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Environment Conservation Journal

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Potential of Remote Sensing and Geographical Information System in Water Resource Management

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Abstract

Water the source of life, is passionate. Too passionate to manage. Excess of it leads to flood and lack of it results in drought and famine. Overgrowing demand of water and increasing shortage of it may lead to major conflicts. It is important to make people aware of values of water more so that they will waste less and pollute less amount of water. Remote sensing technology and Geographical Information system have been extensively used in exploitation of ground and surface water in many areas. Now, time has come to use these technologies to realize the concepts such as artificial recharge, water harvesting and watershed management. These technologies have the potential to help in reaching the ultimate goal of water resource management so that every one can get sufficient amount of water. This article explores the potential of remote sensing and Geographical Information System in water resources management, development, and its capability to handle the issues related to water management and development

Key words: Remote Sensing, Geographical Information System, Water Resources

Introduction

Water, the elixir of life, has highly uneven availability in space, time and quantity. Water shortage or excess may have disastrous consequences. On the one hand there are droughts, on the other, flood devastates vast tract of land year after year. The myriad needs of the thronging population, burgeoning economic ambitions, demanding agriculture, expanding urbanization, increasing industrialization have caused great challenges in the best use of the available water resources. Consequently, the need for planning, conservation, optimum utilization and management of this natural resource is paramount for the economic upheaval of a country.

Water resources world over are under pressure due to land use change, urbanization, overuse and environmental polluting activities. The rapid advances made in spatial data acquisition technology over the last two decades, has given a unique advantage in synoptic, temporal coverage with vastly improved scales of observation.
The most important areas of application of Remote Sensing and GIS in water resource management are:

- Rainfall monitoring, including severe storm and flash flood forecasting and evaluation. (Andrawis *et al.* 1978, Kumar 1993)
- Surface water inventory and monitoring. (Chaurasia *el al.* 1993)
- Snow mapping, measurement and monitoring.
- Soil moisture measurement through mainly for un-vegetated or sparsely vegetated localities. (Brucker and Stenage 1988)
- Evapo-transpiration estimation and monitoring.
- River morphology.(Kumar*et al.* 1993)
- Sedimentation patterns rate in reservoirs and deposition in rivers.(Rao and Mahabaleswara 1990, Jain and Goel 1993)
- Ground water mapping and assessment.(Aggarwal and Mishra 1992, Ravindran and Manchanda 1993)
- Water pollution monitoring.(Baman 1993)
- Hydrological forecasting of the above parameters and phenomena and numerous dependant variables.
- Watershed conservation, planning and management.(Ja and Walsh 1992)

- Drought monitoring.
- Estuary studies and coastal zone management.

Remote Sensing Sensors Used for Water Resource Management Studies

Currently aircraft and spacecraft employ a whole range of sensors for collection of water resources information. Polar orbiting satellites, such as IRS, land sat, SoPT and other satellites have scanners to provide panchromatic and multi spectral information of varying spectral, spatial, and temporal and radiometric resolution. TheNoAA series of satellites in addition to weather related data provide terrain related information of use in snow studies, sea surface temperature, flood mapping and vegetation monitoring. Satellites such as ERS andRadarsat are carrying microwave instruments, like altimeter; scatter meter and synthetic aperture radar to study ocean and related phenomena.

Remote Sensing for Monitoring Water Availability

Remote sensing represents a very supportive tool in the following areas

1. Detection and monitoring of water bodies
2. Water volume estimation
3. Detection of potential ground water sites
4. Population estimation for water supply planning
5. Monitoring agricultural uses in the boundaries of the city for water supply planning
6. Estimating hydrological parameters like runoff., soil moisture and drainage network for estimating water availability.

Remote Sensing for Updating Water Infrastructure

Remote sensing techniques may represent an economic tool for supporting water infrastructure design and maintenance. Particularly, remote sensing is successfully used in different applications

1. Runoff estimation for supporting sewage system design
2. Geological studies for Dam construction
3. Monitoring urban expansion for updating the water supply and sewage systems

Remote Sensing for Monitoring Wastewater

Remote sensing provides an alternative means for obtaining relatively low cost spatial and temporal data about surface water condition from a large geographic area. landsat TM and MSS, Spot multi-spectral images, Air borne Imaging spectrometer AVIRIS can be used for detecting spatial and temporal variation in surface suspended sediments, organic yellow matter, chlorophyll and green algae and bacteria.

Remote Sensing for Monitoring Solid Waste Disposal

Solid waste is not efficiently collected and disposed off. Runoff and leaches can pollute and contaminate surface water and groundwater resources. Therefore, efficient and economic techniques are needed that allow water authorities to identify and monitor illegal dumping sites. Here remote sensing automatic classification techniques find a potential application to detect and monitor solid waste landfills (Karthiketeyan *et al*.,1993). It is to be noted that large landfills could not be resolved due to limited spatial resolution of current sensors.

Integration of SAR data and passive data represent an efficient alternative for increasing accuracy in the detection of landfills by combining high spatial resolution of SAR data with the spatial information contained in the optical remote sensing imagery.

Remote Sensing for Uncontrolled Extraction of Natural Resources

Remote sensing is an efficient tool to monitor environmental degradation. The use of change detection maps, generated by using multi temporal remotely sensed images, allows changes in landscapes to be identified and monitored. This information of land degradation, deforestation and desertification is used for identifying lakes, rivers or wetlands particularly exposed to mud-slides, sediment discharge or floods.

In particular, the main characteristics, which make remote sensing techniques suitable to support water resource management, are

1. Remote sensing data allows a wide variety of information concerning land and water to be extracted
2. Data can be obtained and analyzed with the necessary frequency.
3. A single remote sensing image covers all regions and provides infonnation of the whole area.
4. Remote sensing technique avoids loss of data, or gaps in information.
5. Automatic remote sensing techniques reduce the possible human errors that can occur when manipulating large quantities of data.
6. The integration of remote sensing and GIS provides a very supportive tool for monitoring water resources in large and complex geographic areas.

Main Advantages of Integrated GIS and RS

1. An efficient GIS needs a continuous updating of the various data elements held in its system and RS is an important information source.
2. Remotely sensed data are the only data sources that make a real time information system possible.
3. RS benefits from access to highly accurate ancillary data, available in a GIS, for increasing classification accuracy.
4. RS techniques allow a wide variety of geological, hydrological and urban information to be extracted from imagery data.
5. The capabilities of GIS for displaying geographic information prove very supportive tools for decisions makers.
6. The integration of RS and GIS provide a solid basis for developing a shared database among all the different entities involved in the water management activities.

In this context, an efficient integration of both Geographic Information System and remote sensing data represent a powerful tool for management of water resources and support decision making of water resources experts.

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Fenvalerate: A Synthetic Pyrethroid Toxicity to Fresh Water Fishes

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Abstract

Synthetic Pyrethroids are the new major class of broad spectrum organic insecticides used in Agriculture. Among the Pyrethroids, Fenvalerate (RS a cyano 3 Phenoxy Benzyl RS 2-[4 Chlorophenyl] 3-Metyl Butyrate) is used extensively and is most effective Pyrethroid. The technical isomer is a mixture of four optical isomers 2 S, a S, 2R and a S. The 2S isomers are more toxic than 2R. They are toxic to aquatic organisms. When they are being transported into aquatic environment. The toxic action of the toxicant will depend on metabolism and mode of action in aquatic organism. Hence to study it static and continuous flow through tests were conducted to determine LC_{50} values to the freshwater fish. The possible mechanism of toxic action will be presented.

Key words: Fenvalerate -Toxicity - Freshwater Fishes - Toxicological Mechanism.

Introduction

The pyrethroids are the esters of cyclopropane carboxylic acids with alkenyl methyl cyclopentenolene alcohols. The activity depends on the ester, and is influenced by the absolute configuration of the asymmetrical carbon atom at C1 of the cyclopropane ring and at C4 of the cyclopentenolene ring. All very active pyrethroids have R configuration at C1 and 'S' configuration at C4. The presence of gemdimethyl group at C2 of the cyclopropane ring is essential for a high insecticidal activity. Thesubstituents at C3 of the cyclopropane ring either as CIs or trans position are not an absolute requirement because even withoutsubstituents the insecticidal action is present but only saturated side chains give high activity. The replacement of the isobutenyl group by an isobutyl decreases activity whereas a butadienyl group may enhance potency (Wouters and Berchen 1978). The important pyrethroids are Allethrin, Bioresmethrin, Permethrin, decamethrin, cypermethrin and fenvalerate. All of them are highly active and stable insecticidal pyrethroids, hence being used extensively in agriculture, to control the insect pests, to control the vectors of endemic diseases, to protect the seeds during storage and to fight household insects.

Due to this widespread usage, they will be transported into aquatic environment, which is the ultimate sink for all pesticides, and aquatic toxicity has become an integral part of the process of environmental hazard evaluation of toxic chemicals. Generally, the potential impact of pollutants is more on the aquatic organisms, than terrestrial environment (Murty 1986).

Among the Pyrethroids, the neurotoxic organic insecticide fenvalerate (alfa cyano-3-phenoxy-phenyl) methyl-4-chloro-(1methyethyi Benzene acetate) is used to control boll warms on cotton, tobacco plants and vegetables. It is being extensively used in the local areas and keeping the view of the transportation, accumilation, concentration, the toxic impact of the toxicant to the fresh water fish is attempted. The portenous, palatable precious table item can be linked to the human food chain and the possible deleterious effects can be given a due consideration.

Materials and Methods

The freshwater fishes (sizes of the fish are given in Table- 1) were brought from local fish farms and by fisherman. The fishes were acclimatized to the laboratory conditions in well-aerated non-chlorinated tap water at test medium conditions. During the period of acclimatization and experimentation the fish were not fed. If the number of deaths exceeded 5% in any batch of fish during acclimatization, the concerned batch was discarded. The studies on toxicity were conducted for technical as well as 20 Emuslifiable Concentrate (EC) employing static and continuous flowthrough systems as recommended in the report of the committee on methods of toxicity tests with aquatic organisms (Amon 1975).

The solutions of desired concentrations were prepared in acetone to yield a concentration of 100mg/mL. The control fish received an equal quantity of acetone to that of the highest concentration of the toxicant tested.

For flowthrough system, test solutions of desired concentrations were prepared once in five hours in glass reservoirs and were let into the test containers through thin-walled polythene tubes. The flow rate was adjusted with regulators such that four litres of water passed through containers in one hour. The conditions of the test medium were temperature 28 ± 2 °C, oxygen 6-8 ppm, Hardness 80 mg/L, Alkalinity - 425 mg/L and pH 8.3. All the precautions laid down in the report of committee on toxicity tests were followed (Amon 1975).

The pilot experiments were conducted to determine the concentrations causing mortality of test fish in the range of 10 to 90%. For each concentration, 10 fish were tested and the experiment was repeated thrice.Probit analysis (Finney 1971) as recommended by Roberts and Boyce 1972 was followed to calculate the LC_{50} values. The technical fenvalerate and 20% EC were supplied by Searle (India) Limited, Mumbai.

Results and Discussion

The earlier reports on the toxicity offenvalerate to the fishes are: Bradbury and Coats 1982, Bradbury *et al.*, 1985, 86, 87 Coats and Jeffery 1979, Zitko et al, 1977, 79, Hya 1989 and Anitha *et al.* 1999 a & 1999 b. The LC_{50} values were given in the Table 1. The toxic action of fenvalerate is accounted in earlier reports due to its change as metabolites or due to certain biochemical changes in the tissue.

Table 1: The LC_{50} Values and their 95% confidence limits offenvalerate technical grade to freshwater fishes for 96 hours in static and continuous flow through system.

Name of the Fish and toxicant	Length of the fish	LC_{50} value for 96 hours Static	Continuous flow through system mg/L
Labeo rohita			
Fenvalerate (Technical)	2-4cm	0.012	0.0031
20% EC	2-4cm	0.016	0.0037
Catla Catla			
Fenvalerate (Technical)	2-4cm	0.004	0.0018
20%EC	2-4cm	0.017	0.0006
Cirrhinus mrigala			
Fenvalerate (Technical)	2-4 cm	0.002	0.0001
20%EC	2-4cm	0.016	0.0050
Aplochelus panchax			
Fenvalerate (Technical)	2-4 cm	0.027	0.014
20%EC	2-4 cm	0.002	0.009
Ctenopharyngodon idellus			
Fanvalerate (Technical)	3-5 cm	1.9	1.90
20% EC	3-5 cm	2.60	1.70

The values are tested for chisquare and found to be not significant at $P < 0.05$. The 95% confidential limits are also calculated.

Generally, there are three main chemical reactions involved in the degradation of a toxicant i.e.isomerization, hydrolysis and oxidation (Demoute 1989). The fenvalerate has the common degradation products in mammals, birds and Amphibians. The basic metabolic reactions are similar in all, i.e. cleavage of ester bond and oxidation of released acid and alcohol fragments. The initial transformations are followed by conjugation with sugars or amino acids which allows faster exertion.

Same type of degradation is reported in fish also, Bradbury *et al.* 1987 studied the toxicokinetics of fenvalerate in rainbow trout and reported the uptake of the gill. The qualification of the residues of the gill tissues; confirmed the isomer of venvalerate which is toxic i.e. 2s isomer the degradation product. The qualification and quantification of the residues proves thatfenvalerate is highly toxic fro fish and is species specific. In vertebrates except fish pyrethroids as opposed to organochlorines, which have the same ligophilicity are readily metabolized and excreted. The half-life periods never go beyond a few days. Birds have a larger capacity to eliminate their products than mammals. The high toxicity to fish is partly explained by their poor ability to metabolize them. Takimotto *et al.* 1986 reported that the lower rates of elimination and metabolism of fenvalerate in trout is the factor responsible for higher toxicity.

Their metabolism is largely oxidative in fish. Edwards *et al.* 1987. The fenvelerate acid moiety is very different from the other groups of pesticides and the ester cleavage releases the acid fragment, which is mainly excreted or as a glucorinide conjugate. The cyanide ion is transformed into thiocyanate and also carbon dioxide. Because of this, the freshwater fish are affected due to toxic action of fenvalerate.

The toxicity varies in LC_{50} value of 96 hours in continuous flow through system as well as static. The residue analysis by TLC and GLC (Anitha Susaan *et al.* 1996 & 1999) showed the deposition in fish tissues as residues. In the Table 1, toxicity data of the experiments confirmed that the commercial formulation is more toxic than the technical compound. The metabolites formation, storage of the pesticide after manufacture and as there was no strict quality control all of them are causing synergistic effect to the fish apart from the above mentioned reasons of earlier reports. Although, the pyrethroids are safest insecticides, when administered orally. But they may become highly toxic when they reach central nervous system in sufficient concentration. The sensitivity of the fishes in the present study to technical grade fenvalerate and 20% EC formulation was in the order of

Cirrhinus mrigala > Catla Catla> Labeo rohita >
Aplocheilus panchex > Ctenopharyngodon idellus.

Hence the formulation products must be viewed seriously before any pesticide is given a representation to be introduced into the environmental usage.

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Environmental Assessment Studies of Lime Kilns at Maihar (M. P.)

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Abstract

Environmental Assessment (EA) describes the whole process by which information about the environmental effects of a project is collected and assessed. In a developing country like India an "environmentally compatible development" has to be evolved for which Environmental Impact Assessment is the only answer. EIA of a development project provides the necessary management guidelines and in deciding the corrective measures to be adopted in managing the environmental system. Lime is a natural material, which is collected from nature as limestone since time immemorial all over the world. But the usual process of extraction in the lime kilns has also caused concerned on account of its potentiality of polluting the environment particularly air, water and soil.

In present investigation an attempt has been made to assess the environmental impacts of lime kilns at Maihar (MP) Battelle Environmental Evaluation System (BEES) has been applied in the present assessment study. The addition of environmental impact unit values of all the four sections (Categories) i.e. Ecology, Environmental Pollution, Aesthetics and Human interest provide with a over all negative values as - 476.6 and 36 positive values. In case of no industry situation the EIU values might have a total of 150. This indicates that due to lime kilns and on going mining and expansion work and also other related activities approximately 56.07 % of the over all environmental quality is negatively affected or likely to be affected while only 3.6% of the benefits could be sought in improving living standard.

