Chapter 4
Environmental Degradation and Micro-pollutants in Light of Environmental Laws

Furqan Mahmud Butt, Umair Bin Nisar, and Toqeer Ahmed

Abstract Environment is everything surrounding human beings. Biotic and abiotic contributors of environment affect natural, build, and social aspects of human beings. For healthy livelihood, human beings are dependent on environment. The increase in population, urbanization, and industrialization is having severe effect on world environment. Climate change further aggravates the situation. Despite several laws drafted for the awareness and reduction of environmental degradation, no profound results have been obtained. Environmental issues induce several negative externalities and contribute to market failure, thus affecting economic growth; this becomes a serious problem in developing and underdeveloped countries where there are no strong rules for reducing these negative externalities. Pakistan is ranked fifth among the most affected countries in terms of climate change despite the contribution of less than 01% in emissions. The air quality index of Pakistan is getting poor with every passing day; Lahore and Faisalabad were ranked as most polluted cities all over the world in terms of air quality index. The government of Pakistan has taken some time to realize environmental degradation and has initiated projects like billion tree tsunami and air quality laws to address climate change and environmental degradation.

F. M. Butt
Department of Meteorology, COMSATS University Islamabad, Islamabad, Pakistan
e-mail: furqan.mahmud@comsats.edu.pk

U. B. Nisar (✉) · T. Ahmed
Center for Climate Research and Development, COMSATS University Islamabad, Islamabad, Pakistan
e-mail: umair.nisar@comsats.edu.pk; toqeer.ahmed@comsats.edu.pk

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4.1 Pollution and Environment

Pollution is addition of harmful chemicals/contaminants into the atmosphere which can cause severe damage to health and the environment (Nathanson 2015), whereas the environment is everything that surrounds us and comprises both biotic and abiotic components. These components represent both living and nonliving things in ecosystems. These components represent a relationship between producers, consumers, and decomposers that relay on fluctuations of temperature air and sunlight. With increase in population, urbanization, and industrial developments, the environment is severely affected (Nisar et al. 2018); most of the pollution induced in the environment is the result of automobiles, industrial sector, and solid wastes (Ekins 2010). World population has drastically increased over the years and if it continuously exceeds at the same pace, it will cause severe loss to environment (Hamrick 2004), as population increase demands utilization of more resources thus resulting in overburden on natural resources and increase in environmental degradation (Behrens et al. 2007). World Health Organization (WHO) has estimated that about 4.2 million children die due to ground-level air pollution, causing heart disease, lung cancer, stroke, and acute respiratory infections (WHO 2018). Pollution is unequally induced by some prominent countries in the world, but price is paid by every living organism on earth. Despite the steps taken after Paris accord (2016), the CO2 emissions are continuously increasing, which are causing an increase in temperatures. With China being the largest CO2 emitter, it accounts for more than one-quarter of emissions, followed by the USA with 15% emissions, the European Union (EU-28) with 10%, followed by India and Russia with 7% and 5%, respectively (Lelieveld et al. 2019). A regular passenger car emits around 4.6 metric tons of pollutants each year (Masiol et al. 2014). The average gasoline vehicle on the road has a fuel efficiency of about 22 miles per gallon, with an average annual travel distance of about 11,500 miles (this statement does not apply to developing nations, where average vehicle fuel usage is between 10 and 15 miles per km). At this proportion, every gallon of fuel burned produces about 8,887 grammes of CO_2 (Pachauri et al. 2014). Annual total CO_2 emissions by world region are shown in Fig. 4.1.

Increase in population has severe effect on waste generation which plays a vital role in waste generation. The world annually generates 2.01 billion tons of municipal solid waste, out of which 33% is not managed in environmentally friendly manner. Waste generation by single individual worldwide is about 0.74 kg per day ranging from 0.11 to 4.54 kg. The future projection portrays the generation of wastes could go up to 3.40 billion tons annually, which shows a drastic increase from 2.01 billion tons today (Kaza et al. 2018). Share of global population and municipal solid waste for G20 countries has been shown in Fig. 4.2.

The situation gets worse in developing countries, especially in the SAARC countries where population is increasing rapidly and resources are overutilized, and as a result, pollution is severely affecting the environment (Hasnat et al. 2018).

