Jainism and Environmental Sustainability: Ancient Teachings for Modern Challenges

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Abstract: The Earth is grappling with an escalating environmental crisis fuelled by human-induced activities, including deforestation, pollution, and unsustainable resource use, all intensified by the Industrial Revolution. Environmental pollution, comprising air, water, soil, noise, and plastic contamination, continues to harm ecosystems and human health globally. Despite widespread awareness, pragmatic solutions remain limited. This research delves into the core environmental challenges and the socioeconomic impacts of pollution while highlighting remedial measures rooted in religious perspectives. Jainism, one of the world's oldest religions, emphasizes principles like *Ahimsa* (nonviolence), *Aparigraha* (non-possessiveness), and interconnectivity of life. These teachings offer a profound approach to sustainable living, advocating for reduced resource consumption, ethical practices, and environmental stewardship. Jains' practices, such as vegetarianism, resource conservation, and biodiversity protection, demonstrate actionable solutions for combating pollution and promoting ecological balance. This paper examines how integrating Jain principles can address pressing environmental issues like plastic waste, deforestation, and pollution. By adopting sustainable energy, recycling, and green initiatives, individuals, governments, and businesses can contribute to a healthier planet. Ultimately, this study underscores Jainism's relevance as a timeless framework for fostering harmony between humanity and nature, inspiring collective action towards a sustainable future.

Keywords: Environmental Pollution, Sustainability, Resource Conservation, Religious Perspectives, Jainism, Ahimsa, Aparigraha.

1. Introduction:

The Earth is faced today by numerous negative occurrences and challenges (caused by human beings, animals, organisms, and many more) and each was triggered to the dangerous level as consequence of Industrial Revolution (Spellman, 1999). The impacts of this menace increase day by day, causing irreparable damage to the Earth through increasing various anthropogenic activities such as incessant combustion of fossil fuels, which emit both particulate and gaseous pollutants, which are toxic in nature; disposal of toxic effluents by factories into water bodies, rendering them unusable and destroying aquatic life; sprawling urbanization resulting in deforestation and thus causing the quality of air to be poor; damaging the productivity of soil via plastic waste littering, just to mention a few. Despite all these accompanying impacts of environmental pollution, there have been little to no efforts to intentionally and pragmatically address its environmental effects and human health risks. Defining the term "environmental pollution" can be a bit difficult, as various definitions rendered by various authors in the past have been mainly given, based on their various perspectives of the subject matter. One of such definitions by Spellman and Whiting (2006).

2. Pollution:

Over the years, the state of clearly distinguishing succinctly between the terms “environmental pollution” and “pollution” had often resulted in some mild arguments in the environmental world. Some had termed both concepts to be the same in meaning, while others think otherwise. Even in various colleges and higher institutions of learning around the world, students find it tricky to glaringly differentiate between the two terms, especially as regards the definition of terms. Most of their responses are identical and lie in describing the outright effects of the terms, having witnessed some forms of this scenario firsthand (Spellman, 1999, 2017). Pollution is the state of making every part of the environment including air, land and water dirty and not safe or suitable to use. This is often accomplished via the instauration of contaminants into the natural environment, which may not need to be tangible. Light, temperature and sound as simple as they may look can largely be termed as pollutants when introduced intentionally and artificially into an environment. (Alina Bradford Live Science Contributor) Pollution is described as one of the several serious problems facing humanity which occurs at the release of substances into the environment in manners or quantities that forbid the environment from effectively handling it, and thus leading to detrimental effects on the ecosystem. (Harrison, 1996).

2.1 Pollutants and their various categories:

It is of great importance to look at what pollutants are and how they really affect the environment. The word “pollutant” is closely related to “contaminant” and this may raise some questions if they are not properly defined. Most people use the terms “pollution” and “contamination” interchangeably since they both deal with unwanted elements. According to Mondal (2018), it is simplest to say that the substances that cause pollution are termed “pollutants” while those that lead to contamination are called “contaminants.” Citing as an example, a waste material in a body of water may be termed a contaminant or a pollutant. Also, the cleanup processes that occur in remediation, the ones for pollution are like that of contamination but they are linked in a way that the introduction of harmful contaminants leads to pollution (Mondal, 2018).

2.2 Categories of pollutants:

Pollutants can generally be categorized into two major parts. Although, most often, there exist other categories depending on their existence in nature, but when these are critically analysed, they will fall under one of these two categories. They are natural and artificial pollutants. They can also be termed quantitative and qualitative pollutants, respectively.

1. **Natural pollutants:** These are materials or substances occurring naturally but later attain the position of a pollutant when their amount or concentration in each sphere of environment escalates as a result of the mindless actions and activities of man. That, they are natural does not mean man is not involved, but his unawareness of contribution is unknown to him. For example, when some gas such as CO2 (caused by automobiles and industries) is present in greater quantity in the atmosphere than expected, it results in immeasurable effects on animals, plants, and humans. (Titiksha, 2017)

