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Launching a new phase in the fight against land-based sources of marine pollution

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This Note, *and its associated* Issue Brief, *challenges participants to the 3rd UN Ocean Conference in Nice, France, to discuss and address the question: "What must governments specifically do at national, regional and global levels to rapidly accelerate the implementation of precautionary and ecosystem-based approaches to coastal pollution?". Its content will be discussed in dedicated meetings and workshops over the coming months, and a final version will be published by the end of 2024.*

NOTE

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> "In the age of the Anthropocene, the ocean has typically been viewed as a sink for pollution (…). As global population, wealth and resource consumption continue to grow, so too does the amount of potential pollution produced. This presents us with a grand challenge which requires interdisciplinary knowledge to solve. There is sufficient data on the human health, social, economic, and environmental risks of marine pollution, resulting in increased awareness and motivation to address this global challenge, however a significant lag exists when implementing strategies to address this issue".[1]

1. INTRODUCTION

The 2nd World Ocean Assessment, published by the United Nations in 2021, reported that *"about 40% of the world's population lives in the coastal zone, that is, within 100 km of the coast. The proportion is increasing."* It also highlighted that *"the marine environment brings both benefits and risks to human health, especially for people who live near it."*[2] At the macro-scale, it is indeed estimated that land-based sources contribute about 77% of marine pollution.[3] However, the absolute ratio of land-based to sea-based sources of pollution fluctuates dramatically dependent on physical location, the pollutant concerned, seasonal variability and a suite of other factors. In many locations, close to 100% of marine pollution is derived from land-based sources.

Considerable progress has been made at the international level to address individual categories of coastal and marine pollution. The 2001 Stockholm Convention and the 2013 Minamata Convention have made an effective contribution to combating pollution from Persistent Organic Pollutants (POPs) and mercury. Since 2002 and a resolution adopted by the United Nations Environmental Assembly (UNEA), an Intergovernmental Negotiating Committee (INC) has been established with the objective to *"develop an international legally binding instrument on plastic pollution, including in the marine environment"*[4]. However, there are many other, more diffuse and routine sources of land-based pollution, which receive less attention from the international community.

After a brief presentation of these main pollutants and their associated impacts on the marine environment (2), this paper describes (3) and assesses (4) the international initiatives aimed at combating them and provides some recommendations to strengthen efforts (5).

1 Willis, Kathryn A, *et al.* (2022). Cleaner Seas: Reducing marine pollution. *Rev Fish Biol Fisheries* 32:145–160.

2 The Second World Ocean Assessment Vol II, United Nations, p. 33.

3 Independent World Commission on the Oceans, The Ocean Our Future: The Report of the Independent World Commission on Oceans, (Cambridge University Press, 1998) 27.

4 UNEA Resolution 5/14 entitled "End plastic pollution: Towards an international legally binding instrument", §3.

2. THE DIVERSITY OF LAND-BASED POLLUTANTS AND ASSOCIATED IMPACTS

The long list of pollutants that reach and negatively impact the marine environment includes heavy metals,[5] persistent organic pollutants,[6] pathogens,[7] radioactive substances,[8] hydrocarbons, petrochemicals, plastics[9] and other forms of solid waste,[10] heat and even noise[11] (see also Annex 1). Furthermore, the quantum of naturally occurring substances, such as reactive nitrogen and carbon dioxide,[12] has been significantly increased due to activities of direct benefit to humanity, such as the production of fertilizers[13] and energy.[14] However, for certain marine ecosystems, the altered balances of such substances may have a devastating effect. Similarly, land-based activities such as mining, clearing vegetation for agriculture or forestry, and building roads, homes and hotels can destroy critical habitats and fill rivers and estuaries with mud and silt. Development that modifies riparian and littoral zones also limits the capacity of natural systems to filter out increased levels of pollution. In turn, these practices reduce the resilience[15] of coastal and marine ecosystems, making them more susceptible to pressures such as climate change, coastal storms and over harvesting.

Transported to the marine environment on the wind, along rivers, canals, subterranean aquifers, through sewerage outfalls, stormwater channels and industrial discharge pipes, a toxic soup[16] of anthropogenic effluent and discarded waste eventually makes its way to the marine environment. Upon reaching coastal waters, this cocktail of pollutants feeds algal blooms, generates hypoxic dead-zones, contaminates seafood products, reduces fish stocks, renders swimming and other recreational pursuits unsafe, destroys valuable aesthetics, and produces unpleasant odours. Coastal lagoons, estuaries, harbours, semi-enclosed seas, and even the open ocean with its pollution transporting currents and continental scale gyres, become mirrors of anthropogenic activities on land that pollute the life-giving channels that serve as one-way vectors to the oceans.

Unfortunately, the literature often lacks a clear understanding of interactions between pollutants, primarily due to insufficient data across various marine ecosystems, diverse marine species, and a general scarcity of historical data. Literature on cumulative effects underscores the significant gaps in our understanding of the impacts of land-based pollutants. Notwithstanding this paucity of data, some studies do suggest synergistic interactions between climate change drivers and land-based pollutants, such as the increased deoxygenation rates due to warming.[17] Studies employing cumulative effect assessments have also demonstrated how land-based herbicide inputs interact with ocean acidification, leading to higher bleaching rates of the Great Barrier Reef.[18] The negative impacts resulting from synergistic interactions are threatening coastal and marine ecosystems and the many goods and services they provide.

5 TM Ansari, IL Marr, and N Tariq, 'Heavy Metals in Marine Pollution Perspective-A Mini Review' (2004) 4(1) *Journal of Applied Science* 1.

6 JW Farrington, and H Takada, 'Persistent organic pollutants (POPs), polycyclic aromatic hydrocarbons (PAHs), and plastics: Examples of the status, trend, and cycling of organic chemicals of environmental concern in the ocean' (2014) 27(1) *Oceanography* 196.

7 Y Baskin, 'Sea Sickness: the Upsurge in Marine Diseases' (2006) 56(6) *BioScience* 464.

8 HD Livingston and PP Povenic. 'Anthropogenic marine radioactivity' (2000) 43 *Ocean & Coastal Management* 689; also A Aarkrog, 'Input of anthropogenic radionuclides into the World Ocean' (2003) 50(17-21) Deep-Sea Research II: *Topical Studies in Oceanography* 2597.

9 AA Koelmans *et al*., 'Plastics in the Marine Environment' (2014) 33 (1) *Environmental Toxicology and Chemistry* 5; also JA Ivar do Sul, and MF Costa, The present and future of microplastic pollution in the marine environment (2014) 185 *Environmental Pollution* 352; also M Gold, 'Plastic Pollution: Stemming the Tide of Plastic Marine Litter: A Global Action Agenda' (2014) 27 *Tulane Environmental Law Journal* 165; and C Zarfl *et al*., 'Microplastics in oceans' (2011) 62(8) *Marine Pollution Bulletin* 1589.

10 A Trouwborst, 'Managing Marine Litter: Exploring the Evolving Role of International and European Law in Confronting a Persistent Environmental Problem' (2011) 27 Merkourios-*Utrecht Journal of International & European Law* 4

11 See UNEP/GPA, Protecting the coastal and marine environment from impacts of land-based activities: A guide for national action (UNEP/GPA, 2006); also UNEP Marine Litter: A Global Challenge (UNEP 2009); and Trouwborst, above n 10.

12 Anthropogenic emissions of carbon dioxide impact the marine environment by the increasing presence of hydrogen ions and the decreasing availability of carbonate ions essential for the formation of calcium carbonate – a phenomenon commonly referred to as Ocean Acidification. Ocean acidification is known to have undesirable and harmful effects on the physiology and growth of a broad range of marine biota, particularly calcifying species. Carbon dioxide can therefore be labelled a marine pollutant under the definition provided by UNCLOS.

13 See RW Howarth, 'Coastal nitrogen pollution: A review of sources and trends globally and regionally' (2008) 8 *Harmful Algae* 14; also DW Schindler and JR Vallentyne, The Algal Bowl: Overfertilization of the World's Freshwaters and Estuaries (Earthscan, 2008); and JTA Verhoeven *et al*., 'Regional and global concerns over wetlands and water quality' (2006) 21(2) *TRENDS in Ecology and Evolution* pp 96-103.

14 C Nellemann, S Hain and J Alder (eds) *In* Dead Water – Merging of climate change with pollution, over-harvest, and infestations in the world's fishing grounds (UNEP, 2008).

15 See Simon A Levin and Jane Lubchenco 'Resilience, Robustness, and Marine Ecosystem-based Management, (2008) 58(1) *BioScience* 27.

16 See E Corcoran et al. (eds), 'Sick Water? The central role of wastewater management in sustainable development: A Rapid Response Assessment' (UNEP, 2010).

17 Altieri, A. H., & Diaz, R. J. (2019). Chapter 24 - Dead Zones: Oxygen Depletion in Coastal Ecosystems. In C. Sheppard (Ed.), *World Seas: An Environmental Evaluation* (Second Edition) (pp. 453–473). Academic Press. https://doi.org/10.1016/B978-0-12-805052-1.00021-8

18 Mentzel, S., Nathan, R., Noyes, P., Brix, K. V., Moe, S. J., Rohr, J. R., Verheyen, J., Van den Brink, P. J., & Stauber, J. (2024). Evaluating the effects of climate change and chemical, physical, and biological stressors on nearshore coral reefs: A case study in the Great Barrier Reef, Australia. *Integrated Environmental Assessment and Management*, 20(2), 401–418. https://doi.org/10.1002/ieam.4871

3. INTERGOVERNMENTAL EFFORTS TO FIGHT AGAINST LAND-BASED POLLUTION

3.1 The 1995 Global Programme of Action

The non-binding 1995 Washington Declaration and Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA),[19] adopted by 108 countries and the European Union, was for a long time the primary global instrument recommending practices and procedures for addressing land-based sources of marine pollution in a *holistic* manner at national and regional scales.[20] While international mechanisms have subsequently been developed to address individual pollutant source categories, e.g. POPs or Mercury, the GPA was the only multilateral mechanism, at the global scale, targeting an ecosystem-based approach where all threats posed by pollution are addressed collectively. The drafters of the GPA acknowledged that addressing coastal pollution requires long-term, cross-sectoral, multidisciplinary, and participatory responses. Through the GPA, governments recognized that the combined impact of land-based activities on the marine environment was simultaneously a local, national and regional problem with global ramifications. In short, governments promised to initiate comprehensive and sustained action, including though National Programmes of Action, and to cooperate at the regional level to prevent the degradation of marine and coastal environments from land-based activities.

The GPA outlined a logical adaptive management framework that encouraged governments to assess their respective problems, identify priorities for action, develop strategies, monitor implementation and reassess the effectiveness of management actions based on empirical data from the marine environment. It did not, however, articulate specific strategies for action for each pollutant source category, nor did it provide guidance on appropriate policy combinations and permutations. The flexible nature of the GPA reflected the fact that the type and quantum of pollutants entering the marine environment from land-based activities is a function, not only of the extent of industrial development, urbanization and consumerism, but of the combined policies adopted by governments, industry and civil society. A tangled web of cause-and-effect links these stakeholders in a way that it is extremely difficult, if not impossible, to predict the effect that any one domestic policy, regulation or initiative enacted by any one of the stakeholders will have on the others.

The non-binding and non-prescriptive nature of the GPA sought to translate the obligation articulated in Article 207 of the United Nations Convention on the Law of the Sea (UNCLOS), as well as regional obligations as determined by the respective Regional Seas conventions, into national frameworks in an entirely flexible way that reflected the reality of domestic environmental regimes. The GPA's flexibility reflected the need for adaptive national approaches that respond to "the nature of and relationships between all components of the system, not just law".[21] Its non-binding flexible nature allowed governments to adopt not only a coercive command-and-control paradigm, but also more exhortatory measures such that polluting firms and consumers could be influenced in their behaviour without taking from them the freedom to make their own decision, or requiring the State to have detailed information on what they are all doing.

Unfortunately, the flexibility of the GPA has also proved to be its undoing.[22] While the GPA was sometimes praised for its 'soft law' flexibility.[23] A "more sceptical view is that once again economic and industrial priorities have prevailed' and that there 'is nothing in the Washington Declaration or its subsequent history to suggest that it has in any way changed international law relating to the pollution of the sea from land-based activities".[24] After thirty years of limited funding and lacklustre implementation,[25] identifying locations where the GPA has been the primary driving force of domestic reform is extremely difficult. While it is extremely difficult to anticipate and/or assess the effectiveness of any MEA, hard or soft, in actually changing the behaviour of governments, corporations, and individuals in ways that improve the environment,[26] the broader fleet of binding and more geographically targeted instruments such as the European Marine Strategy Framework Directive (MSFD) and the respective Regional Seas conventions, combined with specific pollutant MEAs, such as for POPs and Mercury, probably have more potential in terms of directly facilitating domestic reform than the non-binding GPA.

Being a non-binding mechanism, an inherent weakness of the GPA was that it did not incorporate mandatory reporting, making it too easy for governments to do nothing. The GPA did, however, require periodic intergovernmental reviews. These occurred in Montreal[27] (2001), Beijing[28] (2005) Manila[29] (2012)

19 UN Doc UNEP(OCA)/LBA/IG2/7, 5 December 1995.

20 U Beyerlin and T Marauhn, *International Environmental Law* (Hart Publishing, 2011)129.

21 Robinson above n91, p30.

22 B Meier-Wehren, 'The global programme of action for the protection of the marine environment from land-based activities' (2013) 17 *New Zealand Journal of Environmental Law* 1. See also, A Nollkaemper, 'Balancing the protection of marine ecosystems with economic benefits from land-based activities: The quest for international legal barriers' (1996) 27(1) *Ocean Development and International Law* 153.

23 See http://www.unep.org/PDF/ourplanet/2007/dec/en/OP-2007-12-en-ARTICLE1.pdf .

24 P Birnie, A Boyle and C Redgwell, *International Law and the Environment*, Third Edition (Oxford University Press, 1009) 465.

25 D VanderZwaag and A Powers, 'The Protection of the Marine Environment from Land-Based Pollution and Activities: Gauging the Tides of Global and Regional Governance' (2008) 23 *The International Journal of Marine and Coastal Law* 423.

26 RB Mitchell, 'International Environmental Agreements: A Survey of Their Features, Formation, and Effects' (2003) 28 *Annual Review of Environment and Resources* 429.

27 See http://www.unep.org/GC/GCSS-VII/Documents/k0260101.pdf.

28 See http://unep.org/gpa/documents/meetings/IGRII/IGRIIBeijingDeclaration.pdf.

29 See http://unep.org/gpa/documents/meetings/IGRIII/IGRIIIReportEn.pdf.

and Bali[30] (2018). The most recent intergovernmental review was held virtually in 2022 prior to the resumed fifth session of the United Nations Environment Assembly (UNEA). It was attended by 37 countries and the European Union

At the third session of the Intergovernmental Review Meeting, held in Manila in January 2012, governments[31] highlighted the GPA *"as a flexible and effective tool for the sustainable development of oceans, coasts and islands, and for human health and well-being"*. Governments furthermore committed to *"comprehensive, continuing and adaptive action within a framework of integrated coastal management relevant to respective national and regional priorities"*.[32] Finally, governments decided that UNEP, through a multistakeholder approach, should focus on addressing nutrients, marine litter and wastewater as the three priority source categories of pollution.

At the fourth session, held in Bali, Indonesia, in 2018, representatives adopted the Bali Declaration on the Protection of the Marine Environment from Land-based Activities, in which it was proposed that the future of the GPA should be based on the function, form and implications of the Programme, including legal, budgetary and organizational aspects. The UNEP secretariat accordingly prepared an analysis of options and alternatives for the overall Programme and its coordinating mechanism, which was presented to the Committee of Permanent Representatives to UNEP for further consideration. On 30 November 2021, the Committee endorsed the proposed way forward and recommended the endorsement by the virtual Intergovernmental Review Meeting in 2022.

At the fifth session, held virtually in 2022, governments stopped short of officially closing the GPA, but definitely downgraded it when it decided to *"hold no further sessions of the periodic Intergovernmental Review Meeting of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities, recognizing that the United Nations Environment Assembly of the United Nations Environment Programme can continue to provide guidance on priorities and actions to address marine pollution from land-based activities"*.[33]

While the GPA has been helpful for a long time in shaping the global narrative on land-based sources of marine pollution, today, the GPA as a non-binding agreement, is a shadow of its former self. While many of the respective pollutant sources categories are now pursued in isolation through subsequent multilateral agreements, there is no longer a strong emphasis on articulating National Prorgrammes of Action that address cumulative impacts through ecosystem-based approaches underpinned by empirical water quality monitoring data. To its credit though, UNEP still undertakes ongoing programmatic activities addressing pollutants from Source to Sea, and/or GEF funded initiatives addressing pollutants from Ridge to Reef.

30 See https://www.unep.org/cep/events/working-group-meeting/fourth-intergovernmental-meeting-global-programme-action

31 Manila Declaration on Furthering the Implementation of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities, Ibid, Annex.

32 Ibid, Annex, operative para 2.

33 https://wedocs.unep.org/bitstream/handle/20.500.11822/40600/K2201191.pdf?sequence=6&isAllowed=y

3.2 Regional seas programmes

The need for cooperation and harmonized approaches is most evident in geographically confined and shared waters, such as the Mediterranean, Black and Caribbean Seas. However, the mobility, persistence and ubiquitous nature of many pollutants make the need for cooperation equally applicable in more open waters, such as the South Pacific or the Western Indian Ocean. The obligation to cooperate is made explicit in Article 197 of the UNCLOS which requires States to cooperate on a global basis and, as appropriate, on a regional basis, directly or through competent international organizations, in formulating and elaborating international rules, standards and recommended practices and procedures for the protection and preservation of the marine environment, taking into account characteristic regional features.

The most visible and comprehensive mechanisms for implementing Article 197 are the 18 regional conventions and/or action plans,[34] known collectively as the Regional Seas programmes. The Regional Seas programmes had their genesis 50 years ago, prior to the adoption of UNCLOS, in the Mediterranean Sea, and expanded rapidly to other regions such as the North Atlantic, the Baltic and the Caribbean. The respective Regional Seas programmes provide a multilateral platform for neighbouring coastal States to reconcile global conservation priorities with the realities of implementation at the regional level, and to fulfil their responsibilities stemming from other contemporary multilateral mechanisms, such as UN Environment Assembly Decisions, relevant targets of Agenda 21,[35] the Johannesburg Plan of Implementation,[36] the Millennium Development Goals,[37] and the 2030 Agenda and related Sustainable Development Goals (SDGs).[38]

Many of the Regional Seas programmes function through action plans, which articulate a comprehensive strategy based on the region's socio-economic and political situation and particular environmental challenges. Fourteen of the Regional Seas have also adopted legally binding conventions that provide a framework consistent with and complementary to national commitments under UNCLOS. Furthermore, many of the regional framework conventions have added legally binding protocols addressing specific issues, such as land-based pollution.

