticsoupfoundation.org/">https://www.plasticsoupfoundation.org/</a>	The Netherlands	52.38205	4.8703			
22	009	Cosita Ealaen	<a href="https://www.cositaleen.nl/en/alternhome">https://www.cositaleen.nl/en/alternhome</a>	Italy	43.07755	8.01791			
23	010	EcoMarine Malta	<a href="http://www.ecomarinemalta.com/ml/">http://www.ecomarinemalta.com/ml/</a>	Malta	35.95653	14.36125			
24	011	Lollare	<a href="https://www.lollare.com/">https://www.lollare.com/</a>	US/UK	51.48169	-0.00869			
25	012	Project Baseline	<a href="https://projectbaseline.org/">https://projectbaseline.org/</a>	Europe	35.971601	16.416732	Mediterranean		
26	012	Project Baseline	<a href="https://projectbaseline.org/">https://projectbaseline.org/</a>	Europe	58.054165	20.443380	Baltic		
27	012	Project Baseline	<a href="https://projectbaseline.org/">https://projectbaseline.org/</a>	Europe	45.892455	-12.237205	Atlantic		
28	012	Project Baseline	<a href="https://projectbaseline.org/">https://projectbaseline.org/</a>	Europe	43.174037	34.109343	Black Sea		
29	012	Project Baseline	<a href="https://projectbaseline.org/">https://projectbaseline.org/</a>	Europe	52.323163	4.178320	North sea		
30	012	Project Baseline	<a href="https://projectbaseline.org/">https://projectbaseline.org/</a>	Europe	51.039735	-7.132920	Celtic Sea		
31	013	Expedition	<a href="https://theexpedition.com/">https://theexpedition.com/</a>	UK	50.754668	-4.142857			
32	014	Swim Guide	<a href="https://www.theswimguide.org/">https://www.theswimguide.org/</a>	Canada	55.676098	12.568337			
33	014	Swim Guide	<a href="https://www.theswimguide.org/">https://www.theswimguide.org/</a>	Canada	51.896893	-8.486316			
34	014	Swim Guide	<a href="https://www.theswimguide.org/">https://www.theswimguide.org/</a>	Canada	43.570181	-15.74283			
35	014	Swim Guide	<a href="https://www.theswimguide.org/">https://www.theswimguide.org/</a>	Canada	43.880070	6.221043			
36	015	Edulis	<a href="https://www.aquaguest-betodis.be/">https://www.aquaguest-betodis.be/</a>	Belgium	51.577616	3.019541			
37	016	The Outdoor Swimming Society	<a href="https://www.outdoorswimmingsociety.com/">https://www.outdoorswimmingsociety.com/</a>	UK	52.955120	-1.143170	map on website		
38	017	Adopt a float	<a href="https://www.monocoanetmool.com/web/index.php?netadopc-a-float-uk">https://www.monocoanetmool.com/web/index.php?netadopc-a-float-uk</a>	France	43.70425	7.31008			
39	018	Reet Design Lab	<a href="http://www.reetdesignlab.com/">http://www.reetdesignlab.com/</a>	The Netherlands, Maldives	53.631741	6.435853			
40	019	CSI - Community Seagrass Initiative	<a href="http://www.csi-seagrass.org/">http://www.csi-seagrass.org/</a>	UK, Plymouth	50.378458	-4.142857			
41	019	CSI - Community Seagrass Initiative	<a href="http://www.csi-seagrass.co.uk/">http://www.csi-seagrass.co.uk/</a>	UK, Torbay	50.451771	-3.557190			
42	019	CSI - Community Seagrass Initiative	<a href="http://www.csi-seagrass.co.uk/">http://www.csi-seagrass.co.uk/</a>	UK, Weymouth	50.608791	-2.454150			
43	020	Ocean Witness	<a href="https://oceanwitness.org/">https://oceanwitness.org/</a>	worldwide	38.356491	-8.38147			
44	020	Ocean Witness	<a href="https://oceanwitness.org/">https://oceanwitness.org/</a>	worldwide	40.47051	19.4916			
45	020	Ocean Witness	<a href="https://oceanwitness.org/">https://oceanwitness.org/</a>	worldwide	51.9179	4.40025			
46	020	Ocean Witness	<a href="https://oceanwitness.org/">https://oceanwitness.org/</a>	worldwide	52.370216	4.895168			
47	020	Ocean Witness	<a href="https://oceanwitness.org/">https://oceanwitness.org/</a>	worldwide	52.20422	5.14476			
48	020	Ocean Witness	<a href="https://oceanwitness.org/">https://oceanwitness.org/</a>	worldwide	51.924419	4.477733			
49	021	SeaValls - Artists for oceans	<a href="https://www.pangaearedfoundation.com/sea-valls/">https://www.pangaearedfoundation.com/sea-valls/</a>	US	39.201147	24.991862	Estonia		
50	021	SeaValls - Artists for oceans	<a href="https://www.pangaearedfoundation.com/sea-valls/">https://www.pangaearedfoundation.com/sea-valls/</a>	US	49.931738	32.875088	Ukraine		
51	022	Stichting Anemoon	<a href="https://www.anemoon.org/">https://www.anemoon.org/</a>	The Netherlands	51.058434	3.926340			
52	022	Stichting Anemoon	<a href="https://www.anemoon.org/">https://www.anemoon.org/</a>	The Netherlands	51.775395	3.970744			
53	022	Stichting Anemoon	<a href="https://www.anemoon.org/">https://www.anemoon.org/</a>	The Netherlands	52.323163	4.178320			
54	023	Save the waves	<a href="https://www.savethewaves.org/">https://www.savethewaves.org/</a>	us	38.962352	-5.415460	North sea		
55	023	Save the waves	<a href="https://www.savethewaves.org/">https://www.savethewaves.org/</a>	us	52.753020	-8.490210			
56	024	LEMA tool	<a href="http://www.ilema.eu">www.ilema.eu</a>	SE Bay of Biscay	43.775695	-2.033605			
57	025	One Ocean FM	<a href="https://www.oneoceanfm/">https://www.oneoceanfm/</a>	UK	53.340358	-2.104731			
58	026	Smartin, surfing for citizen science	<a href="https://www.smartin.org/">https://www.smartin.org/</a>	US	45.982455	-12.237205	Atlantic		
59	027	The Jellyfish App	<a href="https://thejellyfishapp.com/">https://thejellyfishapp.com/</a>	Australia	45.108887	-6.077563	Applicable everywhere		
60	028	Capturing Our Coast	<a href="https://capturingourcoast.co.uk/">https://capturingourcoast.co.uk/</a>	UK	50.375458	-4.142857			
61	028	Capturing Our Coast	<a href="https://capturingourcoast.co.uk/">https://capturingourcoast.co.uk/</a>	UK	50.819767	-1.087377			
62	028	Capturing Our Coast	<a href="https://capturingourcoast.co.uk/">https://capturingourcoast.co.uk/</a>	UK	51.853204	-2.895758			
63	028	Capturing Our Coast	<a href="https://capturingourcoast.co.uk/">https://capturingourcoast.co.uk/</a>	UK	53.233627	-4.128341			
64	028	Capturing Our Coast	<a href="https://capturingourcoast.co.uk/">https://capturingourcoast.co.uk/</a>	UK	56.491492	-5.373438			
65	028	Capturing Our Coast	<a href="https://capturingourcoast.co.uk/">https://capturingourcoast.co.uk/</a>	UK	55.046217	-14.758708			
66	028	Capturing Our Coast	<a href="https://capturingourcoast.co.uk/">https://capturingourcoast.co.uk/</a>	UK	53.743459	6.215721	UK		
67	028	Safe Haven Ireland	<a href="https://www.safehavenireland.com/">https://www.safehavenireland.com/</a>	Ireland	53.367653	-7.870915	Ireland, multiple locations		
68	030	Sea Sanctuary	<a href="https://seasanctuary.org.uk/">https://seasanctuary.org.uk/</a>	UK	50.166098	-5.091138			
69	031	Marine CoLABoration	<a href="https://marinecolab.org/">https://marinecolab.org/</a>	UK	51.48169	-0.00869			
70	032	The Blue Net Festival	<a href="https://www.blunetfestival.org/about/">https://www.blunetfestival.org/about/</a>	UK	55.378052	-3.435973			
71	033	Low Impact Fisheries of Europe (LIFE)	<a href="https://www.life-fish.eu/">https://www.life-fish.eu/</a>	Europe	50.850146	4.351721			
72	034	Seabin	<a href="https://www.seabinproject.com/">https://www.seabinproject.com/</a>	Australia	35.971601	16.416732	Mediterranean		

	A	B	C	D	E	F	G	H	I	J	K	L	M	
1	category	category_color: kan weg?	initiative_id	Climate change/ocean acidification	Commercial fish stocks	loss of biodiversity	eutrophication	harmful algae blooms	plastic pollution	chemical pollution	microbial contamination	and pathogens	none	other
2	Environmental issues	#0080FF	000	0	0	0	0	0	0	0	0	0	1	0
3	Environmental issues	#00CCCC	001	1	0	0	0	1	0	0	0	0	1	0
4	Environmental issues	#00CCCC	002	1	1	0	0	1	0	0	0	0	1	0
5	Environmental issues	#663300	003	0	0	0	0	0	0	0	0	0	0	1
6	Environmental issues	#009900	004	0	0	0	0	0	0	0	0	0	0	1
7	Environmental issues		005	0	1	0	0	0	1	0	0	0	0	0
8	Environmental issues		006	1	0	0	1	1	0	0	0	1	0	0
9	Environmental issues		007	0	0	0	0	0	0	0	0	0	1	0
10	Environmental issues		008	0	0	0	0	0	1	0	0	0	0	0
11	Environmental issues		009	0	1	0	0	0	0	0	0	0	0	0
12	Environmental issues		010	0	0	0	0	0	0	0	0	0	1	0
13	Environmental issues		011	0	0	0	0	0	1	0	0	0	0	0
14	Environmental issues		012	0	0	1	0	0	0	0	0	0	0	0
15	Environmental issues		013	0	0	0	0	0	0	0	0	0	1	0
16	Environmental issues		014	0	0	0	0	0	0	0	0	0	1	0
17	Environmental issues		015	0	0	0	0	0	0	0	0	0	1	0
18	Environmental issues		016	0	0	0	0	0	0	0	0	0	1	0
19	Environmental issues		017	0	0	0	0	0	0	0	0	0	1	0
20	Environmental issues		018	0	0	1	0	0	0	0	0	0	0	0
21	Environmental issues		019	0	0	1	0	0	0	0	0	0	0	0
22	Environmental issues		020	0	0	0	0	0	0	0	0	0	0	0
23	Environmental issues		021	0	0	0	0	0	0	0	0	0	1	0
24	Environmental issues		022	0	0	0	0	0	0	0	0	0	1	0
25	Environmental issues		023	0	1	0	0	0	1	1	0	0	0	0
26	Environmental issues		024	0	0	0	0	0	1	0	0	0	0	0
27	Environmental issues		025	0	0	0	0	0	0	0	0	0	1	0
28	Environmental issues		026	1	0	0	0	0	0	0	0	0	0	0
29	Environmental issues		027	0	0	0	0	0	0	0	0	0	1	0
30	Environmental issues		028	0	0	1	0	0	0	0	0	0	0	0
31	Environmental issues		029	0	0	0	0	0	0	0	0	0	1	0
32	Environmental issues		030	0	0	0	0	0	0	0	0	0	1	0
33	Environmental issues		031	0	0	0	0	0	1	0	0	0	0	0
34	Environmental issues		032	0	1	1	0	0	0	0	0	0	0	0
35	Environmental issues		033	0	0	0	0	0	0	0	0	0	0	0
36	Environmental issues		034	0	0	0	0	0	1	0	0	0	0	0
37	Environmental issues		035	0	0	0	0	0	0	0	0	0	1	0
38	Environmental issues		036	0	0	0	0	0	0	0	0	0	1	0
39	Environmental issues		037	0	0	0	0	0	0	0	0	0	1	0
40	Environmental issues		038	0	0	1	0	0	0	0	0	0	0	0
41	Environmental issues		039	0	0	0	0	0	0	0	0	0	1	0
42	Environmental issues		040	0	0	0	0	0	0	0	0	0	1	0
43	Environmental issues		041	0	1	1	0	0	0	0	0	0	0	0
44	Environmental issues		042	0	0	0	0	0	0	0	0	0	1	1
45	Environmental issues		043	0	0	1	0	0	0	0	0	0	0	0
46	Environmental issues		044	0	0	0	0	0	1	0	0	0	0	0
47	Environmental issues		045	0	0	0	0	0	1	0	0	0	1	0
48	Environmental issues		046	0	1	1	0	0	1	0	0	0	0	0



File Home Insert Page Layout Formulas Data Review View Help Tell me what you want to do										
C157										
A	B	C	D	E	F	G	H	I	J	K
category	category_symbol: kan weg?	initiative_id	Food provision	Marine biotechnology	Water quality	Tourism, recreation and well-being	marine renewable energy	non-living product: none	other	
ecosystem services		000	0	1	0	1	0	0	0	0
ecosystem services		001	1	0	0	0	0	0	0	0
ecosystem services		002	1	0	0	0	0	0	0	0
ecosystem services		003	0	0	0	0	0	0	0	0
ecosystem services		004	0	0	0	0	0	0	0	0
ecosystem services		005	1	0	0	1	0	0	0	0
ecosystem services		006	1	0	1	1	0	0	0	0
ecosystem services		007	0	0	0	1	0	0	0	0
ecosystem services		008	0	0	1	0	0	0	0	0
ecosystem services		009	0	0	0	1	0	0	0	0
ecosystem services		010	0	0	0	1	0	0	0	0
ecosystem services		011	0	0	1	0	0	0	0	0
ecosystem services		012	0	0	0	1	0	0	0	0
ecosystem services		013	0	0	1	0	0	0	0	0
ecosystem services		014	0	0	1	1	0	0	0	0
ecosystem services		015	1	0	0	0	0	0	0	0
ecosystem services		016	0	0	0	1	0	0	0	0
ecosystem services		017	0	0	1	0	0	0	0	0
ecosystem services		018	0	0	0	1	0	0	0	0
ecosystem services		019	0	0	1	1	0	0	0	0
ecosystem services		020	0	0	0	0	0	0	0	0
ecosystem services		021	0	0	0	1	0	0	0	0
ecosystem services		022	0	0	0	1	0	0	0	0
ecosystem services		023	0	0	1	1	0	0	0	0
ecosystem services		024	0	0	1	1	0	0	0	0
ecosystem services		025	0	0	0	1	0	0	0	0
ecosystem services		026	0	0	0	1	0	0	0	0
ecosystem services		027	0	0	0	1	0	0	0	0
ecosystem services		028	0	0	0	1	0	0	0	0
ecosystem services		029	0	0	0	1	0	0	0	0
ecosystem services		030	0	0	0	1	0	0	0	0
ecosystem services		031	0	0	1	1	0	0	0	0
ecosystem services		032	1	0	0	1	0	0	0	0
ecosystem services		033	1	0	0	0	0	0	0	0
ecosystem services		034	0	0	1	0	0	0	0	0
ecosystem services		035	0	0	0	1	0	0	0	0
ecosystem services		036	0	0	0	1	0	0	0	0
ecosystem services		037	0	0	0	1	0	0	0	0
ecosystem services		038	0	0	0	1	0	0	0	0
ecosystem services		039	0	0	0	1	0	0	0	0
ecosystem services		040	0	0	0	1	0	0	0	0
ecosystem services		041	1	0	0	0	0	0	0	0

File Home Insert Page Layout Formulas Data Review			
D24			
A	B	C	D
1 Naam thema's	Kleur/symbool	Code	
2 Climate change/ocean acidification	turquoise	#00CCCC	
3 Commercial fish stocks depletion	blauw	#0080FF	
4 loss of biodiversity	paars	#990099	
5 eutrophication	groen	#009900	
6 harmful algae blooms	roodbruin	#663300	
7 plastic pollution	oranje	#FF8000	
8 chemical pollution	lichtrood	#FF3333	
9 microbial contamination and pathogens	geel	#FFFF66	
10 none	geen kleur		
11 other			
12			
13 Food provision	vis		
14 Marine biotechnology	sput		
15 Water quality	druppel		
16 Tourism, recreation and well-being	strandbal		
17 marine renewable energy	windmolen		
18 non-living products	hijskraan		
19 none	vierkantje		
20 other			
21			

## Appendix D – SOPHIE Online Form

1.	<b>Case-study title *</b>	
2.	<b>Case-study location</b> <b>E.g. city, country, region where the case-study was implemented *</b>	
3.	<b>When was the case-study performed?</b> <b>Please provide year(s) or starting date of the initiative</b>	
4.	<b>Scale of implementation</b>	<div>local</div> <div>national</div> <div>sea basin</div> <div>Europe</div> <div>global</div>
5.	<b>Regional Sea basin</b> <b>Please select the relevant basin where the case-study was implemented. If outside of Europe please select "other" *</b>	<div>Baltic Sea</div> <div>North Sea</div> <div>Celtic Sea</div> <div>North East Atlantic</div> <div>Mediterranean Sea</div> <div>Black Sea</div> <div>other</div>
6.	<b>Environmental issues</b> <b>What are the issues directly addressed by the case-study? *</b>	<div>Climate change, ocean acidification</div> <div>Commercial fish stocks depletion</div> <div>Loss of biodiversity</div> <div>Eutrophication</div> <div>Harmful algae blooms</div> <div>Plastic pollution</div> <div>Chemical pollution (e.g. oils spills, pharmaceuticals, pesticides, heavy metals)</div> <div>Microbiological contamination/pathogens</div> <div>None</div> <div>Other:</div> <div>Other:</div>
7.	<b>Ecosystem services</b> <b>Which marine services and uses can be improved by the case-study? *</b>	<div>Food provision (e.g. fish, shellfish)</div> <div>Marine biotechnology (e.g. medical compounds, cosmetics)</div> <div>Water quality (e.g. for bathing, aquaculture, desalination)</div> <div>Tourism, recreation and well-being</div> <div>Marine renewable energies</div> <div>Non-living products (e.g. minerals, oil, gas)</div> <div>None</div> <div>Other:</div> <div>Other:</div>