2. **Artificial (man-made) pollutants:** These are materials or substances that do not occur naturally in nature but are introduced into the environment via humans and their activities. Depending on the configuration they assume after their discharge into the environment, they can be classified as primary and secondary pollutants. Furthermore, based on their natural disposal as related to ecosystem, pollutants can be further classified as biodegradable and nondegradable pollutants. (Titiksha, 2017)
    a) **Primary pollutants:** These are pollutants that are directly emitted into the environment, and they persist in the form in which they are released from their various sources. Their emission could be through natural ways or human actions. Gas, ash, smoke, dust, nitric oxide, sulphur(iv) oxide, and hydrocarbons are few examples under this category. The emission of gases and ash from a volcanic reaction are primary pollutants released in a natural way, but carbon monoxide (CO) gas emitted from vehicles or generator machines is also a primary pollutant released via human activities. The emission of primary pollutants into the environment or the air is very harmful and can cause serious health and environmental problems such as respiratory diseases, global warming, and acid rains. The major sources of primary pollutants are motor vehicles and industries and, most often, they are precursors for secondary pollutants.
    b) **Secondary pollutants:** These are pollutants not passed off directly into the environment but are formed from primary pollutants. This can be via a chemical interaction between two or more primary pollutants or by reaction with some constituents present in the atmosphere. Examples of these pollutants include ozone, aldehydes, ketones, sulphur(vi) oxide, and nitrogen dioxide.
    c) **Biodegradable pollutants:** These are pollutants broken down by the various actions of microorganism naturally into smaller, nontoxic, substances in due course of time. Domestic garbage, wood, agricultural remains, faecal matter, cattle dung, vegetable remains, and sewage are typical examples of these pollutants.
    d) **Nondegradable pollutants:** These are pollutants that cannot be broken down (or they degrade at a very slow rate) in the environment. Polythene bags, plastics, aluminium plates and cans, synthetic fibres, silver foils, mercury, and lead, arsenic are examples of nonbiodegradable pollutants. Some of these nondegradable pollutants conglomerate and are biologically enlarged as they transit along the food chain and the biogeochemical cycle of the ecosystem. Dichlorodiphenyltrichloroethane (DDT), as a distinctive example, moves to the streams and it is taken in by the phytoplankton that are eaten by the fishes. Therefore, the initial ingested dose of DDT by the phytoplankton, which was not harmful, will accumulate over time in the fish and becomes very harmful.

3. Pollution sources:

3.1 Point source pollution:

Point sources represent single and discrete locations or facilities that emit pollution. Examples of these are automobile engine, factory, ditch, tunnel, smokestack, and pipe. This category of pollution makes it easy to monitor and control the discharge of pollutants. Regulatory bodies such as the United States Environmental Protection Agency (EPA) have established standards

for emission of some chemicals and compounds to control the outflow from any point source and to check and monitor that discharge levels abide by the set regulations.

3.2 Nonpoint source pollution:

Nonpoint sources have no definite origin of concentration and are therefore termed being diffuse and widespread. Discharge of pollutants and contaminants are dispersed into the environment uncontrolled. Wind blows some of these pollutants into the air while others are swept into waterways by rainfall. Some pop up from unrecognized sources, such as oil dripping on roads from faulty vehicles, pesticides used on lawns and fields, livestock and pets droppings, or disturbed soil during excavation. It is difficult to regulate emission of nonpoint sources as the discharge of pollutants cannot be measured at the source but at destination. Samples are collected from any of the sources of pollution in polluted areas and measured. The contribution of various nonpoint sources can only then be estimated. It is difficult for EPA to channel their regulations toward specific individuals or businesses in this case, instead they directed it at municipalities. The federal standards for permissible levels of chemicals in drinking water have been set so that communities are responsible for treating their water until it meets those standards. (Afroza et al., 2015)

4. Types Of Pollution: Air, Water, Soil, Noise, Plastic.

4.1 Air pollution

Air pollution is increasingly becoming an issue globally with many concerns arising from developing cities. It occurs when the atmospheric air is contaminated in such a mode or way that poses potential or real threat to human health, his natural surroundings, and his well-being (Sonibare and Jimoda, 2009). “Unless we clean up the air, by the middle of the century one person will die prematurely every 5 seconds from outdoor air pollution” (OECD, 2016). The use of various modes of sophisticated motorized transports, machineries, and industrial works is expected to increase, thus potentially deteriorating air quality. Also, increase in the concentration of harmful gases and particles being released into the atmosphere causes human and environmental health problems (Sulaymon et al., 2020). Generally, air pollutants can be classified in several ways as follows: 1. Primary air pollutants These pollutants are released right from the source contributor; an example of primary air pollutant is factory chimney. Moreover, primary air pollutants can also be classified into sources of stationary air pollutants (e.g., power plants) or mobile air pollutants (e.g., automobiles). 2. Secondary air pollutants These are pollutants that originate from their source contributors and subsequently combine chemically (usually involving sunlight) with other substances to form toxic compounds. An example of secondary air pollutant is the conversion of nonmethane VOCs to ozone (O3). 3. Indoor and outdoor (or ambient) air pollutants other classification of air pollutants is indoor and outdoor pollutants, which can be further classified into criteria and hazardous air pollutants. The National Ambient Air Quality Standards (NAAQS) declared under the Clean Air Act (CAA) that the following are the six criteria of air pollutants: carbon(ii) oxide (CO), VOCs or ozone (O3Þ particulates, nitrogen oxides (NOx), sulphur(iv) oxide (SO2), and particulate lead (Pb) (Spellman, 2017).

4.2 Water pollution:

Water occupies 71% of the Earth out of which 95.6% is held in the oceans, which is not directly available for human consumption such as drinking without arduous desalination process (Jeevanantham et al., 2019). Water is a necessity for both human and industrial growth as it remains one of the vital and defenseless natural resources, which is impossible to survive without its availability (Ajibade et al., 2020). The two common types of water are surface and groundwater. Surface water exists in various forms such as ponds, wetlands, streams, rivers, oceans, and lakes. Out of these forms, oceans hold the highest volume of the total water yet are not commonly used directly (unlike the other forms) as a result of high natural salt content (Jeevanantham et al., 2019). The remaining small fraction represents the other forms of water, which we refer to as freshwater on which man mainly depends on. Due to population explosion as well as some anthropogenic activities, which alter the cleanliness of water, the demand for clean water is also increasing highly (Ashra

f et al., 2013). Water pollution is one of the global environmental problems that threaten both human and industrial development. Though people at present subconsciously associate dirt to disease, the transmission of disease by pathogenic organisms was recognized in the middle of the 19th century (Peirce et al., 1998). Water quality in rivers and other reservoirs is presently threatened by rapid urbanization and industrialization, mining activities, higher level of usage of chemicals in agricultural sectors, poor environmental management (Afroza et al., 2015; Jeevanantham et al., 2019), and indiscriminate disposal of waste (Ajibade et al., 2019a; Adewumi et al., 2019). Pollution of groundwater is commonly by chemical compounds that are harmful to health. Water pollution emanates from two major sources, which are point sources and nonpoint sources. The point sources are recognized as pollution occurring from sources having well-defined point of discharge. Examples of these come from municipal and industrial discharges where the industrial facilities and municipal wastewater treatment plants (WWTPs) are the main sources of water pollution because it contains some toxic heavy chemicals and other pollutants (Adeniran et al., 2016).

