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A Review of the Need of Protecting Medicinal Plants from Environmental Stress in Jharkhand

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Abstract
Jharkhand, a state surrounded by forests, is well-known for its flora and fauna. This study reviews how environmental pollution affects the medicinal plants in this area and the pollutants that can degrade the quality of medicine. The primary components of medicinal plants are known as phytoconstituents, and their presence is regarded to be safe for treating a wide range of ailments with little or no side effects. As a result, it is critical to apply the best conservation strategies to safeguard medicinal plants from human disturbance and the growing threat of environmental change. Understanding the impacts of pollution on plants that are used for food and medicine and, when included in a regular diet, improve human health is critical. Human-caused environmental changes have an undeniable impact on medicinal plants and all other species in low- to high-ecologically sensitive zones. The plants' roots could absorb contaminants, altering how antioxidants are formed and lowering their overall efficiency. Polluted environment can alter the chemical makeup of medicinal plants, preventing them from forming and growing. Humans inflict massive ecological harm. As a result, the public should be well-informed on how human activities affect biological diversity, keeping in mind that each plant and animal species has unique biological characteristics. If people do not exploit natural resources wisely, biodiversity will be lost until human life ceases to exist. There are several methods for identifying contaminants, including those specified in WHO recommendations. Humans, as the key factor, must make a concerted effort to protect the ecosystem to preserve medicinal plants. Both the government and stakeholders must invest in and raise knowledge about waste management to achieve sustainability.

Keywords: Environment, Pollution, Heavy metals, Ground water, Medicinal plants, Phytoconstituents.

Introduction

As part of quality assurance protocols, the WHO has emphasized the significance of testing herbal products for pesticide residues and particle matter (PM). These days, the contamination of medicinal plants with particle dust and pesticide residues are serious problems (1). These plants should undergo routine quality assurance inspections before being used raw or in herbal formulation. Soil trace metal (TM) pollution and air particle matter (PM) pollution are the two environmental issues that are most harmful to ecosystems and human health, especially in developing India where urbanization and industrialization are happening at a rapid rate. Future study subject recommendations will be based on the gaps in knowledge

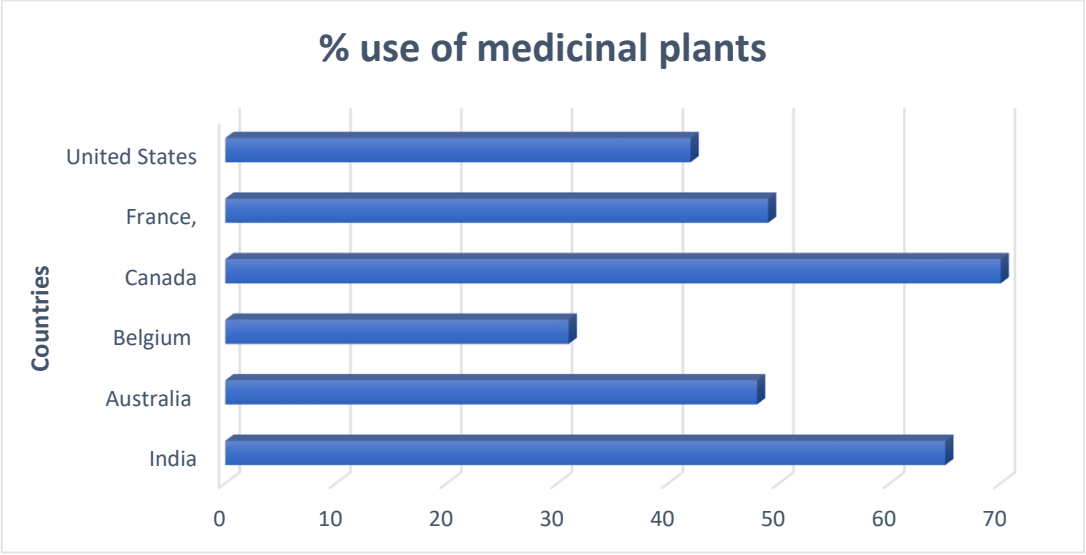
that have been found, both in the present and the future. By lowering the hazards of pollution to environment, these evaluations would help to improve the quality of the urban environment (Escobedo, Kroeger, & Wagner, 2011). Herbal concoctions are becoming more and more well-known globally, with substantial commercialization based on their many medical attributes. The quality of medicinal plants is deteriorating owing to environmental deterioration and changes. In this context, assessing the consequences of various environmental contaminants on the metabolism and growth of medicinally important plants is critical (Lajayer, B. A. *et al.* 2017). Phytoconstituents are the primary components of medicinal plants, and their presence is regarded to be safe for treating a variety of ailments with little or no side effects. Therefore, to conserve medicinal plants from human disturbance and the growing threat posed by environmental change, best conservation measures must be taken (2). This will be essential for the long-term economic viability of the community as well as the conservation of biodiversity.

