

Studies in International Law of the Sea and Maritime Law  
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6

Aleke Stöfen-O'Brien

# The International and European Legal Regime Regulating Marine Litter in the EU



**Nomos**



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Internationales Seerecht und Seehandelsrecht

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## Preface

The dissertation was accepted by the Faculty of Law of the University of Trier during the winter semester of 2014. This monography reflects the state of the law as of August 2015.

I owe a considerable debt of gratitude to my supervisor, Professor Dr. Alexander Proelß, for sparking my interest in all aspects of law of the sea and international public law and for his constant encouragement and advice during the time spent writing this monography. I should also like to thank Professor Dr. Brunhilde Bloemeke for her valuable recommendations as second examiner.

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## *Preface*

portise in different settings. Furthermore, I would like to thank the staff of the Black Sea Commission, the International Commission for the Protection of the Rhine, the International Commission for the Protection of the Elbe River and the International Commission for the Protection of the Danube for their kind support in providing information on the topic.

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## Table of Contents

List of Abbreviations	15
Introduction	19
Chapter 1: Sources and consequences of marine litter	28
A. Sources of marine litter	28
I. Landward factors and activities leading to the introduction of waste into the marine environment	29
1. Urban agglomerations	31
2. Sanitary and sewage-related waste	31
3. Pollution from waste disposal	32
4. Tourism and recreational activities	33
II. Uses of the ocean that lead to marine litter	33
1. Shipping	35
a) Operational pollution	35
b) Accidental pollution	36
2. Fisheries	37
B. Classification and types of marine litter	38
I. Spatial appearance of marine litter	40
II. Monitoring of litter in the marine environment	42
C. Consequences and impacts of marine litter	44
I. Ecological impacts	45
1. Entanglement	45
2. Transport vectors for hitch-hiking of non-native species and smothering of marine habitat	47
II. Toxicological influences of marine litter by ingestion	47
1. Chemicals contained in plastic	49
2. Material science of plastic	50
3. Microplastics	52
a) Primary microplastic	53
b) Secondary microplastic	54
4. The uptake of microplastics	55
5. Adsorption of chemicals and metals onto microplastics	56



*Table of Contents*

6. Trophical transfer of persistent microplastics	59
7. Toxicological considerations	59
III. Socio-economic impacts	63
IV. Preliminary conclusion	64
D. Preliminary conclusion – Uncertainties and knowledge gaps	65
E. Requirements for an effective and integrated protection instrument	67
Chapter 2: Global regulatory framework relating to marine litter	70
A. Principles and their approaches to address marine litter	70
I. Polluter-pays-principle	73
1. The application of the polluter-pays-principle in agreements	74
2. Function of the polluter-pays-principle in marine litter context	75
II. The role of the preventive principle in a marine litter context	76
III. The precautionary principle	80
1. The implementation of the precautionary principle in the context of the introduction of polluting substances in the marine environment	82
2. The precautionary principle in the marine litter context - how to interpret risks and uncertainty?	85
B. Marine litter considerations in the development of environmental law	87
C. UNCLOS	93
I. The UN Convention of the Law of the Sea (UNCLOS) – framing marine environmental protection activities	93
II. The definition of marine pollution in the context of regulatory measures	94
III. The obligation to preserve and protect the marine environment as stipulated by UNCLOS in the context of marine litter regulation	96
IV. Pollution from land-based sources	100
1. Prescriptive jurisdiction	100
2. Enforcement of land-based pollution	102

V. The regulation of ocean-based pollution	105
1. Dumping as a source of marine litter	105
2. Operational pollution from seagoing vessels	106
3. Enforcement measures of ocean-based pollution prevention measures	110
4. Enforcement by coastal States	112
5. Enforcement through port States	114
6. Discussion on scenarios	117
7. Preliminary Conclusion	118
VI. The duty to co-operate as endorsed by UNCLOS and its implication for marine litter regulation	119
VII. Marine litter considerations in semi-enclosed seas under UNCLOS	121
VIII. Preliminary conclusion	122
D. The implementation and substantiation of environmental standards in public international law	124
I. International Convention for the Prevention of Pollution from Ships, as modified by the Protocol of 1978 relating thereto (MARPOL)	124
1. MARPOL Annex V Regulations for the prevention of pollution by garbage from ships	127
a) Role of the distinction between special areas and outside Special Areas under MARPOL Annex V for the regulation of marine litter	128
b) Discharge standards	130
c) Operational requirements under MARPOL	134
d) Port reception facilities	136
e) Port State Control	138
2. Preliminary Conclusion	140
II. The regulation of dumping as a source of marine litter	141
1. Marine litter aspects in the LC	145
2. Aspects of marine litter considerations in the LP	146
3. Boundary issues between the LC/LP and MARPOL Annex V	149
4. The dumping regime in the context of land-based waste management	151
5. Preliminary conclusion	152