4.3 Soil or land pollution:

Soil is a universal sink originating from living organisms and materials of inorganic substances, which bears the greatest burden of environmental pollution (Ajibade et al., 2019b). Soil pollution among other degrading phenomena such as erosion, flood, and urbanization is not just a great threat to the sustainability of soil resources only but also to human health as potential toxic substances move through the food chain and groundwater, which are in turn used and consumed by man (Akinbile et al., 2016a,b; Adewumi and Ajibade, 2015). Okrent (1999) defines soil pollution as the presence of toxic compounds, chemicals, salts, radioactive materials, or disease-causing agents built up in soil, which have adverse effects on plant, human, and animal health. Some sources of soil and subsurface contaminants include graveyards, landfills, septic tanks, sump and dry wells, underground storage tanks, and pipelines. Moreover, soil contamination could also occur below the water table as a result of mining operations, test holes, agricultural drainage pits, and canals (Spellman, 2017). Most technologically advanced regions of the world experience more land pollution than undeveloped areas (Alloway, 2001). Through biogeochemical cycles, nutrients contaminate the

soil, and these contaminants contribute to air pollution. Some of these pollutants include sulfur(iv) oxide, nitrogen gases (NO, NO2, NH3), hydrogen sulfide, hydrocarbons, carbon(ii) oxide, and ozone. However, due to the negligible changes that happen in the soil, their effects toward air pollution are usually neglected when analyzing air pollution. Two typical aerial particulate soil pollutions include the accumulation of heavy metals within smelters, and soils within municipalities where exhaust fumes connected with vehicle and industrial machinery emissions (Spellman, 2017).

4.4 Noise pollution:

Detection and making of sound are important attributes, which help humans in communicating with one another and in receiving valuable information such as sound signal from a whistling tea kettle, warning as from a fire alarms, and entertainment as in music. Besides these beneficial and enjoyable sounds, there is noise that is an unwanted and irregular sound that commonly comes from such products of development as trucks, industrial machinery, airplanes, trains, air conditioners, and the likes. This phenomenon is termed noise pollution. Noise pollution has been recognized as an urban environmental issue in the world specifically in developing nations. It is well established that noise pollution has been affecting the global population increasingly, mainly in large cities (de Souza et al., 2020) and the intensification of noise pollution has been aggravated since the Industrial Revolution in the 18th and 19th centuries, because of the growing use of machinery (Murgel, 2007). Recently, it was reported by the World Health Organization (WHO) (2018) that about 100 million people are affected by road noise in the European Union (EU) and no less than 1.6 million years of healthy life are lost annually. Rinkesh (2019) defines noise pollution as a phenomenon that takes place when there is either an excessive amount of noise or an unpleasant sound that causes a temporary disruption in the natural balance. Psychological health problems such as anxiety, depression, stress, and fatigue can be generated when exposed to high levels of sound pressure (Brazilian Association of Technical Standards, 2019), as well as cardiac, auditory, or cognitive problems, affecting from fetuses to the adults [World Health Organization (WHO), 2018].

4.5 Plastic and microplastic pollution:

The proliferation and accumulation of plastic materials in the natural environment causing undesirable impacts on living organisms and their habitats are referred to as plastic pollution. Plastic pollution occurs in different forms in the environment, such as plastic litter, marine debris, and plastic particles. For many years, plastic pollution has been recognized as a threat to the ecosystem and has become an issue of global concern (Wagner and Reemtsma, 2019). A large percentage of plastics produced are single-use and are released into the natural environment due to poor management, lack of effective recovery methods, as well as limited success in recycling technology. Since most of these materials are resistant to biodegradation, they can remain in the environment for decades, resulting in the massive presence of mismanaged plastics in the environment (Fadare et al., 2019). In effect, about 79% of plastic wastes ended up in landfills (Nature Communications, 2018) while the oceans have become a reservoir for mismanaged plastics through different water channels such as rivers, lakes, and freshwater. It is estimated that by 2050, with the present unabated rate of plastic production, the quantity (in weight) of plastics in the oceans will be more than that of fish (World Economic

Forum, 2016). So far, about 700 marine species have been reported to interact with marine debris (Gall and Thompson, 2015), due to the accumulation of plastic waste in oceans, sandy beaches, and seabed. As a result, mismanaged plastics have become a major challenge raising concerns about sanitation, environmental, and human health issues. Recently, Thompson observed the degradation of mismanaged plastics via natural processes in the environment, which he termed "microplastics" (Thompson et al., 2004). Since then, awareness about the impacts of plastic particles has significantly increased. Micro-/nanoplastics (NPs) are products of mismanaged plastics via degradation or intentionally produced plastic particles that are used in consumer care products or for industrial applications, released into the environment. Plastic debris breaks down over time into smaller particles of various sizes and shapes to form macroplastics (. 25 mm), mesoplastics (525 mm), microplastics MPs (0.15 mm), and NPs (,100 nm) (Alimi et al., 2018), under natural processes such as UV radiation and mechanical abrasion. These are known as secondary microplastics (Mattsson et al., 2015). On the other hand, plastic particles that are produced intentionally for industrial applications (plastic pellets), pharmaceuticals or microbeads used to enhance consumer care products are called primary microplastics. Nevertheless, other sources are yet to be classified, for instance, plastic debris from newly manufactured plastic products, which are not because of natural degradation processes or plastic particles produced intentionally. (Adelodun et al., 2019)

5. Socioeconomic impacts of pollution:

To better understand the socioeconomic impacts of pollution generally, it is pertinent to know what the term "socioeconomic" means. In brief, it is the study on how both social and economic activities affect the totality of the environment. The socioeconomic standing of a given society is commonly evaluated by defining the state of education, income, health, occupation, and sometimes a combination of these aspects within the populace and their economic growth. There are numerous ways this can be explained when relating it to pollution. It makes no sense to further emphasize that environmental pollution has demean and stretched its poisonous grasping hands into the very basic human needs, which include water, air, and soil via numerous activities. All these activities in the long run tend to have several negative impacts on the environment in which humans are most important. Several studies reveal that pollution has enormous negative impacts on the total environment and people living therein. That is to say that environmental pollution does not pose threat to human alone but also to nonhuman nature. This section explains the socioeconomic impacts of pollution on:

1. human health,
2. the environment, and
3. economic growth and development.