8.	<b>Case-study description</b> Please provide a short description of the solution, including main objectives, approach and key outcomes *										
9.	<b>Type of initiative</b> Please select the main type of approach underlying the case-study *	<table border="1"> <tr><td>Awareness campaign/Education</td></tr> <tr><td>Practice/Action</td></tr> <tr><td>Study/Research</td></tr> <tr><td>Monitoring/Information tool</td></tr> <tr><td>Multidisciplinary collaboration</td></tr> <tr><td>Policy/Regulation</td></tr> <tr><td>Voluntary agreement</td></tr> <tr><td>Other</td></tr> <tr><td>Other</td></tr> </table>	Awareness campaign/Education	Practice/Action	Study/Research	Monitoring/Information tool	Multidisciplinary collaboration	Policy/Regulation	Voluntary agreement	Other	Other
Awareness campaign/Education											
Practice/Action											
Study/Research											
Monitoring/Information tool											
Multidisciplinary collaboration											
Policy/Regulation											
Voluntary agreement											
Other											
Other											
10.	<b>Lessons learnt</b> What would you advise to people that would like to try a similar action in their area? When is this type of solution particularly useful and when not?										
11.	<b>Similar applications</b> Do you know other applications of this type of solution?										
12.	<b>Keywords</b> Please provide 3 - 5 keywords that characterize this case-study										
13.	<b>Is there more information available on internet?</b> Please provide website address										
14.	<b>Who are the main promoters of the initiative?</b> Please indicate the entity(ies) responsible for the implementation of the case-study *										
15.	<b>Who can we contact for further information?</b> Please provide contact person and/or e-mail address										
16.	<b>Is there documentation available on this case study?</b> Please upload relevant documents										
17.	<b>May we contact you for further information?</b> (if so, please provide your name and e-mail address)										
18.	<b>Would you like to receive newsletters from the SOPHIE project?</b> (if so, please provide you e-mail address)										

## Appendix E – Interview questions

### Appendix E1

Table 8 Interview guide Europe - experts

<b>Introductory questions</b>	How would you define the (societal) importance of OHH relations in Europe?
	Has there been a shift over time in the way we perceive OHH relations? <ul style="list-style-type: none"> <li>• If so, how would you describe that shift?</li> </ul>
<b>Current practices and policy</b>	What are the current practices in Europe with regards to Oceans and Human Health? <ul style="list-style-type: none"> <li>• I.e. how do we deal with OHH interactions</li> <li>• To what extent formalized and institutionalized and in what ways?</li> </ul>
	To what extent do current European policies and regulations cover the marine environment and human health?
	How would you prioritize key areas of focus in OHH relations for European policymaking and regulations?
	Is there any/could you think of an incentive for European policymaking and regulation to integrate these two disciplines?
<b>Innovations</b>	According to you, can innovative practices in OHH interactions contribute to filling the gap in European policymaking? <ul style="list-style-type: none"> <li>• If so, in what ways?</li> </ul>
	What do you think is the level of public awareness on OHH relations and interactions? <ul style="list-style-type: none"> <li>• Do you think the general public knows how to get benefits out of the ocean?</li> <li>• Do you think the individual and public awareness differ in that sense?</li> </ul>
	Do you think these innovations can contribute to spreading awareness on OHH relations and benefits? <ul style="list-style-type: none"> <li>• If so, in what ways?</li> </ul>
	In your opinion, what are the perspectives for upscaling of local OHH innovations throughout Europe? <ul style="list-style-type: none"> <li>• Do you think they can enhance the health benefits that people get from the ocean?</li> </ul>
<b>Closing question</b>	Do you have any questions or is there anything you would like to add?

## Appendix E2

Table 9 Interview guide Europe – Key informants

<b>Introductory questions</b>	<p><i>If initiator:</i> What motivated you to start up this initiative?</p> <ul style="list-style-type: none"> <li>Was there an issue unaddressed that you aimed to tackle?</li> </ul> <p><i>If participant:</i> What was the motivation for this initiative to take action?</p> <ul style="list-style-type: none"> <li>Was there an issue that was unaddressed that it meant to tackle?</li> </ul>
	<p>What are the main positive impacts of the initiative/innovation on oceans/human health?</p> <ul style="list-style-type: none"> <li>What do you think were key success factors?</li> </ul>
<b>Insight in other innovations</b>	<p>What other OHH innovations do you know of that are present in your region/country?</p>
	<p>Do you know of any similar innovations to yours in other countries?</p>
	<p>Do these innovations have a website or social media channel? If not, can you share a contact?</p>
<b>Missing topics</b>	<p>Can you think of any examples of (environmental/health) issues that are not yet covered by innovations?</p> <ul style="list-style-type: none"> <li>What could be an innovative solution to that issue according to you?</li> </ul>
<b>Link back to innovations</b>	<p>What do you think about upscaling local OHH innovations throughout the country/region/continent?</p> <ul style="list-style-type: none"> <li>How transferrable do you think the innovations are?</li> <li>How effective do you think they are?</li> </ul>
	<p>Is there a platform for local innovations in your country/region that can be contacted for further information?</p>
<b>Closing question</b>	<p>Do you have any questions or is there anything you would like to add?</p>

## Appendix E3

Table 10 Interview guide South-East Asia – Experts

<b>Introductory questions</b>	<p>Could you briefly characterise the livelihoods of coastal populations in SEA?</p> <ul style="list-style-type: none"> <li>• Are they dependent on the ocean?</li> </ul>
	What are the most important health issues among the coastal populations?
<b>Health issues and benefits</b>	In what ways do they experience threats from the ocean/living at the coast?
	What are the most important benefits?
	<p><i>Researcher explains trend of OHH in Europe, purposively getting health benefits from the ocean.</i></p> <ul style="list-style-type: none"> <li>• Does that play a role in SEA?</li> </ul>
	What could be the role of the SDGs in this?
<b>Innovations</b>	<p><i>Researcher gives explanation about innovations in South-East Asia.</i> Do you think innovations could contribute to overall improved health and well-being for coastal communities?</p> <ul style="list-style-type: none"> <li>• <i>Researcher gives a few examples of innovations found.</i> Do you know of any other?</li> </ul>
	What do you think the potential of these bottom up initiatives could be in improving the state of the oceans and people's health and well-being in SEA?
<b>Closing question</b>	Do you have any questions or is there anything you would like to add?

## Appendix E4

Table 11 Interview guide South-East Asia – Key informants

<b>Introductory questions</b>	<p><i>If initiator:</i> What motivated you to start up this initiative?</p> <ul style="list-style-type: none"> <li>Was there an issue unaddressed that you aimed to tackle?</li> </ul> <p><i>If participant:</i> What was the motivation for this initiative to take action?</p> <ul style="list-style-type: none"> <li>Was there an issue that was unaddressed that it meant to tackle?</li> </ul>
	<p>What are the main positive impacts of the initiative/innovation on oceans/human health?</p> <ul style="list-style-type: none"> <li>What do you think were the key success factors?</li> </ul>
<b>Insight in other innovations</b>	<p>What other OHH innovations do you know of that are present in your region/country?</p> <ul style="list-style-type: none"> <li>Is it something common in your country/region?</li> </ul>
	Do you know of any similar innovations to yours in other countries?
	Do these innovations have a website or social media channel? If not, can you share a contact?
<b>Potential of innovations</b>	<p>In what ways do you think you help the coastal population?</p> <ul style="list-style-type: none"> <li>To what are people aware of OHH?</li> <li>Do you notice any incentive from governments to do something with it?</li> </ul>
	<p>What do you think about upscaling local OHH innovations throughout the country/region/continent?</p> <ul style="list-style-type: none"> <li>How transferrable do you think the innovations are?</li> <li>How effective do you think they are?</li> </ul>
	Is there a platform for local innovations in your country/region that can be contacted for further information?
<b>Closing question</b>	Do you have any questions or is there anything you would like to add?

## Appendix F – Coding scheme

### *Europe - experts*

- ❖ Background information
  - Awareness of OHH relations
    - Public awareness
    - Individual awareness
    - Policymakers' awareness
  - Societal importance
    - Climate change
    - Coastal communities
      - Health
      - Safety
      - Livelihoods
  - Food security
- ❖ Current practices
  - Shift in OHH
    - US trends
    - EU trends
  - Disconnected policymaking
    - Policy gap
    - Incentive policymakers
    - Priority policy areas
  - Disconnected research
    - Research gap
    - Lack of evidence
    - International collaboration
  - Lack of vision
- ❖ Role SDGs
  - Guidelines
  - Universal importance
- ❖ Role innovations
  - Complementing policy
  - Storytelling
  - Inspiration
  - Awareness
- ❖ Upscaling
  - Local applicability and context
  - Collaboration and knowledge exchange
  - Network
  - Work alongside policy
  - Local solutions

### *Europe – social innovators*

- ❖ Environmental impact
  - Cleanup
  - Environmentally friendly behavior
  - Awareness
  - Protection
  - Scientific knowledge
- ❖ Health impact

- Awareness
- Mental health
- Physical health
- Safety
- Scientific knowledge
- ❖ Missing topics
  - Awareness
  - Infrastructure
  - Mental health
  - Blue mind
  - Platform
- ❖ Upscaling

*South-East Asia – experts*

- ❖ Background information
  - Health issues
    - Diseases
    - Threats to health
      - Natural threats
      - Alcohol and tobacco
      - Contaminated food
      - Deterioration of ecosystems
      - Climate change
  - Environmental issues
    - Waste
    - Overexploitation natural resources
    - Overdevelopment
    - Climate change
    - Loss of species
  - Awareness of OHH relations
    - Indirect awareness on health
    - Individual awareness
    - Public awareness
  - Societal importance
    - Dependence of livelihood
      - Tourism
      - Food provision
- ❖ Current practices
  - OHH in policymaking
    - Disconnected policymaking
    - Short term policymaking
    - Enforcement issues
    - Incentive
      - Indirect benefits
      - Lack of evidence
      - Small scale impact
- ❖ Role of innovations
  - Policy
    - Bottom up complementation
    - Low impact



- Awareness
- Inspiration
- Conservation
- ❖ Upscaling
  - Protection and conservation
  - Example
  - Government enforcement
  - Livelihood
  - Local circumstances
- ❖ Role of SDGs
  - Funding
  - Priority areas
  - Guidelines

*South-East Asia – social innovators*

- ❖ Environmental issues
  - Waste
  - Water quality
    - Chemical
    - Microbial contamination
    - Plastics/microplastics
  - Destruction ecosystems
  - Loss of species
  - Climate change
- ❖ Environmental impact
  - Cleanup
  - Restoration and protection
  - Waste prevention and regulation
  - Awareness
  - Environmentally friendly behavior
  - Research
- ❖ Human health issues
  - Fisherfolk's safety
  - Health threats nature
  - Diseases
  - Unhealthy settlements
  - Waste burning
- ❖ Human health impact
  - Housing improvements
  - Safety
  - Awareness
  - Water quality
  - Livelihoods
    - More tourism
    - More fish
  - Empowerment
  - Research
- ❖ Upscaling
  - Increase impact
  - Collaboration and knowledge exchange
  - Local adaptation

## Appendix G – List of innovations arranged by DPSI

Table 12 List of innovations arranged by DPSI in Europe<sup>41</sup>

DPSI	Name	Website
D	Co-development of Climate Services for Adaptation to Changing Marine Ecosystems (CoCliME)	CoCliME project website: <a href="https://www.coclime.eu/">https://www.coclime.eu/</a>
D	Stichting Anemoon	<a href="https://www.anemoon.org/">https://www.anemoon.org/</a>
D	Marine CoLABorati on	<a href="https://marinecolab.org/">https://marinecolab.org/</a>
D	Air Powered Sampling for Purse Seine Fisheries	<a href="https://motherboard.vice.com/en_us/article/z4m8yx/the-net-that-lets-fishermen-preview-their-catch">https://motherboard.vice.com/en_us/article/z4m8yx/the-net-that-lets-fishermen-preview-their-catch</a>
D	Valuing the health benefits of physical activities in the marine environment	<a href="https://www.sciencedirect.com/science/article/pii/S0308597X15002936">https://www.sciencedirect.com/science/article/pii/S0308597X15002936</a>
D	Ocean Health Index	<a href="http://ohi-science.org/">http://ohi-science.org/</a>
D	Chiringuitos Responsables / Responsible Beach Bars	<a href="http://www.chiringuitosyvoluntarios.es/chiringuito-responsable/">http://www.chiringuitosyvoluntarios.es/chiringuito-responsable/</a>
D	Blue Flag	<a href="http://www.blueflag.global/">http://www.blueflag.global/</a>
D	Save the Ocean Feed the World	<a href="http://oceana.org/our-campaigns/save_oceans_feed_world/campaign">http://oceana.org/our-campaigns/save_oceans_feed_world/campaign</a>
D	AKTEA	<a href="http://akteaplatform.eu/">http://akteaplatform.eu/</a>
D	SAFE SEA	<a href="https://estlat.eu/en/estlat-results/safe-sea.html">https://estlat.eu/en/estlat-results/safe-sea.html</a>
D	ESTLAT Harbours	<a href="https://estlat.eu/en/estlat-results/estlat-harbours.html">https://estlat.eu/en/estlat-results/estlat-harbours.html</a>
D	EDMAKTU B	<a href="http://www.edmaktub.org/en/2016/06/drones-for-cetacean-research/">http://www.edmaktub.org/en/2016/06/drones-for-cetacean-research/</a>
D	Sofar Ocean	<a href="https://www.sofarocan.com/">https://www.sofarocan.com/</a>
EP	PRIMROSE	<a href="https://www.atlanticarea.eu/project/12">https://www.atlanticarea.eu/project/12</a>
EP	Quut	<a href="https://www.allesvanquut.nl/">https://www.allesvanquut.nl/</a>
EP	International Convention for the	<a href="http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx">http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx</a>

<sup>41</sup> Interviewed organizations are marked in blue

	Prevention of Pollution from Ships (MARPOL)	
EP	Maritime Blockchain Labs	<a href="https://www.maritimeblockchainlabs.com/">https://www.maritimeblockchainlabs.com/</a>
EP	By the ocean we unite	<a href="https://www.bytheoceanweunite.org/">https://www.bytheoceanweunite.org/</a>
ES	CERES	<a href="https://ceresproject.eu/">https://ceresproject.eu/</a>
ES	Project Baseline	<a href="http://projectbaseline.org/">http://projectbaseline.org/</a>
ES	Exxpedition	<a href="http://exxpedition.com/">http://exxpedition.com/</a>
ES	Adopt a float	<a href="http://www.monoceanetmoi.com/web/index.php/en/adopt-a-float-home">http://www.monoceanetmoi.com/web/index.php/en/adopt-a-float-home</a>
ES	Reef Design Lab	<a href="http://www.reefdesignlab.com/">http://www.reefdesignlab.com/</a>
ES	CSI - Community Seagrass Initiative	<a href="http://www.csi-seagrass.co.uk/">http://www.csi-seagrass.co.uk/</a>
ES	Save the waves	<a href="https://www.savethewaves.org/">https://www.savethewaves.org/</a>
ES	LEMA tool	<a href="http://www.lifelema.eu">www.lifelema.eu</a>
ES	Seabin	<a href="https://www.seabinproject.com/">https://www.seabinproject.com/</a>
ES	ORCA	<a href="https://www.orcaweb.org.uk/">https://www.orcaweb.org.uk/</a>
ES	SeaSearch	<a href="http://www.seasearch.org.uk/index.html">http://www.seasearch.org.uk/index.html</a>
ES	Surfers against Sewage	<a href="https://www.sas.org.uk/">https://www.sas.org.uk/</a>
ES	Ghost fishing	<a href="https://www.ghostfishing.org/recycling/">https://www.ghostfishing.org/recycling/</a>
ES	Recycled Park	<a href="http://recycledpark.com/">http://recycledpark.com/</a>
ES	Life Posidonia Andalusia project - Conservation of Posidonia oceanica	<a href="http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&amp;n_proj_id=3829">http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&amp;n_proj_id=3829</a>
ES	Kosterhavet Marine Protected Area	<a href="https://www.vastsverige.com/en/kosterhavet/">https://www.vastsverige.com/en/kosterhavet/</a> <a href="http://extra.lansstyrelsen.se/kosterhavet/SiteCollectionDocuments/sv/english/kosterhavet-national-park.pdf">http://extra.lansstyrelsen.se/kosterhavet/SiteCollectionDocuments/sv/english/kosterhavet-national-park.pdf</a>
ES	Healthy Seas initiative	<a href="http://healthyseas.org/">http://healthyseas.org/</a>
ES	Levävahti - algae watch	<a href="https://environmentalsystemsresearch.springeropen.com/articles/10.1186/s40068-014-0024-8">https://environmentalsystemsresearch.springeropen.com/articles/10.1186/s40068-014-0024-8</a>
ES	Dive the North Sea Clean - removal of ghost fishing	<a href="http://www.duikdenoordzeeschoon.nl">www.duikdenoordzeeschoon.nl</a>