*Table of Contents*

III. The regulatory framework of land-based marine litter in the absence of a legally-binding global agreement	153
1. Marine litter issues in the development of global land-based pollution measures	155
2. Implications of marine litter as a priority contaminant in the framework of the GPA	156
3. The role of the GPA to overcome the fragmented approach in addressing marine litter	159
E. Conclusion	160
Chapter 3: The role of the European Regional Seas Conventions to prevent the introduction of marine litter	164
A. UNEP's Marine Litter Initiative and the Regional Seas Conventions	165
B. Marine litter in the regulatory framework of the Baltic Sea	168
I. The institutional framework established by the Helsinki Convention	171
II. Primary and secondary Helsinki Convention provisions regarding pollution	173
1. The land-based pollution approach of the Helsinki Convention	176
2. The prevention of pollution from ships	178
a) Port Reception Facilities	179
b) The no-special-fee-system as a means to reduce vessel-based pollution	181
c) The role of the polluter-pays-principle and cost recovery	183
3. The role of monitoring of marine litter	186
III. Preliminary Conclusion	187
C. Marine litter regulations in the North-East Atlantic	189
I. The regulatory framework of the North-East Atlantic	189
II. Ship-based pollution prevention in the framework of the OSPAR Convention	192
III. Monitoring obligations under the OSPAR Convention	194
IV. The use of ecosystem quality criteria to assess the impact and presence of marine litter	196
V. Marine litter in the framework of OSPARCOM	199
VI. Preliminary Conclusion	202

D. The regulation of marine litter in the Black Sea Region	203
I. The legal framework of the Black Sea Region	204
1. Measures to address riverine inputs and other land-based pollution	210
2. Critical analysis of the dumping regime as established by the Bucharest Convention	216
II. Marine litter in the overall regulatory framework of the Black Sea Commission	218
III. Preliminary Conclusion	221
E. The regulatory scope of the Mediterranean regarding marine litter	222
I. Marine litter in the context of the Barcelona Convention and UNEP/MAP	227
II. Integrated Coastal Zone Management as an instrument to regulate coastal sources of marine litter	232
III. Preliminary Conclusion	236
F. Regional Action Plans	237
G. Conclusion on the scope and regulatory techniques for preventing marine litter contained in the four European Regional Seas Conventions	245
Chapter 4: Marine litter in the regulatory context of European Union law	251
A. The distribution of competences of the EU institutions	252
I. EU environmental objectives from a marine litter perspective	254
II. The principles of EU environmental policy	256
1. The polluter-pays-principle	258
2. The source-principle	260
3. The precautionary principle	262
B. Marine litter considerations in secondary EU law	264
I. Setting the background: marine litter in the overall strategic work	265
II. Secondary EU law–legislative procedure	268
III. Categorisation of relevant secondary legal instruments touching on the question of marine litter	270
IV. Selection of most pertinent issues and instruments	274

*Table of Contents*

V. Source-related legislation	275
1. The waste management system established by EU law	276
a) The regulatory system established by the Waste Framework Directive	276
b) Marine litter in the context of the definition of waste under the Waste Framework Directive	279
c) The relevance of the Waste Framework Directive in the marine litter context	281
2. Addressing identified point sources of marine litter: the role of the Landfill Directive	282
a) Plastic in the context of the definition of non-hazardous waste under the Landfill Directive	283
b) Evaluation of the regulatory approach of the Landfill Directive with a view to marine litter considerations	285
c) Issues of implementation: the Zakynthos-case	288
d) The interlink between waste management law and biodiversity protection	291
e) Role of reporting and information	292
f) Excursus: Measures reducing the impacts of plastic from landfills	294
g) Preliminary Conclusion	297
3. The adoption of more stringent national measures: the classification of a ban of plastic bags in EU law	298
a) The applicability of the Packaging and Waste Packaging Directive	300
b) Essential requirements under the Waste Packaging Directive	302
c) The derogation clause under Art. 114 TFEU	305
d) Preliminary conclusion	308
4. The Green Paper on a European Strategy on Plastic Waste in the Environment and the proposal for amending waste legislation	311
5. Preliminary Conclusion	314
6. Port Reception Facilities Directive—a mechanism to address operational vessel-based pollution	315
a) General framework	315