It could be seen that the previ ous three categories are a composition of the determining factors (education, income, health, occupation, and economic growth) of the socioeconomic status of a society. These three categories are elaborated one after the other next. (Adelodun et al., 2019)

5.1 On human health:

Environment has a great influence on health, hence, the need to encourage good and healthy environment as the basis of reliable health security. Health is wealth is a common adage because health is very vital for the development and viable growth. The World Health Organization (WHO) estimates that 8.9 million deaths are caused by pollution (Landrigan and Fuller, 2016). Environmental impacts of pollution on health are dependent upon concentration of pollutants, exposure response coefficients, and other related attributes (Feng et al., 2019). It is evident that the severity of most human respiratory diseases such as asthma, bronchitis, sputum, lung cancer, and coughing due to cold increases with prolonged exposure to air pollutants at some degrees of concentrations and nearness (Srinivasan, 2013; Feng et al., 2019); however, the health effects of air pollution vary significantly among individuals with highly susceptible and 332 Microbe Mediated Remediation of Environmental Contaminants high-risk groups as adults, infants, and pregnant women with children at the highest risk level because they are prominently active outdoors and their lungs are still developing (Srinivasan, 2013). The WHO appraises that the maximum amount of suspended particulate matter (SPM), which cannot upset human health is 90 μg/m3 (Srinivasan, 2013). It is estimated that about 2 million premature deaths in developing countries result from indoor air pollution (Srinivasan, 2013), and from drinking contaminated water mainly in developing countries (Asraf) where almost half of these deaths are due to pneumonia in children below 5 years of age, whereas about 1.3 million deaths globally result from outdoor air pollution; and people living in middle-income countries unevenly suffer this problem [World Health Organization (WHO), 2011]. USEPA (US Environmental Protection Agency) (2013) equally affirms that air pollution is also responsible for some acute and chronic lung diseases and other airborne diseases. It is important to note that air pollution also affect crop plants and animals and, hence, indirectly impair human health when consumed. Air pollution affects not only local environment but also the adjacent areas (Ma et al., 2014; Feng et al., 2019). Besides air pollution, water pollution is also another vital aspect that greatly affects human health (Ashraf et al., 2013; Afroza et al., 2015) because water resources are very germane for socioeconomic development (Ugya et al., 2018). Increase in the level of water pollution could be attributed to higher development of many fields and anthropogenic activities (Jeevanantham et al., 2019). However, assimilating contaminants from water through the consumption of crops by man is less pronounced owing to the fact that plants have power of detoxifying heavy metals and this is achieved through different mechanisms such as mycorrhizae, organic acids, phytochelatins, metallothioneins, root reductases, and heat shock proteins (Kumar et al., 2016; Jeevanantham et al., 2019), though traces of contaminants can be received through this consumption. These heavy metals commonly affect areas like heart (carcinogenic and teratogenic impacts), kidneys, nervous system, liver, pancreas, skin, and reproductive system of man (Jeevanantham et al., 2019). Diseases that can spread because of consuming polluted water include typhoid, cholera, poor blood circulation, vomiting, skin leissons, and nervous system problems (Afroza et al., 2015). Ghafoor et al. (1994) affirm that water pollution is the major cause of human death (Ghafoor et al., 1994). About 10% of diseases worldwide are caused by water pollution, hygiene, and sanitation (PrussUstun et al., 2008). It was estimated that half a million population die of malaria as well as 1.4 million deaths recorded for diarrhea among children (Pruss-Ustun et al., 2008; Afroza et al., 2015). UNICEF

(2008) concluded that about 900 million people lack access to safe water, whereas 2.5 million people lack proper sanitation systems (Afroza et al., 2015). Water stress is experienced by one-third of the population globally (IWMI, 2007). Health impacts resulting from water pollution have been highly negative that in 2002 alone; more than 3.5 million people died because of water pollution, sanitation, and hygiene (Pruss-Ustun et al., 2008); and approximate cases of diarrhea of 4 million reported yearly (Afroza et al., 2015). Noise pollution is also another subject of interest due to its negative impacts. Studies showed that noise instigates displeasure at levels above 55 and 85 dB in office and in industry, respectively;, 75 dB causes loss in hearing; and a noise level above 81 dB leads to permanent deafness [World Health Organization (WHO), 2004; Sarikavak and Boxall, 2019]. All these burdens boil down to high medical costs and death in most cases.

5.2 On the environment:

The frequent penetration of pollutants into the soil affects the organisms living therein. Nevertheless, the effect caused by the presence of pollutants in soil or the lithosphere (on both terrestrial animals and ecosystems) is much more appreciable as these substances cumulate in food chains. The roving component of the soil environment such as water or, more precisely, the underground water can diffuse the contaminants through the soil and soil-forming rocks somewhat rapidly. Landrigan et al. (2010) revealed that at every level of income in most countries, polluting industries and hazardous waste sites are disproportionately located in poor, minority, and marginalized communities, a phenomenon termed “environmental injustice” (Landrigan and Fuller, 2016). Similarly, some US-owned companies in developing nations makeLiu use openly, industrial practices not allowed in the United States, thus creating some significant levels of pollution in these countries due to their lack of knowledge on the impending dangers, Environmental pollution and their socioeconomic impacts the economic ability, or the political structure to protect their environment (Spellman, 2017).

