1.3 Land Pollution from Human Activities

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Introduction

Land is a basic natural resource that holds the key for our survival and sustainable development. It provides us with the essential life support systems and it has to meet our growing demands for food, fodder, energy, settlements and industries. With the progressive pressure of human activities, land is being increasingly subjected to pollution and degradation in various forms.

Land is used (and often misused) as a receptacle of pollutants from various human activities which include:-

(a) Municipal wastes,

(b) Industrial wastes,

(c) Agrochemicals and irrigation,

(d) Mining and quarrying.

This paper outlines the nature and extent of land pollution and associated problems attributable to municipal wastes, industrial wastes and pesticides. The possibilities of land treatment for waste management are also discussed. The references are based on Indian experience which is, by and large, typical of developing countries.

Municipal Wastes

It is estimated that in India, municipal solid wastes are produced at an average rate of 0.33 kg per capita per day. From an urban population of about 185 million, this is of the order of 22.35 million tons per year. To this has to be added the large volume of sewage generated from a sizeable population which is not served with sewage systems.

Municipal wastes containing sewage and solid refuse are often discharged on land without adequate treatment. In many places, solid wastes are disposed of in open dumps or land-fills in low lying areas. In addition, industrial wastes containing hazardous substances are often disposed of at such sites, adding to the pollution problem.

In a land-fill, biochemical decay of organic material results in evolution of gases and liquids. Liquid products and extruded moisture tend to flow due to differential head. The dissolved material moves out due to concentration gradient. Among the major products of biodegradation are methane, carbon dioxide, organic chemicals of high BOD (and COD) and nitrates. Thus, the organic constituents and moisture in the wastes becomes a major source of land pollution and ground water contamination.

Several constituents are removed from or added to the percolating effluent depending on the characteristics of pollutants and the nature of soil strata through which infiltration takes place. The time lag between pollution of the land surface and its percolation to the ground water depends on a number of factors. These include the reactions in the topsoil and vadose zone (unsaturated layer), soil moisture, specific gravity and viscosity effects.

Compared to the flow on the land surface, movement of leachates containing pollutants from the topsoil to the ground water system is relatively slow. Hence the impact on the ground water quality often remains undetected until it is too late for remedial action.

Industrial Wastes

Land disposal of industrial wastes without requisite treatment continues to be a common practice for a number of industries. Solid wastes are mostly discharged into open dumps or land-fills which, as in the case of municipal wastes, are sources of land pollution and eventually ground water contamination. The effluents are either discharged into pits or passed through unlined channels to the nearby low lying areas. In some cases, industrial effluents are discharged into public sewers, where they mix with sewage and finally end up in the agricultural fields.

Some pollutants are attenuated by soil and the vadose zone, while a part of the wastes enters the ground water system through leaching. Thus, it is not uncommon to find high concentrations of some trace elements associated with industries in the ground water at a considerable distance from the industrial sites.

In India, systematic studies to monitor ground water pollution from industrial sources have been carried out at only a few places and for selected pollutants. However, even from the limited studies so far conducted, the seriousness of ground water pollution is evident. High concentrations of chromium, nickel, lead, copper and zinc in ground water have been observed near industrial areas. Iron and manganese concentrations exceeding 1,000 mg per litre, much higher than background values, indicate a direct relationship with the industrial sources. These pollutants, when discharged on land, react with soil and vadose zones forming stable complexes which lead to their attenuation. The fact that these pollutants are detected in ground waters in concentrations much above background values indicates that the process of attenuation has been supersaturated. Unless preventive measures are taken the problem of ground water pollution will assume alarming proportions.

Pesticides

Over the years, several hundreds of pesticides have been introduced for agriculture and public health purposes. The use of chemical pesticides in agriculture commenced in India around 1948-49. The manufacture of BHC and DDT started during 1952-53 and since then there has been a steady increase in the use of chemical pesticides. However, in recent years there has been a shift in favour of organophosphorus and carbamate formulations and due to growing concern about the persistence and adverse effects of DDT it has been decided to restrict its use to public health programmes.

The behaviour of pesticides applied on soil depends upon many factors such as absorption, leaching, volatilisation, run-off, uptake by soil organisms, microbial and chemical degradation and photolysis.