	nets from wrecks	
ES	Plogga	Facebook and Instagram @Plogga, <a href="https://ploggase.firebaseio.com/forforetag/">https://ploggase.firebaseio.com/forforetag/</a> , <a href="https://spark.adobe.com/page/i4iKpksF47Qkm/">https://spark.adobe.com/page/i4iKpksF47Qkm/</a> ,
ES	Citizens' Network for the Observation of Marine Biodiversity - COMBER (Greece)	<a href="https://comber.hcmr.gr">https://comber.hcmr.gr</a>
ES	Volvo Ocean Race - Sustainability Programme	<a href="https://www.volvooceanrace.com/en/sustainability.html">https://www.volvooceanrace.com/en/sustainability.html</a>
ES	Environmental kayak (miljoekajakken)	<a href="https://kulturhavn365.dk/miljoekajakken/">https://kulturhavn365.dk/miljoekajakken/</a>
ES	International Coastal Cleanup	<a href="https://oceanconservancy.org/trash-free-seas/international-coastal-cleanup/">https://oceanconservancy.org/trash-free-seas/international-coastal-cleanup/</a>
ES	Dive Against Debris	<a href="http://www.projectaware.org/diveagainstdebris">http://www.projectaware.org/diveagainstdebris</a>
ES	MARLISCO - Raising awareness and co-responsibility for marine litter in Europe	<a href="http://www.marlisco.eu">www.marlisco.eu</a>
ES	Toxicity profiling of marine surface sediments: A case study using rapid screening bioassays of exhaustive total extracts, elutriates and passive sampler extracts	
ES	Marine Litter Watch	<a href="https://www.eea.europa.eu/themes/water/europes-seas-and-coasts/marine-litterwatch">https://www.eea.europa.eu/themes/water/europes-seas-and-coasts/marine-litterwatch</a>
ES	Fishing for Litter - Engaging fishermen in the removal of litter from the sea	<a href="http://www.fishingforlitter.org.uk/what-is-fishing-for-litter">http://www.fishingforlitter.org.uk/what-is-fishing-for-litter</a>
ES	The New Raw	<a href="https://thenewraw.org/">https://thenewraw.org/</a>
ES	PlanBlue	<a href="https://www.planblue.com/">https://www.planblue.com/</a>
ES	Secchi Disk	<a href="http://www.secchidisk.org/">http://www.secchidisk.org/</a>
ES	Gökçeada Marine Underwater Park	<a href="http://gokceadasualtiparki.org/index.php?lang=en">http://gokceadasualtiparki.org/index.php?lang=en</a>
ES	REEFS (Research	<a href="http://reefsproject.net/">http://reefsproject.net/</a>

	and REstoration of the Essential Filters of the Sea)	
ES	Black Sea Watch Project	<a href="http://blackseawatch.org/Default.aspx">http://blackseawatch.org/Default.aspx</a>
ES	Crab Watch	<a href="http://www.seachangeproject.eu/seachange-about-4/crab-watch">http://www.seachangeproject.eu/seachange-about-4/crab-watch</a>
ES	ECONcrete	<a href="https://econcretetech.com/">https://econcretetech.com/</a>
ES	The Marine Foundation	<a href="http://themarinefoundation.org/">http://themarinefoundation.org/</a>
ES	The Shore Thing	<a href="https://www.mba.ac.uk/shore_thing/index.htm">https://www.mba.ac.uk/shore_thing/index.htm</a>
ES	Ecoduikers	<a href="https://www.ecoduikers.be/?fbclid=IwAR1V4CuZImOgcZ0Q-u_uWnmPinBi3Dv0k_AHCTWoy0weBELucMp1JbgHxl0">https://www.ecoduikers.be/?fbclid=IwAR1V4CuZImOgcZ0Q-u_uWnmPinBi3Dv0k_AHCTWoy0weBELucMp1JbgHxl0</a>
ES	Sea Ranger Service	<a href="http://www.searangers.org/en/">http://www.searangers.org/en/</a>
ES	Protect Blue	<a href="http://www.protect.blue">www.protect.blue</a>
ES	The Great Bubble Barrier	<a href="https://thegreatbubblebarrier.com/en/">https://thegreatbubblebarrier.com/en/</a>
ES	OCEARCH	<a href="https://www.ocearch.org/">https://www.ocearch.org/</a>
ES	REEF Check	<a href="https://www.reefcheckmed.org/english/underwater-monitoring-protocol/webgis-map/">https://www.reefcheckmed.org/english/underwater-monitoring-protocol/webgis-map/</a>
HP	The Plastic Soup Foundation	<a href="https://www.plasticsoupfoundation.org/">https://www.plasticsoupfoundation.org/</a>
HP	Loliware	<a href="https://www.loliware.com/">https://www.loliware.com/</a>
HP	Ocean Witness	<a href="https://oceanwitness.org/">https://oceanwitness.org/</a>
HP	SeaWalls - Artists for oceans	<a href="https://www.pangeaseed.foundation/sea-walls/">https://www.pangeaseed.foundation/sea-walls/</a>
HP	One Ocean FM	<a href="http://www.oneocean.fm/">http://www.oneocean.fm/</a>
HP	Smartfin surfing for citizen science	<a href="https://smartfin.org/">https://smartfin.org/</a>
HP	Capturing Our Coast	<a href="https://capturingourcoast.co.uk/">https://capturingourcoast.co.uk/</a>
HP	Ocean Campus - Surfrider Foundation	<a href="http://en.oceancampus.eu/">http://en.oceancampus.eu/</a>
HP	Good Fish Guide	<a href="https://www.mcsuk.org/responsible-seafood/">https://www.mcsuk.org/responsible-seafood/</a>
HP	Blue School programme	<a href="http://escolaazul.pt/en">http://escolaazul.pt/en</a>
HP	EDUCO2CEAN project	<a href="http://www.educo2cean.org/">http://www.educo2cean.org/</a>

HP	Youth Making Ripples - film competition for youngsters	<a href="http://youthmakingripples.org/">http://youthmakingripples.org/</a>
HP	Coastwatch Campaign	<a href="http://coastwatch.org/europe/survey/">http://coastwatch.org/europe/survey/</a>
HP	World Ocean Day	<a href="http://www.worldoceansday.org/">http://www.worldoceansday.org/</a>
HP	Sea Change awareness campaign "Our Ocean, Our Health"	<a href="http://www.seachangeproject.eu/our-ocean-our-health">http://www.seachangeproject.eu/our-ocean-our-health</a>
HP	The European Marine Science Educators Association (EMSEA)	<a href="http://www.emsea.eu/default.php">http://www.emsea.eu/default.php</a>
HP	Pesce Ritrovato / Rediscovered Fish	<a href="http://www.pesceritrovato.it/">http://www.pesceritrovato.it/</a>
HP	Fish Forward Project	<a href="https://www.fishforward.eu/en/fish-forward-description/">https://www.fishforward.eu/en/fish-forward-description/</a>
HP	BioWatch	<a href="http://www.bio-watch.com/">http://www.bio-watch.com/</a>
HP	Hebridean Whale and Dolphin Trust	<a href="https://hwtdt.org/">https://hwtdt.org/</a>
HP	Sea First	<a href="https://www.seafirst.nl/">https://www.seafirst.nl/</a>
HP	ResponSEAb le	<a href="https://www.responseable.eu/">https://www.responseable.eu/</a>
HP	Watertrek	<a href="https://www.watertrek.org/home/">https://www.watertrek.org/home/</a>
HS	Seafarers Hospital Society	<a href="https://seahospital.org.uk/">https://seahospital.org.uk/</a>
HS	The mission to seafarers	<a href="https://www.missiontoseafarers.org/">https://www.missiontoseafarers.org/</a>
HS	Swim Guide	<a href="https://www.theswimguide.org/">https://www.theswimguide.org/</a>
HS	The Jellyfish App	<a href="https://thejellyfishapp.com/">https://thejellyfishapp.com/</a>
HS	Safe Haven Ireland	<a href="https://www.safehavenireland.com/">https://www.safehavenireland.com/</a>
HS	Sea Sanctuary	<a href="https://seasanctuary.org.uk/">https://seasanctuary.org.uk/</a>
HS	The Blue New Deal	<a href="http://www.bluenewdeal.org/about/">http://www.bluenewdeal.org/about/</a>

HS	Low Impact Fishermen of Europe (LIFE)	<a href="http://lifeplatform.eu/">http://lifeplatform.eu/</a>
HS	Surfing Medicine International	<a href="http://www.surfingmed.com/">http://www.surfingmed.com/</a>
HS	Welcome Wave	<a href="https://www.joe.ie/life-style/welcome-wave-636783">https://www.joe.ie/life-style/welcome-wave-636783</a>
HS	Safe Water Sports	<a href="https://safewatersports.com/en/">https://safewatersports.com/en/</a>
HS	KOSTASystem,	<a href="http://www.kostasystem.com/">http://www.kostasystem.com/</a>
HS	Mobile qPCR E.coli	
HS	Expeditie Juttersgeluk / "Beachcombers delights"	<a href="http://www.juttersgeluk.nl/expeditie/">http://www.juttersgeluk.nl/expeditie/</a>
HS	ECsafeSEAF OOD Project	<a href="http://www.ecsafeseafood.eu/">http://www.ecsafeseafood.eu/</a>
HS	Med Jelly-Risk / Spot the jelly Fish	<a href="http://jellyrisk.eu/en/#.Wuh95KSFOpo">http://jellyrisk.eu/en/#.Wuh95KSFOpo</a> <a href="http://www.ioikids.net/jellyfish">http://www.ioikids.net/jellyfish</a>
HS	Bathing Water Quality Forecasting System	<a href="http://environment.data.gov.uk/bwq/profiles/">http://environment.data.gov.uk/bwq/profiles/</a>
HS	Amphicruiser Rescue	<a href="https://www.amphicruiser.com/rescue/">https://www.amphicruiser.com/rescue/</a>
HS	Autism on the water	<a href="https://www.facebook.com/pg/AutismOnTheWater/about/?ref=page_internal">https://www.facebook.com/pg/AutismOnTheWater/about/?ref=page_internal</a>
HS	Obonjan Island	<a href="https://www.obonjan-island.com/">https://www.obonjan-island.com/</a>
HS	Sirens	<a href="http://www.inspiresirens.org/">http://www.inspiresirens.org/</a>
HS	Depththerapy	<a href="http://depththerapy.co.uk/index.html">http://depththerapy.co.uk/index.html</a>
HS	SUPYogaPilates	<a href="http://supyogapilates.com/">http://supyogapilates.com/</a>
HS	Research Project Sea-Kayaking & Wellbeing, Dissertation 2019	n/a at this stage
HS	Sailing into Wellness	<a href="https://www.sailingintowellness.ie/">https://www.sailingintowellness.ie/</a>
HS	Wave by wave	<a href="http://wavebywave.org/index.html">http://wavebywave.org/index.html</a>
HS	SurfABLE Scotland	<a href="https://friendlyaccess.org/what-we-do/surfable-scotland/">https://friendlyaccess.org/what-we-do/surfable-scotland/</a>
HS	Liquid therapy	<a href="http://liquidtherapy.ie/">http://liquidtherapy.ie/</a>



HS	Healing Waves	<a href="http://www.healingwaves.org.je/">http://www.healingwaves.org.je/</a>
HS	WetWheels	<a href="https://www.wetwheels.je/">https://www.wetwheels.je/</a>
HS	Oceans of Hope	<a href="http://www.oceansofhope.org/">http://www.oceansofhope.org/</a>
HS	Ocean Recovery	<a href="https://oceanrecoverycentre.com/">https://oceanrecoverycentre.com/</a>
HS	Adria Experience	<a href="https://adriaexperience.com/">https://adriaexperience.com/</a>
HS	Coral Biome	<a href="https://www.coralbiome.com/pharma/">https://www.coralbiome.com/pharma/</a>
I	Scott Haldane Foundation	<a href="https://www.scotthaldane.nl/nl/">https://www.scotthaldane.nl/nl/</a>
I	Mater Museoa	<a href="http://www.matermuseoa.com/">http://www.matermuseoa.com/</a>
I	CoolRoute	<a href="http://www.sailcoolroute.eu/">http://www.sailcoolroute.eu/</a>
I	Costa Balenae	<a href="http://www.costabalenae.it/en/home">http://www.costabalenae.it/en/home</a>
I	EcoMarine Malta	<a href="http://www.ecoMarineMalta.com.mt/">http://www.ecoMarineMalta.com.mt/</a>
I	Edulis	<a href="http://www.aqua.ugent.be/edulis">http://www.aqua.ugent.be/edulis</a>
I	The Outdoor Swimming Society	<a href="https://www.outdoorswimmingsociety.com/">https://www.outdoorswimmingsociety.com/</a>
I	School at Sea	<a href="https://www.schoolatsea.com/">https://www.schoolatsea.com/</a>
I	Wild Swimming	<a href="http://www.wildswimming.co.uk/">http://www.wildswimming.co.uk/</a>
I	SUPKids	<a href="https://sup-kids.com/">https://sup-kids.com/</a>
I	Surf Therapy	<a href="https://intlsurftherapy.org/">https://intlsurftherapy.org/</a>
I	Vies Braves	<a href="https://viesbraves.com/en/">https://viesbraves.com/en/</a>
I	Seafarm project - Seaweed farming in Sweden	<a href="https://www.kth.se/en/forskning/artiklar/alger-framtidens-allroundmat-1.612780">https://www.kth.se/en/forskning/artiklar/alger-framtidens-allroundmat-1.612780</a> ; <a href="http://www.seafarm.se/web/page.aspx?refid=135">http://www.seafarm.se/web/page.aspx?refid=135</a> ;
I	The Wave Project - surf therapy for disabled and vulnerable young people	<a href="http://www.waveproject.co.uk">www.waveproject.co.uk</a>
I	Community "Oceans and Human Health Chair"/"Càtedra Oceans i Salut Humana"	<a href="http://www.oceanshealth.udg.edu/ca/qui-som.html">http://www.oceanshealth.udg.edu/ca/qui-som.html</a>
I	My Ocean Sampling Day	<a href="https://www.microb3.eu/osd.html">https://www.microb3.eu/osd.html</a> , <a href="http://www.assembleplus.eu/research/ocean-sampling-day-2018">http://www.assembleplus.eu/research/ocean-sampling-day-2018</a>

I	Mr. Goodfish Campaign	<a href="https://www.mrgoodfish.com/en/">https://www.mrgoodfish.com/en/</a>
I	Stichting Noordzeeboerderij	<a href="https://www.noordzeeboerderij.nl/">https://www.noordzeeboerderij.nl/</a>
I	PharmaSea	<a href="http://www.pharma-sea.eu/">http://www.pharma-sea.eu/</a>
I	High Quality Whale Watching Certificate	<a href="http://www.whale-watching-label.com/accueil">http://www.whale-watching-label.com/accueil</a>
I	Yayakarsa	<a href="http://www.yayakarsa.org/index.php/en-US/">http://www.yayakarsa.org/index.php/en-US/</a>
I	Slow Mill	<a href="http://www.slowmill.nl/">http://www.slowmill.nl/</a>
I	Waddenwier	<a href="https://www.waddenwier.com/">https://www.waddenwier.com/</a>
I	Seaweed for Food and Feed	<a href="https://www.noordzeeboerderij.nl/projecten">https://www.noordzeeboerderij.nl/projecten</a>
I	Swansea Bay Tidal Lagoon	<a href="https://www.marineenergywales.co.uk/marine-energy-in-wales/projects/tidal-lagoon-swansea-bay/">https://www.marineenergywales.co.uk/marine-energy-in-wales/projects/tidal-lagoon-swansea-bay/</a>
I	VoyageVert	<a href="http://voyagevert.org/">voyagevert.org/</a>
I	WaveSub	<a href="http://marinepowersystems.co.uk/">http://marinepowersystems.co.uk/</a>
I	Coastal hiking	<a href="https://estlat.eu/en/estlat-results/coastal-hiking.html">https://estlat.eu/en/estlat-results/coastal-hiking.html</a>
I	CITiZAN	<a href="https://www.citizan.org.uk/">https://www.citizan.org.uk/</a>