5.3 On the economic growth and development:

When it comes to economic growth and development, environmental pollution has tremendous adverse effects on the livelihoods, businesses, education, and occupation of the populace in general. Moreover, other hostile effects of pollution on the environment and economic growth include loss of biodiversity and diminished food and agricultural production levels. In some cases, for instance, the Niger Delta region (where the livelihoods of people come mainly from land and water) of Nigeria that are commonly faced with oil spillage, many residents lose their occupation such as fishing, canoe carving, and forestry, which account for about 70% of the total employment in the region; this often leads to dropping out of school by children of most families who can no longer pay their wards’ school fees (Ipingbemi, 2009). It is evident that this menace leads to reduced family income level and, hence, perpetuating poverty. Therefore, pollution could be said to have a close relationship with poverty. Some disease like arsenicosis is very dangerous as its patients most likely do not feel or look ill at the early stage but still are treated as “dangerous people” and stripped of their social status (Rahmana et al., 2018), and, hence, face many economic difficulties such as reduction in work efficiency, financial losses, sequestration, and failure to get suitable jobs as a result of judgment (Ahmad et al., 2007; Rahmana et al., 2018). This problem of ostracism of arsenicosis patients has been reported in

Bangladesh (Ahmad et al., 2007). These patients of school-age are most times discouraged from appearing in public, attending schools and social event, as well as have been abandoned by their friends and classmates (Alam et al., 2002; Rahmana et al., 2018).

Remedial measures to control environmental pollution:

To promote a sustainable environment, we need to embrace the "green engineering." Green professionals are those environment-friendly and concerned experts such as engineers, scientists, planners, or decision makers who try to incorporate the significance of sustainability while delivering their services. Green engineering, therefore, is a systematic engineering for effectiveness, efficiency, and sustainability. To control or prevent most environmental problems faced today, we need to think and embrace the green engineering by adopting better means of using materials and energy. Pollution as a great threat to the environment and public health has gained enough concern globally. Waste products or pollutants enter the environment in various forms and means and endanger the quality of water, air, and land, which in turn, endangers the public health through the flow of these pollutants within the food chain and, in some cases, direct consumption. The need to prevent pollution has led to the adoption of four types of control, which include legal, social, economic, and technological measures. These measures however help to control environmental pollution by various techniques or methods of operations. These techniques are further applied according to the environment and characteristics of the pollutants and their source contributors. The control actions available for preventing water, air, noise, and land pollution are enumerated as follows.

6.1 Corrective actions to control air pollution:

Emissions into the air are basically random and indefinitely numerous. Precipitation is the commonly known air cleaner though, not quite efficient and its seasonal occurrence. Sustainable air quality is dependent upon effective prevention of pollution and possible emission of pollutants. It is technically difficult and costly to prevent or control air pollution. However, some methods or techniques have been employed and confirmed efficient for the control of air pollution. These air pollution control techniques are discussed as follows:

1. Source correction (including raw materials substitution, process/equipment modification): Prevention is generally affirmed to be better than cure. Hence, it is better to change or eliminate the practice that causes emission of pollutants into air than striving to confine the pollutants when already released. For instance, the further refining of gasoline for proper removal of lead and, hence, eliminating lead emission to air. In the same way the removal of sulphur from coal, and oil also helps in the elimination of SO2 during fuel combustion. Some processes such as the control of odors from municipal incinerators by incinerating at high temperature capable of completely oxidizing the odorants. The 1990 CAA in an effort to improve air quality by reducing CO emissions from automobiles decrees that oxygenated fuels should be used in urban areas (Peirce et al., 1998). On the other hand, the substitution of raw materials, and modification of process and/or equipment are all resourceful in the control of air pollution.

2. Pollutants collection: There is a great challenge often experienced in the collection of pollutants, which often makes it often almost impossible especially for preventing mobile air pollutants sources, for example, that from automobile exhaust. Recycling of exhaust gases is confirmed a good control process. Though automobiles cannot meet 1990 exhaust emission standards through recycling exhaust and blowby gases, the method is still proven to be a promising control technique for controlling emission from automobiles (Peirce et al., 1998). However, recycling better employed in stationary industrial machines and satisfactory results are obtained. Carbon monoxide (CO) and VOCs are the usually recycled. CO serves as fuel as it releases heat when burnt to CO2 (Peirce et al., 1998). Channeled exhaust gases through one or more stacks are easier to be collected, but emissions through windows, doors, some cracks in walls, and dust particles raised during on-site transportation of materials offer great hitches to collection; hence, there is need for industries to renovate the entire airflow arrangement for efficient control.
3. Cooling: By cooling the temperatures of some pollutants drop below their condensation points hence, making it easier to collect them as liquids. Some common techniques often employed in carrying out this are dilution, quenching, and heat exchange among which quenching relatively higher advantage of cleaning of some gases and particulates, nonetheless, its drawback is that it yields dirty, hot liquid that equally needs to disposed of. For heat conservation, use of cooling coils method is preferred.
4. Treatment: What is important in this regard is the selection of the most efficient device for each or a particular set of pollutants since pollutants even though they may come from the same stack vary in size, characteristics, and magnitude. Considering the basic nature of air pollutants, the control or treatment devices are divided into:
    a. Particulate matter control devices: They are cyclones, fabric (baghouse) filters, wet (venture) collectors, electrostatic precipitators, and gravity settlers.
    b. Gaseous pollutants control devices: These can be classified according to classification of the mobility of the source contributors. Hence, treatment processes for controlling pollutants (and other gaseous emissions) from stationary sources include absorption, adsorption, condensation, and incineration (which could be any of: direct flame combustion or flaring, thermal combustion or afterburners, catalytic combustion). While treatment processes for controlling pollutants (and other gaseous emissions) from mobile sources often involve the modification of the devices or their components. Common technologies used include (1) positive crankcase ventilation; (2) catalytic converters (types include oxidizing catalytic converters, reducing catalytic converters, and threeway catalytic converters); (3) hydrocarbon adsorbers; (4) ceramic wall-flow particulate filters or traps; (5) DeNOx technologies (selective catalytic reduction, and NOx adsorber); and (6) installation of a canister (under fuel tank) filled with activated charcoal to adsorb hydrocarbon emissions, hence, controlling evaporative emissions.