Applications and therapeutic properties of medicinal plants.

Humans rely on a vast range of plant species for their health advantages, both as important sources of natural nutrients and antioxidants and as an essential component of traditional medicine. They also cost cheaper than manufactured drugs (3). Medicinal plants can create secondary metabolites such as phenolic chemicals, alkaloids, and terpenoids. Strong biological effects of these compounds include anti-inflammatory, anti-cancer, and antioxidant properties (4). Aromatic and therapeutic plants represent a perpetual potential for human survival (5,6). According to estimates from the World Health Organisation (WHO, natural herbal products provide primary medical care to 65-80% of people globally (7).

For centuries, traditional medicine has been an essential source of health care in households and communities. There have been reports on the use of traditional medicine from 170 countries. A rising number of modern nations have begun to recognize and incorporate traditional medicine within their medical systems. According to Sirisha, G.V.D., Vijaya Rachel, K; 2018, almost all the countries use some form of traditional medicine, India- 65%; Australia- 48%; Belgium- 31%; Canada-70%; France-49%; United States-42%. Many other countries, including Chile-71%, Colombia-40%, and various African countries-80%, use traditional medicine extensively. Figure 1 depicts some of the countries where medicinal plants have been used traditionally.

Figure 1: Use of Therapeutic plants in some of the countries



An over view of induced contamination of medicinal plants in Ranchi

Environmental disharmony between Man and Nature is becoming apparent, especially in phenomena such as soil erosion, environmental pollution, population growth, etc. An array of environmental issues is emerging because of increased resource use, which could ultimately harm the environment's capacity to support life, absorb waste, and maintain its aesthetic appeal. The use of natural resources that follows industrialization has led to the pollution issue. The three primary abiotic elements of nature—air, water, and soil are impacted by pollution. Pollution also has an impact on biological components as humans, plants, animals, algae, fungus, and microbes. Medicinal plants are important to most people on the earth since they represent their primary source of treatment for 70–95% of those living in underdeveloped countries and are increasingly being used by large populations in wealthier countries (8,9).

Numerous authors have described he role that therapeutic plants play in both conventional medicine and contemporary human care. This is not the place to try reading through the vast body of research that has shown beneficial biological activity in thousands of species of medicinal plants, or that has shown health benefits in hundreds of species in human clinical trials. It is sufficient to say that most people on the planet benefit from using medicinal plants (10), either because they are more beneficial than or in addition that such people would experience harm if they had reduced or no access to medicinal plants that are both affordable and effective, or because they are not able to afford conventional medical alternative(s) or treatments. The fact that environmental changes may affect the phytochemical composition of surviving populations raises serious concerns since it may affect not only the production and accessibility of these compounds, but also their potential therapeutic value (11). If a plant's composition shifts unfavourably or unexpectedly, those who benefit from its use will be negatively impacted. Customers from lower-class and traditional civilizations are particularly affected by this, as they are unable to execute comprehensive chemical test to find such shifts and alter dosages appropriately. Plant medicines with diminished potency could be overlooked or misjudged by new generation of users as inherently ineffective, leading to the abandonment of beneficial plants.