b) Critical evaluation of the elements of the PRF Directive	318
aa) Notification	318
bb) The fee and cost-recovery system of the PRF Directive	320
cc) Inspections	324
dd) Waste Handling Plans	325
c) Proposal for a Port Reception Facility Directive	325
d) Preliminary Conclusion	327
7. Preliminary Conclusion	327
VI. Impact related legislation	328
1. The Water Framework Directive	329
a) The management units of the WFD– the river basin districts	330
b) The regulatory approach to protect surface waters under the WFD	332
aa) Determining GEcS	333
bb) Good chemical status	334
c) Marine litter considerations despite a clear reference in the WFD?	335
aa) The use of quality elements for GEcS for the classification of marine litter	335
bb) Marine litter in the context of chemical pollution of surface waters	336
d) The combined approach to control point and diffuse sources– addressing microplastics	340
e) Preliminary remarks	343
f) The transboundary co-operation obligations of the WFD in light of marine litter considerations	344
g) Preliminary Conclusion	349
2. The Marine Strategy Framework Directive in the context of the marine litter discourse	350
a) The geographical scope of the MSFD	351
b) The aim to achieve a Good Environmental Status by 2020 and the context of “polluting effects”	352
c) Cyclical assessment of the marine environment	353
aa) Assessment of marine waters	355
bb) The challenge to determine the GES for marine litter	357

## *Table of Contents*

cc)	Descriptor 10 on marine litter: legal challenges	358
	(1) Interpretation of the wording of the provision	359
	(2) Legislative historical interpretation	360
	(3) The effet utile interpretation of descriptor 10 MSFD	362
	(4) The challenge to determine “harm” in the context of descriptor 10 MSFD	364
	(5) Establishing criteria and indicators for descriptor 10: the Commission Decision on criteria for good environmental status of marine waters	366
dd)	Determination of targets for marine litter	368
ee)	Monitoring programmes	372
d)	Marine Strategies: Programme of measures	374
e)	The reference to a public international law instrument by EU law	377
	aa) EU as an actor in international public law	378
	bb) Regional Seas Conventions as an instrument to implement the MSFD	379
	cc) Aspects of institutionalised co-operation by means of the integration of marine litter related MSFD issues in the work and programs of the Regional Seas Conventions	381
f)	Marine litter in the context of the GES by 2020	383
g)	Preliminary conclusion	384
C.	Conclusion concerning EU law	386
	Conclusion and Summary	391
	Bibliography	407
	I. International instruments and cases	407
	II. European Union	420
	III. The Group of 7 (G7)	428
	IV. Literature	428
	V. Internet sources	452
	VI. Presentations	453

## List of Abbreviations

Art.	Article
Barcelona Convention	Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean
Barcelona Convention 1976	Convention for the Protection of the Mediterranean Sea Against Pollution from 1976
BAT	Best Available Technique
BC	Barcelona Convention
BEP	Best Environmental Practice
BIS LBP	Land-Based Pollution Protocol in the context of the Bucharest Convention
2009 BIS-LBP	Revised Land-Based Pollution Protocol in the context of the Bucharest Convention (2009)
BIS ML SAP	Strategic Action Plan for the Management and Abatement of Marine Litter in the Black Sea region
BIS SAP	Strategic Action Plans for the Environmental Protection and Rehabilitation of the Black Sea
BISC	Bucharest Convention
CJEU	Court of Justice of the European Union
COP	Conference of the Parties
CP(s)	Contracting Party (Parties)
DDT	dichlorodiphenyltrichloroethane
DG	Directorate General of the European Commission
DG ENV	Directorate General for the Environment of the European Commission
EC	European Community
EcoQO	Ecological Quality Objective
Ed(s).	Editor (Editors)
EEA	European Environment Agency
EEC	European Economic Community
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EIHA	OSPAR's Environmental Impacts of Human Activities Committee
EPIL	Max Planck Encyclopedia of Public International Law
EQS	Environmental Quality Standard
EQSD	Environmental Quality Standard Directive
EU	European Union
FAO	Food and Agricultural Organisation of the United Nations
GECS	Good Ecological Status