6.2 Corrective actions to control water pollution:

Water pollution is a great threat to health as the accumulation and concentration of the pollutants in food chain by absorption is quickly enhanced by biochemical processes, which often lead to high level of toxicity. Hence, it is greatly important to study the methods of treating waste products and eliminating them from aqueous environment. In water pollution control, it would be helpful to consider the various sources of water pollution as whether point sources or nonpoint sources. To control water pollution from nonpoint sources, the following can be used:

1. Judicious use of agrochemicals such as pesticides, and fertilizers, which will reduce their surface runoff and leaching. However, this option is not effective on sloping lands.
2. Use of nitrogen-fixing plants to supplement the use of fertilizers.
3. Adopting integrated pest management to reduce greater use of pesticides.
4. Diversion of manure runoff to basin for settlement instead of flow of manure to water bodies. The manure in the basin can later be used as fertilizer in the fields.
5. Planting trees does not only reduce soil erosion but can also help in trapping sediments, which would have polluted water bodies.
6. Separate drainage of sewage and rainwater should be provided to prevent overflow of sewage with rainwater.

It should be recalled that point sources of water pollution are municipal and industrial WWTPs. In consequence of the associated health, discomfort problems and environmental degradation from wastewater pollution, the wastewater should be properly treated before being discharged to the environment. While the treatment of wastewater can be costly especially when chemicals and advanced processes such as electrodialysis and ion exchange are used, the natural biomass materials can provide cost-effective, efficient, and sustainable alternative wastewater treatment within the permissible environmental limit (Adelodun et al., 2019). For the control of water pollution from point sources, the following treatment technologies are usually employed.

1. Adsorption: This is a technique that involves the accumulation of the pollutants on the surfaces of specially made chemical, physical, and biological materials known as adsorbents for the removal of pollutants. Adsorption is an economical and effective technique. Examples of commonly used adsorbents include metal organic frameworks, carbon materials, aluminosilicates, zeolites, and mesoporous materials. Biosorbents are biomass-based natural or engineered adsorbents. Other materials used as adsorbents are organic soils, organic carbon framework, activated carbon, activated hydrochars, biochars, carbon nanotubes, graphenes, and clay (Jeevanantham et al., 2019).
2. Nanotechnology This is a special technology that uses good adsorbent materials called nano-adsorbents for removal of pollutants from water environments. Removal of pollutants is done by of nanotubes, carbon- and carbon-based nanomaterials, nanofiltration, nanoparticles, nanofibers, nanoclusters, and nanocomposites. Common nano-adsorbents used for removal of nitrate from water environment include Fe3O4 nanoparticles, magnetic nanomaterials (those with magnetic properties), chitosan and aluminum oxide nanofibers, oxidized carbon nanotubes, polystyrene and zinc, nanocomposites of carbon, silicon, chitosan, polyvinyl acetate, and polyethylene glycol.

3. Electrochemical treatment This technology removes heavy metals from water environment by the application of electric current. Electrochemical treatments include (1) electrochemical precipitation method that removes metals by forming precipitation because of direct current supply, (2) electrodialysis method that removes pollutants using membranes, (3) electrochemical oxidation method, and (4) membrane electrolysis.
4. Biological treatments This involves removal of heavy metals and other pollutants by using biological substances such as bacteria and microorganisms. Biological treatment methods include (1) biosorption, (2) using bacteria and microorganisms, (3) activated sludge process, (4) biofilter, (5) anaerobic digestion, (6) stabilization ponds, and (7) biofilms.
5. Phytoremediation This is a comparatively contemporary method in pollution control especially in constructed wetlands (Omotade et al., 2019). It involves the use of plants that have great ability to store metals or diminish accessible metals in the polluted environment. As these plants grow, they take up the heavy metals and nutrients present in the environment (soil or water) and by some mechanisms convert the toxic contaminants to nontoxic forms. Phytoremediation treatments include phytostabilization, rhizodegradation, rhizofiltration, phytoextraction, phytoaccumulation, and phytovolatilization. According to Jeevanantham et al. (2019), phytoremediation procedure taken by phytoremediators in the removal of contaminants can be shown in the following order:

Upgraded take-up by transporters - Bioactivation of metals - Detoxification by dispersion - Vacuole sequestration.

6.3 Corrective actions to control soil/land pollution:

It is necessary to perform some sorts of remediation or cleanup a contaminated soil where the degree of contamination is high enough beyond the recommended standard. Common options employed include excavating the polluted soil and either disposing of it safely in an approved landfill (also known as “dig and dump”) or taking it out of site (also called ex situ remediation) (Alloway, 2001). Nevertheless, due to high cost associated with haulage and landfilling, the adoption of in situ remediation techniques has been commonly used. Concise definitions of common soil/land pollution control methods are as follows:

1. Containment This is the restriction of contaminants by making of physical barriers such as trenches and reinforcing them with impermeable clay, for example, bentonite; or use of hydraulic barriers in order to maintain fluid pressure differentials by the removal or introduction of water for the confinement of the contaminant column in aquifers.

2. Pump and treat This is a system employed in treating polluted groundwater. In this technique the groundwater is pumped to the surface from custom-built drilled wells and subsequently remedial treatment is employed to remove the contaminants and afterward, the cleaned water is returned to the aquifer.

3. Air sparging This technique is used when dealing with VOCs, for example, chlorinated solvents. It involves the aeration of extracted water, hence, enhancing the volatilization of the organic pollutants in the water.

4. In situ soil washing This technique involves the injection of water through contaminated soil for the dissolution and extraction of the contaminants. Alloway (2001) affirms that this technique can be applied in extracting several contaminants even those that are not water-soluble, and including sulfate salts.

5. Soil vapor extraction This is an enhanced in situ recovery technique that is carried out by aerating the soil of enough macropores to provide enough air penetrability and then collected from special extraction wells where the volatile contaminating compounds can either be burnt in situ or adsorbed into activated carbon. It should be noted, however, that soil pollutants that are adsorbed into the soil solids are highly difficult to treat (Alloway, 2001).

6. Bioremediation This is typically used in treating soils contaminated with organic compounds. It involves improvement of encouraging conditions for microbial decomposition of the contaminating chemicals.