The main reasons behind air pollution in Ranchi are vehicle emissions, burning of fossil fuels and stubble, wildfires, and factory emissions. Aerosols are liquid, solid particles, chemicals from cleaning supplies, smoke from mold, and toxic gases released by cooking fuels (wood, crop wastes, charcoal, coal, and dung). Major air pollutants in Ranchi is given in Table 1.

Table 1: Major Air Pollutants in the capital city of Jharkhand - Ranchi (https://www.aqi.in/in/dashboard/india/jharkhand/ranchi)

Major Air Contaminants in Ranchi		
21 (PM2.5)	**28** (PM10)	**1** (SO2)
823 (CO)	**9** (Ozone)	**6** (NO2)
PM2.5 **1.4X**	The current PM2.5 concentration in Ranchi is 1.4 times above the recommended limit given by the WHO 24 hrs air quality guidelines value.	

Ranchi's PM2.5, concentration is presently 1.4 times higher than the WHO 24 hour air quality guideline threshold, indicating an alarming pace of increase in levels. Increased quantities of carbon dioxide,

nitrogen, and ozone in the environment can damage plant leaves, impede photosynthesis, the process by which plants produce food, and stunt growth. In addition to identifying new bioactive components for the development of novel herbal medications, significant effort must be made to ensure the chemical purity and high quality of therapeutic plants grown in the contaminated areas.

The impacts of metal contamination on plants

According to a 6-month study conducted in Ranchi, Jharkhand, India by M. Singh et al. the impacts of metal contamination on plants and soil found that a significant amount of Co, Cu, Zn, Pb and Cr were present very close to the garbage dump soil. In the patchy distribution surrounding the dumpsite, *Lantana camara*, *Parthenium hysterophorus, and Calotropis procera* were the most common plants. The amounts of metal in the roots and branches of plants were almost the same. This tells that C. *procera* has more ability for these metals to translocate to the plant's shoots while having bioaccumulation capacity for Cr, Co, Cu, Zn, and Pb (12).

Dense Sal vegetation, or *Shorea robusta*, has decreased from 7.23 square kilometers to 7.01 square kilometres, or an estimated (-) 0.22 square kilometres, with a range of (-) 3.14%. Anthropogenic disruptions and degradations brought on by developmental pressures appear to be the cause of this (13). Not all other growing parameters were held constant in the majority of studies that found an increase in concentration for beneficial metabolites with raised CO2. Under regulated circumstances, on the other hand, rising CO2 levels resulted in higher concentrations of artemisinin in *Artemisia annua* (14), and in Zingiber officinale rhizome numerous flavonoids and phenolic compounds are found (15).

It is very significant to understand the impacts of pollution on plants that are used for both food and medicine and, as a staple diet, improve people's health. Without a doubt, human-caused environmental changes affect medicinal plants as well as all other species in low to high ecologically sensitive zones.

Pollutants in the environment and interaction with therapeutic plants

Radiation and metals are two of the numerous naturally occurring pollutants in the earth and environment. Certain pollutants, such as industrial emissions or lingering chemical residues, are produced because of the earlier or current use of substances that damage environment, affecting therapeutic plants as well. Organic herb growth may nonetheless expose a plant to environmental pollutants due to abuse and waste (16).

Plants undergo morphological, functional, and structural changes because of air pollution. Air pollution reduces seed germination, leaf length, bloom yield, and leaf area. Air pollution's principal effects on plant morphology and physiology is described in Table 2.