## *List of Abbreviations*

GES	Good Environmental Status
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
GPA	Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities
HC	Helsinki Convention
HELCOM	Helsinki Commission
HELCOM HOD	HELCOM Heads of Delegation
HELCOM LAND	HELCOM Land-based Pollution Group
HELCOM RAP	HELCOM Regional Action Plan on Marine Litter
ML	
ICGML	Intersessional Group on Marine Litter (OSPAR)
ICJ	International Court of Justice
ICZM	Integrated Coastal Zone Management
ICZMP	Protocol on Integrated Coastal Zone Management in the Mediterranean
IGR	Inter Governmental Review (GPA)
ILM	International Legal Materials
IMCO	International Maritime Consultative Organisation
IMO	International Maritime Organisation
IOC	Intergovernmental Oceanographic Commission
IRBD	International River Basin District
ITLOS	International Tribunal for the Law of the Sea
London Convention, LC	Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter from 1972
London Protocol, LP	Protocol to the 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter
MAP	Mediterranean Action Plan
MARPOL	The International Convention for Prevention of Pollution from Ships (1973/1978)
MED POL	Programme for the Assessment and Control of Marine Pollution in the Mediterranean
MEDU	Coordinating Unit for the Mediterranean Action Plan
MEPC	Marine Environment Protection Committee (IMO)
MoU	Memorandum of Understanding
MPEPIL	Max Planck Encyclopedia of Public International Law
MSFD	Marine Strategy Framework Directive
NEAS	Strategy of the OSPAR Commission for the Protection of the Marine Environment of North-East Atlantic 2010-2020
NGO	Non-Governmental Organisation
NOAA	National Oceanic and Atmospheric Administration
OECD	Organization for Economic Co-operation and Development
OJ	Official Journal of the European Union
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic (1992)

OSPARCOM	OSPAR Commission
OSPAR RAG ML	OSPAR Regional Action Plan on Marine Litter
PAHs	polycyclic aromatic hydrocarbons
Para.	Paragraph
PBT	persistent, bioaccumulating and toxic compounds
PCB	polychlorinated biphenyls
PCDD/PCDF	polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans
PCIJ	Permanent Court of International Justice
POPs	Persistent Organic Pollutants
PRF	Port Reception Facilities
PRF Directive	Port Reception Facilities Directive
QSR	Quality Status Report
RAP ML Med	Regional Action Plan on Marine Litter Management in the Mediterranean
RBD	River Basin District
Res.	Resolution
Rio Declaration	Rio Declaration on Environment and Development
Stockholm Conference	1972 United Nations Conference on the Human Environment in Stockholm
Stockholm Declaration	1972 Declaration of the United Nations Conference on the Human Environment
TEU	Treaty on the European Union
TFEU	Treaty on the Functioning of the European Union
TSG ML	Technical Subgroup on Marine Litter
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNCED	United Nations Conference on Environment and Development
UNCLOS	UN Convention on the Law of the Sea
UNEA	United Nations Environment Assembly of the United Nations Environment Programme
UNEP	United Nations Environment Programme
UNGA	UN General Assembly
UNTS	United Nations Treaty Series
UNTS	United Nations Treaty Series
UWWTD	Urban Waste Water Treatment Directive
WFD	Water Framework Directive
WG PRESSURE (HELCOM)	Working Group on Reduction of Pressures from the Baltic Sea Catchment Area (within HELCOM)
ZaöRV	Zeitschrift für ausländisches öffentliches Recht und Völkerrecht
ZUR	Zeitschrift für Umweltrecht



## Introduction

Each year 6.4 million tons of waste enter our seas. The resultant litter, or in the American discourse marine debris, is a complex environmental issue with scientific, aesthetic, economic and societal impacts. The most well-known story about marine litter relates to the so-called garbage patches in the ocean in which the discarded waste accumulates and rotates within ocean currents. By way of a preliminary statement marine litter is defined as “any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment.”<sup>1</sup>

Marine litter includes several types of solid substances ranging from 5 nm microplastics to discarded vessels. The disposal of radioactive waste stored in barrels in the sea or sunken armadas on places of maritime battles account, strictly speaking, for marine litter. However, since plastic constitutes approximately 80% of the material, it can be assumed to be an environmental problem of the 20<sup>th</sup> century, the major starting point of which is demarcated by the production and commercialisation of plastic as an industrial resource in the 1950s. Admittedly, the seas have been used for centuries as a disposal place for human litter; but the production of plastic has changed the discourse and consequences of the discarded waste.

Marine litter is not an acute environmental catastrophe, but rather a long-term and latent problem. It is not only an aesthetic issue when washed ashore on a pristine beach; it is also known to harm marine organisms, the environment and potentially also human beings. The sources of marine litter are manifold and not entirely known. They range from waste disposal from land-based garbage, disposal of waste from vessels, accidents and unintentional introduction due to lack of knowledge. The complexity of the consequences of marine litter and the marine ecosystems, marine organisms and potentially also human beings are diverse and scientifically demanding. The interdependence of the environment is so mul-

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1 *Coe/Rogers, Marine debris, 1997, xxxi.*

tifaceted and complex that humans cannot exhaustively understand and recognise all potential consequences of their littering actions.