Table 13 List of innovations arranged by DPSI in South-East Asia<sup>42</sup>

DPSI	Name	Website
D	Blue communities	<a href="http://www.blue-communities.org/Home">http://www.blue-communities.org/Home</a>
D	Dugong and Seagrass conservation project	<a href="http://www.dugongconservation.org/">www.dugongconservation.org/</a>
D	Pelagic Data Systems	<a href="http://www.pelagicdata.com/#solutions">http://www.pelagicdata.com/#solutions</a>
EP	Waste4change	<a href="https://waste4change.com/beta/official/">https://waste4change.com/beta/official/</a>
EP	MarPol	<a href="http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx">http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx</a>
ES	Gili eco trust	<a href="http://giliecotrust.com/?fbclid=IwAR1PpN9bv5MKEnMq6K0C4vwciJfHBdLkEx8j09NM4sTJBTYCIo2pY4wH-oQ">http://giliecotrust.com/?fbclid=IwAR1PpN9bv5MKEnMq6K0C4vwciJfHBdLkEx8j09NM4sTJBTYCIo2pY4wH-oQ</a>
ES	Seas sanctuaries	<a href="http://www.seas sanctuaries.org/">http://www.seas sanctuaries.org/</a>
ES	Project Seahorse	<a href="http://www.projectseahorse.org/">http://www.projectseahorse.org/</a>
ES	Greenfins	<a href="http://greenfins.net/en/">http://greenfins.net/en/</a>
ES	LAMAVE	<a href="https://www.lamave.org/about/">https://www.lamave.org/about/</a>
ES	Conservation drones	<a href="https://conservationdrones.org/2016/11/23/cetacean-survey-in-timor-leste/">https://conservationdrones.org/2016/11/23/cetacean-survey-in-timor-leste/</a>
ES	Global Mangrove Trust	<a href="https://www.globalmangrove.org/newblogs">https://www.globalmangrove.org/newblogs</a>
ES	Watertrek - Paddle and Plant	<a href="https://www.watertrek.org/about/action-fields/">https://www.watertrek.org/about/action-fields/</a>
ES	Bali Sea Turtle Society	<a href="https://www.baliseaturtle.org/">https://www.baliseaturtle.org/</a>
ES	The Marine Foundation	<a href="http://themarinefoundation.org/">http://themarinefoundation.org/</a>
ES	Marine conservation cambodia	<a href="https://www.marineconservationcambodia.org/">https://www.marineconservationcambodia.org/</a>
ES	Coral Watch	<a href="https://coralwatch.org/">https://coralwatch.org/</a>
ES	BioRock	<a href="http://www.biorock-indonesia.com/">http://www.biorock-indonesia.com/</a>
ES	SewMates	<a href="http://www.csvsewmates.com.hk/">http://www.csvsewmates.com.hk/</a>
ES	Seagrass Watch	<a href="http://www.seagrasswatch.org/about.html">http://www.seagrasswatch.org/about.html</a>
ES	Team Seagrass	<a href="https://teamseagrass.blogspot.com/p/join-team.html?fbclid=IwAR0VOyFo_otn0aC_j5xaNQDej7Wf_1LC1Ae9Qi-QOKCQBVncxZc0UXX9gpQ#.XLW1cPZuIy8">https://teamseagrass.blogspot.com/p/join-team.html?fbclid=IwAR0VOyFo_otn0aC_j5xaNQDej7Wf_1LC1Ae9Qi-QOKCQBVncxZc0UXX9gpQ#.XLW1cPZuIy8</a>
ES	Bleach-Watch	<a href="https://bleachwatchsingapore.blogspot.com/">https://bleachwatchsingapore.blogspot.com/</a>
ES	PlasticCatchOperations	<a href="http://www.greeneration.org/">http://www.greeneration.org/</a>
ES	Dive against Debris	<a href="https://www.projectaware.org/diveagainstdebrismap">https://www.projectaware.org/diveagainstdebrismap</a>

<sup>42</sup> Interviewed organizations are marked in blue

ES	Marine Environmental Protection Volunteer group	<a href="http://www.pemsea.org/our-work/natural-and-manmade-hazard-prevention">http://www.pemsea.org/our-work/natural-and-manmade-hazard-prevention</a>
ES	BioCarbon Engineering	<a href="https://www.facebook.com/biocarbonengineering/?__tn__=KH-R&amp;eid=ARBkwEZ9VWRax8h9VfkNjskGEv6Eci1i_TzFVCccuJAQ242oqEa2EtB7KUtGjuQ15XSrJJ9_hex2ho94&amp;fref=m">https://www.facebook.com/biocarbonengineering/?__tn__=KH-R&amp;eid=ARBkwEZ9VWRax8h9VfkNjskGEv6Eci1i_TzFVCccuJAQ242oqEa2EtB7KUtGjuQ15XSrJJ9_hex2ho94&amp;fref=m</a>
ES	EcoDiver Reef Check	<a href="https://reefcheck.org/">https://reefcheck.org/</a>
ES	Innoceana	<a href="https://innoceana.org/en/">https://innoceana.org/en/</a>
HP	Misool	<a href="https://www.misool.info/">https://www.misool.info/</a>
HP	EvoWare	<a href="http://www.evoware.id/">http://www.evoware.id/</a>
HP	Divers cleanaction	<a href="https://www.diverscleanaction.org/ocean">https://www.diverscleanaction.org/ocean</a>
HP	Coast2coast	<a href="https://www.coast2coastmovement.com/">https://www.coast2coastmovement.com/</a>
HP	CLEAR Community	<a href="http://www.clearcommunity.org/">http://www.clearcommunity.org/</a>
HS	Yonah	<a href="https://www.yonah.sg/">https://www.yonah.sg/</a>
HS	Scuba for Change	<a href="http://www.scubaforchange.com/">http://www.scubaforchange.com/</a>
HS	Zen harmony diving	<a href="http://www.zenharmonydiving.com/">http://www.zenharmonydiving.com/</a>
HS	The Pink Nose Revolution	<a href="https://maptia.com/easkey/stories/the-pink-nose-revolution">https://maptia.com/easkey/stories/the-pink-nose-revolution</a>
HS	Diving doctors	<a href="https://www.spums.org.au/dive-doctors-list">https://www.spums.org.au/dive-doctors-list</a>
HS	NEVHouse	<a href="https://www.nevhouse.com/">https://www.nevhouse.com/</a>
HS	Samui Open Water Swimming (Swimming to end Finning)	<a href="https://www.facebook.com/samuiswimteam/">https://www.facebook.com/samuiswimteam/</a>
I	SALt	<a href="http://salt.ph/">salt.ph/</a>
I	Ecoranger project	<a href="http://ecoranger.id/">ecoranger.id/</a>
I	Surf and Social good summit	<a href="https://maptia.com/easkey/stories/surf-for-social-good">https://maptia.com/easkey/stories/surf-for-social-good</a>
I	SUP-Kids	<a href="https://sup-kids.com/">https://sup-kids.com/</a>
I	A liquid future	<a href="https://www.aliquidfuture.com/">https://www.aliquidfuture.com/</a>
I	Coastal Use Zoning Sihanoukville	<a href="http://www.pemsea.org/sites/default/files/ICM_Case_Studies_Book_35_Part_II_I_CS33.pdf">http://www.pemsea.org/sites/default/files/ICM_Case_Studies_Book_35_Part_II_I_CS33.pdf</a>
I	FloodTags	<a href="https://www.floodtags.com/">https://www.floodtags.com/</a>
I	GROUNDAsia	<a href="https://www.groundasia.com/environmental-programs/">https://www.groundasia.com/environmental-programs/</a>
I	PeaceBoat	<a href="http://peaceboat.org/english/">http://peaceboat.org/english/</a>
I	Sustainable Surf	<a href="https://sustainablesurf.org/">https://sustainablesurf.org/</a>

## Appendix H – More details of OHH innovations

### Stakeholders

#### Europe

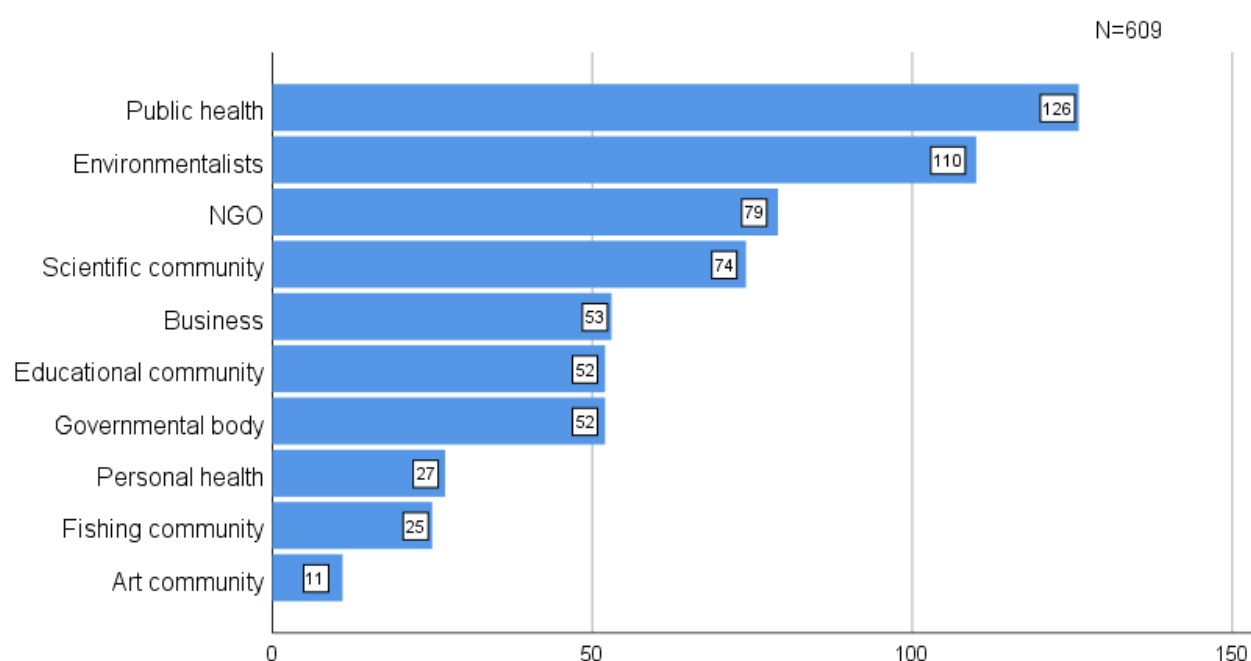


Figure 29 Stakeholders of innovations in Europe

#### South-East Asia

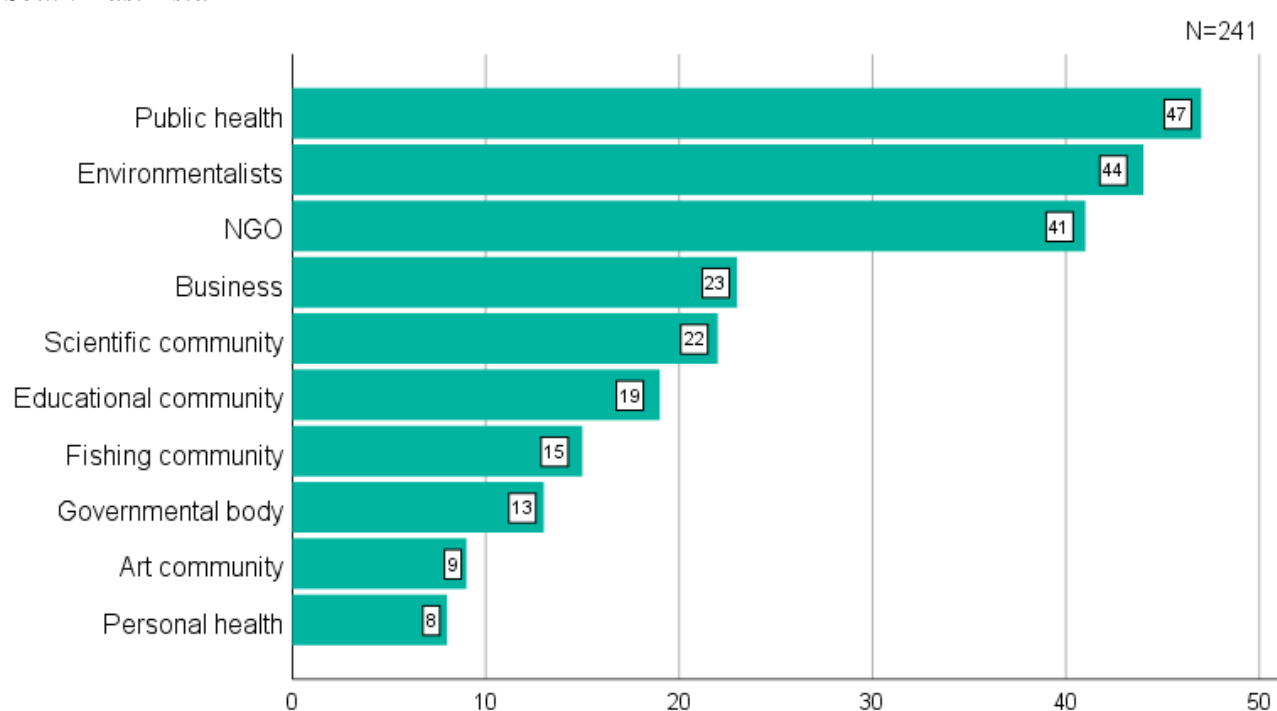


Figure 30 Stakeholders of innovations in South-East Asia

# Distribution over DPSI categories Europe

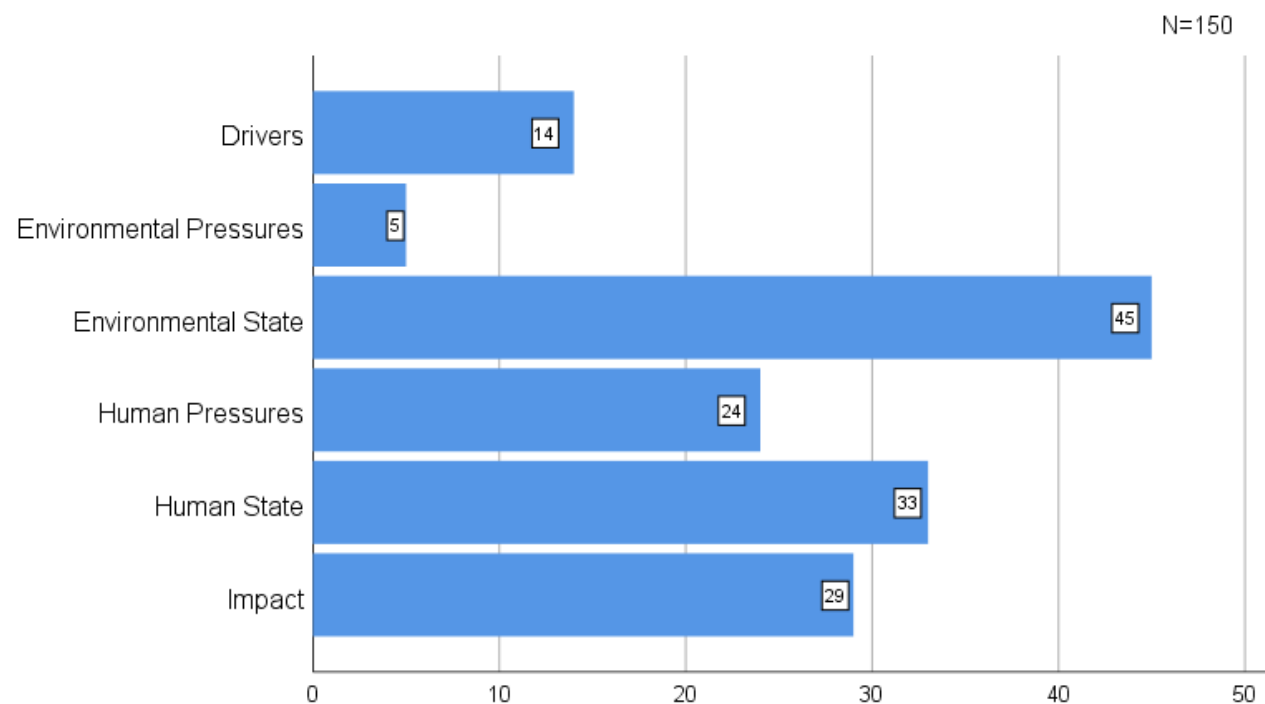


Figure 31 Distribution over DPSI categories of innovations in Europe

# South-East Asia

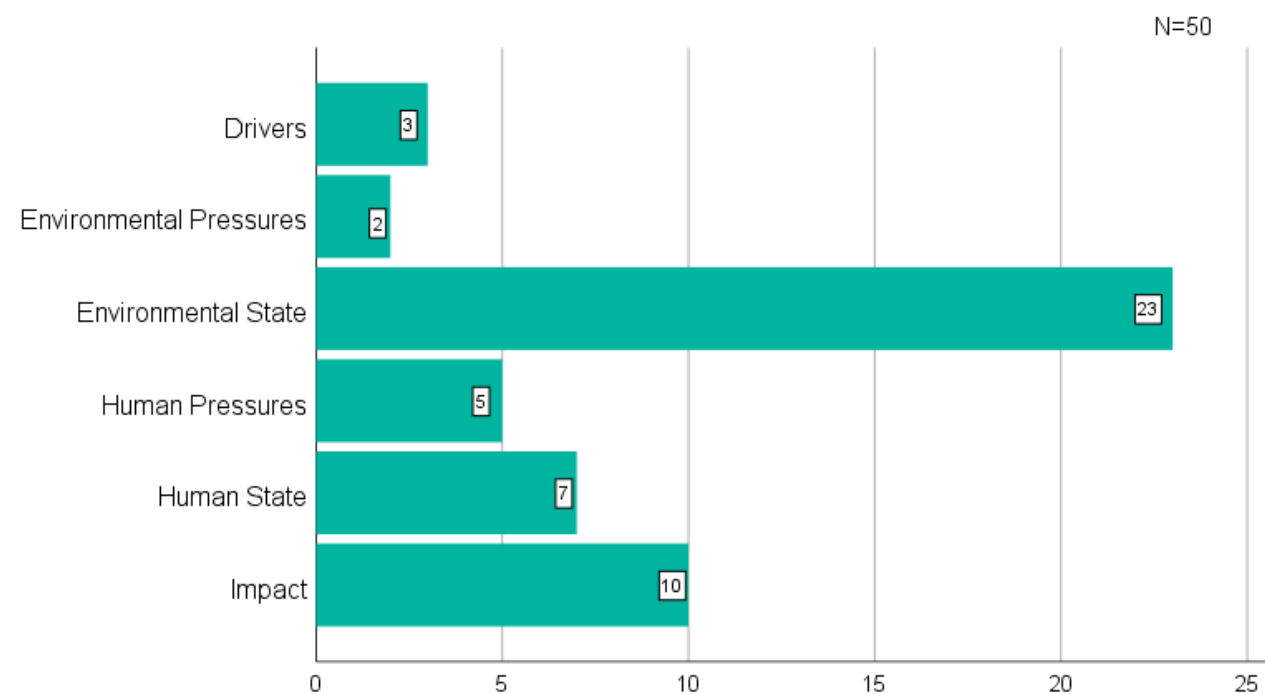


Figure 32 Distribution over DPSI categories of innovations in South-East Asia

## SDGs per DPSI

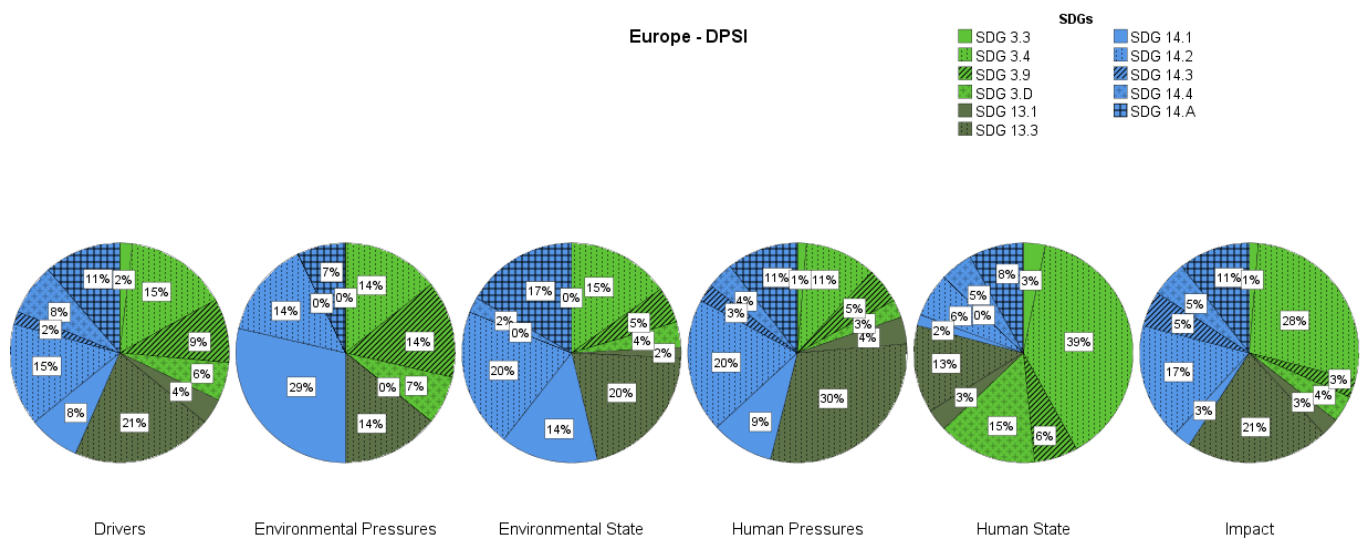


Figure 33 Contribution to SDG targets per DPSI category of innovations in Europe

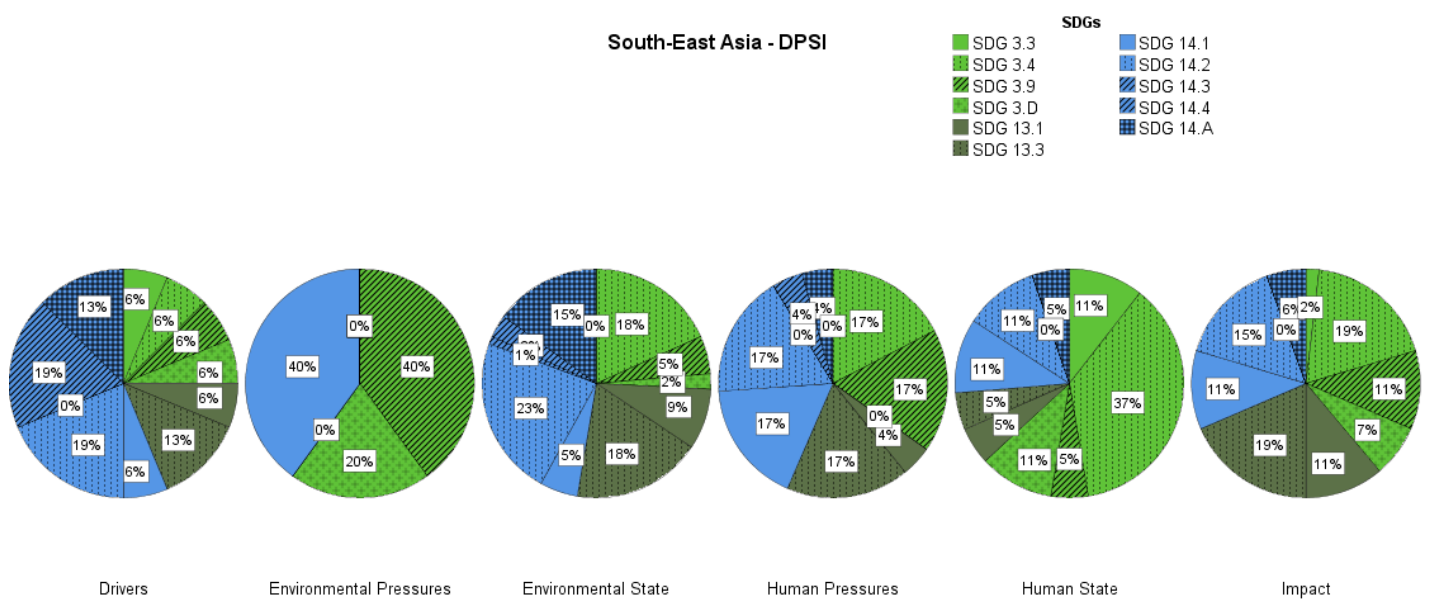


Figure 34 Contribution to SDG targets per DPSI category of innovations in South-East Asia

## Appendix I - Expanding the research network

The researcher took part in a multi-day expert meeting, with the purpose of presenting preliminary results, gaining more insight in the existing research and literature, expanding the research network and receiving expert feedback. A 30-minute presentation of the preliminary analysis of the collected innovations was held by the researcher. These results were based on 100 cases that were analyzed in SPSS and gave an overview of the frequencies, the number of ecosystem services provided, and environmental issues addressed and the geographical distribution of the innovations across the sea basins. An open discussion was held about the collected innovations and results, which provided the researcher the opportunity to check ideas in front of the group and obtain validation. The days of the meeting were furthermore spent expanding the expert network. Informal conversations between the planned activities of the meeting led to suggestions in academic literature, new insights for further setting the scope of research as well as expert input. During the expert presentations, areas of expertise were made clear and informal conversations throughout the days worked as a snowball sampling mechanism to encounter expert participants for interviews.

The researcher furthermore had the opportunity to present the research project at the annual scientific meeting of the Netherlands Centre for One Health (NCOH), that invited young researchers in the field of environment and health to present their research. This gathering was used by the researcher to discuss the research topic with people from various academic and scientific backgrounds, leading to new insights and critical notes, that inspired new reflection perspectives on the thesis research.

### *Multi-day expert meeting*







Credit: European Marine Board, 2019.

*NCOH meeting at Radboud University*



Source: Radboud University



Date  
July 16, 2019

Page  
2 of 2

About work process and influence on positive grading

During her internship, Noortje displayed her strong motivation and commitment to conducting research of high scientific quality. She has proved her ability to work independently and thoroughly, while developing her own original ideas that brought additional value to the understanding of the role of existing innovations in the relatively unknown field of oceans and health in Europe. Her analyses provide new insights into the responses to various pressures on the marine ecosystem and human health. The resulting thesis is of very high quality.

Noortje has been an appreciated member of the team and we have got to know her as a reliable student and colleague. Noortje's contribution has been of high value to Deltares. We have experienced her academic qualities as a researcher and we very positively assess her internship and work.

Yours sincerely,

  
Eline Boelee

  
Anouk Blaauw

## Appendix K – Academic article

### Motivation for academic article

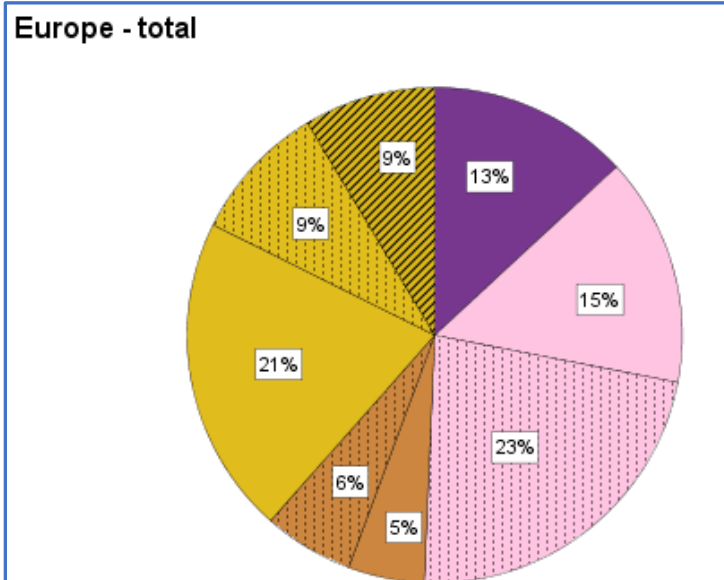
This draft academic article was proposed to give additional value to the original thesis research on Seas, Oceans and Public Health. This article is not part of the requirements of the 45 ECTS thesis. The purpose of writing the article is to share the key results with a broader audience and take the opportunity to contribute to the existing body of knowledge on oceans and human health interactions. The preferred journal for publishing is Health Promotion International, to which researchers from Utrecht University have free access for publishing. Please note that this article is a work in progress that will be completed after the summer break (2019). The outline of the article will be as follows:

### Outline (12,5 page)

1. Abstract – 0,5 p.
2. Background and theory – 2,5 p.
  - a. What is OHH (in Europe) and why it is relevant (problem definition)
  - b. Research objective and area
  - c. Theoretical framework
3. Methodological approach – 2 p.
  - a. Data collection methods
  - b. Participant recruitment
  - c. Methods of analysis
  - d. Limitations
4. Results – 5,5 p.
  - a. Characteristics of innovations
  - b. Outcomes and benefits: Environmental issues and ecosystem services
  - c. SDGs
  - d. DPSIR
  - e. Expert view
5. Discussion and conclusion – 1,5p
  - a. Interpretation of results
  - b. Concluding remarks
  - c. Recommendations for future research
6. Acknowledgements – 0,5 p.
7. References

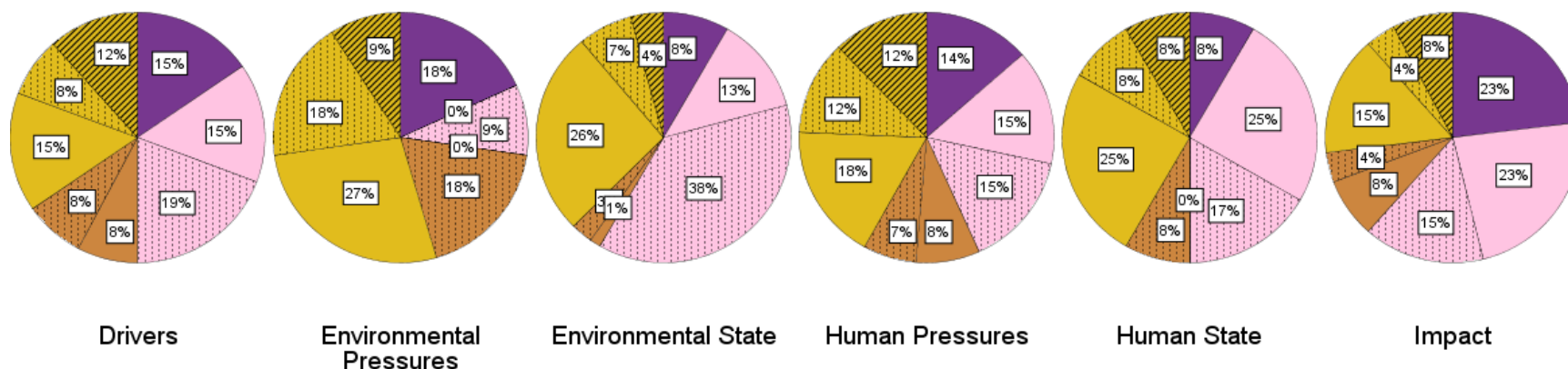
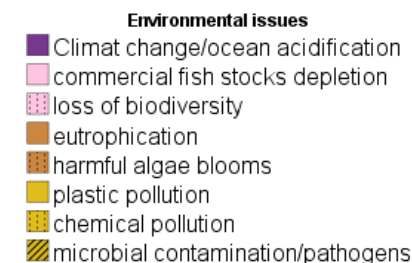


Appendix L – Intermediate steps of analysis  
Total distribution environmental issues over DPSI



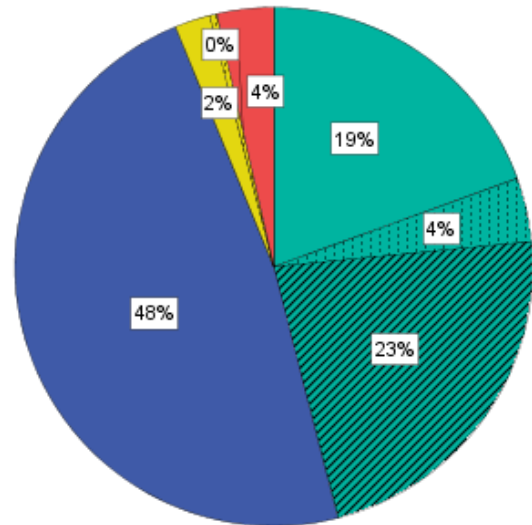
Compared to the total division of environmental issues among innovations in Europe, it can be concluded that the DPSI categories Environmental pressures, environmental state and human state deviate most. For environmental pressures, only 5 innovations were collected, which is too few to make any statements. For environmental state and human state more cases were collected, making it possible to look into the trends of these two categories. For environmental state, the emphasis is on the loss of biodiversity as the most important environmental issue, followed by plastic pollution. For innovations targeting the human state it is noticeable that commercial fish stock depletion and plastic pollution are important.

**Europe - DPSI**



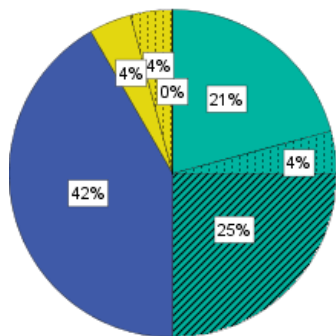
## Total distribution ecosystem services over DPSI

Europe - total

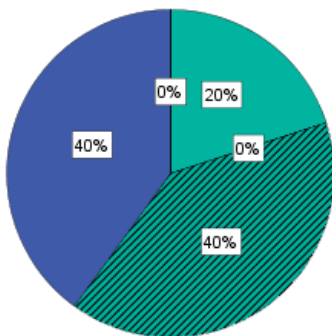


Compared to the total division of ecosystem services among innovations in Europe, all DPSI categories differ, however some more than others. The ones differing most are human state and impact, where for human state the focus is largely on the benefits of tourism, recreation and well-being, including mental well-being as well as the separate category 'other' which often also refers to mental health in specific. For ecosystem services, food provision is rather important, whereas water quality is quite low compared to the total. Furthermore, marine renewable energy is a rather big factor.

