and favourable climate for productivity are valuable assets for any nation. But due to human activities, soil gets many pollution and pollutants by use of pesticides, fertilizers, soil erosion, particular matter from power plants, smoke and stack etc.

5.4.4. Classification of Natural Resources

Natural resources are classified on the basis of the following :

1. Their need of organic or inorganic or mixture of both
2. Their abundance and availability of exaustible, renewable or non-renewable. Thus soil is a mixture of inorganic and organic substance.

5.5. LAND AND SOIL POLLUTION

Land pollution means addition of unwanted substances in any proportion. These unwanted substances are main source of land pollution. Soil pollution is also called land pollution. It is due to the addition of different chemicals or due to erosion of upper layer i.e., soil. These reduce soil fertility. The effect of pollutants on soil is difficult to evaluate. Air borne pollutants emitted by factory stacks travel long distances and slowly deposit on soil. SO_2 present in the fumes are responsible for acid rams and consequent lowering of soil pH. Chlorine and nitrogen oxides are other common gaseous~pollutants which combine with water and pollute the soil. Acid rain has been described earlier. Particulate matter near cement factories, coal transhipments mining belts etc. reach soil surface of neighbouring regions. Land or soil get polluted by the following ways :

1. By Agricultural Practices
2. By Radioactive Materials
3. By Biological Agents.

5.5.1. By Agricultural Practices

Agricultural wastes are common pollutants of soil as well as water pollution. Agro-chemicals such as fertilizer, pesticides, insecticides, weedicides cause land pollution. DDT, BHC etc. and chemicals like lead (Pb), mercury (Hg), arsenic (As), accumulate on the soil permanently.

Soil pollution results from excessive use of insecticides, herbicides and fertilizers. These substances adversely affect the physical, chemical and biological properties of soil.

5.5.2. By Radioactive Materials

Radioactive substances resulting from explosion of nuclear devices also penetrate the soil and enter into food chain. The presence of radioactive substances causing many harmful effects in body tissues. Radioactive radiations also bring about genetic changes through mutation and can cause death of many organisms. During second world war Nagasaki and Hirosima cities were bombarded by nuclear bombs. These two places are good examples of Radioactive pollution.

5.5.3. By Biological Agents

Other important pollutants are the biological agents including various biological organisms from human and animal excreta. In addition to excreta, faulty sanitation, waste

water disposed etc. includes land as well as soil pollution. These also spread various diseases.

Household refuse, Industrial water Agricultural wastes are tipped on land. By these many chemicals undecied substances enter into surface and get mixed with ground water. These chemicals are harmful for living beings and affect plants and animals growth.

5.6. POLLUTANTS

Natural and synthetic materials which may adversely affect the physical, chemical and biological properties of soil and seriously affect its productivity are called soil pollutants and this phenomenon is called soil pollution. The problem of soil pollution differs from air and water pollution in the respect that the pollutants remain in direct contact with the soil for relatively longer periods. The wide-spread industrialization and increasing consumption have changed the very complexion of soil. Thus the soil is getting heavily polluted day by day by toxic material and dangerous micro organisms which enter the air, water and food chain. For all this, man is the original and basic pollutant responsible for pollution hazards and toxic effects. (Table 5.1).

Table 5.1. Nature of Pollutants in Soil

Source	*Gases*	*Colloids*	*Suspended Particles*	*Dissolved Cations*	*Dissolved Anions*
Soil	CO_2	Clay, Fe_2O_3. Al_2O_3, MnO_2	Clay Sand Silt	Na^+, K^+ Ca^{2+}, Mg^{2+}. Mn^{2+}, Co^{2+} Fe^{3+}	CO_3^{2-}, HCO_3^-, OH^-, Cl^-, SO_4^{2-}, F^-, HSO_3^-
Decomposed Organic matter	SO_2, H_2 NH_3, CH_4, CO_2	Organic waste materials	Humus organic wastes	H^+, Na^+, NH_4^+	Organic radicals NO_3^-, NO_2^-, SO^2_4.Cl^-
Soil Organisms	—	Algae, Fungi Bacteria, Protozoa, viruses Ascaris etc.	Algae Bacteria	—	—