7. Phytoremediation Ajibade et al. (2013) defines phytoremediation as a promising cleanup technology for contaminated soils, groundwater, and wastewater that requires both low tech and low cost. Although numerous decontaminating plants with great capacities have been proven, most of them do not yield adequate biomass to excellently extract substantial quantity of metals out of polluted soil. Hence, it is better used to treat soils of low contamination level and in treating severely contaminated soil, further treatment may be recommended. (Adelodun et al., 2019)

6.4 Corrective actions to control noise pollution:

Noise polluted has been identified as another problem of concern when dealing with environmental pollution as it has various significant psychological and health hazards. Transmission of sound involves three stages, production, transmission pathway (or medium), and receiver. To control noise pollution (in industries, communities, and homes) effectively, various techniques must be employed across these three stages of its transmission. Generally, it should be noted that noise pollution is commonly associated with industry, community, and home. Noise pollution is generally controlled by:

1. reducing the sound production,
2. interposing the sound path, and
3. defending the sound receiver.

It should also be noted that noise pollution control involves money and private enterprises tend to avoid incurring such expenditure; hence, government or the public comes into noise pollution by making and enforcing some sustainable policies that would help regulate noise in the environment. (Adelodun et al., 2019)

1. **Industrial noise control** In general, industrial noise control primarily has to do with the substitution of noisy machinery with quieter substitutes. Examples of such technique is the reduction of noise from air fan by increasing its number of blades and decreasing its rotational speed, while gaining the same airflow efficiency. By interposing the sound path, industrial noise can be controlled, for instance, the use of insulating material for covering some necessary parts of a noisy motor. By trying to

defend the receivers (workers) in an industry, protective hearing devices should be provided to the workers however; such devices should be effective enough not to cause impairment on workers from hearing normal human communication and cautionary signals in the workstation.

2. **Community noise control** Community noise comes mainly from aircraft, highway traffic, construction and railway. Peirce et al. (1998) suggests that noise from construction sites should be regulated by local ordinances (unless federal funds are involved). The control techniques usually involve use of mufflers in air compressors, jack hammers, hand compactors, and other similar equipment. In aircraft noise regulation the US Federal Aviation Administration provides major laws on aircraft-associated noise. These are as follows:
    a. A certain limit of aircraft engine noise is allowed in airports, hence, compelling industrialists to develop a quieter engine that would still yield desired thrust.
    b. Diversion of flight pathways away from populated areas, and, whenever necessary, mandates pilots to use less than maximum power when the takeoff transports them above a noise-restricted area.
    c. Another regulation is the banning of the use of supersonic commercial aircraft. This is as a result of great noise produced by the engines and damage to property due to high sonic boom.

    Traffic is another major source of community noise. The components of cars, trucks, and trains such as the exhaust system, tires, engine, gears, wheels, and transmission are the major contributors of traffic noise. Moreover, this noise is often increased when vehicles move over raised highways and bridges owing to the resonation of the bridge and the raised highway with the motion. Generally, the worst contributors of traffic noise are trucks and high-speed trains. Nevertheless, there are three basic useful choices that can be adopted in the control of traffic noise. They are basically noise from the source, which can be regulated by producing quieter vehicles; second, highways should be distantly directed from populous zones; and third, noise can also be controlled by walling or planting vegetation (as in boulevards) along the highways. However, these options have their imperfections: there is possibility of noise bouncing off the walls and creating little or no noise reduction, walling also creates poor ventilation along the highway, hence, increasing the concentration of CO- and traffic-related pollutants.
3. **Noise in the home** Individual dwellings are becoming noisier due to internally produced sound and also sound from the external environment. This is also becoming more pronounced as modern homes buy and use more noise-making gadgets (e.g., the New Year's Eve noisemakers). To curb noise from simple appliances in the homes, it is imperative to ask during shopping for how much noise an appliance makes just as one invariably asks for how much an appliance cost. Also, use of dissipative silencers as effective modifications of appliances should be used. (Adelodun et al., 2019)

6.5 Corrective actions to control plastic/microplastic pollution:

The reports on the environmental implications of plastic/microplastic pollution have provoked ideas on how to address this global problem. Plastic pollution is a problem caused as a result of human activities in the environment; therefore human behavioral change is key to solving

the problem. From the individual user of plastic materials to plastic products' manufacturers, nongovernmental organizations, government regulatory agencies, government at various levels, and international environmental monitoring organizations (Vince and Hardesty, 2016) must come together to address the plastic pollution and its associated problems. Behavioral change is a major panacea in addressing global plastic waste proliferation and pollution. Individuals must cultivate the habit of proper waste disposal to avoid mismanaged plastics in the environment. The principle of three Rs (reducing, reusing, and recycling) of plastic materials must be adopted and fully incorporated at all levels as one of the control measures in combating the impacts of the accumulated plastics in the natural environment. Plastic product manufacturers must take responsibility for their products, even after use. Likewise, more resources must be invested into the development of low cost, effective and efficient plastic waste evacuation, and recovery and recycling techniques. Researchers must come up with alternative uses for plastic wastes that will help to minimize or eradicate plastic pollution in the environment. For instance, some countries such as India (Laskar and Kumar, 2019) have utilized some of their plastic wastes in road construction. Nongovernmental organizations must step up their campaign, awareness, and sensitization of the public on the impacts of plastic pollution on the environment and human health. Moreover, advocacy and education on proper usage and disposal of plastic waste must be incorporated to the elementary schools' curriculum. Stringent regulation on production and consumption of single-use plastics and plastic additives, for instance, more tax may be introduced to discourage unnecessary use of disposable plastics. Regulatory agencies must adopt strict procedures in enforcing compliance both by the users and the producers of plastics. New laws must be promulgated to punish any violation of plastic pollution control laws. Global sanction/regulations on plastic wastes must be adopted; illegal discharge of plastic waste in another nation's territory must be met with a strict sanction. Global constant monitoring and assessment of various efforts in combating plastic pollution will also contribute immensely to reducing the effect of plastic waste on the environment and human health. (Adelodun et al., 2019)

7. More remedial Measures as per religious perspectives:

Jainism, one of the oldest religions in the world, began in ancient India. It is based on the teachings of the Tirthankaras, spiritual guides who taught nonviolence, truth, and self-control. Lord Rishabhanatha, the first Tirthankara, is believed to have lived thousands and thousands of years ago and the last tirthankara was Mahavira 2600 years ago. The core idea of Jainism is **Ahimsa** (nonviolence), which means avoiding harm to all living things.