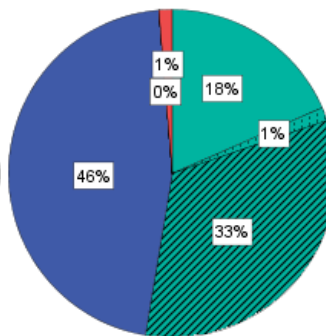
Europe - DPSI



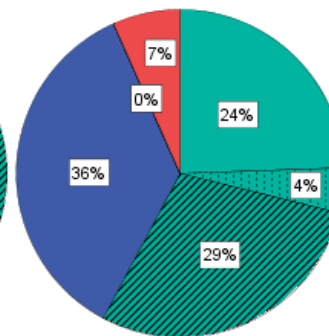
Drivers



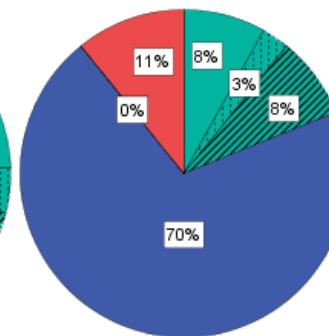
Environmental Pressures



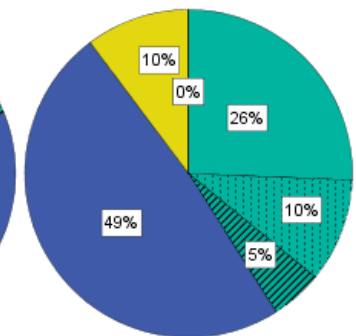
Environmental State



Human Pressures



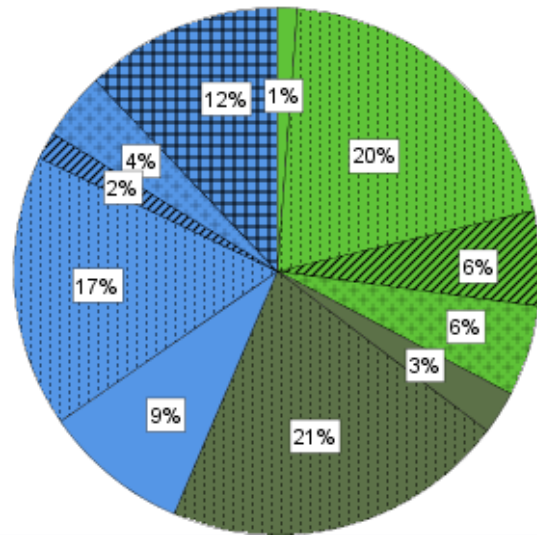
Human State



Impact

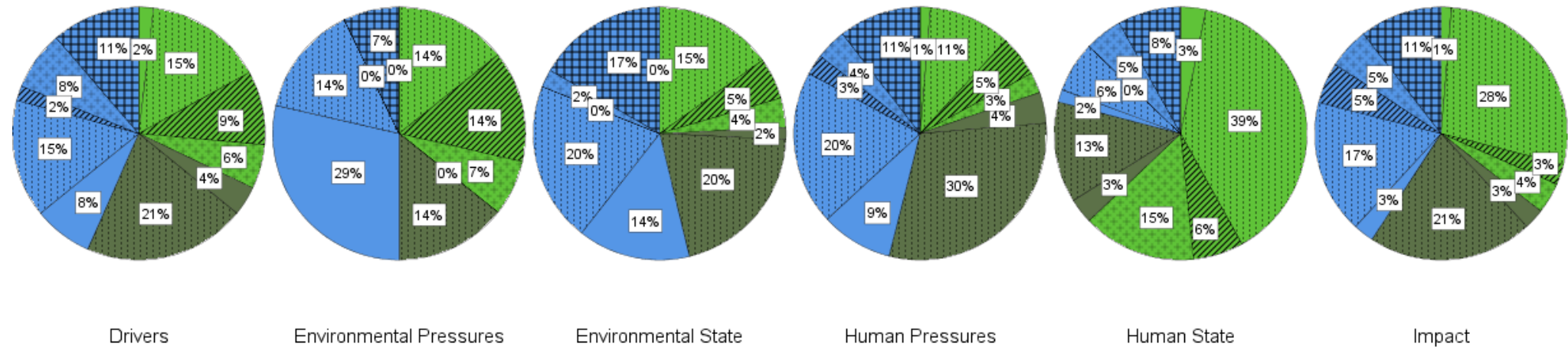
## Total contribution to SDG targets by DPSI

### Europe - total



Compared to the total division of SDGs among all innovations in Europe, the DPSI categories differing most are environmental pressures, human pressures, human state. Again, for environmental pressures, no real conclusions can be drawn due to insufficient data, however for human pressures and human state, this can be done. Innovations targeting human pressures are in specific focusing on changing behavior and willingness for conservation, explaining why they are contributing to SDG target 13.3 more than the others. For human state, the emphasis is on the health-related SDG targets, in particular on reducing non-communicable diseases and promoting mental health and well-being.

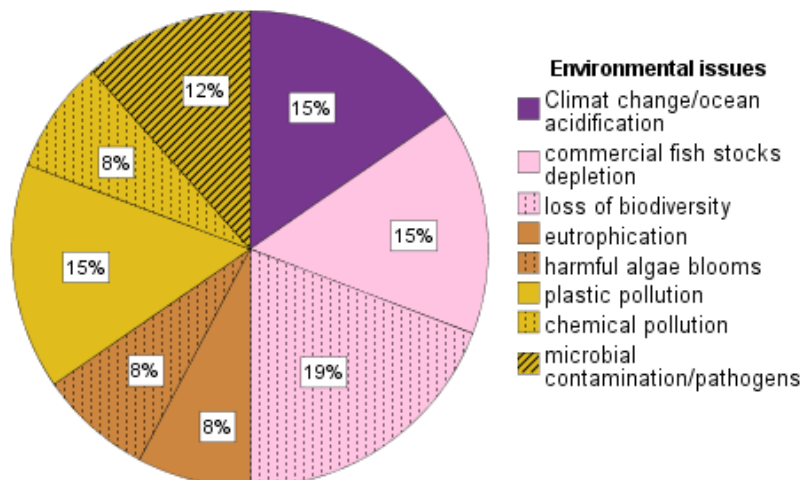
### Europe - DPSI



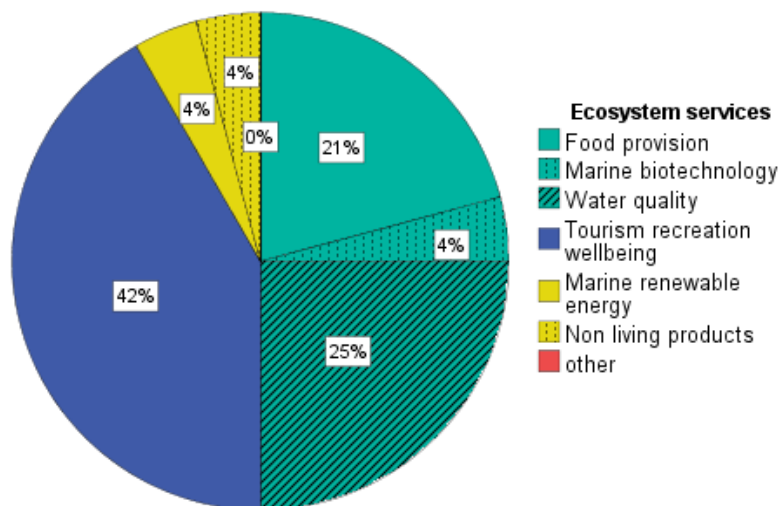
Drivers

Europe

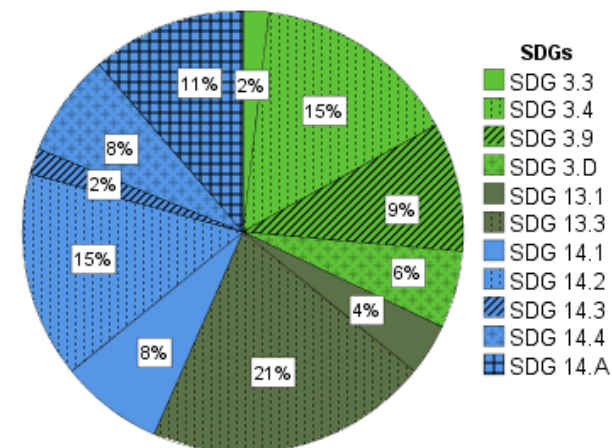
## Europe - Drivers



## Europe - Drivers



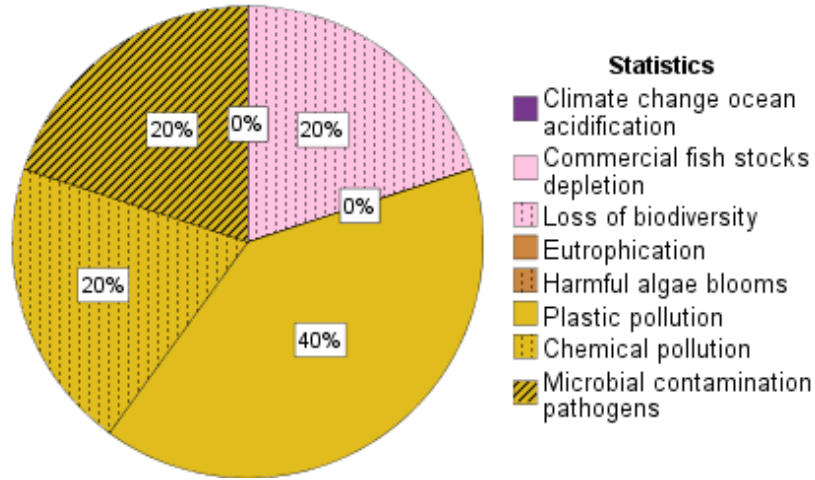
## SDGs per Drivers



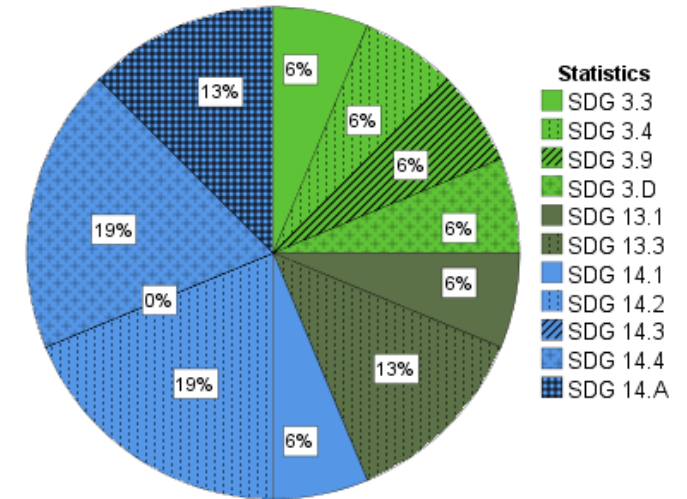
Innovations targeting drivers cover a wide spectrum of topics. They cover all environmental issues that are listed for this research. In particular they impact loss of biodiversity, plastic pollution, climate change and commercial fish stock depletion. The ecosystem services that are provided by these types of innovations are mainly tourism, recreation and wellbeing, water quality and food provision. These innovations furthermore contribute to all SDG targets that were selected for this research, contributing in particular to target 3.4, 13.3 and 14.2. The ecosystem services that are provided by these types of innovations are mainly tourism, recreation and wellbeing, water quality and food provision. These innovations furthermore contribute to all SDG targets that were selected for this research, contributing in particular to target 3.4, 13.3 and 14.2. These innovations furthermore contribute to all SDG targets that were selected for this research, contributing in particular to target 3.4, 13.3 and 14.2.



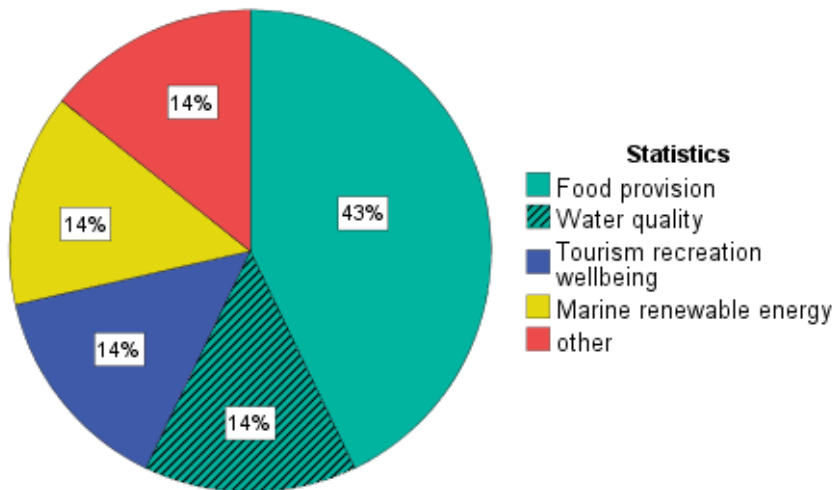
## Environmental issues Drivers



## SDGs Drivers



## Ecosystem services Drivers



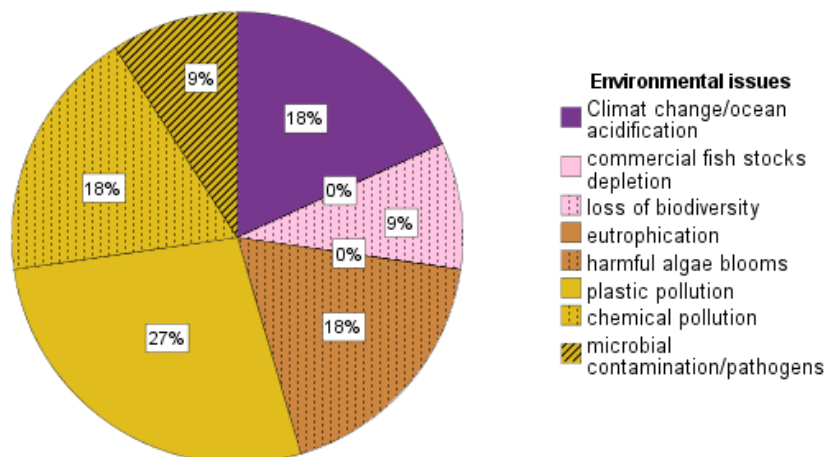
The innovations targeting drivers in SEA also contribute to achieving all selected SDG targets. Regarding environmental issues, they focus in particular on plastic pollution, followed by three categories: Loss of biodiversity, chemical pollution and microbial contamination. For ecosystem services, most impact in on food provision.

## Pressures

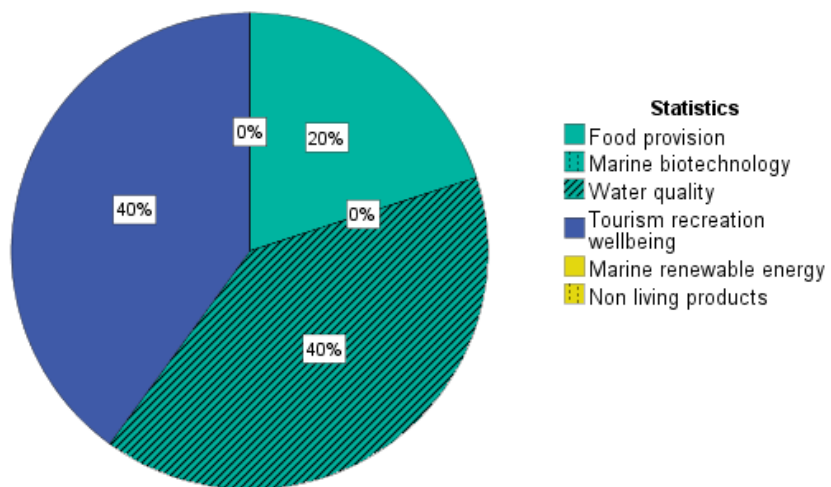
### Environmental Pressures

#### Europe

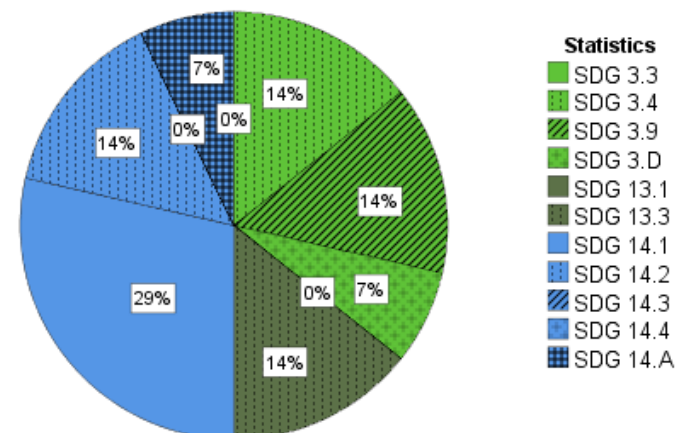
#### Europe - Environmental Pressures



#### Ecosystem services Environmental Pressures

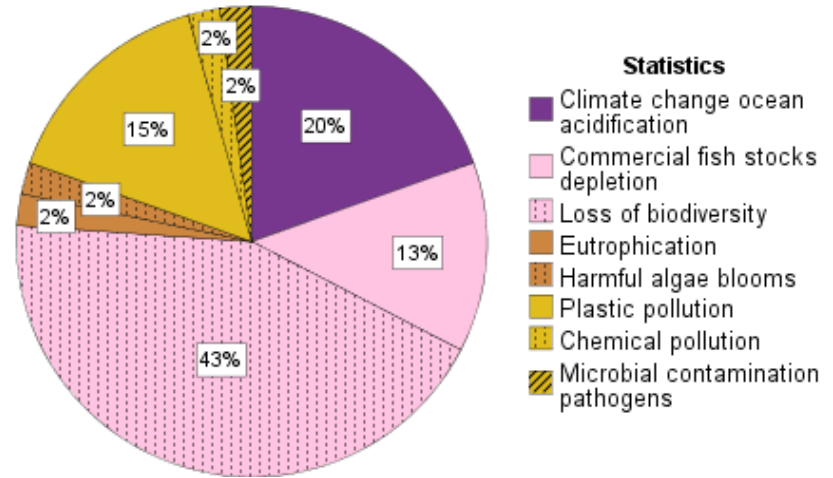


#### SDGs per Environmental Pressures

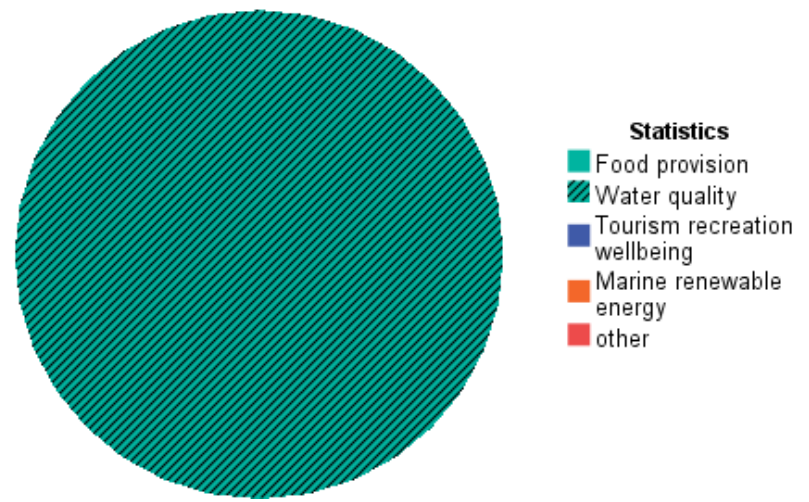


Innovations targeting Environmental pressures are aimed at the prevention and regulation of emissions and pollution. The environmental issues that are crucial in this category of innovations are plastic pollution, chemical pollution, harmful algae blooms and microbial contamination. Ecosystem services that are then generated by these innovations are water quality, tourism, recreation and well-being as well as food production. The impact on the SDGs becomes visible in 14.1, 3.4, 3.9, 13.3 and 14.2.