Pesticides in soil, whether introduced directly or indirectly, may persist and alter the structure and function of non-target organisms. Persistence of these chemicals depends on their nature, temperature, humidity and light and on the activities of soil micro-organisms which break down the chemicals rendering them less harmful. Most of the literature regarding persistence of pesticides is based on work in temperate regions where the half-life of most organochlorine pesticides varies from one to several years. In India, studies have shown that the half-life varies from three to nine months due to the high temperature and humid conditions.

Though the average consumption of pesticides in India is as low as 6.4 grams per hectare, the total consumption in terms of active ingredients is more than 80,000 tons per year. Notwithstanding the favourable climate for breakdown of chemicals, accumulation of pesticide residues has been reported in soil, water, fruits and vegetables and even human tissues.

It is estimated that of the total pesticides applied to crops, less than 0.1% reaches the target pests and more than 99% moves into the environment and in the food chain. It has also been noticed that a number of pests developed resistance on exposure to certain pesticides over an extended period. It thus becomes necessary to synthesise new pesticides creating further pollution problems. While insecticides and other invertebraticides such as nematicides and molluscides have a direct effect, herbicides and fungicides influence the soil faunal populations by affecting their food materials.

Inadequate Date Base

Most of the studies on the effect of land pollution have dealt with soil micro-organisms and insecticides. The available information on the population structure of soil organisms is not sufficient for prediction of models of pollution impacts. There is a need for further investigations on the effect of various pollutants, not only on the structure of the faunal populations, but also on how their functions affect the ecosystem. Pesticide and fertiliser combinations may exert synergistic and interactive effects on the ecosystems which are not yet well studied. The concept of integrated pest management reducing dependence on chemical pesticides also needs further investigation and large scale trials.

Information on the effect of industrial effluents and heavy metals on soil populations is scarce and scattered. Limited information is available on the effect of municipal wastes on the qualitive and quantitive composition of soil fauna.

Pollutants interact with a host of soil organisms. Termites, earth worms and other deep burrowing forms play an important role in the functioning of the ecosystems. Systematic studies on the effect of land pollution on such organisms may lead to useful findings as well as ways of mitigating land degradation.

Land Treatment for Waste Management

While indiscriminate discharge of wastes on land is of serious environmental concern, it needs to be recognised that land is the best available sink for ultimate disposal of wastes. This is particularly relevant in a developing country where it is unlikely that all wastes would be given the fullest treatment at source before disposal.

Controlled application of wastes on land can help in achieving a desired degree of treatment through the physical, chemical and biological processes within the plant-soil-water matrix. Partially treated waste water can be further treated though land application and land can serve as a 'living filter' comprising interaction of soil, vegetal cover and soil micro-organisms.

Depending on the methods of application and percolation, the land treatment of wastes may be of three types, viz. slow rate systems, rapid infiltration systems and overland flow systems.

To ensure safety in land treatment of waters it is essential to ascertain the background concentration of pollutants, the fate of pollutants added to the land and the risks involved in terms of assimilative capacities and acceptable limits. Decisions have to be guided by a clear understanding of the reaction processes and transport phenomena within and among the various sinks, namely living systems, soil, water and air. Pilot projects undertaken in selected areas have shown encouraging results from which it is possible to establish cost effective approaches for waste management through land treatment.

Conclusions

1. Land is a major recipient of pollution, but our knowledge of soil pollution interaction is far from adequate.

2. Land can serve as a 'living filter' as it provides a degree of waste treatment due to a combination of chemical, physical and biological processes in the soil. There is thus a need for better understanding of the processes and pollutant transport phenomena in the soil.

3. Sporadic studies made so far have shown promising possibilities for coupling the conventional pollution control activities (control at source and end-of-pipe treatment devices) with that of land treatment of wastes. This is particularly important where land treatment may be a cheaper and more effective means for prevention and control of pollution.

Discussion

Mr M L Richardson asked why the paper particularly refers to land treatment of wastes while it would be preferable to control at source. The speaker replied that control at source is, no doubt, the preferred option. However, with the given technologies of pollution control it is not possible to have foolproof treatment of wastes at source. Hence, part of it is unavoidably disposed of on land and the land can provide further treatment to such wastes. Since pollution control technologies are energy intensive, land treatment could be a cost-effective means particularly in developing countries. However, this does not mean indiscriminate disposal of the wastes.

Professor S Z Haider asked whether speciation of different chemicals had been done in the studies on land treatment of wastes. The speaker said that characteristics of different chemicals and soil-pollutant interaction studies were the basic pre-requisite for determining the methods for land treatment and so this had been the initial approach.

The Author

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