5.7. SOURCES OF SOIL POLLUTION

Soil pollution mainly results from the following sources :

1. Industrial wastes
2. Urban wastes
3. Radioactive pollutants
4. Agricultural practices
5. Chemical and metallic pollutant
6. Biological agent

5.7.1. By Industrial wastes

Disposal of industrial waste is the major reason for soil pollution. These Industr pollutants are mainly discharged from pulp and paper mills, chemical industries, refineries, sugar factories, tanneries, textiles, steel distillaries, coal and mineral mini industries, drugs, glass, cement, petroleum industries etc. Thermal, atomic and elect power plants are also the villain to add pollutants to the soil.

Fly ash, generates from industries and many industrial effluents are either discharg into streams or dumped into the surrounding land. Industrial wastes mainly consist organic compounds alongwith inorganic complexes and non-biodegradable materials. The pollutants affect and alter the chemical and biological properties of soil.

5.7.2. By urban wastes

Urban wastes comprise both commercial and domestic wastes consisting of dri sludge of sewage. All the urban solid wastes are commonly referred to as refuse.

Solid wastes and refuse contribute to soil pollution. This refuse contains garbag and rubbish materials like plastics, glasses, metallic cans, fibres, paper, rubber, stre sweepings, fuel residues, leaves, containers, abandoned vehicles and other discarde manufactured products.

Pollution concentration in urban areas and unplanned industrial progress have to greater extent contributed to soil pollution problems.

5.7.3. Radioactive Pollutants

Radioactive substances resulting from explosions of nuclear devices, atmospher fall out from nuclear dust and radioactive wastes penetrate the soil and accumulate the creating soil pollution. Radioactive substances Radium, Thorium, Uranium, Carbo (C-14) are very common in soil, rock, water and air.

The product of nuclear fission. Rain water (Sr-90, Cs-137) to be deposited on t soil and emit gamma radiation. Recently it has been indicated that some plants such lichen and mushroom can accumulate Cs-137 and other radio nuclides which concentra in grazing animals.

5.7.4. Agricultural Practices

Agricultural practices pollute the soil to a large extent. Advanced Agro-technolog Huge quantities of fertilizers, pesticides, herbicides, weedicides and soil conditioni agents are employed to increase the crop yield. Many agricultural lands have now excessi amounts of plants and animals wastes which are posing soil pollution problems. Far wastes, manure slurry, debris, soil erosion containing mostly inorganic chemicals a responsible for soil pollution. Some of the agents responsible for this pollution are follows:

(a) Fertilizers. Fertilizers are the chemical compounds containing one or more the plant nutrients i.e.. Nitrogen, phosphorous and potassium. Excessive use of fertilize makes soil pollute. Fertilizers are retained by the soil and crop efficiently but there a some possibilities for the nitrates to be washed out due to negligence appliances

applying fertilizers to arable lands. These nitrates cause several undesirable effects on the water quality of low land lakes or rivers creating numerous health hazards.

(b) **Pesticides.** By growing population density it is necessary to increase food production. Due to this it led to manipulation of land resources. Different kinds of pesticides used to control pests are causing a stress in the natural environment. With the increasing use of pesticides it is observed that pesticide residues coexist within biological system with other forms of life.

(c) **Soil conditioners and other chemical agents.** In addition to the fertilizers, pesticides and biocides, soil conditioners and fumigants are also employed to the land system to increase and protect the soil fertility, to kill the hazardous insects. These chemical agents are reported to cause alterations in both agricultural and horticultural soil areas. They contain several toxic metals such as Pb, As, Cd, Hg, Co etc. which when applied to a land will accumulate on the soil permanently thereby introducing these chemical components into growing crops.

(d) **Farm Wastes.** Increasing population of cow, cattles etc. have resulted in considerable soil pollution. Buildings in which grazing animals are housed can be cleaned using water but the manure is also washed out and disposited as wet slurry on the land. This slurry deposited on soil may seep into ground water and pollute it. Cattles faecal matter mainly consists of phosphates which in conjunction with nitrates cause numerous undesirable effect in the soil texture.