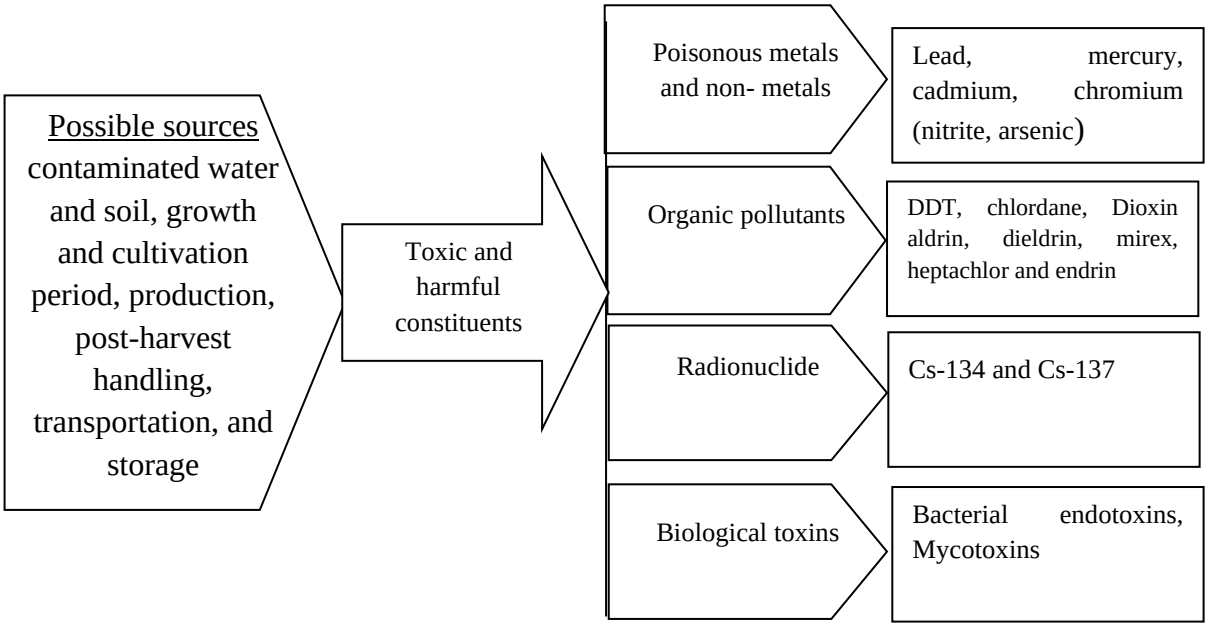
Table 2. Plants and air pollutants on plant

Pollutants in air	Pollutants on plants	Reference
Particulate matter	Reduced leaf area, slowed plant growth, and alterations in photosynthesis, pigment content, transpiration, enzyme activity and stomatal conductance are among the physiological changes that take place.	(17,18, 19)

SO_2	Decrease in the progress of biomass, necrosis, chlorophyll loss, leaf withering, defoliation, and reactive oxygen species (ROS) generation.	(20, 21)
CO_2	High concentrations lower a wide range of nutrients, including influencing carotenoid and chlorophyll concentrations, vitamins and protein, macro and micro components in plants, stomatal closure, and photorespiration suppression.	(22,23)
O_3	Damage to leaves, chlorosis, and a lack of chlorophyll impede breathing, block stomata, bleach, reduce flower output, delay fruiting, intensify leaching, prevent photosynthesis, and hinder development.	(24,25,26)
H_2S	Yellowish leaves, brown streaks on both living and dead tissues, defoliation, and ulcers on the leaves.	(27,28)
NO_2	It impacts the pigments involved in photosynthetic reactions, harms the chloroplast and membrane, lowers transpiration rates, inhibits chlorosis and growth, and can even cause plant mortality.	(29,30,31)

For medicinal plants, which are prized for their curative qualities, soil contamination can have disastrous effects. Medicinal plants' ability to act as antioxidants is diminished by industrial pollution, heavy metal-contaminated soil, and urban pollution. Pollutants may be absorbed by these plants' roots, altering how antioxidants are generated and resulting in a decrease in overall antioxidant activity. Soil contamination can inhibit medicinal plants from growing and developing, as well as affecting their chemical composition (Ghosh *et al.* 2011). Major water and soil contaminants and its possible sources is given in Figure 2.

Figure 2: Major water and soil contaminants in different areas of Jharkhand



As with most Indian cities, Ranchi City's groundwater quality is declining because of unplanned urbani

zation, rural-to-urban migration, inadequate sewage systems, and inappropriate effluent disposal practices in several large and small-scale industries (Naik et al., 2008, Bhattacharya et al., 2012). Table 3 shows main chemicals that Ranchi, Jharkhand, has in its groundwater.