The global cost of air pollution caused by fossil fuels in South Asia is $8 billion a day (Liu et al. 2015), or roughly 3.3% of the entire world's economic output

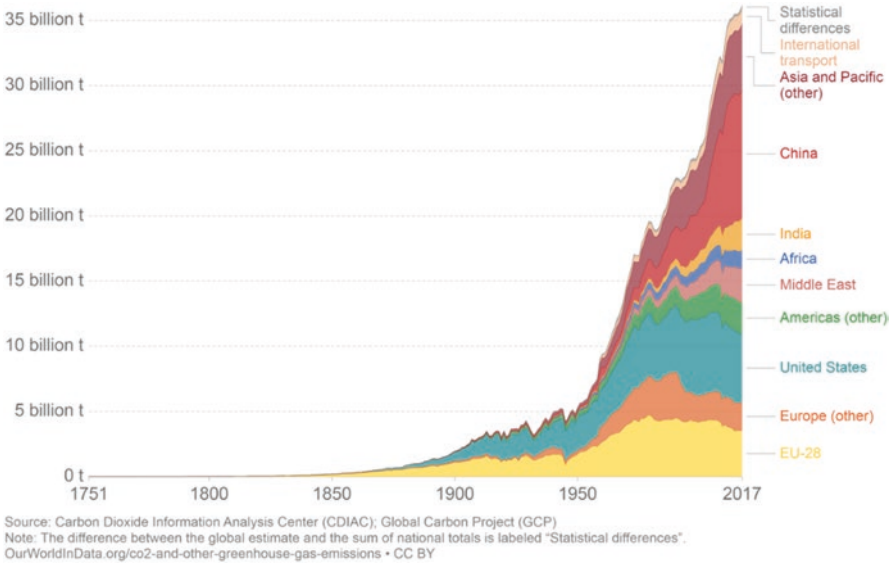

Fig. 4.1 Annual total CO_2 emissions by world region. (Ritchie and Roser 2017)

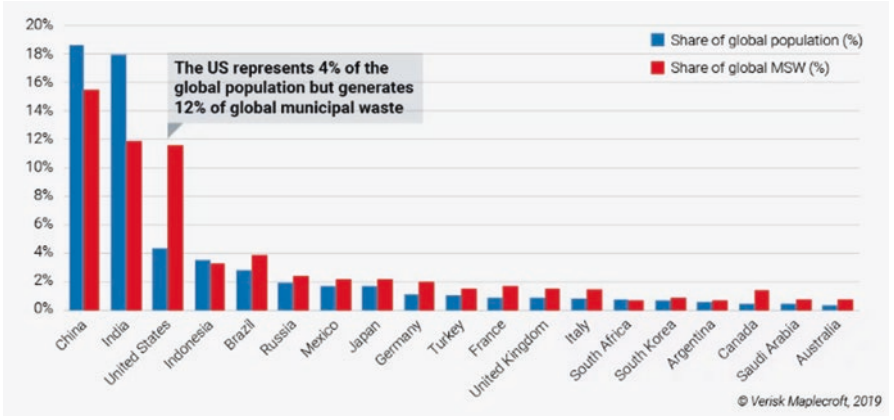

Fig. 4.2 Showing share of global population and municipal solid waste for G20 countries. (Ritchie and Roser 2017)

(CREA and Greenpeace Southeast Asia report). Pakistan is one of the leading countries in Southeast Asia; despite the environmental laws, the implementation faces a big problem.

Presently, several environment-related laws such as pesticide control, motor vehicles emission's regulation, and control of industrial pollution through Pakistan Environment Protection Ordinance 1983 exist. However, these laws are not being implemented fully and effectively.

4.2 Micro-pollutants and Environment

The phrase "micro-pollutants" refers to various chemicals found in trace concentrations in the water-soil-air matrix, ranging from micrograms to picograms per liter, and emphasizes the substances' small concentrations range. Micro-pollutants include pharmaceuticals, cosmetics, synthetic musk, industrial chemical substances, pests, and disinfectants. Agricultural and nonagricultural sources release these pollutants into the water supply (Antakyali et al. 2015). Micro-pollutants are anthropogenic contaminants that appear in the marine ecosystem well above a (potential) normal background level because of human activities, but at trace levels -(Stamm et al. 2016). As a result, micro contaminants are characterized by their anthropogenic origin and low concentration presence, and thousands of chemicals fall into this group (Schwarzenbach et al. 2006). Ice covers more than 70% of the earth's surface, with 97.2% contained in oceans, 2.15% in ice sheets and glaciers, with just 0.65% fresh water available for use. Water is used in agriculture, industries, households, and in every aspect of life (Lutgens et al. 2006).

Around onefifth of the planet's population lack access to clean drinking water, and two-fifths suffer from unsanitary living conditions (WWAP 2003). Waterborne pathogens kill over 2 million people per year, the majority of whom are children under the age of five. The growing chemical contamination of surface and groundwaters, which has relatively unknown long-term consequences on marine life and human health, could easily contribute to a similar or even larger crisis. More than a third of the world's clean freshwater is used for farming, commercial, and domestic uses, and most of these operations pollute the water with a variety of synthetic and geogenic compounds. As a result, it should come as no surprise that chemical contamination of aquatic environments has become a significant public issue in almost every nation (Schwarzenbach et al. 2006).

The municipal drainage scheme and dispersed sources such as irrigation provide input to the aquatic ecosystem. Persistent substances can move through the wastewater treatment plant (WWTP) without being broken down. In addition, input of easily degradable pollutants happens by out-of-date WWTPs and flood water or mixed sewage overflows on a regular basis. Micro-pollutants may accumulate along the strip or in lakes if many WWTPs drain into the same water body. Micropollutants from urban runoff can contaminate groundwater used for drinking water through infiltration of polluted surface water (Gälli et al. 2009). Industry and communities use approximately 10% of the commonly available water, resulting in a current of wastewater that drains or makes its way into rivers, wetlands, reservoirs, or coastal seas (WWAP 2003).

Various chemical compounds of different proportions can be found in these wastewaters. Around 300 million tons of artificial chemicals used in commercial and consumer goods end up in natural waters every year (Schwarzenbach et al. 2006). Agricultural sector, which consumes 140 million tons of fertilizer as well as several million tons of chemicals per year, contributes to additional problems related to water pollution (FAO 2006). For example, in the European Union, there are over

100,000 identified chemical compounds, among which 30,000–70,000 are used on a regular basis (EINECS, European Inventory of Existing Chemical Substances). Another significant cause of water pollution is the consumption of 0.4 million tons of oil and diesel components because of accidental spills. The infiltration of salty water into reservoirs due to aquifer overexploitation; the human-driven mobilization of naturally occurring geogenic hazardous chemicals, such as heavy metals and metalloids; and the biological development of pesticides and malodorous compounds are all notable causes of pollution (Schwarzenbach et al. 2006).

To date, there is a scarcity of a successful and long-term global plan to combat this pervasive and still unnoticed contamination of marine ecosystems. In highly developed nations, source controls and technological infrastructure, such as wastewater treatment plants, serve as partial hurdles, but significant obstacles remain (Schwarzenbach et al. 2006). The source, action, and management of the limited number of macro-pollutants found at μg/liter to mg/liter concentrations, such as acids, salts, nutrients, and natural organic matter, are relatively well-understood: Increased primary productivity, oxygen loss, and harmful algal blooms will all result from high nutrient loads. Predicting environmental responses, optimizing treatment technologies, and developing coordinated policies at the size of river basins are all problems in such situations (Mengis et al. 1997; Jackson et al. 2001).

Several investigations in Europe and North America have recently confirmed the detection of these "micro-pollutants" in wastewater, surface water, ground water, and drinking water (Ternes 1998; Daughton and Ternes 1999; Daughton and Jones-Lepp 2001; Heberer 2002; Kolpin et al. 2002; Calamari et al. 2003; Frick and Zaugg 2003; Boxall et al. 2004; Metcalfe et al. 2004; Ternes et al. 2004; Glassmeyer et al. 2005; Sedlak et al. 2005; Loraine and Pettigrove 2006). The quantities of these substances in surface waters were as low as a few micrograms per liter. Pollutants were found in ground water and drinking water at levels as low as one microgram per liter. Eventually, there are fears that other pharmaceuticals intended for specific biological causes could be harmful for the environment as well (Ternes et al 2004). For the contraceptive 17α-ethinylestradiol (EE2) and the antiphlogistic diclofenac, respectively, estrogenic effects and renal alterations at environmental concentration levels have already been published (Routledge et al. 1998; Triebskorn et al. 2004). It has been highlighted and confirmed that residues from these micro-pollutants are likely to cause renal failure in vultures, resulting in a drastic reduction of the vulture population in Pakistan (by more than 95%) (Oaks et al. 2004).

Water, as we all know, is necessary for human socioeconomic activities. However, owing to overexploitation of water resources and deforestation, stresses on the water system have increased, posing a threat to human health and long-term socioeconomic stability (Vörösmarty et al. 2010; Shevah 2014). This dire situation necessitates elucidating the relationships between the water ecosystem and socioeconomic processes, as well as using appropriate water environment management instruments to deter water environmental destruction and promote socioeconomic growth that is consistent with the water environment's viability. As a result, complete awareness of the social, economic, and environmental settings is needed for both water quality management and the supply and demand balancing of water supplies (Yang et al.

2015). Evaluating the influence of micro-pollutants in water bodies is a daunting challenge that necessitates enhanced analytical and modelling techniques to investigate the distribution, bioavailability, and biological effects of single compounds and chemical mixtures. Current and emerging methods for classifying chemicals based on their ability to affect humans and the atmosphere must also be refined. Micro-pollutant mitigation methods, as well as techniques to mitigate their penetration into the water systems, need to be further developed. The development of "green" chemistry, which involves the creation of more environmentally sustainable manufacturing processes and materials, is a complementary solution (Schwarzenbach et al. 2006).