The first regional regimes addressing land-based sources of marine pollution were adopted in 1974 for the Baltic Sea (the

34 These include the Antarctic, Arctic, Baltic, Black Sea, Caspian, Eastern Africa, East Asian Seas, Mediterranean, North-East Atlantic, North-East Pacific, North-West Pacific, Pacific, Red Sea and Gulf of Aden, ROPME Sea Area, South Asian Seas, South-East Pacific, Western Africa and the Wider Caribbean.

35 UN GAOR, 46th Sess., Agenda 21, UN Doc A/Conf.151/26 (1992).

36 UN General Assembly, World Summit on Sustainable Development: Resolution adopted by the General Assembly, 21 February 2003, A/RES/57/253; See: http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/WSSD_PlanImpl.pdf

37 United Nations, The Millennium Development Goals Report 2013, available at: http://www.un.org/millenniumgoals/pdf/report-2013/mdg-report-2013-english.pdf

38 See JD Sachs, *The Age of Sustainable Development* (Columbia University Press, 2015)

Helsinki Convention) [39] and the North-East Atlantic (the Paris Convention).[40] These were both updated in 1992.[41] Specific protocols concerning land-based sources of marine pollution under Regional Sea conventions are now in place in the Mediterranean (1980 Athens Protocol),[42] the South East Pacific (1983 Quito Protocol),[43] the Arabian Gulf (1990 Kuwait Protocol),[44] the Black Sea (1992 Bucharest Protocol),[45] the Red Sea and Gulf of Aden (2005 Jeddah Protocol),[46] and the Western Indian Ocean (2010 Nairobi Protocol) (Annex 2).[47]The respective regional conventions and protocols adopt similar definitions of land-based sources of marine pollution but vary in relation to waste disposal to or under the seabed by tunnel or pipeline. Black-listed substances are set out in respective annexes. These frequently include heavy metals such as cadmium and mercury, persistent organic pollutants (POPs), and radioactive substances. The discharge or release of grey-listed substances is subject to authorization by the coastal State. Authorization to release grey-listed pollutants may be influenced by the characteristics and composition of the substance in question, any impacts on the receiving environment, and the availability of alternative disposal methods.

3.3 Other initiatives

Beyond the GPA and regional seas programmes, there are a few instruments and initiatives that aim to fight and reduce land-based pollution. This include multilateral agreements that are not specifically focused on the marine environment, such as the 1989 Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention),[48] the 1998 Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam Convention),[49] the 2001 Convention on Persistent Organic Pollutants (Stockholm Convention)[50] and the Minamata Convention on Mercury.[51] Also relevant to the network of legal instruments affecting land-based sources of marine pollution are multilateral instruments targeting atmospheric pollutants. Examples include the 1979 Convention on Long-range Transboundary Air Pollution (LRTAP)[52] in Europe, initially negotiated in response to concerns regarding acid rain, and the 1992 United Nations Framework Convention on Climate Change (UNFCCC).[53]

Multilateral and bilateral donors also play an important role in the fight against land-based pollution, financing projects and initiatives aimed at reducing pollution and managing waste. In February 2024 for instance, the Global Environment Facility (GEF), under its GEF-8 funding round, approved the *Clean and Healthy Oceans Integrated Programme*, providing $112m of GEF resources and $748m of indicative co-funding to address the combined effects of climate change and excessive nutrient loads that create marine hypoxic zones. The programme seeks to curb coastal pollution from agriculture, industrial and municipal sources through policy and regulatory measures and infrastructure investments combined with nature-based solutions. In the programme documentation, the GEF states that "transformational change will be supported by the establishment and strengthening of knowledge management, policy, investment, and best management practice tools required to address coastal marine hypoxia. The programme will help to prevent new marine hypoxic zones, halt further oxygen depletion in current hypoxic zones, and promote innovations to assist countries restore hypoxia degraded ecosystems".

39 Convention on the Protection of the Marine Environment of the Baltic Sea (adopted 22 March 1974, entered into force 3 May 1980), as replaced with the Convention for the Protection of the Marine Environment of the Baltic Sea, opened for signature 9 April 1992, entered into force 17 January 2000, 1507 UNTS 167.

40 Convention for the Prevention of Marine Pollution from Land-based Sources (adopted 4 June 1974, entered into force 29 September 1989).

41 The Paris Convention of 1974 was adopted to supplement the Oslo Convention of 1972 which dealt with dumping at sea. These two conventions were unified, updated and extended in 1992 by the merged Convention for the Protection of the Environment of the North-East Atlantic, adopted 22 September, entered into force 25 March 1998, 2354 UNTS 70 (generally referred to as the OPSAR Convention).

42 Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources, adopted 17 May 1980, entered into force 17 June 1983, available at: http://www.ecolex.org/server2.php/libcat/docs/TRE/Full/En/TRE-000544.txt

43 Protocol for the Protection of the South-East Pacific against Pollution form Land-based Sources, adopted 23 July 1983, entered into force 21 September 1986, available at: http://cpps-int.org/cpps-docs/pda/biblioteca/convenios/prot_fuentes_terrestres.pdf (Spanish), or: http://www.ecolex.org/server2.php/libcat/docs/TRE/Full/En/TRE-000768.txt (English)

44 Protocol to the Kuwait Regional Convention for the Protection of the Marine Environment Against Pollution from Land-Based Sources, adopted 21 February 1990, entered in force 2 January 1993, available at: http://ropme.org/uploads/protocols/land_based_protocol.pdf

45 Protocol on the Protection of the Marine Environment of the Black Sea from Land-Based Sources and Activities, adopted 7 April 2009, entry into force pending, available at: http://www.ecolex.org/server2.php/libcat/docs/TRE/Full/En/TRE-154598.pdf

46 Protocol Concerning the Protection of the Marine Environment from Land-Based Activities in the Red Sea and Gulf of Aden, adopted 25 September 2005, entry into force pending, available at: http://www.persga.org/inner.php?id=62

47 Protocol for the Protection of the Marine and Coastal Environment of the Western Indian Ocean from Land-Based Sources and Activities, adopted 31 March 2010, entry into force pending, available at: http://www.ecolex.org/server2.php/libcat/docs/TRE/Full/En/TRE-157174.pdf

48 Adopted 22 March 1989, entered into force 5 May 1992, (1989)28 *International Legal Materials* 657.

49 Adopted 11 September 1998, entered into force 24 February 2004 (1999) 38 *International Legal Materials* 1.

50 Adopted 22 May 2001, entered into force 17 May 2004, (2001) 40 *International Legal Materials* 532.

51 Adopted 10 October 2013, not yet in force. The text of the convention is available at http://www.mercuryconvention.org/Convention/tabid/3426/Default.aspx.

