Towards a Pollution-Free Planet

Report of the Executive Director
United Nations Environment Programme

Advance Copy (long version)

UN environment assembly

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This advance version of the report "Towards a Pollution-Free Planet" by the Executive Director of the UN Environment Programme is meant to support the preparations for the third session of the UN Environment Assembly. This is not for quotation or citation at this point. Comments to the secretariat are welcome by 14 July. A shorter version of this paper targeting policy makers will be prepared and provided in September.

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Executive Summary

Pollution today is pervasive and persistent. While the world has achieved impressive economic growth over the past few decades, this progress has been accompanied by increased pollution. As populations grow and more people escape poverty and aspire to improved consumption, the linear economic model of "take-make-dispose" is burdening an already polluted planet.

Pollution is clearly not a new phenomenon, and is largely controllable and often avoidable. Many stories exist of countries, cities, and businesses that have addressed serious air, soil, freshwater and marine pollution issues. Adequate knowledge and technological solutions exist to both treat, control and avoid pollution. Encouragingly, more and more governments, industries and citizens are moving towards a sustainable materials and circular economy, with greater resource efficiency, sustainable chemistry and clean technologies, as part of a transition towards a green economy. Differences in capacity and development to tackle pollution adequately worldwide, however, are still huge. As the number of success stories of preventing, reducing and better managing pollution increase, identifying systemic approaches, steps and interventions to transition towards a pollution-free planet is achievable.

"Towards a pollution-free planet" is an aspirational goal, seeking actions to eliminate anthropogenic pollution that degrades ecosystems, harms human health and well-being, and impacts the functioning of all living species. Achieving the 2030 Agenda for Sustainable Development, including its numerous pollution-reducing targets, is a crucial milestone on the path towards a pollution-free planet. Transitioning to a pollution-free world can drive innovations in the economy through seeing pollution regulation compliance as an opportunity to clean the environment, but also create new job opportunities and improve economic productivity. It would be the best insurance policy for future generations as it would improve the ecosystem integrity that they need for survival.

The severity of pollution is based on its chemical nature, concentration, presence and persistence. Some types of pollution are easily noticed, such as contaminated water, poor air quality, industrial waste, litter and light, heat and noise. Others are less visible, for example the presence of pesticides in food, nutrients in the sea and lakes, and endocrine disrupting chemicals in drinking water, personal care products and cleaning solutions. Some, such as those coming from abandoned industrial and mines sites, armed conflict, nuclear power stations, and waste landfill form part of a longer-term legacy. And some others are totally intangible such as those causing the depletion of the ozone layer.

The sources and types of pollution are highly diverse as are the solutions for dealing with them. **Pollution can have particularly disproportionate and negative impacts on the poor**

and the vulnerable such as children and the elderly. Consequently, it constitutes a serious impediment to achieving the objective of the 2030 Agenda for Sustainable Development of "leaving no one behind".

This Report is a call for action towards a pollution-free planet for all. It looks at the evidence, current responses and gaps surrounding these issues, and the opportunity that the 2030 Agenda presents to accelerate action on tackling pollution. It suggests a framework for action for the near, medium and long term for a transition towards a pollution-free planet.

Table I: Global costs of pollution

POLLUTION	COSTS (2015 BILLION US$)	% OF GROSS DOMESTIC PRODUCT	SOURCE
Greenhouse gas emissions	4,987	6.7	United Nations Environment Programme and Principles for Responsible Investment Association (2010). Universal Ownership: Why Environmental Externalities Matter to Institutional Investors.
Indoor and outdoor air pollution	5,322	7.2	Organisation for Economic Co-operation and Development (2016). The Economic Consequences of Outdoor Air Pollution. Paris: OECD Publishing. World Bank and Institute for Health Metrics and Evaluation (2016). The Cost of Air Pollution: Strengthening the Economic Case for Action. Washington, DC.
Chemicals (volatile organic compounds, lead, mercury)	480	0.4	United Nations Environment Programme and Principles for Responsible Investment Association (2010). Universal Ownership: Why Environmental Externalities Matter to Institutional Investors.
General waste	216	0.3	United Nations Environment Programme and Principles for Responsible Investment Association (2010). Universal Ownership: Why Environmental Externalities Matter to Institutional Investors.

Note: Please see Annex 2 for more details on assumptions, methods and sources

Figure1 summarizes the impacts on human health and ecosystems as of 2015.

Figure 1: examples of impacts of pollution on human health and well-being and ecosystems[1,2]

air pollution	6.5 million people die annually as a result of to poor air quality including 4.3 million due to household air pollution Lower respiratory infections: 51 million years lost or lived with disability annually due to household or ambient air pollution Chronic obstructive pulmonary diseases: 32 million years life lost or lived each year with disability because of household air pollution and workers' exposure
freshwater pollution	58 per cent of the cases of diarrheal disease due to lack of access to clean water and sanitation 57 million years of life lost or lived with disability annually due to poor water, sanitation, hygiene
land/soil pollution	Open waste dumps and burning impacts lives, health and livelihoods and affect soil chemistry and nutrition Health impacts of chronic exposure to pesticides for men, women and children Salinization of land and ground water affects health, especially of pregnant women and infants
marine and coastal pollution	3.5 billion people depend on oceans for source of food yet oceans are used as waste and waste water dumps Close to 500 'dead zones', regions that have too little oxygen to support marine organisms, including commercial species Plastics (75% of marine litter) transport persistent bio accumulative and toxic substances to all parts of the world
chemicals	Over 100,000 die annually from exposure to asbestos Lead in paint affects children's intelligence quotient (IQ) Many impacts of chemicals such as endocrine disruptors and developmental neurotoxicants and long-term exposure to pesticides on human health and well-being and biodiversity and ecosystems are still to be fully assessed
waste	50 biggest active dump sites affect the lives of 64 million people, including their health and loss of lives and property when collapses occur; 2 billion people are without access to solid waste management and 3 billion lack access to controlled waste disposal facilities

Responses to pollution exist, but they are still too limited in scope and scale. Global and regional environmental agreements provide a framework for time bound actions, while some also include compliance-related actions, monitoring and reporting. Most countries have adopted national policy and legal frameworks to respond to these agreements but also to address some of the other pollution issues. Voluntary initiatives and global alliances, such as in the case of fuel efficiency improvements and cleaner air, have helped to push forward improved and faster actions. Some have also underlined the **multiple benefits to improved health, productivity, and ecosystems, and achieving the Sustainable Development Goals**. While many businesses have responded to global frameworks and risen to the challenges, much more needs to be done.

Challenges and gaps limit the effectiveness of actions. These centre on availability of data and information, existing infrastructure, institutional and technical capacity, business and industry leadership, mispricing and invisibility of ecosystem values, and consumer behaviours. Strengthened environmental governance in relation to pollution requires greater multi-level and multi-actor coordination, policy innovation, coherence and integration. However, the nature of pollution suggests that responses need to go beyond governance, and tackle head-on the choices we make about how we produce and consume.

A significant opportunity to achieve an accelerated outcome exists within the 2030 Agenda for Sustainable Development. The 2030 Agenda provides an opportunity to both accelerate pollution action, but also through actions on pollution to achieve other Sustainable Development Goals. One target in particular stands out: Target 3.9 (under Goal 3 on health and well-being) commits to "substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination". Global actions towards this goal have to be: targeted and systemic; preventive and curative; near and longer term; innovative and forward-looking. The actions will need champions from policymaking, non-governmental organizations, research communities, individuals and business. It will also require interministerial coordination, integration across sectors and multi-governmental levels, as well as engagement from all parts of society.

The framework proposed comprises principles, targeted interventions to address the hard hitting pollutants through multilateral as well as national actions to address pollution risks, plus a range of system-wide transformations and enablers associated with a move towards a greener, circular, more resource efficient economy.

The five principles which underpin the framework are **universality, sustainability, integration, precaution** and **inclusiveness.** Irrespective of the voluntary commitments and confirmed actions stakeholders may take, and the urgency and ambition with which they choose to take them, the five normative principles imply that all interventions for action on pollution should consider that:

(i) Everyone in society is responsible for moving towards a pollution-free planet;
(ii) Access to environmental information and data, education and public participation are key to effective actions and enhanced access to justice in environmental matters;
(iii) Multiple risks to human health and well-being, especially to women, children and vulnerable groups, and to ecosystem health require a preventive approach;
(iv) Innovation and leadership are central to tackling pollution in an effective and impactful manner;
(v) Multiple benefits of action on pollution need to be recognized, policy uncertainty reduced, and innovation placed at the centre. This will require a 'whole-of-government' approach.

The principles apply to a dual track of actions:

- **Targeted interventions** to address on a priority basis the hard hitting pollutants and focus national action on the five key pollution areas: air pollution, land and soil pollution, freshwater pollution, marine and coastal pollution, and chemicals and waste;
- **System-wide actions** for the medium and longer term to shift the economy to greener, more circular, and cleaner development paths.

Possible near term interventions to address priority areas at a multilateral level have been identified where:

1. International risk reduction actions are already agreed, mainly through multilateral environmental agreements, but implementation needs to be scaled up;
2. Scientific evidence and/or global agreement exists to reduce risks, but policy actions are required;
3. Emerging scientific evidence concerning human health and the environment warrants a greater understanding of the nature and magnitude of risks.

Interventions to target specific forms of pollution are highlighted for immediate national actions where commitments from different stakeholders are needed to fast track pollution prevention and reduction:

Air pollution

1. Adopt the World Health Organization air quality guidelines, including those for indoor air quality, as a minimum for their national standards and invest in strong air quality monitoring systems;
2. Meet World Health Organization air quality guidelines, through the reduction of emissions from major industrial sources including particulate matter, sulphates, nitrogen oxides, persistent organic pollutants and heavy metals;
3. Reduce global vehicle emissions by at least 90 per cent through the introduction of advanced vehicle emissions standards (e.g. at least Euro 4 level) in 5 years and a move to only electric vehicles being added to fleets by 2030;
4. Offer effective and affordable public transport and non-motorized transport infrastructure in all cities above 500,000 inhabitants by 2030;
5. Increase the share of non-polluting renewable energy sources such as solar, wind, and tidal to 36 per cent by 2030, while addressing production and waste stages related to for example solar panels (notably batteries);
6. Increase access of households to clean cooking fuels and technologies;
7. Protect and restore ecosystems to avoid air pollution in drylands, rangelands and other areas prone to erosion, fire, desiccation and other forms of degradation;
8. Expand green spaces in urban areas to improve ambient air quality in cities.

Water pollution

9. Provide clean drinking water and sanitation for improved health by 2030;
10. Avoid direct disposal of untreated wastewater into the environment and reduce the amount of untreated wastewater that is discharged into freshwater bodies by at least 50 per cent by 2030, through improved wastewater treatment, increased access to safely managed sanitation and improved land management practices;
11. Establish adequate water quality monitoring networks, including for tracking municipal and industrial effluents, in all significant freshwater bodies;

12. Protect and restore wetlands and other natural systems contributing to water purification.

Land and soil pollution

13. Optimize fertilizer use in agriculture and enhance nutrient management and plant uptake efficiency to reduce excess nutrient run-off and water contamination;
14. Increase the use of non-chemical alternatives to fertilizers and pesticides and adoption of agroecological practices;
15. Control the use of antimicrobials in the livestock sector to avoid releases into the environment;
16. Support the improvements in pollutant inventory systems, especially for mining, and make sustainability reporting mandatory;
17. Provide funding for long-term environmental monitoring after a mining project is closed, to ensure that rehabilitation is effective.

Marine and coastal pollution

18. Phase out single-use plastics and modify manufacturing in order to reduce packaging and phase out non-recoverable plastic materials;
19. Stop the production and use of plastic in non-recoverable items, such as microbeads in personal care products and cosmetics.

Chemicals and waste

20. Identify and characterize pollution / chemicals-related hotspots (such as obsolete stockpiles of chemicals, contaminated sites) to protect vulnerable groups and the environment, minimize exposure and take measures to decontaminate them and prevent new ones;
21. Reduce and mitigate risks associated with extractive activities, including controlling the use and release of chemicals in mining, such as mercury in artisanal and small scale gold mining;
22. Effectively provide and apply reliable information along the product life cycle, including at the consumer stage, in particular on the presence of harmful chemicals in manufactured products and raise consumer awareness of hazards and risks throughout the value chain;
23. Develop eco-labelling schemes to inform customers on the potential environmental and health impact of their consumer choices;
24. Extend product lifespans through sustainable design, maintenance and upgrades, and recovery of broken products;
25. Reduce exposure to lead through actions on battery recycling, pottery, and paint;
26. Phase out the use of mercury in a number of specific products by 2020 and manufacturing processes by 2025, and phase down in dental amalgam and in mining;
27. Minimize waste generation, improve collection, separation and final disposal practices and regulation;
28. Eliminate uncontrolled dumping and open-burning of waste;
29. Phase out the production and use of asbestos.

To address some of the root causes of pollution and further reduce pollution in the medium and longer term, there is a need for **system-wide level action to transform the economy**. Five actions are key to shifting the economy to more innovative and cleaner production and consumption patterns, and greener investments in less polluting activities and practices as well as alternatives. These include:

(i) Building circularity in production and supply processes and key economic sectors;
(ii) Redirecting finance and investments to less polluting and cleaner economic activities;
(iii) Promoting and disseminating green technologies and ecosystem based solutions, including ecosystem protection and restoration;
(iv) Scaling up actions on pollution through horizontal and vertical integration in cities;
(v) Incentivizing responsible consumption and lifestyles choices.

Underpinning change and system-wide action with enablers: clear targets, science-based standards and monitoring programmes can play a central role in facilitating transformative actions and progressing a prevention-focused pollution agenda. They aim at incentivizing and correcting market and policy failures and address some of the key gaps and issues identified in the document that make pollution so globally present, pervasive and persistent. Key enablers include:

(i) Facilitating evidence-based decision-making;
(ii) Enhancing the effectiveness of pollution-related governance;
(iii) Applying economic instruments to shift consumer and producer behaviours towards cleaner paths;
(iv) Investing in education for change;
(v) Strengthening cooperation and partnerships on knowledge, technology, finance and investments.

Introduction

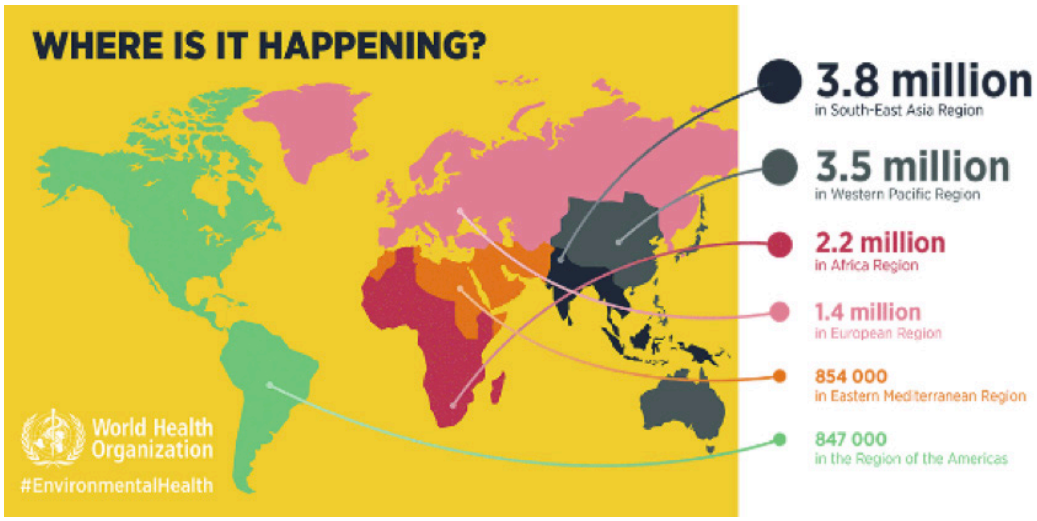
The health of both people and the planet is central to the attainment of sustainable development and contributes to the broader development of a country. Good health is the outcome of many factors, including public awareness and education about lifestyle choices, access to basic sanitation services, a clean environment and safe products, investments in innovative solutions, and effective governance. The 2030 Agenda for Sustainable Development sets clear goals that reinforce the integration of people and planet issues, committing to "ensure that all human beings can enjoy prosperous and fulfilling lives and that economic, social and technological progress occurs in harmony with nature."

Pollution is the introduction of substances or energy into the environment, resulting in deleterious effects of such a nature as to endanger human health, harm living resources and ecosystems, and impair or interfere with amenities and other legitimate uses of the environment (source: eionet)

Pollution touches all parts of the planet. This is affecting our health through the food we eat, the water we drink and the air we breathe. Even in the most remote areas of the polar ice caps, the deep abyssal ocean and high mountains, pollutants such as heavy metals and persistent organic pollutants (commonly used in for example electrical insulators and flame retardants) can be found in the tissues of plants and animals.[3]

The World Health Organization has estimated that nearly a quarter of all deaths worldwide, amounting to 12.6 million people in 2012, are due to environmental causes, with at least 8.2 million attributable to non-communicable, environmental causes, and more than three quarters in just three regions (Figure 1).[1] Low- and middle-income countries bear the brunt of environment-related illnesses, with a disproportionate impact on children.

Figure 1: Number of deaths attributable to environmental factors in 2012 by region[1]



Pollution can take many forms, ranging from chemical substances and organic compounds, to different types of energy. The severity of a pollutant for human health and ecosystems is based on its chemical nature, concentration and persistence. The specific harm caused by different pollutants depends not only upon the environment it is in (air, water or soil) but also the mix of others that are present.

Some types of pollution are easily noticed, such as certain forms of contaminated water, poor air quality, industrial waste, litter, and light, heat and noise. Others are less visible, for example the presence of pesticides in food, nutrients in the sea and lakes, and endocrine disrupting chemicals in drinking water, personal care products and cleaning solutions. Some, such as those coming from abandoned industrial sites, armed conflict, nuclear power stations, and waste landfill form part of a longer-term legacy.

The sources and types of pollution are highly diverse (Table 1) as are the solutions to dealing with them. For example, the hazardous chemicals in paints, cleaning compounds, dyes, and many other household substances, can become pollutants if not managed correctly. Highly hazardous chemicals, such as ammonia, ozone, and perchloric acid, used in a range of industries, are toxic and reactive and some have the potential to cause cancer, birth defects, induce genetic damage, cause miscarriage, injury and death from relatively small exposures if released into the environment[4]. Ecosystem functions are then also put at risk[5,6].

Table 1: Main sources of pollution

Pollution sources	
Agriculture and food	Land-based farming; food- and agro-industry; fisheries and aquaculture
Energy	Combustion plants, fossil fuels, biomass, nuclear
Industrial	Chemicals, extractives, forestry and paper products, cement, waste management industry
Manufacturing	Information technology, construction, homebuilding and building products, textiles, apparel, footwear and luxury goods, pharmaceuticals, batteries
Services	Retail, hospitality and tourism, hospitals and health care services, sewer and wastewater, municipal solid waste
Transport	Automobiles, fuel use and supply, engine emissions, road: tyres, surface, shipping, aviation, urban mobility
Waste	Municipal solid waste (includes E-waste, plastics, food waste, organic waste and open burning), industrial waste (includes E-waste, construction and demolition waste), hazardous waste (includes E-waste, plastics), wastewater

Pollution can have a particularly disproportionate and negative effect on the poor, the disadvantaged, marginalized and the vulnerable, due to their higher exposure and reduced resilience to social, environmental and economic risks. Consequently, pollution constitutes a significant impediment to achieving the pledge of the 2030 Agenda for Sustainable Development to "leave no one behind". Pollution poses a direct threat to respecting, protecting and promoting human rights and gender equality in delivering on the environmental dimension of the 2030 Agenda, international human rights obligations related to health, life, food and water, as well as safeguarding a healthy and sustainable environment for present and future generations.

Solutions to help clean up pollutants and detoxify our environment exist in all parts of the world. They now need to be expanded and scaled up because the more time is taken to act, the greater the exposure of humans and ecosystems to existing pollution and the higher the cost of cleaning up. Along with solutions to help clean up existing pollution, better risk assessment and management of new pollution sources are urgently needed.

In Part 1, the evidence on pollution is presented. Part 2 discusses ongoing responses, challenges to effectiveness of actions, and the opportunity that the Sustainable Development Goals provide to tackle pollution head-on. Part 3 concludes with a framework for action to reduce pollution and move towards a pollution-free planet.

1 Evidence of a Polluted Planet: The Science, Impacts and Economic Costs

The latest global and regional environmental assessments give an indication of the magnitude of current pollution issues[7,8,9,10,11,12,13]. For example: air quality is a problem in nearly all regions; water pollution is a major cause of death of children aged under 5 years; nutrient over-enrichment of land and water is causing shifts in ecosystems and loss of biodiversity; and plastic in the ocean is on the rise. Data gaps prevent us from giving a fully comprehensive picture of the magnitude of pollution on the planet across regions, although proxy indicators can give us some indication (Annex 1).

1.1 AIR POLLUTION

Air pollution is the world's single greatest environmental risk to health. Some 6.5 million people across the world die prematurely every year from exposure to outdoor and indoor air pollution, and nine out of ten people breathe outdoor air polluted beyond acceptable WHO guidelines levels[14]. Approximately 2 billion children live in areas where outdoor air pollution exceeds the guidelines, and 300 million in areas where outdoor air pollution is at least six times higher than recommended levels[15]. Some 570 000 children under 5 years die from respiratory infections, such as pneumonia, attributable to indoor and outdoor air pollution, and second hand smoke[16]. In addition to the impact on human health, others also cause climate change and affect ecosystems, such as short-lived climate pollutants including black carbon and ground level ozone[17] (Table 2).

Table 2: The impacts of different air pollutants on human health and ecosystems

AIR	HUMAN IMPACT	ECOLOGICAL EFFECT	ECOSYSTEM SERVICES IMPACTED
Fine particulate matter ($PM_{2.5}$) containing sulphates, nitrates, ammonia, sodium chloride, polycyclic aromatic hydrocarbons, , organic carbon, mineral dust, and water	Breathing disorders Cardiovascular disease	Loss of visibility Impaired photosynthesis	Changes in productivity
Black carbon - a specific type of fine particulate produced from energy production and incomplete combustion	Breathing disorders Cardiovascular disease[17] Cancer	Albedo reduction and thus further contribution to climate change Impaired photosynthesis	Cooling Changes in productivity
Nitrogen oxides emissions from transport, energy production	Lung irritation	Acidification Eutrophication	Altered nutrient cycling; increased system losses
Ammonia (active nitrogen) emissions from agriculture	Lung irritation	Eutrophication	Reduced food provisioning; increased net primary productivity
Sulphur dioxide	Damage to buildings	Acidification	Loss of biodiversity
Ground level ozone	Impaired immune system; breathing disorders, cardiovascular effects, some reproductive and development effects[17]	Reduced plant growth; increased plant susceptibility to stress	Reduced plant biomass and net primary productivity; altered climate regulation through carbon sequestration
Heavy metals from transport, energy production, industrial sources, contaminated sites, extractives industry	Neurological development, harmful effects on the nervous, digestive and immune systems, lungs and kidneys[18]	Toxicity build-up in food chains	Reduction of available food due to contamination
Benzene - use of benzene-containing petroleum products including motor fuels and solvents	Range of acute and long term adverse health effects and diseases, including cancer and aplastic anaemia[19]	High acute toxic effect on aquatic life. Long-term effects on marine life can mean shortened lifespan, reproductive problems, lower fertility and changes in appearance or behaviour. Damage to plants[20]	Potential reduction of plant biomass, long term reduction of marine populations in polluted areas

The main sources of outdoor air pollution are emissions from coal burning for power and heat, transport, industrial furnaces, brick kilns, and waste incinerators (Figure 2). Other important sources include wildfires and burning of peatlands that generate haze (Box 1), sand and dust storms, desertification and other forms of ecosystem degradation, including deforestation and wetland drainage. Particulate matter ($PM_{2.5}$ and PM_{10}) affects more people than any other air pollutant. Over the years for which data exist, $PM_{2.5}$ has remained largely constant despite efforts to tackle the problem; PM_{10} however has been decreasing in some cities across the world[21].

Box 1: Transboundary haze from forest and peat land fires in South-East Asia

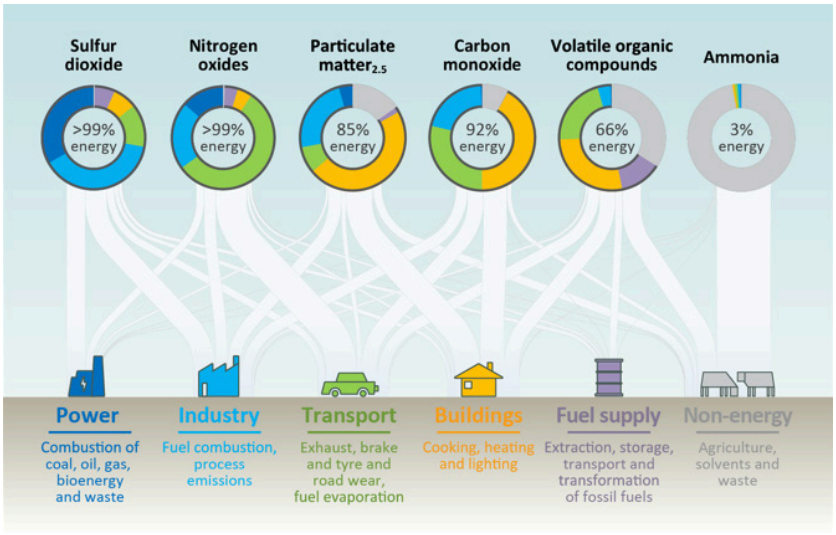
The 2015 haze in South-East Asia contributed to the death of 19 people and more than 500,000 cases of acute respiratory infections. Immediate health costs totalled US$ 151 million. The long-term costs cannot yet be quantified. Existing research suggests long-term exposure to air pollutants correlates with increased cardiovascular and chronic respiratory illness. The Jakarta Post newspaper suggested a total of 53,428 reported cases of respiratory infections in South Kalimantan, 34,846 in Pekanbaru, 22,855 in South Sumatra, 21,130 in West Kalimantan and 4,121 in Central Kalimantan. Children, who are more vulnerable to the ill effects of haze, may suffer from reduced lung development and develop diseases such as asthma. A study on the effects of the 1998 Indonesian haze crisis on foetal, infant and under-three child mortality showed that air pollution led to 15,600 fewer surviving children.[22]

- Habitat destruction: According to the Government, 2.6 million hectares of Indonesian land burned between June and October 2015; an area 4.5 times the size of Bali. Burned peat areas can be restored, but short-term impact includes the loss of timber and non-timber forest products, and the loss of habitat for pollinators, wildlife, and grazing lands. The long-term impact on wildlife and biodiversity is not fully known, but thousands of hectares of habitat for orangutans and other endangered species have been destroyed. A third of the world's orangutan population was threatened by the 2015 fires, with 358 fire hotspots detected inside the protected Sabangau Forest in Borneo alone. Other endangered species at risk include the southern Bornean gibbon, Sumatran rhinoceros, clouded leopard and storm's stork;

- Long-term breakdown of ecosystem services: When peat is dried, it subsides, reducing its water holding capacity. This impacts the ability of peat to re-absorb water, increases vulnerability to flooding, and decreases overall agricultural potential. Furthermore, when peat is dried it releases organic carbon into the water supply, reducing water quality;

- Climate change: In terms of global impact, the fires are releasing enormous amounts of greenhouse gases to the atmosphere. Recent estimates are that the fires in Indonesia, on their most intense days, were emitting more than the daily emissions of the entire economy of the United States. If Indonesia could stop the fires, it would meet its stated target to reduce greenhouse gases emissions by 29 per cent by the year 2030. Lost capacity for carbon storage represents the single biggest cost of the fires, underscoring their global impact.

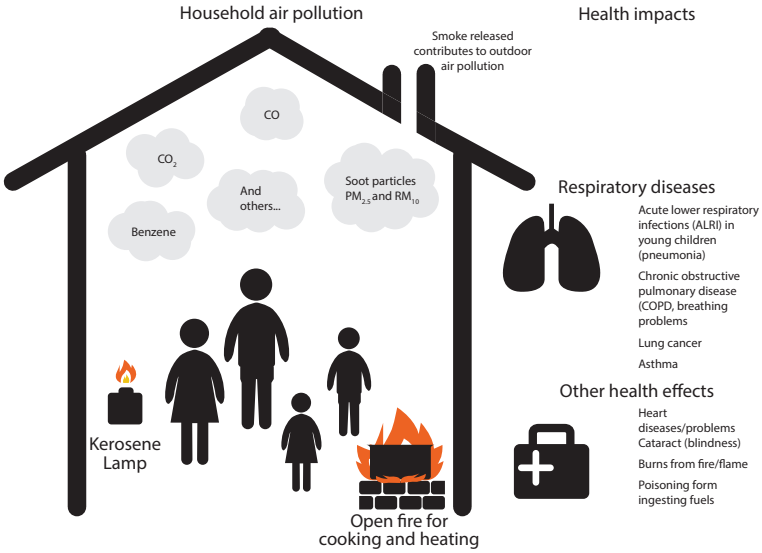
Figure 2: Sources of different air pollutants [23]



Ground level ozone is responsible for an estimated 150,000 premature deaths every year [24, 25] and is particularly dangerous for children, the elderly and people with lung or cardiovascular disease. It reduces the ability of plants to absorb carbon dioxide, altering growth, and damages ecosystems and their functions, as well as the health and productivity of crops. Over the past 100 years there has been a threefold increase in ground level ozone concentrations in the northern hemisphere. Methane emissions, a precursor of ground level ozone, is contributing to this increase through uncontrolled releases into the atmosphere, mainly from livestock, poor management of landfills and leakages from gas production and transport.

Overall, air pollution affects women, children, the sick and the elderly in particular, and those in low-income groups as they are often exposed to high levels of outdoor air pollution and indoor air pollution from cooking and heating (Figure 3).

Figure 3: Indoor air pollution causes a number of respiratory diseases and other health effects. It accounts for 18 per cent of ischaemic heart disease and 33 per cent of all lower respiratory infections globally.[26]



1.2 LAND AND SOIL POLLUTION

Land and soil pollution is largely the product of improper solid waste management including unsafe storage of obsolete stockpiles of hazardous chemicals, poor agricultural practices, irrigation, and a range of industrial, military and extractive activities. Leachates from mismanaged landfills, and uncontrolled dumping of waste from households, industrial plants and mine tailings can contain heavy metals, such as mercury and arsenic, trace metals, organic compounds, pharmaceuticals and microorganisms[27]. Whereas it is easy to degrade land with pollutants, it is very hard to recover.

As demand for land is high, increasingly people are living, and food is grown, in formerly industrial areas. The primary pollutants of concern include heavy metals such as lead, mercury, arsenic, cadmium and chromium, persistent organic pollutants such as DDT and other pesticides, waste and pharmaceuticals, such as antibiotics used for livestock management. The prevalence of these degrades soil biodiversity and agricultural productivity of land, and thus negatively impacts livelihoods, disease control and food security, while human exposures to these pollutants can cause a variety of non-communicable diseases, brain damage and even death (Table 3).

Table 3: The impacts of different soil and land pollutants on human health and ecosystems

LAND AND SOILS	HUMAN IMPACT	ECOLOGICAL EFFECT	ECOSYSTEM SERVICES IMPACTED
Heavy metals from sedimentary and aerosolization processes, transport, energy production, industrial sources, contaminated sites, extractives industry	Neurological development, harmful effects on the nervous, digestive and immune systems, lungs and kidneys	Toxicity build-up in food chains	Reduction of available food due to contamination
Pesticides	Cancer; sterility and other reproductive disorders	Disappearance of bees, other insects and butterflies, reptiles, birds and mammals	Control of pests, vectors
Plastic debris and litter	Various leachates causing potential harmful effects	Congested alimentary systems, leading to starvation. Toxicity build-up in fodder and prey	Reduction in productivity and cycling of nutrients Distorted predator prey dynamics
Pharmaceuticals from use of antibiotics in livestock	Immunity suppression; increased antimicrobial resistance	Soil microbial populations developing new resistant forms	Provisioning services: Productivity of soil and livestock

Pollution with toxic heavy metals presents public health risks around the world – especially for children [28,29]. Sources of heavy metal pollution include a variety of industrial, household and agricultural activities, including mining and smelting operations, coal and other fuel burning, pigment and dye production, chemical and pharmaceutical production, leather

tanning, informal recycling of lead-acid batteries and electronic waste, pesticide and fertilizer use, and mismanagement of household and industrial waste. Although the specific impacts vary by pollutant and exposure pathway, these often include damage to internal organs and the nervous system causing developmental impairments, non-communicable diseases and sometimes cancer. Once released into the environment, these metals do not biodegrade and can jeopardize ecological and human health for generations.

Although many high-income countries have robust programmes to identify, assess and remediate soil contamination, many low- and middle-income countries lack basic information about the location, severity and potential risks of "hotspots" within their borders. Without such information, it is difficult to effectively prioritize challenges, allocate resources and implement (often very costly) solutions. There also is a serious risk that – without timely and appropriate measures - soil pollution contaminates rivers and groundwater, threatening ecosystems and safe drinking water supply.

Intensive use of pesticides and fertilizers has facilitated a large increase in food production, but also generated an almost universal human and environmental exposure to agricultural chemicals[25]. Lifestyles are driving this through consumption patterns (food waste, meat consumption, packaged foods), and so do agricultural subsidies which lead to less diversity and more monocultures, reducing consumer and traditional communities' choices for pursuing healthy food. Pesticides are toxic by design and hence have adverse impacts on all living organisms. This poses risks to ecosystem services such as litter breakdown and nutrient cycling, food production, biological pest control, and pollination.[30] There is much uncertainty concerning the health and environmental effects of chronic exposure to pesticides at low doses. The negative health effects from acute exposures to pesticides at higher doses are better understood and studies show that in high-income countries, occupationally exposed groups, such as farmers, have higher rates of some forms of lymphoma and Parkinson's disease, attributed to pesticides.[31,32] While exposure to chemicals such as DDT has fallen in recent years due to regulatory frameworks, a myriad of other synthetic compounds continue to enter ecosystems and the food chain.

Chronic pesticide exposures on women and men vary considerably, and some scientists have identified a connection between pesticides and breast cancer rates.[33,34] While the importance of pesticides for breast cancer is not widely accepted among public health experts, a plethora of studies suggest that some classes of pesticides (such as organochlorines) may be more carcinogenic to breast tissue than others.[35,36] Women's higher levels of hormonally-sensitive tissues make them more vulnerable to the effects of the endocrine disrupting substances in pesticides, with pregnant and breast-feeding women at particular risk, as well as children exposed at a time when they are developmentally vulnerable. Overall, women generally have higher percentages of body fat, which means that they carry more lipophilic pesticides and for longer periods, resulting in greater internal exposure and more bioaccumulation.[34,37] This is especially true in the Arctic.[38]

The rise of antimicrobial resistance as a result of the excretion in the environment of antimicrobials and antibiotics used in food production is an emerging issue. As this may cause rapid changes to microbial composition and driving development of antimicrobial resistant infections, this is a major emerging concern.[39]

1.3 FRESHWATER POLLUTION

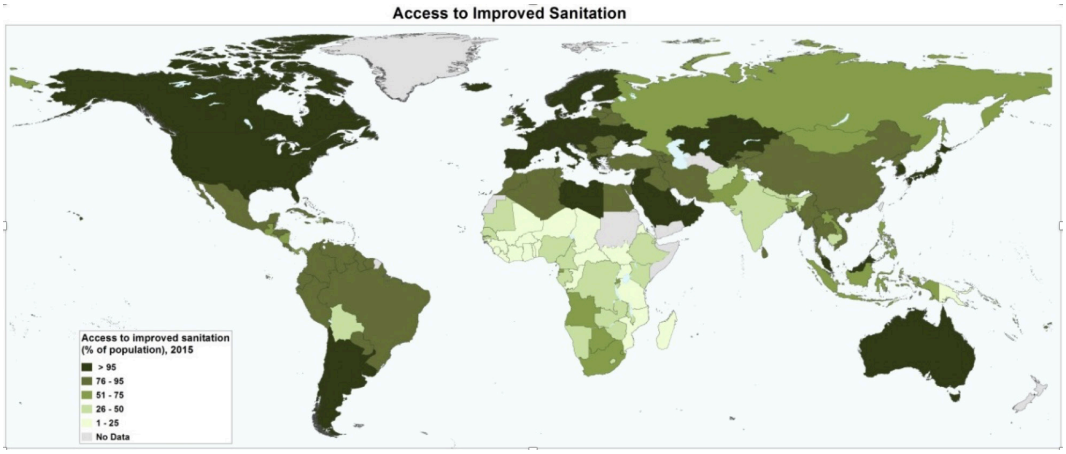
Freshwater bodies are heavily affected by pollution, particularly by pesticides and nutrients coming from agriculture, pathogens from untreated wastewater, and heavy metals from mining (Table 4). Polluted water is also more likely to host disease vectors, such as cholera-causing *Vibrio* and parasitic worm-transmitted *schistosomiasis*. The main impacts are loss of biodiversity, changes in ecosystems and their services – including water quality improvement, waterborne diseases, a reduction in the productivity of food chains, and contamination and blockage of drainage by plastics and other improperly managed solid waste. The increasing presence of harmful pharmaceuticals and antimicrobials are also emerging concerns[40].

Table 4: The impacts of different freshwater pollutants on human health and ecosystems

Freshwater	Human health	Ecosystem	Ecosystem services
Nutrients (nitrates and phosphates)	Impairment of neurological development; cancers due to harmful algal blooms	Eutrophication, harmful algal blooms	Provisioning services: Productivity of fish stocks
Heavy metals	Impairment of neurological development, heart, kidney disease	Toxicity	Provisioning services: Productivity of food and fish stocks
Pesticides	Cancer; sterility and other reproductive disorders	Reduction in population size of species such as frogs	Control of pests, vectors
Endocrine disrupting chemicals	Hormonal disruption	Feminization of fish	Habitat or supporting services: Widespread population impacts, affecting habitats and maintenance of genetic diversity
Pharmaceuticals	Immunity suppression; increased antimicrobial resistance	Reproductive disorders of fish	Provisioning services: Productivity of fish and stock

In Latin America, Africa and Asia, severe pathogenic pollution was found in one-third of all rivers, putting at risk people's health and the use of river water for irrigation, industry and other purposes[41]. Severe organic pollution, found in one-seventh of all rivers, and severe and moderate salinity, found in one-tenth, further threatens the fishing industry, food security and livelihoods. Improved sanitation is helping to counteract these trends (Figure 4); although untreated sewage continues to be discharged into the environment (Figure 5). Wastewater management is of basic importance not only for environmental sustainability, but also for gender equality, reducing the workload of women fetching water[42].

Figure 4: Proportion of population using improved sanitation facilities in 2015[43]



Nutrient pollution (nitrogen and phosphorus) caused by over-application of fertilizers continues to pose a very significant threat to biodiversity and ecosystem services globally and is projected to continue rising beyond 2020, with growth concentrated in Asia, South and Central America, and sub-Saharan Africa. Although a natural process, eutrophication can be accelerated by excessive nutrient loading from point and non-point sources, leading to increasing algal growth.[44,45] It is one of the most pervasive water quality issues on a global scale, interfering with many human water uses and causing major shifts of species in ecosystems. Nutrient loads into coastal areas have increased by an estimated 10-80 per cent between 1970-2000, increasing eutrophication, hindering tourism, and negatively impacting economic livelihoods. The associated harmful algal blooms can cause liver and colorectal cancers.

Figure 5: Trends in organic pollution (measured as biological oxygen demand concentrations) in rivers between 1990-1992 and 2008-2010[41]

Heavy metals and other pollutants from oil and gas exploration using fracking techniques in shale gas basins can accumulate in groundwater, lakes and reservoirs, contaminate aquifers

with potentially explosive methane levels,[46] and pollute streams receiving water discharges and downstream communities following dam removal.[47]

Other contaminants that can be found in streams and freshwater systems include plastics, personal care products and pharmaceuticals, insect repellents, stimulants, fire retardants, non-ionic detergent metabolites and nanomaterials[48]. A particular concern for the health of both people and freshwater organisms are the potential endocrine disruption and carcinogenic effects arising from some of these pollutants.[50]

1.4 MARINE AND COASTAL POLLUTION

Oceans and coastal waters receive 80 per cent of their waste and pollutants from a multiplicity of land-based sources; the other 20 per cent is from the shipping industry, fisheries and other sea-based sources[50,51,52]. Nutrients from agricultural run-off is causing eutrophication in seas around the world. This is having an impact on fishing communities and, on the productivity of fish stocks. Aquaculture can also be a significant source of pollution, because of outflows of nutrient-rich waters, and in some cases the use of antibiotics (Table 5).

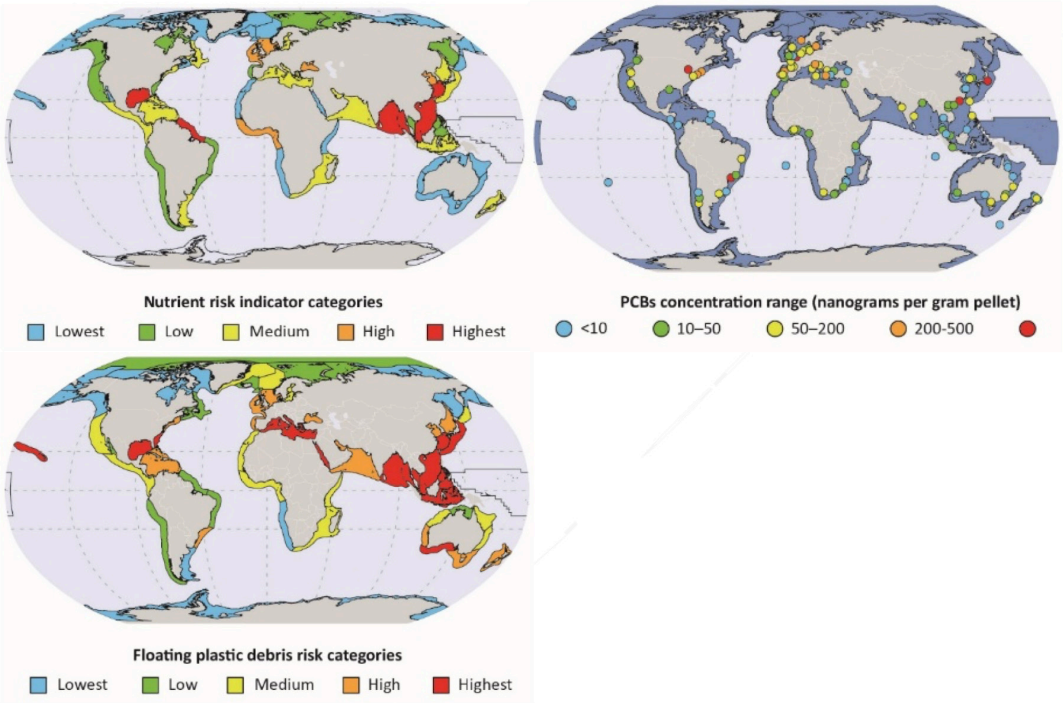
Table 5: The impacts of different marine pollutants on human health and ecosystems

MARINE	Human health	Ecosystem	Ecosystem services
Nutrients (nitrates and phosphates)	Impairment of neurological development, cancers due to harmful algal blooms	Eutrophication, harmful algal blooms	Provisioning services: Productivity of fish stocks
Heavy metals e.g. from mining and seabed extractive industries; lead from land-based sources now found in surface waters in all oceans (Royal Society, 2017)	Impairment of neurological development, heart, kidney disease	Toxicity; impact on seabird populations	Provisioning services: Productivity of food and fish stocks
Booster biocides	Cancer; sterility and other reproductive disorders	Disappearance of algae, corals, invertebrates and fish species	Control of pests, vectors
Pesticides	Cancer; sterility and other reproductive disorders	Impacts on seabird populations and other species	Changed predator prey dynamics
Endocrine disrupting chemicals	Hormonal disruption	Feminization of fish, thyroid disorders in whales and other mammals	Habitat or supporting services: Widespread population impacts, affecting habitats and maintenance of genetic diversity
Pharmaceuticals	Immunity suppression, increased antimicrobial resistance	Reproductive disorders of fish	Provisioning services: Productivity of fish and stock
Waste and plastics	Consumption related	Reduced alimentary functioning; mortality related to entanglement and ingestion	Provisioning services: Productivity of fish and stock

In the Arctic, persistent environmental contaminants have accumulated and been biomagnified into species at the top of the food chain and traditional food sources of many Arctic peoples.[38] Records of persistent organic pollutants found in beached plastic pellets and modelling of the distribution of plastic debris in the ocean (Figure 6) show that pollution reaches all large marine ecosystems, raising concerns about the health of ecosystem and of the over 3.5 billion humans who depend on the ocean as their main food source.[53,54] The concentration of some chemicals that have been banned for over 20 years is falling, however the same trend is not observed for the most recently regulated chemicals. In particular, the levels of mercury found in fish and marine mammals in many parts of the world remain worrying.

Figure 6: Marine and coastal pollution risks in large marine ecosystems[55]:

a) Nutrient risk: The nutrient risk indicator takes into account both the amount of nutrients discharged by rivers to each large marine ecosystem and the extent to which these added nutrients will lead to harmful algal growth;
b) Persistent organic pollutants risk: global distribution and hotspots show that poluchlirine biphenyls (PCBs) have spread around the global ocean, including to remote areas;
c) Floating plastic debris risk based on the amount of plastic debris per unit area of each large marine ecosystem estimated from models. This map is for plastic pieces of about 5 mm diameter and bigger. Estimated distribution of smaller plastic particles is similar.



Three quarters of marine litter is now comprised of plastic[56]. Plastic debris, that fragments into small pieces (Box 2) but does not biodegrade in the marine environment, is found in all the world's oceans and seas, even in remote areas such as deep trenches and uninhabited islands in the Pacific Ocean, far from human contact. It can cause physical harm to marine life (entanglement, ghost fishing, ingestion) and act as a carrier for persistent bio-accumulative and toxic substances; provide habitats for microbial communities; act as a potential vector

for disease; and provide a means to transport invasive alien species across the ocean[57]. The Mediterranean Action Plan/Barcelona Convention adopted in 2013 outlines legally binding measures addressing the prevention and reduction of marine litter. Concerted action has proven effective in the region: between 2003 and 2013, pollutant loads showed a consistent reduction for polycyclic aromatic hydrocarbons (98 per cent), mercury emissions (94 per cent) and the heavy metals lead (81 per cent), zinc (89 per cent) and chrome (88 per cent).[58]

Box 2: Impacts of microplastics

Microplastics, of less than 5mm in size, are now present in all marine habitats, from the seabed to ocean surface. Research on the physical and toxicological effects of microplastics provides evidence of trophic transfer in planktonic food chains as well as the direct uptake of microplastics by marine invertebrates[59,60]. Ingestion of microplastics by fish has been shown to cause physiological stress, liver cancer, and endocrine dysfunction, affecting female fertility and the growth of reproductive tissue in male fish. These effects are thought to be caused by the plastic itself (physical components and chemical ingredients) as well as from chemical pollutants that sorb onto the plastic from the surrounding seawater[61]. Under laboratory conditions, nano-size microplastics have been shown to cross cell membranes, resulting in tissue damage.

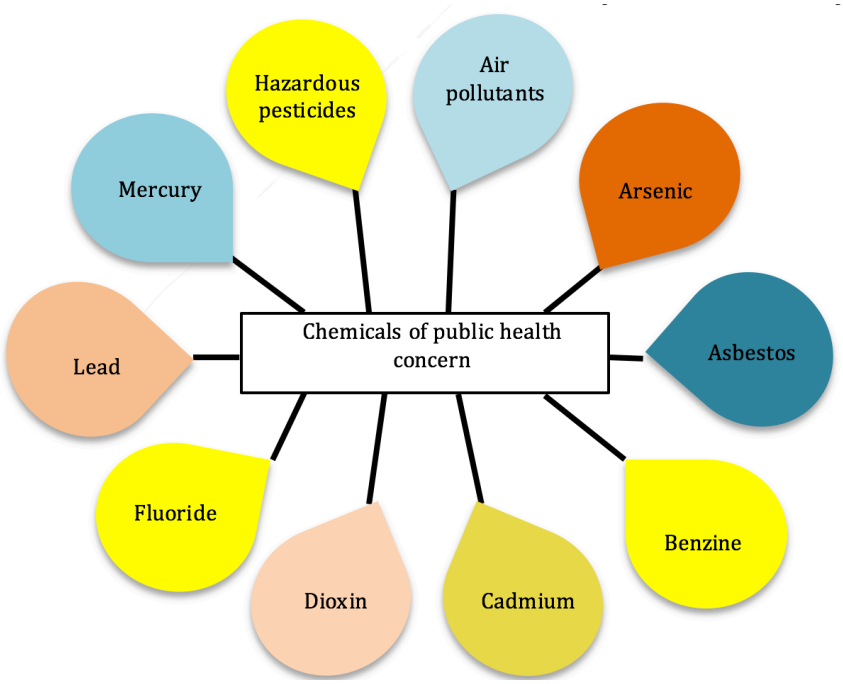
Oil spills are responsible for only 12 per cent of the oil in the ocean. However, oil spills can have locally devastating impact on the environment. The cleaning of oil spills introduces further chemicals in the ocean.

1.5 CROSS-CUTTING SOURCES OF POLLUTION

1.5.1 Chemicals

Following industrial disasters such as Bhopal, public concern over pollution has resulted in a top ten of chemicals being identified as of greatest concern[62] (Figure 7). The impacts of chemicals on people and other living organisms vary from cell-mutagenesis to neurological damage, pulmonary inflammation and the emergence of antibiotic resistant bacteria[4,51]. With new chemicals and materials continuously being designed and released on the market, it is important that adequate chemicals management over their entire life cycle takes place – from the extraction, production, formulation and use phases, through to final disposal – as very little is known about their behaviour in the environmmemt (for example, transboundary transport via water, air or bio-accumulation) and the effects of these materials on biodiversity and whole ecosystems.

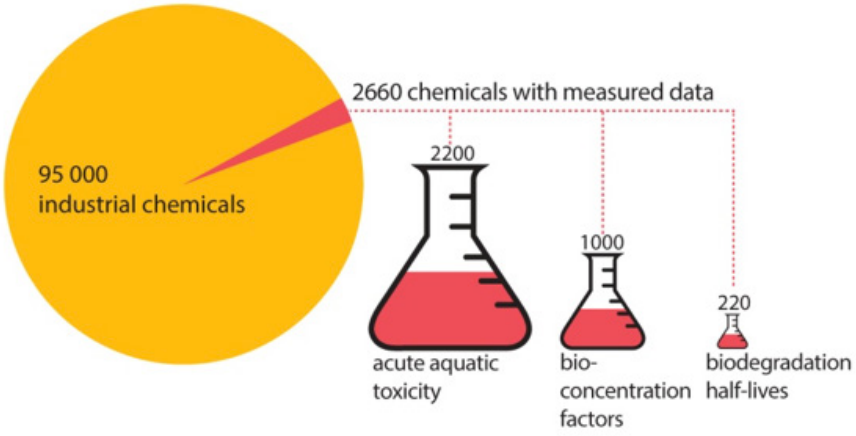
Figure 7: Top ten hazardous chemicals and groups of pollutants of serious public health concern[62]



One of the main problems in dealing with chemicals is the large gap in publically-accessible data on chemical performance and safety. Of the tens of thousands of chemicals on the market, few have been thoroughly evaluated to determine their effects on human health and the environment[63,64] (Figure 8). Moreover, the assessment of the health risk of chemical substances focuses primarily on the effects of individual substances for determining the doses of toxicological concern, and have a limited ability to evaluate the combined impact of chemical mixtures[65,66]. The European Union Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) legislation requires companies to identify and manage the risks linked to the substances they manufacture. However, this legislation only focuses on individual substances, disregarding the effects of combined exposure to mixtures of chemical and physical agents. To date, under the pre-registration requirement of the European Union's chemicals regulation, REACH, over 145,000 chemical substances have been pre-registered[67]. This gives a reasonable indication of the approximate number of chemicals in commerce globally. In June 2017 the Global Product Strategy Chemicals Portal of the International Council of Chemistry Associations provided access to data for over 4,500 chemicals[68].

Figure 8: Testing of chemicals and data gaps.

Out of a set of 95 000 industrial chemicals, 2200 had data on acute aquatic toxicity, 1000 on the extent to which they build up in the environment (bio-concentration factors), and 220 on how long it takes them to break down (biodegradation half-lives).[69]



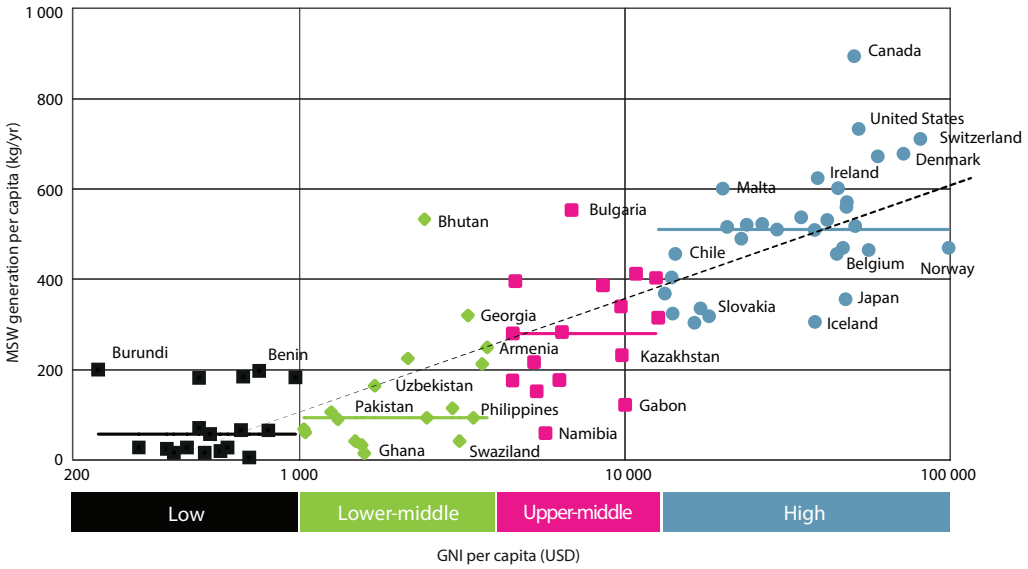
The major route of human and environmental exposure is through food or water intake. Food safety is therefore intimately linked to the state of the environment, the soil and land where food is produced, the marine environment where fish live, as well as the water that is used for food production – at farm production level but also further down the chain in food processing, washing, and preparation. The joint Food and Agriculture Organization/WHO committee on food additives carries out food safety risk assessments on food additives, contaminants and residues of veterinary drugs residues.

Finally, armed conflicts and insecurity can cause severe pollution and reduce the ability of a country to manage pre-existing or emerging pollution issues.[70] While scorched earth tactics – such as deliberate attacks on oil facilities – and industrial environmental emergencies may capture the headlines[71] the influence of conflicts and insecurity on the management of waste and chemicals, and their impact on air quality, soils and the freshwater and marine environments remains largely undocumented. Improvements in military guidelines and conduct could help reduce the most severe incidents, while remote monitoring could provide early warnings of serious pollution hazards as well as inform emergency humanitarian responses.

1.5.2 Waste

Waste continues to be generated, with a near doubling between 1970 and 2000[72]. There is a clear relationship between municipal solid waste per capita and national income levels (Figure 9).

Figure 9: Waste generation by income level[69]



The total volume of 'urban' waste in 2010 – made up of municipal solid waste including food waste, commercial and industrial waste, and construction and demolition waste but excluding agricultural, forestry, mining and quarrying wastes – was estimated at 7 to 10 billion tonnes. Disasters such as earthquakes and industrial accidents contributed 1-30 million tons of disaster waste per incident. Industrial and hazardous waste generation is shifting from the developed to the emerging economies that are often poorly prepared to safely manage these waste streams. Waste generation in developed countries is beginning to stabilize, suggesting some level of decoupling from economic development.

Dumpsites around the world are sources of complex pollution mixtures, with emissions of gases such as methane, leachate of heavy metals and hazardous waste all mixed together, including electronic waste. They have become home to an estimated 15 million of informal waste pickers scavenging for food and recyclables and diverting 20 to 30 per cent of municipal solid waste through recycling at little to no cost to business or government, but with no protection and high exposures to chemical hazards and significant risk of physical injury.[73,74]Poor people are especially vulnerable to physical hazards, including landslides and polluted water as the dumpsites are often surrounded by informal settlements (Table 6).

Table 6: Human impacts of events at dumpsites

Event	Year	Human impact
Samut Prakan landfill fire in Thailand	2014	increased cancer risks[75]
Landslide in Shenzhen, China, triggered by collapse of a construction waste disposal site 60	2015	at least 69 people were killed
Poor waste management at dumpsites occurred in just the first seven months of 2016[58]	2016	750 deaths
Waste landslide at Koshe landfill in Addis Ababa, Ethiopia	2017	at least 115 people were killed
90 metre dump collapsed in Colombo, Sri Lanka	2017	145 houses were buried and 32 people killed

It is estimated that at least 2 billion people worldwide lack access to solid waste collection. In developing countries, the priority is to phase out open dumping, burning or uncontrolled disposal, but there is also a need to focus on city cleaning, collection and safe disposal of waste to sanitary engineered landfills, subject to certain compliance requirements, as the foundation from which countries can drive prevention, reuse, recycling and recovery.

Mining generates one of the world's largest waste streams, often containing high concentrations of compounds that have severe effects on ecosystems and humans. As they are often outside national waste control regimes, official data on waste volumes is limited. The annual global production of mine waste is estimated to approach 100 billion tonnes, with about 90 per cent of this being waste rock and the rest tailings[76]. Mine wastes can be a major source of water pollution, especially acid mine drainage as well as dust pollution. A review of failures of tailings storage facilities in the period 1910-2010 suggests a correlation between commodity price trends that squeeze earnings and the failure of mining dams due to reduced commitment to good practices in mine waste management.[77]

It is estimated that global generation of electrical and electronic equipment (E-waste) amounted to 41.8 million metric tons in 2014 and is forecast to rise to 50 million metric tons in 2018, an annual growth of 4-5 per cent (Box 3)[78]. Only a limited number of countries have national E-waste legislation and an official take-back system. Out of the estimated 41.8 million metric tons, only 6.5 million tons were estimated to have been collected by official take-back systems and other collection mechanisms.

Box 3: Impacts of E-waste

E-waste contains hazardous materials such as heavy metals (including cadmium, chromium, mercury and lead) and chemicals (such as brominated flame retardants and chlorofluorocarbons). E-waste management is of grave concern in developing countries where recycling and treatment infrastructure is limited and the legal and institutional capacity is less stringent. Illegal and illicit transboundary movements of E-waste and trade in second hand products have made the E-waste issue more complicated in destination countries. In particular, unsound management and burning of E-waste often exposes people to harmful substances (including dioxins, polycyclic aromatic hydrocarbons and heavy metals) with serious health consequences such as altered thyroid function, reduced lung function, birth defects, reduced childhood growth, negative mental health outcomes, impaired cognitive development, cytotoxicity and gene-toxicity[79]. Hazardous substances such as lead and mercury may leak from discarded and illegally dumped E-waste into surface and groundwater.

Food waste globally has been estimated by the Food and Agriculture Organiszation to be as high as one third of all food produced for human consumption – nearly 1.3 billion tons. Of this, countries in the developed world waste as much as the entire food production of sub-Saharan Africa i.e. 230 million tons. The problem for human health and ecosystems lies in the spoilage and the ecosystem impacts caused by insect pests and rodents feeding off this waste. Aflatoxins, toxic fungal metabolites, increasingly occurring in staple crops, are contaminating food supplies throughout the world and if eaten can have toxic effects on humans and livestock. Ingestion of low levels of aflatoxins over a long period has been implicated in primary liver cancer, chronic hepatitis, jaundice, cirrhosis and impaired nutrient conversion. Aflatoxins may also play a role in other conditions, such as kwashiorkor an outcome of childhood malnutrition. Aflatoxins can be removed through moisture control of grain stores; however in many developing countries, climate controlled storage facilities are often not available.

1.6 COSTS OF POLLUTION: GLOBAL AND REGIONAL

A review of the literature illustrates the enormous scale of the economic impact of pollution (Annex 2). In 2013, the global welfare costs associated with air pollution were estimated at about US$ 5.11 trillion.[80] The welfare costs from mortality related to outdoor air pollution were estimated at about US$ 3 trillion and US$ 2 trillion from indoor air pollution. Mortality costs from outdoor air pollution are projected to rise to about US$ 25 trillion by 2060 in absence of more stringent measures[81].

Declining water quality also has a wide range of economic impacts including human health, ecosystem health, agricultural and fisheries productivity, and recreational uses. With regards to human health, the welfare cost of mortality from unsafe water is remarkable in many developing countries. In Africa mortality costs from unsafe water (calculated using the value of statistical life) is estimated at US$ 252 billion (costs are expressed in 2015 prices), an equivalent of 4 per cent of gross domestic product. In 2004, losses due to inadequate water

and sanitation services in developing countries was estimated at US$ 260 billion a year[82] – this equals 10 per cent of gross domestic product for some poor countries.

Inadequate attention to pollution, even with limitations of the studies reviewed suggest substantial economic costs. These are conservative estimates given that not all pollutants and waste are included. The evidence of the physical and economic cost of pollution presented here, though just indicative of the scale of pollution impacts, is a clear-cut case for immediate action.

While a better understanding the staggering economic costs of pollution can inform evidence-based decision-making and support more effective policies, the human costs of pollution are even more critical. A United Nations Special Rapporteur has been appointed to provide up-to-date information on the adverse impact of the improper management and disposal of hazardous substances and wastes on the full enjoyment of human rights, including on the human rights implications of waste recycling programmes and the transfer of polluting industries, industrial activities and technologies from one country to another and new trends therein (E-waste, dismantling of ships) and to provide support and assistance to victims of human rights violations relating to the environmentally sound management and disposal of hazardous substances and wastes.[83] The work of the Special Rapporteur reveals that the true costs of pollution are preventable human suffering that disproportionately affects persons, groups and peoples in vulnerable situations.

2 Addressing Pollution: Global Frameworks, Challenges and Opportunities in the Context of the 2030 Agenda

Principle 1 of both the 1972 Stockholm[84] and 1992 Rio Declarations focus on the human right to a safe and clean environment stating "the fundamental right to freedom, equality and adequate conditions of life, in an environment of a quality…" and that humans "are entitled to a healthy and productive life in harmony with nature" respectively. These declarations, have together with other principles (Annex 6) informed many national constitutions over the past three decades. Voluntary initiatives have supported the more formal environmental agreements, resulting in progress in some areas but much more is required to work towards a pollution-free planet. The Sustainable Development Goals provide an opportunity to accelerate actions on pollution, which have been hitherto limited and inadequate.

2.1 GLOBAL AND REGIONAL ENVIRONMENTAL AGREEMENTS AND NATIONAL REGULATIONS: TACKLING POLLUTION

Multilateral environmental agreements provide a framework for targeted and time bound actions, while some also include compliance-related actions, monitoring and reporting. They also enable exchange of resources and information, sharing of technologies and best practices, for controlled international trade, and promote international partnerships on addressing pollution, including among non-state actors.

A number of multilateral environmental agreements are related to different types of pollution. For example, the implementation of the Paris agreement on Climate Change will be a major step forward in tackling air pollution as the root causes of climate change and air pollution largely overlap. Addressing Short-Lived Climate Pollutants could avoid as much as 0.5°C of warming, and prevent 2.4 million premature deaths from air pollution. Air pollution-related specific agreements, such as the Convention on Long-Range Trans-boundary Air Pollution, provide additional protocols to address transboundary issues, such as acid rain (box 4).

Box 4: Acid rain in Europe

The Convention on Long-Range Transboundary Air Pollution was established in 1979 and has been particularly successful in connecting scientific evidence with policy options. The greatest success, following the 1985 Sulphur Protocol and subsequent protocols, has been the reduction in acidification or "Acid rain" which was causing significant damage to soils, lakes and streams and the built environment, including historic buildings and cultural monuments. Abatement measures such as flue gas desulphurisation and low-sulphur fuels have led to a total reduction of about 80 per cent of sulphur emissions since 1990.[85] As a result, freshwater and terrestrial ecosystems are now recovering and the exceedance of critical loads is only found in limited parts of Europe.

With regards to chemicals and waste, existing multilateral environmental agreements[a] enable actions notably in relation to ozone depleting substances, persistent organic pollutants, transboundary movement of hazardous waste, and more recently mercury, with the entry into force of the Minamata Convention on 16 August 2017.

Global conventions provide a legal framework for international governance of seas and the ocean, prevention of pollution from ships, as well as dumping at sea, and are often complemented by regional agreements and conventions on specific seas[b]. Freshwater pollution is mostly addressed by regional agreements looking at specific transboundary water basins, while land and soil pollution is indirectly addressed by the United Nations Convention to Combat Desertification and chemicals and waste conventions and processes.

The Convention on Biodiversity, through the Aichi Biodiversity Targets, calls for a decrease in pollution, as one of the direct pressures on biodiversity, asking for specific actions on excess nutrients. Most of the other environmental agreements at the regional or global level have an indirect impact on various pollution areas.

Annex 3 and 4 provide a summary of the mandates of global and regional agreements on pollution. The potential of global and regional environmental agreements is not necessarily fully utilized, due to various factors, including the lack of capacity and financial resources to assist parties and stakeholders. Whereas global and regional environmental agreements can help to safely manage some of the most polluting substances, some other pollutants are not covered through such agreements, including plastics and non-persistent industrial chemicals. Some pollutants do not have substitutes or alternatives, and others are too pervasive[86].

a In particular, The Vienna Convention for the Protection of the Ozone Layer and its Montreal Protocol on Substances that Deplete the Ozone Layer, the Stockholm Convention on Persistent Organic Pollutants, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, the Rotterdam Convention on Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade and the Minamata Convention on Mercury.

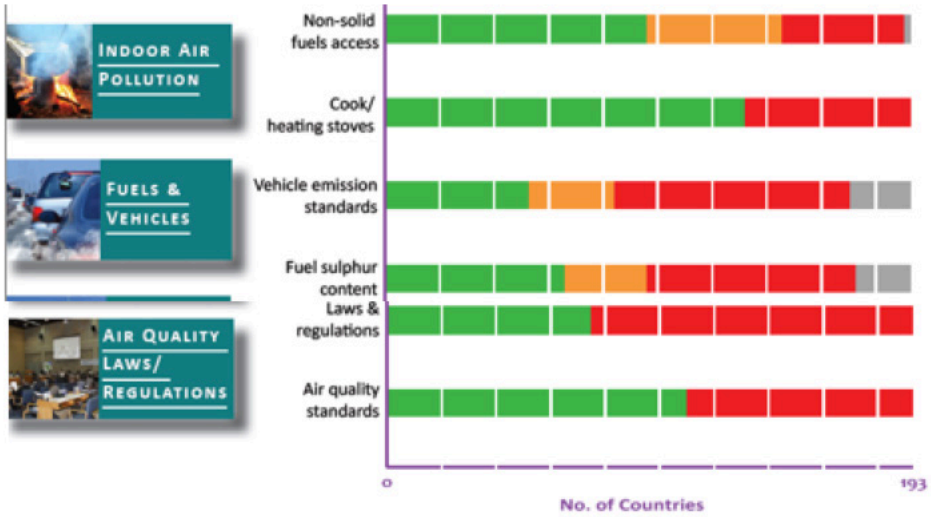
b Such as the Barcelona Convention for the Protection of the Mediterranean Sea against Pollution, Helsinki Convention on the Protection of the Marine Environment of the Baltic Sea Area. See annex 3 and 4

In analysing global pollution, it is important to take into account the fact that market demand in one side of the globe is satisfied by labour, production, and natural resources originating from halfway across the globe. As such, the environmental impacts and pollution generated by global consumption habits are dissociated from the locals that are most impacted. Trade patterns, policies and agreements can play a crucial role in internalizing some of the environmental and social costs of production in order to minimize pollution at a global scale.

In some regions, ministerial environment and health forums are in place, which aim at supporting integrated action to tackle environmental risks affecting health. Their integrative role offers significant opportunities for upscaled and impactful results and exchange of experiences within and across regions. Formal legal agreements are often complemented by non-legally binding policy frameworks and initiatives, such as for example the Strategic Approach to International Chemicals Management (SAICM[87]), in the case of chemicals, the Climate and Clean Air Coalition in the case of air pollution or the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA).

Countries are increasingly adopting national policy and legal frameworks to address pollution issues. By 2015, 109 Member States had adopted air quality standards, 73 had a specific air quality policy, Act or Rules (Figure 10), and 104 had vehicle emission standards.

Figure 10: Ongoing actions taken by countries to address air pollution (source: UN Environment, 2016)[88]



Legislation, regulations, and standards for chemicals and waste management are diverse and complex. Some countries have more than 100 different instruments. They cover imports and exports, product standards, occupational exposure limits, bans and restrictions, registration schemes, framework legislation etc.[89] 167 countries have national legislation addressing the issues covered by the Basel Convention, 142 of which have specific chemicals or wastes legislation. As of 2017, 65 countries had legally binding controls on lead in paint. In water pollution management, the WHO 2006 guidelines for safe use of wastewater is used by all countries. Of 130 countries, 41 per cent indicated that, in 2012, they had fully implemented, started or advanced implementation of integrated water resources management plans or equivalent.[90]

However, implementation, compliance and enforcement remain a great challenge, especially in developing countries, due to factors such as lack of institutional capacity, insufficient training of relevant officials to enforce legislation, and availability of information and national guidance materials to enforce the law.

Voluntary initiatives and global alliances have been instrumental in aiding and pushing improved and faster actions as seen in the case of fuel efficiency improvements and cleaner air (Box 5 and 6) These strategic initiatives help leverage and motivate key stakeholders to deliver on planned outcomes. The SAICM is an international, voluntary, and non-binding approach to achieve the 2020 goal of protecting human health and the environment from the harmful effects of chemicals. Its global approach covers all agricultural and industrial chemicals throughout their life cycle. It aims at supporting the development of an overall, preventive chemicals management system in every country as well as addresses a set of emerging policy issues, including among others, chemicals in products[91], environmentally persistent pharmaceutical pollutants, perfluorinated chemicals and the transition to safer alternatives for highly hazardous pesticides. Significant progress has been achieved in the areas of risk reduction, governance, capacity-building and technical cooperation, whereas less progress has been measured in that of knowledge and information, and little information is available to assess progress related to illegal international traffic. The ongoing multi-stakeholder process on sound management of chemicals and waste beyond 2020 offers opportunities to agree on measurable goals and actions that contribute to achieving the 2030 Agenda for Sustainable Development in the area of chemicals and waste management.

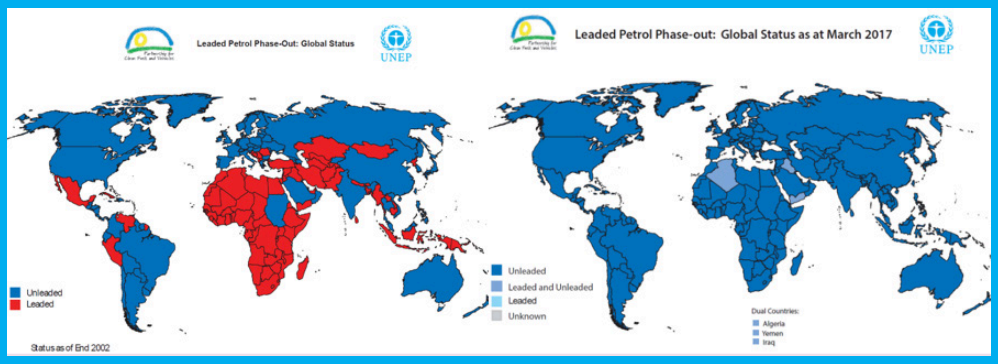
Box 5: Eliminating lead in fuels and paint through partnerships

By the end of the twentieth century all developed countries had banned leaded petrol, a key air pollution source. However, more than half the world's countries, including most developing countries were still using leaded petrol, with corresponding impacts on health, especially on children.

Impacts and Results:
In 10 years, the Partnership for Clean Fuels and Vehicles – a public-private partnership formed by UN Environment – supported more than 80 countries. Governments, the industry (both oil and vehicles) and civil society worked together to promote and support a global shift to unleaded fuels. To date only three countries still use small amounts of leaded fuels (all are set to stop by the end of 2017).

Health impacts: This saves an estimated 1.2 million premature deaths per year. Studies showed that blood lead levels dropped dramatically in countries where leaded petrol was eliminated. It also has a positive impact on the intelligence quotient (IQ) of children.[92]

Figure 11: The use of unleaded petrol in 2002 (left) and today (right)



Now that lead in automobile fuels has been almost completely phased out, **decorative paint is one of the largest sources of exposure to lead**. Although global regulation on white lead paint started as early as 1921, decorative paint containing lead is still sold in many developing countries. They are used in homes and schools, on furniture and toys, exposing children to this dangerous neuro-toxic pollutant.

Results:
As of April 2017, regulation on lead paint is in place in 65 countries. The Global Alliance to Eliminate Lead Paint is working towards the goal of having regulation in place in all countries by 2020. Countries that introduced new regulations include India, Kenya, Nepal, the Philippines, Sri Lanka, Tanzania and Thailand. Many paint manufacturers, including AkzoNobel and PPG Industry, the two largest global companies in the sector, have committed to phasing out lead paint. In addition, for change to materialize:

- All paint manufacturers should stop producing and selling paints containing lead additives by 2020. If they produce paints containing lead for restricted purposes, a warning label should be attached to prevent misuse. A certification scheme for lead free paints[93] has been established;

- Governments, intergovernmental organizations and non-governmental organizations should organize effective awareness-raising campaigns on lead paint at the International Lead Poisoning Prevention Week. Awareness raising campaigns were held in at least 47 countries during the International Lead Poisoning Prevention Week in October 2016.

Box 6: Climate and Clean Air Coalition - a voluntary partnership model

Established in 2012, the Climate and Clean Air Coalition (CCAC) is a voluntary partnership of governments, the private sector, civil society and other stakeholders committed to "achieve concrete and substantial action to accelerate efforts to reduce short-lived climate pollutants." Concerted global action to reduce these pollutants has the potential to prevent an estimated 2.4 million premature deaths annually from outdoor air pollution, significantly reduce the estimated 4.3 million deaths and other health impacts from indoor air pollution, and avoid more than 52 million tons of crop losses annually, while reducing the near-term warming of up to 0.5° Celsius by 2050.

The membership has grown from 7 to 115 partners including 53 country, 17 intergovernmental organization and 45 nongovernmental organization partners. The Coalition combines strong science, high-level political will, and partnership leadership, with a range of cost-effective measures to reduce emissions, commitments by partners to implement actions at home and a Trust Fund to finance some initial, collective activities. This is delivered through 11 initiatives targeting transformational change in household energy, cooling, bricks production, oil and gas production, agriculture, transport, solid waste, and national/local planning. A Scientific Advisory Panel is keeping the Coalition abreast of new scientific developments on short-lived climate pollutants that informs policy.

2.2 ACTUAL AND POTENTIAL BENEFITS OF ADDRESSING POLLUTION

Limited and inadequate as current responses may be, it is evident that tackling pollution has already brought multiple benefits. Projections indicate that further actions have the potential to enhance health and well-being and the economy.

Many case studies already point to the multiple benefits of tackling pollution (see table 7). Two success stories in particular show what change can be achieved: the healing of the ozone layer (Box 7), and the phasing out of lead in fuel (see box 5).

Table 7: Selected examples of multiple benefits of tackling pollution

Pollution area	Intervention	Benefits of interventions
Air pollution	Regulation	The United States Environmental Protection Agency regulations issued between 2004 and 2014 to limit air pollution generated benefits between US$ 157 billion and US$ 777 billion (2010 prices). Costs of implementation were estimated to be in the range of US$ 37 billion and US$ 44 billion. This is a clear indication that benefits outweighed costs by a ratio of at least 4 to 1[94]. Of the benefits accrued from pollution control of US$2,516 billion, or 3.4% of GDP, 93% was attributed to the EPA Clean Air Act.
	Air pollution reduction	The health welfare benefits of air pollution reduction in China in the period 2015 to 2025 were estimated at US$ 125 billion (2015 prices).
Freshwater	Access to drinking water	Access to improved drinking water can yield substantial welfare gains to many developing countries. WHO (2012), estimates the benefits of avoided mortality from universal access to improved drinking water to be US$ 3 billion per year (2015 prices) for sub-Saharan Africa, Asia (East, South, South-East and West), Latin America and the Caribbean. The benefits of water pollution control amounted to 7.4 billion or 0.01 per cent of GDP (2015 prices). This includes averted mortality from unsafe drinking water, externality effects from agriculture and other costs.
Chemicals and waste	Strengthened governance Management governance	In Uganda, the benefits of strengthening the governance of chemicals management for the agriculture sector are estimated to be US$ 1.98 billion over the period 2011 to 2025. Crop yield gains are estimated at 20 per cent in the cultivated areas concerned[95].
	Reduction of global mercury emissions	If global mercury emissions could be reduced by 50 to 60 per cent before 2020, the resulting prevention of water and fish contamination, and exposures to pregnant women and children, could have global economic benefits of US$ 2.2 to US$ 2.7 billion in 2020[96].

Box 7: Healing of the ozone layer

The ozone treaties[c][97] have ensured that to date more than 99 per cent of the historic baseline levels of consumption and production of harmful ozone depleting substances have been phased out. Through the Multilateral Fund, nearly US$3.7 billion has been allocated to developing countries. As a result the ozone layer is healing and is expected to be restored by the middle of the century.

Impacts:

Health impacts: Up to 2 million cases of skin cancer may be prevented each year by 2030.[98] Further, 283 million cases of skin cancer (including 8.3 cases of melanoma) will have been avoided, 1.6 million deaths from skin cancer prevented and 46 million cases of cataracts prevented for those born between 1890 and 2100 in the US alone.[99]

Economic impacts: The phase-out of ozone depleting substances has avoided loss to agricultural and fishery yields: US$ 460 billion may be saved during the period 1987 to 2060 from avoided damage to agriculture, fisheries and materials such as plastic and wood alone.[100]

Climate change impacts: Averted 135 billion tons of carbon dioxide equivalent emissions into the atmosphere from 1990 to 2010[101]. In October 2016, the parties adopted the Kigali Amendment to the Montreal Protocol in which they agreed to phase down hydrofluorocarbons (HFCs). These measures are expected to avoid up to 0.5°C of global warming by the end of the century, while continuing to protect the ozone layer.

Overall, although data are not widely available, global benefits of pollution intervention are significant even if, only looking at air and water pollution control, as well as benefits from removal of lead and reduced mercury emissions are considered (Table 7).

Moving to less polluting and nature-based technologies also offers economic and employment opportunities. Renewable energy provided jobs for 9.8 million people worldwide in 2016 [102], compared to 5.7 million in 2012.[103] Waste recycling and reuse also offers the opportunity of converting waste into economic opportunities including jobs. The scope and extent depends on the availability of the secondary materials market, which can be local (compost), national or regional (glass, fertilizers) or global (ferrous and non-ferrous materials) depending on the material recovered.[104] As secondary materials replace virgin materials (e.g., phosphate from fertilizer nutrient recovery) they reduce the resource and environmental footprint of growth but

c The Vienna Convention for the Protection of the Ozone Layer (1985) and its Montreal Protocol on Substances that Deplete the Ozone Layer (1987)

they can also have income and job impacts on primary exporting countries and hence need careful transition planning for those affected by these transformations.[105]

Environmental technologies that help to control and prevent pollution also bring tremendous trade and investment opportunities. It is estimated that the global market for environmental goods and services reached US$ 866 billion in 2011, and is expected to rise to US$ 1.9 trillion by 2020.[106] Innovation in the chemicals sector opens up new ways of using existing resources at lower cost or more productively through the development of safer alternatives to hazardous synthetic chemicals currently used in industry, and the supply of new chemical resources.[107] Forecasts indicate that total savings across industry from green chemistry developments could reach US$ 65.5 billion, and that it represents a market opportunity worth approximately US$ 100 billion by 2020.[108]

Potential of enhanced health and economic benefits from tackling pollution

Various scenarios, projections and stories of success highlight the opportunity, added value and multiple benefits of accelerating action to tackle pollution.

Under its 'Clean Air Scenario', the International Energy Agency projections indicate that an increase of 7 per cent in total clean energy investment over the period to 2040 could lead to a reduction of premature deaths of 1.7 million from outdoor air pollution in 2040 compared to the baseline scenario, and a reduction of 1.6 million deaths from household pollution. Investments focus on advanced pollution control technologies, mostly to comply with higher vehicle emissions standards, in a more rapid transformation of the energy sector, as well as stronger efforts to improve energy efficiency. Under the scenario, most people in urban areas gain access to efficient cookstoves by 2030, and in rural areas by 2040. As a result, the share of India's population exposed to air with a high concentration of fine particle falls to less than 20 per cent in 2040, from more than 60 per cent today; in China, this figure shrinks from well over half to below one-quarter, and in Indonesia and South Africa it falls to almost zero.[109]

OECD scenarios suggest that specific measures to further reuse nutrients in agriculture and reduce both domestic and agricultural discharges of nitrogen and phosphorus could bring significant benefits. By 2050, nitrogen and phosphorus surpluses in agriculture could be almost 20 per cent less than in a baseline scenario, the effluent of nutrients in wastewater could fall by nearly 35 per cent, total nutrient loads to rivers could be reduced by nearly 40 per cent for nitrogen and 15 per cent for phosphorus compared to baseline. These would require a combination of measures on nutrients: 1) an increase in fertilizer use efficiency, 2) higher nutrient efficiencies in livestock production 3) using animal manure instead of synthetic nitrogen and phosphorus fertilizers in countries with a fertilizer-dominated arable system 4) investments in sewage systems that separately collect urine from other wastewater in household 5) recycling treated wastewater back into agriculture to significantly reduce wastewater nutrient flows and fertilizer use.[110]

Well planned, appropriate ecosystem restoration, compared to loss of ecosystem services, may provide benefit/cost ratios of 3–75 in return on investments and an internal rate of return of 7–79 per cent, depending on the ecosystem restored and its economic context; thus providing in many cases some of the most profitable public investments including generation of jobs directly and indirectly related to an improved environment and health. Ecological restoration can further act as an engine of economic growth and a source of green employment.[111]

2.3 CHALLENGES THAT LIMIT THE EFFECTIVENESS OF POLLUTION ACTIONS

Evidence of continuing impacts and trends of pollution, despite current actions and the existence of environmental governance frameworks, suggest that the problem of pollution is still persistent and pervasive. In addition, new pollution issues continue to emerge for which responses are yet to be developed. Not only is administrative and financial capacity inadequate in many countries, but there is often a lack of information at many levels and data to improve on regulatory effectiveness. Beyond this there is an absence of interministerial coordination towards a pollution reduction objective. Absence of property rights or enforceable rights on the environment, for example on oceans, atmosphere, open lands, result in them being treated as dumping grounds. Stronger action on pollution is observed with higher income and development levels caused by greater availability of resources, less competing policy objectives (as pollution is still often seen as a trade-off with economic growth), and greater citizen demand. Emerging risks exist from new chemicals and materials (e.g. endocrine disruptors, nano-materials), although not enough information is available on their impacts on the environment and human health and well-being.

The following key gaps have been identified to explain why pollution is still an issue:

1. **Inadequate awareness, data and information on pollution:** There is a need for much greater awareness of, and information on, the sources of pollution, the pathways, impacts and (potential) risks to food, health and well-being, and ecosystems, for preventive and curative actions to be taken by relevant parts of society. Such information disclosure and sharing will help develop more effective interventions and allow the public to play a role in ensuring government institutions and the regulated community meets their legal obligations and strengthen implementation. This includes addressing the lack of knowledge on chemicals spread globally through the use of everyday products such as textiles, household products, toys and electronics as well as the lack of information on chemicals in products when recycling materials. This would reduce exposure to toxic substances and remove obstacles to resource efficiency;
2. **Poor institutional and technical capacity:** Effective regulatory functioning and strong monitoring and enforcement institutions are key to addressing pollution. In many countries even when regulations exist, the resources and capacity for implementation, enforcement, and monitoring are lacking;
3. **Absence of infrastructure to manage and control pollution:** Major forms of pollution exist due to the absence of infrastructure, such as wastewater and sewage treatment plants, controlled waste collection, reception and disposal, recycling facilities, food storage, etc. This lack of infrastructure not only prevents better practice, but also enhances hazards associated with pollution, such as waste dump collapses, flooding of sewage water or disease outbreaks after natural disasters;
4. **Limited scope and scale of finance and industry leadership on pollution matters:** While larger companies are increasingly disclosing pollution costs and risks of portfolios and investments, systemic internalizing and reporting of costs of pollutions and externalities is often lacking in small and medium firms. Improved assessments and reporting of pollution exposure risks need to be supplied by industry to ensure more informed product and process regulation;
5. **Mispricing and invisibility of ecosystem values and absence of internalization of pollution costs:** Lack of valuation of ecosystem goods and services, such as those from oceans, rivers, land, wetlands, and others result in the treatment of these ecosystems as dumps and sinks for waste. Subsidies on e.g., energy, water, electricity, commodity crops, also result in wastage and over-use. One of the key barriers to change is the absence of

integration of economic costs of pollution in policy and decision-making. This results in choices made without full knowledge of what is being traded off. Integration of economic costs of pollution into product pricing would incentivize consumers to make more informed choices and would create pressure on producers to reduce their pollution footprint and adopt better practices;

6. **Limited understanding of pollution's social dimension:** There is a need for more disaggregated data to better understand the different health impacts of some pollutants on women, men, children and the elderly. There is very little research on how such impacts are shaped by social and occupational roles, and vary across contexts and over time. It is therefore important to carry out social impact assessment taking into account the regional and national contexts, gender dimensions, economic vulnerability and geospatial differences;
7. **Lack of capacity, knowledge-sharing, funding and technologies**: countries and communities– especially developing and emerging countries – often lack capacity and technologies to manage pollution. There is also a lack of financial resources and information on available technologies, to implement many of the multilateral environmental agreements related to pollution. Not enough knowledge is shared about successful and failed policies and solutions adopted by countries to better manage pollution. These need to be shared more widely allow countries to leapfrog in terms of knowledge, technological and nature-based and green solutions;
8. **Behaviour of citizens, the profit motivation of industry and the short termism of governments result in choices that have pollution consequences:** such choices even when regulations and policy exist suggest the need of a serious engagement with their rationale. These can be out of habit, a feeling that one person/firm cannot make a difference, a free rider problem, peer pressure or the lack thereof, social norms and practices and even the absence of information on products and alternative affordable options.[112]

2.4 THE SUSTAINABLE DEVELOPMENT GOALS: AN OPPORTUNITY TO ACCELERATE POLLUTION ACTION

The 2030 Agenda for Sustainable Development offers a great opportunity to enhance and accelerate action to tackle pollution. Pollution control and reduction will also create multiple opportunities for achieving the Sustainable Development Goals in a mutually beneficial manner.

Every pollution area described under Part 1 is addressed by one or more targets. Addressing pollution helps to reduce poverty (Goal 1) as it improves health and worker productivity and work days. Addressing pollution 'protects' the poor as these are often most exposed to pollution for lack of options in where they work, live or how they cook or what they eat or drink. Addressing pollution also contributes to poverty alleviation by support to Target 15.9 on 'integrating ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts'. Addressing pollution in all its forms helps to fight hunger and ensure the provision of safe food year round (Target 2.1), as it tackles the food safety issues of irrigation with untreated wastewater/ sewage as well as the growing of food on contaminated soil. In all actions against pollution, it is also important to ensure women's equal participation, decision-making and access to opportunities and resources (Goal 5). In this respect, the provision of clean water (Goal 6) and energy (Goal 7) also have the co-benefits of reducing the unpaid domestic burden of women, and women's risks of suffering gender-based violence on the way to water and firewood collection. Under Goal 3 on health and well-being, one target (Target 3.9) is central, requiring that by

2030 we "substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination". Human health and the environment (and therefore efforts in sustainable development) are compromised by the mismanagement of chemicals and waste, which form a fundamental obstacle to the achievement of the SDGs. This is strongly linked to how we produce and consume (Goal 12) and reduce resource degradation, pollution and waste.

Other goals and related targets are also essential to reduce and prevent pollution, such as Target 6.3 under Goal 6 that aims to improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials. Not only could it significantly reduce the number of deaths from diarrhoeal diseases, but also provide incentives to more innovative water resource management practices, including recycling and safe-reuse. The prevention and significant reduction of all kinds of marine pollution, in particular from land-based activities, including marine debris and nutrient pollution will help achieve Goal 14. The ubiquity of marine litter poses risks to ecosystem and human health through the potential bioaccumulation of toxic substances as well as habitat destruction, taking a heavy toll on local fisheries.

Clean household energy (Goal 7) and access to affordable, reliable, sustainable and modern energy can cut air pollution indoors, which will particularly benefit women and children. Sustainable transport, waste management, buildings and industry (Goal 11 on inclusive, safe, resilient and sustainable cities and settlements) will lead to cleaner air in cities. Those policies could prevent more than six million deaths each year due to air pollution and mitigate climate change and its impacts (Goal 13).

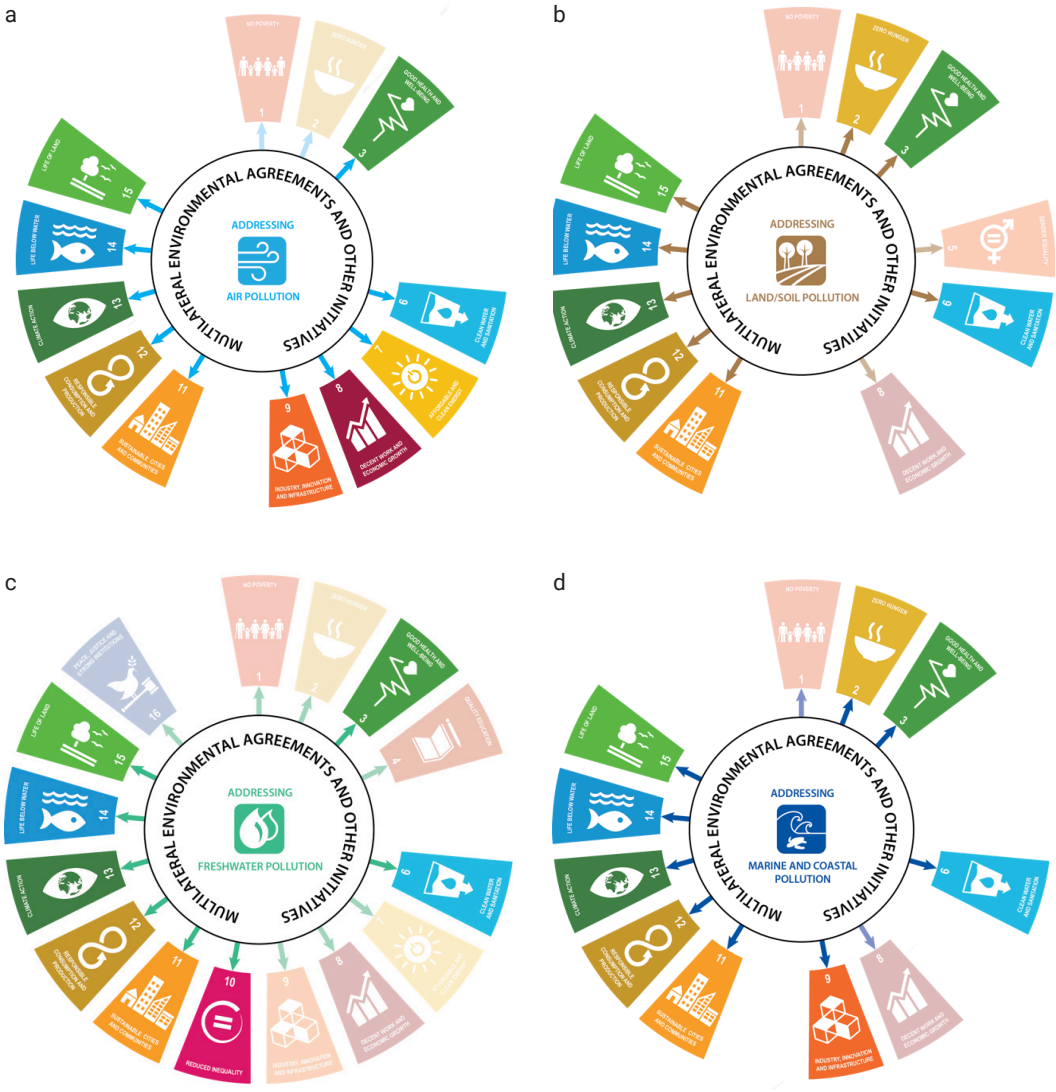
Another group of Sustainable Development Goals is instrumental in enabling the effective implementation of actions to address various forms of pollution. Goal 16 provides the momentum for good governance, public access to environmental information, public participation and access to justice for all in environmental matters. Goal 17 is an enabler for achieving all Sustainable Development Goals and focuses on means of implementation, such as finance, technology, capacity development, global partnerships and policy coherence. Goal 4 promotes quality education so that people acquire the knowledge and skills needed to promote sustainable development and sustainable lifestyles (Target 4.7).

A fundamental principle of the 2030 Agenda is to "leave no one behind". In the context of pollution, this means that no group or community is made to bear a disproportionate share of the harmful effects of pollution. Sustainable development is not possible without a healthy population. Goal 10 – the inequality goal – includes the specific target: 'By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status' (Target 10.2).

As all Sustainable Development Goals are interlinked and indivisible, while there is ample scope to achieve synergies from acting on various SDGs to reduce pollution, there is also potential conflict between achieving targets related to economic growth, industrialization, infrastructure, agricultural development and urbanization, and working towards a pollution-free planet. A case in point is Target 2.3 which aims at doubling agricultural productivity by 2030. However, this may result in increased air, land and freshwater pollution, in a business as usual scenario. Modelling studies suggest that sustainable consumption and production (Goal 12) policies are the most effective in reducing trade-offs.[113] Addressing pollution therefore requires an integrated approach and a strong science-policy interface to build synergies and avoid negative impacts.

Figure 12 visualizes how addressing pollution through environmental agreements and other international initiatives does –directly or indirectly- support the achievement of the Sustainable Development Goals. Annex 5 provides a detailed mapping of the specific targets that are benefiting from addressing pollution and also explores in a preliminary way how the international environmental governance landscape is currently set up to address pollution.

Figure 12: Co-benefits of addressing pollution through multilateral environmental agreements and other initiatives in achieving Sustainable Development Goals. The contribution can be direct (e.g. emission reduction – solid icons) or indirect (e.g. protect ecosystems – transparent icons). The four graphics represent addressing (a) air pollution, (b) land and soil pollution, (c) freshwater pollution and (d) marine and coastal pollution.



Sources: IAEG-SDG 2016[114] , UN-Water 2016[115] (basis for freshwater pollution map); Le Blanc et al. 2017[116] (adapted marine and coastal pollution map)

The 2030 Agenda also provides business with an opportunity to respond to the SDGs and to act on pollution. The Business and Sustainable Development Commission in their 2017[117] report proposes to business leaders an alternative to business as usual, in the form of a business strategy in line with the SDGs. The report shows the linkages between business needs and the global goals. The report identifies at least US$ 12 trillion in opportunities, of which the 60 biggest are in food and agriculture, cities, energy and materials and health and well-being. Many of these opportunities are important to help mitigate pollution and reduce, recycle, recover and remake.

2.5 MULTI-STAKEHOLDERS AND MULTI-LEVEL ENGAGEMENT: CENTRAL TO IMPROVED ENVIRONMENTAL GOVERNANCE

The challenges of addressing pollution despite the existence of Multilateral Environmental Agreements (MEAs) suggest the need for a greater multi-level and multi-actor coordination and policy coherence across global, regional, national, subnational and local levels. Improving environmental governance calls for the following:[118]

- **Strengthening the science-policy-business-society interface:** Bringing knowledge flows into policy requires a rigorous political economy analysis, taking science to various communities; incorporating traditional, business, and other knowledge into science; and bringing all of this combined knowledge into policy formulation;
- **Supplementing and complementing legal agreements and conventions with more outcome-based and light footed, voluntary initiatives:** International and regional agreements require national implementation, which in turn requires appropriate infrastructure, capacity, local partners and direct technical and financial assistance. There are several benefits of having the global and regional environmental agreements work together, and more synergistically with other initiatives. Supporting voluntary initiatives such as the Global Plan of Action on the Protection of the Marine Environment from Land-based Sources, the Climate and Clean Air Coalition, the Batumi Action for Cleaner Air, the Global Alliance for Clean Cookstoves, Global Partnership on Marine Litter, the Lead Paint Alliance, Partnership for Clean Fuels and Vehicles, Global Mercury Partnership, Principles for Sustainable Insurance, etc., can provide the integrating, catalytic, and scaling up power of partnerships and initiatives for layered actions and next steps;
- **Engagement of diverse actors and stakeholders:** Protecting the environment and human health using resources in a sustainable way and combating pollution require commitment and action from all parts of society: governments (national, provincial and local), industry, civil society, the academic and scientific community, youth groups, farmers and the individual consumer. Involving diverse actors early in the discussions enhances the understanding of the problem and the viability of proposed solutions and enables the buffer that is required in the face of reluctant parties;
- **Engagement of industry and the business community in solutions:** One of the key reasons, among others, for the success of the Montreal Protocol was that relevant industrial sectors were assisted to transition to new technologies and improved practices. Ozone-depleting substances phase-out brought significant investment in the innovative redesigning of products and equipment to use greener chemicals, and has stimulated more efficient production processes including energy efficiency;
- **Integrated innovations in production systems with social considerations, competitiveness and employment:** Changing production systems involves conversion of existing production facilities and training of personnel in new technologies and processes while retaining existing jobs, in order for the protection of the environment to go hand in hand with social development and economic growth.

It is evident that pollution is a much more pervasive and complex problem that cannot be resolved solely through global and regional multilateral agreements, even with better coordination and synergies. The problem of pollution is closely connected with behavioural and technology choices, production and consumption practices, industrial processes and pricing policies, financial and business sector orientation and a culture of consumerism and irresponsibility to the environment and impacts on people's health.

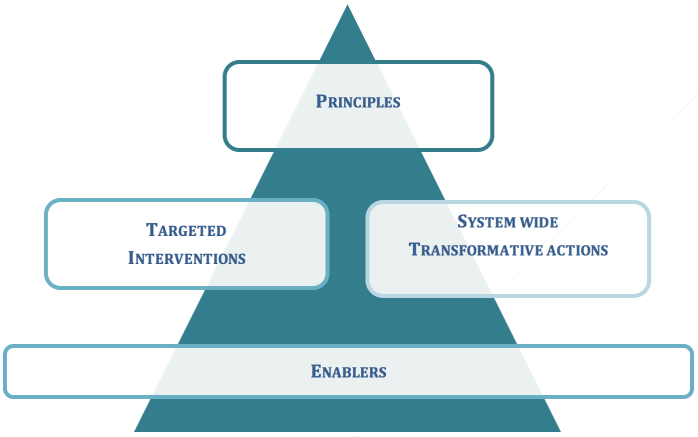
3 Transitioning to a Pollution-Free Planet

Transitioning towards a pollution-free planet is an aspirational goal. It seeks to eliminate the waste, hazardous pollutants, and pollution of media that emanates from anthropogenic activity and that degrades ecosystems and impacts human health and welfare of the living species.

As populations grow and more people escape poverty and aspire to improved consumption, the linear economic model of "take -make-dispose" can no longer be maintained as it results in ever more waste and pollution of an already polluted planet. Instead, transitioning to a pollution-free planet needs innovation, targeted and time bound action (with focus on the most urgent and hard hitting pollutants and polluted areas), as well as a more pervasive longer term shift in the economy to be low carbon, circular and less toxic. This transition can only take place if accompanied by system-wide enablers, and preventive and curative actions, based on opportunity and innovations.

This section proposes a framework for actions that seeks to reinforce integration and coherence in the way society responds to social, environmental and economic challenges related to pollution. It fully recognizes that what already has been achieved by governments and stakeholders needs to be built upon and can be reproduced in other countries through sharing and adoption of good practices. Targeted pollution interventions can be both based on global and regional environmental agreements, or direct action beyond these to address the most pressing problems. It then provides suggestions on how both targeted interventions as well as transformative actions can be supported by system-wide enablers to avoid and reduce pollution in the medium and the long term.

Figure 13: A framework for actions



The Rio Principles (Annex 6) and the 2030 Agenda for Sustainable Development guide this framework of actions. The five principles which underpin the framework are universality, sustainability, integration, precaution and inclusiveness. Irrespective of the voluntary commitments and confirmed actions stakeholders may take, and the urgency and ambition with which they choose to take them, the five normative principles imply that all interventions for action on pollution should consider that:

(i) **Everyone in society is responsible for moving towards a pollution-free planet.** While national governments have a clear role in enabling and guiding actions and including pollution management into development agendas, the state and local authorities, communities, businesses, multi-stakeholder partnerships and citizens have a clear responsibility to act;
(ii) **Access to environmental information and data, education and public participation** are key to effective actions and enhanced access to justice in environmental matters;
(iii) **Multiple risks to human health and well-being, especially to women, children and vulnerable groups, and to ecosystem health require a preventive approach.** The precautionary principle and the polluter pays principle are key for guiding change, as these ensure not just responsibility but stewardship by different societal actors, ensuring the financing of pollution abatement and reduction and holding the originator of pollution liable;
(iv) **Innovation and leadership are central to tackling pollution in an effective and impactful manner;**
(v) **Multiple benefits of action on pollution need to be recognized, policy uncertainty reduced, and innovation placed at the centre.** This will require a 'whole-of-government' approach.

3.1 TARGETED PRIORITY INTERVENTIONS FOR POLLUTANTS AND KEY POLLUTION AREAS

Part 2 shows that—despite the existence of international agreements and other initiatives—important gaps remain in addressing pollution.

3.1.1 Interventions targeting hard hitting pollutants

The evidence in Part 1 highlights a number of hard hitting pollutants and those that have crossed exposure thresholds (where these have been established). Targeted interventions are needed to eliminate or reduce risks posed by these pollutants.

Table 8 gives an overview of the main categories of these hard hitting pollutants based on what could be done to reduce their risk to human health and ecosystems. Possible near term interventions to address priority areas mostly at a multilateral and global level have been identified where:

1. International risk reduction actions are already agreed, mainly through MEAs, but implementation needs to be scaled up;
2. Scientific evidence and/ or global agreement exists to reduce risks but policy actions are required;
3. Emerging scientific evidence concerning human health and the environment warrants a greater understanding of the nature and magnitude of risks.

Table 8: Types of action per pollutant categories, based on scientific evidence

Chemicals/Pollutants	Scientific evidence	Objective/Focus of Action
• Persistent Organic Pollutants under Stockholm Convention (PCB-polycholorobyphénile, PB-DEs- Polybrominated dyphenil ethers, DDT- dichlorodiphenyltri-chloroethane, Endosulfan) • Mercury • Asbestos (ILO Convention)	International risk reduction action already agreed (mainly through MEAs)	• Need to scale up implementation action (through e.g. identification of alternatives, financing, strengthening institutional and technical capacity, compliance assistance teams, industry support)
• Highly Hazardous Pesticides • Lead • Other heavy metals (cadmium, arsenic, chromium) • Phosphorous and Nitrogen • Environmentally Persistent Pharmaceutical Pollutants • Chemicals included under Rotterdam Convention • Selected solvents (e.g. trichloroethylene) • PVC polyvinyl chloride • Certain fluorinated compounds (e.g. PFAS) • Selected flame retardants • PM 2.5 – PM 10 (Particulate Matter) • Black carbon • Ground level ozone • Sulphur dioxide • Nitrogen oxides	Scientific evidence exists to advance risk reduction action	• Enforce emission and release standards if in place, establish standards if none exist. • Apply best available techniques and best environmental practices • Identify and promulgation of further appropriate risk reduction measures at the national and possibly international level[d] including full implementation of the Globally Harmonized System for Classification and Labelling of Chemicals (GHS)[119] • Improve resource efficiency and sustainability in production methods to increase recycling and reuse of material where feasible and in accordance with international, regional and national requirements (catalysts, solvents etc.)
• Endocrine disrupting chemicals • Nanotechnology • Neonicotinoids • Certain pharmaceuticals	Emerging scientific evidence concerning risk to human health and environment	• Need to scale up research and knowledge-sharing to better understand nature and magnitude of risks in particular in developing countries • Apply precautionary principle

d Measures may include bans, restriction, standards, labelling, economic incentives.

The policy actions and support required should consider putting in place the right regulations and legislation, and voluntary industry agreements developed with broad stakeholder input, and public awareness to promote the need for action.

3.1.2 Interventions targeting key pollution areas

There are 29 interventions to target specific forms of pollution mostly at a national/regional level – also taking into account the transboundary aspects of pollution – highlighted below for immediate action where commitments from different stakeholders are needed to fast track pollution prevention and reduction.

Air pollution

1. Adopt the World Health Organization air quality guidelines, including those for indoor air quality, as a minimum for national standards and invest in strong air quality monitoring systems;
2. Meet World Health Organization air quality guidelines, through the reduction of emissions from major industrial sources including particulate matter, sulphates, nitrogen oxides, persistent organic pollutants and heavy metals;
3. Reduce global vehicle emissions by at least 90 per cent through the introduction of advanced vehicle emissions standards (e.g. at least Euro 4 level) in 5 years and a move to only electric vehicles being added to fleets by 2030;
4. Offer effective and affordable public transport and non-motorized transport infrastructure in all cities above 500,000 inhabitants by 2030;
5. Increase the share of non-polluting renewable energy sources such as solar, wind, and tidal to 36 per cent by 2030, while addressing production and waste stages related to for example solar panels (notably batteries);
6. Increase access of households to clean cooking fuels and technologies;
7. Protect and restore ecosystems to avoid air pollution in drylands, rangelands and other areas prone to erosion, fire, desiccation and other forms of degradation;
8. Expand green spaces in urban areas to improve ambient air quality in cities.

Water pollution

9. Provide clean drinking water and sanitation for improved health by 2030;
10. Avoid direct disposal of untreated wastewater into the environment and reduce the amount of untreated wastewater that is discharged into freshwater bodies by at least 50 per cent by 2030, through improved wastewater treatment, increased access to safely managed sanitation and improved land management practices;
11. Establish adequate water quality monitoring networks, including for tracking municipal and industrial effluents, in all significant freshwater bodies;
12. Protect and restore wetlands and other natural systems contributing to water purification.

Land and soil pollution

13. Optimize fertilizer use in agriculture and enhance nutrient management and plant uptake efficiency to reduce excess nutrient run-off and water contamination;
14. Increase the use of non-chemical alternatives to fertilizers and pesticides and adoption of agroecological practices;
15. Control the use of antimicrobials in the livestock sector to avoid releases into the environment;

16. Support the improvements in pollutant inventory systems, especially for mining, and make sustainability reporting mandatory;
17. Provide funding for long-term environmental monitoring after a mining project is closed, to ensure that rehabilitation is effective.

Marine and coastal pollution

18. Phase out single-use plastics and modify manufacturing in order to reduce packaging and phase out non-recoverable plastic materials;
19. Stop the production and use of plastic in non-recoverable items, such as microbeads in personal care products and cosmetics.

Chemicals and waste

20. Identify and characterize pollution / chemicals-related hotspots (such as obsolete stockpiles of chemicals, contaminated sites) to protect vulnerable groups and the environment, minimize exposure and take measures to decontaminate them and prevent new ones;
21. Reduce and mitigate risks associated with extractive activities, including controlling the use and release of chemicals in mining, and mercury in artisanal and small scale gold mining;
22. Effectively provide and apply reliable information along the product life cycle, including at the consumer stage, in particular on the presence of harmful chemicals in manufactured products and raise consumer awareness of hazards and risks throughout the value chain;
23. Develop eco-labelling schemes to inform customers on the potential environmental and health impact of their consumer choices;
24. Extend product lifespans through sustainable design, maintenance and upgrades, and recovery of broken products;
25. Reduce exposure to lead through actions on battery recycling, pottery, and paint;
26. Phase out mercury use in a number of specific products by 2020 and manufacturing processes by 2025, and phase down of dental amalgam and in mining;
27. Minimize waste generation, improve collection, separation and final disposal practices and regulation;
28. Eliminate uncontrolled dumping and open-burning of waste.;
29. Phase out the production and use of asbestos.

3.2 TRANSFORMATIVE ACTIONS TO SHIFT THE ECONOMY

Transition to a pollution-free world can drive innovations in the economy through viewing regulatory compliance as an opportunity rather than a cost. Innovations can draw on a fusion of technologies – digital, biological, information and connectivity technologies[120] to not only clean the environment, but also as a driver of economic productivity and job creation. This requires that: production and supply chains are made cleaner; products and services are designed to be reusable, durable, recoverable and recyclable; and new business models are developed while creating good and next practice platforms. Leadership, policy certainty and investments in talent are critical to incentivizing innovations.[121]

Key actions required to achieve system-wide, long-term change include:

(i) Building circularity into production processes and supply chains and key economic sectors;
(ii) Redirecting finance and investments to less polluting and cleaner economic activities;
(iii) Promoting and disseminating green technologies and ecosystem based solutions to prevent, better manage and reduce pollution;
(iv) Scaling up actions on pollution through horizontal and vertical integration; cities and local governments play a key role in that respect;
(v) Incentivizing responsible consumption and lifestyles choices.

3.2.1 Building circularity into production processes and supply chains and key economic sectors

Production and supply chains need to become circular, responsible, and green and focused on the 5 Rs - reduce, reuse, recover, recycle, remake. Where waste is produced, it is regarded as a resource, an investment and an employment opportunity. This involves a review of industrial processes and provision of organizational solutions to reduce pollution, adopting a preventive and circular approach.

Systemic changes aiming at preventing pollution require a complete life cycle approach. While individual producers can decide to adopt such an approach, transformative change can only materialize if individual companies' efforts are supported by an enabling environment.[122] The use of life cycle approaches in the regulation of toxic chemicals is key, as the hotspots can be delineated and targeted for regulation. Gathering data to identify substances that pose a risk based on known intrinsic properties through watch lists is another way to improve regulation. Lack of knowledge on chemicals spread globally through their use in everyday products such as textiles, toys and electronics as well as the lack of information on chemicals when recycling the material from such products is an obstacle for resource efficiency and raises the risk for pollution. In order to incentivize life cycle and circular approaches to material and product flows, integration of the costs of pollution in the process of production and supply chains is a central game changer.

Environmental goods and services encompass a broad range of products and services for pollution control and management for air, water, waste, and noise. By opening markets for these products and services, international trade and investment help to connect producers with consumers, stimulate innovation, reduce costs through economies of scale, and make pollution control technologies more accessible to less developed countries.

Box 8- Life cycle management to address pollution and improve production chains in industries: the example of a Ugandan organic produce cooperative

RUCID, Ugandan organic produce cooperative (dried fruits and fruit juices), applied the Life Cycle Management (LCM) concepts to their company resulting in significant changes in the way they considered their resources and waste, relationships with their suppliers, creation of new market opportunities (systemic changes in their production chain). They were supported by a conducive policy environment backing organic agriculture (adapting the country to reduced access to agro-chemicals). Applying LCM led to systemic change to the way they do business, and to the adoption of new technical solutions, including increased fuel efficiency in their boilers (identified as a hotspot through the life cycle management approach); replacing fuelwood by biogas produced from their own waste (with significant increase in efficiency and product quality); turning waste streams into new market opportunities (e.g. producing pineapple suckers from the crowns, instead of wasting them). They reported a 25 per cent increase in revenue in the first year of applying the learnings from the LCM approach.

More info:
http://www.lifecycleinitiative.org/case-study-rucid-fruit-juices-and-sun-dried-fruit-crisps/

Although all economic sectors need to revisit their production and supply chain processes, four sectors are particularly highlighted in this report due to their significant role in causing but also solving some of the most blatant pollution issues:

- food and agriculture systems to reduce footprints but also become more sustainable and resilient;
- the extractives sector;
- terrestrial transportation as well as building and construction as examples of particularly intensive energy sectors.

Table 9 provides examples of measures that can be taken at every stage of the production or supply chain of any given sector in order to prevent, better manage and reduce pollution

Table 9: examples of actions to prevent, better manage and reduce pollution in key economic sectors

Cleaner production	Changing supply-chains/ enabling systemic change	Incentivizing sustainable consumption
Food and agriculture systems		
Incentivizing the uptake of more sustainable, climate smart and agroecological production systems and technologies at the farm and landscape levels • Recalibrate current subsidies to reward good behaviours on farm rather than perpetuating bad • Adopt the integrated landscape approach/management that follows the principles of ecosystem management, sustainable land and water use reduce footprint and builds resilience of farming systems and increase diversity • Apply the principle of minimum harm in registering pesticides, managing pests, weeds, and disease and good on farm chemical input management including the use of Personal Protective Equipment, storage and disposal of containers	• Develop more integrated strategies and transformative road maps, as well as enabling conditions for specific innovations towards more sustainable food systems at national and local level • Engage food manufacturers and producers to produce more sustainable products and supply chains, reduce post-harvest losses and food waste in the entire food chain • Apply the polluter pays principle to pesticides and chemical fertilizers to level the playing field by internalizing the costs of pollution	• Promote more sustainable consumption of food through education around healthy, more nutritious and diverse diets, consumption of locally grown foods and the reduction of food waste
Extractives – liquid (oil), gaseous and solid/mineral reserves		
The Extractives/Materials sector needs to lower its overall footprint and ensure that best standards and practice becomes normal practice: • Minimize waste, reduce pollution of air, soil and water and reduce resource use during production • Address resource scarcity and stranded assets by providing more accurate scenarios on demand and supply that are ecologically viable and integrate societal needs and constraints • Promote best available technology in the production chain including for methane pollution reduction, water use and tailings • Reduce, and where feasible, eliminate mercury use in artisanal and small scale gold mining • Ensure safe management of chemicals (notably cyanide) that are produced, transported and used for the recovery of ores, and on mill tailings and leach solutions • Support investment and research into new mineral extraction technologies to maximize efficiency and reduce the consumption of water and minimize waste and ensure safety of tailings storage facilities and waste disposal methodologies	• Engage with companies to Internalize environmental risks and costs related to depletion of ecosystems, biodiversity loss, soil erosion and degradation, and water pollution through indicators, mitigation hierarchy and monitoring systems • Increase connection between governments and industries to manage coexistence of extractive and other land uses and make informed decisions and trade-offs • Work with government to manage and redirect revenues from extractive activities towards sustainable development and environmental services • Encourage further transparency and access to information on environmental and social risks and impacts to reduce asymmetries of information and have an integrated approach along the whole value chain	• Increase recycling rate of minerals and availability of information and data on recycle material availability • Enhance coherence between market-based standards, due diligence processes and certification schemes with legislation and regulation in both countries of production and countries of consumption to ensure environmental responsibility from source to destination (e.g. “conflict minerals”.)

Transport sector		
• Adopt cleaner vehicle emission standards of Euro 4 level (aiming ultimately at EURO 6 emissions standards) • Adopt cleaner fuels standards, including eliminating leaded petrol and introducing low sulphur fuels of not more than 50 parts per million (aiming ultimately at 10 parts per million) • Develop national road maps for only electric vehicles – all new vehicles to be added should be electric as from 2030. By 2050 the complete global fleet should be electric • As technologies further develop and become cheaper, heavy duty transport, trucks, and aircraft need to switch to electricity[123]	• All large cities should have effective, safe, friendly to all (including women and children), and reasonably priced mass transit and/or public transport systems • Countries and cities should adopt policies for active transport (walking and cycling) that will result in all new roads to be built and existing roads being upgraded to include facilities for active transport • Cities should introduce clean bus fleets	• Urban mobility systems need to maximize shared vehicle trips. New approaches to urban planning will be required to achieve this • Cities need to developed integrated mobility plans that combine public transport with active transport and electric transport, this can include zoning
Buildings and construction sectors		
In all countries, minimize the environmental impact of construction and operation of buildings through application of life-cycle approaches and sustainable building policies. • Apply resource efficiency and energy efficiency as guiding principles in policies, building design and in operations and maintenance • Reduce toxicity of building materials and on-site construction processes, including demolition and management of construction waste • Upscale use of recycled building materials and resource recovery programmes	• Promote use of certification systems, as an approach to address sources of indoor pollutants, such as Heating, Ventilation and Air-Conditioning (HVAC) systems and particulates from toxic or chemicals in building materials, such as plaster, paint, construction compounds and plastics • Support development of life-cycle approaches and databases for building and construction related products • Engage stakeholders (designers, contractors, suppliers, governments, end users and SMEs) to strengthen environmental standards for building products and construction processes • Enhance decision-making on housing choices, including from consumers as well as through government housing strategies to enable integrated approaches at urban level (land use, infrastructure, transport, waste, district energy, etc.)	• Support mainstreaming of sustainable buildings through industry initiatives and networks, as well as incentives such as green mortgages, leases, etc. • Raise awareness of resource and energy efficiency to influence consumer behaviour and decisions on lifestyle choices, including buildings and appliances

3.2.2 Reorienting finance and investments

Financial institutions have an important role to prevent and mitigate pollution, and reduce its negative impacts by:

- **Internalizing the costs of pollution in financial decisions:** Pollution impacts that were previously considered by financial institutions to be externalities are becoming more material.[e] A range of environmental risk analysis tools and techniques are already being developed, including, for example, the use of 'environmental scenario risk analysis' which then influence financial flows. The primary focus of innovation in this market has been at the firm level, however there are also examples of innovation being driven at the industrial sector level, often in response to new regulations on environmental and social risk management;

- **Disclosure of costs and risks of pollution:** Enhanced reporting on environmental and social impacts enables more responsible portfolio choices by investors. Increased disclosure can be voluntary, but decision- makers have a key role to play in levelling the playing field through mandatory requirements;

- **Reorienting financing away from polluting companies and activities and towards greener technologies:** Financial institutions can refrain ("divest") from any further investment or lending to companies or activities identified as highly polluting. They also have the option to maintain at least part of their funding to these activities but use it as leverage to engage with the companies to explore means of reducing their impact by, for example, adopting environmentally sustainable production methods, such as renewable energy, water-efficient irrigation and waste recycling;

- **Preventing, reducing, managing and carrying risk:** Insurance pricing can reward risk reduction efforts from companies, private and public sector investors, local authorities or individuals. As risk managers, insurers also help communities understand, prevent and reduce risk through risk research and analytics, catastrophe risk models, and loss prevention measures. There are many examples of insurance industry initiatives on pollution and climate change (box 9).

e Financial institutions have been addressing environmental sources of risk for many years through compliance with regulation, voluntary industry policies and products such as environmental pollution liability insurance (also known as environmental impairment liability insurance). But these impacts have always previously considered as externalities.

Box 9: Examples of actions by insurers on pollution

Examples of innovative insurance industry initiatives on pollution and climate change include:

- Since 2009, the Brazilian insurer, SulAmérica has encouraged the use of water-based paints in its accredited auto shops to repaint damaged vehicles. In 2013, it launched its Responsible Disposal programme for its home and business insurance clients. In partnership with Ecoassist Serviços Sustentáveis, the programme provides services to collect, separate and recycle home appliances, consumer electronics and furniture. Since the start of the programme, 76 collections have been made in 19 cities of seven states. About 2,300 items have been collected, totalling 9.2 tons of waste, which have been disposed of in an environmentally-responsible way;

- Allianz offers tailor-made insurance products for large-scale renewable energy projects, green building insurance, and advisory services to cover facilities or offices that have been built or refurbished to be more resource efficient. For retail clients, examples include special discounts on car insurance for drivers with fuel-efficient vehicles, property insurance for roof-mounted solar panels, and investment products which allow customers to invest their money in funds that support sustainable development;

- In May 2015, AXA became the first global financial institution to divest from companies most exposed to coal-related activities, amounting to EUR 500 million. It also committed to tripling its green investments to more than EUR 3 billion by 2020, mainly in clean technology, green infrastructure and green bonds. In November 2015, Allianz announced that it will stop financing coal-based business models, affecting investments worth about EUR 4 billion, and committed to double its wind power investments to EUR 4 billion. Moreover, in April 2017, AXA became the first global insurer to disengage from underwriting insurance for coal-intensive businesses.;

- Munich Re, the world's largest reinsurer, has dealt with renewable energy risks for more than 20 years. To extend its competence, Munich Re established Green Tech Solutions Corporate Insurance Partner to pool expert resources and know-how, offering insurance solutions for photovoltaics, solar thermal power, wind energy, LED technology, and energy efficiency projects to cater to stakeholder needs across the renewable energy value chain. Munich Re also offers green property insurance products that enable entities such as schools and municipalities that suffer a loss to rebuild according to the LEED® Green Building certification. Furthermore, Munich Re has joined forces with Impact Hub Munich to support social entrepreneurs and initiatives such as Hawa Dawa ("air medicine"), which aims to empower citizens, organizations and cities to work towards cleaner and healthier air through a bottom-up air quality monitoring technique that provides remote, real-time and in situ air quality data, anytime, anywhere.

All these insurers are signatories to the Principles for Sustainable Insurance (PSI), a global sustainability framework and initiative developed by UN Environment's Finance Initiative and endorsed by the United Nations Secretary-General and insurance CEOs.

3.2.3 Promoting green technologies and ecosystem based solutions to mitigate and manage pollution

3 categories of technological solutions serve to address pollution:

- **Pollution prevention and reduction technologies,** which are more energy/resource efficient and create less pollution in their life cycle than those they replace or eliminate the source of pollution entirely. Cleaner lighting, for example, offers great environment and health benefits (see box 10 below). Some of these emerging technologies include those for clean energy, industry, health, transport, waste management and agriculture. For example, a recent project in Nepal replacing traditional brick kilns which had collapsed in the 2016 earthquake with more efficient induced draught and zigzag kilns reduced particulate matter emissions by 60 per cent and reduced coal consumption by up to 50 per cent when compared to traditional kilns.[124] Biotechnology is being used for cleaning oil-contaminated environments using bacteria or fungi for decontamination. Drone technology helps to monitor crops leading to substantial reductions in the use of resources particularly fertilizers and water;
- **Recycling technologies** recover valuable materials from waste or wastewater, preventing pollution of the environment. In the area of water treatment, new technologies are being used to transform wastewater into drinking water and energy resource. A level playing field is however required in terms of environmental standards for recycling markets to expand for the purposes they are being designed: resource recovery, environmental protection, efficient resource use. In its absence, materials will be exported to countries with low environmental standards for re-export to the originating countries;
- **Pollution treatment and control technologies,** which monitor pollutant emissions and ensure that toxic pollutants are not released in the environment.

However, some green technologies can also involve trade-offs, as seen with green energy, between reduced carbon emissions but increased material use.[125] Hence the need to address product design and material use early in the development of these technologies.

Box 10: Cleaner lighting

A switch to electric lighting is the most promising pathway to fully eliminating the risks associated with fuel-based light sources, while also contributing to climate change mitigation.[f] Improved lighting technologies for use by women and children will yield particularly significant health benefits by significantly reducing indoor air pollution. These include improved illumination in health care facilities, and safe and efficient lighting systems distributed and promoted where housing is dense and poorly defended from fire, also potentially making urban spaces safer for women. The potential savings and benefits estimated for 120 developing countries and emerging economies, if they were to transition from fuel-based lighting (i.e. kerosene and candles) to solar LED lanterns, are up to 120 million barrels of kerosene a year and 1.31 million tons of candles a year. This would be equivalent to 42 million tons a year of CO2 and US$17 billion a year of residential revenue savings.

f UN Environment carried out a study to compile and synthesize information on the health and safety impacts of fuel based lighting from 112 data sources and 33 countries

Ecosystems based solutions

- Ecosystems play a vital role in reducing quantities of pollutants in the air, water and soil. Pollution regulating services provided by ecosystems greatly alleviate the harmful effects of pollution on human health. Managing and restoring ecosystems can consequently enhance the provision of pollution regulation across rural as well as urban landscapes;
- Green infrastructure can be used to great effect in urban areas to improve air quality. Examples include vegetative barriers (e.g. hedges) and green/living walls and roofs. Low-level, dense vegetation structures such as hedges, which form dense barriers, are particularly effective at reducing the flow of pollution from streets to curbwalks and adjacent properties. Morocco, for example, has been successful in building a greenbelt of trees around Ouarzazate and greening the surrounding drylands using treated wastewater and clean energy for irrigation;
- Natural and artificial wetlands serve as natural water filters. The diverse plants and microorganisms that occur in natural wetlands have the potential to: i) remove between 20 and 60 per cent of metal pollutants; ii) retain 80 to 90 per cent of sediment from run-off; and iii) eliminate 70 to 90 per cent of nitrogen from the water flowing through them. Artificial wetlands can have similar pollution-retention capacities and are frequently used to treat municipal or industrial greywater, wastewater and/or stormwater run-off;
- Phytoremediation[126] uses plants to restore soils contaminated by heavy metals, such as mine dumps and polluted industrial sites. It involves the absorption of heavy metals in the soil by the plant roots, stems and leaves. The heavy metals can then be removed from the environment through harvesting.

Technology diffusion and transfer

Although technological and ecosystem based solutions exist to address many pollution problems, information about the costs-benefits and successes and failures in deploying technologies are not always available to decision makers, particularly those in developing countries. The challenge is how to diffuse these technologies more widely and make them more affordable to everyone and compatible with development goals and the national environmental, socioeconomic, and cultural priorities, and how to encourage local solutions based on local or traditional knowledge. Overcoming these challenges requires building and strengthening the enabling environment for technology transfer including putting in place supporting policies, providing technology users with the choice they need, and reducing risks for investment. Mechanisms to support developing countries with issues of technology transfer are as a consequence a part of many multilateral environmental agreements. Best Available Techniques (BAT) and Best Environmental Practices (BEP) also need to be more systematically defined, as is done by some multilateral environmental agreements, such as the Stockholm Convention or the Oslo and Paris (OSPAR) Convention. BAT and BEP evolve over time in the light of technological advances, economic and social factors, and changes in scientific knowledge and understanding. Developing countries also have the opportunity to harness the potential of North-South, South-South collaboration in order to stimulate technology transfer and long-term domestic economic growth.

Innovative financing for green technological solutions and innovation

Public-private partnerships can be an effective way to catalyse investment into cleaner technologies and to support innovation. In Chile, Cleaner Production Voluntary Agreements have been signed with 10 industrial sectors, and more than 1200 companies have participated in their application. The Government provides 70 per cent of the funding to cover the sustainability assessment of the sector, internal audit, technical assistance,

training, certification, impact studies and the overall coordination of the agreements. Private companies fund the remaining 30 per cent of the costs involved.

In complex situations, tailor-made solutions need to be developed that analyse the root causes of the pollution problem, the levers for action. An example of this is the approach to landscape management in Indonesia (box 11).

Box 11: The Tropical Landscapes Finance Facility, Indonesia

In October 2016, the Indonesian Government and key partners launched an initiative to provide access to long-term finance for projects and companies that stimulate green growth and improve rural livelihoods. The Tropical Landscapes Finance Facility will leverage public funding to provide access to long-term finance at affordable rates to support smallholder producers and other land users' investment in sustainable Indonesian landscapes. The Facility aims to provide a mix of loans and grants to drive renewable energy production, reduce deforestation and forest degradation, and restore degraded lands. [127]

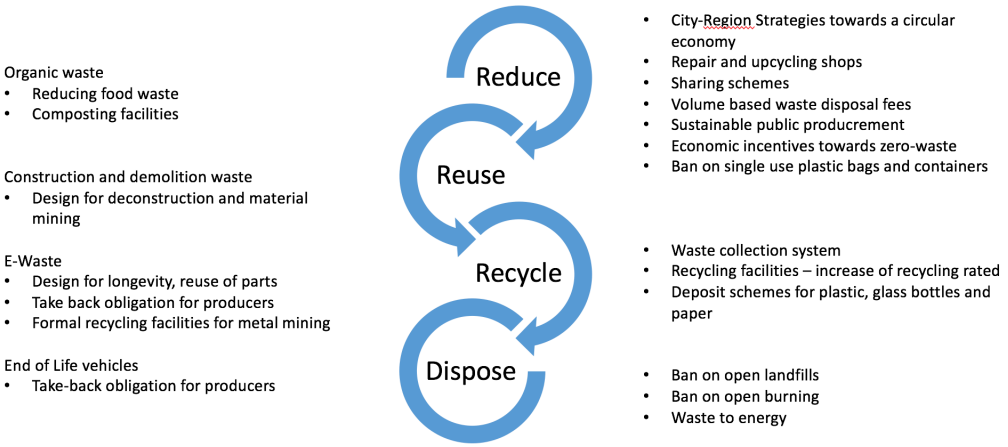
Crowd funding has also emerged as a new financing model. Instead of relying on wealthy individuals and institutional investors making large financial commitments, it seeks small financial commitments from a large number of people i.e. the crowd. An example, is SunFunder (www.sunfunder.com) which aims to crowdfund solar installations for the 1.3 billion people who live without electricity, which can also have significant impacts to reduce household air pollution. In 2014, the Ocean Cleanup[128] - which aims at developing advanced technologies to rid the world's oceans of plastic - launched a crowdfunding campaign which successfully mobilized 38,000 backers from 160 countries, raising over US$2 million in 100 days.

3.2.4 Integrating policies to tackle pollution: the example of city level actions

Local governments are key players in the move towards a pollution-free world. High concentration levels of emission sources and high density of people are responsible for impacts being most felt at the city level. At the same time, cities can benefit from density efficiencies and economies of scale. While local context and culture shape the solutions and actions that local governments can take, there are a number of concerns that are common to all cities of the world. Irrespective of their level of development, most cities around the world are contributing to and facing increasing episodes of air pollution that exceed WHO standards for air quality. The non-urban and transboundary share of air pollution in cities cannot be underestimated.

Figure 14 shows a number of solutions, some quick wins and easy to implement, others longer-term and requiring more planning and resources. What each entails in terms of data gathering and analysis, strengthening of institutional and enforcement capacity is determined by the local context.

Figure 14: examples of city level solutions



3.2.5 Incentivizing responsible consumption and lifestyles choices

As (urban) populations grow, the middle class expands and incomes rise, and aspirational messaging and advertising continues to be pro-consumption, consumption will increasingly lead to resource constraints and increased pollution. We need to find a way to live well and live light.

All parts of society have a role to play. Governments need to create appropriate frameworks and infrastructures, such as new public services, and regulatory instruments, for example, to restrict some types of advertising, and use public procurement to enhance the market for more sustainable goods and services. Businesses have to systematically integrate sustainability into core business strategies and develop innovative solutions to meet consumer needs in a less resource intensive way. Educators in formal and non-formal education sectors can equip students with the understanding and skills around sustainable consumption to be able to integrate it into their daily lives and future professions. International organizations can facilitate synergies and scale up impacts. Global policy frameworks like the 10-Year Framework of Programmes on Sustainable Consumption and Production offer platforms to bring these initiatives and partners together. Examples of powerful game changers include:

- **Product lifetime extension** to reduce the rate at which we use up (natural) resources and engage in waste production. This can be done: (1) by simply using products (i.e. telephones, computers) for a long(er) time, (2) by extending their use through design, maintenance and upgrades, and/or (3) by recovering broken products through repair, refurbishment or remanufacturing.
- **Product sustainability information** (e.g. claims, labels, campaigns) to enable and encourage consumers to drive sustainability through the products they buy, and the way they (re)use/ recycle/ discard them. Insights into purchasing behaviour indicate a growing interest in products that are considerate of the environment and/or social concerns.[129] In some sectors, certified production has grown considerably, for instance the global market share of certified coffee increased from 15 per cent in 2008 to 40 per cent in 2016.[130] In order to address greenwashing and the multitude of different information tools which lead to confusion and mistrust, 'Guidelines for providing product sustainability information' have been developed to support companies, governments and organizations to drive transformative change in this area.

- **Sharing economy initiatives,** food waste reduction campaigns, vehicle sharing models, are other examples of how companies and individuals are trying to adopt more sustainable consumption practices. For these companies, consumer needs are met (and quality of life enhanced) in creative ways which do not depend on the ownership of the physical infrastructure. Transformative shifts introduce resource efficiency and eco-innovation to the business strategy of a company.

A movement towards a pollution-free planet from the consumption side will need changes in collective and individual mindsets, values and behaviours, along with changes in policies and regulations which make those choices the default. As Wangari Mathai famously said "It's the little things citizens do that will make a difference", but there is much that can be done to change the structures, regulations and incentives to facilitate better consumption practices.

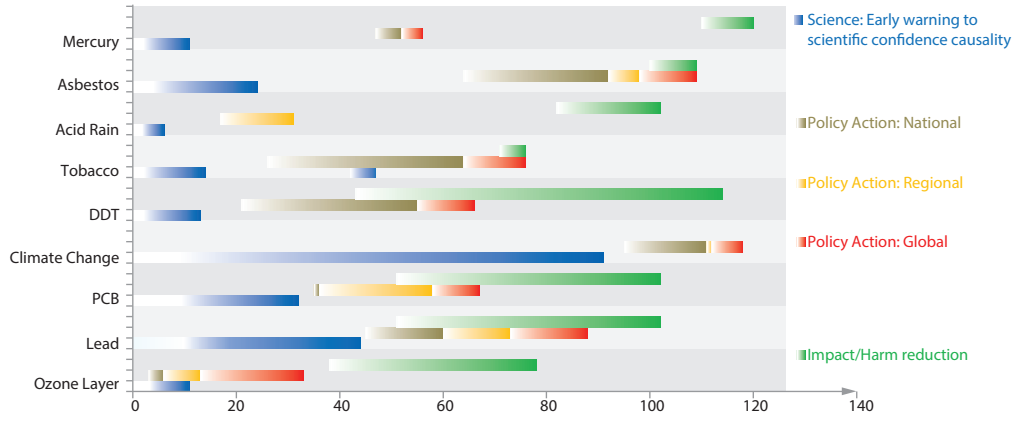
3.3 ENABLERS

Enablers are crucial to incentivize and correct market and policy failures and other issues and gaps identified earlier to facilitate transformation actions to move forward a preventive pollution agenda. They address some of the key issues that make pollution so pervasive and persistent.

3.3.1 Evidence-based decision-making

Providing timely scientific and empirical information in an accessible manner to policymakers is at the heart of strengthening the science-policy interface. An analysis of nine major pollution areas has shown that there exists a considerable time lag between the establishment of the science around pollution issues and policy action – let alone the first signs of harm reduction (Figure 15). These time lags need to be addressed to avoid unnecessary costs and harm to human well-being and the environment.

Figure 15: Time lags in years between science and policy for selected environmental issues



The key challenge in dealing with pollution is that processes leading to health risks, chronic diseases and ecosystem impacts involve many stages of causality. The causal chain can be affected by many interdependent, co-causal risk factors.

The decision about when there is sufficient evidence to justify action involves more inputs to decision-making than just science. The strength of evidence deemed appropriate depends on the costs of being wrong with actions or inactions, including their impacts on different age groups and gender; the various risks to current and future generations; costs and benefits for the agents of the activities that pose potential threats to health and the availability of feasible alternatives.

Waiting for the high strength of evidence needed to act means missing opportunities to act preventively and avert future harm. In tackling pollution, the boundaries of knowledge are continuously changing. Expanding the sharing knowledge through open access systems as a policy measure will help to enhance the exchange of evidence and experiences under real-life conditions.
Decisions can be about overall policies, but also very concrete projects. Environment and health impact assessments can be powerful tools to analyse the environment and health interactions of selected projects, plans, programmes or policies.[131]

3.3.2 Improving pollution-related governance

The environmental rule of law as well as sound and effective institutions make it possible for societies to respond to pollution in a way that respects fundamental rights and principles of justice and fairness, including for future generations and across national borders.

The challenge is not about more regulatory measures, but improving effectiveness, using the knowledge, experience and tools already available, and also harnessing appropriate new technologies. Corruption can be a major deterrent for good pollution-related governance. Corrupt regimes and administrations, for personal gain, may accept bribes from polluters to allow illegal activities to happen or continue. Corruption can lead to a loss of revenue from uncollected fines, or to an inability to prevent or stop pollution. Integrating behavioural insights in the formal rules and practices that govern public organizations is a way to improve public policies.

Enhancing regulatory, enforcement and judiciary capacity

The implementation of measures under the multilateral environmental agreements and other forums often remains a challenge, very often due to the lack of proper regulatory and enforcement capacity and contradictory policies. Building capacity and skills and sense of urgency is essential and needs to be a continuing process that must be rooted in an understanding of the legal basis for implementation and enforcement.

Institutional changes are required to equip judiciaries worldwide to effectively deal with environmental cases and strengthen the overall institutional landscape to combat pollution. Today there are over 1,200 environmental courts or tribunals in 44 countries at the national or state/provincial level, with some 20 additional countries discussing or planning to establish similar courts or tribunals. With or without the existence of these specific courts, what is critical is for judiciaries, prosecutors, etc., to be trained in being able to deal with environmental cases and take them seriously. Effective institutions can lead to potentially significant novel approaches in dealing with pollution. Recently a court in India granted the Ganges and Yamama rivers the same legal rights as a person in order to deal with the massive pollution affecting these rivers. This followed a decision by the Government of New Zealand to grant the same rights to its Whanganui river.

Regulatory and public policy innovations

There are several innovations that can be used to improve regulatory functioning and public policy for pollution management in countries. Experimental research is ongoing in some developing countries to assess whether and how enabling and allowing industry to feedback reliable information to regulators can help improve regulatory functioning through a reduction in costs to industry and government and greater efficiency.[132]

Strengthened national registration processes can be based on producer disclosure as is done in many developed economies. The use of life-cycle approaches in the regulation of toxic chemicals is key as then hotspots can be delineated and targeted for regulation. Gathering data to identify substances that pose a risk based on known intrinsic properties through watch lists is another way to improve regulation.

Active citizen participation through effective environmental information systems based on data gathering, monitoring and open access

To be able to tackle pollution effectively, governments need an informed citizenry that can participate in decision-making and in protecting human health and environment from pollution and that can easily access justice. Citizens, including children, have the right to know and to engage. Governments can ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements (SDG 16:10) and in line with Principle 10 of the Rio Declaration and the Bali Guidelines for the Development of National Legislation on Access to Information, Public Participation and Access to Justice in Environmental Matters.

Effective public participation can only be ensured through transparent and effective environmental information systems and disclosure based on data gathering, monitoring and open access to make information on emissions to air, land and water and in products known to the public through registers such as toxic release inventories/pollutant release and transfer registers, portals on pollutants being discharged, publishing standards, air and water monitoring systems, and permit systems of discharging wastewater or effluent, noise pollution permissible levels etc. Open data and citizen science, such as in the role of water and air quality monitoring or the measurement of biological indicators such as bird or frog counts, also have a very promising role to play.

Information also has to be made accessible by local authorities, when relevant such as in the case of air pollution, to all areas that are affected so that the affected public can take the necessary measures to protect themselves. Information disclosure from the regulatory community is also needed for public supervision of compliance by industries and public institutions.

Cultivating a compliance culture by all

To ensure effective implementation, compliance and enforcement, not only efforts should be made to strengthen the capacity of enforcement agencies to implement and enforce laws and regulations through various innovative mechanisms, but also to engage private corporates and private citizens and encourage voluntary compliance. Building a strong compliance culture within institutions, the private sector and the community is essential to ensure effective compliance and enforcement, including conducting information and education programmes based on sound science explaining the need to change behaviour to protect the environment, educating the industry and the community about the benefits of environmental regulation

and its compatibility with economic growth, and providing support to help them comply with their legal obligations, recognizing that it is the most cost-effective means of promoting compliance.

3.2.3 Economic instruments

The cost of pollution to national economies is an often neglected issue. Pollutants are emitted without an appropriate price, while the environmental cost of economic activity is largely ignored.

Fiscal incentives to stimulate systemic and behavioural changes to prevent and reduce pollution

Through pricing measures and incentives, introducing toxicity of a compound into the levy for example, fiscal policies can shift consumer and producer behaviour towards a more sustainable path, and help to reduce pollution, improve health and address global challenges such as climate change, or nutrient overload. Fiscal incentives should be implemented alongside other policies including regulatory measures, such as emission standards, and information tools, such as labelling and communication campaigns. Combined, this complementary mix of policies and incentives can effectively stimulate the systemic and behavioural changes needed to prevent and reduce pollution. The case studies below provide examples of how such successful policy mixes work in practice.

Box 12: Reducing plastic bag litter in Ireland

In Ireland, a levy on plastic bags has led to a reduction in plastic bag use from an estimated 328 bags per capita before the introduction of the levy in 2002 to 14 bags per capita in 2012. The levy was introduced at a rate of US$ 0.20 (EUR 0.15) per plastic bag and increased to US$ 0.31 (EUR 0.22) in 2007. After its introduction, the distribution of bags in retail outlets dropped by 90 per cent and there has been a significant reduction in plastic bag litter. This reduction has also had an impact on the marine environment and coastal pollution. Results from beach surveys indicate a reduction in the number of plastic bags found on beaches from a mean high of 17.7 per 500 meters in 2000 to a mean of 5.5 bags per 500 meters in 2002.[133] Revenues from the levy are earmarked to an environment fund which is used to cover the administrative costs of the levy, support waste management, recycling centres, litter clean-up and other environmental initiatives.[134] The introduction of the levy was preceded by stakeholder consultations and an extensive national publicity campaign which helped overcome resistance to the levy among the public and retailers.[135]

Box 13: Environmental taxes in Chile[136]

Chile faces several environmental problems relating to climate change, atmospheric pollution, congestion and motor vehicle pollution. To help address these challenges, the Government adopted a General Tax Reform Bill in September 2014 which introduced three new green taxes, which are expected to raise over US$ 170 million annually, with revenues allocated to the general budget:

- A CO2 tax of US$ 5/ton on emissions from stationary sources with boilers or turbines (with an aggregated capacity of 50 MW or more). The tax targets large facilities (food processing, refinery, and the electricity sector) and covers approximately 40 per cent of the country's carbon emissions. Small plants and those operating on non-conventional renewable energy (biomass) are exempt from the tax;
- A tax on local pollutants[g] from stationary sources, which takes into account local air quality factors, the social costs of each pollutant and population density in the municipality in which the facility is located;
- A one-time tax on new light and mid-size vehicles which takes into account the vehicle's urban performance and NOx emissions.

The tax on local pollutants which varies by pollutant and municipality (local authority district) is an innovative mechanism designed to reflect local conditions. The tax rates were deliberately introduced at a low level to increase their political and public acceptance. The necessary monitoring, measurement, recording and verification of emissions for taxes is ensured by the use of the Chilean single window Pollutant Release and Transfer Register.[137]

Proper pricing of resources

Pricing resources properly through fiscal policies not only reduces environmental damage but can also generate substantial domestic public revenues. Removing fossil fuel subsidies altogether would raise US$2.9 trillion annually, while reducing global carbon emissions by more than 20 per cent and premature deaths from air pollution by 55 per cent.[138] These revenues can be used for different purposes, for example they can be allocated to the general budget to support investments in clean technologies, natural capital and social infrastructure, as illustrated in Indonesia (see case below).

g Local pollutants concerned: Particulate Matter (PM), Nitrogen Oxide (NOx) and Sulphur dioxide (SO2)

Box 14: Fossil fuel subsidy reform in Indonesia

In late 2014 and early 2015, the Indonesian Government initiated a range of reforms to gasoline and diesel subsidies. A new social assistance scheme was introduced alongside the reforms to compensate for the impact of the higher energy prices. The fuel subsidy reforms resulted in savings of IDR 211.3 trillion[139] which has allowed an increase in investments in social welfare and basic infrastructure (e.g. food security, connectivity, maritime, public transport infrastructure in Jakarta) through increased budgets for ministries, state-owned enterprises and transfers to regions and villages.

These fossil fuel subsidy reforms are expected to result in a decline in energy consumption and fuel switching which is estimated to reduce CO2 emissions by over 9 per cent relative to the baseline in 2030.[140] If higher prices cause a reduction in the growth of vehicle ownership and an increase in the supply of higher-quality fuels, local air pollution is also expected to decline which could have major health impacts given worsening urban air quality.[141]

3.2.4 Education for change

Education is critical if patterns of development are to shift towards more sustainable, cleaner practices. In particular, lifelong learning on pollution can encourage changes in knowledge, attitudes and practices and can empower learners to effect change. Those who are exposed directly to the impacts of pollution have demonstrably different perspectives on the issue. In a study carried out in Shanghai, parents of hospitalized children perceived pollution as a much worse problem than care-givers in the general community[142]. Likewise a study on haze in Malaysia revealed higher levels of knowledge, and of participation in actions to address haze, among those who regularly practised outdoor sports compared to the general population.[143] In both cases, the groups that saw, first-hand, the impacts of pollution were more able to participate in finding a solution. Education seeks to build the same effect without the damaging direct exposure to pollution.

Education on pollution can take many forms. In India, significant positive results in terms of changing knowledge and practices were achieved through water and air quality monitoring projects for school-age children.[144] In China, a key aspect of plans to reduce air pollution includes offering training and degree programmes in green engineering and renewable energy. Within UN Environment, an online course on nutrient and wastewater management provides an open learning opportunity for learners seeking to understand the links between land-based activities and water pollution. Additional examples can be found throughout the world through an analysis of education for sustainable development approaches and methodologies.

A gender responsive access to knowledge and education in pollution can be a driver of change. When informed, there are studies showing that women are more likely to act on sustainable consumption than their male peers.[145]

Providing courses and training are not the only links between education and pollution. In fact, both the public and private sector regularly turn to universities as centres of innovation

in pollution reduction technologies and sources of important research. Such research and innovation tend to be cross-disciplinary involving students and faculty from programmes ranging from environmental sciences to economics to engineering and design.

Finally, the UN Environment Global Universities Partnership on Environment and Sustainability, a network of over 800 higher education institutions, supports members as they directly tackle pollution reduction. The University of Nairobi, for example, has made a commitment through its environmental policy statement, to prevent pollution through waste management and clean production. Building an understanding of pollution prevention approaches, recognizing best practices and providing a platform for universities to network and share their experiences ensures that students are able to live sustainable, low pollution lifestyles on campus.

3.2.5 Cooperation and partnerships

Cooperation and partnerships can be key enablers to promote change and action on pollution. Cooperation between countries, cities and groups can help bring to the fore success stories and opportunities to share knowledge and good experiences of what did and did not work in countries, key sectors, and regions. They help reduce the asymmetry of information and capacity, help leverage actors and actions where they are most needed, highlight the multiple benefits of actions and tend to focus from the global to the local and local to the global. Partnerships also help connect businesses and other stakeholder groups around the pollution issue in different parts of the world, North-South, South-South, and North-South-South. They can enhance the capacity to deliver, measure and monitor change, by engaging key stakeholders in the design and the planning of initiatives.

Partnerships with business can help transform markets in line with the SDGs and act on pollution, given the earlier discussion on the pollution-SDG nexus in Part 2. The Business and Sustainable Development Commission has shown the business case for the Global Goals and identified 60 biggest market opportunities related to achieving these goals.[146] At least 23 of these can deliver on pollution avoidance, reduction, mitigation and rehabilitation. As pollution actions can help achieve these goals, key strategic partnerships can be built around action on pollution.

Part 2 has also highlighted several benefits of having the global and regional environmental agreements work together, and more synergistically with other voluntary initiatives such as the Climate and Clean Air Coalition, the Global Partnership on Marine Litter, the Lead Paint Alliance, Partnership for Clean Fuels and Vehicles, Global Mercury Partnership, and Principles for Sustainable Insurance mong others. These are able to provide the integrating, catalytic, and scaling up power of partnerships and initiatives for layered actions and next steps and strengthen the compliance aspects of global and regional environmental agreements.

Finally, and importantly, partnerships can help bridge financial resources and technical knowledge gaps. Depending on the nature of the cooperation, knowledge can be shared about successful and failed policies and solutions adopted by countries to better manage pollution to help countries leapfrog in terms of knowledge, technological and nature-based and green solutions. Many innovative partnerships can be developed around research and development on alternative products, new product designs and green solutions.

CONCLUSION

The environment is the resource base that sustains both economic and social development, and while pollution affects all of us, it has a particularly negative effect on women, children, the elderly and people living in low-income and vulnerable conditions. As a consequence, pollution constitutes a significant impediment to achieving sustainable development, and making sure no one is left behind, and is an important driver of international displacement and migration. A pollution-free planet would thus help improve overall human well-being, prosperity, and the conditions for the poor and the disadvantaged through improving the ecosystems that we rely on for our food, water, air and livelihoods. As pollution is to a large extent socially constructed, transitioning to a pollution-free planet, is not only possible, but is an imperative. It would be the best insurance policy for future generations as it would improve the ecosystem integrity that they need for survival.

Building on the mandates of UN Environment, this report alerts Member States and relevant stakeholders to the human and environmental dimension of pollution. It provides evidence on the state, trends, impacts and costs of pollution, discusses the key connections between actions on pollutions and the 2030 Agenda for Sustainable Development and multilateral environmental agreements. It highlights what has driven successful interventions, identifies the key policy and action gaps, and makes the case for principles and transformative actions at the global, regional, national and local levels in key pollution risk areas.

A framework for action towards a pollution-free planet is presented that has both a preventive and curative aspect, and that is based on opportunity and innovations. This requires political leadership and high-level champions and commitments, but with action at the local level in cities, villages, beaches and slums. To achieve high-level political commitment in strategic sectors, there is a need to go beyond the environmental ministries and to include relevant sectoral ministries such as finance, agriculture, industry, urban, transport, energy and health. There is also a need to engage local government, civil society organizations, business leaders and the citizen at large. Reporting back on progress made on pollution actions – even if voluntary and informal – is a crucial step on the pathway to transition. Telling and retelling stories of positive actions and changes is key to keeping the momentum.

Pollution is clearly not a new phenomenon, but is at such a high level that it affects lives, health, ecosystems and economies, and disproportionately impacts the poor. It is, however, controllable and avoidable. Many stories exist of countries and cities that have dealt with serious air, soil, freshwater and marine pollution. Adequate knowledge and technological solutions exist to both treat, control and avoid pollution. Whole-of-government approaches and increased political will for transformative actions are required to tackle pollution at source in its different forms, and to come up with integrated, more holistic solutions. A challenge for industries and society is to both generate less pollution at the source level, put in place safeguards for low-probability but high-impact accidents, as well as cleaning up the legacy of past contamination.

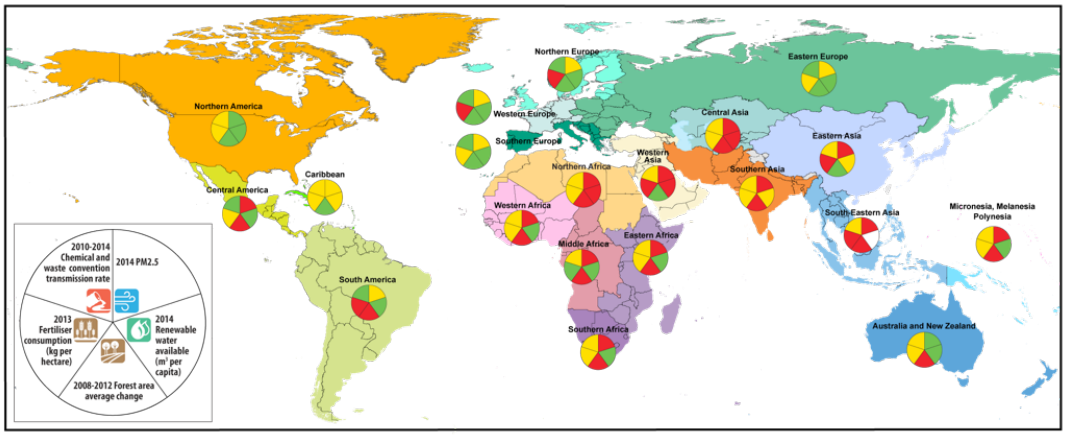
Encouragingly, more and more governments, industries and citizens are moving towards a sustainable materials and circular economy, with greater resource efficiency, sustainable chemistry and clean technologies, as part of transition towards a green economy.[147] Differences in capacity and development to tackle pollution adequately worldwide, however, are still huge. While developed and some emerging economies chase the ideals of a circular economy and greater resource efficiencies, developing countries face growing pollution challenges as amounts of waste increase as population and consumption grow, and waste streams change in response to globally dynamic product value chains. They must not be left behind. This report is a call for action towards a pollution-free planet for all.

ANNEXES

Annex 1

Comparison of the magnitude (severity) of different types of pollution by proxy

The latest global environmental assessments give an indication of the magnitude of current pollution issues. Fine particulate matter, and hence air quality, remains a problem in nearly all regions; over-extraction of water, leading to the concentration of pollutants, is a key issue in northern Africa and Central Asia; declines in forest cover with the loss of ecosystem services, such as water purification and natural attenuation of pollutants is a problem in Asia; fertilizer consumption that can lead to nutrient over-enrichment of ecosystems is an issue in all regions, and meeting the reporting obligations of the international chemicals agreements remains below 75 per cent in Asia, Africa, the Caribbean and North America. However, data gaps prevent a fully comprehensive picture of pollution levels in air, freshwater, marine and land ecosystems at a regional level.



Air pollution: particulate matter ($PM_{2.5}$)
below threshold (World Health Organization: 10ug/m³ annual mean)
within 100% above threshold (World Health Organization: 10ug/m³ annual mean)
greater than 100% above threshold (World Health Organization: 10ug/m³ annual mean)
Water extraction (percentage renewable water available)
between 50-100% of renewable water available
between 20-50% of renewable water available
below 20% of renewable water available
Forest decline area
no area decline
area decline detected is low <25%
area decline detected >than 25%
Fertilizer consumption (kg per hectare)
<15kg per hectare (causes biodiversity loss)
>15kg per hectare (causes biodiversity loss)
>150kg per hectare (is critical)
Chemical conventions and agreements:
> 75% of reporting obligations to Basel, Rotterdam and Stockholm Conventions and Montreal Protocol
50-75% of reporting obligations to Basel, Rotterdam and Stockholm Conventions and Montreal Protocol
< 50% of reporting obligations to Basel, Rotterdam and Stockholm Conventions and Montreal Protocol

Sources: All data is available from Environ-mentLive.unep.org (the original source of the data and methodology used in computing the aggregates is also available online). The stop-light thresholds in this table are based on the most recent data as compared with a 2000 (or nearest year) baseline.

Annex 2

The costs of pollution

Different techniques are used to assess the monetary costs of mortality and morbidity to establish unit values. These include a cost-of-illness approach and direct monetary valuation techniques such as stated preference (SP) or revealed preference (RP) methods to assess the willingness-to-pay (WTP) to reduce environmental risks. The welfare-based approach is more appropriate for evaluating the full economic costs of premature mortality, which include the loss of various valuable things to an individual apart from their paychecks, such as consumption, leisure, good health, and simply being alive. This value is reflected in the WTP, which captures the marginal trade-offs that individuals are willing to make to reduce their chances of dying. The value of statistical life (VSL) represents the sum of many individuals' WTP for marginal reductions in their mortality risks. It is not the value of any single person's life or death, nor does it represent a society's judgment as to what that value should be. The WTP-based approach is best suited for analyses of economic welfare, and it has become the standard approach in high-income countries for valuing mortality risks associated with pollution . The welfare costs of mortality reported were estimated using the WTP approach using the value of statistical life. However, WTP studies are still lacking in many parts of the world, as such, it is practical to implement a welfare-based approach by adjusting some "base VSL" from the original context where data is available. The value of statistical life for countries where original studies were not available was estimated based on 2005 OECD VSL base value. The reference VSL value was adjusted for differences in per capita GDP with an income elasticity of 1.2 with a range of 1.0 to 1.4 for sensitivity analysis for low- and middle-income countries. For high-income countries, a central value of 0.8 is assumed, with a range from 0.6 to 1.0 for sensitivity analysis.

Table 1: Global costs of pollution

NATURE OF IMPACT	METHOD USED	ASSUMPTIONS	COSTS (2015 BILLION US$)	% OF GDP	SOURCE
Greenhouse gas (GHG) emissions	Trucost uses a forward-looking price to calculate the global annual external costs of greenhouse gases emitted in 2008 as US$ 4.5 trillion. This represents the present day value of future climate change impacts and is based on the social cost of carbon from the Stern Review on the Economics of Climate Change (2006).	The Stern Review models the cost of emissions over 200 years based on likely climate change impacts, if business continues as usual with low per capita economic growth, rising population levels and slow, fragmented technological development, based on projections in a "scenario by the Intergovernmental Panel on Climate Change".	4 987	6.7	United Nations Environment Programme and Principles for Responsible Investment Association (2010). Universal Ownership: Why Environmental Externalities Matter to Institutional Investors. http://www.unepfi.org/fileadmin/documents/universal_ownership.pdf
Indoor and outdoor air pollution	Value of statistical life (VSL) (Welfare costs of mortality and morbidity)	Estimated based on 2005 OECD VSL base value. For low- and middle-income countries, a central value of 1.2 is assumed, with a range from 1.0 to 1.4 for sensitivity analysis. For high-income countries, a central value of 0.8 is assumed, with a range from 0.6 to 1.0 for sensitivity analysis.	5 322	7.2	Organisation for Economic Co-operation and Development (2016). The Economic Consequences of Outdoor Air Pollution. Paris: OECD Publishing. http://dx.doi.org/10.1787/9789264257474-en World Bank and Institute for Health Metrics and Evaluation (2016). The Cost of Air Pollution: Strengthening the Economic Case for Action. Washington, DC. https://openknowledge.worldbank.org/bitstream/handle/10986/25013/108141.pdf?sequence=4&isAllowed=y
Chemicals (Volatile organic compounds (VOCs), Lead, mercury)	External costs were applied to data on releases of NOx, SOx, volatile organic compounds, particulate matter and mercury based on the IPCC business as usual scenario, which includes the probable trajectory of future quantities of a range of pollutants.	Other heavy metals with potentially toxic effects, such as arsenic, cadmium and lead, were excluded due to lack of global data.	480.4	0.4	United Nations Environment Programme and Principles for Responsible Investment Association (2010). Universal Ownership: Why Environmental Externalities Matter to Institutional Investors. http://www.unepfi.org/fileadmin/documents/universal_ownership.pdf
General waste	To value external costs for general waste and the pollutants analysed, studies use objective techniques that rely on observable environmental changes and market prices.	The study assumed that damage values per unit of waste and pollution would increase in line with population and wealth (measured as GDP in purchasing power parity per capita).	216	0.3	United Nations Environment Programme and Principles for Responsible Investment Association (2010). Universal Ownership: Why Environmental Externalities Matter to Institutional Investors. http://www.unepfi.org/fileadmin/documents/universal_ownership.pdf

Table 2: Regional costs of pollution

REGION	NATURE OF IMPACT	PHYSICAL IMPACTS	METHOD USED	ASSUMPTIONS	COSTS (2015 BILLION US$)	% of GDP	SOURCE
Africa	Air Pollution	700,000 deaths in from indoor and outdoor air pollution	Value of Statistical Life (VSL) (Welfare costs of mortality)	Estimated based on 2005 OECD VSL base value. Adjusted for differences in per capita GDP with an income elasticity of 1, and adjusted for post-2005 income growth and inflation. Only economic costs of mortality were included.	Welfare costs of mortality 450	7.9	Organisation for Economic Co-operation and Development (2016). The cost of air pollution in Africa. OECD Development Centre Working Papers 333
	Water Pollution	542,855 deaths in 2013 from unsafe water	Value of Statistical Life (VSL) (Welfare costs of mortality)	Estimated based on 2005 OECD VSL base value as described above.	252.5	4.3	Organisation for Economic Co-operation and Development (2016). The cost of air pollution in Africa. OECD Development Centre Working Papers 333
South and South-East Asia	Outdoor and indoor air pollution	974,000 deaths from outdoor air pollution in 2010 1 177 000 deaths from indoor air pollution in 2013	Value of Statistical Life (VSL) (Welfare costs of mortality)	Estimated based on 2005 OECD VSL base value. Adjusted for differences in per capita GDP with an income elasticity of 1.2 with a range of 1.0 to 1.4 for sensitivity analysis for low- and middle-income countries. For high-income countries, a central value of 0.8 is assumed, with a range from 0.6 to 1.0 for sensitivity analysis.	797	0.2	Organisation for Economic Co-operation and Development (2016). The Economic Consequences of Outdoor Air Pollution. Paris: OECD Publishing. http://dx.doi.org/10.1787/9789264257474-en
East Asia & the Pacific	Outdoor and Indoor air pollution	1,147,000 deaths from indoor air pollution in 2013 905 000 deaths from outdoor air in 2010 (China only)	Value of Statistical Life (VSL) (Welfare costs of mortality)	Only included countries for which data was available during the study period.	1849	0.09	World Bank and Institute for Health Metrics and Evaluation (2016). The Cost of Air Pollution : Strengthening the Economic Case for Action. Washington, DC. https://openknowledge.worldbank.org/bitstream/handle/10986/25013/108141.pdf?sequence=4&isAllowed=y

North America (USA only)	Outdoor air pollution	101,000 deaths in 2010	Value of Statistical Life (VSL) (Welfare costs of mortality)	Estimated based on 2005 OECD VSL base value. Adjusted for differences in per capita GDP with an income elasticity of 1.2 with a range of 1.0 to 1.4 for sensitivity analysis for low- and middle-income countries. For high-income countries, a central value of 0.8 is assumed, with a range from 0.6 to 1.0 for sensitivity analysis.	400	3.4	Organisation for Economic Co-operation and Development (2016). The Economic Consequences of Outdoor Air Pollution. Paris: OECD Publishing. http://dx.doi.org/10.1787/9789264257474-en
OECD Europe	Outdoor air pollution	229,000 deaths in in 2010	Value of Statistical Life (VSL) (Welfare costs of mortality)	Estimated based on 2005 OECD VSL base value. Adjusted for differences in per capita GDP with an income elasticity of 1.2 with a range of 1.0 to 1.4 for sensitivity analysis for low- and middle-income countries. For high-income countries, a central value of 0.8 is assumed, with a range from 0.6 to 1.0 for sensitivity analysis.	730	2.1	Organisation for Economic Co-operation and Development (2016). The Economic Consequences of Outdoor Air Pollution. Paris: OECD Publishing. http://dx.doi.org/10.1787/9789264257474-en
WHO European Region	Indoor air pollution	164,231 deaths in 2010	Value of Statistical Life (VSL) (Welfare costs of mortality)	Estimated based on 2005 OECD VSL base value. Adjusted for differences in per capita GDP with an income elasticity of 1.2 with a range of 1.0 to 1.4 for sensitivity analysis for low- and middle-income countries. For high-income countries, a central value of 0.8 is assumed, with a range from 0.6 to 1.0 for sensitivity analysis.	299	1.5	World Health Organization, Regional Office for Europe and Organisation for Economic Co-operation and Development (2015). Economic Cost of the Health Impact of Air Pollution in Europe: Clean Air, Health and Wealth. http://www.euro.who.int/__data/assets/pdf_file/0004/276772/Economic-cost-health-impact-air-pollution-en.pdf
Europe Combined Total	Outdoor and indoor air pollution				1 029	3.6	

Notes: * Where a range of values is given, only lower bound estimates are included in calculating the total benefits through out all the tables

a The costs of pollution intervention have been converted to US$ 2015 prices assumed a linear trend continues from the year of estimation
b Estimated costs are likely to be sensitive to the different methodologies, data and assumptions used
c Costs are expressed as a percentage of the 2015 GDP obtained from the World Bank (2017) database, http://databank.worldbank.org/data/download/GDP.pdf
d The values were adjusted for changes in inflation using OECD Indices available at: http://stats.oecd.org/Index.aspx?DataSetCode=MEI_PRICES
e Other impacts of air pollution for example, impacts on agricultural production, biodiversity and ecosystem services are not included or inadequately represented. A synthesis of studies by OECD (2008) indicate that the health impacts represent a very large proportion of the total costs of air and water pollution – often in excess of 90%, https://www.oecd.org/environment/ministerial/40501169.pdf

Annex 3

How pollution is reflected in the various multilateral frameworks and environmental agreements

Multilateral Environmental Agreements (MEAs) and related initiatives and frameworks form the overarching international legal basis that supports overnments and other stakeholders in addressing environmental issues and sustainable development. They play a critical role in the analysis of linkages between pollution, human well-being and the environment and are a tool-set that helps to achieve international and national environmental objectives[148,149]. Environmental degrading pressures such as air pollution, contamination of water and soil with hazardous chemicals and waste, uncontrolled waste generation and disposal, and ecosystem disruption have effects which are direct and immediate as well as indirect effects that occur over the medium to long term in the achievement of MEAs and other international and national environmental objectives.

International Environmental Principles and Declarations

1. **The Declaration of the United Nations Conference on the Human Environment (Stockholm Declaration (1972)** was the first instrument to recognize the impact of pollution in water, air, earth and living beings. Principle 6 of the Declaration proclaims that the just struggle of the peoples of all countries against pollution should be supported. Principle 7 calls on States to take all possible steps to prevent pollution of the seas by substances that are liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea. Principle 22 provides that States shall cooperate to develop further the international law regarding liability and compensation for the victims of pollution and other environmental damage caused by activities within the jurisdiction or control of such States to areas beyond their jurisdiction.

2. **Principle 13 of the Rio Declaration on Environment and Development (1992)** added that States shall develop national law regarding liability and compensation for the victims of pollution and other environmental damage. States shall also cooperate in an expeditious and more determined manner to develop further international law regarding liability and compensation for adverse effects of environmental damage caused by activities within their jurisdiction or control to areas beyond their jurisdiction. Principle 16 calls upon National authorities to endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment.

The principles envisaged in the Stockholm Declaration and Rio Declaration have subsequently been reflected in various MEAs.

Key Global Multilateral Environmental Agreements, initiatives and frameworks

3. **The United Nations Recommendations on the Transport of Dangerous Goods (1956)** establishes principles for all aspects of classification, packaging, testing, and labelling of dangerous goods. The recommendations are presented in the form of "Model Regulations on the Transport of Dangerous Goods" that present a basic scheme of provisions that allow uniform development of national and international regulations governing

the various modes of transport; yet they remain flexible enough to accommodate any special requirements that might have to be met. The recommendations have been used for determining classes of wastes under the Basel Convention and in developing the Globally Harmonised System of Classification and Labelling of Chemicals (GHS)[150].

4. The Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat (1971) provides measures for the conservation and wise use of wetlands. Each Contracting Party shall arrange to be informed at the earliest possible time if the ecological character of any wetland in its territory and included in the list has changed, is changing or is likely to change as the result of technological developments, pollution or other human interference.

5. The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Dumping Convention) (1971) aims to control and prevent pollution of the sea by the dumping of waste and other matter that is liable to create hazards to marine life.

6. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973) seeks to regulate international trade in endangered animals and plants and their products. It does not specifically provide for pollution control in its articles. The Convention does not seek to prevent pollution. However, its objectives to reduce pressures on wildlife would include reduction of pressures resulting from habitat loss and pollution. The impact of pollution on sea turtle populations and their habitat has been recognized by Conference of the Parties. CITES works closely with the INTERPOL Pollution Crime Working Group to tackle pollution crime.

7. The International Convention for the Prevention of Pollution from Ships (MARPOL) (1973) aims to eliminate pollution of the sea by oil and other toxic substances which might be discharged during normal operations, or released accidentally as a result of collisions or stranding of ships. The Convention, further, seeks to regulate the handling of substances that would present a major hazard to either marine resources or human health or cause serious harm to amenities or other legitimate uses of the sea

8. The Convention On The Prevention Of Marine Pollution From Land-Based Sources (1974) obligates Parties to eliminate, if necessary by stages, pollution of the maritime area from land-based sources and strictly limit pollution of the maritime area from land-based sources.

9. The Barcelona Convention for the Protection of the Mediterranean Sea against Pollution (1976) and its Protocols seeks to protect the maritime waters of the Mediterranean Sea from substances that could harm the living resources, cause hazards to human health, and impair quality of seawater.[151]

Seven Protocols addressing specific aspects of Mediterranean environmental conservation processes have been adopted since 1976:

1. Dumping Protocol: Protocol for the Prevention of Pollution in the Mediterranean Sea by Dumping from Ships and Aircraft (1976) amended as Protocol for the Prevention and Elimination of Pollution in the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea (1995)
2. Prevention and Emergency Protocol: Protocol Concerning Cooperation in Preventing Pollution from Ships and, in Cases of Emergency, Combating Pollution of the Mediterranean Sea (2002), which replaced the Protocol Concerning Cooperation in Combating Pollution of the Mediterranean Sea by Oil and other Harmful Substances in Cases of Emergency (1976).
3. LBS Protocol: Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources (1980)
4. The Land-based Sources and Activities Protocol: Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities (1996)
5. Specially Protected Area and Biodiversity Protocol: Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean (1995)
6. Offshore Protocol: Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil (1994)
7. Hazardous Wastes Protocol: Protocol on the Prevention of Pollution of the Mediterranean Sea by Transboundary Movements of Hazardous Wastes and their Disposal (1996)
8. Integrated Coastal Zone Management Protocol: Protocol on Integrated Coastal Zone Management in the Mediterranean (2008)

10. The International Convention for the Safety of Life at Sea (SOLAS) (1980) specifies minimum standards for the construction, equipment, and operation of ships, compatible with their safety. The Convention's Chapter VII - Carriage of dangerous goods covers construction and equipment of ships carrying dangerous liquid chemicals in bulk and requires chemical tankers to comply with the International Bulk Chemical Code (IBC Code).

11. The United Nations Convention on the Law of the Sea (UNCLOS) (1982) provides the legal framework for international governance of seas and oceans. Article 194 of the UNCLOS prescribes measures to prevent, reduce and control pollution of the marine environment, taking into consideration international rules and national laws. UNCLOS seeks to control pollution from land-based sources pollution from seabed activities subject to national jurisdiction, pollution from activities in the Area, pollution from dumping, pollution from vessels and pollution from or through the atmosphere.
12. The Convention on the Conservation of Migratory Species of Wild Animals (1983) seeks to conserve migratory species by ensuring that Contracting Parties take the necessary action, individually and collectively, to avoid species becoming endangered. It does not specifically provide for pollution control in its articles. However, its objectives have been expanded to include reduction of the impact of pollution on any migratory species. Resolution 4.5 empowered the Scientific Council to recommend solutions to problems relating to the scientific aspects of the implementation of the Convention in particular with regard to the habitats of migratory species. The Convention's report on "Migratory Species, Marine Debris and its Management" revealed the impact of marine pollution on migratory species. Parties are encouraged to implement monitoring processes in order to assess the cumulative environmental impacts of pollution on migratory species.

13. The Vienna Convention for the Protection of the Ozone Layer (1985) and the Montreal Protocol on Substances that Deplete the Ozone Layer (1987) seeks to protect human health and the environment against adverse effects resulting or likely to result from human activities which modify or are likely to modify the ozone layer.

    The Montreal Protocol was designed to reduce the production and consumption, as well abundance of ozone depleting substances in the atmosphere. The protection of the ozone layer would result in reduced production, import, and export of ozone-depleting substances. If implemented, the Kigali Amendment to the Montreal Protocol will help reduce pollutants, prevent millions of premature deaths from air pollution and improve environmental quality.

14. The International Code of Conduct on Pesticide Management (1985) is the framework on pesticide management for all public and private entities engaged in, or associated with, production, regulation and management of pesticides. The new Code of Conduct on Pesticide Management, which was approved by the FAO Conference in 2013 and recognized by the WHO Executive Board in January 2014, provides standards of conduct that serve as a point of reference in relation to sound pesticide life cycle management practices, in particular for government authorities and the pesticide industry. The Code of Conduct is supported by technical guidelines that are developed by the Panel of Experts on Pesticide Management.

15. The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (1989) was adopted to protect human health and the environment against the adverse effects of hazardous wastes. Parties have committed to protect, by strict control, human health and the environment against adverse effects which may result from the generation and management of hazardous wastes and other wastes. Each Party shall take the appropriate measures to ensure that persons involved in the management of hazardous wastes or other wastes within it take such steps as are necessary to prevent pollution due to hazardous wastes and other wastes arising from such management and, if such pollution occurs, to minimize the consequences thereof for human health and the environment; Parties shall undertake to review periodically the possibilities for the reduction of the amount and/or the pollution potential of hazardous wastes and other wastes which are exported to other States, in particular to developing countries.

    The preamble to Basel Convention Protocol on Liability and Compensation for Damage Resulting from Transboundary Movements of Hazardous Wastes and their Disposal (1999) provide that States shall develop international and national legal instruments regarding liability and compensation for the victims of pollution and other environmental damage.

16. The International Labour Organization Chemicals Convention (1990) (No. 170) specially addresses the protection of workers from harmful effects of chemicals at the workplace. Because of the tri-partite composition of the ILO under whose jurisdiction the Convention was negotiated, it includes obligations for governments, suppliers, employers and workers regarding the safe management and handling of chemicals. This ranges from developing coherent policies to the establishment of information exchange mechanisms.

17. The Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC)(1990) aims to facilitate international cooperation and mutual assistance in preparing for and responding to major oil pollution incidents that threaten the marine environment and coastlines, and to encourage countries to develop and maintain the capability to respond to major oil pollution emergencies involving ships, offshore units, seaports, and oil handling facilities. The Convention, which entered into 1995, currently has 108 Parties. In 2000, the Protocol on Preparedness, Response and Co-operation to pollution Incidents by Hazardous and Noxious Substances (OPRC-HNS Protocol) was adopted, extending the scope of the Convention to hazardous and noxious substances.

18. The Convention on Biological Diversity (1992) does not specifically mention pollution in their articles. However, it provides that conservation and sustainable use of biological diversity is of critical importance for meeting the food, health and other needs of the world population. The Strategic Plan for Biodiversity 2011-2020, including the Aichi Biodiversity Targets, adopted at the Tenth Meeting of the Conference of the Parties under decision X/2, called for a decrease in pollution as one of the direct pressures on biodiversity.

    Aichi Biodiversity Target 8 provides that by 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.

    The Cartagena Biosafety Protocol (2000) aims to protect biological diversity and human health from the potential risks arising from the import and export of living modified organisms . The Protocol addresses the need to protect human health and the environment from the possible adverse effects of the products of modern biotechnology.

    Nagoya-Kuala Lumpur Supplementary Protocol on Liability and Redress to the Cartagena Protocol on Biosafety (2010) contributes to the conservation and sustainable use of biological diversity by providing international rules and procedures for liability and redress relating to living modified organisms.

    The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity (2010) does not make specifically mention or call for control of pollution

19. The United Nations Framework Convention on Climate Change (1992) presents the framework on how to tackle climate change, including pollution challenges that contribute to climate change. Article 4(1)(f) surmises that Parties, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, shall take climate change considerations into account, to the extent feasible, with a view to minimizing adverse effects on, inter alia, public health and the environment. The goal of the Marrakech Declaration for Health, Environment and Climate Change is to reduce pollution-related deaths by promoting better management of environmental and climate risks to health.

    Kyoto Protocol for Climate Change (1997) objectively aims to stabilize the levels of greenhouse gases in the earth's atmosphere with the aim of stalling global warming. It is argued that stabilizing greenhouse gases, which are major pollutants, could contribute to the abatement of environment and health risks.

20. The UN Economic Commission for Europe Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) (1992) and its Protocols aim to protect and ensure the quantity, quality and sustainable use of trans-boundary water resources by facilitating cooperation. It provides an intergovernmental platform for Parties to prevent, control and reduce pollution of waters causing or likely to cause transboundary impact. Measures taken under the convention shall not directly or indirectly result in a transfer of pollution to other parts of the environment. Initially negotiated as a regional instrument, it turned into a universally available legal framework for trans-boundary water cooperation, following the entry into force of amendments in February 2013, opening it to all UN Member States.

The Protocol on Water and Health (1999) seeks to protect human health and well-being by better water management, including the protection of water ecosystems, and by preventing, controlling and reducing water-related diseases. The Protocol is the first international agreement of its kind adopted to attain an adequate supply of safe drinking water and adequate sanitation for everyone, and effectively protect water.

The Protocol on Civil Liability and Compensation for Damage Caused by the Transboundary Effects of Industrial Accidents on Transboundary Waters (2003) establishes international civil liability for all damages caused on humans, transboundary waters and the environment.

21. The International Convention on Civil Liability for Oil Pollution Damage (CLC) (1992) was adopted to ensure that adequate compensation is available to persons who suffer oil pollution damage resulting from maritime casualties involving oil-carrying ships. It places liability for such damage on the owner of the ship from which the polluting oil escaped or was discharged. It covers pollution damage resulting from spills of persistent oils suffered in the territory, including the territorial sea, of a State Party to the Convention.

22. The United Nations Convention to Combat Desertification (UNCCD) (1994) requires Parties to combat desertification and mitigate the effects of drought. The related health effects from extreme weather events include malnourishment and dehydration from reduced food, water supplies and energy; waterborne and foodborne diseases resulting from poor hygiene and contamination; and the spread of infectious diseases through population movements. Under Annex V, the UNCCD provide guidelines and arrangements for the effective implementation of the Convention in affected country Parties of the Central and Eastern European region, including countries affected by unsustainable exploitation of water resources leading to serious environmental damage, including chemical pollution, salinization and exhaustion of aquifers.

23. The Convention on the Law of the Non-navigational Uses of International Watercourses (1997) commits Watercourse States to, individually and, where appropriate, jointly, prevent, reduce and control the pollution of an international watercourse that may cause significant harm to other watercourse States or to their environment, including harm to human health, to the use of the waters for any beneficial purpose or to the living resources of the watercourse.

24. The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (1997) applies to spent fuel and radioactive waste resulting from civilian nuclear reactors and applications and from military or defence programmes if and when such materials are transferred permanently to and managed within exclusively civilian programmes, or when declared as spent fuel or radioactive waste for the purpose of the Convention by the Contracting Party. The Convention also applies to planned and controlled releases into the environment of liquid or gaseous radioactive materials from regulated nuclear facilities.

25. The Rotterdam Convention on Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (1998) does not specifically mention pollution in its articles. However, the substances it controls are those likely to cause pollution and harm human health and the environment. It seeks to promote shared responsibility and cooperative efforts among Parties in the international trade of hazardous chemicals in order to protect human health and the environment from potential harm. It also seeks to contribute to the environmentally sound management of these chemicals when their use is permitted by facilitating information exchange about their characteristics, potential dangers, safe handling and use by providing for a national decision-making process on their import and export and by disseminating these decisions to Parties.

26. The Stockholm Convention on Persistent Organic Pollutants (2001), reaffirming Principle 16 of the Rio Declaration, seeks to protect human health and the environment from persistent organic pollutants. The Convention calls upon Member States to restrict and ultimately eliminate the production, use, trade, release and storage of persistent organic pollutants.

27. International Health Regulations (IHR) (2005) are meant to help the international community prevent and respond to public health risks and emergencies that can have devastating impacts on human health and economies.

28. The Strategic Approach to International Chemicals Management (SAICM), adopted by the First International Conference on Chemicals Management (ICCM1) on 6 February 2006, is a policy framework to promote chemical safety around the world. The objective of SAICM is to achieve sound management of chemicals throughout their life cycle so that by 2020, chemicals are produced and used in ways that minimise adverse

impacts on human health and the environment. The "2020 goal" was adopted by the World Summit on Sustainable Development in 2002 as part of the Johannesburg Plan of Implementation. SAICM is, however, not legally-binding like other Conventions.

29. **The Bali Declaration on Waste Management for Human Health and Livelihood (2008)** reaffirms the commitment, of Parties to the Basel Convention and from other States, to the principles and purposes of the Basel Convention, including the fundamental objective to protect, by strict control, human health and the environment against the adverse effects resulting from the generation, transboundary movement and management of hazardous wastes and other wastes.

30. **The objective of the Minamata Convention on Mercury (2013)** is to protect the human health and the environment from the adverse effects of mercury and mercury compounds. Its preamble recognizes the substantial lessons of Minamata Disease, in particular the serious health and environmental effects resulting from the mercury pollution, and the need to ensure proper management of mercury and the prevention of such events in the future.

31. **The Paris Agreement (2015)** does not specifically call for control of pollution. However, the objective to hold the increase in the global average temperature to well below 2°C and increase the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, can only be achieived if Parties undertake control the emissions of climate/air pollutants and rapidly reductions emission of greenhouse gases.

32. **The Kigali Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (2016) (not yet in force)** commits parties to cut the production and consumption of hydrofluorocarbons by more than 80 percent from 2019-2047 and thereafter. The agreement will further enhance the processes for control greenhouse gases under the Paris Agreement, the UN Framework Convention on Climate Change and its Kyoto Protocol.

Annex 4

Regional initiatives, networks and agreements

Regional MEAs, initiatives and networks are also significant platforms for enhancing synergies and cooperation in tackling global pollution issues at localized levels, while benefiting from the localized knowledge bases that cannot be easily accessed at the global levels. For example, the Pan-European Strategic Framework on Greening the Economy[152] provides a platform for a coordinated regional approach to a green and inclusive economy, operationalized by the Batumi Initiative on Green Economy (BIG-E)[153] at present comprising 115 commitments to actions by 25 countries and 12 organizations.

The degree of focus on the various types and elements of pollution varies from one region to another, but across all the five regions, water and air pollution are given a greater focus. The various regional agreements, networks and initiatives have established or are in the process of establishing databases, tools and joint actions taking into consideration the different sectoral and regional experience, cultural and political practices and challenges as regards pollution control. The available data reflects in detail the character and focus of the particular region, including policy and regulatory gaps. The Global Atmospheric Pollution Forum, for instance, relies on data from Africa, Asia and Latin America and the Caribbean to support the development of solutions to air pollution-related problems and promote effective cooperation among nations at the regional, hemispheric and global scales.[154]

The European Environment and Health Process (EHP) and its Ministerial Conference provide a unique intersectoral policy platform to bringing together environment and health sectors and partners to shape policies and actions to reduce the adverse health impact of environmental threats through effective environmental health interventions. The latest conference held in Ostrava, Czech with a strong political commitment (Ostrava Declaration[155]) accompanied by a compendium of meaningful actions[156] to protect the health and well-being of European citizens and the environment they live in. The EHP enhances synergies and cooperation and an important platform to tackle the causes and consequences of pollution.

There is need for additional resources or efforts to enhance the capacity of weak regional initiatives, specifically in Africa, Asia and Latin America and the Caribbean and further develop joint initiatives, e.g. like Environment and Health, Environment and Water, Environment and Agriculture, or integrating them in the concept of Green/ Blue or Circular Economy.

Africa

1. African Ministerial Conference on the Environment (AMCEN) (established 1985)
2. Air Pollution Information Network for Africa (APINA) (1997) (network of scientists, policy makers and private sector and non-governmental organisations from Africa)
3. Harare Resolution on Prevention and Control of Regional Air Pollution in Southern Africa and its Likely Transboundary Effects (1998)

4. Dakar Declaration on the Phasing-out of Leaded Gasoline in Sub-Saharan Africa (2001)
5. The Maputo Declaration on the Prevention and Control of Regional Air Pollution in southern Africa and its likely Transboundary Effects. (2003)
6. Health Strategy of the African Union (2006)
7. Regional Policy Framework on Air Pollution (2008)
8. Algiers Declaration on Health Research in Africa (2008)
9. Ouagadougou Declaration on Waste Management for Human Health and Livelihood (2008)
10. Southern African Development Community (SADC) Regional Policy Framework on Air Pollution (Lusaka Agreement 2008)
11. Eastern Africa Regional Framework Agreement on Air Pollution (Nairobi Agreement 2008)
12. West and Central Africa Regional Framework Agreement on Air Pollution (Abidjan Agreement-2009)
13. North African Framework Agreement on Air Pollution
14. Southern Africa Development Community Protocol on Regional Air Quality and Atmospheric Emissions
15. **Libreville Declaration on Health and Environment in Africa (2008)** recognizes the need for further research to increase understanding of the vulnerability of humans to environmental risk factors, particularly in Africa. It calls upon countries to develop or update national, subregional and regional frameworks in order to address more effectively the issue of environmental impacts on health.[157]
16. West, Central and Southern Africa Region Regional Contingency Plans and other Means of Preventing and Combatting Pollution Incidents (2011)
17. The African Convention on the Conservation of Nature and Natural Resources (2003).[158]
18. Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa (1991).
19. Convention for Cooperation in the Protection, Management and Development of the Marine and Coastal Environment of the Atlantic Coast of the West, Central and Southern Africa Region (Abidjan Convention) and the Additional Protocol to the Abidjan Convention Concerning Cooperation in the Protection and Development of Marine and Coastal Environment from Land-based Sources and Activities in the Western, Central and Southern African Region (LSBA Protocol - 2012) .
20. Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region (Nairobi Convention).

Asia

1. The Association of Southeast Asian Nations (ASEAN) (1967)
2. ASEAN Agreement on Transboundary Haze Pollution (2002)
3. Central Asian International Environmental Forum
4. Intergovernmental Networks on Regional Air Pollution in Asia and the Pacific Region
5. The Acid Deposition Monitoring Network for East Asia (EANET) (1998)
6. Joint Forum on Atmospheric Environment in Asia and the Pacific
7. Asia-Pacific Regional Forum on Health and Environment
8. The Asia Pacific Clean Air Partnership (APCAP)[159]
9. Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (CCAC)
10. Clean Air Asia's Integrated Programme for Better Air Quality in Asia (IBAQ)
11. Asian Co-benefits Partnership (ACP)
12. The Long-range Transboundary Air Pollutants in North East Asia (LTP)
13. The Northeast Asian Subregional Programme for Environmental Cooperation (NEASPEC)
14. Framework Convention on Environmental Protection for Sustainable Development (Central Asia) (2006)
15. The Convention on Conservation of Nature in the South Pacific (Apia Convention)
16. Malé Declaration on Control and Prevention of Air Pollution and Its Likely Transboundary Effects for South Asia (1998)
17. **Regional Environmental Centre for Central Asia (CAREC) (1998)** creates opportunities to attract to Central Asia the advanced knowledge, best international practices and technologies in the field of environmental management and sustainable development.
18. **The Convention to Ban the importation into Forum Island Countries of Hazardous and Radioactive Wastes and to Control the Transboundary Movement of Hazardous wastes within the South Pacific Region (Waigaini Convention) (1995**) objectively seeks to reduce and eliminate transboundary movements of hazardous and radioactive waste, to minimize the production of hazardous and toxic wastes in the Pacific region and to ensure that disposal of wastes in the Convention area is completed in an environmentally sound manner. The Convention applies the strict controls of the Basel Convention to the South Pacific area, and ensures that hazardous waste cannot travel from New Zealand or Australia to another Pacific country, or to Antarctica.

19. Kuwait Regional Convention for Cooperation on the Protection of the Marine Environment from Pollution (1978) and Protocol concerning Regional Co-operation in Combating Pollution by Oil and other Harmful Substances in Cases of Emergency (1978).

Europe and North America

1. European Environment and Health Ministerial Board (EHMB)[160]
2. Batumi Action for Cleaner Air (2016–2021) hosted by UNECE: a voluntary initiative supporting countries' efforts in improving air quality and protecting public health and ecosystems. 108 commitments have been submitted by 27 countries and 4 organizations.[161]
3. European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) (1968).
4. The United Nations Economic Commission for Europe Convention on Long-range Trans-boundary Air Pollution (1979) and its Protocols :
    a) Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) (1984);
    b) Protocol on Reduction of Sulphur Emissions or their Transboundary Fluxes by 30% (1985);
    c) Protocol on Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes (1988);
    d) Protocol on Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes (1991)
    e) Protocol to the Convention on long-range Transboundary air pollution concerning the further reductions of Sulphur Emissions (1994).
    f) Protocol on Persistent Organic Pollutants (1998)
    g) Protocol to the Convention on long-range Transboundary air pollution on Heavy Metals (1998)
    h) Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (1999).
    i) Protocol to the Convention on long-range Transboundary air pollution to abate acidification, eutrophication and ground-level ozone (1999)

5. The United Nations Economic Commission for Europe Convention on the Transboundary Effects of Industrial Accidents (1992).[162]
6. Helsinki Convention on the Protection of the Marine Environment of the Baltic Sea Area (1992).
7. The UN Economic Commission for Europe Aarhus Convention on Access to Information, Public Participation in Decision Making and Access to Justice in Environmental Matters (1998) and the Kyiv Protocol on Pollutant Release and Transfer Registers (2009) (All UN Member States can join the Protocol).
8. Oslo and Paris (OSPAR Convention) - Convention for the Protection of the Marine Environment of the North-East Atlantic (1992)
9. The UN Economic Commission for Europe Espoo Convention on Environmental Impact Assessment (1991) and the Protocol on Strategic Environmental Assessment (2003).
10. Alpine Convention (1991) and its Protocols encourage parties to adhere to the basic principles of all the activities not harmful to humans, animals and plants and their habitats.
11. Bern Convention on the Conservation of European Wildlife and Natural Habitats (1979).
12. River Basin Conventions (Danube (1994), Elbe (1990), Oder (1996), Rhine (1999)) seek to ensure that surface waters and groundwater within river basins are managed and used sustainably and equitably; improve water quality and reduce hazardous pollution to ensure that human health and the aquatic ecosystem of the waters are not threatened by hazardous substances.
13. Agreement for cooperation in dealing with pollution of the North Sea by oil and other harmful substances (Bonn Agreement) (1983) is applicable whenever the presence or the prospective presence of oil or other harmful substances polluting or threatening to pollute the North Sea presents a grave and imminent danger to the coast or related interests of one or more Contracting Parties.

Latin America and the Caribbean

1. The Forum of Ministers of Environment of Latin America and the Caribbean
2. Regional Action Plan for Intergovernmental Cooperation on Air Pollution for Latin America and the Caribbean (2014)
3. Regional Intergovernmental Network on Atmospheric Pollution of Latin America and the Caribbean
4. Regional Agreement on the Transboundary Movement of Hazardous Wastes (1992)(not yet in force)
5. Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region (Cartagena Convention) (1983) calls on Parties to take appropriate measures to control pollution of the wider Caribbean Sea region from land based sources, ships, dumping, sea bed activities, and airborne

sources. It covers the marine environment of the Gulf of Mexico, the Caribbean Sea and the areas of the Atlantic Ocean and is complimented by the following protocols:

a) The Protocol Concerning Co-operation in Combating Oil Spills in the Wider Caribbean Region (1983).
b) The Protocol Concerning Specially Protected Areas and Wildlife (SPAW) in the Wider Caribbean Region (1990).
c) The Protocol Concerning Pollution from Land-Based Sources and Activities (1999)

6. **Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific (1981) (Lima Convention)** obligates Parties to take measures to prevent, reduce and control pollution of the marine environment and coastal area of the South-East Pacific and to ensure appropriate environmental management of natural resources.[163]

The Antarctic Treaty System

1. Protocol on Environmental Protection to the Antarctic Treaty (1991)
2. Convention for the Conservation of Antarctic Seals (1972)
3. Convention on the Conservation of Antarctic Marine Living Resources (1980) (CCAMLR)
4. **The Antarctic Treaty Consultative Meeting (ATCM)** adopts Measures, Decisions and Resolutions for implementing the principles of the Antarctic Treaty and the Environment Protocol and provide regulations and guidelines for the management of the Antarctic Treaty area. The Decisions address internal organizational matters of the meeting. The Resolutions are not legally binding on Contracting Parties but they can provide guidance on the implementation of the Antarctic Treaty system. The Measures, once approved, are legally binding on the Consultative Parties.
5. **The Committee for Environmental Protection (CEP)** provides advice and formulate recommendations to the Parties in connection with the implementation of the Environment Protocol Protocol.[164]

The Arctic Council

1. Arctic Contaminants Action Program (ACAP) mandated to prevent adverse effects from, reduce, and ultimately eliminate pollution of the Arctic environment.[165]
2. Arctic Monitoring and Assessment Programme (AMAP) mandated to provide reliable and sufficient information on the status of, and threats to, the Arctic environment, including scientific advice on actions to be taken to support Arctic governments in their efforts to take remedial and preventive actions relating to contaminants.[166]
3. Conservation of Arctic Flora and Fauna (CAFF) mandated to develop common responses on issues of importance for the Arctic ecosystem, including responses on conservation opportunities and political commitments.[167]
4. Emergency Prevention, Preparedness and Response (EPPR) mandated to contribute to the protection of the Arctic environment from the threat or impact that may result from an accidental release of pollutants or radionuclides.[168]
5. Protection of the Arctic Marine Environment (PAME) mandated to address policy and non-emergency pollution prevention and control measures for the protection of the Arctic marine environment from both land and sea-based sources.[169]

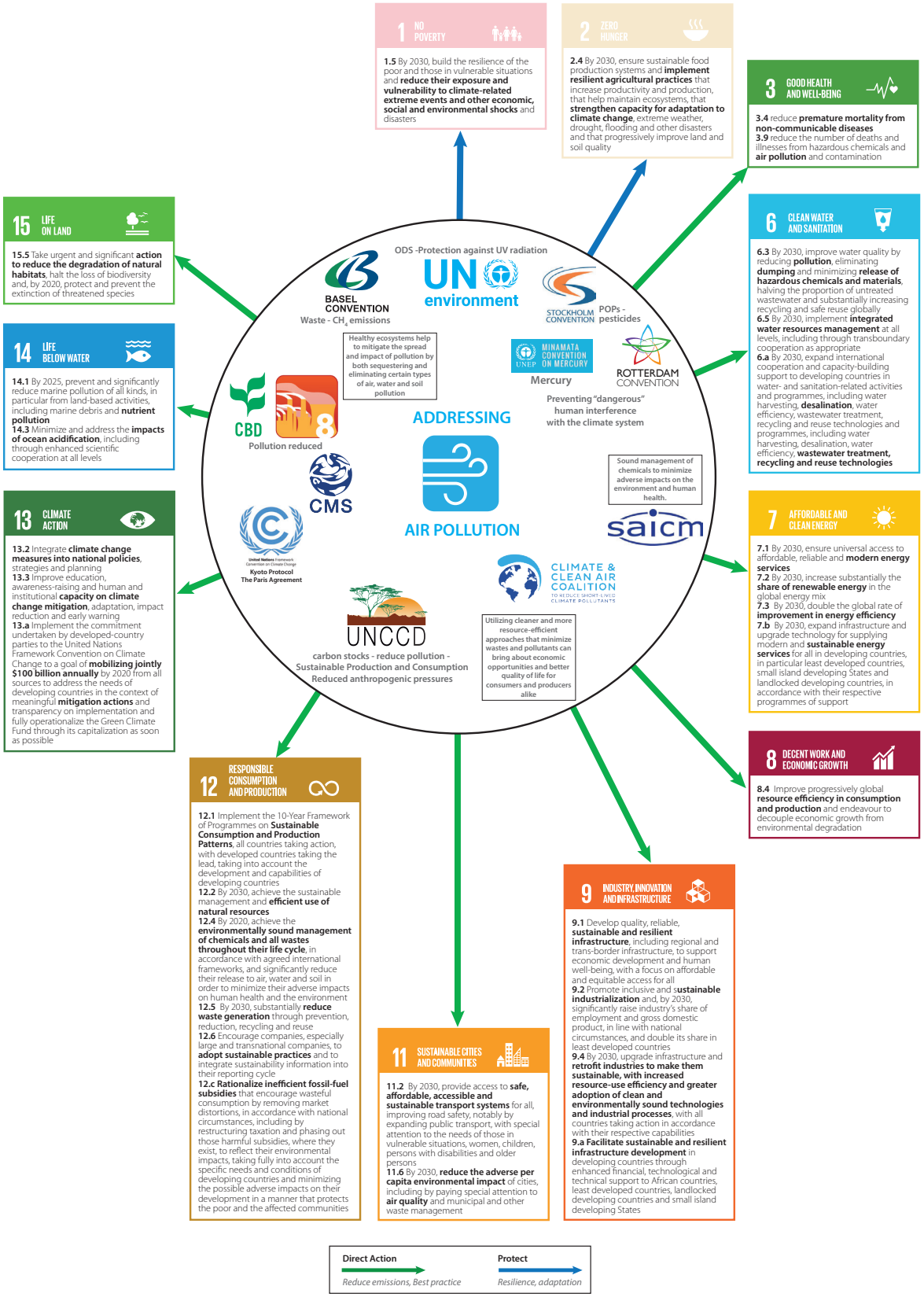
Sustainable Development Working Group (SDWG) incorporates activities to prevent and control disease and injuries by monitoring the impact of pollution and climate change on health and Sustainable Development of the people living in the Arctic [170]

Annex 5

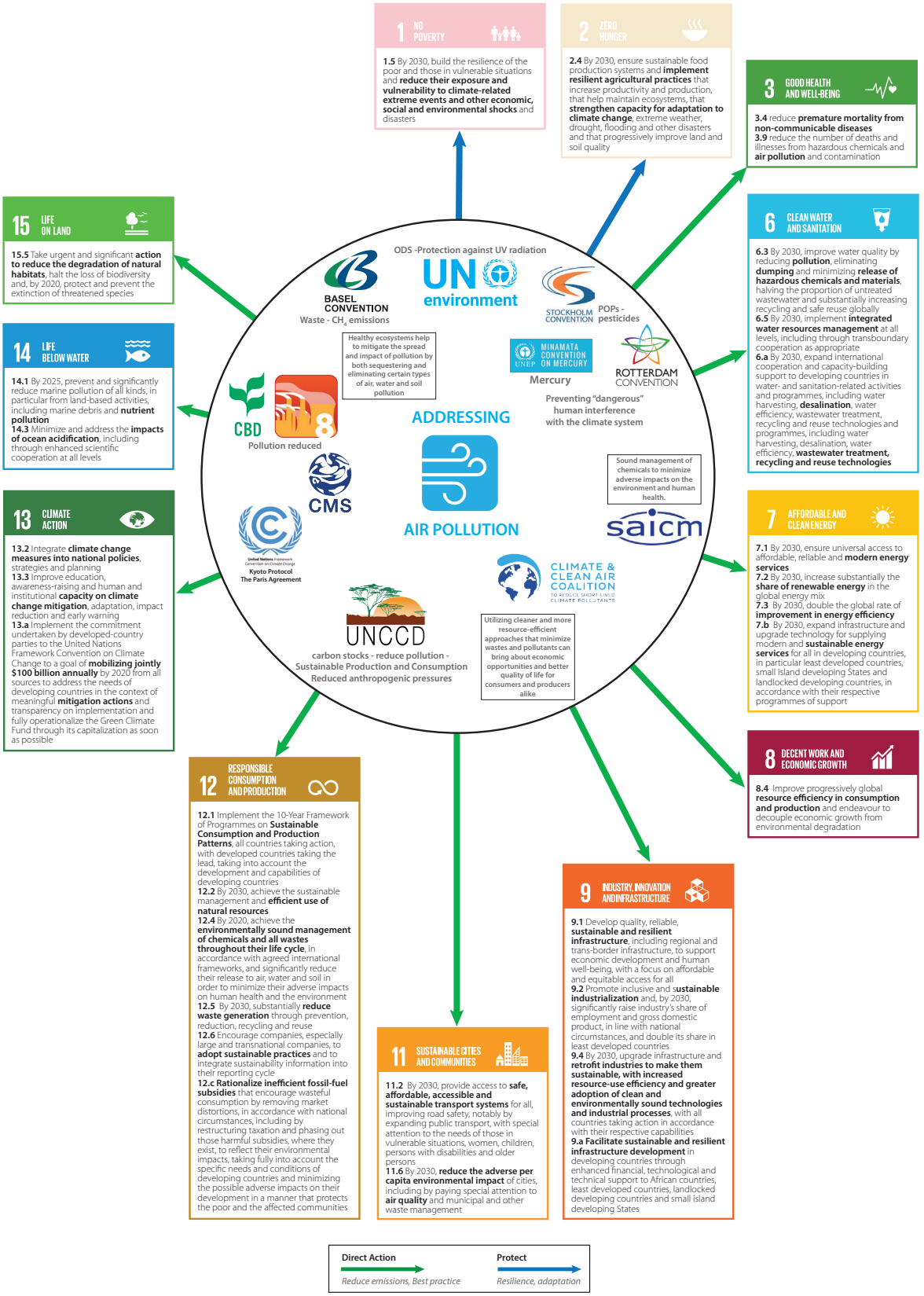
Analysis of the linkages between addressing pollution types and implementing sustainable development goal targets.

The figures below map how addressing pollution through multilateral environmental agreements and other international initiatives contributes to achieving Sustainable Development Goal targets. The icons in the centre give an indication of the institutions that play a key role in tackling that type of pollution.

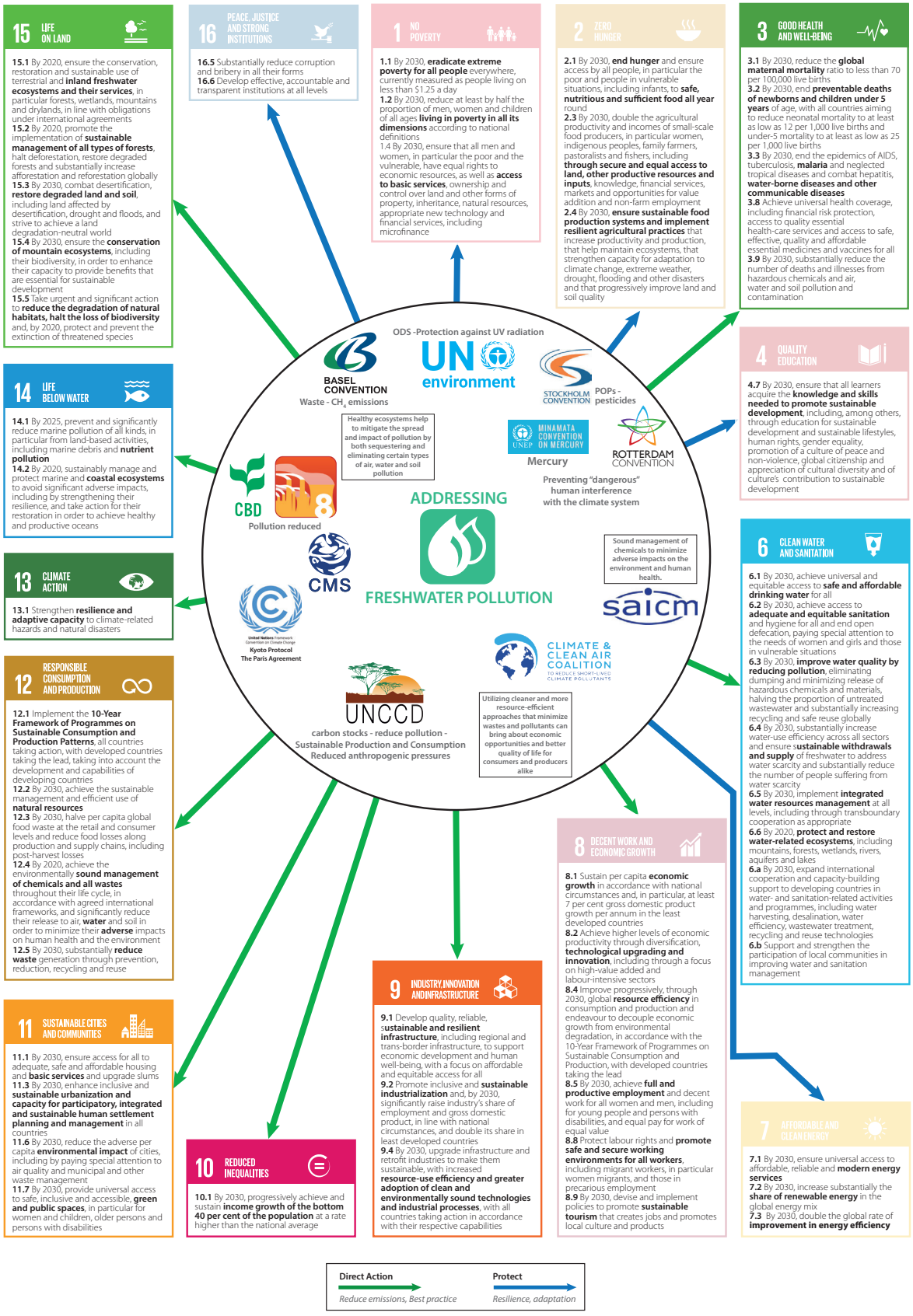
a) Air pollution



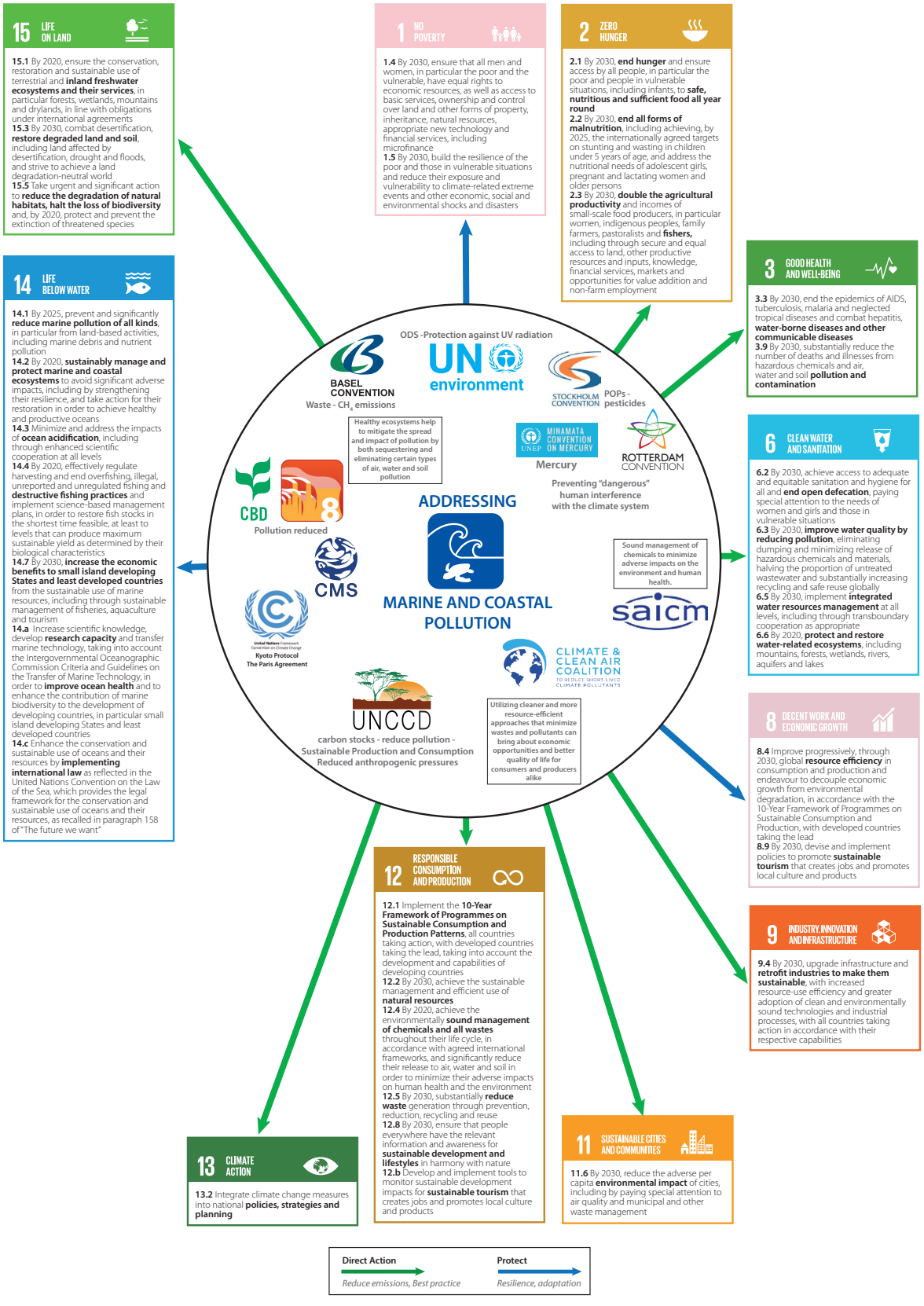
b) Land and soil pollution



c) Freshwater pollution



d) Marine and coastal pollution



Annex 6

Rio Principles relevant to a pollution-free planet

RIO PRINCIPLES

1. Human beings are at the centre of concerns for sustainable development.
2. States have the sovereign right to exploit their own resources pursuant to their responsibility to ensure that activities do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.
3. The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations.
4. Environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it.
5. All States and all people shall cooperate in the essential task of eradicating poverty.
6. The special situation and needs of developing countries, particularly the least developed and those most environmentally vulnerable, shall be given special priority.
7. States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem. States have common but differentiated responsibilities.
8. States should reduce and eliminate unsustainable patterns of production and consumption and promote appropriate demographic policies.
9. States should cooperate to strengthen endogenous capacity-building for sustainable development, including new and innovative technologies.
10. Environmental issues are best handled with the participation of all concerned citizens. Appropriate access to information is required including information on hazardous materials and activities in their communities. States shall facilitate and encourage public awareness and participation by making information widely available.
11. Environmental standards, management objectives and priorities should reflect the environmental and developmental context to which they apply.
12. Trade policy measures for environmental purposes should not constitute a means of arbitrary or unjustifiable.
13. States shall develop national law regarding liability and compensation for the victims of pollution and other environmental damage.
14. States should effectively cooperate to discourage or prevent the relocation and transfer to other States of any activities and substances that cause severe environmental degradation or are found to be harmful to human health.
15. The precautionary approach shall be widely applied by States according to their capabilities.
16. National authorities should endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution,
17. Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities
18. States shall immediately notify other States of any natural disasters or other emergencies that are likely to produce sudden harmful effects on the environment of those States.
19. States shall provide prior and timely notification and relevant information that may have a significant adverse transboundary environmental effect.
20. Women have a vital role in environmental management and development.
21. The creativity, ideals and courage of the youth of the world should be mobilized.
22. Indigenous people and their communities, and other local communities, have a vital role in environmental management and development
23. The environment and natural resources of people under oppression, domination and occupation shall be protected.
24. States shall therefore respect international law providing protection for the environment in times of armed conflict and cooperate.
25. Peace, development and environmental protection are interdependent and indivisible.
26. States shall resolve all their environmental disputes peacefully.
27. States and people shall cooperate in good faith and in a spirit of partnership in the fulfilment of the principles embodied in this Declaration.

Annex 7

Impacts, benefits and limitations of cleaner technologies

Type of Pollution	Pollution Areas	Technologies to Prevent Pollution	Impacts/Benefits	Limitations
Air Pollution	Road Transport	Clean petrol/ diesel vehicles technologies (incl. filters) Electric cars	Reduce CO2 emissions, fine particles and other pollutants. therefore resulting in improved human health	Most clean vehicles technologies depend on clean fuels Electric vehicles still have limited range
	Agriculture	Improved fertilizer (nutrient) and manure management (incl. field application and storage) Restrict agriculture residue burning	Encourages efficient use of fertilizer. Handling manure as a solid versus a liquid helps to decrease emissions. Encourage efficient ploughing after harvesting	When mismanaged, emissions from field spread manure has the potential to pollute air, land, and water resources through deposition. Investment in good ploughing machine has relatively high cost
	Energy production and distribution	Renewable energy sources include wind energy, geothermal energy, solar energy, and hydropower	Little to no global warming emissions, Improved public health and environmental quality, increase gender equality. A vast and inexhaustible energy supply	Biomass plants raise concerns about air emissions and water use similar to fossil fuel plants
Freshwater Pollution	Industrial waste	Adsorption process (treatment and removal of organic contaminants in wastewater treatment)	Simple design and can involve low investment in term of both initial cost and land required	High operational costs
	Domestic wastewater and sewage	Anaerobic wastewater treatment, advanced tertiary treatment (membrane filtration, ozonation) Constructed wetlands/green infrastructure Small-scale decentralized systems (e.g. ecosan; low/no water systems) Small-scale decentralized systems – eg ecosan; low/no water systems; Biodigestors; septic tanks; composting toilets; Duckweed lagoons	Less waste produced than aerobic treatment. Methane produced as energy source. relatively low-labor and low-energy Simple, durable and easy to maintain; Clean and low cost energy alternative to fuelwood; improved indoor air	Production of odours; does not remove ammonia-nitrogen; Temperature must be maintained year-round. Need for preliminary treatment of wastewater; may require relatively large land area Not attractive on large scale; challenge in linking markets with productions sites i.e for ecosan
	Agricultural runoff and Waste	Integrated pest management, efficient fertilizer use (improved nutrient use efficiency), enhanced product formulations, Erosion control. Livestock waste management and treatment	Proper wastewater treatment can provide water for agriculture (reusability) Nutrient recovery from manures Cost savings for farmers	When mismanaged, has the potential to pollute air, land, and water resources
	Radioactive Waste	Multinational repositories	Since some countries are limited in area, or have unfavourable geology, multinational repositories can help in safer management of radioactive waste.	However, for the time being, many countries would not accept nuclear waste from other countries under their national laws.

Land Pollution	Agricultural activities	agroecology; minimum or zero tillage for soil structure and health; organic and permaculture; agroforestry; pasture and grass-fed livestock systems; alternate wetting and drying in rice; reversion back to mixed (crop and livestock) farming systems ensuring nutrient recycling on-farm (crops and pasture consumed by livestock and nitrogen returned to the ground through manure and other organic matter	Reduces pollution Nutrient recovery from manures Cost savings for farmers	
Marine Pollution	Domestic waste water and sewage	Storm water filters + see freshwater pollution	Reduces pollution and prevents flooding	High construction and maintenance costs are relatively high
	Large-scale oil spills	NOTIL -new generation trawler to recover oil spills	100% recyclable and light weight	
	Plastic waste	Redesign of products Washing machine filters Recovery/recycling and conversion to other products Innovations in alternative materials Ocean Cleanup (Long floating barriers)	Possibility of harmful atmospheric emissions; costly and requires large volumes to generate energy Closing the material loop and increase recyclability of product e.g. fishing gear to carpets Preventing synthetic fibres (Oceans clean up) Prevents by-catch of unwanted fish and other marine species. Designed for large-scale deployments	Recycling is not a profitable option for many polymers, requires large amounts to justify investments in infrastructure which smaller countries or islands would not have Alternative materials may not be possible to scale up, also caution that these need to be thoroughly tested in marine conditions so that we do not create a bigger problem (Oceans clean up) pilot stage and only “end-of-pipe” solution. Does not address the root cause of the problems
	Agricultural runoff and Waste	Integrated Pest Management, Efficient fertilizer use (improved nutrient use efficiency) – enhanced product formulations; Erosion control, Livestock waste management and treatment	Proper wastewater treatment will result in water for agriculture (reusability); nutrient recovery from manures; cost savings for farmers	When mismanaged, has the potential to pollute air, land, and water resources.

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