Table 3: Main chemicals that Jharkhand, has in its groundwater

Chemical Contamination	References
Fluoride	Prabhu nath Singh *et.al* (2014) [20]
Arsenic	Tirkey P *.et.al* (2016) [7]
Heavy metals – Manganese, Selenium and Nickel etc.	Tirkey P. *et.al* (2017) [19]

Pollutants include pesticides, industrial chemicals, and heavy metals can accumulate where medicinal plants are grown. They may permeate into the plant's tissues, altering the plant's chemical structure and possibly dropping its health advantages. Cobalt promotes the growth of other nitrogen-fixing organisms and blue-green algae (32). Since it contains vitamin B12, it is also essential for animals in small doses (33). Cobalt and other dangerous metals may be released into the environment because of industrial processes. Most people are exposed to cobalt through food, air, and water when cobalt. Cobalt permeates the environment and cannot be eradicated.

There are several industrial applications for chromium and its compounds. These human-caused activities have resulted in the deposition of waste polluted with Cr and the extensive contamination of the environment with Cr (34). There are several indicators of this metal's toxicity in plants, including decreased yield, altered leaf and root development, mutagenesis, and suppression of enzyme activity. In soils treated with sewage sludge, toxic amounts are frequently seen (35). Large levels of copper may be found in soils, causing some plants to absorb or assimilate the copper (36). Consuming excessive amounts of copper at levels far exceeding the WHO limits may be detrimental (37). Lead acid batteries and other industrial products, paint chips, old ammunition, fertilizers, pesticides, and atmospheric lead (mostly from car emissions) are the most common sources of lead in the environment. Lead is mostly carried and disseminated via air from substantial emission sources, both fixed and mobile (38). Lead's effects on ecosystems are commonly regarded as a form of stress (39). Lead is exceedingly toxic to plants, animals, and humans (40).

A few grams of zinc can be detected in one kilogram of dry soil in locations where zinc pollution occurred due to mining, refining, or applying zinc sludge fertilizer. The recommended daily intake of zinc (Zn), an essential element for human health, is 5 mg for children and 15 mg for adults. It is thought that people who ingest more than 150 mg of zinc per day may suffer adverse effects (41).

In 2013, Kerketta P et al. assessed the connections between water's physicochemical characteristics and heavy metal content, as well as the chemical components of these metals frm in and around Ranchi, Jharkhand, from diverse sources (42). They assessed that the lead and cadmium levels above the WHO's recommended limits (43)

Through their roots, therapeutic plants draw heavy metals from soil, which sets off a chain of actions that modify uptake of metal, transport, and succeeding molecular and cellular reactions. This is when things become tricky. Table 4 illustrates the complex connection that exists between medicinal plants and heavy

metals, this relationship affects the antioxidant defences, synthesis of bioactive compounds and general plant health.

Table 4: The impact of heavy metals on medicinal plants.

Species	Secondary metabolites effect	References
Adhatoda vasica	Elongation, fresh weight, area and leaf number were all inhibited by an increase in Cd concentration.	Al-Khayri *et al*., 2023
Alternanthera tanella	With a rise in the concentration of Cd, the roots and shoots decreased.	Al-Khayri *et al*., 2023
Amaranthus spinosus	Notable decrease in fresh weight, root length, and shoot length in a way dependent on the dosage of Cd	Al-Khayri *et al*., 2023
Andrographis paniculata	With an increase in Cd metal concentration, there was a steady decrease in root and stem elongation, weight of the root, stem, and leaf, and an increase in percent phytotoxicity values.	Al- Khayri *et al*., 2023
Anethum graveolens	With increasing Cd content -leaf area, root length, root and shoot dry weight decreased.	Al- Khayri *et al*., 2023
Bacopa monnieri	The elevated Fe in the media caused an increase in bacoside-A levels.	Sinha & Saxena, 2006
Cajanus cajan	Reduced fresh and dry weight as well as seedling stunting were both exacerbated by Cd.	Al- Khayri *et al*., 2023
Catharanthus roseus	Cd prevented the root length from growing.	Al- Khayri *et al*., 2023
Coriandrum sativum	Root and shoot lengths reduced as the concentration of Cd was raised to 100 mg kg−1 Cd.	Al - Khayri *et al*., 2023
Dioscorea bulbifera	Presence of Cu increased - the production of diosgenin.	Narula *et al*.,2005
Hypericum perforatum	The plant was unable to synthesize or accumulate hyperforin in the presence of Ni.	Murch *et al*., 2003
Mentha piperita	Mint plant development and productivity are less affected by heavy metals when Non-Ferrous Metals combine (NFMC) is used.	Davies,1993
Moringa oleifera	With Cd, the root and shoot lengths drastically decreased.	Al-Khayri *et al*., 2023
Ocimum tenuiflorum	Eugenol was produced in response to Cr stress.	Rai *et al*.,2004
Phyllanthus amarus	Stress from Cd increased phytophyllanthin and hypophyllanthin.	Rai et al.,2005
Trigonella foenum	Diosgenin levels rose with Cd and Co, while its production was blocked by Cr and Ni.	De & De, 2011