52 Adopted 13 November 1979, entered into force 16 March 1983 (1979) 18 *International Legal Materials* 1442.

53 Adopted 9 May 1992, entered into force 24 March 1994, (1992) 31 *International Legal Materials* 849.

4. LOCAL SUCCESS BUT NO TRANSFORMATIVE CHANGES

The efforts of governments, donors, industry, civil society and local communities to address marine pollution can generate success,[54] however more often than not, such success requires a long-term commitment and sustained investment. In the case of Chesapeake Bay,[55] one of North America's largest estuaries, efforts to reduce nutrient loads entering the bay have taken decades. The River Input Monitoring (RIM) system, established in the 1980s, comprises a network of water quality monitoring stations strategically positioned along riverine systems. This system has enabled the quantification of nitrogen levels and loads directly transported to the Bay from major tributaries.[56] The data from the RIM has been important in setting policies and improving policy actions.

Similarly, the European Union's Marine Strategy Framework Directive (MSFD) requires EU Member States to report the environmental status of their marine waters–with Good Environmental Status (GES) being an indication of reduced pollution or negative impact. The most recent assessments reveal that dissolved inorganic nitrogen (DIN) has shown decreasing trends mostly in the Baltic according to time series data between 1980 and 2021.

The need for long-term commitments however does not mean that rapid results cannot be achieved. For example, Indonesia faces significant challenges with plastic pollution. As the world's fourth most populous country and the second-largest plastic polluter, it generates a staggering 3.2 million tonnes of plastic waste annually, with approximately 1.29 million tonnes finding its way into the sea[57]. While plastic makes up 10.6% of the total waste generated nationwide, only about 7% of plastic waste is recycled. It was estimated in 2018 that plastic waste leakage from Indonesia into the ocean reached between 0.27 to 0.59 million tonnes per year, making the country contribute about 10% to global marine plastic in the ocean.[58] However, to its credit, Indonesia has been able to make significant trends in

TABLE 1. Challenges in the fight against land-based pollution

Political inattention	As long as it does not lead to major ecological disasters or health problems for coastal populations, marine pollution does not receive the attention it needs from decision-makers at national and local levels.
Subsidies harmful activities	A lot of money is spent every year on land-based pollution control, but even more money is given to activities that have a negative impact on the marine environment.
Funding	Donors have increasingly directed funding towards individual pollutant source categories, e.g. plastics, at the expense of holistic programmes addressing the cumulative impacts of coastal and marine pollution.
Knowledge/ technology transfer	The policy, technical and social solutions to many coastal pollution challenges are frequently location-specific and are not easily transferable. International cooperation is required to extract the key elements of success and to support governments tailor those elements to their own particular circumstances.
Cost-effectiveness	Many solutions to coastal pollution have involved large and expensive infrastructure projects, e.g. municipal wastewater treatment facilities, that are not always feasible in many developing countries. Increased support is needed for nature-based solutions, e.g. coastal wetlands.
Lack of guidelines	User friendly flexible guidelines are required to support both national and sub-national governments implement multilateral commitments, e.g. regional protocols and EU Framework Directive.
Broad-brush MEAs	There is frequently a large gap between the language of global or regional MEAs, and the locally-specific challenges faced by municipal authorities, industry or agricultural districts. At the local scale, global MEAs may be irrelevant, or lack the necessary triggers to support real change. The consensus nature of multilateralism means that pollution hotspots are rarely identified, and solution remain broad in their application.
Use of indicators	The plethora of performance indicators and reporting frameworks imposed on governments by multilateral instruments is increasingly a burden for many governments. There exists a need to rethink indicators, including aligning/ streamlining regional and global indicators.
Reporting requirements	There is a lack of alignment between reporting requirements for many global issues, e.g. sustainable production and consumption, sustainable development, biodiversity.
Capacities	There exists a need to significantly upscale the training of policy officers and local practitioners in methods and approaches to reducing coastal pollution
GPA Secretariat	Adequate funding is no longer available for a dedicated GPA Secretariat within UNEP to support the implementation of the GPA.
Transboundary river management	Rivers are major vectors for pollution to coastal ecosystems. However, transboundary river management is highly complex and, in some instances, politically challenging.
Mitigation and restoration	Multilateral efforts to address coastal pollution, either holistically or for individual pollutant source categories, should focus on clean-up/ecosystem restoration as much as on reducing new pollution entering the system.

54 See, for example, T Ko and Y Chang, 'Integrated marine pollution management: A new model of marine pollution prevention and control in Kaohsiung, Taiwan' (2010) 53 *Ocean and Coastal Management* 624; and PD Jones, 'Water quality and fisheries in the Mersey estuary, England: A historical perspective' (2006) 53 *Marine Pollution Bulletin* 144.

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56 Clune, J. W., Capel, P. D., Miller, M. P., Burns, D. A., Sekellick, A. J., Claggett, P. R., Coupe, R. H., Fanelli, R. M., Garcia, A. M., Raffensperger, J. P., Terziotti, S., Bhatt, G., Blomquist, J. D., Hopkins, K. G., Keisman, J. L., Linker, L. C., Shenk, G. W., Smith, R. A., Soroka, A. M., … Zhang, Q. (2021). Nitrogen in the Chesapeake Bay watershed—A century of change, 1950–2050. In *Circular* (1486). U.S. Geological Survey. https://doi.org/10.3133/cir1486

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its marine plastic debris management since 2017 with about 15% and 35% decrease in marine plastic pollution levels in 2020 and 2022, respectively.

Notwithstanding numerous localized success stories, the world's ocean and seas continue to be under the severe threat of pollution. Much has been learned through trial and error regarding domestic implementation,[59] however the marine environment continues to receive unacceptable levels of pollutants from land-based activities via subterranean, riverine and atmospheric vectors. Table 1 summarises the main challenges faced by stakeholders, at different levels.

5. CONCLUSION AND RECOMMENDATIONS

In the 1970s, oil pollution from ships and land-based pollution were considered the two main threats to the ocean. Thanks to a number of factors, including increasingly strict regulation of the shipping sector, pollution from ships is no longer a major problem, and international declarations on ocean no longer emphasize it. However, the same cannot be said for land-based pollution, which remains a significant challenge for the health of the ocean and its inhabitants. Notwithstanding a labyrinth of national, regional and international instruments devoted to the prevention of individual categories of coastal and marine pollution, the overall results, in terms of environmental improvement, are mixed. Some sources of pollution, such as agricultural discharges and urban wastewater, have not been significantly reduced. Moreover, in the absence of a holistic approach, the cumulative impact of pollutants–the "cocktail effect"–is barely addressed by policies: solving one pollution source category does not necessarily mean the marine environment is free from pollution. On a global scale the degradation of coastal and marine ecosystems has therefore continued and in many places has intensified.

Yet, high-level declarations on the state of the ocean, as well as some recent intergovernmental agreements, place the issue at the heart of priorities. The declaration adopted in 2022 in Lisbon following the second UN Ocean Conference highlights the need for a "*precautionary approach and ecosystem-based approaches*" and commits States to prevent, reduce and control "marine pollution of all kinds, *from both land- and sea-based sources, including nutrient pollution, untreated wastewater, solid waste discharges, hazardous substances, emissions from the maritime sector, including shipping, pollution from ship wrecks and anthropogenic underwater noise, through improving our understanding of their sources, pathways and impacts on marine ecosystems, and through contributing to comprehensive life-cycle and source-to-sea approaches that include improved waste management*".[60] In the same way, the 2022 Kunming-Montreal Global Biodiversity Framework (GBF) includes targets that are particularly relevant for land-based pollution, such as Target 7 that commits States to: "*reduce pollution risks and the negative impact of pollution from all sources by 2030, to levels that are not harmful to biodiversity and ecosystem functions and services, considering cumulative effects, including: (a) by reducing excess nutrients lost to the environment by at least half, including through more efficient nutrient cycling and use; (b) by reducing the overall risk from pesticides and highly hazardous chemicals by at least half, including through integrated pest management, based on science, taking into account food security and livelihoods; and (c) by preventing, reducing, and working towards eliminating plastic pollution*".[61] However, these high-level declarations and instruments have not yet been put into effect. The recent downgrading of the GPA, along with the ongoing subsidization of activities that impact the ocean, significantly hampers efforts and impedes the scaling-up of successful initiatives.

In 2025, the international community will commemorate the 30th anniversary of the Washington Declaration and the inception of the GPA. This significant milestone coincides with the organization of the 3rd United Nations Ocean Conference, scheduled to convene in Nice (France). This juncture offers a timely opportunity for the global community to initiate a new phase in combating land-based pollution. To this end, governments should:

1. Review how the existing international institutional infrastructure e.g. the GPA and the respective Regional Seas protocols and action plans, can be better supported to facilitate and accelerate coordinated responses to the cumulative effects of all forms of coastal pollution, even in the absence of complete scientific understanding of those cumulative effects, i.e. applying precautionary approach.

2. Initiate and implement sustained ecosystem-based initiatives that address the cumulative impacts of coastal pollution using ecosystem-based approaches. In this context, governments could:

a. Launch a coalition of like-minded countries wishing to reinvigorate, support and/or create new global and/or regional mechanisms that address coastal pollution through integrated coastal zone and river-basin management, i.e. ecosystem-based approaches to coastal pollution;

b. Empower local and municipal authorities to regulate coastal pollution in all forms, while also providing adequate funding and expertise for improved wastewater/industrial effluent management and to restore riparian zones/coastal wetlands; and

c. Encourage, support and connect community-based initiatives, such as beach, harbor and lagoon clean-ups.

59 See, for example, S Tuan Vo, J Pernetta and C Paterson, 'Lessons learned in coastal habitat and land-based pollution management in the South China Sea' (2013) 85 *Ocean and Coastal Management* 230; J Brodie et al., 'Terrestrial pollutant runoff to the Great Barrier Reef: An update of issues, priorities and management responses' (2012) 65 *Marine Pollution Bulletin* 81; SJ Metcalf, 'Identifying key dynamics and ideal governance structures for successful ecological management' (2014) 37 *Environmental Science and Policy* 34.

60 Our ocean, our future, our responsibility, §13.

61

3. Invest in ecosystem-based approaches that build the resilience of coastal communities to the combined threats of pollution, climate change and loss of biodiversity.

4. Increase funding for global and regional scale collaboration on coastal pollution, e.g. UNEP's Source to Sea programme, with a particular focus on information management, mutual learning and knowledge sharing, reporting and capacity building.

5. Accelerate the implementation of the 2022 Kunming-Montreal Global Biodiversity Framework, with a specific attention to Target 7 (pollution) and 18 (harmful incentives and subsidies).

ANNEX 1. MAIN CATEGORIES OF LAND-BASED SOURCES OF MARINE POLLUTION

Marine litter

Marine litter encompasses any persistent, manufactured, or processed solid material discarded into marine ecosystems often transported indirectly via rivers, wastewater, or winds (UNEP, n.d.). While marine litter can come from the sea approximately 80% of marine litter is from LBS and this can go up to 90% if we consider plastic. Prevailing literature views land-based marine litter from a plastic lens with past analyses showing that plastic debris in rivers correlates positively with mismanaged plastic waste (MMPW) (Lebreton *et al.*, 2017). Due to poor solid waste management, riverine transportation is the main source of LBS– since Schmidt *et. al*. (2017) estimated that the 10 most polluted rivers account for 88-95% of the up to 4 million tonnes of global riverine plastic load per year. Meijer *et al.* (2021) also pointed out that small urban rivers can be more polluting than previous literature estimated. More work, however, is needed to show the extent to which marine litter transportation is influenced by different riverine ecosystems, geographic locations, population characteristics, economic systems and the diversity in global climatological differences (Meijer *et al.*, 2021).

Wastewater

Wastewater serves as a crucial conduit for a myriad of solid, dissolved, or liquid pollutants that find their way into marine environments. Despite global advancements in wastewater treatment rates, with approximately 58% of domestic wastewater treated (according to the latest data on the SDG 6 progress website) and 55.5% (according to WHO using 2020 data), developing regions like Sub-Saharan Africa still face significant challenges in adequately managing untreated wastewater disposal (Indicator | SDG 6 Data, n.d.). In terms of leading pollutants from wastewater, industrial inputs, mostly from agriculture, continue to be a major talking point in nutrient literature. Tuholske *et al.* (2021), found that wastewater contributes about 40% of total nitrogen inputs from land-based agricultural activities, primarily due to inadequate sewer systems. However, limited attention has been given to non-nutrient pollutants in wastewater, such as heavy metals, pharmaceuticals and emerging contaminants (ECs). Efforts to mitigate their entry into marine areas hinge not only on treatment methods but also on understanding the physical and chemical properties of the pollutants (Freeman et al., 2020; Massima Mouele *et al.*, 2021).

Nutrient inputs

Despite efforts on wastewater treatment, nutrient inputs to inland riverine systems have doubled over the 20th century (Beusen *et al.*, 2016). For nitrogen (N), inputs into the ocean have increased with fairly the same factor with a simulation on yearly riverine N inputs to the ocean finding an increase from 17 Tg/year from the preindustrial era to 37.6 Tg/year in the 21st century (Yamamoto *et al.*, 2022). Currently, anthropogenic nitrogen inputs into the global ecosystem exceed the anticipated planetary threshold, and natural nitrogen fixation in the ocean (Bhuiyan *et al.*, 2024). Just as well, 80% of phosphorus (P) supplied by rivers end up reaching the ocean with most of the remaining 20% being used up in coastal areas (Sharples *et al.*, 2017). Nevertheless, clear global trends linked to human land use, such as increasing synthetic fertiliser use in developing countries, have been identified, emphasising the importance of studying how changes in land use and other human activities will impact nutrient inputs in the future.

Persistent organic pollutants

Persistent organic pollutants (POPs) encompass a diverse array of long-lasting substances, frequently halogenated, that persist in the environment. POPs can be found in areas remote from their sources, such as the Poles, particularly due to atmospheric processes (AMAP, 2021; Xie *et al.*, 2022). They predominantly originate from human activities, with notable sources being petrogenic (oil seepage), pyrogenic (burning of fossil fuels), and agricultural sources (the primary source for organic pesticides) (Dasgupta *et al.*, 2018). Recent studies have highlighted that younger deep waters tend to accumulate higher levels of fluorinated POPs (Sanganyado *et al.*, 2021), while microplastics could play a significant role in transporting dispersed POPs into deep-sea environments (Gateuille & Naffrechoux, 2022). Significant progress has been made in terms of reducing the concentration of POPs in marine environments thanks to the Stockholm Convention.

Pharmaceuticals and personal care products

Pharmaceuticals and personal care products' (PPCPs) concentrations have increased in marine environments. The presence of PPCPs in marine environments is closely associated with inefficient wastewater treatment, population growth, urbanisation, industrial activities, pharmaceutical needs and lifestyle changes (Massima Mouele *et al.*, 2021; Ojemaye & Petrik, 2022; Samal *et al.*, 2022). For instance, the growth of awareness on the importance of photosensitive protection, has led to increased UV filter chemicals being detected in significant concentrations (Cadena-Aizaga *et al.*, 2020, 2022). Changing pharmaceutical and personal care needs in developing countries' coastal areas has also led to the proliferation of agents such as diclofenac (Ojemaye & Petrik, 2022). Focus on recent PPCPs has brought more attention to chemicals of emerging concern. With an increasing mental health crisis, antidepressant agents have been registered in Norwegian fjords from wastewater treatment facilities (Magnuson *et al.*, 2022).

Heavy metals

Since the implementation of the Stockholm Convention, heavy metals have been effectively regulated. However, heavy metal-dependent land-based industries such as textiles, cement plants and ship recycling have expanded, impacting approximately 40% of the world's seas (Taslima *et al.*, 2022). For instance, mercury levels in the Persian Gulf have increased to levels higher than what they were in the 1980s (Al-Ansari *et al.*, 2017). Recent studies indicate that legacy metals persist in specific environments and higher trophic levels (Al-Sulaiti *et al.*, 2022, 2023; Basu *et al.*, 2022). The polar regions, for instance, have experienced rising metal concentrations in polar bears. This trend is likely attributed to permafrost thawing that releases legacy metals (AMAP, 2021; Basu *et al.*, 2022; Dodino *et al.*, 2022; Miner *et al.*, 2021). Additionally, studies have identified an age disparity between organisms in higher trophic levels, with older ones exhibiting higher concentrations of metals (Rokni *et al.*, 2023).

ANNEX 2. REGIONAL SEAS PROGRAMMES' INITIATIVES ON LAND-BASED POLLUTION

REGIONAL FRAMEWORK	LBS PROTOCOL	OTHER DEDICATED INITIATIVES
UNEP Administered		
Mediterranean | Mediterranean Action Plan | Convention for the Protection of the Mediterranean Sea Against Pollution or Barcelona Convention (Barcelona Convention)	Yes; adopted in 1980 and amended in 1996 The Protocol for the Protection of the Mediterranean Sea Against Pollution from Land-Based Sources	Marine Litter MED II is endowed with a budget of US$1,28 million. It is executed for a duration of 36 months by the UNEP/MAP-Barcelona Convention Secretariat and MAP Components.
Caribbean | Caribbean Environment Programme | The Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (WCR) (Cartagena Convention)	Yes; adopted in 1999. LBS Protocol Text	The Caribbean Node of the Global Partnership on Marine Litter and Plastic Pollution (GPML-Caribe) represents a partnership for national and regional organisations, governments, research, and technical agencies and individuals.
Caspian Sea | Tehran Convention	Yes, adopted in 2012 and amended in 2023. Moscow Protocol	There was a regional project on marine litter aiming to create a robust network aimed at tackling marine litter and fostering collaboration among relevant stakeholders and to formulate a comprehensive Caspian Marine Litter Action Plan, which will focus on preventing and minimising marine litter pollution in the Caspian Sea.
Eastern Africa region | The Nairobi Convention	Yes; adopted in 2010. LBS Protocol text.	2016 to 2021 WIOSAP project | strived to reduce land-based stresses by protecting critical habitats, improving water quality, and managing river flows.
Eastern Asian Seas | Coordinating Body on the Seas of East Asia | Coordinating Body on the Seas of East Asia (COBSEA)	Not yet but has 2 strategic frameworks that can impact LBS: COBSEA Strategic Directions 2018-2022, adopted in 2018, with a focus on addressing land-based marine pollution. COBSEA Regional Action Plan on Marine Litter (RAP MALI), adopted in 2008 and revised in 2019, identifies common priorities and provides a regional framework for cooperation in tackling marine litter.	
Northwest Pacific | The Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region (NOWPAP)	No protocol but there is an action plan on marine litter (NOWPAP Regional Action Plan on Marine Litter) launched in 2008	
West and Central Africa |The Convention for Cooperation in the Protection, Management and Development of the Marine and Coastal Environment of the Atlantic Coast of the West and Central Africa Region (Abidjan Convention)	Yes; adopted in 2012 Protocol concerning the Cooperation in the Protection and Development of the Marine and Coastal Environment from Land-Based Sources and the Activities (LBSA) in the Western, Central and Southern Africa Region	

Non-UNEP Administered		
Regional Organization for the Protection of the Marine Environment (ROPME)	Yes, adopted in 1990	Monitoring of land based sources - One of the main elements of the Kuwait Action Plan is the periodical assessment of the state of the marine and coastal environment of the ROPME Sea Area (RSA), of the trends in the quality of the environment, of the sources of its degradation and the impacts of the degradation on human health, ecosystems and amenities.
South-East Pacific | Permanent Commission of South Pacific | 'Convention for the Protection of the Marine Environment and Coastal Areas in the South-East Pacific' (Lima Convention)	Yes, adopted in 1983 Protocol for the Protection of the Southeast Pacific against Pollution from Land Sources (1983)	
Red Sea and Gulf of Aden | The Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA) or Jeddah Convention	Yes, adopted in 2005 Protocol Concerning the Protection of the Marine Environment from Land-Based Activities in the Red Sea and Gulf of Aden (2005)	
Pacific | Pacific Regional Environment Programme (SPREP)	No	Among other key achievements, US$17 million has been secured to address land- and vessel-based pollution
Black Sea | Convention on the Protection of the Black Sea Against Pollution (Bucharest Convention)	Yes adopted in 1992	
South Asian Seas | South Asia Co-operative Environment Programme (SACEP) (Colombo Declaration)	No	Recognizes land pollution as transboundary and has prepared a framework for marine litter management in South Asia Ongoing 2020 project with a five-year funding strategy that looks to reduce riverine plastic inputs into the marine environment There is a regional action plan to prevent plastic inputs specifically for the Indian Ocean
North-East Pacific | North East Pacific Regional Seas Programme | Convention for Cooperation in the Protection and Sustainable Development of the Marine and Coastal Environment of the North-East Pacific (The Antigua Convention)	No but the convention (adopted in 2002) includes an action plan on combating pollution from sewage and other pollutants (land-based sources only mentioned in Article 3 and Article 6 of the Convention)	
Independent		
Baltic Sea | Baltic Marine Environment Protection Commission	No, but the Helsinki Convention adopted in 1974 and latest amendment entering into force in 2014	Article 6 of the Convention details the Principles and obligations concerning pollution from land-based sources
North East Atlantic | OSPAR Commission	Yes, Adopted in 1992 Annex I: Prevention and elimination of pollution from land-based sources; https://www.ospar.org/convention	The implementation of the Eutrophication Strategy operates within the context of existing obligations and commitments of Contracting Parties. I.e., EU legislation aimed at reducing nutrient discharges – Nitrates Directive and Urban Waste Water Treatment Directive
Antarctic | Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)	No	
Arctic | Protection of Arctic Marine Environment (PAME)	No	Regional Action Plan on Marine Litter in the Arctic - Will address both sea and land-based activities, focusing on Arctic-specific marine litter sources

ANNEX 3. RELEVANT FINDINGS FROM THE 2ND WORLD OCEAN ASSESSMENT REGARDING COASTAL POLLUTION

The lack of appropriate wastewater treatment and the release of pollutants from the manufacturing industry, agriculture, tourism, fisheries and shipping continue to put pressure on the ocean, with a negative impact on food security, food safety and marine biodiversity. Marine litter, ranging from nanomaterials to macromaterials, is a further problem, given that, in addition to the damage caused by its presence, it can also carry pollutants and non-indigenous species over long distances.

Concentrations of some pollutants (such as persistent organic pollutants and metals) in some regions are declining, but information on concentrations is not spatially uniform. Knowledge gaps remain with regard to not only recognized but also emerging pollutants. In several regions, capacity gaps remain in applying consistent, coherent policies and related enforcement to prevent and control inputs of pollutants into the ocean.Anthropogenic inputs of nitrogen and phosphorus into coastal ecosystems from direct discharges, land run-off, rivers and the atmosphere have generally continued to rise, even though better control of their release is reducing inputs into some bodies of water. Owing to excessive inputs of such nutrients, eutrophication is an increasing problem, and the number of hypoxic zones (sometimes called "dead zones") has increased from more than 400 globally in 2008 to approximately 700 in 2019. The ecosystems most affected include the northern part of the Gulf of Mexico, the Baltic Sea, the North Sea, the Bay of Bengal, the South China Sea and the East China Sea. It is estimated that coastal anthropogenic nitrogen inputs will double during the first half of the twenty-first century. In addition, deoxygenation is projected to worsen through increases in ocean temperatures and changes in stratification and ocean currents driven by climate change, in particular in coastal regions of Africa, South America, South and South-East Asia and Oceania.

Industrial development and the intensity of agriculture have continued to increase, resulting in both ongoing and new inputs of hazardous substances into the ocean. New types of input include pharmaceuticals, personal care products and nanomaterials that cannot be removed by wastewater treatment in many parts of the world. The detection of pharmaceuticals and personal care products is increasing across the ocean, including in the Arctic Ocean and the Southern Ocean. A number of such products have been observed to cause harm to plants and animals, but the scale of the impact on marine organisms is unknown, largely because they are generally not monitored.

Although the Stockholm Convention on Persistent Organic Pollutants has generally had a positive effect on global concentrations, persistent organic pollutants continue to be detected in marine areas and in marine species far from their sources of production and use. Even low concentrations have been shown to reduce reproductive success in marine species, including Arctic seals. In most ocean regions, information on trends is lacking.

The Minamata Convention on Mercury has generally reduced global mercury concentrations, with evidence, in most regions, that mercury concentrations in the ocean are levelling off. However, a slight increase in concentrations of some metals in higher trophic organisms has been reported. To better assess metal concentration trends, expanded coastal time-series analyses are needed globally, including of levels of metal nanomaterials in the ocean.

Concentrations of most radioactive substances continue to decrease through the decay of historical inputs. There have been no major nuclear accidents since 2011, and discharges from nuclear reprocessing plants in Europe continue to decrease substantially. Smaller amounts of radionuclides continue to be released by nuclear power reactors in 30 countries.

Inputs of solid waste into the ocean (including marine litter) from unintentional releases and the intentional dumping of waste are largely unquantified around the world. Plastics represent up to 80% of marine litter, with annual inputs into the ocean from rivers estimated at 1.15–2.41 million tonnes. The presence of plastics has been recorded in more than 1,400 marine species.

Osborn, D., Rochette, J. (2024). Launching a new phase in the fight against land-based sources of marine pollution. *Note*, IDDRI.

The Oceano Azul Foundation is an international organization that contributes to protecting and conserving the ocean, integrating key areas such as Ocean Conservation, International Ocean Advocacy and Ocean Policies, Frameworks and Economics. The Foundation also promotes raising awareness, involving, and educating society in order to influence a change in behaviour.

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