5.7.5. Chemical and Metallic Pollutants

A number of industries including textiles, dyes, soap and synthetic detergents, drugs, cement, rubber, paper and pulp etc. and metal industries pour their hazardous effluents in soil and water creating disastrous effects on living organisms.

Synthetic chemicals and fertilizers are a source of trace metals which are added to the soil either deliberately or as an impurity. In many soils 50 to 100% of soil carbon is found complexed with clay containing organic and inorganic components which affect the soil texture, its fertility and stabilization of soil organic matter.

5.7.6. Biological Agents

Soil gets large quantities of human, animals and birds excreta which constitute the major source of land pollution by biological agents. Digested sewage sludge as well as heavy application of manures to soil without periodic leaching could cause chronic salt hazard to plants within a few years. Sludges to have faults as they contain enough live viruses and viable intestinal worms. The pathogenic organisms that pollute the soil may be classified into three major categories:

1. **Pathogenic Organisms occurring naturally in contaminated soil.** Bacteria algae, protozons nematodes etc. These organisms are important agents in increasing or decreasing the soil fertility, in altering the physical texture of the soil and in attacking roots of plants.

2. **Pathogenic Organisms Excreted by Man.** Human excreta includes pathogens such as enteric bacteria and parasitic worm such as tenia solium. These organisms are transmitted to the man by the consumption of vegetables or fruits.

3. Pathogenic Organisms Excreted by Animals. This category includes pathogenic bacteria and worms excreted by animals like earth-worms, millipedes, dipterous larvae, snails including higher animals carry fungal and bacteria spores. The disease producing organisms are transmitted from animals to soil and then from soil to man.

5.7.7. Other Sources

1. By absorption of toxic metals.
2. By soluble salts.
3. By mining.
4. By waste water added to soil.
5. By solid waste applied to soils.
6. By food processing wastes.
7. By sugar cane trash in field.
8. By municipal garbage and composts.

5.8. MAN—THE ULTIMATE SOURCE OF SOIL POLLUTION

"The degradation of systems or substances for people's use',' would seem not to include people as a pollutant. The mad rat race among nations over the entire globe for development has jeopardised the existence of man himself.

According to 'Josae de Castro' — "Under development itself represents a type of pollution and every bit of natural resources are unjustly exploited by great industrial powers."

People destroy land, pollute water, air etc. over load treatment system, dumping wastes into land etc. has degraded several cities, made water polluted and caused many social stress to each other. Resources exploitation and pollution are inter-related phenomena. Human activities are responsible for the creation, development and increase of environmental problems. Over exploitation of forest resources has already created ecological imbalance in many parts of the world. The advanced technology has considerably disrupted the man-biosphere relationship, due to which the very existence of man is in peril.

According to International Union for Conservation of Nature (1972) in Stockholem Conference on Environment, "the war economy in which we live must be converted into peace economy and the enormous savings resulting from partial disarmament must be used to obtain such type of development that would not only be more equitable but also non-polluting to the land."

5.9. CAUSES OF SOIL POLLUTION AND THEIR CONTROL

Causes of soil pollution are classified into the following:

(A) Direct Causes

(1) Poor waste management
(2) Due to application of agro chemicals
(3) Faulty sanitation practices
(4) Salination due to irrigation and flood
(5) Soil Erosion.

(B) Indirect Causes

(1) Acid rain
(2) Photochemical smog
(3) Radioactive disposed substances.