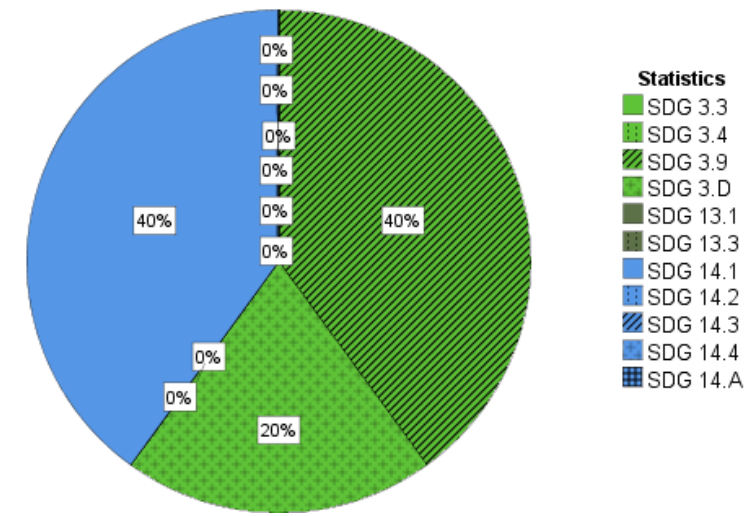
Environmental issues Environmental Pressures



Ecosystem services Environmental Pressures



SDGs Environmental Pressures

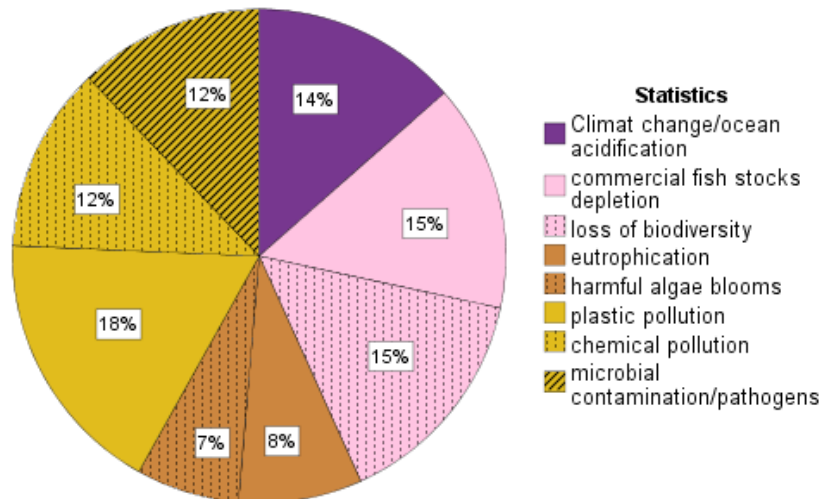


Innovations targeting environmental pressures in Southeast Asia have a big impact on combating the loss of biodiversity. Furthermore, this category of innovations helps to reduce the flows of plastic pollution, as well as combats climate change and prevents commercial fish stocks depletion. The main ecosystem service that is generated by these innovations is improved water quality. The SDG targets that are impacted by these innovations are linked to health and life below water, notably 3.9, 3.D and 14.1.

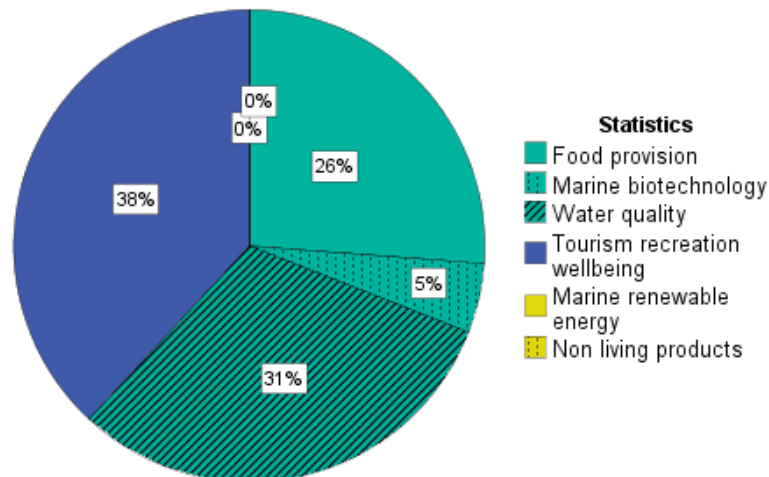
## Human Pressures

### Europe

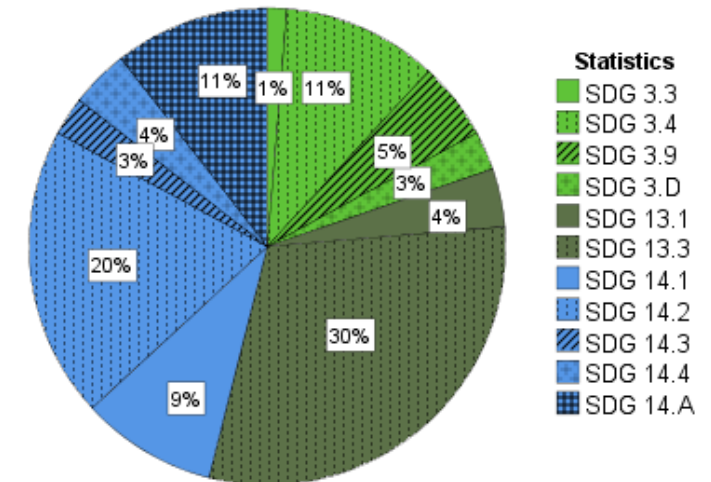
#### Environmental issues Human Pressures



#### Ecosystem services Human Pressures



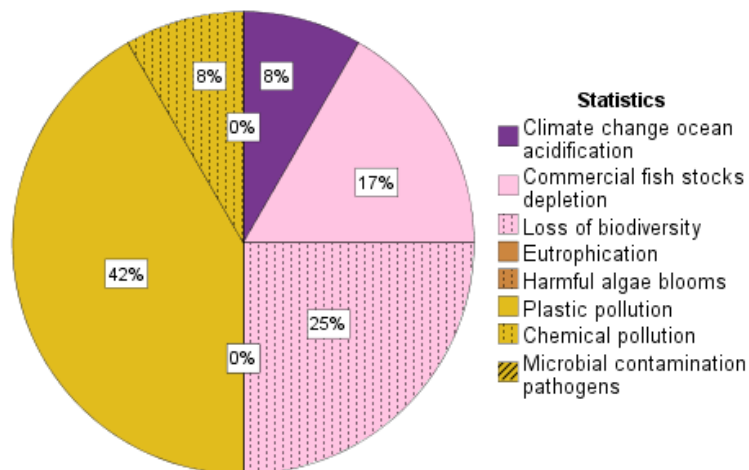
#### SDGs per Human Pressures



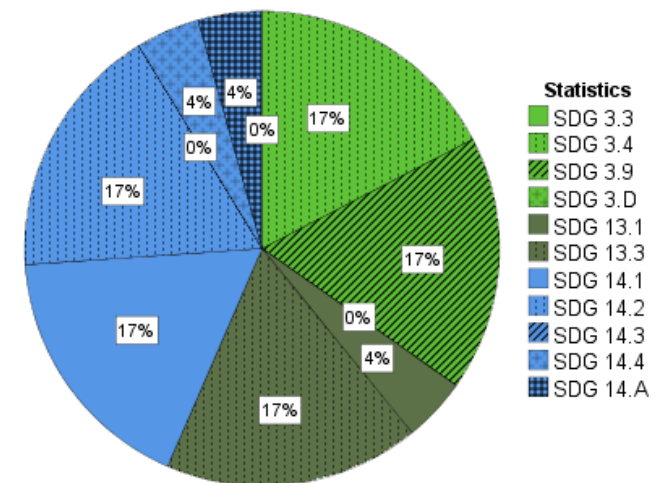
Innovations targeting human pressures aim to achieve environmentally friendly human behavior and willingness for conservation as well as adapted lifestyle patterns. For Europe, the environmental issues that this type of innovations address are highly diverse. All environmental issues are covered, whereas for ecosystem services, the emphasis is on tourism, recreation and well-being, water quality and food provision. In line with the intentions of this DPSI category, the most prominent SDG target is 13.3, corresponding with education and awareness, followed by 14.2.

## South-East Asia

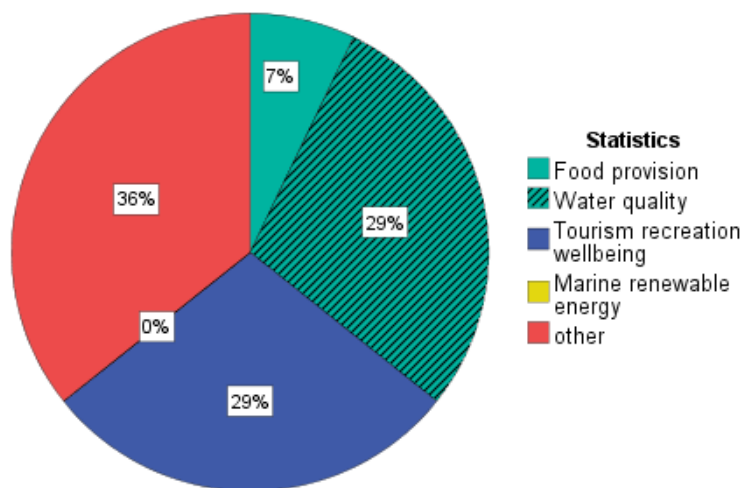
### Environmental issues Human Pressures



### SDGs Human Pressures



### Ecosystem services Human Pressures



Innovations aimed at human pressures in Southeast Asia focus primarily on human behavior and lifestyles with regards to plastic pollution. Second is loss of biodiversity, followed by commercial fish stock depletion. The ecosystem services that are generated in this category of innovations relate to water quality, tourism, recreation and well-being, and 'other'. The SDG targets are all but one covered by these innovations.

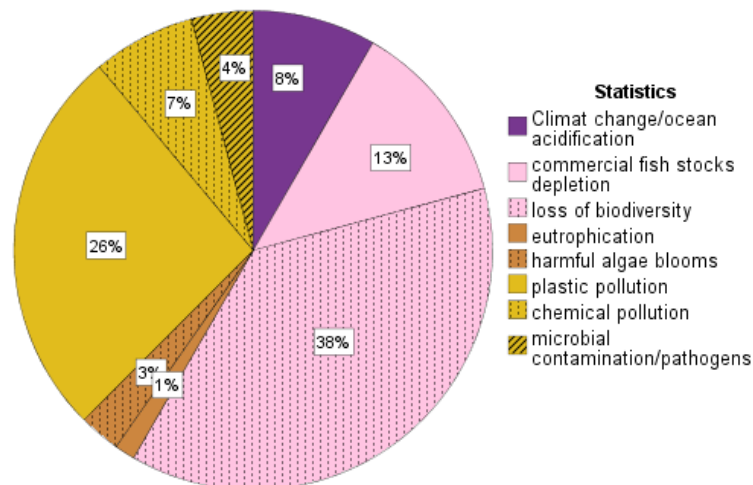


State

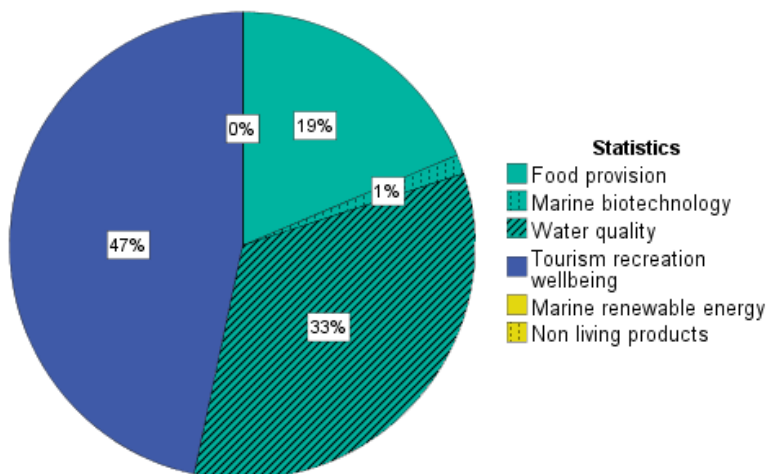
*Environmental State*

Europe

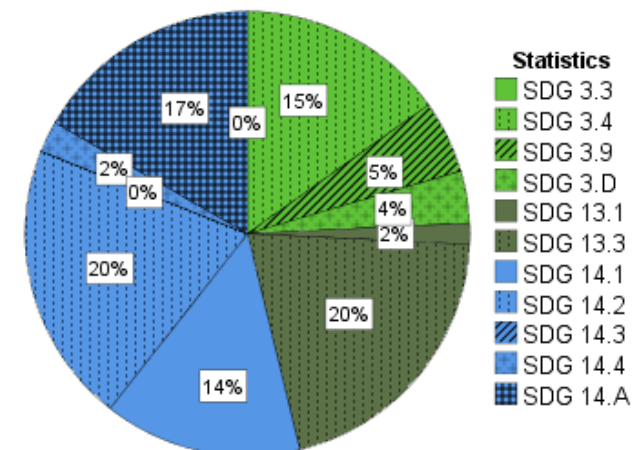
**Environmental issues Environmental State**



**Ecosystem services Environmental State**

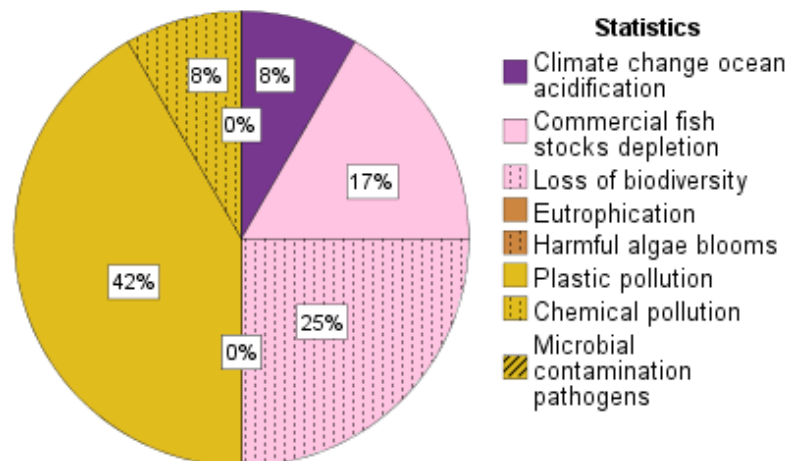


**SDGs per Environmental State**

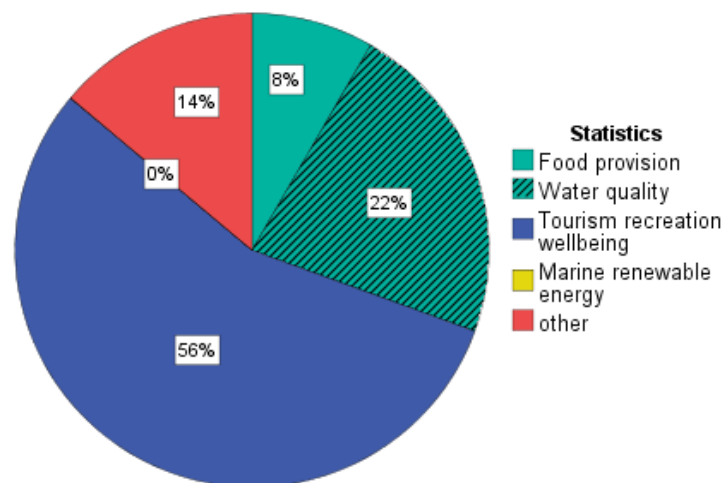


Innovations directed towards environmental state have an impact on the conditions of the marine environment, being mainly the ecosystem health and biodiversity. The most important environmental issues addressed by these innovations are loss of biodiversity, plastic pollution and commercial fish stock depletion. The ecosystem services that they simultaneously provide are tourism, recreation and well-being, food provision and water quality. The SDGs that are most impacted by these innovations are 13.3, 14.2 and 14.A.