Key words: *Environmental Assessment (EA), Environmental Quality (EQ), Environmentally Compatible Development (ECD), Battelle Environmental Evaluation System (BEES).*

Introduction

In a developing country like India an " Environmentally Compatible Development " has to be evolved for which Environmental Impact Assessment is the only answers. EIA of a developmental project provides the necessary management guidelines and in deciding the collective measures to be adopted in managing the environmental system.

Environmental Assessment (EA)

Describes the whole process by which information about the environmental effects of projects is collected and assessed by the developer before deciding to grant planning permission. The expression "Environmental Impact Assessment" (EIA) is also in common use and for practical purposes means the same as EA.

Lime is a natural material, which is collected from nature as limestone from time immemorial all over the world. But the usual process of extraction in the lime kilns has also caused concern on account of its potentiality of polluting the environment particularly air, water and soil.

Methods

For the purpose of computation of environmental impacts, an environmental evaluation system was developed in 1972 at Battelle Laboratories for the bureau of reclamation. In this system, about 78 environmental parameters grouped in 17 components are organized into 4 categories. The feature of this method is that the impacts are compared in the common units. This is a fairly ideal approach since environmental factors are measured in different units.

The steps involved in development of commensurate units include:

1- Estimation of various environmental parameters.
2- Transformation of parameter estimates into environmental quality scale (EQ)
3- Assignment of importance weight to the individual parameters.
4- Multiplication of scale value by importance values to obtain environmental impact units(EIUs).

Transformation of parameter estimates into an EQ scale is based on the fact that there is certain range of anticipated values for a given parameter with the range depends upon the units of measurement of the parameters.

Assignment of importance units to each of the individual parameters is based on the ranked pair wise comparison technique in which subjective judgment determines the relative importance or significance of individual parameters. The Battelle Environmental Evaluation System developed for reclamation has 1000 PIUS distributed into 4 major categories. In the present study this distribution adopted with certain modifications, taking into account only the relevant environmental parameters.

The whole process includes following steps

1- Obtaining of the parameters data without the project for each of the relevant environmental factors.
2- Conversion of these parameter data into EQ scale values.
3- Multiplication of these scale values by the PIU for each of the individual parameters to develop a composites chore for the environment with the project.

Environmental Impact Analysis

Battelle Environmental Evaluation System (BEES) for environmental assessment was developed byDee *et al.* 1973 Relevant environmental parameters where identified for the purpose of present study based upon this system.

Parameter importance weight for most of the parameters in the present investigation have been kept similar to those of Dee *et al.* 1973 developed for reclamation projects. Some of the new parameters and also slightly higher parameter importance weight values have been considered to give enough importance and relevant assessment.

A few of parameters though not very relevant were retained to honour the spirit of the inventor of the system. The environmental parameters selected for the present study as well as the importance weights for each parameter are present in Figure-1.

The environmental parameters selected for the Presents study are described as under:

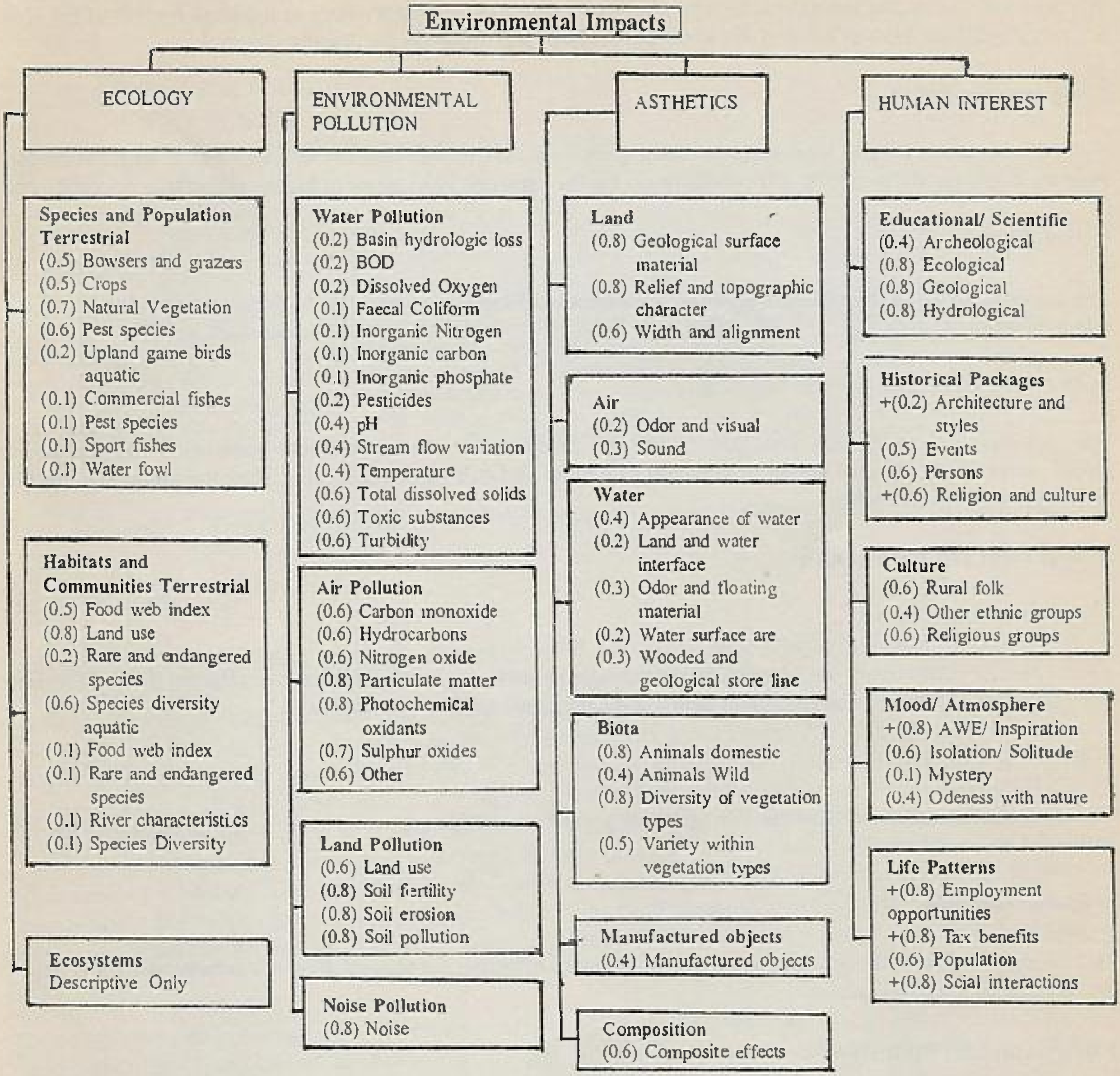

Figure - 1: Importance Weight Unit (IWU) for Various Descriptors of Environmental Quality

Ecology

This has been divided into two sub-sections:

A. Species and population - Aquatic and Terrestrial
B. Habitat and Communities - Terrestrial and Other Communities.

A. Species and Population

a- Browsers and grazers

The domestic herbivores from the adjoining area are deprived of grazing territory as the large portion of the area is either under lime kilns or spoiled due to the particulates deposition on the grazing material.

b- Natural Vegetation

Natural Vegetation around lime kilns is facing great loss rather sacrificed because of adverse impacts on the vegetation and environmentally difficult situation for the survival. The impact of higher magnitude is visualized.

c- Insect Fauna

The insect fauna from the natural vegetation as well as soil insect community are destroyed as a result of lime kiln activity in the area.

d- Over all productivity

The gaseous and particulate emissions from the limekiln and the subsequent deposition on the green photosynthetic area affected the photosynthesis of natural and cultivated vegetation. Thus the ultimate impact is on productivity of the region.

B- Habitat and Communities:

a- Food web Index

The impact on productivity and the denial of grazing and browsing by the herbivorous affected the food web in this region. The kiln site is large enough to affect the parameters with high magnitude.

b- Land Use

The land use earmarked for the lime kiln companies was earlier under agriculture. This has changed the land use pattern of the area.

c- Species Diversity

The whole complex of the limekiln area has a potential of affecting the species diversity substantiality and hence the rare and endangered species.

Environmental Pollution

This section has been divided into four sub-sections:

a-Water Pollutionb- Air Pollution c- Land Pollution d- Noise Pollution

a- Water Pollution

The deposition of the particulate emission from the lime kilns on the surface of the water degrades the water quality.

b- Air Pollution

The operation of lime kilns needs a great amount of fuel consumption. This leads to the emission of oxides of carbon, nitrogen, sulphur, hydrocarbons and the particulate matter. The lime kilns thus are potent enough to alter the air quality.

c- Land pollution

The dumping of the solid waste and their wash outs during rains cause soil pollution in a limited area. The soil erosion and soil degradation is not much due to lime kiln operation. The impact thus assessed is of low magnitude.

d-Noise pollution

The lime kiln processes and transportation activities are contributing to the noise pollution to a limited extent.

Aesthetics

The third section is on aesthetics witch include six subsections, as follows.

a- Land b-Air c- Water d- Biota e- Manufactured objects
f- Composite Effects

a. Land

The land waste dumping from lime kilns and particulate deposition on the land surface spoils the overall look of the land area around lime kilns, thus causing bad visual impacts.

b- Air

Consumption of fuel causes odor and visual impacts due to the dense smoke generated by the lime kiln operation, there by affecting the aesthetics of the area.

c- Water

Particulate deposition on the surface of water and lime waste wash outs duringrains spoils the visual beauty of the water bodies and badly affected the aquatic biota.

d- Biota

As mentioned earlier animals (both domestic and wild) and diversity of the vegetation types have been severally affected because of lime kilns coming up in the area.

e. Manufactured objects

Since, no proper planning for the lime kiln area is done, the construction structures are coming up in a disorganized manner, thus causing deterioration in the aesthetics of the project site.

f- Composite effect

The composite effects of various structures and activities are negatively affecting the area.

Human Interest

The last section on human interest has following sub sections.

a- Ecologucal and hydrological b. Historical c. Culture d. Mood/atmosphere e. Life patterns
f. Health status

a- Ecological and Hydrological

The ecological and hydrologic parameters (particularly ground hydrology) are moderately negative in the project site.

b- Historical

The Maihar area has historical importance. It is one of the important pilgrimages ofHindus.Maa Sharda temple is visited by thousands of pilgrims every year. Any damage to the ecology of the area will cause negative impact on the pilgrimage.

c- Culture

Present project does not have any serious impact on the cultural aspects of the region, but would definitely affect the cultural relations and would also have an impact on the local inhabitants.

d- Mood/ Atmosphere

Since the economic opportunities would be plenty, the local population would be inspired to take up new ventures. The growth in the population would affect the solitude of the local people and may also have some negative impacts on the general attitudes towards the nature and natural process.

e- Life Patterns

As a result of lime kilns coming up, people will get enough opportunities and there would be substantial increase in the population due to migration from adjoining areas. The region would be benefited by trade taxes and increased industry worker population would open up newer avenues for social interactions.

f- Health Status

The workers and the people living around lime kilns are suffering from various health problems due to lime kiln.

Computation of Commensurate Impact Value

Due to time constraints it was not possible to measure and estimate each one of the environment socio-economic parameters identified and chosen for the present study. An objective assessment of various parameters in terms of 'Environmental Quality' has been done after inspecting the project site as well as the lime kilns several times. The values are presented in Figure-2.

The transformed environmental quality values in turn are multiplied with the importance weight values to obtain Environmental Impacts Unit (EIU), which are presented in Figure -3.

The addition of environmental impact unit values of all the four sections (categories) provided us with an over all negative values as - 476.6 and 36 positive values. In case of no industry situation the EIU values might have a total of 150. This indicates that due to lime kilns and on going mining and expansion work and also other related activities, approximately 56.07% of the over all "Environmental Quality" is negatively affected or likely to be affected while only 3.6% of the benefits could be sought in improving living standards.

The irreversible commitments of resources like fuel, raw materials, electricity, cannot be avoided. The lime kiln dust and poisonous gases are fouling air, water, and soil system significantly. Worker engaged inlime kilns operations and other activities are suffering from various diseases.

Conclusion

The limekilns are the structures built to meet the lime requirement of the country, which have serious impacts on local environment. In the present study an attempt has been made to highlight various environmental impacts caused by lime kiln activity at Maihar. The environmental impact analysis in the present study revealed that adverse impact on local environment due to lime kiln activity at Maihar is 56.07%. This clearly indicates an adverse impact on the environmental system and point out the degree of damage to the existing environmental system as 56.07%. Obviously, the lime kiln activities are disastrous in terms of existing environment and would destroy the environmental system in long term.

The lime kilns have a great on impact various ecosystem components. Lime kiln emissions affect the vegetation growing in the vicinity negatively. A part from emitting gaseous and particulates pollutants from lime kilns generate heat, which increases the temperature of its environs. All these factors in combination affect the plant life negatively with invariable loss in vitality and vigor, and ultimately biological and economic yield. The air and water quality is badly effected due to emissions from lime kilns. Emissions from lime kilns are affecting various environmental components both biotic andabiotic drastically.

The health and welfare of mankind is intimately linked with the viability and productivity of natural and agricultural ecosystems. Evidence accumulated so far have clearly demonstrated that both the integrity and yield of these life-supporting ecosystems can be adversely affected by air pollution. The air quality control management and impact assessment aims at a healthy and aesthetically pleasing environment. Air pollution is no longer merely a local or a national problem, but has squired global dimensions.

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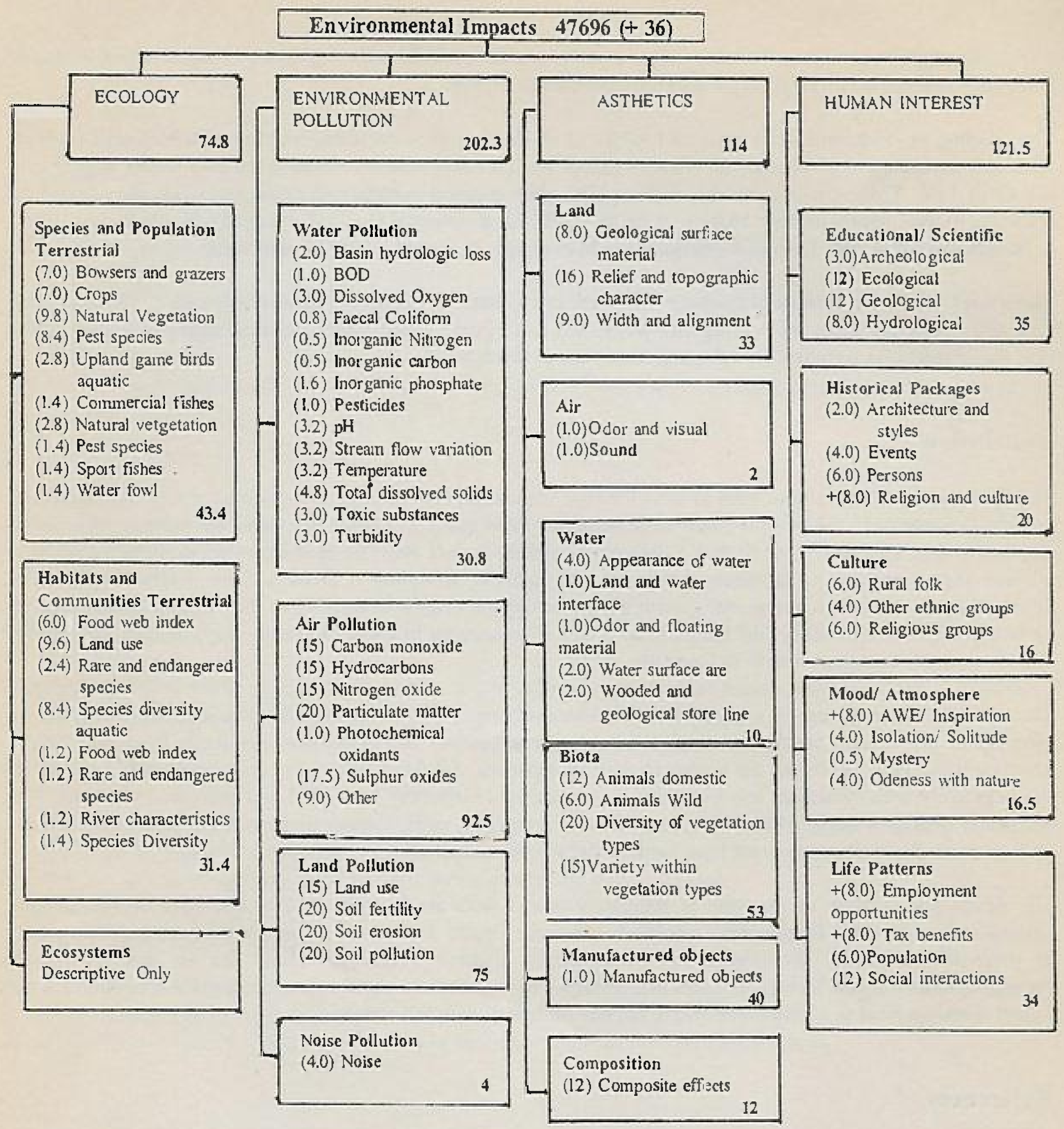