Jainism teaches people to live in a way that protects nature. Jains practice vegetarianism, use resources carefully, and create sanctuaries to save animals and plants. They even filter water to avoid harming tiny organisms. Jain beliefs see all life as connected, encouraging respect for the environment. These ideas help reduce harm to the planet and promote a sustainable way of living.

About 2000 years before the Jain Acharya "Umaswami" explain in his Tattwarth Sutra the following sutra related to environmental conservation.

- ***।पृथिव्यप्तेजोवायुचनस्पतयः स्थावरा।*** Earth, water, fire, air, and plants are immobile living beings. **(Sutra No. 13 Chapter 2)**
- ***।परस्परोपग्रहो जीवानाम्।***]The function of souls is to help one another. The word paraspara means reciprocity of action. Paras- parasya upagraha means rendering help to one another. That is, the help rendered by the human being to all other living beings. **(Sutra No. 21 Chapter 5)**
- ***।हिंसाऽनृतस्तेयाब्रह्मपरिग्रहेभ्यो विरतिव्रतम्।*** Desisting from injury, falsehood, stealing, unchastity and attachment is the (fivefold) vow. **(Sutra No. 1 Chapter 7)**
- ***।मैत्रीप्रमोदकारुण्यमाध्यस्थानि च सत्त्वगुणाधिकक्लिश्यमानाविनेयेषु।*** Benevolence is the wish for all living beings to be treated kindly, feeling happiness when witnessing the virtuous, showing compassion and sympathy for those in distress, and displaying patience towards the rude and misbehaved. It involves desiring that others be relieved from suffering and pain. **(Sutra No. 11 Chapter 7)**
- ***।हिंसादिष्विहामुत्रापायावद्यदर्शनं।*** The consequences of violence etc. are calamity reproach in this world and in the next. Calamity is the tendency to destroy activities which lead to prosperity and bliss. **(Sutra No. 9 Chapter 7)**

The main fundamental aspects of Jainism are five anuvrat Ahimsa, Satya, Astea, Brahma charya & Aparigrah.

1. **Ahimsa (non-violence):** - In a broader feel, ahimsa; love and compassion.; Practice of ahimsa entails refraining from causing bodily and mental ache to any dwelling being. Ahimsa is forgiveness, divine love, and sacrifice. **Ahimsa, in brief, is being non-violent in thought and movement, in body and soul.**
2. **Satya (Truth): -** Not to speak a lie carelessly in a big way and not to speak the truth that can endanger someone's life is called Satyavrata. One can also speak a lie for the protection of life.
3. **Astea (non-stealing):** - Today's economy is also based on theft. Stealing patents, stealing technology, stealing ideas has become a common thing. Developed nations are now depriving us of using Ayurvedic remedies used in India for centuries by making them their patents. The time is not far when formulations of medicines like Arjuna, Neem, Gugal, Brahmi will be imported from foreign countries. People will get patents and sell them by taking royalty from India.
4. **Brahma chary (Celibacy): -** Where the population is high, lack and poverty are seen there. The vow of celibacy is very widespread. The celibacy fast of a monk and a householder can be different. Without any adverse result, population can be controlled by this fast. And a moral society can also be created, which can ultimately provide a stable and strong economy.

5. **Apari-grah (non-possession):** - Jainism give the principle of limitation of possession to the householders. Doctrine of Jainism non-attachment is based on the limitation of desires.

Other four principles which are also very useful to conserve environment:

1. **Maitri (Benevolence):** Desire for others not to suffer is Maitri.
2. **Pramod (Joy) -** Joy (Pramod) - To express inward devotion and affection through facial delight and so forth is pleasure. Noble men are entirely thrilled when they see virtuous men; this is the mark of the Aristocracy. Ignoble folks become distressed at the sight of virtuous men; this is a sign of their ignobility. Although regard for the virtuous raises your own esteem, the person without benefit does not come forward to revere the virtuous. Joy's disposition is the technique of showing deep regard through superior appearance.
3. **Kaarunya (Compassion) -** To have a compassionate attitude concerning every living thing - to be humanitarian. A lot of individuals in society who rejoice in their own happiness and are disturbed by others' happiness may be exceedingly high; nevertheless, the number of people who rejoice in others' pleasure and are saddened by others' suffering may be relatively small.
4. **Madhyastha – Bhav (Naturality)–** Neutrality (Madhyastha-Bhav) is a willingness of being free from bias, free of attachment and aversion. If you wish to keep your equanimity, you must be handed the virtue of neutrality to defend yourself from cognitive acts of violence.

8. Conclusion:

The modern world is dealing with big environmental problems like global warming, pollution, cutting down forests, and running out of natural resources. The ancient teachings of Jainism give us a powerful way to solve these problems. Jainism's ideas, such as **Ahimsa** (non-violence), **Aparigraha** (not being greedy), and showing kindness to all living things, encourage people to live simply and avoid harming the environment. Jainism teaches us to use only what we need, live in an ethical way, and take care of nature wisely. For example, instead of wasting resources, we can use solar or wind energy, recycle more, and plant trees to make our surroundings green. Following these principles can also help with specific problems like reducing plastic waste, stopping deforestation, and cleaning up polluted air and water. By practicing Jain values, we can make better choices for the environment in our daily lives and encourage governments and businesses to do the same. Simple actions, like using reusable bags, saving water, and planting trees, can make a big difference. This way, we protect our planet for future generations and create a world where people, animals, and plants can live peacefully together.Jainism shows us how to respect nature and live in harmony with it. If more people follow these ideas, we can stop harming the environment and build a sustainable future where everyone benefits.

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