With a view to the starting point of “modern marine litter” it is quite surprising that the extent of the problem has only very recently found substantial attention and interest by decision-makers, the media, civil society and individuals. Consequently, there is a time delay between the occurrence of the issue and the global perception of its risks and adverse consequences outside of interested circles.

John Steinbeck wrote in his book “The Log from the Sea of Cortez” about boat expeditions he made in 1940 in the Gulf of California “The debris from ships from hundreds of miles around is piled on this beach-mountains of sea-washed piles of it, mixed in with bottles and cans and pieces of clothing. It is the termination of some great sweeping in the Pacific.”<sup>2</sup>

Steinbeck perceived the issue as an aesthetic problem. The adoption of the Convention on the Prevention of Marine Pollution by Dumping of Wastes and other matter from 1972 (London Dumping Convention) under which plastic may, in principle, not be dumped as well as Annex V of the International Convention for the Prevention of Pollution from Ships from 1973/1978 on prevention of pollution by garbage from ships are illustrative of the prevalence of a certain level of awareness of the consequences of plastic in the environment prevailing at that time.

Also, certain authors indicated the potential threat and damage arising from marine litter in the 1980s and 1990s.<sup>3</sup> It is therefore striking that awareness of the broader public for this pollutant has been (more or less) dormant in the policy and legislative context for approximately 30 years, until it was categorised as a high priority on the agenda of decision-makers. Marine litter is a rather ‘abstract’ problem that generally does not affect people’s lives until they are directly exposed to it themselves such as during holidays at the ocean.

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2 *Steinbeck/Ricketts*, *The log from the Sea of Cortez*, 1995, 206.

3 *Baur/Iudicello*, *Ecology Law Quarterly* 17 (1990) 71; *Joyner/Frew*, *Ocean Development & International Law* 22 (1991) 33; *Timagenis*, *International control of marine pollution*, 1980, 18 *et seq.*

### *Definition of marine litter*

The definition of marine litter has been subject to many amendments over time. In 1997, *Coe and Rogers* outlined that scientists use the following definition of marine litter: “Marine litter is defined as any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment.”<sup>4</sup> Consequently, the definition contained four criteria that identify marine litter:

- A substance (a processed physical material)
- Fate in the environment (persistence)
- Activity leading to the introduction of marine litter
- Location of introduction

With a view to the factual background<sup>5</sup>, this definition lacks certain elements. Primarily, it ignores the land-based dimension of marine litter. Also, it does not include additional activities such as unintentional or accidental introduction. In 2005, the United Nations Environment Programme (UNEP) proposed a refinement of the definition of marine litter that is, for the most part, identical with the definition mentioned above. It reads as follows

“Marine litter is defined as any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment.

Marine litter consists of items that have been made or used by people and deliberately discarded into the sea or rivers or on beaches; brought indirectly to the sea with rivers, sewage, storm water or winds; accidentally lost, including material lost at sea in bad weather (fishing gear, cargo); or deliberately left by people on beaches and shores.”<sup>6</sup>

Despite the vague and rather descriptive terms of the refined definition, it is preferable to the older version. This is mainly due to the inclusion of the catchment areas of rivers and other activities. This definition serves, unless otherwise provided, as the reference definition in the context of the

---

4 *Coe/Rogers*, *Marine debris*, 1997, xxxi. This appears to be based on the definition that is used in the Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA).

5 See the discussion on the sources of marine litter in chapter 1 of this study.

6 *UNEP*, *Marine litter, an analytical overview* 2005, 3.

study.<sup>7</sup> The definition is, however, not a legal definition *per se*, since it is not used in a legally binding document.<sup>8</sup>

*Legal approaches to addressing marine litter*

Marine litter is part of the greater regulatory context of marine pollution and environmental law. Both regimes are interlinked and regulate a diverse range of substances, sources of pollution and consequences that pose a challenge with regard to marine litter aspects. Marine litter is only one of many types of polluting substances, thus the provisions of the regulatory agreements are sometimes not suitable or adequate for the specific problems and challenges posed. Therefore a legal analysis of marine litter makes understanding and interpreting the broadly formulated provisions and obligations through a marine litter perspective indispensable. Whereas sectoral aspects such as shipping or dumping as a source of marine litter have been intensively researched in legal studies, literature exclusively focusing on legal aspects addressing every source of marine litter is not abundant.<sup>9</sup>

*Marine litter as a tragedy of the commons*

Marine litter considerations must also be seen in the context of “sustainable development.” The Brundtland report of the World Commission on Environment and Development from 1987 defines this notion as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”<sup>10</sup> The two underlying and linked dimensions of sustainable development are “intragenerational equi-

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7 This definition is also used in the context of the EU: *Galgani/Fleet/van Franeker et al.*, Marine Strategy Framework Directive, Task Group 10 Report Marine Litter, 2010, 4.