4.3 Landscape of Environmental Laws for Pollution Remediation and Micro-pollutants

Environmental law is a generalized term that encompasses various laws that support the environment (Sands and Peel 2006). It can be defined as a collection of different common laws and pacts that govern how humans will interact with Mother Nature (Hempel 1996). The purpose of making such laws is to protect the environment and devise some rules for utilizing the natural resources (Palmer 1992) Most of these laws restrict pollution, stress on the sensible use of natural resources, and protect forestation and animal population (Wiggins et al. 2004). The vast field of environmental laws includes topics in legal settings; for example, regulation of standards of emission in Germany, green great wall initiative in China, and the bottle return law in the United States are among the several other laws that focus on environmental protection. Environmental laws are relatively new and lawmakers started documenting these laws in the twentieth century (Palmer 2002). History reveals the implementation of laws to safeguard environmental issues regarding human health as a societal part; in 80 AD, a legislation was passed by the senate of Rome to protect water supply for drinking and bathing. In the fourteenth century, the British banned burning of coal and dumping waste into waterways (Evans 1997). Benjamin Franklin organized many trips to correct disposal of trash when William Penn, the Quaker leader of the English colony of Pennsylvania, issued an order to conserve one acre of woodland for every 5 acres of land acquired for habitation. The British government established rules to limit the harmful consequences of coal burning and chemical manufacturing on humans and the environment in the mid-nineteenth century, when environmental pollution was at its worst (owing to the industrial revolution) (Fenger 2009). Twelve European nations signed an agreement for the preservation of agriculturally valuable birds around twenty-first century (Ferrero-García 2013). The United States, Japan, Russia, and the United Kingdom signed a treaty in 1911 to preserve and conserve fur seals. This treaty, which was ratified by the United States and the United Kingdom (on behalf of Canada) in 1916, cleared the way for the protection of migrating birds. It was later extended to Mexico in

1936 (Dorsey 2009). The conference for the conservation of flora and fauna in Africa in the form of nature reserves was adopted by Belgium, Egypt, Italy, Portugal, South Africa, Sudan, and the United Kingdom in 1930, signaling a shift in the framework towards flora and fauna sustainability in their original environment. Spain and France, while signing the agreement, never ratified it (Adams 2013).

The environmental movement began to gain traction in the West in 1960, both politically and philosophically. Or, to put it another way, many events/incidents led to the understanding of the necessity for environmental preservation. The stage was set by Rachel Carson's publication of Silent Spring (Carson 1962), which studied chlorinated hydrocarbon insecticides and the damage they produced (Gavrilescu et al. 2015). This work led to the realization of actual environmental hazards on broader scale. After this realization, majority of environmental developments took place at that time. Lawmakers began to pass environmental laws in the twentieth century. United States government passed several environmental laws that challenged the status quo dominated by industrialists, including solid waste disposal, air and water pollution, and endangered species protection. The final step was the establishment of an environmental protection agency to oversee the implementation of these laws (Kolln and Prakash 2002). This environmental legislation expanded the national government's role, as these issues had previously been deemed to be the responsibility of local governments.

There has been rapid industrialization in Japan, especially after world war-II (Tsurumi 2015). As a result of this industrialization, industrial wastes were released indiscriminately into the human food cycle. The tragedy in Minamata, where a significant number of people were poisoned by mercury after eating a fish tainted with industrial toxins, sparked the movement (Harada 1995). This resulted in consideration by the Japanese government in the early 1960s to formulate a comprehensive pollution control policy; the efforts materialized in 1967 when Japan created the first law for Environmental Pollution Control (Sumikura 1998).

After realization by leading countries in the world, several other countries started joining in the issue by devising or joining pacts for several environmentally friendly laws. The Ramsar Convention, which focuses on Wetlands of International Importance, particularly as Waterfowl Habitat, was signed by thirty-four countries in 1971. This agreement went into effect in 1975, and it presently has over 100 signatories (Gardner and Davidson 2011). The accord required participating countries to establish one protected wetland area so that the importance of wetlands in preserving natural balance could be recognized. As countries became more aware of environmental issues, they began to work together to address them. The United Nations conference in 1972 led to the formation of the United Nations Environment Program (UNEP) (Ivanova 2007). Despite its little influence in implying the sanctions on different countries, it serves as a baseline for many consortiums to follow. Two commissions directly raised under the influence of UNEP were established in 1972 (marine life) and 1973 (endangered species of flora and fauna), respectively (Coggins 1974).

European countries were slow responders in managing environmental legislations until the Stockholm conference. In 1972, European countries started realizing

that industrial growth should be balanced with environmental issues (Coggins 1974). In the same year, the European Commission published its first environmental implementation strategy, and European governments began to make environmental policy a priority (Wallace et al. 2020). Quoting the example of Germany, the public perception about environmental legislations changed drastically in the 1980s, which became evident when they elected the Green Party in Germany as a representative in the national parliament in 1983 due to its strict environmental campaign; at the end of the twentieth century, this party got its share in government and developed Germany extensive policies (Otto and Steinhardt 2014). Later on, with integration with Netherlands and Denmark (green troika), it took environmental laws to the next level (Liefferink and Andersen 1998). The Chernobyl incident marked the development in transboundary effects of environmental degradation as the countries that were facing the downwind effects of the incident had to devise some laws and reduce the consumption of daily intakes of food (Howland 1987). This incident generated two international agreements. The first convention was on sharing of information on priority basis of an incident. The second convention focused on assistance to prevent the loss of life and environment due to nuclear incidents. These two conventions were drastically drafted and implemented in 1986 (IAEA 2016). Another convention on nuclear prevention was applied in 1994 that compelled the signatories to develop basic procedures to safely manage the nuclear assets.