Fig. 2: Environmental Impact Units (EIUs) for Various Descriptors of Environmental Quality
(Numbers in parenthesis are parameter importance unit (PIU) and number at bottom represents the total)

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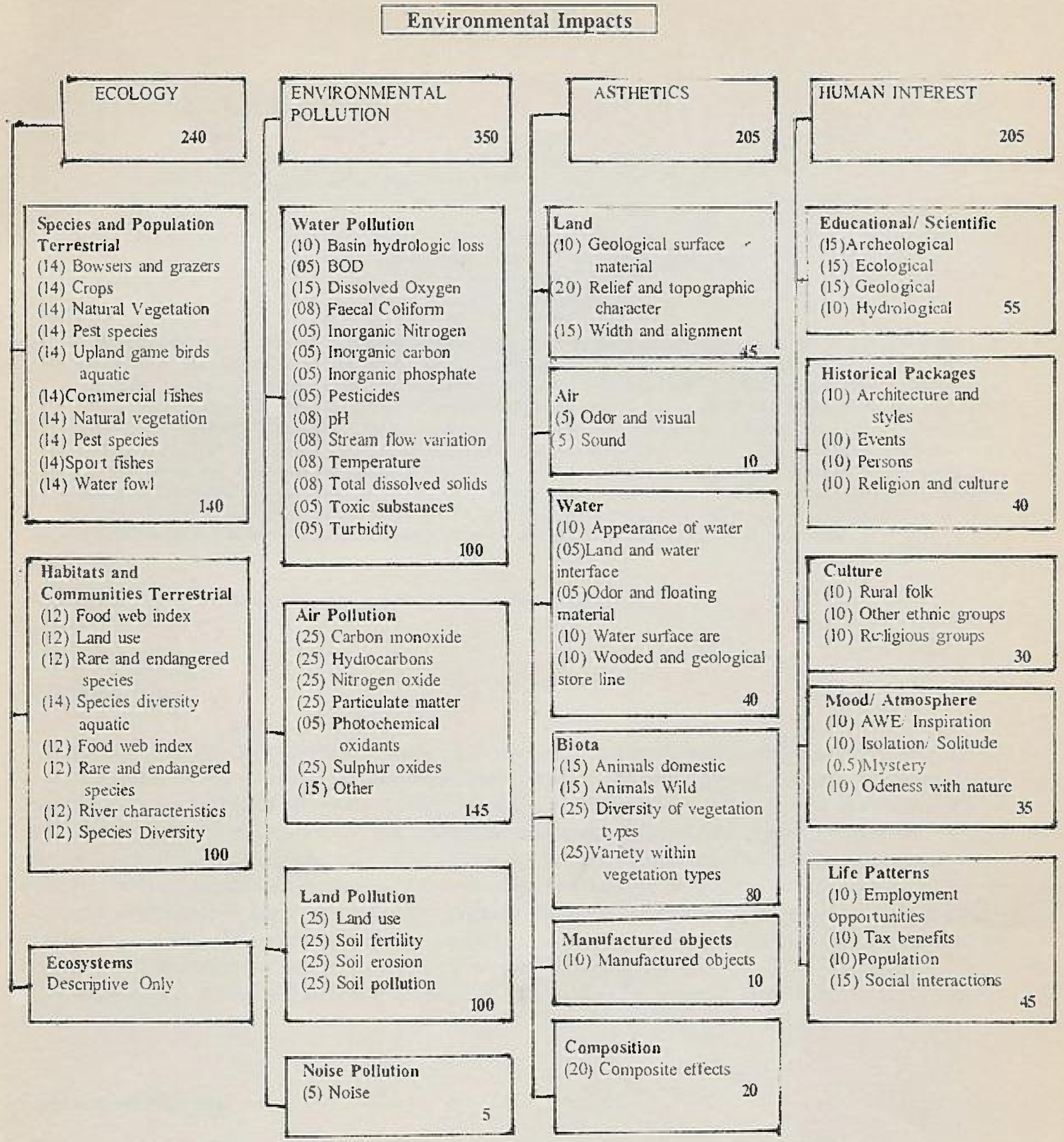

Fig. 3: Basttele Modified Environmental Evaluation System

(Numbers in parenthesis are parameter importance unit (PIU) and number at bottom represents the total)

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Removal of Nitrate from Drinking Water-A Review

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Abstract

The concentration of nitrates in ground water is observed to be increasing in the world in general and Asian countries in particular. Ground water is still a man source of drinking water especially in rural areas of Asian countries. Nitrates are known to cause methaemoglobinemia in babies and intestinal cancer due to formation of nitrosamines in general population. Several treatment processes for the removal of nitrates from drinking water have been studied. These processes comprise; vegetative de-nitrification, reverse osmosis, electrodialysis, catalytic reduction, chemical reduction, ion exchange and biological denitrification. Combinations of two methods like combined ion exchange-biological denitrification have also been studied. Every method have merits and demerits, however, the methods based on ion exchange for the removal of nitrates from drinking water and regeneration of resin by biological denitrification appear to have edge over other methods. This communication presents a review on existing denitrification processes and spells out needs for future research.

Keywords: *Nitrate, Denitrification, Drinking water, Pollution*

Introduction

Nitrogen exists in the environment in several oxidation states, with ammonia, nitrate and diatomic nitrogen gas being the main forms. Nitrates constitute the final stage in the oxidation of nitrogen compounds and are; therefore a measure of the original quantity of organic matter with which water is associated. The nitrate contained in pure well waters derived from extensive catchments is largely the result of biological activity in the surface layers of soil enhanced by cultivation and the application of manures. The nitrate of stream of rivers may, however receive substantial increment from well-nitrified sewage effluents. Excessive use of nitrogenous fertilizers in agriculture has been one of the primary sources of high nitrates in ground water (De Roo 1980, Scheper et al., 1984). The increase in levels of nitrates nitrogen can also arise in intensively cultivated area under horticultural lots and under animal feed lots (Wilson *et al.* 1999). Presence of high level of nitrates has been reported in several countries (Pande and Hasan 1979 and Fried 1991, Spalding and Exner 1991, 1993 and Nixon 1992).

Sources of Nitrate

The primary source of all nitrates is atmospheric nitrogen gas, which is converted to organic nitrogen by some plant species by a process called nitrogen fixation. On the death of the plants, the organic compounds are decomposed by microorganisms to inorganic ammonium salts (ammonia fixation), which in turn are converted to nitrates by a process called nitrification. The intermediate product nitrite is generally short lived and seldom accumulates in significant quantities in any natural environment in environment that are depleted in oxygen, some microorganisms can use nitrate in place of gaseous oxygen to carry out their metabolic processes. The products of this reaction are nitrogen gas and/or nitrous oxide. This process is called denitrification (Hounslow

1995). Nitrate occurs in almost all natural waters and its concentration can go up to hundreds of mg/L except when contamination is present, they seldom exceed 20 mg/L. However 10 mg/L as NO_3^- N or greater may be regarded as probable indication of contamination from fertilizers, municipal wastewater, feedlots, septic systems and sometimes the cultivation of grasslands.

Nitrogen chemistry in natural water is complex because nitrogen exists in different oxidation states such as NO_3^- (+5), NO_2^-(+3) and ammonium NH_4^+(-3). The NO_3^- (+5) form is expected under oxidized conditions and NO_2^- is found under moderately reduced conditions. In addition, nitric oxide NO (g), nitrous oxide N_2O (g), and nitrogen (N_2)(g) are also expected in moderately reducing conditions (Stumn and Morgan 1996). Among several N species, NO_3^- is the most stable and is commonly found in groundwater associated with intensive agriculture. Nitrate itself is nontoxic. Doses up to 9 gm/day have been used to treat phosphatic kidney stones in humans without any adverse effect. Contamination of drinking water with nitrate presents a health hazard because NO_3^- can be reduced to NO_2 in the gastrointestinal tract and causes 'Methaemoglobinaemia' alternatively called as 'Blue Baby Syndrome', a some times fatal disease to which infants are particularly susceptible and also affects adults deficient in glucose phosphate dehydrogenase. In addition nitrate and nitrite have a potential to from carcinogenic N-nitroso compounds, which is a postulated cause of stomach cancer. (Majumdar and Gupta 2000). Thus it is important to maintain low levels of nitrate in drinking water. WHO and U.S.E.P.A. have suggested the guideline value of 10 mg/L as NO_3^- N (Lunkad 1994).

Nitrate contamination of our ground and surface water resources is becoming an ever increasing problem. In central Himalayan snow and ice, NO_3^- content is about 0.5 mg/L (Lunkad 1994) while world average river water contains 1.0 mg/L NO_3^- and the ultimate sink of terrestrial waters, the oceans, on average, have 0.67 mg/L NO_3^- (Mason and Moore 1985). In some parts of Europe, nitrate concentrations in ground water reached serious levels 20 years ago and have continued to increase (Barrenstein*et al.* 1986). In 1970 nitrate levels in 60 public supply groundwater sources in England and water intermittently exceeded guideline value, in 1980 this number increased to about 90; and in 1987 about 142 (Hourse of Lords 1989). Surveys conducted in India have shown excessive level of nitrates in ground water (Pande *et al.* 1979, Gopal *et al.* 1977, Gupta 1981 and Handa *et al.* 1982)

Methods of Nitrate Removal

Nitrate is highly soluble in water and there are very few known insoluble compounds of nitrate. The removal of nitrate is therefore difficult using conventional flocculation and sedimentation methods. In view of this, technologies based on physico-chemical principles and biological denitrification has been used for the removal of nitrate from drinking water. Some of the prominent methods used fordenitrification of drinking water are 0described below.

Reverse Osmosis

Reverse Osmosis (RO) is a pressure driven process, which is accomplished by passage of water through a membrane against the natural osmotic pressure to accomplish separation of water and ions. Membranes commonly used are made up of cellulose acetate (0.10 to 0.15 mm thick), while membranes made up of polyamides and composite membranes are also available.

In the reverse osmosis process, a thin membrane separates two salt solutions. Water from the side of lower salt concentration flows through the membrane to the solution of high concentration attempting to equalize the salt content, while the membrane allowing water flow blocks passage of salt ions. If pressure is applied to side of higher salt content, flow of water can be prevented. If pressure is increased the water flow is reversed and passes from salt water to the fresh water; in this manner the salt are separated from the solution. Reverse osmosis operating pressures very between 350 and 1500 psi with a typical range of 600 to 800 psi. Because of high rejection of salt ions, the necessary reduction of the nitrate concentration of well water may be achieved by treating only part of the total amount of water and bypassing the rest. Reverse osmosis, however, cannot separate nitrate selectively. Reverse osmosis generally results in a reduction of mineral content in water.

Rautenbach *et al.* 1986 commented that the economics of RO process requires high nitrate rejection of the membranes, high water flux at low driving forces and a high recovery rate. They informed that in most of the cases of high nitrate in ground water in Germany, the dissolved solids are below 600 mg/L and therefore, low pressure modules can be used for nitrate removal. Based on a pilot plant studies they reported that (1) all reverse osmosis membrane are not suitable for nitrate separation (2) feed treatment and recovery rate have to be adjusted individually to the feed water quality and composition, specially the levels of Ca,Sr, Ba, Si, HCO_3 and SO_4 and (3) permeate must be conditioned by process like CO_2 stripping, lime treatment to overcome CO_2 and consequently avoid passing of CO_2 through the membranes. They finally commented that the removal of nitrates by RO system is economically viable. Well water having nitrate concentration of 94 mg/L was reduced to 18 mg/L by RO process.

The concentrate resulting from the reverse osmosis system had a pH value of approximately 7.0 so that the wastewater could be directly discharged into the sewers without any further treatment.

Electro dialysis

In the electro dialysis (ED) process, ions are separated from the water by attracting them through selective ion-permeable membranes using an electrical potential. The unit consists of membranes interposed in the path of a direct current generated by end electrodes. Electro dialysis employs two different kinds of membranes- anion and cation selective membranes-, which are stacked alternatively from thediluate and retentate compartments. The feed is concentrated in the retentate compartment and depleted in the diluate compartment as a consequence of the selectivity of the membranes (Hammer 1991). An electro dialysis system requires a supply of pressurized water (50-75 psi), a membrane stack and a direct current power source. Nitrate removal efficiency in ED is about equal to that of reverse osmosis and the process requires lesser acid dosages than RO and higher water recovery rates.

Inorganic and organic both types of membranes are used for electro dialysis process. White *et al.* 1991 used inorganic membranes for the electro dialysis (barium silicate, phosphate composite membrane).Adhikari *et al.* used electro dialysis for desalination of brackish water and 86.7-97.8 percent reduction in nitrate concentration resulted in water containing nitrate in the range of 26.0-144.0 mg/Land feed water TDS in the range of 6000-36000 mg/L. A selective nitrate removal process was developed by Miquel and Oldani 1991, which was effective in removing nitrate concentration from 50 mg NO_3/L to 25 mg NO_3/L without the addition of any chemical.

Nitrate has been removed by electro dialysis method using a nitrate specific anion exchange membrane (Indusekhar *et al.* 1991). Amine groups were incorporated in the membrane prepared fromchloromethylated poly sulphone. The membrane exhibited a larger nitrate flux in comparison to chloride flux.

A pilot electro dialysis unit 'Micro Acilyzer. G5' with monovalent permselective membrane was used by Saddi 1998 for the removal of nitrate and chloride from groundwater. It was found that ED reduced both the nitrate and chloride level below the WHO guidelines at 77% recovery without any acid dose. The energy consumption per Kwh/g salt/m^3 product water was 0.48. The membrane selectivity depended strongly on the individual ion concentrations of the feed water. Linear flow velocity increase needed a longer process path length (membrane length) in order to reach the same product water quality.

Segall and Clifford 1992 presented theoretical fluid transport and chemical reaction equations for one and two dimensional fluid flow induced by an electric field. Laboratory columns and two dimensional model studies examine electroosmosis (EO) as a method of contaminant removal. Nitrates dissolved in EO column influent water more through a column and are reduced at the cathode as follows:

$NO_3^- + 2H^+ + 2e^- \rightarrow NO_2^- + H_2 + O,$ $E_o = +0.84$ Volts
$NO_2^- + 8H^+ + 6e^- \rightarrow NH_4^+ + 2H_2O,$ $E_o = +0.89$ volts
$2NO_3^- + 12H^+ + 10e^- \rightarrow N_2(g) + 6H_2O,$ $E_o = +1.24$ volts

At high pH, little N_2 is expected, but ammonia gas does evolve from the collected column effluent.

$NH_4^+ + OH^- \rightarrow NH_3 + H_2O$

Catalytic Reduction

The catalytic reduction of nitrate represents an effective, selective and almost residue free process for the selective removal of nitrate from water. Nitrate and its intermediates like nitrite are selectively reduced to nitrogen on Pd-based bimetallic supported catalysts.

Horold *et al.* 1993 tested bimetallic catalysts to remove nitrate from drinking water. A catalyst with lead (5%) copper (1.25%) impregnated on Al_2O_3 was observed to completely remove nitrate from water having initial nitrate concentration of 100 mg NO3 -/ L. The reaction was completed in 50 minutes. The nitrate removal activity of the catalyst was 3.13 mg NO3-/min/g of catalyst, which was 30 times greater than that of microbial denitrification. The process operated effectively in the pH range of 6-8.