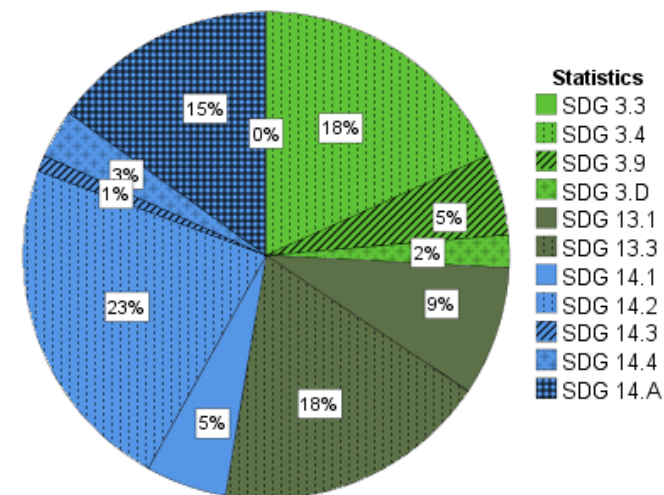
## Environmental issues Environmental State



## Ecosystem services Environmental State

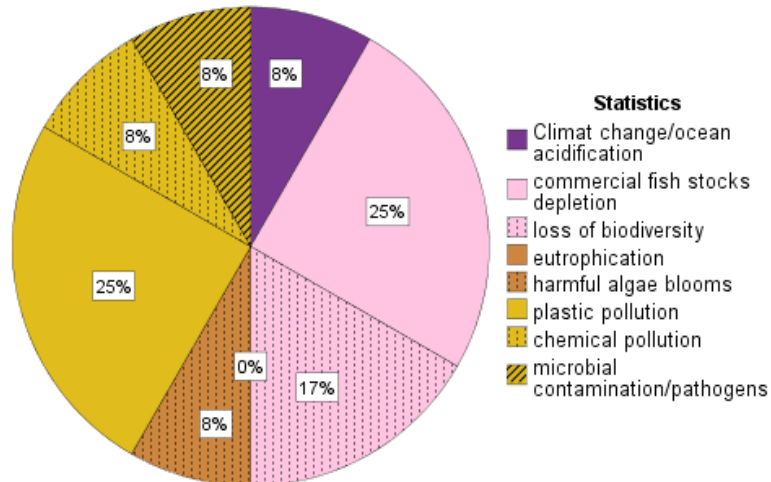


## SDGs Environmental State

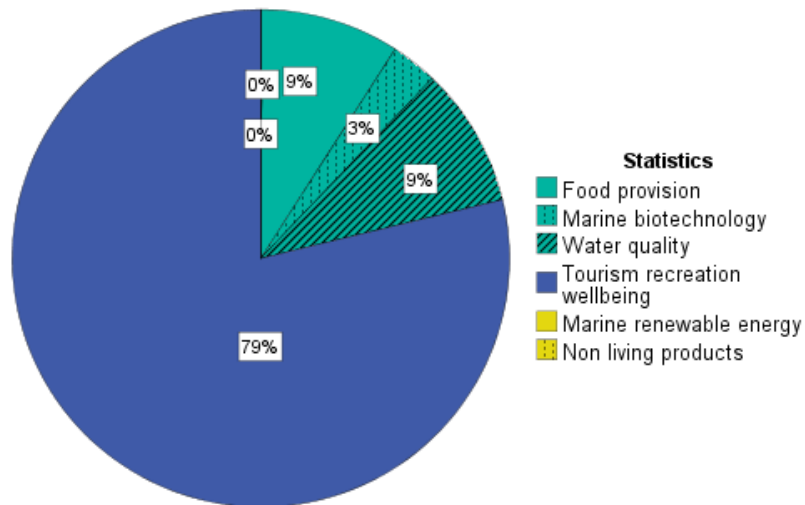


In South-East Asia, the innovations targeting the environmental state focus mainly on plastic pollution, followed by loss of biodiversity and commercial fish stock depletion. The ecosystem services that these innovations generate are tourism, recreation and well-being, water quality and 'other'.

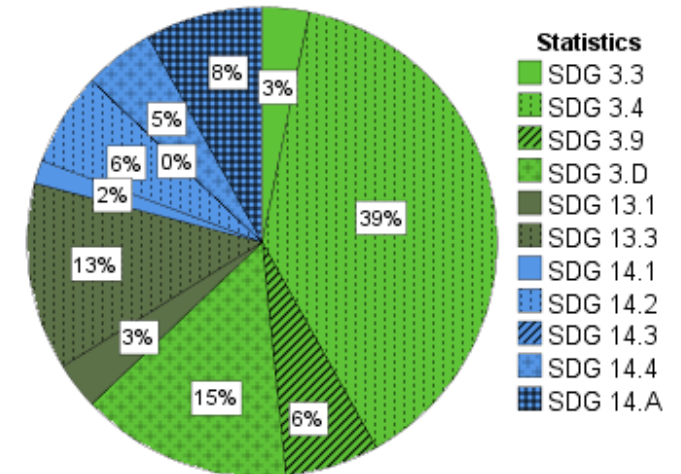
Environmental issues Human State



Ecosystem services Human State



SDGs per Human State

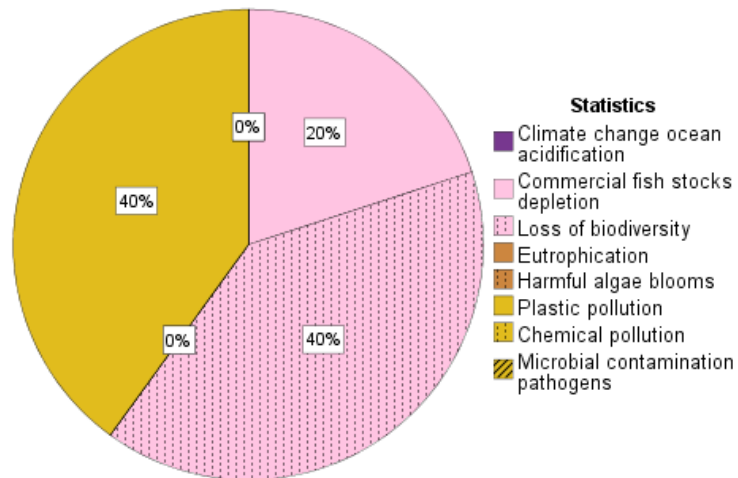


Innovations that address the human state component are aimed at improving people's physical and mental state. The environmental issues that these initiatives try to tackle are commercial fish stock depletion, plastic pollution and in lesser amount loss of biodiversity. The ecosystem services that are provided by these innovations are mostly tourism, recreation and well-being. This includes to a large extent mental health and well-being. Concerning the SDGs, the health-related SDGs experience most impact, where 3.4 is the largest category.

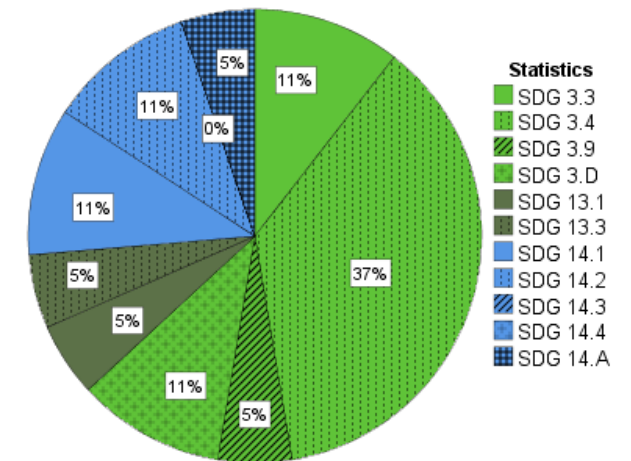


## South-East Asia

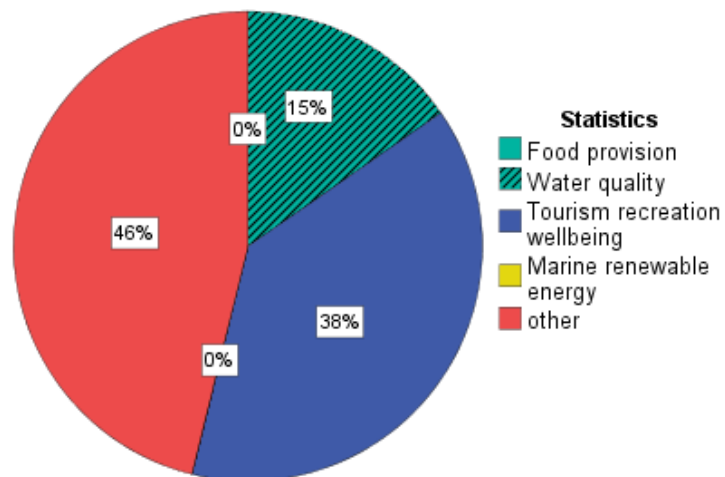
### Environmental issues Human State



### SDGs Human State



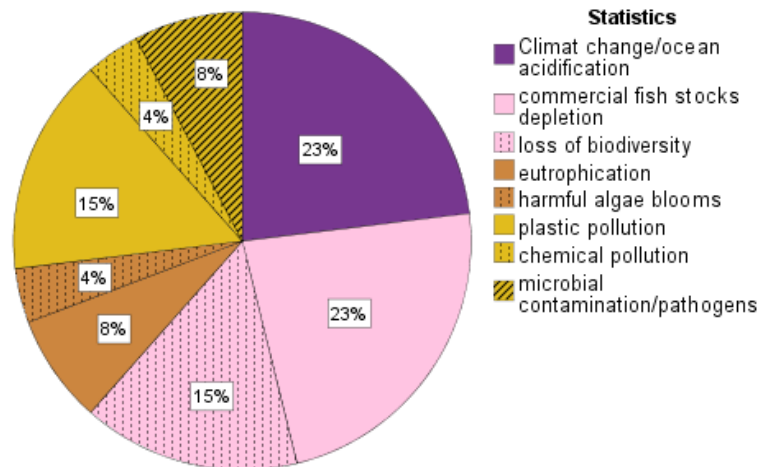
### Ecosystem services Human State



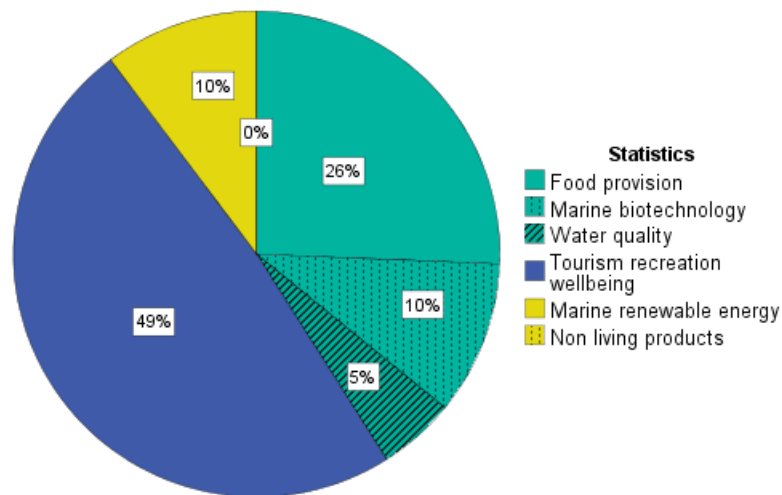
For innovations targeting human state in South-East Asia, the most important environmental issues are loss of biodiversity and plastic pollution. Commercial fish stocks depletion plays a smaller role in the innovations. The ecosystem services provided are firstly 'other'. Furthermore, tourism, recreation and wellbeing is important, as well as water quality. Concerning the SDGs again, the innovations focus mostly on health-related targets, with 3.4 as the most important target.

## Impact Europa

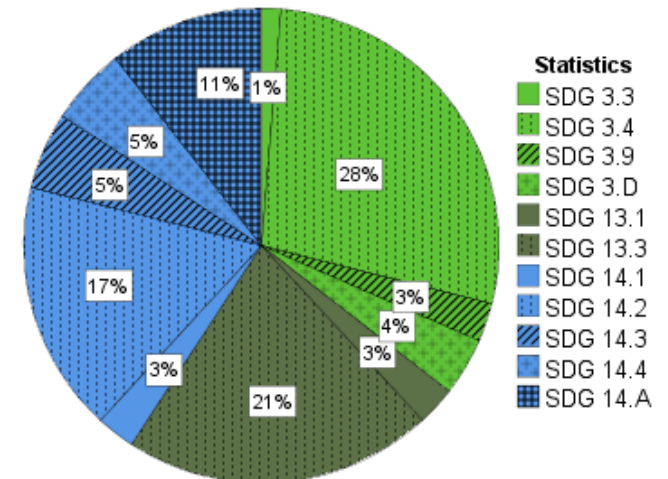
### Environmental issues Impact



### Ecosystem services Impact



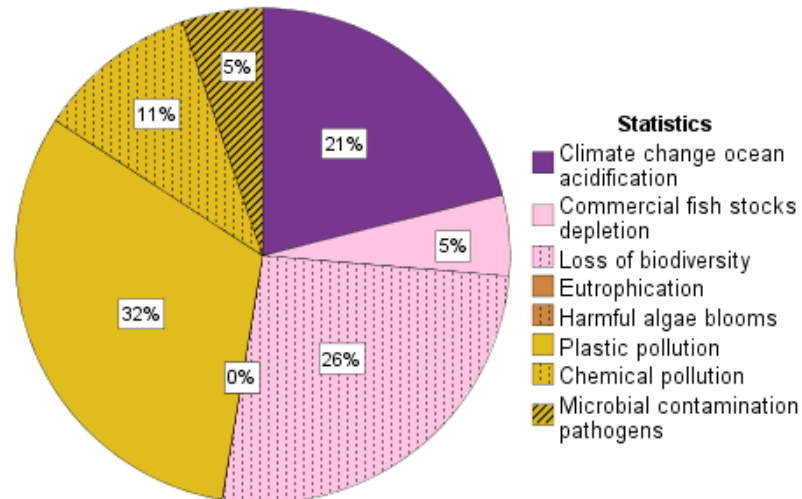
### SDGs per Impact



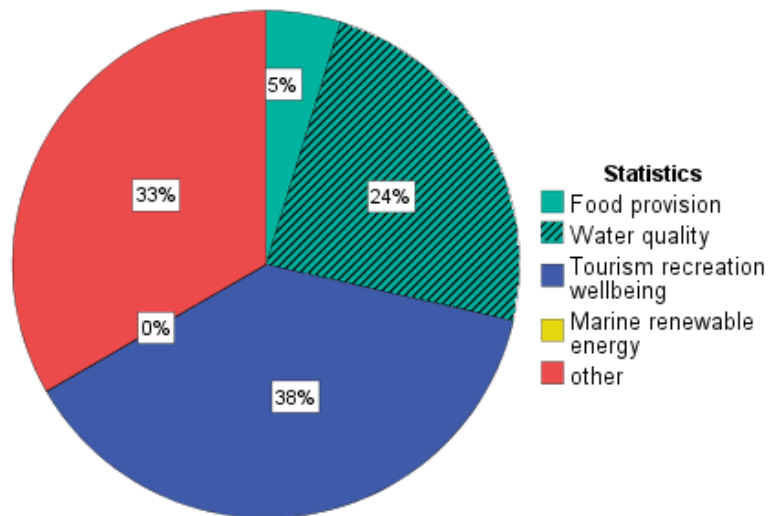
Innovations targeting Impact have as main objective to improve the ecosystem services, being the trade-offs between the environmental state and human state, that are provided by the oceans. This also implies to reduce the risks that are posed by overexploitation of these services and to reverse deterioration. The main environmental issues that are addressed by these innovations are climate change/ocean acidification, commercial fish stocks depletion and loss of biodiversity. The ecosystem services provided are tourism, recreation and wellbeing and food provision, but also marine renewable energy and biotechnology. The key SDG targets that these innovations contribute to are 3.4, 13.3, 14.2 and 14.A.

## South-East Asia

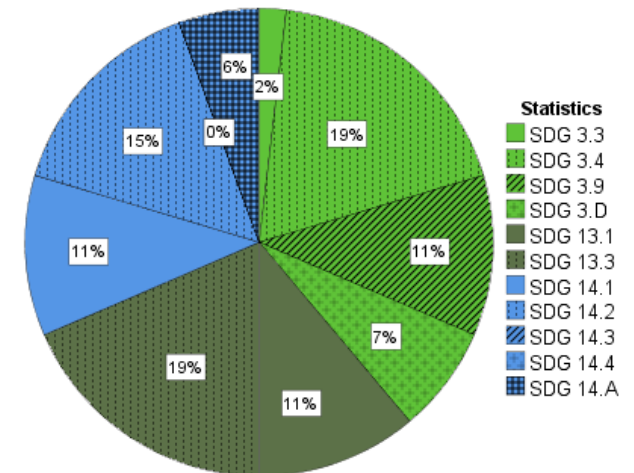
### Environmental issues per Impact



### Ecosystem services per Impact



### SDGs Impact



In South-East Asia, plastic pollution, loss of biodiversity and climate change are important environmental issues for these innovations. The most important ecosystem services that they provide are tourism, recreation and well-being, 'other' and water quality. The SDG targets are addressed in a rather equal manner, with 3.4, 13.3 and 14.2 being the most important targets.