The interesting thing regarding the unreliability of datasets associated with impacts of human activities is often a problem. It has always been a challenge to write laws that handle human involvements; these rules were frequently adaptable enough to meet scientific and technical advances.

Convention in Vienna on the Depletion of the Ozone Layer was another step toward solving worldwide environmental problems (Bodansky 2001). In 1995, the breakthrough in global environmental development was the UN conference on environmental development, known as "Earth Summit," in which 178 countries adopted this law (Grub et al. 2019). The environmental laws after 1995 were seen in global perspective. Another important development during this year (1995) was the development of Intergovernmental Panel on Climate Change (IPCC) jointly by the UNEP and the world meteorological organization (WMO) (Metz et al. 2001). IPCC was a global initiative to study the human influence on global temperature changes. The work of IPCC was criticized by communities for using insufficient datasets as reports ring the bell about severe climate changes due to emissions. Kyoto protocol came as an answer to the IPCC report critics and assigned the signatories emission targets for sustainable development (Meyer 1999). This protocol introduced a brilliant concept of emissions trading that was intended for controlled emissions throughout the world. This protocol allowed the developed countries to sell their emission reduction units, which they have earned by controlling the emission well below the authorized limits. In addition, those developed countries can also earn these reduction units by supporting the developing countries in terms of supplying the technology for the reduction of emissions. It is a wonderful rectification protocol, but since its adoption, it faced strong opposition, especially from developed countries such as the United States (Hovi et al. 2012).

With development in analytical methods involving detection of concentrations from micro to nanograms in water samples, new pollution directories for the world have been opened (Allan et al. 2006). Unfortunately, now new legislations/laws are being devised to tackle the micro-pollutants that are causing a serious threat to the human populations. The main reason for increase in micro-pollutants is the growing population and industrialization. Several research projects in European countries (Riskwa2, Strategie, COHOBAI etc.) are identified and addressed reduction measure for substance pollution in water (Amann et al. 2011). The major contribution was by German Environment Agency (also known as Umweltbundesamt), which in collaboration with other international partners (Rhine protection commission) has devised several strategies and decisions on this matter. The developments have occurred in the form of competence centers and equipping 19 treatment plants with fourth treatment stage (NA 2000)

Switzerland has introduced several additional measures in wastewater treatment since 2016 in addition to the introduction of several laws (Czekalski et al. 2014). European water frame directive (WFD) also stressed and provided directives on the reduction and prevention of micro-pollutants. These legislations focus on ecosystems biodiversity and availability of drinking water by using natural treatment methods. Micro-pollutants have become a growing world problem and are often linked with climate change (Delpla et al. 2009). Ever-growing climatological changes throughout the world have triggered higher concentrations of micro-pollutants in rivers, oceans, and subsurface aquifer system. It is the need of time to address these issues considering growing climate changes. The laws associated with micro-pollutants are at early stage. Most commendable work is done by European Union (EU) with legislations focusing on the treatment at source of micro-pollutants. The micro-pollutants from pharmaceutical industry and plastic industry are stressed to be treated at the source before dumping them in water. German water protection policy has set up benchmarks in addressing the issues associated with micro-pollutants that have small concentrations and can end up in water bodies, which later become part of the food chain, thus having adverse effects on health (Metz 2011).

Actors participating in development policy and development in the rest of the world have discussed how to deal with the problem. To decrease the use of dangerous pollutants at the source, proposed legislative measures might target consumers, farmers, or industry (Press 2020). An alternative policy approach addresses the end of pipe agreement that focuses on the treatment of sewage before introducing it to the water body (Triebskorn et al. 2019). The three principles (source control, polluter pays, and end of pipe treatment) legislated in the EU, if implemented in true sense, can set an example for rectification of micro-pollutants, but despite strong environmental laws' implementation, EU has lot more to do in devising laws for addressing micro-pollutants. The same stands for the rest of the world, where majority of countries don't have details regarding micro-pollutants' effects on their environment; thus, a strong legislation about awareness and eradication is desired all over the world.

4.4 Micro-pollutants: A Threat to Growing Economy of Pakistan

Pakistan, like other developing countries around the world, is experiencing severe water scarcity and pollution. The country's available water supplies are almost depleted. The rising toxicity of Pakistan's drinking water supplies, as well as the implications on human health and the environment, is a major cause of concern (Azizullah et al. 2011).

Since ground aquifers provide water to most of Pakistan's population (roughly 70%), surface water is also a significant source of water for irrigation, drinking, and domestic uses (Aziz 2005). The most basic source of supply in most Pakistani cities is groundwater, which includes a variety of pathogens, including many infectious, bacterial, and protozoan agents, resulting in 2.5 million deaths per year from endemic diarrheal disease (Daud et al. 2017). Every year, an estimated 250,000 children die because of waterborne diseases. Diseases such as diarrhea, typhoid, intestinal worms, and hepatitis are caused by insufficient quantities or consistency of water, as well as a shortage of sanitation facilities. The annual risk of drinking contaminated water is projected to be Rs 114 billion. Similarly, patients with water-borne diseases occupy 20–40% of all hospital beds in Pakistan (Khalid and Khaver 2019). The consequences of the lack of clean drinking water and sanitation facilities are observed not only on public health, but also on the economy. Pakistan spends Rs 365 billion a year on environmental depletion. A third of this amount is spent on health-related costs because of insufficient water supplies and sanitation (Mughal 2016).

Contaminated water is the most common cause of water contamination, which has a negative impact on Pakistan's economy and has a negative impact on Pakistani people's living standards (Ahmad et al. 2019). According to an estimate of the gross economic burden of inadequate sanitation, it was calculated to be 343.7 billion PKR (US$5.7 billion). This is the equivalent of 3.94% of Pakistan's GDP. The direct financial burden, which is equal to 0.8% of GDP, is 69.52 billion Pakistani rupees (US$1.15 billion). Most overall economic costs were attributed to health-related issues. They accounted for 87.16% of all quantified economic expenses, or 3.43% of gross domestic product. The gross economic burden on health is projected to be 299.55 billion PKR (US$4.93 billion), with financial losses accounting for 48.76 billion PKR (US$801.53 million). The economic burden of inadequate sanitation due to water is projected to be 15.98 billion PKR (US$262.68 million), or 0.18% of GDP. This accounts for 4.65% of the overall damage, with financial losses of 15.51 billion PKR (US$254.85 million) accounting for 15.51 billion PKR (US$254.85 million). Other welfare losses, such as consumer needs (which include comfort and acceptability, privacy and ease, stability, avoidance of conflict, status and popularity, and time loss), are estimated to be 22.77 billion PKR (US$374.4 million), or 6.63% of overall impacts and 0.26% of GDP. Most of the expense comes from lost time due to household access to free defecation sites (16.5 billion PKR [US$271.6 million]), which accounts for 73% of all welfare costs or 5% of all costs (Nishat 2013).

According to a preliminary estimate, Pakistan is losing 25% of its possible crop production (Abedullah 2006). The contribution of environmental problems to Pakistan's economy is estimated to be about 1.8 billion dollars. This expenditure was attributed to the costs that citizens and the country expend on welfare, as well as the lack of productivity that happens as a result of labor and individual absenteeism from factories, workplaces, and schools due to poor health (Brandon and Ramankutty 1994). In January of 2000, the Ministry of Environment released a report stating that Pakistan spends about 17 million dollars per year on pollution-related issues, especially expenses related to clean-up activities, but that 84 million US dollars are needed to fully resolve Pakistan's environmental problems (Ahmad et al. 2019). This reduction in pollution would also contribute to the long-term survival of Pakistan's natural resources. The additional benefits that will most likely be provided by preserving existing capital have not yet been factored into the above calculations (Abedullah 2006).

4.5 Environmental Policy and Economic Relation in Pakistan

Every action done by the government, corporation, or other public or private entity to identify the impact of human activities on the environment, including actions aimed at preventing or reducing negative consequences on environments, is referred to as environmental policy (Bueren 2019). Air and water contamination, landfill control, habitat conservation, biodiversity preservation, nature conservation, habitats, and endangered animals are some of the topics that are addressed by environmental policies (Eccleston and March 2011). For example, environmental policies may be tackled by the introduction of a global eco-energy policy to resolve global warming and climate change concerns (Banovac et al. 2017). The policies include economic planning as well as the control of harmful substances such as pesticides and various types of industrial waste. This approach should be used to intentionally manipulate human behavior to minimize harmful repercussions for the biophysical climate and natural resources, as well as to guarantee that environmental changes do not have unfavorable consequences for humans (Jordan 2005).

Pakistan's Environmental Policy is focused on a collaborative approach to achieving long-term sustainability goals through constitutionally, administratively, and professionally strong organizations. On December 6, 1997, the Pakistan Environmental Protection Act was enacted to provide for environmental protection, restoration, recovery, and enhancement, as well as pollution prevention and control and the promotion of sustainable development (Ministry of Environment Government of Pakistan 2005).

The National Environment Policy establishes an overarching mechanism for tackling Pakistan's environmental challenges, including degradation of freshwater sources and coastal waterways, air pollution, inadequate waste management,

erosion, habitat depletion, desertification, natural disasters, and climate change. It also offers recommendations on how to resolve cross-sectoral issues, as well as the root causes of environmental pollution and international commitments (Ministry of Environment 2005). Economic policies that ensure optimal resource use are a prerequisite, but not adequate, for establishing effective environmental incentives. Environmental strategies are often required to resolve industry failures that result in environmental concerns. Command and control policies and opportunity or market-based policies are two types of policies that can be used to fix environmental concerns. Government-imposed environmental quality requirements on emissions, technology type, or input usage are examples of command-and-control policies. Prices are used in incentive- or market-based programs to attempt to affect waste and resource utilization. Despite the benefits of market-based interventions, Pakistan, like many other countries, has largely relied on regulation policies. However, these initiatives have frequently struggled to produce outcomes because regulating agencies lack the financial and technological tools to successfully enforce them (Faruqee and Kemal 1996). In April of 1997, Pakistan has adopted market-oriented policy reform, which would support both economic development and the climate if it is enforced and extended rapidly. Non-distortionary economic policies that encourage economic development by optimizing resource distribution often generate adequate conditions for environmental conservation, according to experience in other countries. Of necessity, sound economic policies are insufficient. Environmental policies that fix industry failures are also expected. Economic policy failures also lead to environmental issues, such as forest, rangeland, and rainfed and irrigated agriculture. Subsidies for irrigation water, for example, allow farmers to overuse water, worsening the irrigated agriculture's waterlogging and salinity issues. Deforestation and depletion of Pakistan's forestland have been compounded by a loss of property rights in communal forests and a failure to provide local people with resources to engage in forest-management decisions (Faruqee 1997).

4.6 Steps Taken by Government to Tackle Micro-pollution

Plastic pollution is caused by the deposition of plastic trash in the ecosystem. The Greek term "plastikos" indicates "ability to be changed or molded into numerous forms/shapes." (Mukheed and Khan 2020). Plastic waste with a diameter of less than 5 mm is referred to as microplastics (Betts 2008), which are either immediately released into the atmosphere or created when larger plastic debris degrades. Microplastics are graded as primary or secondary microplastics based on how they are produced. Microplastics, such as microbeads in cosmetics, are manufactured on a microscale. The breakdown of macroplastic produces secondary microplastics (Horton et al. 2017).

The sources of microplastics in aquatic and coastal environments have already been addressed. (Duis and Coors 2016). Sewage leakage, microfibers from textiles, contaminants emitted from paints, and tires are all significant causes of

micro-pollution (Browne et al. 2011; Klein et al. 2015; Coppock et al. 2017). Microplastics have been discovered in a variety of aquatic ecosystems, such as wastewater treatment wastes, industrial runoff, and wastewater discharge following heavy rain occurrences (Anderson et al. 2016).

Microplastics have become a regular part of the global ecosystem, posing a significant danger to marine and coastal environments (Cai et al. 2017; Bordós et al. 2019; Koongolla et al. 2018). The presence, distribution, and impact of microplastics have been extensively researched in aquatic environments, but less focus has been paid to freshwater systems, and as a result, research on microplastic pollution of rivers and lakes is scarce when compared to oceans (Zhang et al. 2016; Sruthy and Ramasamy 2017). Because of their smaller size range, microplastics are eaten by invertebrates, fish, and marine animals because they are identical to food sources (Thushari et al. 2017).

Many nations have banned the commercial usage of microplastics like microbeads owing to their harmful consequences. The Microbead-Free Water Act, for instance, was passed in the United States in 2015, prohibiting the use of microbeads (NOAA 2018). Canada approved legislation limiting the use of microbeads in 2017 (Lam et al. 2018). In 2016, the Australian Microbead Working Group was formed with the goal of negotiating voluntary agreements with the cosmetics sector to eradicate microbeads from rinse-off cosmetics (EPAN 2016; Lam et al. 2018). Since these laws were just newly enacted, the result is still unknown. Taiwan's Waste Disposal Act, which is administered by the Environmental Protection Agency, bans the use of microbeads (Central News Agency 2018). In Pakistan, there is no clear legislation on microplastic contamination. In Islamabad and the capitals of other provinces of Pakistan, regulations governing the use of plastic items such as polyethylene bags are made, in which the use of plastic bags is banned (Pakistan Environmental Protection Agency 2019). These rules prohibiting the use of plastics would act as a starting point for the creation of further legislation to combat plastic waste. Implementing a ban on the use of plastic materials would further mitigate microplastic waste by preventing unsafe disposal (Irfan et al. 2020).