There are numerous ways to identify pollutants, including those indicated in WHO recommendations (44). Pesticide residues are mostly determined using chromatography (capillary gas chromatography, HPLC)

in conjunction with various detectors such as electron capture, flame photometric, nitrogen-phosphorous, or mass spectrometry. Contamination of medicinal plants is an unavoidable side effect of growing ambient heavy metal contamination. The most polluted parts of the plant, the roots and stem, absorb contaminants from the soil before moving to the leaves, which are frequently used to extract active components from plants. Toxic metal contamination must be regulated throughout the whole production process, from raw material extraction, processing to finished items and disposal of waste material. To test the allowed heavy metal limits, good manufacturing practices (cGMPs) system is required. Contamination of heavy metal issues can be decreased by using cGMPs in industrial manufacturing processes (Gurley et al., 2018). Furthermore, one of the most effective strategies to prevent heavy metal contamination is to incorporate the purifying process into the manufacturing process. Standard techniques such reverse electrodialysis, osmosis, chemical precipitation, ion exchange, adsorption and ultrafiltration are used to extract heavy metal ions from herbal extract solutions (Li et al., 2019b).

Humans cause enormous ecological devastation. Because of this, the general people must be well-informed on how human activities affect biological diversity, keeping in mind that each plant and animal species has distinct biological traits. If people do not use natural resources responsibly, biodiversity will be eliminated until human life no longer exists.

Noss *et al. (*2005) identify three major variables that contribute to the extinction of species:

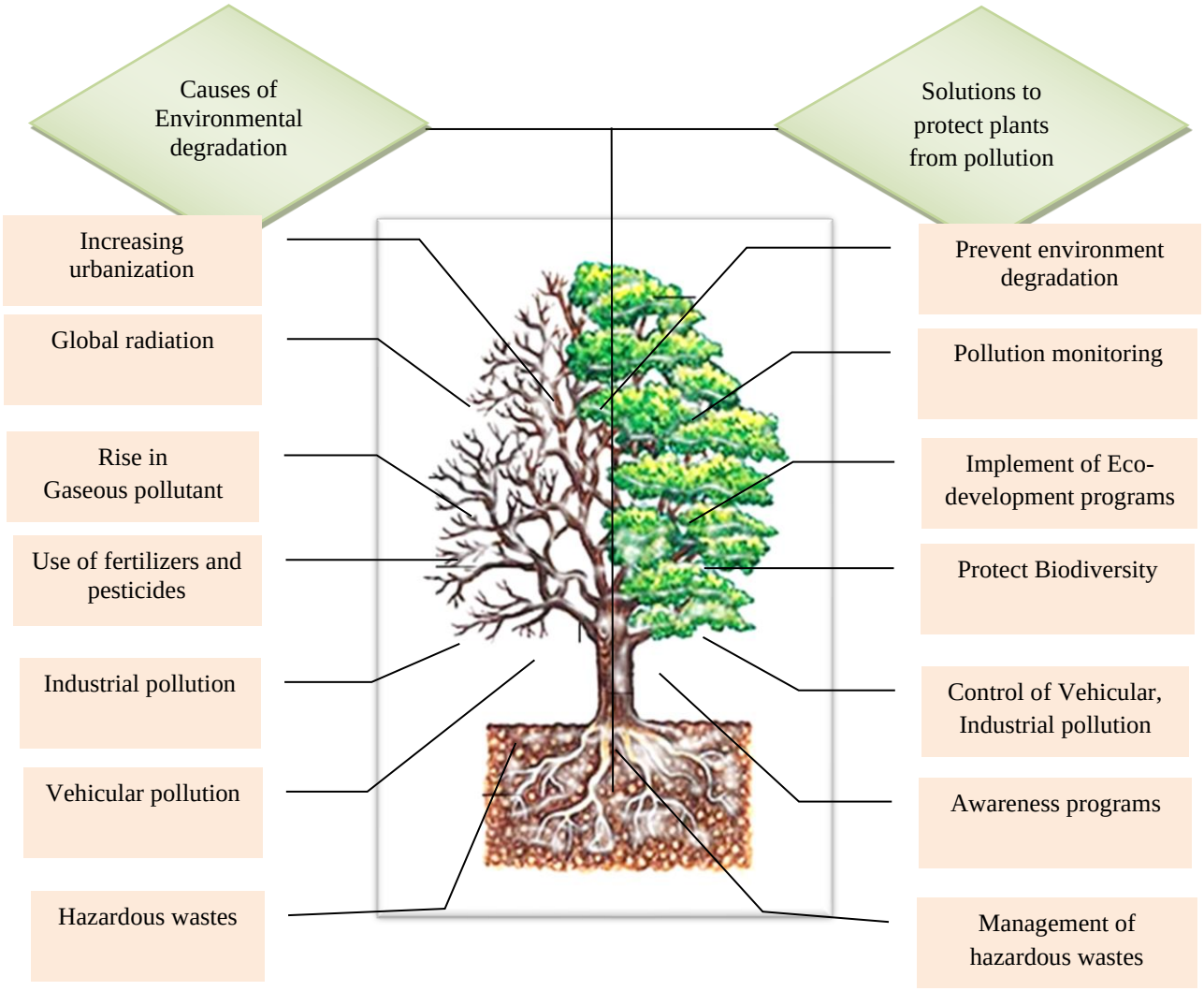
• Species loss happens when a habitat is lost.

• Habitat degrading takes place when a habitat deteriorates to the point where it is no longer capable of supporting and nourishing biological communities.

• Habitat disintegration occurs when an area is partitioned into smaller land portions for expansion.

When these three concerns develop in an area, there is a strong signal of species extinction, which may be linked to the effects of human activity on habitat. Many projects focused on waste management, pollution control, renewable energy, and replanting extinct species have been put into improve the managing of natural resources, especially medicinal plants. Humans, as the primary factor, must make a conscious effort to maintain the ecosystem to conserve medicinal plants. Both the government and stakeholders have a part to play in investing in and raising awareness of waste management for sustainability.

Figure: 3. Causes of environmental degradation and solutions to protect medicinal plants



The growth and phytochemicals of therapeutic plants can be affected by changes in atmospheric situations caused by industrialization and population increase. According to the published studies, environmental changes have also been connected to chlorophyll degradation, which reduces photosynthetic efficiency and induces metabolic abnormalities.

Conclusion

Together with the government, the public health and ethnobotanical communities should ensure that all communities, mainly those that rely on therapeutic plants for income or healthcare, have access to high quality traditional medicine. To maintain local access, some potential ways to support medicinal plant cultivation in community gardens include preserving the value of traditional plant knowledge, enforcing, or encouraging the usage of documentation programmes for collected material, particularly in international market, and applying large-scale preservation programs, such as protection of habitat. If use patterns need to be altered, consumers and product producers can be advised through local phytochemical study or value control programs that monitor the bio market content of economically valuable therapeutic floras.

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