8 As will be demonstrated in the course of the study, the incorporation of a definition of marine litter into legally binding instruments has only been pursued in recent years: see chapter 4.

9 See for early accounts of studies that relate to legal questions regarding marine litter: *Lentz*, Marine Pollution Bulletin 18 (1987) 361; *Bean*, Marine Pollution Bulletin 18 (1987) 357; *Joyner/Frew*, Ocean Development & International Law 22 (1991) 33. See also *Trouwborst*, Utrecht Journal of International and European Law 27 (2012) 4.

10 *World Commission on Environment Development*, Our Common Future, 1987, 43.

ty” and “intergenerational equity”<sup>11</sup> that relate broadly to the right to development and the use of resources. Intergenerational equity implies that “[t]he right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations.”<sup>12</sup> On the other hand, intergenerational equity “requires equity in the distribution of the outcomes of development within one generation as much as internally (within one national society) as internationally (between developed and developing States).”<sup>13</sup> Even though the legal status of sustainable development in international law is debated, the essence of the concept contains important considerations in respect of marine litter regulations. The “plastic footprint” in the seas links our generation with that of many others that are limited in using this resource.<sup>14</sup>

The sustainable use of (non-renewable) resources is also linked to the tragedy of the commons.<sup>15</sup> Already in 1968 Hardin outlined his visionary view on the tragedy of the commons as a social problem in which the unlimited availability of a resource leads to a depletion of it, for example fish. With regard to pollution he states that:

In a reverse way, the tragedy of the commons reappears in problems of pollution. Here it is not a question of taking something out of the commons, but of putting something in--sewage, or chemical, radioactive, and heat wastes into water; noxious and dangerous fumes into the air, and distracting and unpleasant advertising signs into the line of sight. The calculations of utility are much the same as before. The rational man finds that his share of the cost of the wastes he discharges into the commons is less than the cost of purifying his wastes before releasing them. Since this is true for everyone, we are locked

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11 *Barral*, *European Journal of International Law* 23 (2012) 377, 380. *Birnie, Boyle and Redgewell* also include the integration of environmental protection and economic development, the right to development, the sustainable utilization and conservation of natural resources as elements of sustainable development: *Birnie/Boyle/Redgewell*, *International law and the environment*, 2009, 116 *et seq.* The core of the concept of sustainable development is in need of substantiation *Proelß*, *Völkerrecht*, in *Bothe/Dolzer/Kau et al.*, *Völkerrecht* (2013) 352–438, 417.

12 Principle 3 of the Rio Declaration on Environment and Development, *UN*, *UN Doc. A/CONF.151/26* (vol. I); 31 *ILM* 874 (1992) (Rio Declaration) (emphasis added).

13 *Barral*, *European Journal of International Law* 23 (2012) 377, 380.

14 See only the reference of ecological footprint concept of *Wackernagel* in *Meadows/Randers/Meadows*, *Grenzen des Wachstums: das 30-Jahre-Update*, 2006, 301.

15 *Brown Weiss*, *Sustainable development and international law*, in *Lang*, *Sustainable development and international law* (1995) 17–33, 18.



into a system of "fouling our own nest," so long as we behave only as independent, rational, free-enterprisers.<sup>16</sup>

*Challenges of marine litter regulatory efforts*

The conceptual problems of legal efforts regulating marine litter issue are quite complex. Marine litter is a transboundary issue that emanates from the territory of a State or is disposed of in the High Seas, but potentially has consequences and impacts in other places than their location of introduction. The transboundary issue of marine litter therefore necessitates particular questions.

The functions of a regulatory framework to address marine litter are on the one hand to establish obligations on States to prevent transboundary harm, to protect the marine environment and to take measures; they however also establish rights for States. The regulatory framework of marine litter should also have the function to translate socially acceptable levels of marine litter pollution and to integrate scientific knowledge on its risks into a legal context. Regulatory efforts are, however, aggravated by certain problems. With a view to the manifold sources and impacts as well as the variety of potentially applicable instruments, it is argued that the different possible solutions and regulatory approaches run the risk of creating a fragmented regulatory regime. The scientific uncertainties and knowledge gaps that prevail regarding the sources and consequences also pose a challenge when undertaking a legal evaluation of the issue.

*Determining the aim of a regulatory framework of marine litter*

The potential aims that marine litter regulation can achieve are important considerations before embarking on a legal analysis of the subject. Whereas in other areas of environmental regulation it is possible to eliminate emissions (such as major point sources), the success of establishing objectives of marine litter regulations is limited. The legacy of polluting activities and the persistence of the material aggravate the determination of a time scale of the finalization of the problem. In this regard, aiming to eliminate the overall pollution of the sea by litter is not feasible at the moment due to the pre-existing pollution load. Clean-up efforts are at this stage developed in pilot studies. These should, however, serve to complement measures that are aimed at preventing the introduction of marine lit-

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<sup>16</sup> *Hardin*, *Science* 162 (1968) 1243, 1244.

ter. It is suggested that starting from the current *status quo*, a conceivable aim is the reduction or elimination of the introduction of litter overall. The impact of efforts following this objective might potentially only be visible several decades later.

All existing legal responses serve as mechanisms to prevent the introduction of marine pollution. Therefore, the aim of this legal analysis is to understand what *agreements establish the current regulatory regime* that serves to eliminate or reduce the introduction of marine litter. In this regard, their scope, function and underlying logic are important assessment parameters. An additional element is to illustrate what *legal measures are currently in place* to specifically address the issue. The identification of regulatory gaps and particularities will be a central purpose of the study. Central questions in this context are: *which jurisdictional level and actors or institutions* (global, regional or in the EU) and *which level of specificity of legal measures* are the most suitable to address the reduction of the introduction of marine litter.

### *Scope of the study*

Due to the many potentially applicable instruments, the geographical scope of the study is limited to those instruments that are applicable in the four seas surrounding Europe: the North-East Atlantic, the Baltic Sea, Mediterranean Sea, and Black Sea. Even though such an approach potentially runs the risk of ignoring the transboundary impact of polluting activities from outside these territories, a geographical delimitation allows for greater focus throughout the study so as to enable an in-depth discussion. The four seas surrounding Europe represent a particular interesting study area since several regulatory layers are applicable to their conservation. Not only are they covered by public international law, but they are also subject to the effects of provisions of European Union law. European Union law is to be differentiated from public international law and constitutes a legal order *sui generis* whereby the distinguishable element of this regulatory order is based on its supranational character as well as a comprehensive body of instruments that is applicable also to the sources and impacts of marine litter.

The study is divided into four chapters. The first chapter presents the *factual aspects of marine litter* used as a basis and reference framework for the subsequent legal assessment. It intends to present the sources and consequences of marine litter so as to guide and reflect upon existing or

future regulatory responses. It is argued that the factual background and its associated uncertainties and knowledge gaps are important considerations when assessing existing legal responses. Ultimately, developing and/or implementing legal responses without taking adequate consideration of the factual circumstances would, in most cases, significantly diminish the effectiveness of such instruments, rendering them ineffective and failing to address the issue at the core. Additionally, understanding the adverse consequences and risks associated with marine litters an important yardstick in measuring the urgency and level of action taken as well as determining the acceptability of polluting effects. Due to the debate on microplastics as an “emerging pollutant”, the consequences of this type of marine litter will be a particular focal point. The factual background is then taken as a starting point to establish requirements for an effective regulatory regime of marine litter.

In the second chapter, the *global regulatory framework* of marine litter in general will be examined by way of analysing pertinent principles, treaties and other programmes. Following an overview on how the issue of marine litter has been dealt with over the last decades in different instruments and declarations of public international law, the role of principles in guiding and interpreting legal norms is elucidated. Thereafter, pertinent treaties and action programmes with a global scope will be analysed with regard to their role in a marine litter context. Due to the broad substantive and geographical scope of these instruments, the fundamental obligations pertinent to marine litter of these frameworks will be analysed. An aspect to which particular attention is paid is whether marine litter considerations are directly or indirectly addressed and whether and to what extent the defined requirements for an effective regulatory regime are fulfilled.

In the third chapter, the regulatory regime governing the *four Regional Seas Conventions surrounding Europe* will be analysed. Depending on the Regional Seas Convention in question, its scope, protocols and subsequent implementing actions are measured against the requirements of an effective regulatory regime. The analysis is not limited to legally binding instruments *per se*, but also extends to include soft law i.e. non-binding recommendations or monitoring instruments as the case may be. A particular question will be whether regional approaches to the issue of marine litter could result in increased protection standards and tailor-made solutions that effectively address the introduction of marine litter.

In the fourth chapter, the complex body of regulation in the *European Union* will be analysed. In this regard, the competence of the EU and its

institutions to act on the different aspects of marine litter such as waste management or marine environmental protection will be analysed. In a second step, the application of principles as embodied in EU primary law will be discussed with regard to their specific implementation and application to the various questions associated with marine litter. Before embarking on a systematic analysis of the secondary law instruments that directly or indirectly relate to marine litter, the issue will be classified in the overall strategic work of the EU and its institutions. This chapter aims to understand whether the assumption that EU law plays a major role in reducing the introduction of marine litter into the seas surrounding the EU, can be confirmed.

## Chapter 1: Sources and consequences of marine litter

Marine litter is not only an acute environmental problem, but due to plastic and other persistent synthetic materials, it is also a chronic, cumulative and complex issue. The following discussion on the consequences, sources and possible monitoring strategies serves as a fundamental background for the ensuing questions relating to regulatory answers. In particular the impacts of marine litter are a starting point to assess the gravity of the problem.

### *A. Sources of marine litter*

In the regulatory legal framework relating to marine litter, sources are generally differentiated according to their geographic origin.<sup>17</sup> Knowledge about the pathways and influx vectors of marine litter are prerequisites for the adoption of effective measures. This classification is necessitated by the multicausal origins and the inadequate knowledge about the sources of marine litter in general. The underlying logic behind this, also from a legal point of view, is that marine litter pollution can only be prevented by taking measures at the source. A regulatory response at the source is, however, aggravated by the diffuse nature of sources and the multiplicity of entry points and activities that cause marine litter. Consequently, one cannot only reduce the sources to mere geographic factors, rather such an assessment needs to integrate the influence of other factors leading to the emission of solid waste such as weather conditions, physical structures of waste management and the behavioural patterns of individuals.<sup>18</sup> With a

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17 See only the International Convention for the Prevention of Pollution from Ships (MARPOL) (London) of 2 November 1973, in force 2 October 1983 as amended by the 1978 Protocol (London), of 01 June 1978; 1340 UNTS 61 and the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Dumping Convention) (London, Mexico-City, Moscow, Washington) of 29 December 1972, in force 30 August 1975; 1046 UNTS 120; 11 ILM 1294 (1972).

18 *Ryan/Moore/van Franeker et al.*, *Philosophical Transactions of the Royal Society B: Biological Sciences* 364 (2009) 1999, 2000.

view to structuring this analysis, the different sources and activities known to add to the problem are divided into two main categories: land-based pollution and ocean-based pollution. Since a sectorial perspective, dealing with each source or activity individually, without observing the overall context, does not reflect the complex causal relations and the variety of activities, the distinction between land-based and ocean-based sources and activities is also made as both sources are currently addressed by a different regime of instruments and mechanisms.

#### I. Landward factors and activities leading to the introduction of waste into the marine environment

The matter of land-based pollution of marine litter is highly controversial in the academic debate. An overview of possible sources estimated that 50-90% of marine litter stems from land-based activities.<sup>19</sup> This percentage is explained by the large geographical scope including the catchment areas of rivers, bays and estuaries that take up and transport solid waste to the oceans. Rivers play an important role in introducing inland pollution into the marine environment. Their catchment areas or drainage basins include small streams and rivers that collect surface water.<sup>20</sup> Consequently, waste from leakages of landfills and overflowed sewage systems, notwithstanding their distance to large rivers or the coast, could end up ultimately in the sea. Rivers and estuaries are thus the major transport vectors in this

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19 The percentages are taken from the different regionals overviews of Marine Litter: A Global Challenge, 2009, chapter 2. Depending on the region in question, the percentage of land-based pollution differs. However, the exact amount of the ratio between land-based and ocean-based pollution is disputed. *Hammer et al.* suggested in a study in 2012, that land-based pollution amount to approximately 12% and ocean-based pollution to approximately 88% of marine litter sources. Nevertheless, given the vast drainage basin of rivers and the amount of coastal urbanization, these figures should be carefully handled: *Hammer/Kraak/Parsons*, Reviews of Environmental Contamination and Toxicology, in *Whitacre*, Reviews of Environmental Contamination and Toxicology (2012) 1–44, 9. *Andrady* on the other hand outlines that 80% are land-based pollution and 18% of marine litter sources are from the fishing industry: *Andrady*, Marine Pollution Bulletin 62 (2011) 1596, 1597.

20 In this way, a variety of pollutants is introduced into the freshwater including fertilisers introduced by agricultural run - offs, thermal pollution and chemicals: *Wither/Bamber/Colclough et al.*, Marine Pollution Bulletin 64 (2012) 1564, 1564.