Reddy *et al.* 2000 designed and developed an apparatus for testing the catalytic reduction process under different redox potentials and evaluated the effectiveness of different catalysts in removal of nitrate from groundwater. Three catalysts Palladium (Pd), Platinum (Pt) and Rhodium (Rh) on 5-10% carbon were tested in this study. One litre of groundwater was amended with 0.5g catalysts and reacted at differentredox potentials (340 to - 400 mv) and reaction times (1-6 h). During the catalytic reduction process the pH was maintained around 6.5 by bubbling 5% carbon dioxide (CO_2). Initial nitrate concentrations ranged between 32 and 41mg/L. Among the three catalysts, Rh was observed to be most effective the removing NO_3 in groundwater samples. Results with Pt catalyst showed very slow reduction e.g. at -400mv and 6 & 14 hours reaction times nitrate level decreased only by 25% and 44% respectively. Results suggest that Rh catalyst at-400mv and 6 hours reaction time can decrease NO_3^- concentration from 40 to 11.9 mg/L (68%) Nitrate was not detected during the nitrate reduction process. The re-oxidation of formerly reduced sample to 390mv resulted in no increase in the concentration of NO_3^- and its reduction rate significantly increased on application of a small flow of current. Application of 4.6-6.1v to - 250 mv and 6 hours reaction time resulted in 80% (40 to 7.9 mg/L) decrease in NO_3 concentration. These results suggested that the Rh catalyst was effective in lowering NO_3 concentrations in groundwater (Horold *et al.* 1993). The reaction is as under.

$2NO_3^-(aq.) + 5H_2(g) \rightarrow N_2(g) + 2OH^-(aq.) + 4H_2O$

The proposed process has a potential for field application because Rh catalyst can be coated onto a fiberglass mesh and the desired redox potential can be acquired with a photo voltic cell. This process could become potentially inexpensive method as the sunlight could be used as the energy source to activate the catalyst.

Chemical Reduction

Nitrate can be removed by its chemical reduction, to nitrogen. Murphy 1991 described a chemicaldenitrification process by use of powdered AI, which is a powerful reductant, can decompose water, NO_3 and SO_4 and has an optimum pH 10.25 for nitrate reduction. Al powder reduces nitrate to ammonia, nitrogen and nitrite. The removal of nitrate ion by al may first occur by adsorption onto the particles. The reactions probably proceed to nitrite as under.

$3NO_3^- + 2Al + 3H_2O \rightarrow 3NO_2^- + 2Al(OH)_3$
and from nitrite to either ammonia
$NO_2^-\ 2Al + 5H_2O \rightarrow NH_3 + 2Al(OH)_3 + OH^-$
Or Nitrogen
$2NO_2^- + 2Al + 4H_2O \rightarrow N_2 + 2Al(OH)_3 + 2OH^-$

This process can be effectively used in water treatment plants using lime for water softening. The pH is usually raised to or above 9.1 using lime, thus very little additional cost for pH change will be required. Al also reacts with water according to the following reaction.

$2Al + 6H_2O \rightarrow 2Al(OH)_3 + 3H_2$

The loss of reductant decomposition of water can be minimized to less than 2% between pH 9.1 & 9.3 and 1.16 gm of Al is required to reduce 1 gm of nitrate. Nitrate reduction also occurs with iron under basic pH conditions. This reaction requires Fe: NO_3 ratio of about 15:1 in presence of Cu catalyst and the process proceeds according to the following reaction (Sova 1986).

$NO_3^- + 8\ Fe\ (OH)_2 + 6H_2O \rightarrow NH_3 + 8Fe(OH)_3 + OH^-$

Iron is used by many workers for the successful removal of nitrate from water. Chemical reduction of nitrate by iron in hot sulphuric acid is quantitative but ammonia is not the principal product (Pepin-Lahllur 1930). Szabo *et al.* 1951 described NO_3^- reduction quantitatively by boiling ferrous hydroxide suspension in the presence of catalysts such as colloidal silver or copper hydroxide.

Young 1964 described reduction of nitrate with Ferrous Hydroxide at room temperature at pH 7.0-10.3. The initial nitrate concentration was 100 mg/L (as N) and colloidal copper hydroxide employed as a catalyst was proved to be optimum as 25mg/L (as Cu) and was used at that level in subsequent experiment. The best result obtained was 90% reduction of NO_3 in four hours at pH 10.3. The reduction was slower and less complete at lower pH.

Young 1964 used powered and coarse iron for the reduction of NO_3^- in water. Powdered iron (2g/L) was added in water at various pH levels, which results in94, & 93% reduction of nitrate in five hours at pH 3.0 and 2.5 respectively. Coarse iron at 2g/L yielded 57% reduction in NO_3^-. Ammonia was the principal end product in each case. The balanced equation for this mechanism is,

$NO_3^- + 4Fe^o + 6H_2O^- \rightarrow 4Fe^{+2} + NH_3 + 9OH^-$

The rate of reaction for the reduction of nitrate decreased when coarse iron was used. This is because of decreased surface area with increased particle size.

Cheng *et al.* 1997 described a method for the reduction of 12.5 mM nitrate solution to less than 0.1 mM by zero valent iron under aerobic conditions at room temperature and normal pressure. At pH 5.0 with a 0.05M sodium acetate/acetic acid buffer, nitrate was rapidly reduced to ammonia is a pseudo first order reaction.

Ottley *et al.* 1997 described the significance of trace metal catalysed reduction of nitrate in deep ground water where organic carbon concentration were Very low, laboratory experiments were conducted in which nitrate was reduced chemically by Fe (II) to ammonium at pH 8 and at 20°C in the presence of copper (II). Solid phase Cu rather than dissolved copper was directly involved in the nitrate reduction reactionscatalysed by goethite.

Zawaideh *et al.* 1998 demonstrated the effects of pH and addition of an organic buffer (HEPES) (4-(2-hydroxyethyl)-1- piperazine ethane sulfonic acid) on nitrate transformation in zero valent iron systems, Nitrate-nitrogen was removed by 94% when 0.01 M of HEPES was added to a non shaking batch reactor containing 20 mg/L nitrate-nitrogen and 41%(W/V) ofFe^{o}. Shaking was proved to be effective in removal of nitrate. Using the response surface technology, it was found that nitrate removal was closely related to pH. At low pH (e.g. pH<2), the nitrate removal was fast and efficient (95% to 100%) this was because of formation of Fe^{2+} at low pH. At high pH (e.g.>11), the transformation of nitrate was fast and efficient only for low concentrations nitrate in Fe^{o} - H_2O system. At high pH (e.g. of 11), some solid compounds such as$Fe(OH)_2$, $Fe(OH)_3$ or $FeCO_3$ are formed which would eventually form a surface layer on FeO surface that would inhibit further decomposition of Fe^{o} (Stumn *et al.* 1996). Therefore the nitrate removal will not increase with initial nitrate concentration. At normal pH range (pH=6 to 8), nitrate removal was usually lower than 50% without buffer treatment. Mass transport of substrate to the iron surface proved to be important in achieving high removal efficiency.

Siantar *et al.* 1996 used zero valent iron on hydrogen/palladium catalyst (H_2 /Pd- Alumina) for the treatment of nitrate-contaminated water.

Flis 1991 reported that iron may reduce nitrate to nitrogen, nitrite or ammonia depending on the reaction conditions.

$$10Fe^{o} + 6NO_3^- + 3H_2O \rightarrow 5Fe_2O_3 + 6OH^- + 3N_2$$
$$Fe^{o} + NO_3^- + 2H^+ \rightarrow Fe^{2+} + H_2O + NO_2^-$$
$$NO^- + 6H_2O + 8e^- \rightarrow NH_3 + 9OH^-$$

Nitrate can also be reduced to nitrogen using H_2 and Pd on copper under water treatment conditions (Sell *et al.* 1993)

$$5H_2 + 2NO_3^- \xrightarrow{Pd/Cd} N_2 + 4H_2O + 2OH^-$$

Chew and Zhang 1998 indicated that electrokinetics / iron wall process can be used to remediate nitrate-contaminated ground water. In the iron wall oxidative dissolution ofFe^{o} takes place resulting in the formation of Fe^{2+} ions.

($Fe^{o} \rightarrow Fe^{2+} + 2e^-$)having a reduction potential of 0.44v (Sawyer*et al.* 1994)
$2NO_3^- + 12H^+ + 10e^- \rightarrow N_2(g) + 4H_2O$, E_0=1.24V,
The combined reaction is
$5Fe^{o} + 2NO_3^- + 12H^+ \rightarrow 5Fe^{2+} + N_2(g) + 6H_2O$, E_{rxn} = 1.68v,

Nitrates are anions, which will move to the anode in the elctrokinetics. When only electrokinetics was used at various constant voltages, 25 to 37% of nitrate nitrogen was transformed. Amount of nitrate-nitrogen transformed improved when aFe^{o} wall (20 g or about 8-10% by weight) was placed near the anode. For test runs at various constant voltages, the amount of nitrate-nitrogen ranged from 54 to 87%. By switching to constant currents, the amount of nitrate-nitrogen transformed was about 84 to 88%. The major transformation products were ammonia nitrogen and nitrogen gas. Nitrite nitrogen was less than 1% in all-experimental runs. Two localized pH conditions exist in the system, a low pH region near the anode and a high pH region near the cathode. Placing of an iron wall near the anode increase the pH in that area as time increases. Movement of the acid front did not flush across the cathode. High nitrate transformation efficiencies can be achieved with pH in the range of 4 to 10.

Ion Exchange

Ion exchange is a unit process in which ions of a given species are displaced from an insoluble exchange material by ions of different species from solution. In practice an ion exchange material is placed in a bed and the contaminant to be treated is passed through it. When ion exchange capacity of the bed is depleted, the feed is stopped and a regenerating solution (concentrated Solution of NaCl or $NaHCO_3$) is passed through bed. Ion exchange materials both natural and synthetic are adsorbents which carry charged ionic groups. To maintain electroneutrality, each ionic site must have associated with it an ion of opposite charge (counter ion). The success of ion exchange depends on the ability of the counter ion to be replaced or exchanged for another ion of the same charge. When all counter ions have been replaced, the ion exchange material is exhausted. Acid or cationic resins will exchange cations such as Ca^{2+} or Mg^{2+} and base or anionic resin will exchange OH^- or Cl^- anions (Reeves 1972).

Guter 1981 tested a pilot-scale ion- exchange study conducted at McFarland, California for the removal of nitrate from groundwater containing nitrate-nitrogen in the range of 16-23 mg/L. He was able to remove nitrate almost completely.

Lin 1997 used Dowex- Sar as a strong base, anionic ion exchange resin of the Cl type. Regeneration was attained with a salt solution containing 10 % w/w salt in about 10 hours. The pH and temperature effect on the equilibrium exchange capacities for nitrate removal was seen to be rather small. A higher initial concentration of nitrate was observed to enhance the ion exchange process.

Basic bismuth nitrate has low solubility in water. Utilizing this property several bismuth compounds were examined by Fritsche 1993 for their ability to remove nitrate from water. Yellow Bismuth hydroxide, prepared by the reaction of bismuth salt solution with excessive sodium hydroxide proved to be an effective material for anion exchange. Besides nitrate, it also removes phosphates, sulfates and chlorides. The selectivity of the method, which is based on ion exchange with hydroxl ion (OH^-) as counter ion depends on the pH value. Regeneration can be achieved by sodium hydroxide.

Hoek *et al.* 1988 used a strong base, macro porous anion exchange resin Amberlite IRA 996 for nitrate removal from ground water. Amberlite appeared to be more nitrate selective than sulfate selective in treating high nitrate concentrations in potable water. High nitrate concentration of 18 mg NO_3- N/L was reduced to 5-6 mg NO_3 -N/L after the treatment with this resin at a flow rate of 35 Bed Volume (BV)/ hour.

Liang *et al.* 1999 studied the removal of nitrate from contaminated groundwater using three types of strong base anion resin. In type I resin three methyl groups make up the functional group, in type II an ethanol group replaces one of the methyl group of resin I and third type of resins were nitrate/sulfate selective (NSS) resins and similar to type I resin containing tri methyl amine functionality but ethyl,propyl o butyl groups substitutes. They observed that type I resin provided longer run before regeneration than the type II or NSS resins. The removal of nitrate was almost 100 percent up to 400 bed volumes in type I resin, up to 300 bed volumes in type II resinand up to 250 bed volumes in NSS resin. It was also observed that in type I resin bicarbonate interferes less with nitrate removal than it did in type II resin. Less regenerant salt was also required for regeneration producing less waste in type I resin than in type II or NSS resin.

Hoell and Feuerstein 1985 developed a process called CARIX process to provide simultaneous removal of nitrate, sulfate and hardness. The CARIX process is based on the combined use of a weakly acidic cation exchanger in the hydrogen ion form and a strongly basic anion-exchanger in the bicarbonate (HCO_3^-) form. Both resins are regenerated simultaneously with carbon dioxide in a non-polluting fashion.

The nitrate ion exchange process involves multicomponent ion exchange with sulfate as the major competitor with nitrate for ion exchange sites. Conventional strong base anion exchange resins prefer divalent hydrophilic sulfate over monovalent hydrophobic nitrate. This sulfate preference needs to early nitrate breakthrough and causes nitrate peaking when nitrate breakthrough is exceeded. For high sulfate water greater than 140 mg/L, the nitrate selective TEA and PBA (Tri Ethyl Amine & Tri Butyl Amine) resins generally perform better than the conventional TMA (Tri Methyl Amine) resins for nitrate removal.

Biological Denitrification

The process refers to the dissimilatory reduction by essentially aerobic bacteria of one or both of the ionic nitrogen oxides (NO_3^- and NO_2^-) to the gaseous (NO and N_2O) which may themselves be further reduced to dinitrogen (N_2). Denitrification is catalysed by either heterotrophic or autotrophic bacteria that derive their energy requirements by the oxidation of organic and inorganic material, respectively (Hiscock *et al.* 1991).
The oxidation half reaction of carbohydrate is

$CH_2O + H_2O \rightarrow CO_2(g) + 4H^+ + 4e^-$
and that of pyrite is
$^1/_{14}\,FeS_2 + ^4/_7\,H_2O \rightleftharpoons ^1/_7\,SO_4^{2-} + ^1/_4\,Fe^{2+} + ^8/_7\,H^+ + e^-$

Heterotrophic denitrifying microorganisms can use a variety of organic carbon sources; however most of the work regarding denitrification of water involves the use of methanol or acetic acid.

$5CH_3OH + 6NO_3^- \rightarrow 3N_2 + 5CO_2 + 7H_2O + 6OH^-$ (Sherrard 1988)
$5C_2H_5OH + 12NO_3 - \rightarrow 6N_2 + 10CO_2 + 9H_2O + 12OH$ (Richard *et al.* 1980)
$5CH_3COOH + 8NO_3^- \rightarrow 4N_2 + 10CO_2 + 6H_2O + 8OH^-$ (Frick and Richard 1985)

Methane and Carbon mono oxide can also be used as substrate fordenitrification.

$5CH_4 + 8NO_3^- + 8H^+ \rightarrow 5CO_2 + 4N_2 + 14H_2O$ (Brrenstein *et al.* 1986)
$2NO_3^- + 5CO + H_2O \rightarrow N_2 + 2OH^- + 5CO_2$ (Sherrard 1988)

Denitrification can also be accomplished by autotrophic bacteria, which can use hydrogen or various reduced - sulfur compounds as energy sources.

The following stoichiometric relationship for hydrogen and sulfur has been reported.

$2NO_3^- + 5H_2 \rightarrow N_2 + 4H_2O + 2OH^-$ (Kurt *et al.* 1987)
$5S_2O_3^- + 8NO_3^- + H_2O + 2OH^-$ (Kurt *et al.* 1987)
$5S^{--} + 8NO_3^- + 8H^+ \rightarrow 5SO_4^{--} + 4N_2 + 4H_2O$ (Barrenstein *et al.* 1986)

Biological denitrification is commonly used in municipal and industrial wastewater treatment. However, it may be used to treat drinking water if bacterial contamination of the treated water can be avoided. Denitrification takes place under anionic conditions. Nitrate reduction to nitrogen gas occurs through a series of steps as follows (Knowles 1982).

$NO_3^- \rightarrow NO_2^- \rightarrow NO \rightarrow N_2O \rightarrow N_2$

Autotrophic denitrification

Flere and Zhang 1999 evaluated sulfur and limestone autotrophic denitrification (SLAD) processes with four laboratory scale fixed bed reactors. A maximumdenitrification rate of 384g NO_3^- -N/ (m^3 day) was achieved at a loading rate between 600 and 700g NO_3^- - N/(m^3day). The effluent nitrite concentration started to rise gradually once the loading rate was above 600g NO_3^- - N/(m^3day). A loading rate between 175 and 225g of NO_3^--

$N/(m^3day)$ achieved the maximum nitrate- N removal efficiency (approximately 95%). A SLAD column requires backwashing after 6 months of operation when the influent is synthetic ground water but will foul and requires backwashing within 1-2 months when the influent is real ground water.

Schippers *et al.* 1987 described denitrification using sulfur limestone filtration. Limestone granules were added to sulfur to maintain the pH because pH was reduced by the hydrogen ions, which was released in this in this process. Filtration was carried out at 0.5 m/h, similar to the rate used in slow sand filtration. The influent was degassed to remove nitrogen and oxygen and 0.3 mg PO_4^{-3}/L phosphate was added. The pilot plant consisted of a vaccum degasser, a slow sulfur /limestone filtration unit, a cascade tray and an infiltration pond. The concentration of NO_3- N was reduced from 20 to 3-5 mg/L at a filtration rate of 0.25 m/h.

Denitrification with sulfur/limestone was also achieved by Blecon *et al.* 1983 and Hoek *et al.* 1992. Some authors have evaluated reduced sulfur compounds such as sulfide andthiosulfate for the denitrification of water and domestic and industrial wastewater (Claus 1985, La Motta Diaz 1985 Martin 1982 and Batchelor 1978). Sulfate was the byproduct of denitrification using sulfur compounds.

Lewandowski *et al.* 1987 evaluated autotrophic denitrification using calcium alginate beads containing elemental sulfur, calcium carbonate and Thiobacillus denitrificans suspended in a bench scale completely mixed batch reactor. Nitrate concentration was reduced from 27 mg/L to 6 mg/Lin seven hours.

Nitrate has been removed in fixed film reactors using various support media composition, hydrogen generation, degassing technique and post-treatment methods. Various methods have been used to remove microorganisms and dissolved organic carbon from denitrified water (Gros and Ginocchio 1982 and Ginocchio 1984).

Kurt *et al.* 1987-used hydrogen for autotrophic denitrification in a bench scale fluidized bed reactor. Nitrate and hydrogen were assumed to be limiting substrates in the firstdenitrification step, and nitrite and hydrogen were assumed limiting in the second step. The nitrification rate was shown to be more stronglydependednt on the nitrate concentration than on hydrogen. A residence time of 4.5 hours was required from completedenitrification of water containing 25 mg/L NO_3 - N at the optimum pH of 7.5.

Gros *et al.* 1986 and Gros and Treutler 1986 reported on the performance of a commercial scale biological denitrification plant utilizing hydrogen, in Minchegladbach, West Germany and the process was given the trade name 'Denitropur. The plant design incorporates indirect hydrogen saturation, phosphate addition, four-packed bed reactor in series, post aeration, flocculent addition, filtration and UV disinfection. Carbon dioxide was added as an inorganic carbon source and to buffer against an alkaline pH shift. The sludge production was less (approximately 0.2 kg/ per kg N removed). Residence time of one to two hours was required to remove 50 mg/L nitrate.

In electrode biofilm reactor, denitrifying organisms are immobilized on the cathode utilizing H_2 produced by the electrolysis of water and subsequently reduce nitrate to nitrogen gas.

$$2NO_3^- + 2H^+ + 5H_2 \rightarrow N_2 + 6H_2O$$

carbon electrode was used as the anode, so that the CO_2 formation seems to occur instead of O_2 formation (Kinoshita 1988).

$$C+2H_2O \rightarrow CO_2 + 2H_2 (emf=0.207v)$$

Sakakibara *et al.* 1994 used Electrochemical and biological reactor for denitrification. Denitrifying microorganisms were immobilized with a sodium alginate gel on a cathode electrode as the anode. Biological reductions of nitrate through the use of H_2 at the cathode and formations of inorganic carbons at the anode wee observed. Concentrations of nitrite and ammonium in effluent were less than lmg-N/L.effluent nitrate concentration decreased with time and components of produced gas were H_2, N_2 and CO_2.

Heterotrophic Denitrification

Hetertrophic biological denitrification is a well-established process for wastewater treatment. This process has not been used in full scale in U.S. however there are several full scale plants being operated in Europe (Dahab*et al.* 1991 and Gayle *et al.* 1989).

In heterotrophic biological denitrification, facultative microorganisms are contacted with the water supply containing nitrates and an added carbon source in an anoxic environment. Under the conditions the bacteria utilize nitrates as a terminal electron acceptor in lieu of molecular oxygen. In the process nitrate is reduced to nitrogen gas, which is harmless. Carbon source is necessary since it supplies the energy required by the microorganisms for respiration and synthesis (Dahab and Woodbury 1998).

The removal of nitrate nitrogen from groundwater by using two rotating biological contactors (RBC) in series was investigated by Bandpi and Elliott 1996. The first RBC reactor was operated under anoxic condition to remove nitrate-nitrogen. A fraction of effluent of the anoxic RBC was fed to a bench scale aerobic RBC to study the degradation of residual organic carbon and oxidation of nitrite nitrogen. Ethanol was used as a carbon source. The first reactor achieved 90% nitrate removal efficiency at a loading rate of 76mg/m^2h. The optimum ethanol to nitrate-nitrogen ratio was found to be 2.35. Effluent removal of residual carbon and re-oxidation of nitrite was also achieved by aerobic biological process. Thus high nitrate removal with negligible residual carbon could be achieved by employing an anoxicdenitrification followed by an aerobic process.

Bandpi and Elliott 1998 investigated a pilot scale rotating biological contactor (RBC) for the removal of nitrate-nitrogen from groundwater using three different carbon sources: methanol, ethanol and acetic acid. Optimum carbon sources to influent nitrate nitrogen ratio were established by varying the influent concentration of carbon sources. The optimum ratio of methanol, ethanol and acetic acid to nitrate-nitrogen ratios were found to be 2.9, 2.35 and 4.3 respectively. The nitrate-N removal efficiency averaged 93, 91 and 98 for methanol, ethanol and acetic acid at a loading rate of 76 mg/m^2h. The results of this study showed that the acetic acid was the most efficient carbon source for removal of nitrate-nitrogen.

Hamzah 1996 used an anoxic static bed column to investigate the influence of type of carbon source and nitrate loading on the nitrate contaminated drinking water. Results showed that the system operated at 0.45kg NO_3-N/m^3. day loading of nitrate to treat waters having a nitrate concentration of 500 mg/L. On astoichiometric basis, ethanol as a substrate for bioremediation gave better results as compared with methanol and acetic acid.
A study was carried out by Christensson 1994 in two anoxic chemostates to see the performance of ethanol and methanol as carbon source for denitrification. An efficient denitrification with ethanol was established in a short time, while denitrification with methanol required a substantial adoption time and never showed the same ability as denitrification with ethanol.

Akunna *et al.* 1993 used batch tests to determine the potentials of digested sludge to reduce nitrate and nitrite in the presence of five different carbon sources; Glucose, Glycerol, Acetic acid, Lactic acid and Methanol. Ammonium accumulation was found in glucose and glycerol media. Dissimilatory reduction to ammonium accounted for up to 50% of reduced nitrate and nitrite. Ammonification was higher than denitrification when glucose and glycerol were present in the media. Nitrate/ Nitrite reduction in acetic and lactic acid media was essentially a denitrification study. Up to 100% reduced nitrate and nitrite in the culture media with these acids were denitrified at average rates between 27 and 23 mg NO_3-N/g MLVSS. Soares *et al.* 1988 conducted denitrification studies on groundwater containing 22.6 mg/L NO_3-N using a down flow sand column with sucrose as the carbon source. Complete nitrate removal was achieved at C:N ratio of 2. Soares *et al.* 1991 studied microbiological denitrification in a sandy matrix by means of laboratory sand columns operated at continuous and pulse feed regimes. Formate was used as the carbon source. The results suggest that pulse application of carbon source is preferable to a continuous supply regime because continuous supply of carbon source leads to almost complete clogging of the column.

Liessens *et al.* 1993 studied heterotrophic denitrification in a fluidized bed reactor for surface water at low temperature. Methanol was used as thereductant with a nitrate removal efficiency of 9.0 Kg NO_3-/m^3 reactor day at 3.5 °C, the system, has shown superior performance compared with conventional fixed bedbiofilm reactors. With an influent concentration of 75 mg/L NO_3- complete nitrate removal was achieved at an empty bed contact time of 15 minutes. Residual methanol was easily removed by the existing downstream drinking water treatment processes.

Various processes have been adapted and used for the denitrification of drinking water. Drinking water denitrification was studied on a membrane bioreactor pilot plant byDelanghe *et al.* 1994. The nitrate removal yields remained constant at 99%. The specificdenitrification activities averaged 0.16 kg N-NO_3. Kg-1 MLSSd-1 (Mixed Liquor Suspended Solid) at 20 °C. and pH 8. The permeation flux was about 0.5 m^3. m^{-2} .d^{-1} throughout the study and did not vary with an increase in the suspended solid concentration. The specific denitrification activity decreased by a factor 1.9 with a temperature decrease of 10°C. The optimal pH was found to be 8.0-8.5. The ethanol was used as the carbon source and its consumption was 1.4 gC.g^{-1}N-NO_3. The pilot plant study showed that the shear stress on the ultra filtration membrane surfaces did not affect the specificdenitrification activity of suspended cultures.

Dahab and Kalagiri 1996 studied a cyclically operated fixed film bio denitrification process to remove nitrates from drinking water. They also investigated the ability of two-stage system to remove nitrate and residual organics from treated water as compared to single stage units. The removal of nitrate was observed to be 98 and 95 percent in single stage and two stage denitrification reactors respectively at hydraulic retention time (HRT) of 1.0 and 0.5 hrs. They also observed that the two stage cyclic operation was more effective in maintaining low nitrite concentration than the single stage reactor.

Combined Ion Exchange Biological Denitrification

Ion exchange is a physical-chemical process where by means of an anion exchange resin nitrate is exchanged for chloride or bicarbonate. The process has a problem of regeneration of the resin, which requires a large excess of salt producing a voluminous brine with high nitrate, sulphate and chloride concentrations (Gauntlett 1975, Deguin 1982 Richard and Leprince 1982 and Hoek *et al.* 1988). Brine disposal is very difficult and requires careful consideration and adds to the operating cost. Biological denitrification is a process by which nitrate is converted to nitrogen gas denitrifying bacteria. A direct contact is created between ground water, which is generally free of microorganism and bacteria. In the case of heterotrophicdenitrification, a carbon source has to be added to the ground water. Both cause a serious risk of the bacteriological contamination of the ground water, and extensive post treatment is necessary for the removal of microorganisms and organic substrate (Sorg 1979, Barlog 1980, Richard and Leprince 1982 and Sontheimer *et al.* 1982). Also the production of nitrite, an intermediate product of denitrification is a serious risk.

Therefore by combining ion exchange and biological denitrification process into one process, most problems connected with the separate techniques can be avoided (Hoek 1985, Hoek and Klapwijk 1985,1986). The basic concept of this process is to use sludge blanket reactor (SBR) to biologically denitrify the spentregenerant brine, which is then filtered, compensated with NaCl and reused. Bench scale test suggested that the salt consumption could be reduced by 50 percent and the salt discharge by 90% (Liu and Clifford 1996).

Hoek and Klapwijk 1987 described a combined ion- exchange (IX) and biological denitrification process in which nitrate is removed from ground water by ion exchange and for the regeneration of nitrate loaded resin a denitrification reactor is used. In contrast with traditional denitrification process there is no direct contact between ground water and denitrifying bacteria. Also brine production and regeneration salt requirements are minimal as compared with conventional regeneration of ion exchange resins.Ion exchange resin Duolite A 165 was used for the removal of nitrate and an up flow sludge blanket reactor (USBR) was used for theregenerant denitrification which was able to denitrify highly saline solution containing 25-30 g/L $NaHCO_3$ and 10-15g NaCl/L.The process is suitable for treating water with high sulphate concentrations. The waste brine produced was 13- 20% of the amount produced in ion exchange columns. A sand filter was recommended between the USB denitrification reactor and the ion exchange column to remove the suspended solids from theregenerant before they reached the resin along with resin disinfection with per acetic added during disinfection.

Hoek *et al.* 1988 evaluated the combined process using ground water with sulphate -selective and nitrate selective resins. Regeneration with $NaHCO_3$ was possible but the regeneration efficiency was very low. Regeneration salt requirement and brine production was minimized by using closed circuit regenerator using biological denitrification reactor to remove nitrate from the regenerant. The combined process resulted in about 95% reduction of waste brine in comparison to the conventional ion exchange.

A bench scale ion exchange process with batch biological denitrification of the spent regenerant brine in a sequencing batch reactor (SBR) was developed by Clifford and Liu 1993. It consisted of chloride ion exchange and 0.5N (3%) NaCl regeneration followed by batch denitrification and reuse of the spent brine. Complete (>99%) denitrification of spent 0.5 NaCl brine was achieved in 20 hours using a non optimum methanol to nitrate- nitrogen ratio® of 2.2. At the optimum R value of 2.7, the time for greater than 95 percentdenitrification was 8 hours. The research indicated that the combination procedure resulted in 50 percent reduction of regenerant consumption and 90 percent reduction in the mass of waste salt discharged. Compared with USBR, the SBR ad several advantages that were pertinent to small systems: simplicity, flexibility of operation, stability of effluent quality and built in equalization. Although the higher rate USBR requires less reactor volume, when equalization and brine were taken into account, the space occupied by the process was not much different.

Fonseca *et al.* 2000 developed a novel ion exchange membrane bioreactor able to prevent secondary pollution of biologically treated drinking water and specifically tested for water denitrification. This system combines ion selective membrane dialysis and biological conversion. The ion selective membrane facilitate the extraction of pollutant from the water to the biological compartment, hinders the transfer of organic and inorganic nutrients and confines the microbial culture involved in the conversion process within the bioreactor. In the study hereby a system was used to investigate the removal of nitrate from a synthetic groundwater containing 50 mg/L of nitrate-N. The treated water obtained was free of inorganic nutrients and ethanol, the carbon source was selected for the biological process, and the surface denitrification rate achieved was 7g-N $m^{-2}day^{-1}$. This system proved to be effective in producing a treated water effluent that does not require the extensive post treatment associated with conventional biological treatment.

Vegetative Denitrification

Vegetation can prevent herbicides, pesticides and fertilizers from contaminating surface and ground water. Tree buffers can protect ground water from different contaminants at the contaminant site. At an agricultural test site on a Iowa farm, a 3-year-old popular crop planted by universityof Iowa research team reduced NO_3-N levels in leachate from fertilized fields. The trees were planted between the corn field and the stream along the stream bank. The average nitrate content of ground water leaving the corn field was 150 mg/L, which is more than 300 percent greater than EPA's permissible limit of 45 mg/L for nitrate in drinking water. Level was 8mg/L in the ground water between the field and the stream. Poplar trees were chosen because the trees take up soluble inorganic nitrogen through their roots, converting them into protein and nitrogen gas.

The occurrence of saturated and non-saturated soils in Riparian buffer strips provides ideal condition for denitrification. The rate of denitrification depends on the amount of organic carbon, the degree of soil saturation, the activity of denitrificant bacteria, the temperature and pH of the system (Engler and Patrick 1974, Reddy *et al.*

1978 and Schippers *et al.* 1993). Todd *et al.* 1983 observed that a forested buffer removed 82% of water borne nitrogen from agricultural runoff. Fennessy and Cronk 1997 reported that the denitrification is the predominant process for the nitrate removal in riparian zones. Vegetation in Riparian buffers serves as a source of carbon for microbial denitrification. They also reported that sedimentation; soil adsorption and microbial transformation are mechanisms by which nitrogen, phosphorous and solids are removed from agricultural runoff. Nitrate removal is favoured in forested areas with subsurface flow and is less in grassed areas with surface flow.

Brown 1971, studied removal of nitrate from subsurface agricultural drainage using algal system consisting of algae, harvesting and disposal as a possible means of removing nitrate. The findingsshowed that about 15-90% of the nitrate was assimilated by shallow algal culture.

Summary and Conclusions

Studies on the development of processes for the removal of nitrates from drinking water are either based on physico-chemical or biological denitrification system. Merits and demerits of a process are to be considered for finding its potential for full-scale application. In ion exchange process the water is passed through beds of ion-exchange resin beads, which absorbs nitrate in exchange for another anion. Counter flow regeneration is normally used for nitrate removal by ion exchange process. In this process the spentregenerant is disposed to agricultural field. Nitrate selective ion exchange resins are now available. The high nitrate capacities of these membranes prevent the displacement of nitrate by sulphate and also lower cost for regenerant chemical and waste disposal.

Reverse osmosis results in the production of treated water stream and waste disposal concentrated waste stream. The waste volumes in this case are larger as compared with ion exchange and operating costs are also higher.

Electrodialysis treats the water by selective removal of nitrate ions through a semi permeable membrane. The removal efficiency for nitrate is almost equal to that of reverse osmosis. Nitrate selective membranes are now available which makes the process more effective. In this process however pre treatment of water is required. The wastes are also very concentrated and create disposal problems.

Biological denitrification process occurs naturally in the presence of sufficient carbon source and anoxic conditions. The method may be used for treating drinking water by avoiding bacterial contamination of the treated water. Both autotrophic and heterotrophic processes have been used for denitrification. However heterotrophic process is faster than autotrophic. Autotrophic denitrification increases the sulfate concentration in water and operated at low carbon level results in nitrite production. These reasons impair the efficiency of the process. With fluidized sand bed excess biomass is removed without shutting down the process. The waste volumes are small and due to low level of dissolved solids the waste can be disposed to agricultural land. The process of denitrification using ion exchange for nitrate removal from drinking water and treatment ofregenerant by biological denitrification shows that the process may find more adaptation in future. The method of converting nitrate into insoluble salt of some metal ion also has potential for future research. Some preliminary studies have been conducted on denitrification using zero valent iron. This process also appears to be a potential process for future research. Nature provides self-purificatiòn of water. The roots of plants are capable of absorbing nitrate through bacterial reaction and thereby reducing nitrate from water. Several studies have been conducted on the removal of nitrate by allowing the water to flow through the subsurface under plantation. This process has high potential for large-scale treatment of drinking water.

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Nutritional Status of Three Tribal Populations of Jharkhand State in Relation to Environmental Conditions

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Abstract

The present study was carried out to find out the nutritional status of three tribal populations- Santhal, Ho and Bhumij, inhabiting in different environmental conditions i.e. industrialized and dense forested regions of Jharkhand State. The Population inhabiting in industrialized region have least calorific intake (Santhal- 1967. 25 K.Cal: Ho- 2003.20 K.Cal. and Bhumij-1942. 11 K.Cal) than the population of dense forested region (2553. 30 K.Cal. Ho-2426.86 K.Cal. and Bhumij 2008.18 K.Cal.). No doubt, industrialization provides better opportunities to earn money but its major portion is wasted on the elevation of so called standard of living and the Theka (Wine shop) besides, immigration among tribal also resulted in changed nutritional as well as calorific intake. The diet of these tribal populations is inadequate as per Indian standards. The deficiency in diet is both qualitative and quantitative, as a result population suffers from a large number of nutritional disorders like anemia, night blindness, bigot spot etc. on the basis of the study it is suggested that a short term training programme should be launched at Panchayat level to provide knowledge of balanced diet or essential nutrients of the food as per requirements of Men, Women and children.

Key Words : *Tribal population, Nutritional status, Environmental condition, Jharkhand.*

Introduction

Information regarding nutritional status of tribal groups is still very scanty but they are essential in formulating nutritional programme. In this direction, Anthropological Survey of India (ASI) started in 1948 and the Systematic investigation on the dietaries, nutrition and adequacy of foods. The study conducted bySen Gupta in Abor Hills of Arunanchal Pradesh on different tribal population revealed that they suffer from malnutrition. Jain and De 1964 has studied the plant foods among tribal of West Bengal. Gupta 1974 has pointed out that the low consumption of cereals by Birhors and Korwas in compensated by the higher consumption of wild roots and tubers. Pandey and Sharma 1998 have reported a variety of disease like anaemia, Night blindness, endemic goiter, gingivitis, skin dry and rough, angularsomatitis etc. due to malnutrition in the tribes of Purnia district (Bihar).

Malnutrition has emerged as a major health problem of much population (Rao *et al.* 1986, Basu *et al.* 1989, Sharma 1992 and Pandey 1999). A malnourished body is the victim of a number of deficiency diseases. Eating habits and diet pattern have changed considerably over rather a short period of about half a century and so physical activity pattern. The diet and disease relationship appears relevant to coronary artery diseases, hypertension, diabetes mellitus and some form of cancer (Wasir 1995). Nothing is known about the nutritional status of the tribal population in newly created Jharkhand state. Therefore the present work was undertaken which deals with the food, nutrients and calorific intake of three tribal populations (Santhal, Ho and Bhumij) of Industrialized and dense forested regions.

Study Area

The present study was conducted on East Singhbhum (Jamshedpur), which is one of the most industrialized districts of Jharkhand state having two diametrically opposite environmental conditions of industrialized and densely forested regions of Potka and Musabani blocks respectively. It was taken into consideration after assimilating three tribal populations i.e. Santhal, Ho and Bhumij.

Materials and Methods

Data on food, food habits and food consumption pattern were collected with the help of questionnaires and by personal interview with the trials inhabiting industrialized and dense forested regions by using recalls methods. The mean daily food intake was analysed with respect to different groups viz. Cereals, pulsed, green leafy vegetables, other vegetables, roots, tubers, milk products, fats, oils and beverages etc. The respondents were asked to estimate the amount of different food consumed in possible units. The main nutrient intake was computed using food table as suggested byGopalan *et al.* 1981 with respect to carbohydrates, proteins and fats.

Results and Discussion

Generally, the populations of this area use to take two meals in a day - morning and evening. But children take food three to four times daily. Majority of the studied populations are known non-vegetarian. From the Table-1 it is quiet clear that rice consumption is highest among tribal of dense forested regions as well as the consumption of roots and tubers, green leafy vegetables, fruits, fats and oils is also more than the populations of industrialized region. The tribal populations of industrialized region have higher consumption of wheat, meat, fish and eggs. The intake of pulsed and beverages pattern was almost equal in tribal of both the regions. The variation in food intake among them is due to easy availability and cost affectivity of the food. The diet of majority of the tribal groups of the present study is inadequate as per the Indian standards. The deficiencies are both qualitative and quantitative. The intake of pulses is marginal and that of milk is negligible.

It is clear from the Table-2 and Figure-I that tribal groups are ofpotka study cluster have least calorific intake in comparison to tribal groups of densely forested region of Musabani cluster. Despite the fact that tribal groups living in the industrialized region ET more money but major portion of the earned money goes toTheka (wine shop). Further their living condition is higher in comparison to those living in densely forested region. Likewise, population living in the dense forested region still gets some forest products like fruits, flowers, roots and tubers to meet their food intake. Further, they are addicted to Handia (rice beer), which is prepared from fermented boiled rice. Rice beer is the rich source of minerals.

There is in fact a direct relation between calorie intakes, work out and body weight. If an adequate supply of calorie is not available, people become lethargic and sluggish, movements become slow, infrequent and interrupted by long pauses and any continuous efforts is avoided as far as possible. This condition is largely a result of the inadequacy in food consumption. During fieldwork of the present investigation, it was realized that most of the tribal population is weak, lethargic and sluggish, particularly Bhumij, due to inadequacy of energy intake. It is to be noted that the tribal population inhabiting forested regions are landless or having a very little land and have no irrigation facilities. Due to lack of irrigation facilities, the crop yield is very poor, which is sufficient only for a few months. For rest of the period they have to depend on other sources of livelihood. Further, increasing rate of deforestation is one of the major causes of scarcity of forest products used by these tribal as food. As a result they have become victim of malnutrition.

Table -1: Mean daily food intake in grams by Tribal population of industrialized and dense forested regions of Jharkhand State

Food Type	Industrialized Regions			Densely Forested Regions		
	Santhal	HO	Bhumij	Santhal	HO	Bhumij
Rice	158.33	166.67	155.00	180.00	183.33	161.67
Wheat	55.00	50.00	46.67	50.00	53.33	41.67
Maize	36.67	36.67	36.67	46.67	46.67	33.33
Coarse Grains	71.67	80.00	83.33	73.33	73.33	80.00
Pulses	30.00	26.67	36.67	31.67	33.33	20.22
Leafy Vegetables	70.00	70.00	70.00	133.33	133.33	113.33
Other Vegetables	43.33	40.00	40.00	63.33	63.33	30..
Roots and Tubers	86.67	73.00	80.00	133.33	133.33	162.67
Fruits	26.67	26.67	20.00	66.67	66.67	46.67
Milk and Milk Products	-	-	-	-	-	-
Meat, Fish and Egg	103.33	93.33	93.33	90.00	96.67	80.67
Fats and Oils	25.00	30.00	25.00	33.67	40.00	25.00
Beverages	146.67	150.00	136.67	150.00	146.67	180.00

Migration is associated with nutrition as well as other changes in ling style that may, in turn affect health Friis *et al.* 1998). In the present investigation, one of the major factors considered to influence nutrient intake is the migration. The non migrants (forest dwellers) have better intake pattern of energy in comparison to industrialized region where tribal populations have migrated from dig gerent corners in search of jobs. Hanna and Fitzgerald 1993 have found alteration in dietary pattern among three migrant Samoan communities as a result of acculturation. The present investigation lends support to them. People suffering from malnutrition may fall easy prey to incurrent ailments. In addition to diseases, directly attributable to malnutrition, it is now known that it aggravates the clinical course of many infectious diseases. Thus directly or indirectly it accounts for ill health. On the whole it can be concluded that tribal populations of these industrialized and dense forested regions need special attention for providing daily dietary allowance. It is suggested that a short-term training programme should be launched at panchayat level to provided knowledge of balanced diet for essential nutrient constituents of the food as per requirements of children, men and women.

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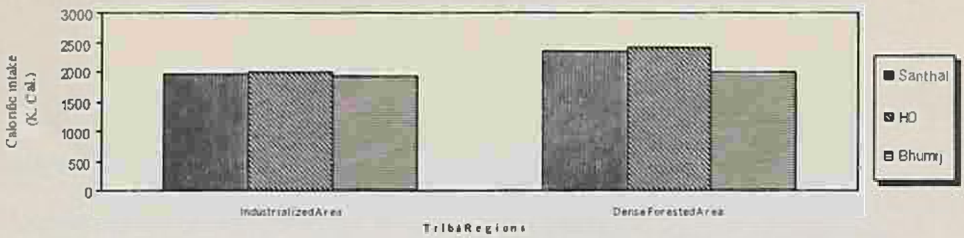
Table-2: Mean daily nutrients intake and calorific value of the tribal population of industrialized and dense forested regions of harkhand state (India)

Region	Tribe	Food Items	Rice	Wheat	Maize	Coarse Gram	Pulses	Leafy Vegetables	Other Vegetables	Roots^ Tubers	Fruits	Milk & Milk Product	Meat, Fish & Egg	Fats & Oils	Beverages	Total
Industrialized Region	Santhal	Carb.	123.44	57.26	36.41	51.29	17.54	4.85	5.32	22.69	4.61	-	5.63	-	10.20	337.29
		Prot.	11.87	9.99	6.11	5.83	7.43	2.51	1.44	2.56	0.30		14.79	-	2.23	65.06
		Fat.	1.58	1.41	1.41	1.28	0.26	0.55	0.15	0.11	0.11	-	4.96	25.00	1.52	38.91
		K.Cal.	547.83	281.83	281.33	238.64	102.24	34.30	28.38	101.75	20.59	-	126.16	225.00	72.93	1967.25
	HO	Carb.	127.83	52.05	52.05	57.28	15.59	4.85	4.91	19.20	4.61	-	5.11	-	10.43	338.27
		Prot.	12.50	9.08	9.08	6.46	6.60	2.51	1.33	2.16	0.30	-	13.36	-	2.28	62.69
		Fat.	1.67	1.28	1.28	1.40	0.24	0.55	0.14	0.09	0.11	-	4.49	30.00	1.55	43.50
		K.Cal.	576.67	255.75	255.75	266.07	90.88	34.30	26.20	86.09	20.59	-	113.97	270.00	74.58	2003.20
	Bhumij	Carb.	118.89	48.58	48.58	59.65	21.43	4.85	4.91	20.94	3.46	-	5.21	-	9.50	333.20
		Prot.	11.63	8.48	8.48	6.76	90.8	2.51	1.33	2.36	0.22	-	13.25	-	2.07	63.80
		Fat.	1.55	1.20	1.20	1.48	0.32	0.55	0.14	0.10	0.08	-	4.48	25.00	1.41	38.29
		K.Cal.	534.30	238.70	238.70	277.37	124.96	34.30	26.20	93.92	15.44	-	113.87	225.00	67.95	1942.11
Dense Forested Region	Santhal	Carb.	138.06	52.05	52.05	52.48	27.77	9.24	7.77	34.91	11.52	-	4.93	-	10.43	395.50
		Prot.	13.50	9.08	9.08	5.97	11.77	4.77	1.90	3.93	0.75	-	12.99	-	2.28	74.71
		Fat.	1.80	1.28	1.28	1.31	0.42	1.04	0.22	0.16	0.27		4.28	36.67	1.55	51.52
		K.Cal.	622.80	255.75	255.75	244.20	161.88	65.33	41.48	156.53	51.48	-	109.87	330.00	74.58	2353.30
	HO	Carb.	140.62	55.52	55.52	52.18	29.23	9.24	7.77	34.91	11.52		5.39	-	10.16	403.18
		Prot.	13.75	9.68	9.68	6.97	12.38	4.77	2.11	3.93	0.75	-	13.72	-	2.27	77.10
		Fat.	1.83	1.36	1.36	1.31	0.44	1.04	0.22	0.16	0.27	-	4.65	40.00	1.54	55.34
		K.Cal.	634.33	272.80	272.80	244.20	170.40	65.33	41.48	156.53	51.48	-	117.94	360.00	72.97	2426.86
	Bhumij	Carb.	124.00	43.38	43.38	57.29	17.54	7.86	3.68	42.32	8.06		4.71	-	8.97	350.91
		Prot.	12.13	7.57	7.57	6.43	7.43	4.06	1.00	4.77	0.52	-	12.60	-	2.06	64.62
		Fat.	1.62	1.07	1.07	1.38	0.27	0.89	0.11	0.19	0.19	-	4.10	25.00	1.39	38.01
		K.Cal.	55.37	213.13	213.13	265.88	102.24	55.53	19.65	189.99	36.04	-	105.82	225.00	64.72	2008.18

Figure-1: Calorific intake of three tribal populations of Jharkhand State (India)



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Water Quality Management: Strategies for Conservation of Bhopal Waters

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Abstract

The city of Bhopal is crowned with lakes and reservoirs, which are major sources of potable water, recreational activities and aquaculture. These reservoirs are under great environmental stress due to agricultural run offs, human encroachments, siltation and growth of aquatic needs. In order to maintain Upper lake as a healthy water- resource for drinking purposes, lower lake as a recreational ground for boating, water games, tourism and surface transport and Shahpura reservoir as a pisciculture station, an attempt has been made to formulate certain measures, that can cure the already spoilt lakes and check the water sheds from getting eutrophicated further.

Key words: *Lake, Conservation, Restoration, Bhopal waters, Eutrophication.*

Introduction

Man made eutrophication of fresh water emerged in sixties as one of the most relevant causes of water quality deterioration. Excessive enrichment of inland waters, coupled with dramatic urbanization, has led to formidable algal blooms in many parts of the world. These algal blooms are, not only believed to impair the over all quality of water but, also known to produce toxins, which when accumulate in fish, can along with food chain, be transferred to man.

Since 1980's Italy bas progressively introduced legislation limiting phosphate content from 26% (1982) to just 4% (1988) in waters (Water and Environment International 1992). In South Sweden, the agricultural areas especially of Lake Rings fan ere given so much attention that in 1985, Government restricted the use of fertilizers, storage and distribution of manure and operation of sewage treatment systems (For berg 1987). Countries like USA, Sweden and Israel have taken several concrete measures to restore the already etrophied lakes but unfortunately very little information are available on suchprogrammes in India and that too on Bhopal waters. In the present communication, a few restoration measures have been explored after thoroughly consulting a number of successful examples from abroad and from the data compiled in the laboratory during last ten years. The purpose is directed to plough right through the problem practically rather than giving mere deductions.

Exploration Zone

Bhopal, the capital of Madhya Pradesh, is situated amidstVindyachal ranges at an altitude of495 m above MSL. The city has a pride possession of lakes and reservoirs. Upper lake has been the lone source of drinking water to 12 lac population of the city. The reservoir is said to have been a part of much larger sheet of water that existed in the 11^{th} century. The present stretch of 32 kms2 has been resulted by impounding a seasonal rivuletKolans. The lake is dammed at two places, the eastern end near Kamla Park and the western bank, which is surrounded by agricultural fields. Forested slopes of Shamla hills adorn the southern fringe of the lake, contributing raw sewage and agricultural runoffs. During festivals, nearly 2000 idols are immersed every year that adds to 75 tons of sill into lake. Consequently the sinuosity of lake has receded over the years. Lower lake, located in a densely populated area of the town, was created in 1749 by constructing an earthen dam across the Upper Lake. Human interventions like bathing, washing of clothes and dumping of garbage have impinged radical changes in the composition of lake water. Cultivation of lotus with a primary aim to add beauty has been causing reduction in the depth of the lake. Further, the southern arm of this lake is completely occupied by huge vegetation comprising *Hydrilla, Lemna and Azolla in the name of Jal Upvan.*

Shahpura lake is an elliptical receptacle situated in thickly populated southern part of Bhopal. Created due to stone quarrying activity adjacent to village Shahpura, the lake was filled up by storm water and developed into the present form. Due to inadequate catchment area, most of the impounded water contains sewage inflow, which imparts colour, odour and taste to it. Despite immense strain experienced due to extrinsic as well as intrinsic factors, the lake is serving as a pisciculture station for the Department of Fisheries, Got. Of M.P. To save the water shed from extinction, its management has been taken over by E.P.C.O.

Thus very little attention has so far been given to these beautiful reservoirs, which offer drinking water supply and wonderful opportunities for water sports, tourism and surface transport.

Recommendations

In order to save Bhopal waters from hypereutrophy as well as propagation of obnoxious algal species, it is necessary to minimize harmful fluxes from land to water. Diversion of sewage is likely to be one of the most effective ways of checking eutrophication as nutrients input is largely derived from this source (Edmondson 1972 and Bjork 1972). In U.S.A., restoration of Lks has been successful in Lake Washington and Shangava Lake using waste water (sewage) treatment (Goldman and Horne 1983). In Sweden, similar efforts were made by lowering detergents, phosphorus contents and nutrient load.

Studies conducted by Garg and Garg 1997, 1998, 1999, 2000 and 2001 on Bhoal waters under microcosmic conditions, also revealed that control of Phosphorus had a check on propagation of algal growth. In controlled microcosm, when no nutrient was added, observed that algae found it arduous to multiply obviously due to deficiency of nutrients mainly phosphorus. In treated microcosms, they flourished well, till the time; the added nutrients already present in natural waters were available. In the later days, very low abundance was determined in microcosms. Thus in order to check the entry of nutrients, in upper lake, the sewage should be immediately diverted to Biogas based sewage treatment in the northern and southern side of the lake (long pipes for sewage transport are not recommended as they are undesirable and uneconomical). In lower lake, washer men colony should be shifted away from the bank to prevent detergent in flow, which accrues hardness and phosphorus inputs to water. Shahpura Lake is being polluted by *Panchsheel Nullah.* The suspended nitrates and phosphates of the Nullah should be prevented by putting a solid masonry barrier across it so as to head up the water and then the water should be taken into sever line by passing through a grit chamber.

Some scientists believe that nitrogen control is needed to maximize the benefits of phosphorus reduction in fresh waters. Phosphorus stimulates algal growth, which, in turn, consumes nitrogen. When phosphorus is removed, the algal growth stops and the unconsumed nitrogen is left as such where it is available to create even larger blooms. To overcome this situation, use of wetlands is expedient, which serve as a means of reducing the nutrient load to adjacent bodies of water (Kadlec 1987 and Kusler *et al.* 1994). It is a combination of saturated soil, plants and Microorganisms that provide aerobic and anaerobic conditions and encourages nutrient removal (especially nitrogen) from the overlying flood water (Johnston 1991). These buffer zones act as sink-preventing nitrate built up (nitrification) and in turn recycle it to nitrogen gas (denitrification) by the same mechanism. Thus, in order to remove excessive nitrogen from water, wetlands should be created in the vicinity of Bhopal lakes.

Encroachments on the water margins of lakes should be taken off and dumping grounds oncatchment areas should be completely banished. Human and animal intervention should be minimized in the fringe areas by making fences and a live barrier in the form of a highway.

Introduction of grass carp *Ctenopharyngodon Idella* in 90 water systems of Sweden proved quite successful. Judicious stocking of selected fish types like *Ctenopharyngodon idella* (grass carp), *Hypophthalmicthys molttrix* (Silver Carp), *Cyprinis carpio* (Common Carp) may effectively be used as biological agents to control plankton in the ecosystem of lakes (Bhatiya *et al.* 1973 and Juanico *et al.* 1994). This indirectly curbs the growing eutrohy if proper type is selected. If planktiferous fish are massive in number, they consume zooplankton consumer fish varieties are bred in Shahpura Lake or selective zooplankton community is allowed to flourish, lake water becomes comparatively cleaner. The task already taken up by fisheries department, Govt. ofMdhya Pradesh is praiseworthy, still better varieties are to be bred and techniques improved. Besides, aquatic macrophytes are also reported to control eutrophication as they shade algal growth and assimilate nutrients released from both external and internal sources. This situation of limiting nutrients by macrophytes in open lakes has been proposed by Goel *et al.* 1985 Petr 1987 and Sen *et al.* 1992. Two species of Chlorophyceae viz Chlorella and Scendesmus, are also found to reduce nitrogen and phosphorus load from sewage water (Tam and Wong 1989) and hence can be proved effective in preventing eutrophication. In upper and lower lakes, useful plants like lotus and trapa should be sown to check the entry of nutrients, which would also serve as an additional source of revenue.

The lake waters can also be provided with copper treatment, as it is economical as well as effective to kill the floating masses. The chemical is non-toxic to fish and zooplankton and is rapidly lost to sediments. Besides, nitrate can also be reduced by carbon additions as performed experimentally in aquifer microcosms by Obenhuber and Lawrence 1991.

Bubbling and hypolimnetic aeration removes oxygen deficiency (Forsberg 1987). When nutrients diversion is not possible, excess nutrients and low oxygen in bottom waters may be altered by physical or chemical means as flushing and aeration.Trees should be planted around the three water formations to check soil erosion, siltation and flooding. Deweeding campaign should be launched for manual removal of weeds, which can be used later as compost. This step is especially needed in Shahpura lake whose 75 % of lake area is covered by weeds. In upper lake de-silting should be done at least at the shores especially from where the water enters the lake and turns towards Bhadbhada while in Shahpura reservoir, drain entering it should be cemented at both banks, up to the stream of barrier.

Process of sediments removal should be started early and huge amount of organic matter that comes out can be used for agricultural purposes in the form of fertilizers. Sign boards with slogans depicting the importance and cleanliness of water should be put all around to create / awareness. A central lake authority should be set up for periodical monitoring of lakes and implementation of schemes for lake restoration. Economic development should be promoted by bringing back aesthetic beauty and vitality.

In this direction, ministry of environment and forest, Govt. of India, has drafted a scheme for conservation and management of twin lakes of Bhopal (the upper and the lower) on the guidelines laid down at Ramsar Convention held in Egypt and a Grant worth Rs. 335 crores has been sanctioned by O.E.C.F. Japan. The project has taken off with an aim to deepen and widen the spill channels, restoration of island, installation of fountains and improvement in the quality of water. However, to ensure the availability of potable water in increased quantity and satisfactory quality from upper lake and to preserve the aesthetics of lower lake ofShahpura reservoir, it is of vital importance to curb the entry of agricultural run offs, divert the inlets of sewage of impose a ban on anthropogenic activities in and around the lake basin

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Resource Depletion and its Environmental Management in Kiarda Dun, Himachal, Himalaya, India

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Abstract

In the present study resource depletion and environmental management of the Kiarda Dun have been highlighted to work out the resource management in this region which is being degraded by overgrazing, deforestation, over lopping, unscientific blasting, over mining over ploughing, Such activities have activated the natural 'geo- catastrophic processes like land sliding, mud flowing, soil creeping, gulling and slumping and are responsible for depletion of resources in the Kiardadun. Further, unplanned extension and non-coordination of various development agencies, along with a poor ecological perception has caused the evolution of various environmental problems in the Kiardadun.

Kew Words: *Kiarda dun, Geo-identity, Environmental Management*

Geo-identity

The Kiarda dun is a unique geomorphic unit in Himachal Himalaya in the north and the siwalik in the south west and transversely boarded by the river Yamuna in southeast and Giri River makes its eastern boundary. The valley lies between 30° 22' 50" to 30° 36' 20" latitude and 77° 16' 25" to 77° 42' longitude, with an area of 450 sq. km, ranging between 300 and 1400 above msl. Yamuna River makes its southeastern boundary by dividing it from Dehradun. On the west it is up to the water divided between Kaggar and Yamuna system. Length from East to West is 40 km and width from North to South is 25 kms.

Resource Depletion

Kiarda Dun is an elongated structural valley between thesiwalik and the lesser Himalayan ranges. The M.B.F. occurring between outer and lesser Himalaya, this is an unstable and fragile zone, and if such a sensitive area is subjected to unplanned or indiscriminate biotic pressure, it becomes highly vulnerable to erosion, mass wasting and landslides.

The undulating topography of the area have became rugged due to rapid erosion by crossing streams, originating in the lesser Himalaya and draining antecedently through the outer Himalaya. Human activities like road construction, quarrying, over lopping, over grazing and overploughing are other important factors responsible for the degradation of environment in the Kiarda Dun. Unplanned extension and non- coordination of various development agencies along with a poor ecological perception, has caused various environmental problems in the Kiarda Dun.

Land Resource Depletion

Generally, land depletion in the study area has been recorded in the form of soil erosion, land sliding, rock slip, soil creeping, mass wasting, severe infiltration and gulling which is due to ecological imbalances caused by deforestation, over lopping, over grazing, unscientific quarrying, mining, road construction, over flowing and over ploughing.

The intensity of landform depletion generally depends upon the nature of topography, type and mode of drainage, nature of gradient and intensity of rainfall. Erosion is associated with elevated elements of the relief of forest steeper, especially the area situated along the sides of the right bank of the rivers. The present day erosion converting lands in to truncated and scoured land. At the same time the drainage of eroded area is increasing which is resulting in the washing down of grounds. The alluvial fans and talus cones, purely valuable land are silting up river channels, thereby swamping the adjoining land. Erosion is attained by swamping of the flood plains. Erosion destroys the rich and relatively good soil horizons. The soil productive capacity goes down until the soil is completely destroyed and the soil forming material crops out.

In the study area, erosion is more pronounced on the southern slopes and convex slopes as compared to the northern and concave slopes. The most important factor causing destruction of the land is road construction. These constructions are very badly executed and lead to destabilization of colossal amount of debris. The road, building, and canal construction have greatly helped to promote erosion by providing tools to the run off water of the basin. It is estimated that the construction of just one –kilometer long road requires removal of about 40000 to 80000 m^3 of debris (Valdiya 1985). The lesser Himalayan belt through its entire length is quite rich in limestone and dolomite. This had led to the opening of numerous small pits for the excavation of the raw material leading to the landforms degradation and its related problems.

Forest Resource Depletion

Forests offer a great service to man. They provide products for human use and indirectly safeguard man's environment. The natural resources are highly beneficial. If they are not managed properly, face serious injuries. The biotic factors include over grazing, soil erosion, over lopping, damage by insects and wild animals. Overgrazing by animals is heavy all over the study area but heaviest in the outcrop of the forest. Over lopping is another important source of injury to the forest.

Soil Resource Depletion

The increasing pressure on the land disturbs the natural balance between soil formation and soil conservation on the one hand and soil erosion on the other hand. The Kiarda Dun valley is constantly subjected to severe soil erosion due to deforestation. Quarrying, flood water logging run off.Land sliding and soil creeping leads to the depletion of soil, water, forest, mineral and climatic resources. The study area has maximum run off during rainy season causing severs erosion. The practice of deforestation prevails in the forest villages of the valley. Towards lesser Himalayan and shiwalik slopes deforestation also occurs on account of flow of rain water which washes out the decomposed layers of silts, pebble and in turn weakens the roots due to which tree falls down. Over grazing is responsible for the causation of soil erosion in the study area. The cultivated land adjacent to the forest roads is generally decomposed by the movement of animals and this decomposed layer of soil is badly washed out during rains. Quarrying is another most prominent geo-factor of soil erosion.

Water Resource Depletion

In the Kiarda Dun valley the rain fall is very heavy but most of it is wasted away by in the form of surface run-off. The hill tracts are deficient in agricultural water, the delluvial terraces possess hardly sufficient agricultural water but dun aquifer zone has sufficient agricultural water. The available water is wasted by high gradient, heavy surface run off, infiltration through structurally weak zones, misuse and obstruction of spring by human being. In the present study environmental management has been diagnosed by intensive field studies and ther the study pin points their ecological treatments. The resource management schemes have also been worked out after applying suitable techniques. Before implementing the environmental management schemes it is needed to work out the environmental management strategies and policies.

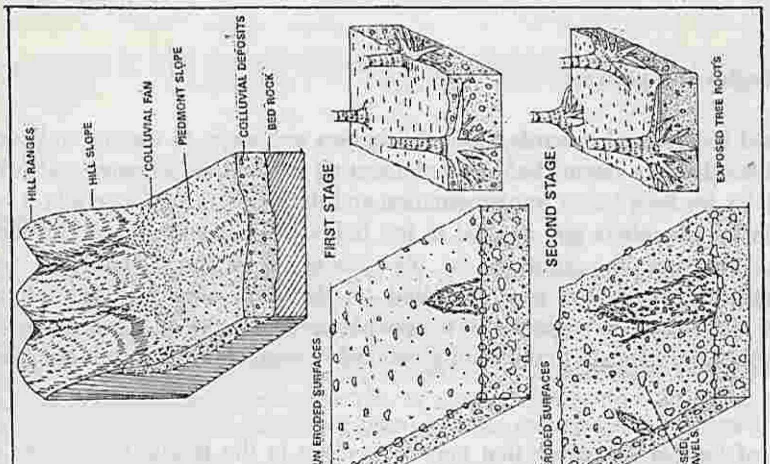

Figure-1 Location Map of Kiarda Dun

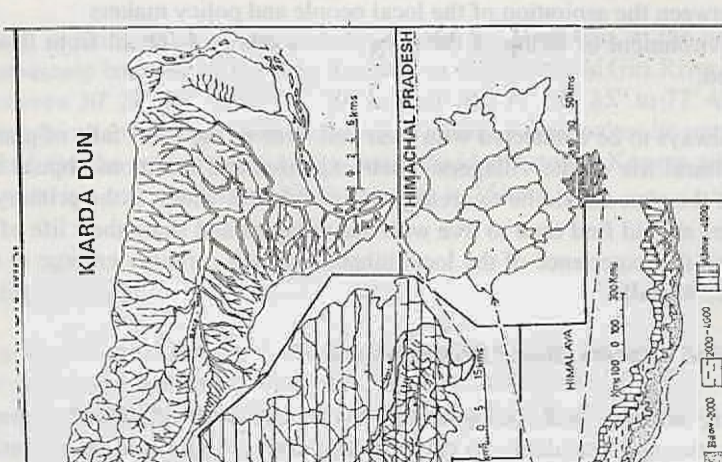

Figure-2: Process of soil erosion on pedmont slope

Environmental Management

Environmental management is a dynamic concept of co- partnership between man and nature. It demands strict management of soil, forest and water to ensure optimum economic value and continuity of their supply to the over increasing public demands. Environmental management normally involves four major phases. Problems identification, policy formation, projects planning, policy implementation and policy evaluation.

Environmental Resource Strategies and policies

Basically, the government should be oriented towards rational schemes and steps to restore and conserve the environmental resources to balance the ecosystems before implementing in-testified schemes and reforms. It is needed to formulate certain policies for their better implementation and their follow up. Generally it is observed that the schemes are prepared in the chambers and applied in the fields without taking into consideration the landform systems and the socio-economic conditions of the concerned region. Therefore, policies for implementing resource programmes should also be formulated on the field after inviting the views and experiences of the inhabitants of the region. Participation of the people in the process of involving and evolution of suitable options will ensure minimum damage to the ecology and environment, as it would increase the social acceptability of the plans.

Considering the serious nature of the consequences that may take place in the fragile Himalayan ecosystem through indiscriminate human intervention and multipurpose land use strategies (Naven.Z 1979) should be adopted for securing highest overall benefits, which will be flexible enough to leave options for the future instead of present single option approach

The main contradictions of the hill development are

1- Lack of co-ordination between the aspiration of the local people and policy makers
2- The standard and the environment of living of the planners are totally different from those for whom the plans are implemented.

The aspirations of the locals are always to be connected with their soil. One of the short falls of plans until now, has been the neglect of socio cultural life of the villagers. Their expenses and traditions shpuld be given top priority. The ultimate objective of the plan should be to create self-confidence, which is the primary need of hill development. For this, the planners should find time to live with the villagers and share their life of struggle. By combining experts' knowledge and the experience of the local inhabitants will certainly emerge in to a practical strategy for solving the problem of the hills.

Optimum Resource Utilization and Conservational Programmers

The Kiarda Dun has been suffering due to several ecological problems associated with the development process. The unplanned development activities and a tendency to exploitmaximum resources of the region at minimum cost & time have caused grave ecological imbalance with in a short duration of four decades. Deforestation, soil erosion, soil fertility decline, soil, water and air pollution are the most notable ecological menace confronting the inhabitants of Kiarda Dun. In order to overcome these issues, preventive as well as restorative measures should be adopted for the proper utilization, preservation and improvement of natural environment. A rational scientific approach towards non – society environment has been considered for the optimum utilization of environment in an integrated form. The main objective of the managementprogrammes put forward is to create suitable environmental conditions keeping in mind the deficiency of capital investment. Utilization of raw materials and energy is to be improved and benefits of interlinking and balanced growth are to be realized. It should be ensured that every unit operates under the most favorable environmental and social conditions for its economic development.

The increasing pressure of population is creating severe stress on the limited and almost fixed resources of the study area as the topography does not allow enhancement of resources by human efforts. Consequently, the population is increasing and in desperation of growth depleted resources endangering their own survival in the very near future. Most primary resources seem to have been stretched to the limit beyond which their use will shape the fragile environment it to a chord. Limited and optimum use of local non-renewable, or difficult to renew resources combined with development of a structure of material, light and skill, intensive activities with the minimum adverse effect on environment and ecology could alone offer a better living to the local inhabitants and prevent damage to ecological balance.

Resource Management

Management of Land

Basically the geomorphology is concerned with landform materials and their related processes which are relevant to all aspects of environmental management. The morphology of the landform is made and modified by past and present processes in a time scale. There are two approaches of landform classification. First considers classifying it into natural unit and than attempting to measure their properties quantitatively and relate them to land use. The second method of landform classification is parametric method. Some times both can be applied for identifying the land resources. In the sub- mountain track of the lesser Himalaya, thegeomorphological mapping and terrain classification provide a valid basis of duns and sub mountain zone for economic development of the areas. On the basis of geomorphological mapping, terrain classification, structural characteristics, slope character relief variation and other morphometric attributes, the Dun can be divided in to different land classes. Each class of land is produced by geomorphological processes. The Kiarda Dun and its environs are divided into three broad physiographic Zones.

1. Lesser Himalayan zone
2. Dun proper
3. Shiwalik Zone

Further, above physiographic zones can be divided into second and third order of land classes. This type of classification is very significant for the management of land, soil , water and other environmental resources.

The lesser Himalayan ranges are dominated by slope failure processes i.e. landslides, rock fall, slumping etc, out of these natural processes human factor is also important to create the environmental problems. Construction of roads, settlement, agricultural practices, construction of the new field, mining, deforestation and overgrazinging are main activities indirectly responsible for land degradation. Some important suggestions of land management are given hereunder.

1. Land slide, slumping and other slope failures can be checked by check dams, plantation at hazardous sites, minimizing the grazing practices and stopping deforestation. The check dames on the stream lines can also minimize the bank erosion, gully erosion, soil erosion and water flow of flood water.
2. The proper agricultural practices are required on the hill slopes.
3. Roads, settlement should be constructed at proper sites, wherever the erosion can be minimized.
4. The limestone and stone mining site should be selected at appropriate location and scientific mining should be implied keeping in view the environment management.
5. Afforestation of the reserved forest land should be started on rotational basis which minimizes natural processes and regenerate the spring.

The shiwalik landscape is quite different from the lesser Himalaya, as already definedshiwalik structure in very young and unconsolidated. Therefore the denudational processes actively eroded theshiwalik in different forms.

Slumping, landslide, gully erosion, bad land topography and erosion are the main features which require suitable management.

In the case of Dun, the agriculture land use (57.92%) is dominant. Land classification scheme exit in order to grade land according to its qualities for agriculture. Primarily the Dun area is classified into different land use classes. The basic problems are management of these classes. Proper agriculture practices should be started on agricultural land.

1. The irrigated land should be increased by developing the different means of irrigation i.e, tube wells and lift schemes. The canal and tube well can be developed along the lower terraces where as the lift scheme can be developed for the upper cultivated terraces and water divides.
2. Flood plain can be utilize for agriculture land in rabbi season
3. The basic problems in the Bata Dun are river bank erosion which degrade the agricultural land. It is the very serious problem, which requires proper management. Check wall plantation of tree and grasses can be of great help.
4. The siltation problem on agricultural land from hill slopes can be checked by diverting rain water into stream lines, afforestation of the hill slope and construction of stonewalls along the overflow canal bank in the proper Dun area.

Waste Land Management

Waste land management is a very good criterion for environmental management. There are mainly three types of waste land in the study area. First is the land under river beds, second is colluvial slopes, hill slopes and terrace scarp, and third is steep slopes and land under scrub land. The proper tree spaces should be replanted on the scrub land, steep slop sides. The colluvial cone should be converted to cultivated land by washing the boulders and pebble. The soil bindery species should be replanted on the terrace scarp; gardens and archers can be grown on the wasteland of Dun area. The pediment slope can be converted into cultivated land if means of irrigation are developed.

Management of Soil

Soil is non-renewable and depleting resources of the earth surface. The subject of soil involves understanding the process, that forms the soil, their texture and compositional characters and their capacities for supporting different types of plants and making different use of it such as construction of structures roads, disposal of wastage, agriculture, horticulture etc. The environmental geomorphologist is thus required to identify the soil that can support different activities and have the requisite strength to withstand the loads of the artificial structure being bait on them (Valdiya 1987).

Soil conservation is the practice of arresting or minimizing artificially accelerated soil erosion .The first Order River basins are the best locations for planning soil conservation schemes. It takes into account the maximum area under its influences and these are the sites from where the river grows headwords, thus responsible for maximum soil erosion.

A noteworthy feature of soil erosion in the study area is that theshiwalik area is more affected by severe erosion then the cultivable and fallow lands. Thus, Giri, Banswali, Sudanwala, Kata pathar, Paniwala, Rajban, Janglot, Tandoli, Kotaba, Rama and Dhon zone are very responsible to afforestation.

Soil erosion though may not be prevented; its frequency and severity may certainly be minimized through appropriate and timely biological and engineering measures. Soil erosion problem in the study area may be tackled effectively by following conservation measures.

Restoration of Gullies Land

The removal of runoff from terraces usually requires the construction of waterways and if these are inappropriately designed they easily become gullies. Natural waterways may also become gullied by increased run off from area of poor land use practices. In both these cases biotic as well as mechanical measures are required to remove the gullies and to decrease the rate of soil erosion. The following steps are required.

1. To reduce the flow velocity of water as well as gradient of the gully, steps- like structure are to bebuild, also spillways and wires, which dissipate the flow energy should be fixed.
2. Plugging the mouth of the gullies at suitable points by earthwork. This will cause the rain water, gushing down the slopes, to accumulate behind the earthen plugs and thus the loosened soil brought by it from the higher region be deposited.
3. Gullies increase in size by headword erosion. To check the gully heads soil binding creepers likeKodzu grass may be grown and trees like Bhimal, Arjun and Silver oak be planted.
4. After growing grasses and trees may be slowly turned to orchards or fuel and fodder tree plantation which provide rich forage for the cattle and high calorific value wood for domestic use.

Torrential Flow Control

Excessive movement of sediments is the most important factor responsible for the disturbance of channel stability by way of minor meandering and lateral vertical erosion. The sediments, acting as tools for erosion, are contributed by the securing of torrent bed and river banks together with slope failure debris (landslides, rock-fall etc). Thus torrent erosion control aims at arresting the contribution and movement of sediments. The following biotic measures are most suitable in the Kiarda Dun as permanent measures instead of mechanical steps, which have been found to be unsuitable in the presence of high torrential flow during the monsoons.

1. The most important is that the torrent control working should be started from both the river banks, simultaneously taking care that the channel width is not restricted and sufficient area is left for the discharge of expected peak run-off (Singh,Mathur and Gupta 1971)
2. The freshly deposited terraces should be planted with *Pennisctum purpureum, Coccharum begalese or Sachchrum spentaneum.*
3. The vertical and steep bluffs and escarpments may be planted with *behri grass, gorda grass; narcul elephant grass or grant star grass.*
4. The riverbanks along the waterways of the basin may be planted with*smabhaloo and besharam booti or narkul and ipomea carea* paris for best results.

The best months for erecting vegetative plantings are in January and February after the winter showers so that the vegetation would get sufficient time for establishing it self before the torrential floods in the river during the monsoon.

Slope Failure

Preventive Measures

These include attention to rockslides and rock fall in time, vigilance to detect signs of slope failure or hazard areas and banning development activities in these hazard zones. Mining activities should be completely banned in the Rajban and other effected areas in the study region. Furthermore, there should be a legislative provision for fixing responsibility of treatment and environmental rehabilitation of excavation and cutting for roads, canals, buildings etc, squarely on the executing agencies. There should be legal binding on house and road builders to restore the land they have damaged and rendered vulnerable to mass-movement by application of appropriate biological and engineering technique and suitable disposal of debris in order to save the vegetal cover, agricultural fields and human settlements down slope and hydraulic system of the terrain.

In the identified landslide prone areas, up slope encroachment into the forests for human settlements should be prohibited. Public facilities and utility services such as water and electricity supplies telephone and telegraph lines, bus service etc., should not be provided to the sites where constructions have taken place against the provision of law on land use in relation to environmental conditions and risk factors.

Protective Measures

Protection of active slide faces against grazing, deforestation etc. can be done by erecting a barbed wire fence around the protected area. Before using vegetative measures it is essential to protect the damaged slope. The net prevents not only the erosion from the impact of rain drops but also holds together grains, thus checking movement of soil constituents. The noted area may then be seeded with suitable local grass, or grant star grass. The soil should then be applied with fertilizer, such as calcium, ammonium nitrate (Natrajan and Gupta 1980) to promote quick growth. For the stabilization of fresh deposit near spur, grass may be planted in general direction of the flow. The growth of grass, which ensures partial stabilization, is then followed by a programme of intensive afforestation. Among the trees those have been recommended are populars, willows, oakes, *acacias* and certain species of eucalyptus, *lantana camera shrub* is also good soil checked otherwise it becomes a menace.

Management of Forest

In view of its National and local importance, conservation augmentation of forests should get the top priority in the planning for the development of these areas. Hill forests are undoubtedly the national resources not in the form of wood, but as the preserver of soil and regulator of water flow in the rivers. Only such trees should, therefore, be promoted in the regions which are capable of producing more biomass.

Second need to be realized is that agriculture should be used mainly for proper Dun and Silviculture for the lesser Himalayan part in study area. Extension of conventional agriculture to encroach upon forests be strictly banned and similarly ban should be imposed against all commercial green felling until 60% green coverage as envisaged in the national forest policy of 1952, is regained in the study area. For theafforestation of forests as well as other hill slopes in the region tree species which give fuel, fodder and fiber will be most suitable. In Kiarada Dun there is medium to good forests, yet there is need for afforestation. Besides their environmental uses they are also helpful for economic reasons.

The areas of denuded hill slopes; planner hilltop, panchayat land and soyam forestland need immediate rehabilitation through forestry. The tasks can be achieved successfully only through mobilizing the local people of village level. The aim of forestry should be blanching of the commercial and protective aspects and, therefore, conservation, resource renewal and expansion must be the guiding principles. The economic use of the forest, however, is made only after the environmental needs of the region and fuel and fodder needs of the people are satisfied. The management of forests should be so oriented as to increase the present stock ware, as it is deficit. It needs that the production will be gradually and progressively increased to the potential productivity of the land as earliest as possible. These plantations need adequate protection from all injuries by man, animal, insects, pest, grazing and fire.

Correct choice of species is most important consideration that will determine success or failure of a plantation. The soil is shallow no fast growing species is likely to succeed in the first stage. Where the area is subject to landslip a species that can be raised vegetativey must be preferred. Erosion prone area needs species with a spreading root system. At present the local requirement is primarily for firewood and fodder trees. In site that have a shallow soil depth and are under active erosion it will be more desirable to grow certain shrubs in the first stage. After site stabilization, some humus is built up and moisture regime improves, tree species may be planted. Success of plantation will depend on careful matching of species and provenances rose if the local persons are not interested in its protection.

Management of Water

For a particular drainage basin, the precipitation which falls within its watershed is the ultimate water potential of that basin. Thus, the water requirement of the inhabitants of the regions for drinking, irrigation, industry, etc., should be wholly met within this water potentially of the basin.

The Kairda Dun does not receive an equal amount of rainfall throughout the year. The maximum amount of rain occurs during the months from July to September, which is the water surplus period in the basin with most of the water flowing out from the region through the rivers. The rest of the months are water deficient. Therefore, the optimum economic utilization of water resources in the study area and the water during the surplus months should be considered.

Afforestation

Mountainous forest area and grassland is a great asset for the conservation of water. A cover of perennial vegetation holds the soil and protects it while also holding the water drops and slowly lettingthem seep into the soil for being collected in the aquifer zone.

Trees may be planted along streamlines, canals, mines, motorways and footpaths. Mulberry trees, fruit trees, floral and medicinal trees may be grown wherever it is possible. The waste and scrubby lands of the study area may be planted with fuel and fodder trees species.

Irrigation

The most important aspect of water management is to ensure adequate and timely water supply for irrigation to an agricultural society. The principal benefits from the extension of irrigation facilities inKiarda Dun will be:

1- Better utilization of land resource
2- Introduction of more profitable cropping pattern with high yielding seeds and use of chemical fertilizers
3- To create an incentive for investment in farming
4- Increase employment opportunities in agriculture and its allied activities
5- Stimulus to trade and transport

Increased per capita income of the inhabitants, leading to economic prosperity. The management in respect to utilization of water should be done at the mouth of maximum river order channel. Due to this, the river is able to perform its geomorphic functions along its path and also large amount of water is at man's disposal. This aspect is greatly forgotten in this area. Canals have been dug out from near the river sources making the water channels dry all the year round except during the monsoon when the amount of water exceeds the canal's capacity in turn leading to flesh floods with loss of human as well as cattle life due to its suddenness. Thus, surplus water during July to September may be stored in reservoirs, tanks, built along the agricultural fields and this surplus will be consumed during the waste deficient summer months.

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