In South Asia, Pakistan has the highest proportion of mismanaged plastic. Bangladesh, France, and Rwanda are among the countries that have outlawed the use of plastic bags. Plastic bags are prohibited in Pakistan's Capital Territory, Islamabad, as well as several other towns such as Lahore and Hunza, according to a Statutory Regulatory Order (SRO). Currently, there is no federal or regional regulatory system in place to address the issues of single-use plastics and plastic trash treatment in general (Mukheed and Khan 2020). Plastics are less expensive, more dependable, and more widely available in the country; in a struggling economy, a blanket prohibition will lead to the loss of many employments or a drop in consumer footfall if no other bag is available. Though PET bottles and other high-value plastics are scavenged, most of the single-use nonbiodegradable plastic ends up in uncovered waste sinks, landfills, or public sewers, clogging sewage treatment systems (Mukheed and Khan 2020). The root of the issue has been identified as the current municipal waste management scheme, which prioritizes picking waste from

collection point and properly disposing of it in city outskirts without filtering, resource conservation, or recycling, as well as failing to require communities to take responsibility (Mukheed and Khan 2020). We all know that waste management firms cannot address this complicated challenge on their own; they need comprehensive policy, technology, and funding from both public and private stakeholders. Every year, 30 million tons of solid waste are generated in Pakistan, with plastics accounting for 9% of that total. A total of 55 billion plastic bags are manufactured here each year. These single-use nonbiodegradable bags typically end up in open waste dumps, landfills, or urban sewers, clogging waste collection systems and the service costs. Existing municipal waste management strategies exacerbate the problem by focusing solely on collecting garbage from community bins and dumping it on the outskirts of cities without segregation, resource reuse, or recycling, as well as failure to encourage people to act properly (Qari and Shaffat 2015; Rajak et al. 2019; Dawei and Stigter 2010).

In 2017, Pakistan introduced oxo-biodegradable technologies as a tool to combat plastic waste. After their useful life, oxy-biodegradable plastics completely biodegrade in the environment, leaving no adverse effects on the environment. As a result, all the problems related to plastic pollution will be addressed. After close analysis of both alternative solutions and empirical facts, the legislation was formulated (Daily Times Pakistan 2020). In 2019, the Islamabad Capital Territory adopted a new model, prohibiting the use of plastic bags and encouraging the use of biodegradable bags. The Ministry of Climate Change took the initiative (MoCC). The MoCC is trying to ensure that the prohibition is fully implemented by enforcing harsh penalties and hefty fines on anyone who break it. Polypropylene bags are nonbiodegradable; as major commercial polymers, polyethylene and polypropylene are extremely resistant to biodegradation, i.e., degradation by microorganisms (Mukheed and Khan 2020). Authorities have overlooked an important fact: polyethylene is not the only pollutant in the world. Plastic contamination is also caused by polypropylene and other single-use plastics. Nonwoven PP, BOPP, CPP, Metalized films, WPP, and shrink wraps are often found in single-use materials that are discarded in the field. The negative consequences of plastic waste accumulation are rapidly growing. As a result, removing them from the ecosystem is important (Daily Times Pakistan 2020). Plastic waste accumulation has a growing number of negative consequences. Therefore, it is important that they be excluded from the community. Fabric-like nonwoven polypropylene bags are made entirely of polypropylene, a plastic. These polypropylene bags in the industry are mistakenly labelled as biodegradable because they disintegrate into pieces, resulting in microplastics. Microplastics enter the food chain, posing a threat to the lives of thousands of land and sea mammals. Microplastics can't be collected or seen by the naked eye because of their small size. As a result, rather than fixing the plastic waste issue, these bags will exacerbate it (Mukheed and Khan 2020).

4.7 Conclusion

Many organic materials, such as medicines, pathogens, chemical contaminants, etc., are found in wastewater as these contaminants are seldom eliminated during wastewater treatment; they are released into aquatic ecosystems, which are sometimes utilized to produce water for drinking.

Up till now, the effectiveness of biological and oxidative sewerage and water purification processes has been based mostly on the dispersion of target chemicals, even though it is well-known that the conversion of organic pollutants can result in products with equivalent or even higher toxicities. To comprehend and analyze the reactive and biological treatment methods, it is critical to unravel the degradation/oxidation routes and determine the products formed.

Many of Pakistan's environmental issues may be traced back to economic policies that have had unforeseen and indirect environmental consequences. The Environmental Protection Act of 1997 is a significant piece of environmental legislation in Pakistan's legal history. This policy was created with the goals of environmental preservation, protection, rehabilitation, and betterment, pollution prevention and control, and the implementation of sustainable development. The National Environmental Action Plan (NEAP), which was approved in February 2001 to follow the NCS program, intends to achieve four goals: clean air, clean drinking water, wastewater treatment, and sustainable development. Another important policy in Pakistan's history is the Pakistan's National Environmental Policy (2005–2015), which aims to improve the quality of life of Pakistan's citizens via environmental protection, preservation, and development, as well as effective cooperation among government entities, civil society, the private sector, and other partners.

Environmental authorities have not done a good job of monitoring and regulating natural resource usage and pollution.

To summarize, the government should not rely solely on regulation in the future, but rather progressively adopt market-based measures, which can be more successful.

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