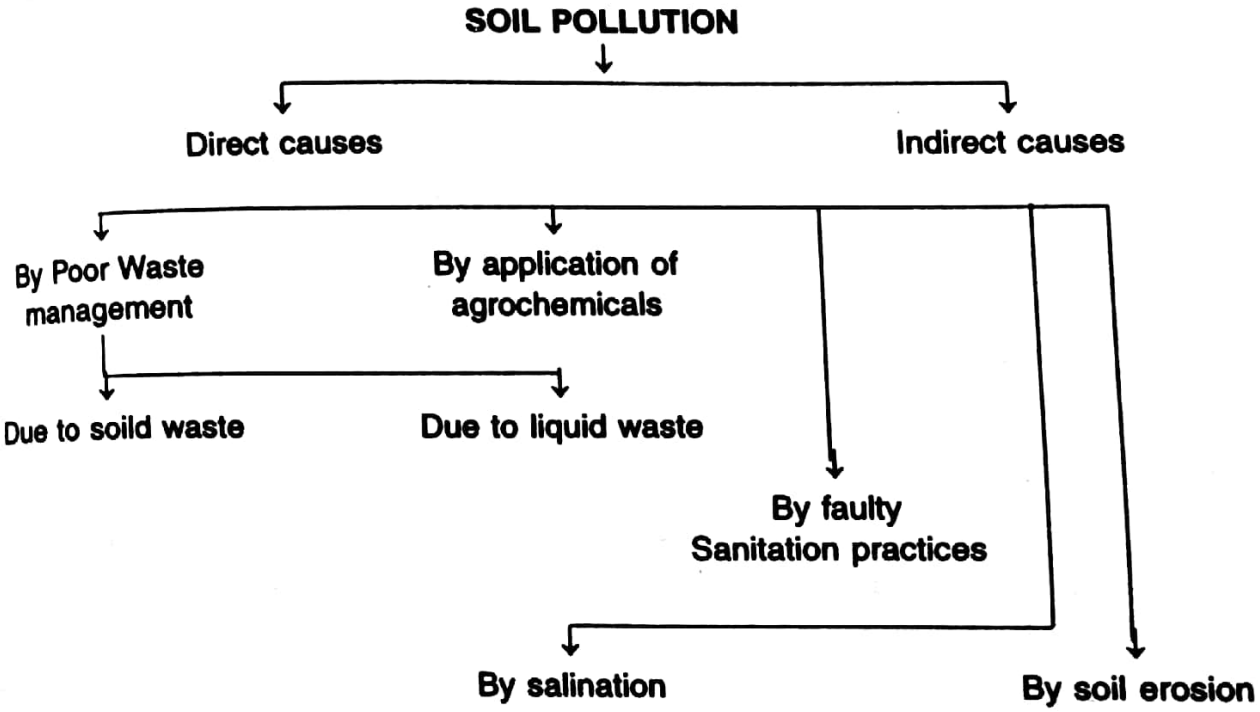

Fig. 5.4. Causes of Soil Pollution and their control

5.9. DIRECT CAUSES

Some pollutants directly affect soil texture. Soil is directly polluted by the following ways.

5.9.1. Poor waste management

Wastes are unwanted and useless substances, results from different human activities of human beings. There are following types of waste :

(i) Solid waste (ii) Liquid waste.

Management of solid waste is a serious problem in urban areas out of the above wastes.

I. Soil pollution due to solid waste

(a) Solid waste source. Unwanted or discarded substances that have weight size is called solid waste. Some sources of solid wastes are :

1. Sewage sludge
2. Municipality solid waste
3. Industrial solid
4. Agricultural.

(b) Waste preventive approach. This approach considers solid waste as a resource. Two measures are suggested:

(i) Reduction in solid waste (ii) Reuse and Recycling.

(i) ***Reduction in solid waste.*** Solid waste can be induced by manufactures by using less material and redesigning manufacturing processes.

(ii) ***Reuse and Recycling.*** Materials can be reused after repairs and also recycled using certain methods. Such that high technology method and low technology method.

In high technology method MRF machines (Material recovery facilities) separate mixed solid waste like glass, iron, aluminium and other waste like paper plastic and combustible substance.

In low technology method waste materials collected from home, business concerns etc. This waste is finally passed on the manufactures. Recycling process can be completed by two ways.

Primary recycling such as newspapers to newspapers, secondary recycling— conversion of waste resource into different products.

(c) Control of solid waste. Control of solid waste can be done by using certain methods like :

Composting. Priodegradable solid waste is used to produce compost (manure).

Incineration. NON degradable household and garbage is reduced to ash through burning in incinerators at high temperature. The ash is dumped into landfills. This is intact also considered as a source of soil pollution. This Method is costly and hence used in developed countries.

Landfills. Priodegradable soild waste dumped into landfills and non degradable substances should be removed and used for recycling.

II. Soil pollution due to liquid waste

(a) Liquid waste and source. Liquid waste from point sources such as industries municipal sewage are causes water as well as soil pollution. Soil and water pollution are also caused by non-point source of liquid water such as run off agriculture chemicals.

(b) Measures for soil conservation.

Water treatment. Liquid waste can be treated by the following methods:

(a) Primary treatment of water.
(b) Secondary treatment of water.
(c) Advanced water treatment.
(d) Chlorine treatment to treated water before discharging to land and water.

5.9.2. Soil pollution due to application of agro-chemicals

Pesticides, fertilizers. Pesticides are used to control pests whereas insecticides, weedicides are used for controlling insect and unwanted plants. Fertilizers are used for increasing production of agriculture products. These chemicals are not degraded quickly. Their concentration affected life and health of the man. It is important to know environmental hazards of these chemicals and take appropriate steps to check them out. One of the ways is the minimum use of these substances and utilising other operations along with their use.

5.9.2.1. Health Problems due to agro-chemicals

1. Chlorinated hydrocarbons cause cancer, birth defects neurological disorders.
2. Most of the organic phosphates are toxic and humans may suffer from drowsiness, diarrhoea, vomitting, air and breathing difficulty. High concentration may cause paralysis tremors, coma and death.
3. Carbonates cause birth defects and genetic damages.
4. Food items contain residues of agro-chemicals which are harmful to our health.
5. Farm and chemical workers are expired to agro chemicals. The causes many health problems in them.
6. Increased concentration of agro-chemicals per unit weight of organism with the rise in trophic level of an ecosystem is called biomagnification e.g. it is interesting to note the manner in which DDT accumulates in the food chain. Plankton in water contains about 0.04 ppm DDT. The clams that consume plankton concentrate it ten times.

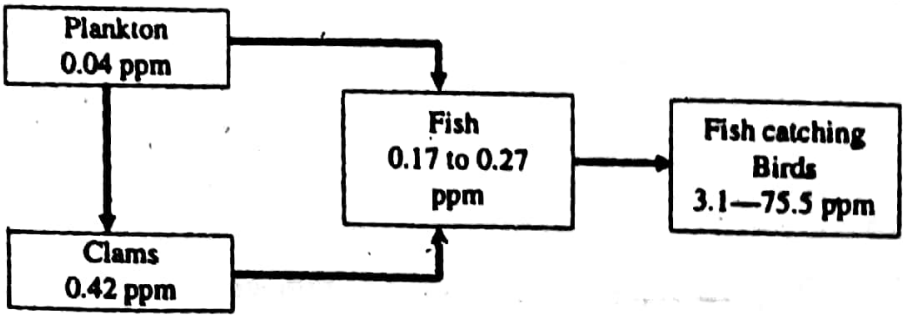

Fig. 5.5 Accumulation of DDT in aquatic food chain.

7. The degradation of agro-chemicals in the environment is slow and this results increasing concentration. This is dangerous for all living things.
8. Due to the over use of these harmful chemicals pests infects have developed resistance.
9. The chances of accidents increase where these agrochemicals are manufactured. Best example of this is Bhopal gas tragedy.
10. These substances disturb Predator relation land Ecological balance.

Some Common Pesticides

Chemical groups	*Type of chemical*	*Period of persistence*
Insecticides and Acaricides		
Organic	DDT	10 years
	Aldrin	9 years
	BHC	11 years
Herbicides	2,-4D	
	2-4.5-T	6 months

5.9.2.2. Control of soil pollution due to agro-chemicals

Soil pollution due to agro-chemicals can be controlled by following ways: