RAPID ENVIRONMENT IMPACT ASSESMENT OF DEHRADUN CITY (LAND ENVIRONMENT)

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RAPID ENVIRONMENT IMPACT ASSESSMENT OF DEHRADUN CITY (LAND ENVIRONMENT)

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Certificate

This is to certify that the work contained in this thesis titled **"Rapid Environment Impact Assessment of Dehradun City (Land Environment)"** has been carried out by **ABHISHEK RAJVANSHI** under my supervision and has not been submitted elsewhere for a Degree.

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Abstract:

The planning and management of **Land Environment** require huge amount of information regarding almost all aspects of natural and man-made features of that area. Until lately, such a study could be analyse the achieved through days of soil sampling, soil analysis and tedious calculations. **Soil analysis** provide huge database for Land Environment as a powerful tool for earth surface analysis for Rapid EIA data. The present paper seeks to analyse the role of soil sampling & soil analysis in the management of land environment. Land environment basically consist of built up area, i.e. building, roads, industries, business area, park etc. and natural feature vegetation cover, soil and water inside urban activity zone. The paper highlight how the chemical analysis and solid waste management surveys can be used in study of land environment of Dehradun city and in the study of urban sprawl and its growth trend, updating the monitoring using repetitive coverage, urban environment especially land use and land cover citing the study of Dehradun municipality.

Advantages of this project are:

- Collect data the fertility of soil.
- To get the data and review the standard.
- Analyse the condition of soil, which could be affecting due open dumping of solid waste.
- Analyse Soil characteristics changes due use of pesticides, herbicides & fertilizer in agriculture.

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Nomenclature

EIA	Environment Impact Assessments
MDS	Middle Dun Surface
LDS	Lower Dun Surface
PCCs	Pollution Control Committees
PCB	Pollution Control Board
ES	Environmental Statement

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Chapter-1

Introduction of Dehradun City

1.1 Geology of Dehradun City

Dehradun city is located in the intermountain valley within the Shiwalik foreland basin of Garhwal Himalaya.It is a crescent-shaped, longitudinal and synclinal valley controlled by a series of tectonic faults on all sides. Most prominently it is bounded by the Main Boundary Thrust (MBT) that brings the Precambrian rocks of the Lesser Himalaya in contact with the Shiwalik Group of rocks forming the northern boundary of the Doon Valley. The southern boundary of the Doon Valley is marked by the anticline structure known as Mohand anticline that in turn is separated from the plains in the south by the Himalayan Frontal Thrust (HFT), locally known as the Mohand Thrust. On the east and west, it is bounded by two prominent strike-slip faults known as Ganga Tear Fault and Yamuna Tear Fault respectively. Doon Valley mainly consists of coalescing fan deposits derived from the Lesser Himalayan rocks in the north and Shiwalik Group of rocks in the south. The fan deposits mainly consist of pebbles and gravels, with pockets of clay. The Doon gravels at places are hard and compact due to the presence of lime and clay acting as cementing material. The degree of compaction increases with depth. The depth level of this bed varies from 15 m in the north and central parts to more than 30 m in south-southwestern part of the city. Auden5 postulated that the Doon gravels are underlain by Upper Shiwalik deposits, which are lithologically similar to the former. The study area covering the entire urban part of the Doon Valley consists mainly of fan deposits, with the exception of the northern part, where Shiwalik sandstones are exposed on the surface. Geomorphologically, Dehradun city can be differentiated into two major geomorphic surfaces. These are the hilltop surface (residual hills) and piedmont surface (which can be further divided into Middle Dun Surface (MDS) and Lower Dun Surface (LDS)). The hilltop surface consists of thick boulder gravel beds, including boulders as large as 2 m across, occurring at the crest of the residual hills in the northern part of the city. Both the piedmont surfaces (MDS and LDS) comprise less consolidated and weathered gravel beds. The LDS is recognized as the lowest alluvial fan of the major tributaries of the Ganga and Yamuna rivers in the central part of the Doon Valley. This surface is composed of boulder gravel beds that overlay the finer deposits of the MDS. The thickness of the LDS is not more than 10 m, but the surface is quite extensive on which Dehradun city is located.

1.2 Climate of Dehradun City

The Climate of the district is generally temperate. It varies greatly from tropical to severe cold depending upon the altitude of the area. The district being hilly; temperature variations due to difference in elevation are considerable. In the hilly regions, the summer is pleasant, but in the Doon, the heat is often intense, although not to such degree as in the plains of the adjoining district. The temperature drops below freezing point not only at high altitude but even at places like Dehradun during the winters, when the higher peaks are also under snow. The area receives an average annual rainfall of 2073.3 mm. Most of the annual rainfall in the district is received during the months from June to September, July and August being rainiest.

Table 1.1: Climate Data of Doon Valley for all the months is as under on the basis of mean of last 25 years

Month	Rainfall	Relative Humidity	Temperature		
	(mm)	(%)	Max	Min	Avg.
January	46.9	91	19.3	3.6	10.9
February	54.9	83	22.4	5.6	13.3
March	52.4	69	26.2	9.1	17.5
April	21.2	53	32	13.3	22.7
May	54.2	49	35.3	16.8	25.4
June	230.2	65	34.4	29.4	27.1
July	630.7	86	30.5	22.6	25.1
August	627.4	89	29.7	22.3	25.3
September	261.4	83	29.8	19.7	24.2
October	32.0	74	28.5	13.3	20.5
November	10.9	82	24.8	7.6	15.7
December	2.8	89	21.9	4.0	12.0
Average Annual	2051.4	76	27.8	13.3	20.0

Chapter-2

Introduction and Background of Study

2.1 INTRODUCTION OF ENVIRONMENT IMPACT ASSESSMENT

2.1.1 The Need for EIA

Every anthropogenic activity has some impact on the environment. More often it is harmful to the environment than benign. However, mankind as it is developed today cannot live without taking up these activities for his food, security and other needs. Consequently, there is a need to harmonize developmental activities with the environmental concerns. Environmental impact assessment (EIA) is one of the tools available with the planners to achieve the above-mentioned goal.

It is desirable to ensure that the development options under consideration are sustainable. In doing so, environmental consequences must be characterized early in the project cycle and accounted for in the project design.

The objective of EIA is to foresee the potential environmental problems that would arise out of a proposed development and address them in the project's planning and design stage. The EIA process should then allow for the communication of this information to:

(a) The project proponent;
(b) The regulatory agencies; and,
(c) All stakeholders and interest groups.

EIA integrates the environmental concerns in the developmental activities right at the time of initiating for preparing the feasibility report. In doing so it can enable the integration of environmental concerns and mitigation measures in project development. EIA can often prevent future liabilities or expensive alterations in project design.

2.1.2 Indian Policies Requiring EIA

The environmental impact assessment in India was started in 1976-77 when the Planning Commission asked the then Department of Science and Technology to examine the river-valley projects from environmental angle. This was subsequently extended to cover those projects, which required approval of the Public Investment Board. These were administrative decisions, and lacked the legislative support. The Government of India enacted the Environment (Protection) Act on 23rd May 1986. To achieve the objectives of the Act, one of the decisions that were taken is to make environmental impact assessment statutory. After following the legal procedure, a notification was issued on 27th January 1994 and subsequently amended on 4th May 1994, 10th April 1997 and 27th January 2000 **making** environmental impact assessment statutory for 30 activities. This is the principal piece of legislation governing environmental impact assessment.

2.1.3 The EIA Cycle and Procedures

The EIA process in India is made up of the following phases:

a. Screening
b. Scoping and consideration of alternatives
c. Baseline data collection
d. Impact prediction
e. Assessment of alternatives, delineation of mitigation measures and environmental impact statement
f. Public hearing
g. Environment Management Plan
h. Decision making
i. Monitoring the clearance conditions

(a) SCREENING

Screening is done to see whether a project requires environmental clearance as per the statutory notifications. Screening Criteria are based upon:

i. Scales of investment;
ii. Type of development; and,
iii. Location of development.

(b) SCOPING

Scoping is a process of detailing the terms of reference of EIA. It has to be done by the consultant in consultation with the project proponent and guidance, if need be, from Impact Assessment Agency.

The Ministry of Environment and Forests has published guidelines for different sectors, which outline the significant issues to be addressed in the EIA studies. Quantifiable impacts are to be assessed on the basis of magnitude, prevalence, frequency and duration and non-quantifiable impacts (such as aesthetic or recreational value), significance is commonly determined through the socio-economic criteria. After the areas, where the project could have significant impact, are identified, the baseline status of these should be monitored and then the likely changes in these on account of the construction and operation of the proposed project should be predicted.

(c) BASELINE DATA

Baseline data describes the existing environmental status of the identified study area. The site-specific primary data should be monitored for the identified parameters and supplemented by secondary data if available.

(d) IMPACT PREDICTION

Impact prediction is a way of 'mapping' the environmental consequences of the significant aspects of the project and its alternatives. Environmental impact can never be predicted with absolute certainty and this is all the more reason to consider all possible factors and take all possible precautions for reducing the degree of uncertainty.

The following impacts of the project should be assessed:

Air

- Changes in ambient levels and ground level concentrations due to total emissions from point, line and area sources
- Effects on soils, materials, vegetation, and human health

Noise

- Changes in ambient levels due to noise generated from equipment and movement of vehicles
- Effect on fauna and human health

Water

- Availability to competing users
- Changes in quality
- Sediment transport
- Ingress of saline water

Land

- Changes in land use and drainage pattern
- Changes in land quality including effects of waste disposal
- Changes in shoreline/riverbank and their stability

Biological

- Deforestation/tree-cutting and shrinkage of animal habitat.
- Impact on fauna and flora (including aquatic species if any) due to contaminants /pollutants
- Impact on rare and endangered species, endemic species, and migratory path/route of animals.
- Impact on breeding and nesting grounds

Socio-Economic

- Impact on the local community including demographic changes.
- Impact on economic status
- Impact on human health
- Impact of increased traffic

(e) ASSESSMENT OF ALTERNATIVES, DELINEATION OF MITIGATION MEASURES AND EIA REPORT

For every project, possible alternatives should be identified and environmental attributes compared. Alternatives should cover both project location and process technologies. Alternatives should consider 'no project' option also. Alternatives should then be ranked for selection of the best environmental option for optimum economic benefits to the community at large.

Once alternatives have been reviewed, a mitigation plan should be drawn up for the selected option and is supplemented with an Environmental Management Plan (EMP) to guide the proponent towards environmental improvements. The EMP is a crucial input to monitoring the clearance conditions and therefore details of monitoring should be included in the EMP.

An EIA report should provide clear information to the decision-maker on the different environmental scenarios without the project, with the project and with project alternatives. Uncertainties should be clearly reflected in the EIA report.

(f) PUBLIC HEARING

Law requires that the public must be informed and consulted on a proposed development after the completion of EIA report.

Any one likely to be affected by the proposed project is entitled to have access to the Executive Summary of the EIA. The affected persons may include:

i. Bonafide local residents;
ii. Local associations;
iii. environmental groups: active in the area
iv. any other person located at the project site / sites of displacement

They are to be given an opportunity to make oral/written suggestions to the State Pollution Control Board as per Schedule IV of **Annex I.**

(g) DECISION MAKING

Decision making process involve consultation between the project proponent (assisted by a consultant) and the impact assessment authority (assisted by an expert group if necessary)

The decision on environmental clearance is arrived at through a number of steps including evaluation of EIA and EMP.

(h) MONITORING THE CLEARANCE CONDITIONS

Monitoring should be done during both construction and operation phases of a project. This is not only to ensure that the commitments made are complied with but also to observe whether the predictions made in the EIA reports were correct or not. Where the impacts exceed the predicted levels, corrective action should be taken. Monitoring will enable the regulatory agency to review the validity of predictions and the conditions of implementation of the Environmental Management Plan (EMP).

2.1.4 Components of EIA

The difference between **Comprehensive** EIA and **Rapid** EIA is in the time-scale of the data supplied. Rapid EIA is for speedier appraisal process. While both types of EIA require inclusion/ coverage of all significant environmental impacts and their mitigation, Rapid EIA achieves this through the collection of 'one season' (other than monsoon) data only to reduce the time required. This is acceptable if it does not compromise on the quality of decision-making. The review of Rapid EIA submissions will show whether a comprehensive EIA is warranted or not.

It is, therefore, clear that the submission of a professionally prepared Comprehensive EIA in the first instance would generally be the more efficient approach. Depending on nature, location and scale of the project EIA report should contain all or some of the following components.

Air Environment

- Determination of impact zone (through a screening model) and developing a monitoring network
- Monitoring the existing status of ambient air quality within the impacted region (7- 10 km from the periphery) of the proposed project site
- Monitoring the site-specific meteorological data, viz. wind speed and direction, humidity, ambient temperature and environmental lapse rate
- Estimation of quantities of air emissions including fugitive emissions from the proposed project
- Identification, quantification and evaluation of other potential emissions (including those of vehicular traffic) within the impact zone and estimation of cumulative of all the emissions/impacts
- Prediction of changes in the ambient air quality due to point, line and areas source emissions through appropriate air quality models
- Evaluation of the adequacy of the proposed pollution control devices to meet gaseous emission and ambient air quality standards
- Delineation of mitigation measures at source, path ways and receptor

Noise Environment

- Monitoring the present status of noise levels within the impact zone, and prediction of future noise levels resulting from the proposed project and related activities including increase in vehicular movement

- Identification of impacts due to any anticipated rise in noise levels on the surrounding environment

- Recommendations on mitigation measures for noise pollution

Water Environment

- Study of existing ground and surface water resources with respect to quantity and quality within the impact zone of the proposed project

- Prediction of impacts on water resources due to the proposed water use/pumping on account of the project

- Quantification and characterisation of waste water including toxic organic, from the proposed activity

- Evaluation of the proposed pollution prevention and wastewater treatment system and suggestions on modification, if required

- Prediction of impacts of effluent discharge on the quality of the receiving water body using appropriate mathematical/simulation models

- Assessment of the feasibility of water recycling and reuse and delineation of detailed plan in this regard.

Biological Environment

- Survey of flora and fauna clearly delineating season and duration.
- Assessment of flora and fauna present within the impact zone of the project
- Assessment of potential damage to terrestrial and aquatic flora and fauna due to discharge of effluents and gaseous emissions from the project
- Assessment of damage to terrestrial flora and fauna due to air pollution, and land use and landscape changes
- Assessment of damage to aquatic and marine flora and fauna (including commercial fishing) due to physical disturbances and alterations
- Prediction of biological stresses within the impact zone of the proposed project
- Delineation of mitigation measures to prevent and / or reduce the damage.

Land Environment

- **Studies on soil characteristics, existing land use and topography, landscape and drainage patterns within the impact zone**
- **Estimation of impacts of project on land use, landscape, topography, drainage and hydrology**

- **Identification of potential utility of treated effluent in land application and subsequent impacts**

- **Estimation and Characterisation of solid wastes and delineation of management options for minimisation of waste and environmentally compatible disposal.**

Socio-economic and Health Environment

- Collection of demographic and related socio-economic data

- Collection of epidemiological data, including studies on prominent endemic diseases (e.g. fluorosis, malaria, fileria, malnutrition) and morbidity rates among the population within the impact zone

- Projection of anticipated changes in the socio-economic and health due to the project and related activities including traffic congestion and delineation of measures to minimize adverse impacts.

- Assessment of impact on significant historical, cultural and archaeological sites/places in the area

- Assessment of economic benefits arising out of the project

- Assessment of rehabilitation requirements with special emphasis on scheduled areas, if any.

Risk Assessment

- Hazard identification taking recourse to hazard indices, inventory analysis, dam break probability, Natural Hazard Probability etc.
- Maximum Credible Accident (MCA) analysis to identify potential hazardous scenarios
- Consequence analysis of failures and accidents resulting in fire, explosion, hazardous releases and dam breaks etc.
- Hazard & Operability (HAZOP) studies
- Assessment of risk on the basis of the above evaluations
- Preparation of an onsite and off site (project affected area) Disaster Management Plan

Environment Management Plan

- Delineation of mitigation measures including prevention and control for each environmental component and rehabilitation and resettlement plan.
- Delineation of monitoring scheme for compliance of conditions
- Delineation of implementation plan including scheduling and resource allocation

2.1.5 Roles in the EIA Process

EIA involves many parties, grouped by their role definition within the process. The following section outlines the basic responsibilities of various bodies:

i. The Project Proponent
ii. The Environmental Consultants
iii. The State Pollution Control Board / Pollution Control Committees (PCCs)
iv. The Public
v. The Impact Assessment Agency

The Role of the Project Proponent

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The project proponent during the project planning stage decides the type of projects i.e. new establishment, expansion or modernisation. Later the project proponent needs to prepare the Detailed Project Report/Feasibility Report and submits the Executive Summary, which shall incorporate the project details, and findings of EIA study, which is to be made available to concerned public.

Role of Environment Consultant

Environmental consultant should be conversant with the existing legal and procedural requirements of obtaining environmental clearance for proposed project. The consultant should guide the proponent through initial screening of the project and establish whether EIA studies are required to be conducted and if so finalise the scope of such study. The consultant should also be fully equipped with required instruments and infrastructure for conducting EIA studies. The environmental consultant is responsible for supplying all the environment-related information required by the SPCB and IAA through the proponent. The consultant is also required to justify the findings in the EIA and EMP during the meeting with the expert groups at IAA.

The Role of the State Pollution Control Board (PCB) /Pollution Control Committee (PCC)

The State PCBs/PCCs are responsible for assessing the compatibility of a proposed development with current operational and prescribed standards. If the development is in compliance, the PCB will then issue its NOC. They shall also hold the public hearing as per the provisions of EIA notification. The details of public hearing shall be forwarded to IAA.

The Role of the Public

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The public also has an important role to play in EIA. The concerned persons will be invited through press advertisement to review information and provide their views on the proposed development requiring environmental clearance.

2.2 Environmental Impact Assessment of Land Environment

Directive requires that an Environmental Statement must include 'a description of the likely effects, direct and indirect on the environment of the proposed development, explained by reference to ... D) Soil. Environmental Statements should provide information on 'the type and quantity of expected pollutants including pollution of soils and water'. While soil is of importance in its own right, the EIA process should consider potential effects in terms of their implications for soil functions including:

1. Soil's role in providing a platform for development and land use;
2. Soil's ability to buffer, filter and store other substances including air and water;
3. Soil's role in supporting the production of food and fiber;
4. Soil's role in supporting and contributing to biodiversity;
5. Soil's role in providing raw materials;
6. Soil's role in contributing to, and protecting, cultural heritage.

Different kinds of development will have varying implications for soil's physical, chemical and biological properties, determining in turn, the effects on these soil functions.

2.2.1 KEY STEPS IN EIA

It is important that the potential effects of a development are considered throughout the EIA process including:

1. **Site selection and scheme design -**

   The scale and nature of potential impacts on soil and soil functions be reduced by selecting an alternative location or changing the scheme design? While these are questions that are likely to be informed by continuing iterations throughout the EIA process, soil should be considered as a factor during the site selection and decisions concerning the design of the development in question. This is likely to require broad information about the soil types associated with different locations and an appreciation of the implications of the development.

2. **Screening** - is the development likely to have a significant effect by virtue of its impacts on soil or soil functions? If the answer is 'yes', the project should be subject to EIA.

3. **Scoping** – what are the potential impacts on soil and soil functions and how will these be considered through the EIA process? The local authority or developer may need specialist advice at this point.

4. **Information** – what relevant information on soil and soil functions do consultees and other organizations hold?

- **Baseline Study** – collection, interpretation and evaluation about existing soil conditions and soil functions. This may require additional soil survey work;

- **Impact Prediction** – prediction of the potential impacts of activities associated with the development on soil and soil function, distinguishing between construction, operation and decommissioning phases and direct and indirect impacts;
- **Avoidance and Reduction of Impacts** – can the scheme be modified (for example by altering the detailed layout, or the proposed construction method) to avoid or reduce the predicted impacts on soil?
- **Assessment of Significance** – how significant are the potential impacts on soil and soil functions?
- **Mitigation and Enhancement Measures** – can the significant potential impacts on soil and soil functions be reduced by the use of mitigation

measures? Can positive effects be increased or other enhancement measures introduced?

- **Evaluation** of the Environmental Statement by the planning authority and statutory consultees – does the ES adequately identify, address and predict potential impacts on soil and soil functions?
- **Decision-making** – are impacts on soil of significance to the decision making process?
  Can mitigation or enhancement measures be reflected in planning conditions or agreements?
- **Implementation and Compliance** – are impacts on soil and soil functions as anticipated in the ES? Are conditions and agreements being followed?

The following sections focus on the coverage of soil issues at screening and scoping stages, and the way that the Environmental Statement is evaluated. Other parts of this guidance describe the coverage of soil issues in development control and monitoring.

1. Screening:

The Regulations define a range of 'sensitive locations' where Schedule 2 projects should be 'screened' to determine whether an EIA is required.

These 'sensitive areas' are nationally or internationally designated landscapes, nature conservation or cultural heritage sites or areas, many of which are dependent to some degree on soil. The Regulations also refer to other, more locally defined, types of sensitive areas, and point to the role of strategies such as Local Biodiversity Action Plans in identifying such areas. There is a clear role for local soil strategies to identify areas, or indeed types of development, where screening is required to ensure that potentially damaging schemes are subject to EIA. The regulations provide some guidance on the thresholds that should be used to trigger the requirement for an EIA. Schedule 3 (Box 5) of the regulations provides guidance on the criteria for screening. Many of these criteria are directly or indirectly related to soil functions. While some developers may volunteer an EIA, perhaps anticipating the requirement to undertake one, they have the right to ask the planning authority for a formal 'screening opinion' on a given development. Where this occurs, the planning authority should include consideration of the potential effects of the development (given its nature, size and location) on soil functions.

2. Scoping

The scoping process is designed to highlight which potential effects should be considered in detail through the EIA process, in particular the key areas of potential environmental impact and the ways in which these will be assessed and evaluated. Developers may approach planning authorities for a formal opinion on the information to be provided in the Environmental Statement, in effect defining the scope of the assessment process and the topics on which the EIA should focus. It allows the developer to be clear about the range of environmental issues that will be taken into account in making a decision whether to grant planning consent. The 'scoping opinion' is prepared by the local authority in consultation with statutory consultees.

The scoping stage therefore provides an ideal opportunity to ensure that the potential effects on soil – and soil functions – are fully explored and assessed during the EIA process. Where development is likely to have effects on soil, the planning authority should request sufficient information to judge the scale and significance of these effects, and the significance of implications for key soil functions. In responding to requests for scoping opinions, or in reviewing scoping reports, planning authorities should consider whether there are likely to be activities that could have a significant impact on soil functions. While the effect of such activities will depend on issues such as location, scale, design and of course the properties of the soil in question, it may be helpful to consider the extent to which construction, operation or decommissioning could result in

1. Erosion;
2. Pollution (e.g. From heavy metals,
3. Industrial waste, Fertilizers or pesticides,
4. Airborne pollution;
5. Changes in acidity or alkalinity;
6. Changes in the soil's biodiversity;
7. Loss of organic matter;
8. Compaction;
9. Structural damage or deterioration
10. Loss of characteristic soil horizons;
11. Damage during soil stripping or storage;
12. Permanent soil sealing;
13. Loss or decline in fertility;
14. Changes in the water content of soil;
15. Removal or alteration of soil's parent material;
16. Loss, removal or burial of soil.

It is likely that scoping will identify the need for information on existing soils within the area likely to be affected by construction, operation or decommissioning of the development. Data availability varies between different parts of the Dehradun, particularly at a local level where information is collected and held by a wide range of different interests. The most comprehensive information relates to agricultural land quality. While this is relevant to the assessment of impacts on the 'food and fibre' function, it will not be appropriate for other impacts. Planning authorities should consider the need for additional survey work and specialist advice where it is considered that significant impacts on other soil functions are possible.

3. Evaluation

The Environmental Statement should provide sufficient information to assess the likely impacts of the proposed development on soil properties and soil functions. Where significant adverse effects are identified, the Statement should consider how such effects would be mitigated. Where information on the effect on soils is not adequate to draw conclusions, the planning authority should request additional information. Ensuring that the effects of a development on soil functions are fully assessed will only be valuable if planning authorities and their statutory consultees have the knowledge and Expertise to evaluate the results, and use these to inform the decision making process (including the use of planning conditions). Additional specialist skills may be required in this respect. Planning authorities should use the Environmental Statement, including the description of potential mitigation measures, to inform both the decision on whether consent should be granted, and the range of conditions that should be used to minimize adverse effects on soil.

Table 2.1: Guidance for assessment of representativeness and reliability of baseline environmental attributes

Attributes	Sampling		Measurement Method
	Network	Frequency	
D. Land Environment			
Soil 1. Particle size distribution 2. Texture 3. pH 4. Electrical conductivity 5. Cation exchange capacity 6. Alkali metals 7. Sodium Absorption Ratio (SAR) 8. Permeability 9. Water holding capacity 10. Porosity 11. Organic carbon 12. Nitrogen 13. Phosphorus	One surface sample from each village, (soil samples be collected as per BIS specifications)	Seasonwise (only one season)	Collected and analysed as per soil analysis reference book, M.I.Jackson and soil analysis reference book by C.A. Black
Land use/Landscape 1. Location code 2. Total project area 3. Topography 4. Drainage (natural) 5. Cultivated, forest, plantations, water bodies, roads and settlements	At least 20 points along the boundary		Global positioning system Topo sheets Satellite Imageries* (1:25,000) Satellite Imageries* (1:25,000)

Table 2.2: Guidance for assessment of representative and reliability of baseline environmental attributes

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
Solid Waste				
Domestic Waste 1. Per capita contribution 2. Collection, transport and disposal system 3. Process waste 4. Quality (oily, chemical, biological)	Grab and composite samples	Seasonwise (only one season)	Guidelines IS 9569 : 1980 IS 10447 : 1983 IS 12625 : 1989 IS 12647 : 1989 IS 12662 (PTI) 1989	
Quality 1. Loss on heating 2. pH 3. EC 4. Calorific value, metals etc.	Grab and composite samples	Seasonwise (only one season)	Analysis IS 9334 : 1979 IS 9235 : 1979 IS 10158 : 1982	

Chapter-3

Literature Review

3.1 INTRODUCTION

In the present day scenario, cities are becoming hub of almost all human activities. Be it job opportunities for unemployed, educational facilities for learners, availability of health services for the sick, economic uplift men of have-nots, assured base of large consumers of agro-products reaching from rural sectors, cities have always attracted human beings. This has resulted in ever-growing size of cities, squeezing open spaces available within the city and has started exerting pressure on civic amenities. This extra ordinary growth of population and pressure on amenities are the most dramatic phenomenon associated with urbanization. This is also a fact that the pressure of the continuously growing city center gradually changes the structure of surrounding neighborhoods. Further, extension of urban areas and merging of fringe areas into main city seems to be a continuous process, a phenomenon called urban sprawl. Generally speaking, growth of population is the fundamental factor in human ecological system and its relationship to the natural resources, environment and technology. Man, therefore, has a pivotal role in the ecosystem as the most resourceful asset as well as the most influential force in it , and to maintain the required balance in the ecosystem is obligatory on his part. It, therefore, becomes essential to understand the nature of the cities, their functions and their services so as to build its future in such a manner that the advantages of urban concentration can be preserved for the benefit of man and disadvantages minimized. It has been rightly pointed out that city like any other living organism, have the potential to grow in favourable conditions and a tendency to die in adverse. Architectural experiments, echnological advances in communications, changes in social structure, changing social balances between urban centers and suburban regions, shifting national policies and priorities and economic trends have most direct influence on the organisms that are cities. For the survival and growth of a city, a balance between all the relevant elements is essentially desirable. Healthy growth of a city will rest on its immediate environment, which is under stress owing to the developmental changes. Therefore, land use planning assumes importance in creating a living city. In this context, urban development monitoring and mapping are necessary to make effective policy for development of unplanned areas. But monitoring and mapping requires reliable data at regular intervals. Momentum of urban growth has out-paced the traditional techniques of surveying and mapping. The main advantage of EIA is its repetitive and synoptic coverage that is very much useful for the study of urban area. It helps to create information base on land use, land cover distribution, urban change detection, monitoring urban growth and urban environmental impact assessment. In any study of urban landscape, the two components of urban ecology can be perceived:

(i) The natural environment comprising location, physical structure, and

(ii) The created environment comprising of buildings, streets, civic amenities and social facilities.

3.2 LAND ENVIRONMENT OF DEHRADUN CITY

Land use refers to man's activities and the various uses, which are carried on land. Land cover refers to natural vegetation, water bodies and rock/ soil, artificial cover and others as resulting due to land transformation. Land use data are needed in the analysis of environmental processes and problems, which must be understood, if living condition and standards are improved or maintained at current level. Information on the rate and kind of change in the use of land resources is essential for proper planning, management and regularizing the use of resources. Traditionally, the methods of monitoring changes in the land use were field methods and were time consuming and expensive. The changes in land use/ land cover can be linked to the human and natural activities. The analysis of land use land cover as obtained in Figure 3.3 by superimposing ward wise map shows that the predominant land use of the city is the built up land, which is 52.7 percent of the total area of the city (see Table 2). The built up area comprises residential, Institutional, Commercial and Industrial, roads and religious and cultural places. The next class, which follows the built up area, in terms of area covered and percentage is the thick vegetation, i.e. 20.71 per cent. Dehradun being on the foothills of the Himalayas is partially covered by the forest. Moreover FRI, which has vast area under thick vegetation, is also a part of the city. The open land comprises 3% of total land area- that include open grounds, parks and Stadium. The area covered by water bodies form .02 percent of the total area. It comprises of the ponds near Gurudwara off Saharanpur Chowk.

1. Ward Wise Land Use and Land Cover Classification

Most of the wards in central Dehradun and on the outer fringe of eastern part are densely built up; say about 80 to 90 per cent. The ward wise analysis of different classes shows that the built up area is maximum in ward 1.4, while it is least in ward number 13. The reason for less built up area in this ward is the fact that it lies on the outer periphery of the city and hence less development has taken place here as compared to the central part of the city. Further, it comprises more of cropland and recent fallow land. Cropland is minimum in ward number 4, which is also the Old Dalanwala area of the city and hence very highly populated. Other details about land use and land cover may be obtained from the map (Fig. 3.3). The existing pattern of land use can be linked to human and natural activities (see Table 2.3). The entire city is broadly classified into seven classes. Regarding the results, most of the objects of interest could be identified. For urban planning, the maps made in this manner can be used as:

a. Identification of vacant land for acquisition,

b. Updating of base maps

c. Alignment of major roads and railways; and In change detection over a period of time with reference to land use/ land cover.

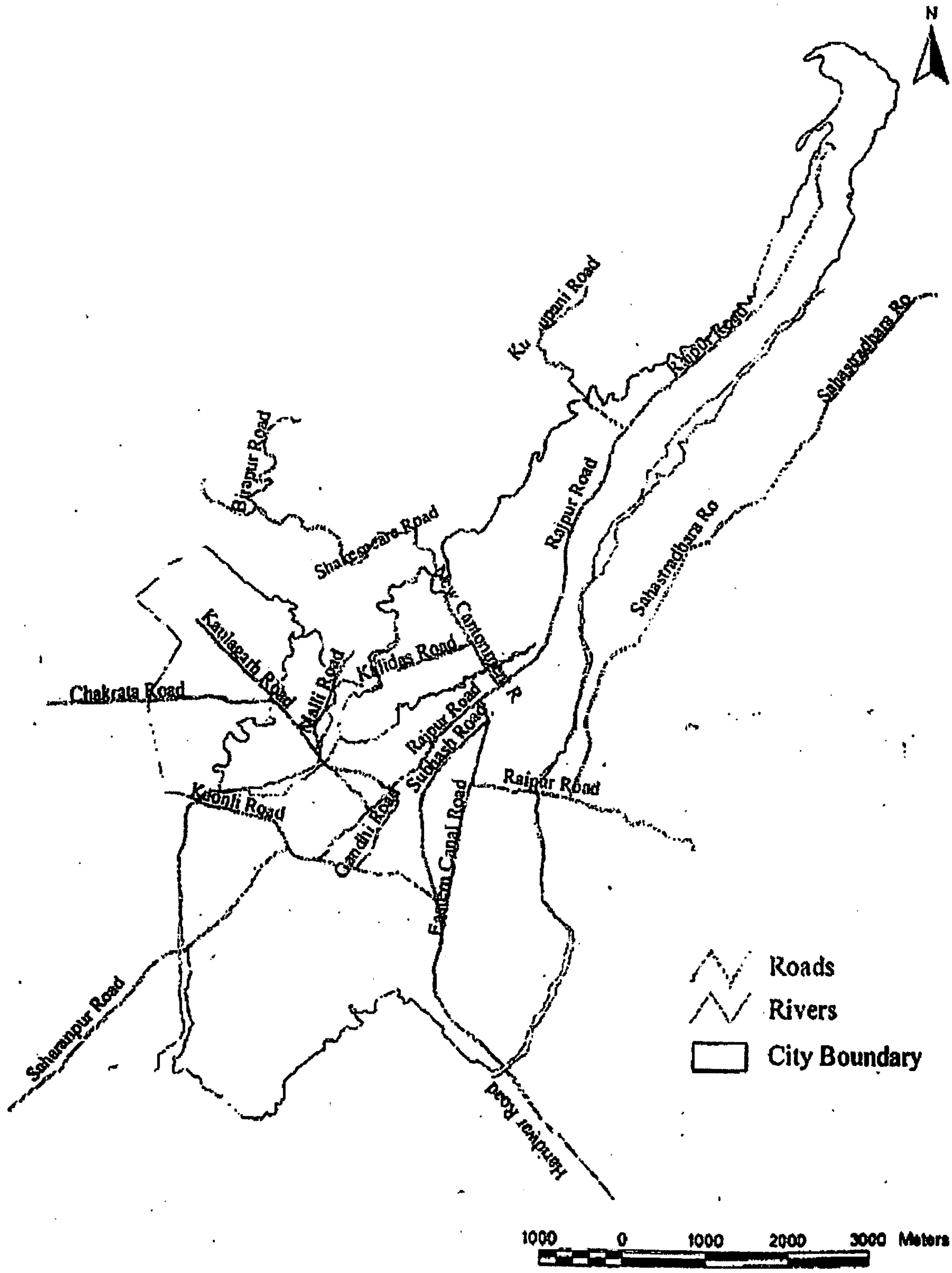


Fig 3.1: Base Map of Dehradun Municipal Area

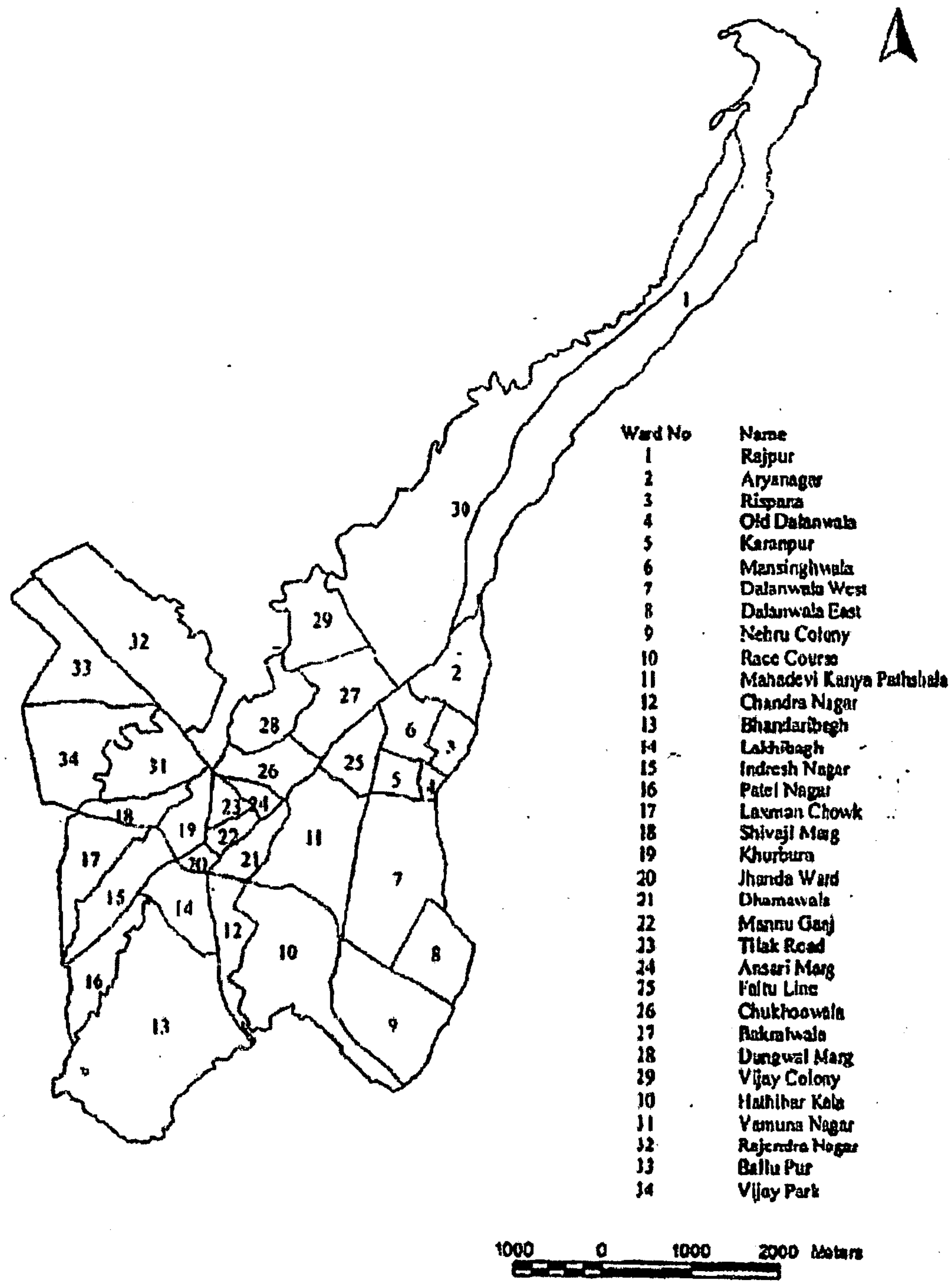


Fig 3.2: Ward Boundary of Dehradun Municipality

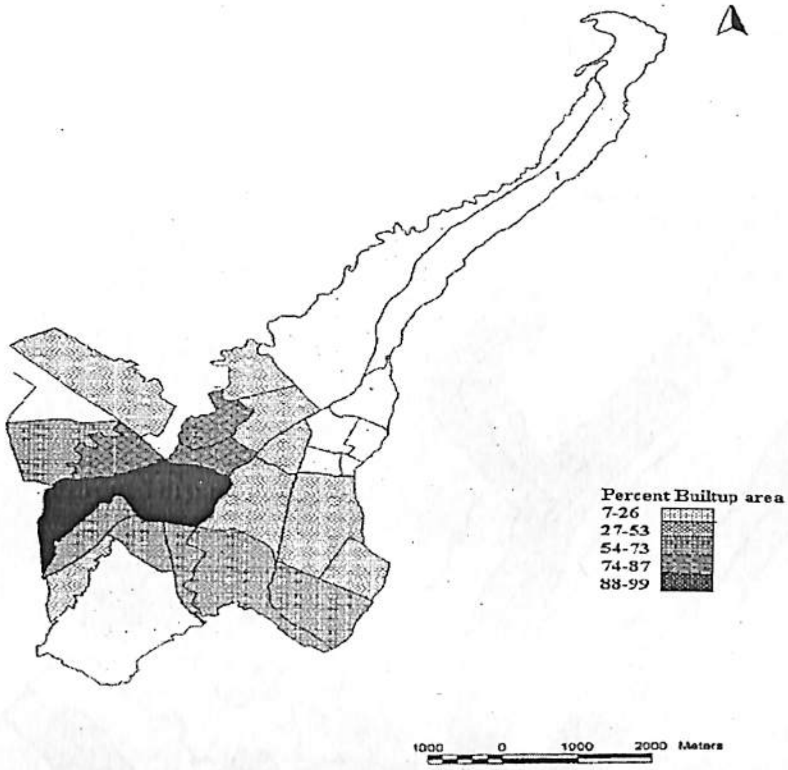


Fig 3.3: Ward-Wise Build Map Area

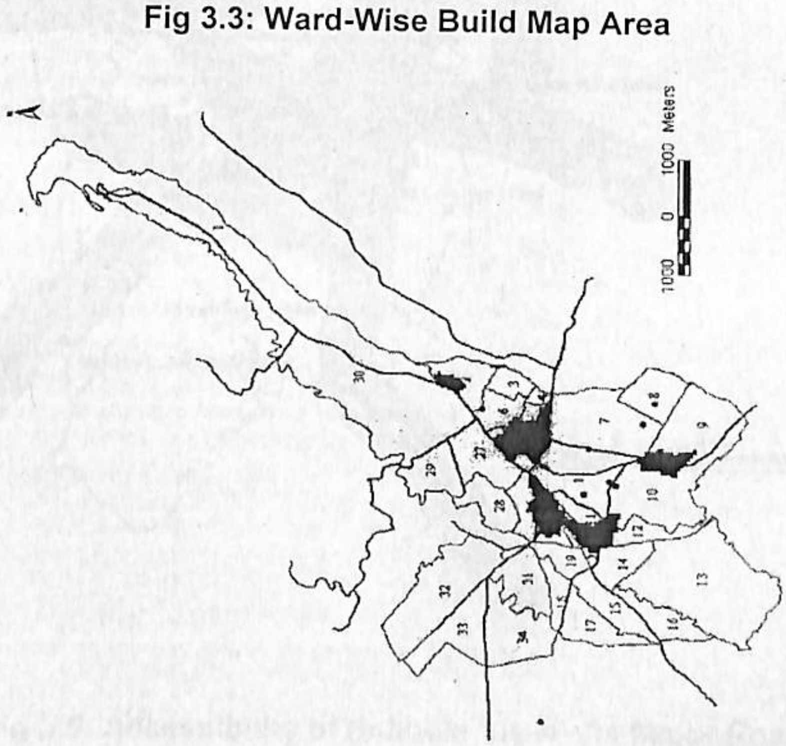


Fig 3.4: Suitable Site for Hospitals

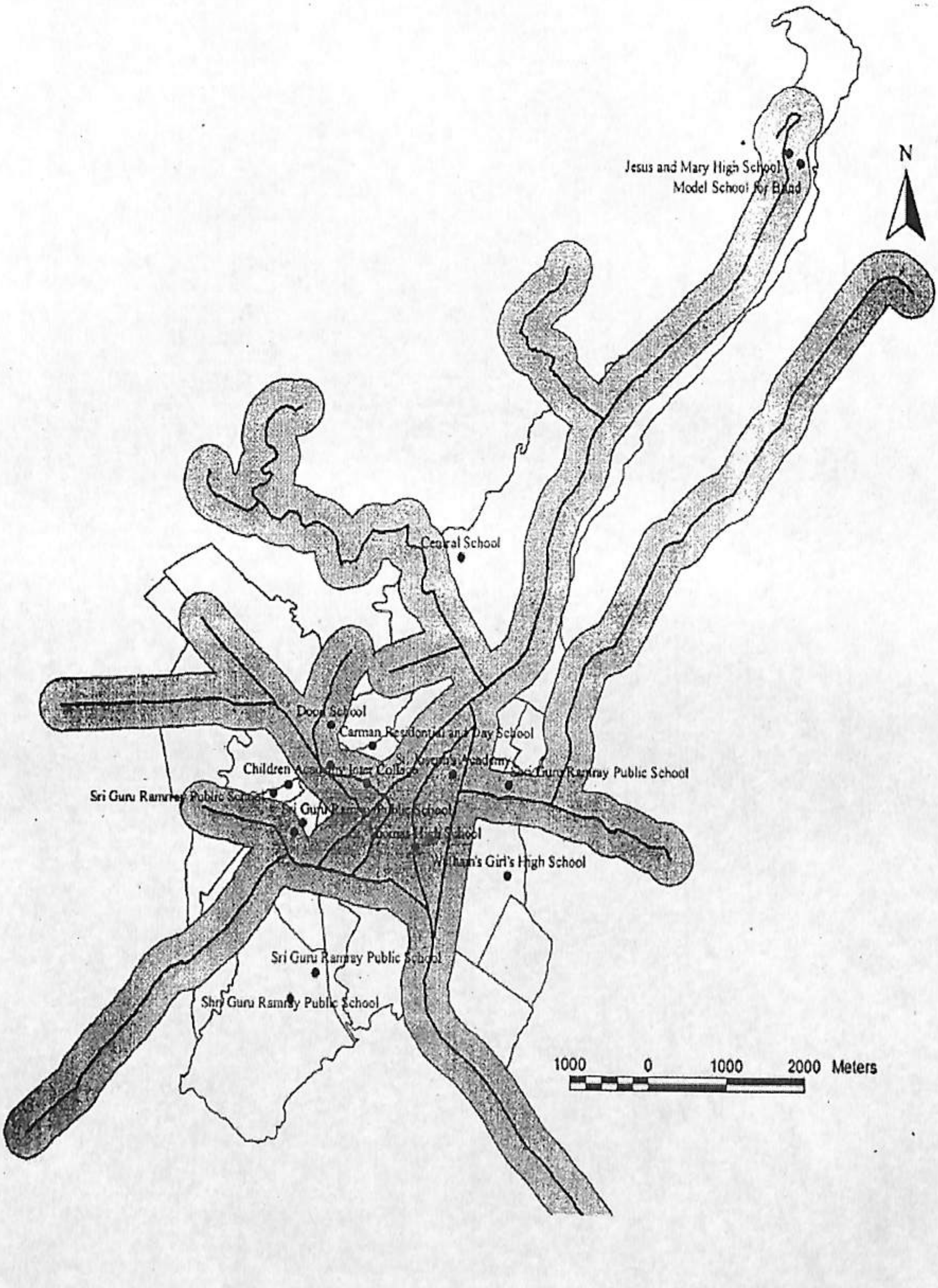


Fig 3.5: Accessibility of Schools Vis-À-Vis Major Roads

2. Management of Urban Infrastructure/ Facilities or Utility Services:

The quality of life in the urban area largely depends on the availability of infrastructure as, water supply, waste disposal, road rail infrastructure, communication facility, house types and availability of various other basic services, health and education). Here we are taking two major facilities like educational facilities and hospitals. An area within an urban settlement, in the absence of these basic services and infrastructure, may inevitably be a slum. Hence, in order to prevent total anarchy in matters of utilities and services, the planning of facilities/ infrastructure becomes absolutely vital. One can obtain area wise availability of services, their concentration and dispersal. By this the city planners can calculate service demands for public facilities, such as schools, hospitals, and many more. Network analysis can be carried out and one may know which facility is most linked and which are the points of least connectivity as shown in Figure 3.4. Further, site suitability of various services, which is much needed for planning purposes, can be carried out much easily. In the present study of Dehradun city, site suitability of services has been shown in various maps. The exercise is carried out for schools and hospitals. For this, a multiple theme-based query has been carried out in case of Dehradun. It shows three theme based queries - with major road network of the city, ward wise population density and inter separable distances of the existing facility. Figure 3.4 shows suitable sites of hospitals in Dehradun, which fulfils specified criterion. It was if the population density is more than city's average density (i.e. more than 8000 persons per square km), distance from existing facility should be more than 5 km., and the distance from road is not more than 500 m. The query was run, and it located the existing vacant areas or suitable sites for hospitals in the city. Similar query was run for Schools but with a different proposition. In case of Schools, three theme based queries included major road network (A indicator of access to school), ward-wise population density and children population (a indicator of demand for school) and distance among existing schools. The resulting map shows the best possible locations for additional schools. Similar queries can be run for a number of other welfare services and the queries can be modified according to the need. It therefore, implies that the tools can be used more appropriately and quickly in case of urban management and planning.

Table 3.1: Land use / cover classes

Broad classes	*Type of land included*
Built up Land	Residential Institutional Roads Rivers
Cropped Land	Plantation/Cultivation
Thick Vegetation	Dense Forest (FRI) Open forest
Water Bodies	Pond
Open Ground	Play ground/ Stadium

Table 3.2: Land use and land cover for Dehradun

Classes	*Area in (square meters)*	*area Percent*
Built up	15124886	52.677
Crop Land	2435142	9.237
Recent fallow	6378080	14.295
Thick Vegetation	7220816	20.710
Open Ground	1322720	3.022
Water body	5392	0.0209

Table 3.3: Urban land use and land cover classification System

Level I	Level II
Urban built up land	Built up: residential, commercial and service, industrial, transportation, communication and utilities, industrial and commercial complexes, mixed urban and built up
Agricultural land	Cropland and pasture, orchards, groves, vineyards, nurseries and ornamental Horticulture areas. Other agricultural Areas
Rangeland	Shrub and bush rangeland and mixed Rangeland
Forest land	Deciduous forest land, Evergreen forest mixed forest
Water	Streams, lakes, reservoirs, Bays and Estuaries
Wetland	Forested wetland and non-forest Wetland
Barren land	Dry-salt flats, beaches, sandy areas other than beaches, bare exposed rocks, strip mines, quarries and gravel bits Mixed barren and transitional areas.
Tundra	Shrub and bush tundra, bare ground Tundra and mixed tundra.

Chapter 4

Material & Methodology

4.1 Objectives

The objective of the present paper is to highlight the importance of Rapid EIA (Land environment) in the study of Dehradun city.

For this purpose it aims:

1. To analyse the urban land use and land cover of Dehradun City using analytical techniques.

2. to obtain a pattern of location of various types of facilities and how they can be managed in terms of better urban planning using land of Dehradun district (lying between 78 degree East to 78° 10' and 30°15' N to 30°25' N), also the capital of Uttrakhand. The city located at an altitude of 640 Mt. above mean sea level slopes gently from north to south and southwest with a gradient of 1:37.5. The city is highly dissected by a number of streams, which are locally known as Khalas. The drainage of the city is borne by Bindal and Rispana rivers. At the outskirts, there are denser forests (Town Directory of Dehradun). Broadly, the city has expanded towards south along major radial corridors. The road pattern of the city is radial with 5 main transportation corridors originating from the center of the city. The character of the city is changing from services to industry, trade and commerce, while expanding its secondary and tertiary sectors in order to strengthen its economic base has contemplated many changes in its functional character. This has attracted a large population from surrounding areas. Thus, putting additional strains on the existing infrastructure.

4.1.1 DATA AND METHODOLOGY

Different types of data have been used in this study, soil sampling , soil analysis and solid waste management of Dehradun city.

4.2 REQUIREMENTS IN ANALYSIS

- **Equipments used**

1. Soil sampling luxuries
2. U-V Spectrophotometer
3. Flame photo Meter
4. pH Meter
5. Conductivity Meter
6. Magnetic stirrer

- **Deferent types of glassware**

Pipette, burette, conical flask, round bottom flask, beaker, kjeldal flask, etc

- **Deferent types of chemicals for analysis**

4.2 SOIL SAMPLING

A soil test, the best available guide to the application of fertilizers and other nutrient sources, also is an excellent diagnostic tool for problem soils. Routine analysis for fertilizer recommendation generally includes soil pH, electrical conductivity, organic matter, nitrate-nitrogen, phosphorus and potassium. The widespread growth in soil testing programs is due, in part, to improvements in analytical methods and procedures and better and more calibration data, which allow increased efficiency in nutrient management decisions.

Successful soil testing depends upon the initial soil sample. The soil is a heterogeneous material, as shown by the visual differences in surface appearance and in the profile. A routine soil sample weighs approximately one pound. This represents 0.00005 percent or one part out of each two million parts of the average top 6 inches of an acre of soil, commonly referred to as an "acre furrow slice." The importance of a representative soil sample prior to laboratory preparation, extraction, analysis and interpretation of results for a fertilizer recommendation is readily apparent. Above all, *soil sampling requires time and effort.* The result is optimum production, if not limited by other factors, and most importantly, maximum return from the fertilizer investment.

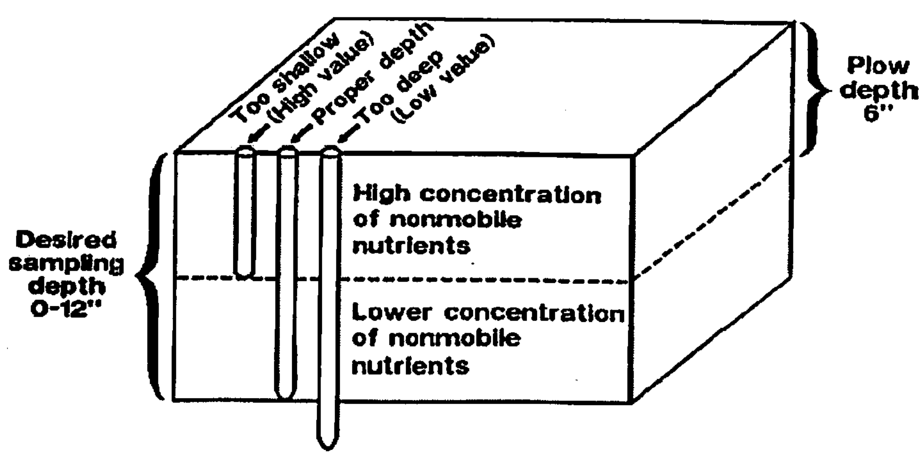


Fig 4.1: Too deep or shallow a sampling depth can produce inaccurate soil test result

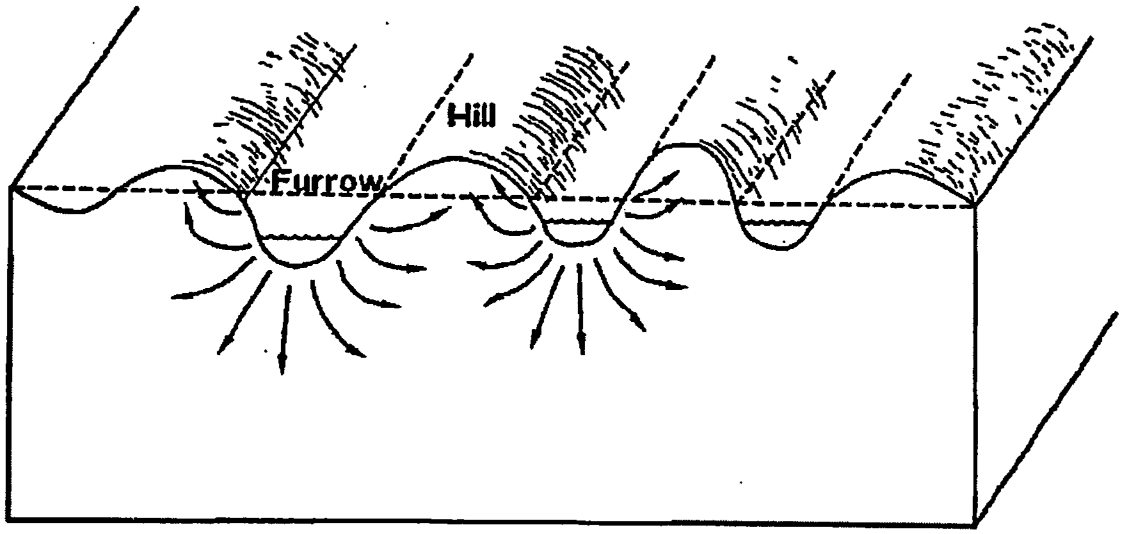


Fig 4.2: Movement of Mobile Nutrients in Furrow-Irrigated Fields.

- **TIME OF SAMPLING**

Fields used for crop production are best sampled at any time after harvest and before planting. To obtain an accurate estimate of nitrogen availability (as nitrate-nitrogen), take samples as close to planting time as possible. Fields with non-cultivated crops can be sampled during the dormant season. Adequate lead-time should be allowed for sample analysis, data interpretation, fertilizer recommendation and actual application.

To account for seasonal variations, soil samples should be collected at approximately the same time each year. Soils should be re-tested as often as necessary to determine the influence of cultural practices and crop production on soil chemical properties. Nitrate-nitrogen concentrations should be determined on an annual basis. Phosphorus and potassium determinations should be made every three or four years.

- **SAMPLING MATERIALS**

Common tools used to sample soils for routine analysis include: spade, hand probe, hand auger, bucket auger, Oakfield probe and King tube, or vehicle-mounted hydraulic probe and auger. Suppliers of soil sampling equipment are listed at the end of this MontGuide. Sampling equipment should be clean, free of rust and chrome plated or made of stainless steel, especially for micro-nutrient analysis. Store sampling tools in a location free from contaminationfor example, away from fertilizer materials.

Fig 4.3: Common soil sampling equipment.

- **SAMPLING PROCEDURES**

Obtaining a representative soil sample is the key to a successful soil testing program. A representative soil sample gives an average estimate of the whole area sampled. If sampled as one unit, a field with a high degree of variability may not reflect the field's average condition.

Specialized areas, such as dead or back furrows, manure piles, fences, roads, eroded knolls, low areas, salty or wet spots and other variable areas should be sampled separately or avoided. Separate soil samples are suggested for areas within a field that have had different crop rotation and fertilizer treatments, or that vary in slope, texture, organic matter and depth, as shown by soil color, plant growth or yield.

Individual soil cores from a minimum of 20 locations should be mixed thoroughly in clean plastic containers. A subsample of the soil mixture is removed and placed in a soil sample bag, often lined with plastic. This sample, commonly referred to as the composite sample, consists of a mixture of the individual cores.

The alternative to compositing is physical averaging of the analytical results of individual soil cores (a costly procedure) to obtain an arithmetic average. Compositing decreases the cost of individual analysis for each soil core. The bags must be properly labeled with field identification, sampling depth, management history and other descriptive characteristics. Moist samples must be air-dried before submission to a laboratory to prevent alteration of the nutrient concentrations by soil microorganisms. Sample contamination from dust and foreign materials should be avoided during the air-drying process. Frozen samples are an alternative, but usually are not practical. Oven drying moist soil samples is not recommended because modification of nutrient form and availability make soil test results invalid.

Preliminary results indicate that microwaving soil samples for two to three minutes may prevent nitrogen transformation by microorganisms. The goal is to stop microbial functions, with no increase in soil temperature. This method, which requires further study, may be useful for on*ly* nitrate-nitrogen analysis and not for a total fertility analysis program.

Generally, a 100-acre field comprises the largest area to be sampled as one unit. The number of cores to represent an average soil from a field is determined by field variability, not by the number of acres. The number of cores obtained determines the accuracy and precision of the analytical result.

Crop residues should be removed from the surface before sampling. Sampling depth for most soils traditionally has been the tillage depth, consisting of 0? to 6-

inch interval. The top 6 inches is the area that has the majority of root activity and fertilizer applications generally are restricted to this depth. Deep-rooted crops, such as wheat, barley and grasses, need deeper sampling if nitrogen fertilizer recommendations are desired. Subsoil samples from the 6- to 24-inch depth or to a root (or probe) restricting layer, are used to estimate available nitrogen and, in some cases, sulfur. The 6- to 24-inch sample should be divided into the 6- to 12 and 12- to 24-inch depth intervals if cost is not prohibitive. Nitrate-nitrogen and sulfate-sulfur are mobile in soil and will move below the 6-inch tillage layer. If leaching has not moved these nutrients below the rooting depth, they will be available for plant uptake. Soil samples down to 48, or even 60 inches, can be obtained with a hydraulic probe designed for deep sampling. Deep sampling can improve fertilizer management for certain crops and/or situations.

Uniform fields can be sampled in a simple random, stratified random or systematic pattern. The result from these sampling plans, the soil test value, provides an estimate of the entire population of possible soil test results. As the number of cores increases, the error, or chance of obtaining an inaccurate estimate of the average soil test value, decreases. Practically speaking, the time required to obtain soil samples governs the number of cores taken. A good sampling plan helps to ensure the accuracy of the soil test result.

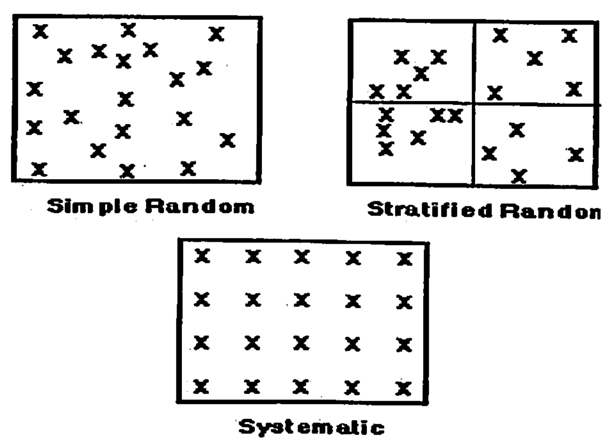


Fig 4.4: Sampling Plans (X Represents an Individual Soil Core Location).

With a simple random system each soil core is selected separately, randomly and independently of previously drawn units. A stratified random sample is taken from a field that has been divided into several subunits or quadrants from which simple random cores are obtained. This increases the precision for the field. The systematic sample is a further progression in an attempt to ensure complete field coverage, similar to the change from the simple random to the stratified random. Cores are taken at regularly spaced intervals in all directions.

The systematic sampling plan has been widely accepted, because it is straightforward and potentially increases the accuracy of soil tests.

Recent research termed "prescription farming" or "farming by soil" has attempted to integrate the inherent variability of soils with differential fertilizer application. This may or may not include sophisticated application equipment. From a soil sampling perspective, a field is divided into management areas that have similar soil types, terrain position (ridge, side slope, bottom) or other unique features (Figure 4.4).

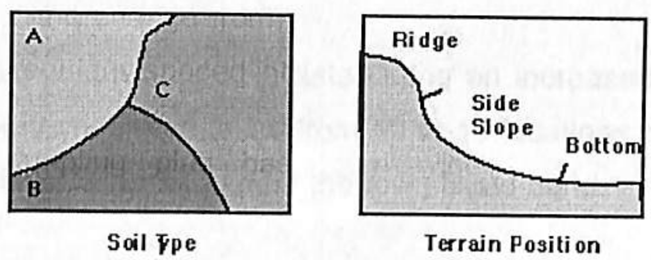


Fig 4.5: Prescription farming soil sampling plans.

Once these areas are identified, then either a simple random or systematic sampling plan is utilized for soil sampling.

SPECIALIZED SAMPLING

Widespread acceptance of conservation tillage necessitates the adaptation of suitable soil sampling techniques for reduced tillage fields. The lack of tillage in reduced and no-till systems results in stratified physical and chemical characteristics of the surface soil. Conservation tillage changes the distribution of soil acidity, phosphorus and potassium, which affects fertility and herbicide programs. When soil sampling, the plow layer should be divided into two depths, from 0 to 2 inches and from 2 to 6 inches. Sample cores between the rows if starter fertilizer was banded in past years. If all fertilizer is applied in a band for irrigated crops, sample three to four cores that are spaced equally between the ridge or row. For example, if the row spacing is 36 inches, cores are taken at 9, 18 and 27 inches from one reference row. This evens out chances of sampling directly in a fertilizer band.

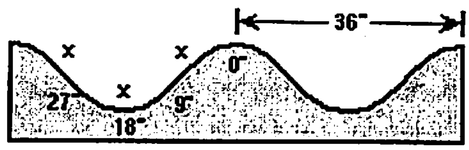


Fig 4.6: Soil sample locations for irrigated row crops (X represents one individual soil sample location).

Soils that have been deep banded dictate taking an increased number of cores. Several sets of cores should be taken from 10 to 15 locations at a distance equal to one-half the fertilizer band width near the row placed band.

Fields irrigated with a center pivot system require special sampling techniques because of the varied terrain and specialized management. Divide the circle into several units and further subdivide the hills and valleys. Sample each area and either combines the laboratory results if soil test results are similar or treat each area separately. The expense of laboratory analysis will influence the number of areas to be sampled. Areas where salt detrimentally affects seedling germination should be sampled near the seeding depth to successfully troubleshoot. Additional sampling guidelines are required for pesticide or toxicant analysis and individuals should consult with the individual laboratory, agency or the appropriate Extension Service specialist.

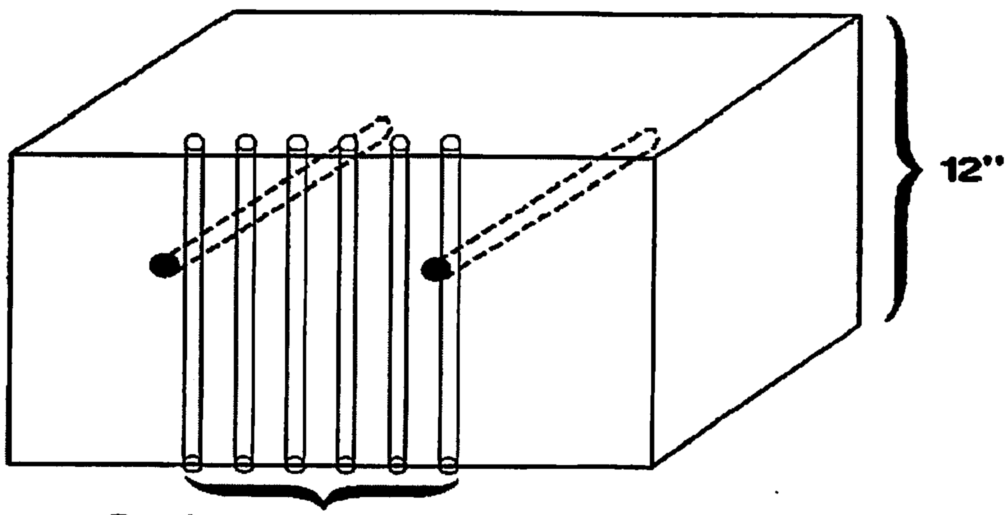


Fig 4.6: Systematic Soil Sampling In a Field Where Fertilizer Has Been Banded

- **COLLECTING A SUBSAMPLE**

Use a sampling tube, or if using a spade, follow these instructions:

1. Dig a V-shaped hole six inches deep or plow depth.
2. Take a 1-inch slice from one side of the hole.
3. Trim the sides of slice, leaving a 1-inch strip on the spade. Place this strip into the clean plastic pail.

Repeat this procedure until a representative number of subsamples are collected to make up the sample. Break up clods with your hands and thoroughly mix the soil in the pail by rotating the pail at a 45 degree angle. Remove approximately one pint of soil, place it into a paper bag, and label the bag as to garden, flower bed, south slope field A, etc., the date and your name. Discard the remaining soil.

Repeat the above procedure for the next area to be sampled, placing the samples in a separate paper bag. Be sure to label the paper bag promptly before you forget where the samples were obtained. Maintain a record of sampling areas to assist you in correctly applying the recommendations when they are received.

DRYING THE SAMPLES

Air dry all soil samples before mailing. Wet or damp samples stored for only a few days may yield unreliable results. Remove the soil sample from the paper bag and spread out in a thin layer about 1/4-inch deep on wax or butcher paper. Dry at room temperature.

CAUTION: Do not apply artificial drying by oven, stove or furnace as this may alter the sample results.

PROVIDE COMPLETE INFORMATION

After the soils have completely dried, place the samples into the soil test kit bags, fill to the correct mark, and clearly label. Fill out all requested information as completely as possible. This will ensure an accurate recommendation.

4.4 SOIL TESTING

Soil characteristics mainly define in three categories i.e.:

- **Soil physico-chemical**: Analysis of physico –chemical characteristics of soil.

- Organic matter
- Gypsum content
- Cation exchange capacity
- Calcium carbonate equivalent $CaCO_3$
- Lime requirement
- Moisture retention
- Particle size analysis

- Bulk density

➢ **Soil Salinity:** analysis of those ions which increase the salinity of the soil.

- pH
- Estimated soluble salts (electric conductivity)
- Bicarbonate in saturated paste extract
- Chlorine in saturated extract
- Boron in saturated paste extract
- Potassium, sodium, calcium, magnesium
- Sodium absorption ratio
- Sulfate sulfur in saturated paste extract

➢ **Soil fertility**: analysis of those ions which effect on soil fertility Soil.

- Nitrate and extractable ammonium by flow injection analyzer
- NO_3-n, NH_4-n
- Total kjeldal nitrogen
- Total nitrogen and carbon
- Sulfate- sulfur
- Extractable phosphorous
- Exchangeable X-K,X-Ca,X-Mg, X-Na
- Extractable micronutrient Zn, Mn, Cu, Fe

4.4.1 SOIL PHYSICO-CHEMICAL

1. ORGANIC MATTER - WALKLEY-BLACK METHOD

Physio Chem: OM, Org C

Organic Matter by potassium dichromate reduction of organic carbon and subsequent spectrophotometric measurement (modified Walkley-Black).

Summary: This method quantifies the amount of oxidizable organic matter in which OM is oxidized with a known amount of $Cr_2O_7^{2-}$ in the presence of sulfuric acid. The remaining Cr^{3+} chromate is determined spectrophotometrically at 600nm wavelength. The calculation of organic matter is based on organic matter containing 58% carbon. The method has a detection limit of approximately 0.10% and is generally reproducible within 8%.

2. GYPSUM CONTENT

By Special Request

Estimated value of the amount of gypsum present in soils.

Summary: The procedure is based on the measurement of the loss of crystal water associated with the hydrated form of gypsum. The precise determination of gypsum is difficult because of sources of Ca and SO_4 other than from gypsum. The method has a detection limit of approximately 0.1meq 100 gm^{-1} and is reproducible within 20%.

3. CATION EXCHANGE CAPACITY

Physio Chem: CEC

Cation Exchange Capacity by barium acetate saturation and calcium replacement.

Summary: The method determines the cation exchange capacity (CEC) of soil. The soil is quantitatively displaced of all exchangeable cations with barium, followed by four deionized water rinses to remove excess barium. A known quantity of calcium is then exchanged for barium and excess solution calcium is measured. CEC is determined by the difference in the quantity of the calcium added and the amount found in the resulting solution. The method has a detection limit of approximately 2.0 meq/100g.

4. CALCIUM CARBONATE EQUIVALENT

Physio Chem: $CaCO_3$
Gravimetric determination by reaction with hydrochloric acid.

Summary: This method is based on the gravimetric loss of carbonates as carbon dioxide in the presence of excess hydrochloric acid. Major sources of error are: evaporation of water and failure to adequately degas CO_2 from the sample. Soil carbonates are measured to determine soil buffering capacity with relation to soil fertility, chemical and pedogenic processes. This procedure is an estimate of free calcium carbonate in the sample. This procedure does not adjust for magnesium, potassium, or sodium carbonates or organic matter which may be present. The method detection limit is approximately 0.2% $CaCO_3$ equivalent (on a dry soil basis) and is generally reproducible within 10% (relative).

5. LIME REQUIREMENT

Physio Chem: LiR
The amount of lime required to raise the soil pH to its desired value, usually 6.5 - 7.0.

Summary: Buffer pH is the measure of a soil's active and reserve acidity (i.e., buffer capacity) and is used to estimate lime recommendations. The method is based on the reaction of soil buffered acidity with a chemical buffer resulting in a change in the pH of the buffer. This method is used for estimating exchange acidity including that associated with exchangeable aluminum. Standard calibration curves exist for liming based on a SMP value to a desired pH for soil groups in a geographic area. The lime requirement reported for this test is based on a desired pH of 7.0. The result is reported in T/A/8in (tons per acre of 100% $CaCO_3$ required based on an 8 inch furrow slice weighing 2.4 million pounds). The table used is taken from Soil, Plant and Water Reference Methods for the Western Region.

6. MOISTURE RETENTION

Physio Chem: Moisture Retention

Moisture retention determination using the pressure plate system.

Summary: The method determines the soil moisture content under constant preset pressure potential (ranging from -10 to -1500 kPa (0.1 atm to 15 atm)). Soil is brought to near saturation and then is allowed to equilibrate under a set atmospheric pressure potential. The method is used to determine the available water capacity of soils and/or moisture release curve. The method detection limit is 0.5%.

7. PARTICLE SIZE ANALYSIS

Particle Size Analysis (Sand/Silt/Clay)

Particle Size Analysis of sand, silt and clay in soil suspension by hydrometer.

Summary: This method quantitatively determines the physical proportions of three sizes of primary soil particles as determined by their settling rates in an aqueous solution using a hydrometer. The hydrometer method of estimating particle size analysis (sand, silt and clay content) is based on the dispersion of soil aggregates using a sodium hexametaphosphate solution and subsequent measurement based on changes in suspension density. The use of the ASTM 152 H-Type hydrometer is based on a standard temperature of 20°C and a particle density of 2.65 g cm^{-3}. Corrections for temperature and for solution viscosity are made by taking a hydrometer reading of a blank solution. The method has a detection limit of 2%

sand, silt and clay (dry soil basis) and is generally reproducible within 8% (relative).

8. BULK DENSITY

Physio Chem: BD

Determination of bulk density by measurement of volume and mass.

Summary: Soil bulk density is the ratio of the mass of dry solids to the bulk volume of the soil. The bulk volume includes the volume of the solids and of the pore space. The determination of bulk density consists of drying (105°C) and weighing a soil sample, the volume of which is known (core method) or must be determined.

4.4.2 SOIL SALINITY

1. SATURATED PASTE AND SATURATION PERCENTAGE

Saturated Paste Extract: SP

The saturation of soil with water and subsequent vacuum extraction of the liquid phase for the determination of dissolved salts.

Summary: This method involves saturating the soil with water and subsequent extraction under partial vacuum of the liquid phase for the determination of dissolved salts. Soil moisture at the point of complete saturation is the maximum amount of water held when all the soil pore space is occupied by water and when no free water has collected on the surface of the paste. Over a wide soil textural range, the saturation percentage (SP) is approximately twice the Field Capacity (FC) or -33kPa soil water potential and is four times the Permanent Wilting Point (PWP) or -1500 kPa soil water potential for soils of loam, to clay loam texture. The soil pH may be determined directly on the paste. From the saturated paste extract, estimates of ECe, and solution concentrations of Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}, Cl^{-}, B, HCO_3^{-}, CO_3^{2-}, SO4 estimate (actual measurement is total S in extracts), SAR and ESP can be made. The method is generally reproducible within 8%.

Saturated Paste Extract: pH

Semi-quantifies soil pH using the saturated paste and pH meter.

Summary: This method determines the pH of soil, using a saturated paste prepared from the soil and a pH meter. It is most applicable to soils with a pH ranging from 4.0 to 9.0. It is not possible to determine the total acidity or alkalinity of the soil from pH because of the nature of the colloidal system and junction potential. This method does however provide information on the disassociated H-ions affecting the sensing electrode. The method is generally reproducible within 0.2 pH units.

2. pH OF A 1 + 10 SOIL SUSPENSION

Semi-quantifies soil pH using an extract of a 1 to 10 dilution of soil with water.

Summary: This method determines the pH of soil, using an extract of a 1 to 10 dilution of soil with water and a pH meter. The pH of a soil sample increases with the degree of saturation (dilution effect). This rise in pH from pHs to pH 1+10 is usually 0.2 to 0.5 pH units but may be one or more units in certain alkaline soils where there is an increase in dissociation due to dilution of soluble salts.

3. ESTIMATED SOLUBLE SALTS (ECe)

Saturated Paste Extract : EC

Semi-quantifies the amount of soluble salts in the saturation paste extract using conductivity meter.

Summary: This method semi-quantifies the amounts of soluble salts in the liquid phase extracted from the saturated paste of soils and is based on the measurement of the electrical conductivity (ECe) of a saturated paste extract. The higher the concentration of salt in a solution, the higher will be the electrical conductance (the reciprocal of resistance). Electrical conductivity is a function of quantity and specific types of cations and anions in the extract. Plant tolerance can be related to the ECe value of the saturated paste. The method has a detection limit of approximately 0.01 dS m^{-1}(mmhos cm^{-1}) and is generally reproducible within 7%.

4. BICARBONATE AND CARBONATE IN SATURATED PASTE EXTRACT

Saturated Paste Extract: HCO_3^-, CO_3^{--}

Quantification of the bicarbonate (HCO_3^-) and carbonate (CO_3^{2-}) in the saturated paste extract by titration with acid.

Summary: This method quantifies bicarbonate ($HCO3^-$) and carbonate ($CO3^{2-}$) levels in a soil water extract, such as from saturated paste extract. Quantitation is by titration with 0.025 N H2SO4. The measurement should be made immediately due to the potential of the extract being super saturated relative to calcium carbonate (CaCO3). The method has a detection limit of approximately 0.1 meq L^{-1} and is generally reproducible within 7%.

5. CHLORIDE IN SATURATED PASTE EXTRACT - FLOW INJECTION ANALYZER METHOD

Saturated Paste Extract: Cl

Amount of chloride by Flow Injection Analyzer method.

Summary: This method quantifies the amount of Cl^- in a soil water extract, such as from the saturated paste extract. Thiocyanate ion is liberated from mercuric thiocyanate by the formation of soluble mercuric chloride. In the presence of ferric ion, free thiocyanate ion forms the highly colored ferric thiocyanate, of which the absorbance is proportional to the chloride concentration. The absorbance of the ferric thiocyanate is read at 480 nm. Plant tolerance to chloride can be related to the concentration of chloride in the saturated paste extract. The method has a detection limit of 0.1 meq/L of Cl^- and is generally reproducible within 5%.

6. POTASSIUM, SODIUM, CALCIUM, AND MAGNESIUM IN SATURATED PASTE EXTRACT

Saturated Paste Extract: K, Na, Ca, Mg

Amounts of soluble calcium and magnesium in the saturated paste extract by ICP-AES. Amounts of soluble potassium and sodium in the saturated paste extract by emission spectrometry.

Summary: This method quantitatively determines the concentration (meq L^{-1}) of dissolved K, Na, Ca, and Mg in the saturated paste extract using inductively coupled plasma emission spectrometry (ICP) for Ca and Mg and emission spectrophotometry (AA) for K and Na. These four ions generally are the dominant cations in the saturated paste extract of soils. Concentration of soluble Na, Ca, and Mg is used to determine the sodium absorption ratio (SAR) of soils. Extract solutions containing greater than 10,000 mg L^{-1} (1.0% w/v, estimated from ECe) will require dilution since solutions this concentrated with salt may impair instrument operation. The detection limits for these cations are approximately 0.1 meq L^{-1} on a solution basis.

7. SAR (SODIUM ADSORPTION RATIO) AND ESP(EXCHANGEABLE SODIUM PERCENTAGE)

Saturated Paste Extract: SAR, ESP

Sodium Adsorption Ratio estimated calculation from calcium, magnesium and sodium on saturated paste extract. Exchangeable Sodium Percentage calculated from SAR values.

Summary: The exchangeable sodium percentage (ESP) and the sodium adsorption ratio (SAR) are calculated after determining Ca, Mg and Na concentrations in a saturation extract (SOP# 235).

8. SULFATE-SULFUR IN SATURATED PASTE EXTRACT

Saturated Paste Extract: SO_4-S

Concentration of sulfate-sulfur in the saturated paste extract, by ICP-AES.

Summary: This method quantitatively measures the concentration of sulfate in the extract of the saturated paste. It is based on the determination of sulfate sulfur in the extract using an Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES). Sulfate uptake by plants can be related to the sulfate concentration in the saturated paste extract. The method has a detection limit of approximately 0.1 mg L^{-1} and is reproducible within 8%.

4.4.3 SOIL FERTILITY

1. SOIL NITRATE AND EXTRACTABLE AMMONIUM BY FLOW INJECTION ANALYZER METHOD

Fertility: NO3-N, NH4-N

Equilibrium extraction of soil for nitrate and ammonium with potassium chloride and subsequent determination by flow-injection analyzer.

Summary: This method involves the quantitative extraction of nitrate (NO3-N) from soils using an equilibrium extraction with 2.0 N KCl solution. Nitrate is determined by reduction to nitrite via a copperized cadmium column. The nitrite is then determined by diazotizing with sulfanilamide followed by coupling with N-(1-naphthyl)ethlyenediaminie dihydrochloride. The absorbance of the product is measured at 520 nm. This method is also semi-quantitative for ammonium (NH4-N) in soils. Ammonia is heated with salicylate and hypochlorite in an alkaline phosphate buffer. The presence of EDTA prevents precipitation of calcium and magnesium and sodium nitroprusside is added to enhance sensitivity. The absorbance of the reaction product is measured at 660 nm and is directly proportional to the original ammonia concentration. Extracts can be stored for up to three weeks at low temperature (<4°C). For long term storage, toluene or thymol may be added to the sample to prevent microbial growth. The method has detection limit of approximately 0.1 mg/kg (on a soil basis) and is generally reproducible within 7%.

2. TOTAL KJELDAHL NITROGEN (TKN)

Fertility: TKN

Total reduced nitrogen by the wet oxidation of soil organic matter and botanical materials using a micro Kjeldahl procedure with sulfuric acid and digestion catalyst.

Summary: The Total Kjeldahl Nitrogen (TKN) method is based on the wet oxidation of soil organic matter and botanical materials using sulfuric acid and digestion catalyst and conversion of organic nitrogen to the ammonium form. Ammonium is determined using the diffusion-conductivity technique. The procedure does not quantitatively digest nitrogen from heterocyclic compounds (bound in a carbon ring), oxidized forms such as nitrate and nitrite, or ammonium from within mineral lattice structures. The method has a detection limit of approximately 0.001% N and is generally reproducible within 8%.

3. TOTAL NITROGEN AND CARBON - COMBUSTION METHOD

Fertility: N, C

Combustion gas analyzer method for total nitrogen and total carbon.

Summary: This analytical method quantitatively determines the total amount of nitrogen and carbon in all forms in soil, botanical, and miscellaneous materials using a dynamic flash combustion system coupled with a gas chromatographic (GC) separation system and a thermal conductivity detection (TCD) system. The analytical method is based on the complete and instantaneous oxidation of the sample by "flash combustion" which converts all organic and inorganic substances into combustion gases (N2, NOx, CO2, and H20). The method has a detection limit of 0.01% for carbon and 0.04% for nitrogen and is generally reproducible within 5% (relative).

4. SULFATE - SULFUR

Fertility: SO4-S

Estimate of the concentration of sulfate-sulfur in soil by extraction with mono calcium phosphate.

Summary: This method estimates the quantitative concentration of sulfate sulfur (SO4-S) in the soil by extraction with monocalcium phosphate. This method for extractable sulfur as SO4-S follows the procedure originally outlined by Schulte and Eik (1988) with the following exception: (1) elimination of activated carbon and (2) determination of S by ICP-AES. The ICP-AES determines all sulfur, both organic and inorganic. This method is inappropriate for soil containing greater than 4% organic matter. The method is quantitative only for the time of sampling since sulfur is constantly being mineralized in the soil. The method has a detection limit of approximately 0.5 mg/kg sulfur as sulfate and is generally reproducible within 8%.

5. EXTRACTABLE PHOSPHORUS - OLSEN METHOD

Fertility: Olsen-P

Extractable phosphate based on alkaline extraction by 0.5 Normal NaHC03. Plant available phosphate for soils with pH greater than 6.5 by ascorbic acid reduction of phosphomolybdate complex and measurement by flow injection analysis.

Summary: This method estimates the relative bioavailability of inorganic ortho-phosphate (PO4-P) in soils with neutral to alkaline pH. It is not appropriate for soils which are mild to strongly acidic (pH <6.5). The method is based on the extraction of phosphate from the soil by 0.5 N sodium bicarbonate solution adjusted to pH 8.5. In the process of extraction, hydroxide and bicarbonate competitively desorb phosphate from soil particles and secondary absorption is minimized because of high pH. The orthophosphate ion reacts with ammonium molybdate and antimony potassium tartrate under acidic conditions to form a complex. This complex is reduced with abscorbic acid to form a blue complex which absorbs light at 880 nm. The absorbance is proportional to the concentration of orthophosphate in the sample. The method has shown to be well correlated to crop response to phosphorus fertilization on neutral to alkaline soils. The method has a detection limit of 1.0 mg/kg (soil basis) and is generally reproducible within 8%.

6. EXTRACTABLE PHOSPHORUS - BRAY METHOD

Fertility: Bray-P

Extractable phosphate for acid soils (pH less than 7.0) using a dilute acid-fluoride extractant.

Summary: This method estimates the relative bioavailability of inorganic ortho-phosphate (PO4-P) in soils with acid to neutral pH, using a dilute acid solution of hydrochloric acid containing ammonium fluoride. The orthophosphate ion reacts with ammonium molybdate and antimony potassium tartrate under acidic conditions to form a complex. This complex is reduced with abscorbic acid to form a blue complex which absorbs light at 880 nm. The method is shown to be well correlated to crop response on neutral to acid soils. The absorbance is proportional to the concentration of orthophosphate in the sample. The method has a detection limit of approximately 0.5 mg kg^{-1} (soils basis) and is generally reproducible within 8%.

7. EXCHANGEABLE POTASSIUM, CALCIUM, MAGNESIUM, AND SODIUM

Fertility: X-K, X-Ca, X-Mg, X-Na,

Equilibrium extraction of soil for plant available exchangeable potassium, sodium, calcium and magnesium using 1 Normal ammonium acetate (pH 7.0) and subsequent determination by atomic absorption/emission spectrometry.

Summary: This method is semi-quantitative and determines the amount of soil exchangeable K, Ca, Mg, and Na residing on the soil colloid exchange sites by displacement with ammonium acetate solution buffered to pH 7.0. Generally, these cations are associated with the exchange capacity of the soil. The method does not correct for calcium and magnesium extracted as free carbonates or gypsum. The method has a detection limit approximately of 1 mg/kg or 0.01 meq/100g and is generally reproducible within 7%.

Chapter 5

Result and Discussion

Table-5.1: Results of analysis of different soil samples in Dehradun city

Samples → / Parameter ↓	Standard	G.M.S. Road	Gadhi Cant	Rangers Ground	SAHASTRA Dhara Road
1. pH	6.5-7.5	7.2	7.8	7.5	7.7
2. Conductivity (ml.mho / c.m.)	Less than 1.0	1.23	0.89	0.92	1.11
3. Na^{+} (meq/100gm)	0.40-0.60	0.67	0.47	0.54	0.56
4. K^{+}(meq/100gm)	0.30-0.50	0.14	0.18	0.22	0.19
5. Ca^{++} (meq/100gm)	1.5-2.1	2.4	1.2	1.7	2.2
6. Mg^{++} (meq/100gm)	1.2-1.9	1.5	2.1	1.9	2.6
7. Iron (ppm)	More than 12	15	19	32	23
8. Chloride (mg/)	10-20	34	42	23	32
9. Phosphorous (kg/hact.)	More than 40	61	54	73	51
10. Sulphate(ppm)	More than 10	9	13	11	21
11. Organic Carbon (%)	More than 0.8	1.1	1.4	1.3	1.2

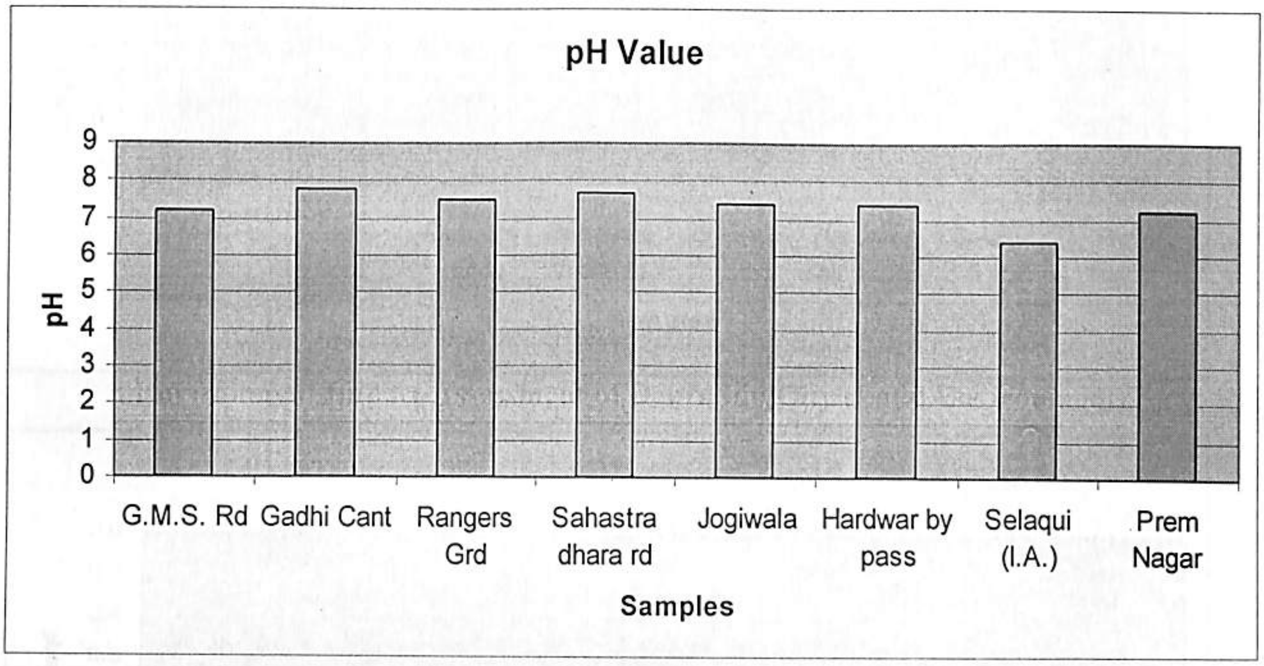
12. Total Nitrogen (kg/ha)	**More than 250**	245	398	231	195
13. Alkalinity (mg/l)	**150**	134	185	148	129
14. Acidity (mg/l)	**120**	93	112	89	83
15. Bulk density (gm/cm^3)	**NA**	1.49	1.45	1.32	1.76
16. Porosity (%)	**NA**	45	41	38	48
17. Water holding Capacity (%)	**NA**	41	39	36	42

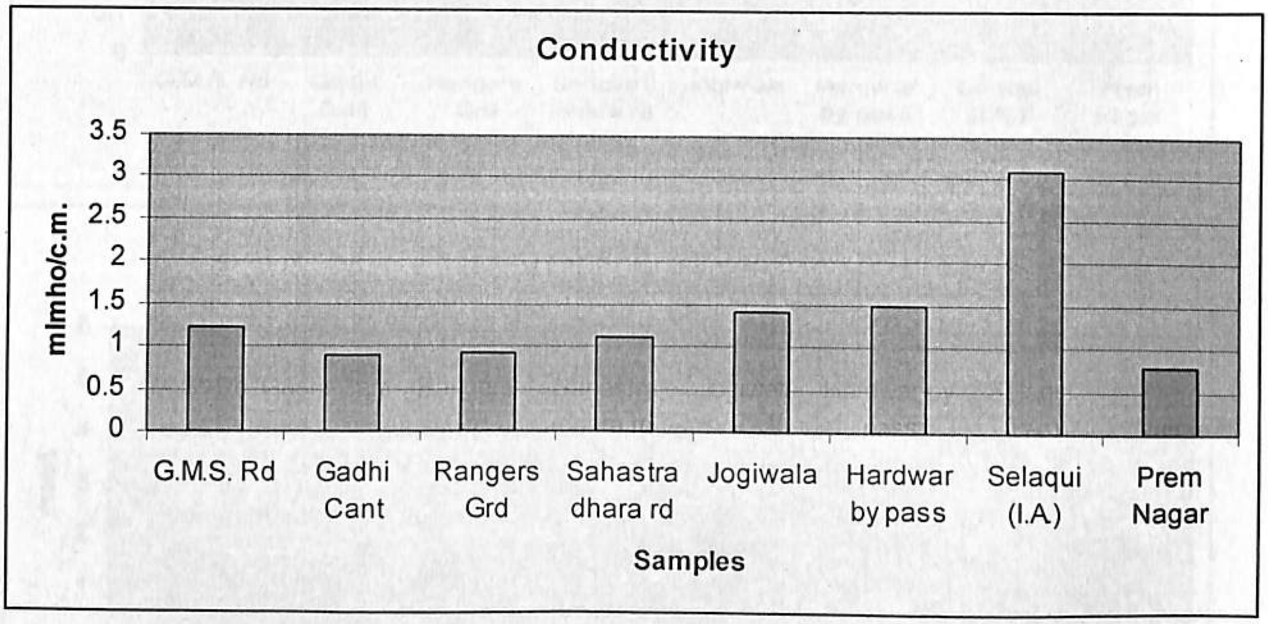
Table-5.2: Results of analysis of different soil samples in Dehradun city

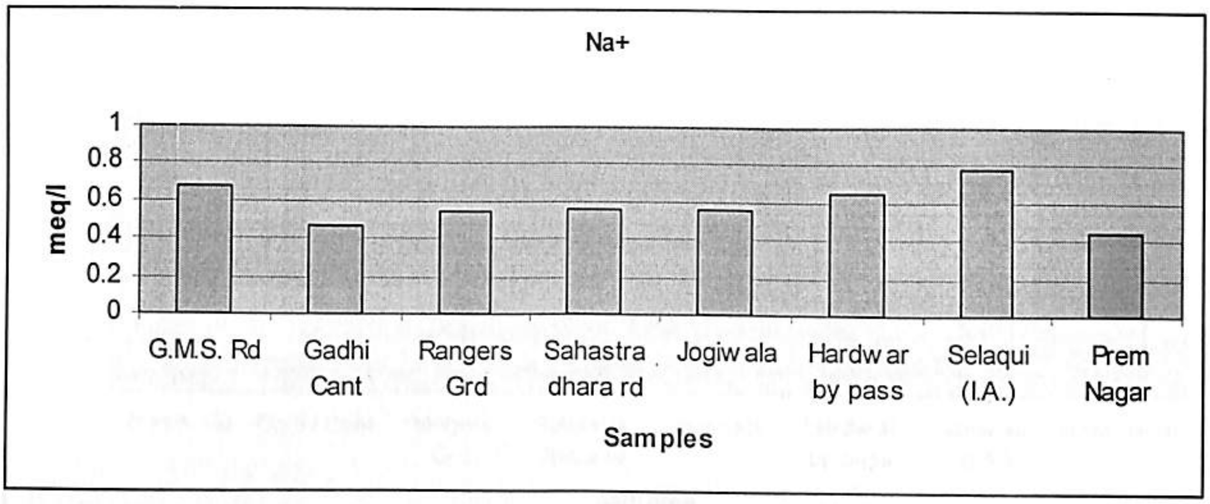
Samples → / Parameter ↓	Standard	Standard	JOGIWALA	HARIDWAR By-Pass Road	Selaqui (I.A.)	Prem nagar
1. pH	6.5-7.5	6.5-7.5	7.4	7.4	6.4	7.2
2. Conductivity (ml. mho/c.m.)	Less than 1.0	1.0	1.4	1.5	3.1	0.8
3. Na^+ (meq/100gm)	0.40-0.60	0.40	0.56	0.65	0.78	0.44
4. K^+(meq/100 gm)	0.30-0.50	0.30	0.18	0.20	0.56	0.19
5. Ca^{++} (meq/100gm)	1.5-2.1	1.5	2.6	2.1	4.8	1.9
6. Mg^{++} (meq/100gm)	1.2-1.9	1.2	1.7	2.2	5.3	2.1
7. Iron (ppm)	More than 12	16	24	19	36	28
8. Chloride (mg/)	10-20	20	54	23	51	48

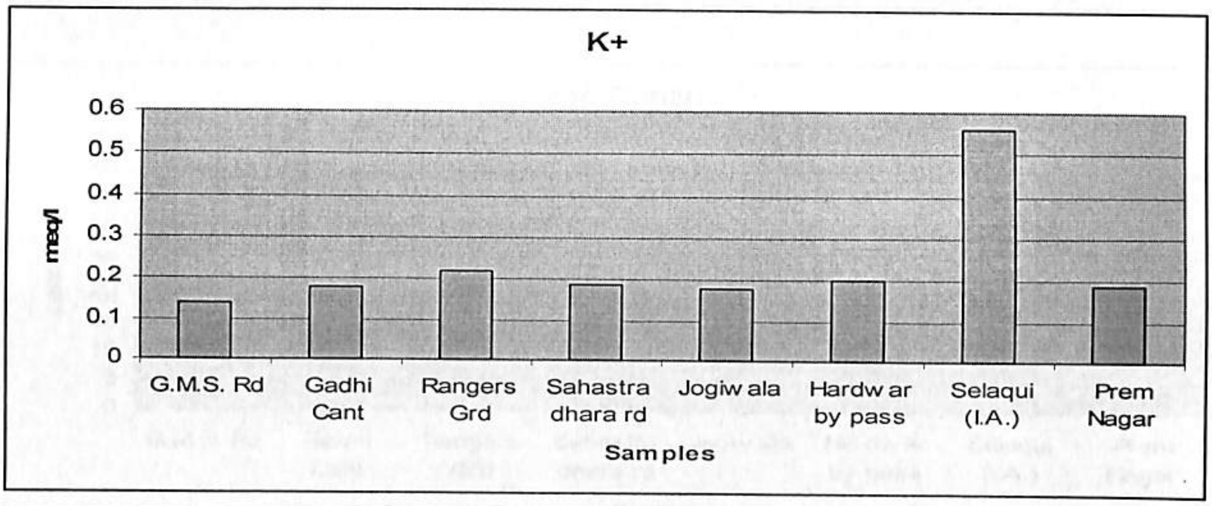
9.	Phosphorous (kg/hact)	More than 40	40	74	83	59	68
10.	Sulphate (ppm)	More than 10	10	16	11	43	13
11.	Total carbon (%)	More than 0.8	0.8	1.8	1.2	2.3	1.1
12.	Total Nitrogen	More than 250	250	342	183	393	371
13.	Alkalinity(mg/l)	150	150	162	128	163	112
14.	Acidity (mg/l)	120	120	75	82	124	92
15.	Bulk density (gm/cm^3)	NA	NA	1.51	1.84	1.74	1.23
16.	Porosity (%)	NA	NA	47	44	54	51
17.	Water holding Capacity (%)	NA	NA	39	38	49	47

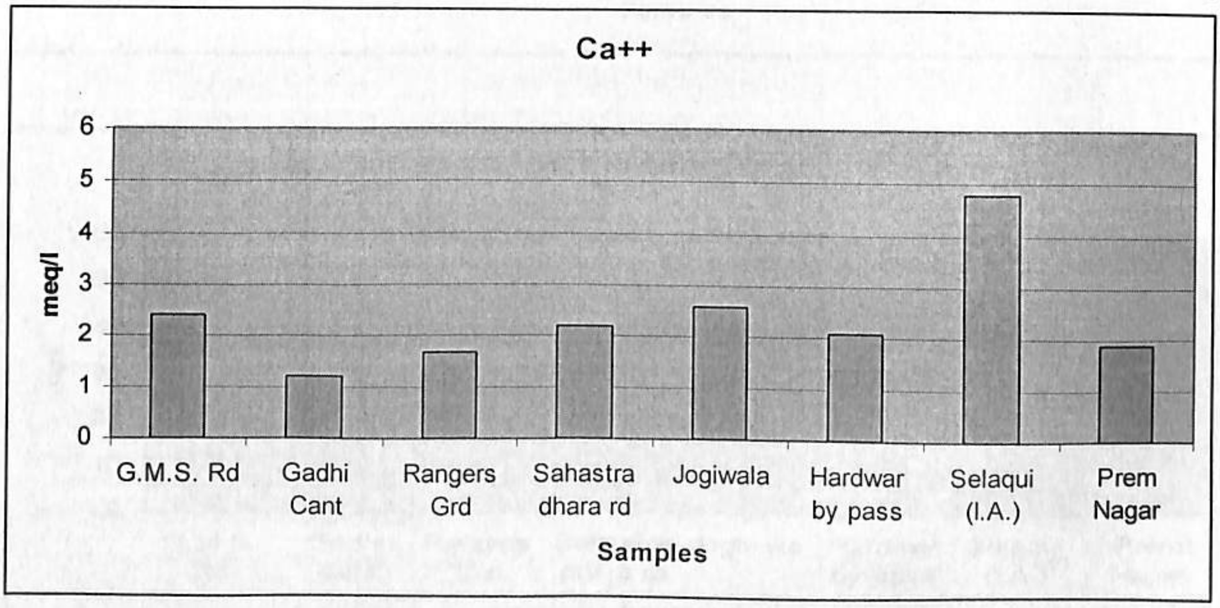
Graphical Representations of Results

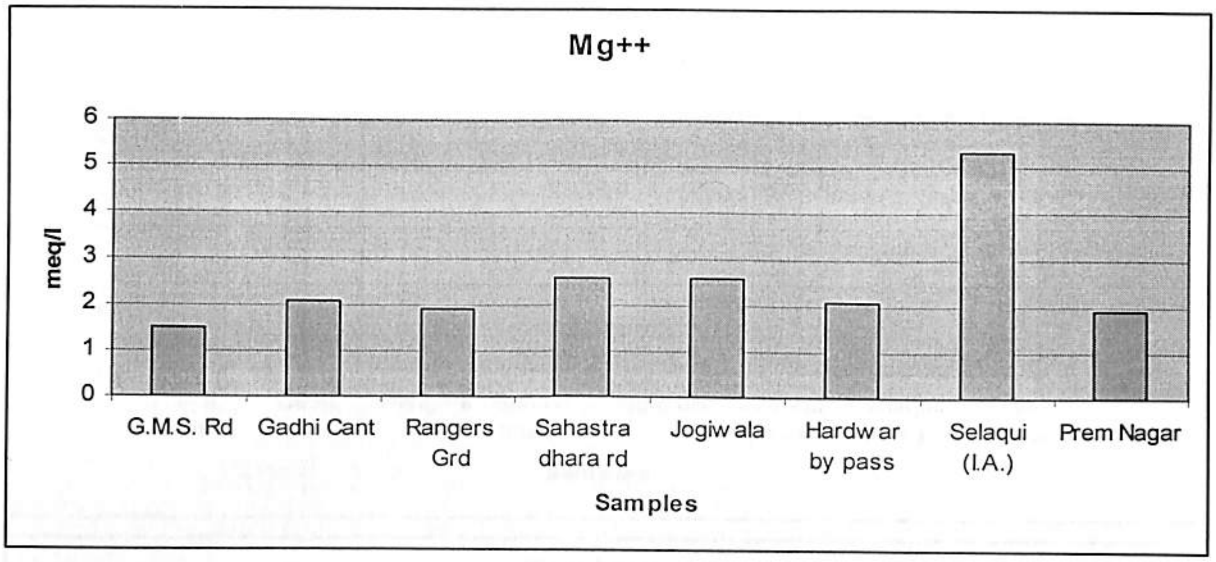


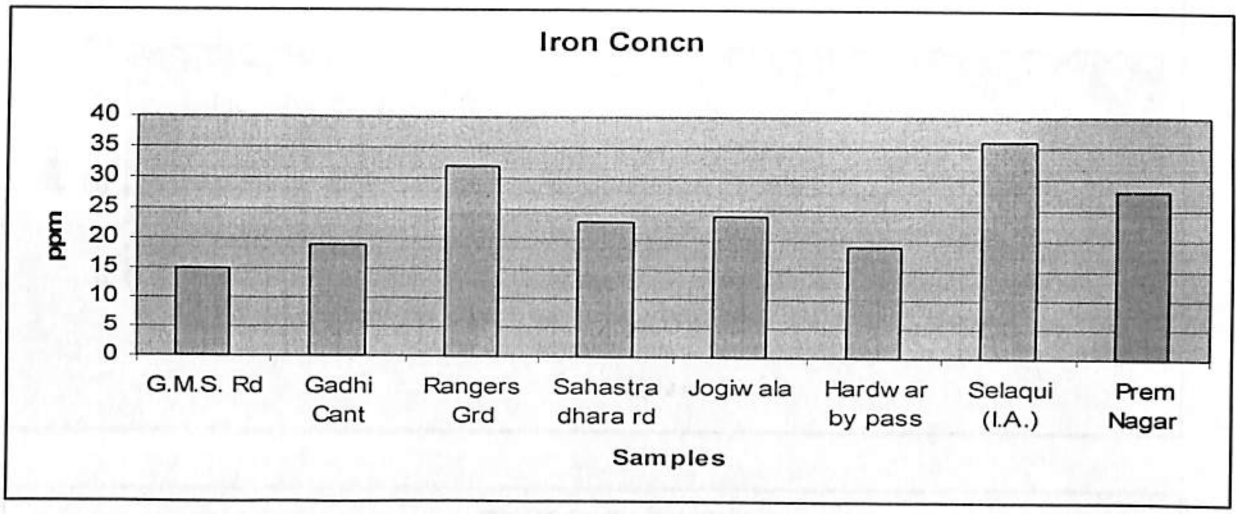


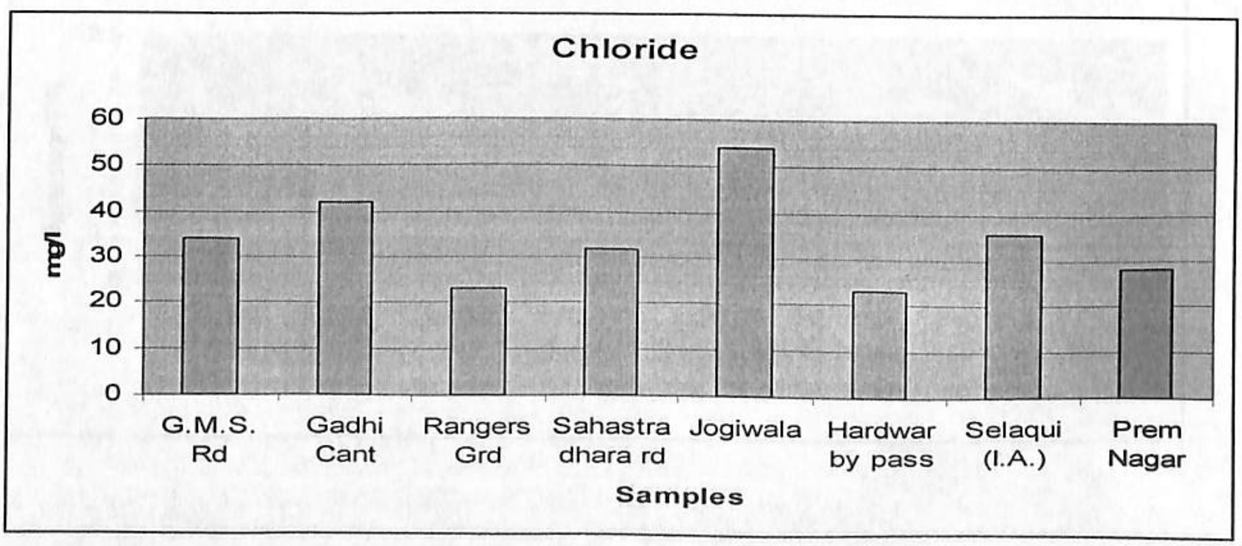

Na+
1
0.8
0.6
0.4
0.2
0
meq/l
G.M.S. Rd
Gadhi Cant
Rangers Grd
Sahastra dhara rd
Jogiw ala
Hardw ar by pass
Selaqui (I.A.)
Prem Nagar
Sam ples

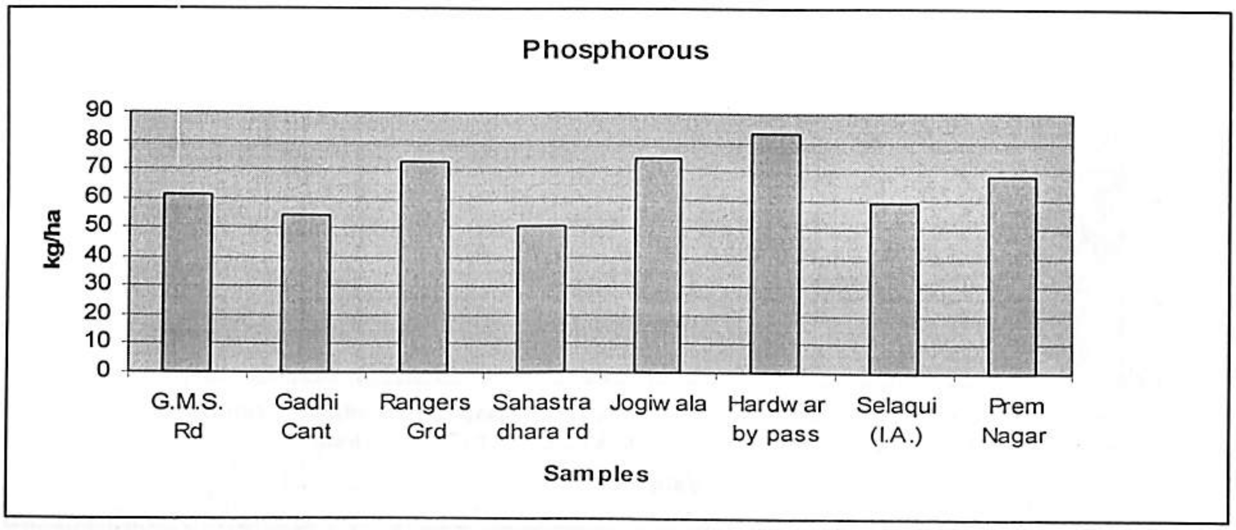

K+
0.6
0.5
0.4
0.3
0.2
0.1
0
meq/l
G.M.S. Rd
Gadhi Cant
Rangers Grd
Sahastra dhara rd
Jogiw ala
Hardw ar by pass
Selaqui (I.A.)
Prem Nagar
Sam ples

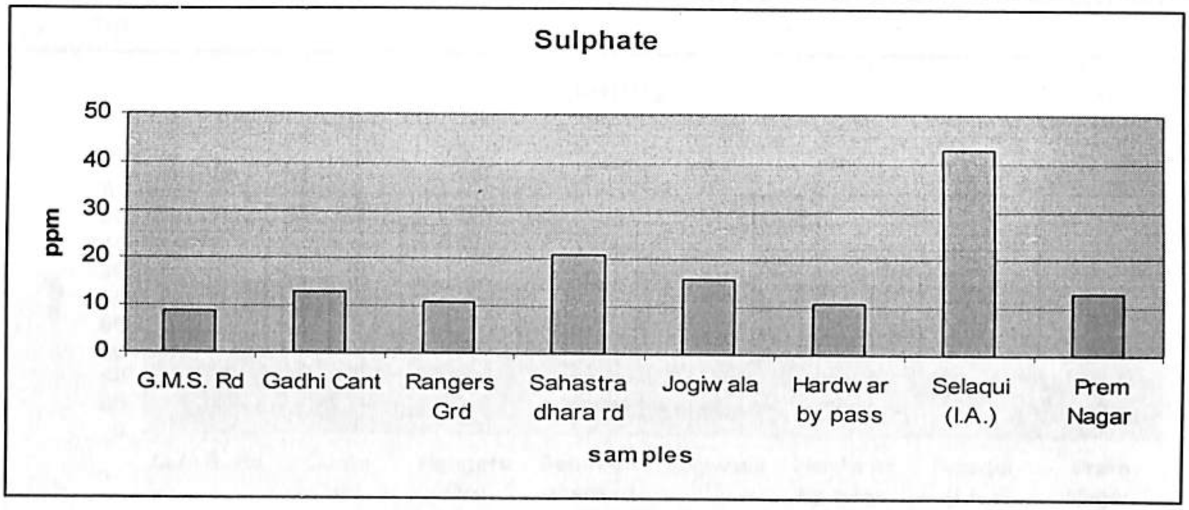

Ca++
6
5
4
3
2
1
0
meq/l
G.M.S. Rd
Gadhi Cant
Rangers Grd
Sahastra dhara rd
Jogiwala
Hardwar by pass
Selaqui (I.A.)
Prem Nagar
Samples

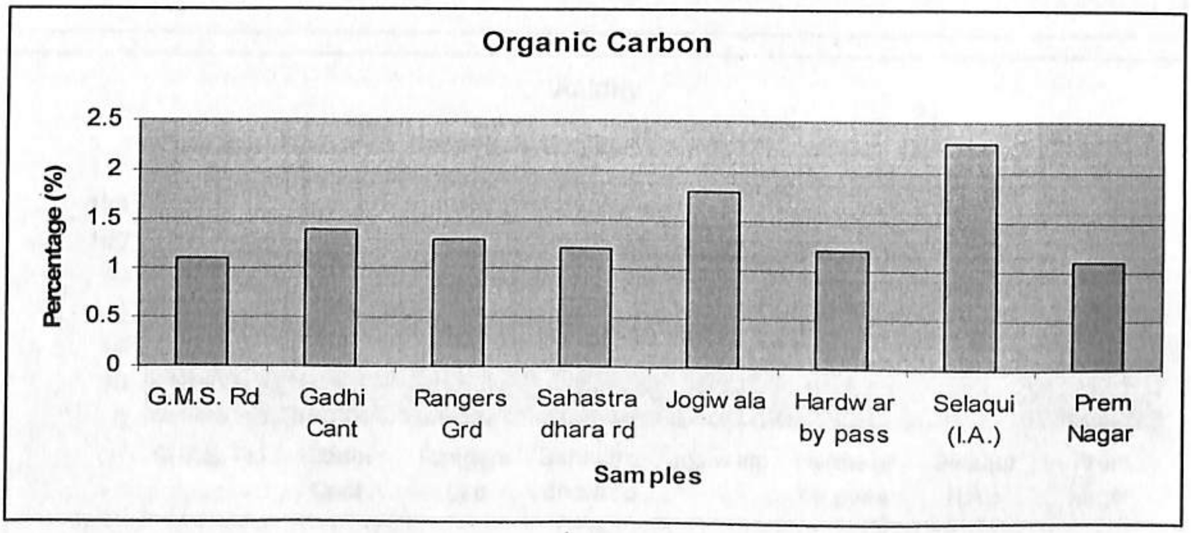

Mg++
6
5
4
3
2
1
0
meq/l
G.M.S. Rd
Gadhi Cant
Rangers Grd
Sahastra dhara rd
Jogiw ala
Hardw ar by pass
Selaqui (I.A.)
Prem Nagar
Samples

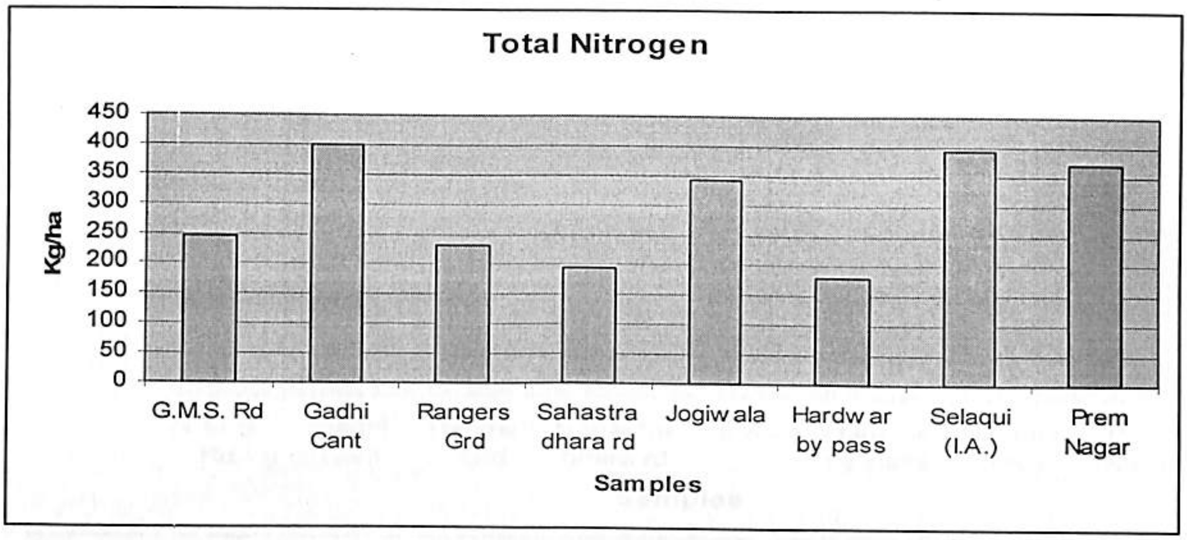

Iron Concn
40
35
30
25
20
15
10
5
0
ppm
G.M.S. Rd
Gadhi Cant
Rangers Grd
Sahastra dhara rd
Jogiw ala
Hardw ar by pass
Selaqui (I.A.)
Prem Nagar
Samples

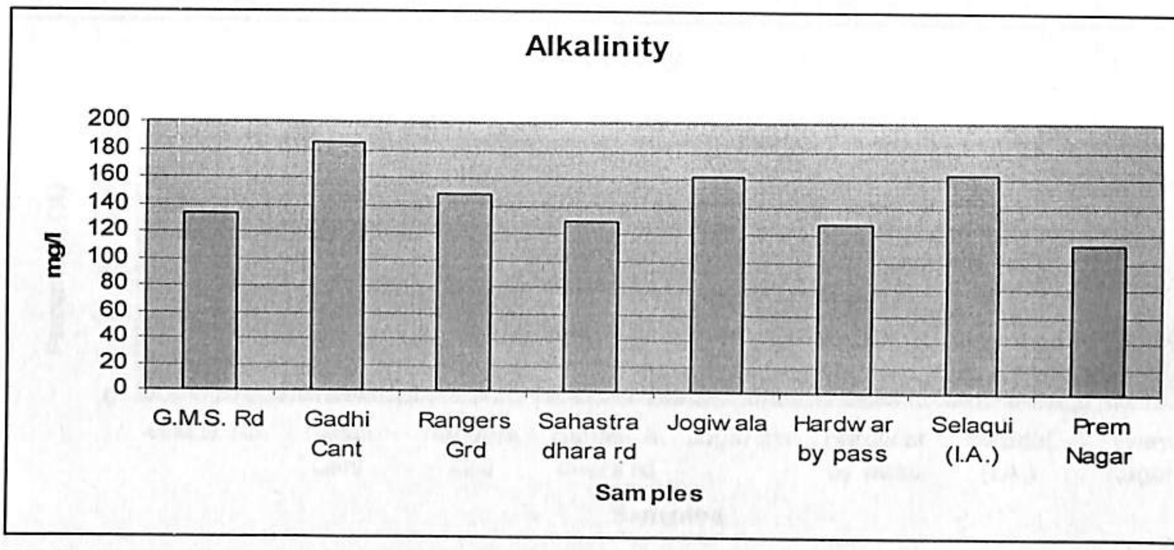

Chloride
60
50
40
30
20
10
0
mg/l
G.M.S. Rd
Gadhi Cant
Rangers Grd
Sahastra dhara rd
Jogiwala
Hardwar by pass
Selaqui (I.A.)
Prem Nagar
Samples

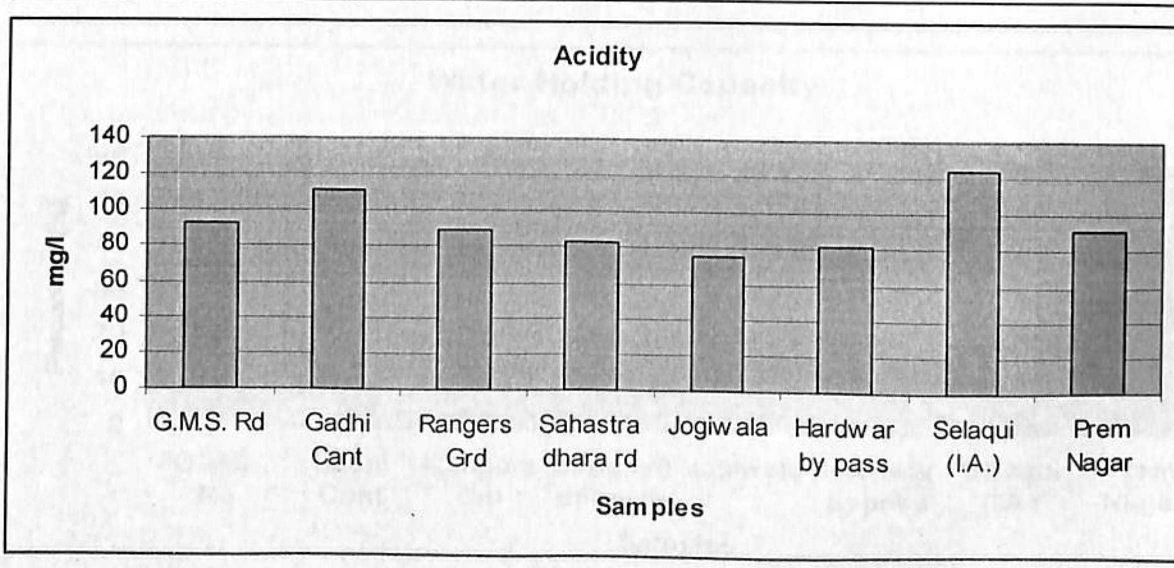

Phosphorous
90
80
70
60
50
40
30
20
10
0
kg/ha
G.M.S. Rd
Gadhi Cant
Rangers Grd
Sahastra dhara rd
Jogiw ala
Hardw ar by pass
Selaqui (I.A.)
Prem Nagar
Samples

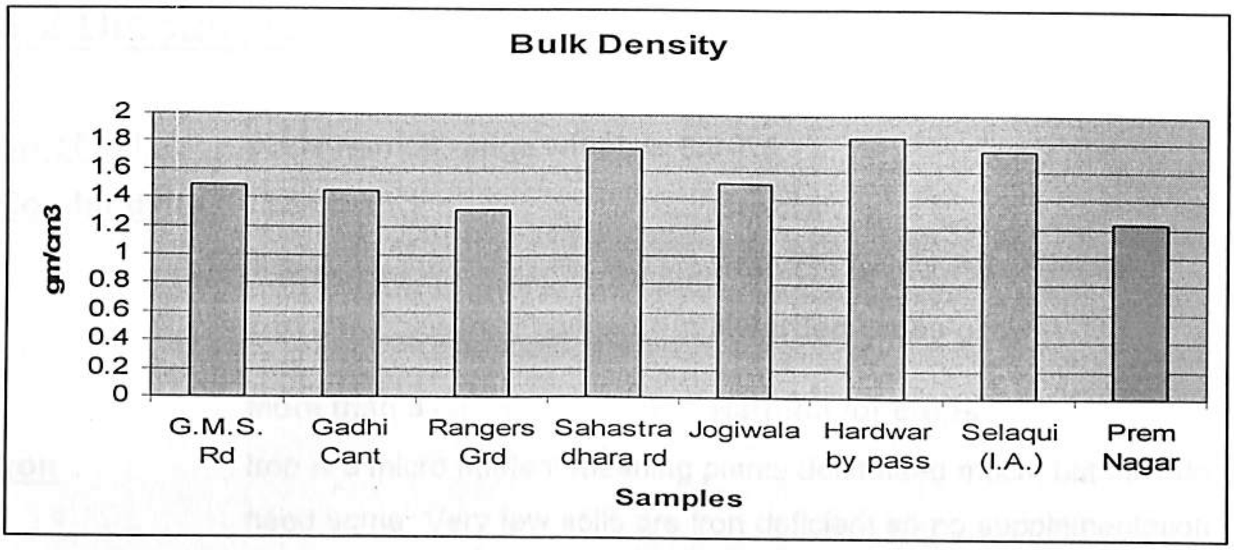

Sulphate
50
40
30
20
10
0
ppm
G.M.S. Rd
Gadhi Cant
Rangers Grd
Sahastra dhara rd
Jogiw ala
Hardw ar by pass
Selaqui (I.A.)
Prem Nagar
samples

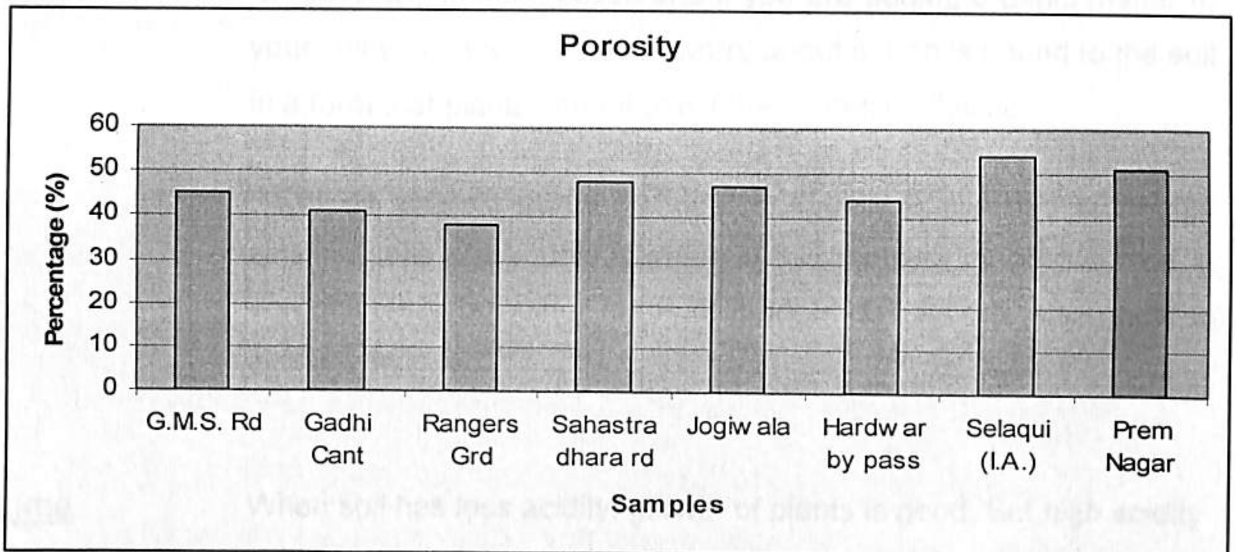

Organic Carbon
2.5
2
1.5
1
0.5
0
Percentage (%)
G.M.S. Rd
Gadhi Cant
Rangers Grd
Sahastra dhara rd
Jogiw ala
Hardw ar by pass
Selaqui (I.A.)
Prem Nagar
Samples

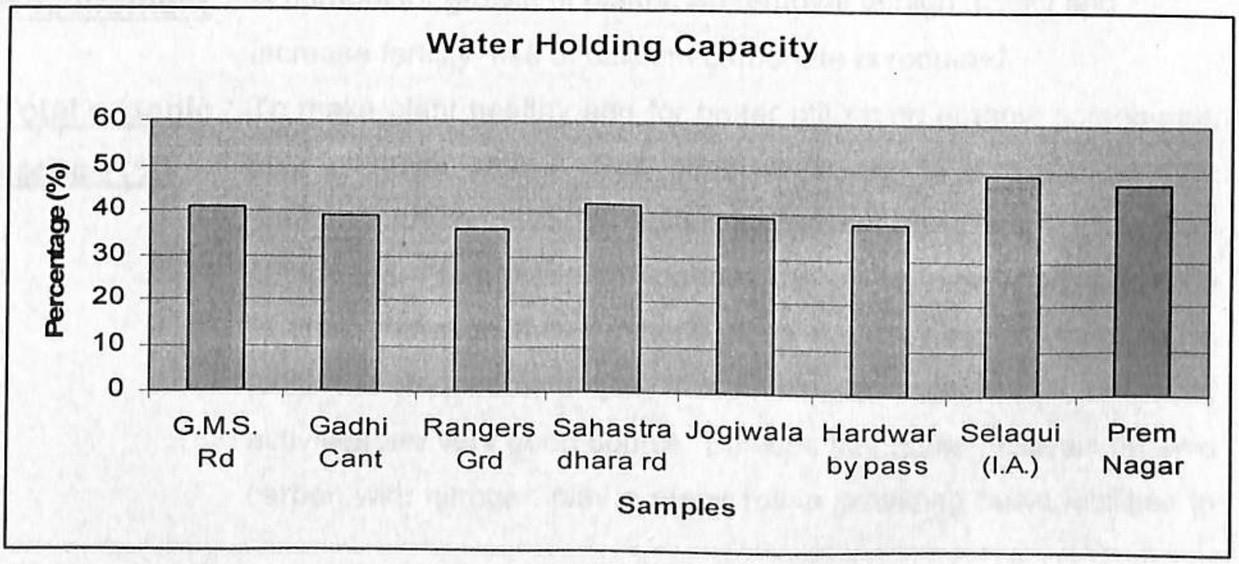

Total Nitrogen
Kg/ha
450
400
350
300
250
200
150
100
50
0
G.M.S. Rd
Gadhi Cant
Rangers Grd
Sahastra dhara rd
Jogiw ala
Hardw ar by pass
Selaqui (I.A.)
Prem Nagar
Sam ples


Alkalinity
mg/l
200
180
160
140
120
100
80
60
40
20
0
G.M.S. Rd
Gadhi Cant
Rangers Grd
Sahastra dhara rd
Jogiw ala
Hardw ar by pass
Selaqui (I.A.)
Prem Nagar
Sam ples


Acidity
mg/l
140
120
100
80
60
40
20
0
G.M.S. Rd
Gadhi Cant
Rangers Grd
Sahastra dhara rd
Jogiw ala
Hardw ar by pass
Selaqui (I.A.)
Prem Nagar
Sam ples


Bulk Density
gm/cm3
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
G.M.S. Rd
Gadhi Cant
Rangers Grd
Sahastra dhara rd
Jogiwala
Hardwar by pass
Selaqui (I.A.)
Prem Nagar
Samples


Porosity
Percentage (%)
60
50
40
30
20
10
0
G.M.S. Rd
Gadhi Cant
Rangers Grd
Sahastra dhara rd
Jogiw ala
Hardw ar by pass
Selaqui (I.A.)
Prem Nagar
Samples


Water Holding Capacity
Percentage (%)
60
50
40
30
20
10
0
G.M.S. Rd
Gadhi Cant
Rangers Grd
Sahastra dhara rd
Jogiwala
Hardwar by pass
Selaqui (I.A.)
Prem Nagar
Samples

5.2 Discussions

pH of soil	pH is normal range which is 6.8-7.5	
Conductivity	Less than 1	General
	1 to 2	Problem in growth of seeds
	2 to 3	Retarded crops growth
	More than 3	Harmful for crops

Iron

Iron is a micro nutrient meaning plants don't need much, but they do need some. Very few soils are iron deficient so no supplementation is necessary in most cases and if you are adding organic matter to your soil you have no need to worry about it. Iron is bound to the soil in a form that plants cannot use if the ph is too alkaline.

Most all veggies prefer soil that is slightly acidic to neutral and alkaline soils are trouble. Generally this problem manifests itself in iron chlorosis, but other forms of nutrient deficiencies also occur in alkaline soils too.

Lime Requirement

When soil has less acidity, growth of plants is good. But high acidity is harmful for growth of plants. So removal of high acidity and increase fertility, use of calcium carbonate is required.

Total organic carbon (%)

To make plant healthy and for better utilization organic compounds play a major roll. A Soil contains 95-99 % nitrogen 33-67% phosphorous and 75 % sulfur is present in a form of carbon compound. From these compounds the plants receive mineral time to time. Although these mineral does not provide full elements to fulfill the requirement yet these mineral, water and microbial activities are very good source. Besides this these minerals organic carbon with nitrogen play a major roll in providing basic facilities to plants.

Total Nitrogen

Soil has more Nitrogen form (more than 90%) present in humus. That nitrogen provides after degradation of Humus. Plants received nitrogen as minerals (Ammonium & Nitrate). So mineral of nitrogen (ammonium & nitrate) are called available nitrogen.

Alkalinity

Alkali soils are clay soils with a relatively high exchangeable sodium percentage, a relative high pH (> 9), a poor soil structure and a low infiltration capacity. Often they have a hard calcareous layer at 0.5 to 1 m. depth. Akali soils are usually not saline, i.e. the total amount of soluble salts, especially sodium chlorides, is not excessive (ECe < 4 to 8 dS/m). Alkali soils are also called sodic soils. This does not differentiate alkali soils from saline soils. Saline soils have a high sodicity (i.e. a high sodium content that may be higher than that of alkali soils), but they are not alkali soils and have usually a good infiltration capacity. In literature, the terms sodality, alkalinity and basicity are not always clearly differentiated. The term "basic" for high pH is ambiguous as readers might think the word is derived from "basis". Therefore many scientists and authors prefer to speak of alkaline instead of basic.

Acidity

Soil acidity, is one of the principal influences for good or bad in soil. This used to be the province of scientists and chemistry students, but over the years it has become part of the home gardener's everyday world. In many, many cases, soil pH is the key to proper plant growth, and a reading of soil acidity can tell you much about what is going on beneath the surface of your garden. The acidity of soil can be a highly technical subject, but for us it need not be. Actually the pH scale is just as easy to work with as the thermometer scale. You don't have to know thermodynamics or heat transfer to understand what happens to your plants when thermometer readings drop to or below 32° Fahrenheit. Similarly, without knowing a thing about hydrogen and hydroxyl ions, logarithm exponents or other technical details of the pH theory, you can make practical use of soil pH elements that your plants (and the soil organisms) need.

Effects of soil pH are both direct and indirect. Direct effects, while not numerous, can be critical. In the case of a soil that is too acid or too alkaline, there can be (1) toxic effects on the plants themselves, and (2) an unfavorable balance between acid and alkaline elements needed by plants.

Indirectly soil acidity can have an effect on one or more of the following:

(1) Availability of essential elements
(2) Activity of soil microorganisms
(3) Solubility and potency of toxic elements
(4) Prevalence of plant diseases
(5) Competitive ability of different plant species
(6) Physical condition of the soil (when lime is used to raise the pH)

Phosphorous Phosphorus exists in soils in organic and inorganic forms. Organic forms of P are found in humus and other organic material. Phosphorus in organic materials is released by a mineralization process involving soil organisms. The activity of these microbes is highly influenced by soil moisture and temperature. The process is most rapid in warm, well-drained soils. Research on Mississippi soils has shown that 1 percent of the total soil organic phosphorus is mineralized per year during cotton and soybean production. However, since initial levels are low, and plant uptake is only one possible fate of the mineralized phosphorus, the contribution by mineralization to plant available phosphorus is small.

Inorganic phosphorus is negatively charged in most soils. Because of its particular chemistry, phosphorus reacts readily with positively charged iron (Fe), aluminum (Al), and calcium (Ca) ions to form relatively insoluble substances. When this occurs, the phosphorus is considered fixed or tied up. In this regard, phosphorus does not behave like nitrate (NO3-), which also has a negative charge but does not form insoluble complexes.

The solubility of the various inorganic phosphorus compounds directly affects the availability of phosphorus for plant growth. The solubility is influenced by the soil pH. Soil phosphorus is most available for plant use at pH values of 6 to 7. When pH is less than 6, plant available phosphorus becomes increasingly tied up in aluminum phosphates. As soils become more acidic (pH below 5), phosphorus is fixed in iron phosphates. Some soils in the upland Prairie areas of Mississippi have pH values greater than 7. When pH values exceed 7.3, phosphorus is increasingly made unavailable by fixation in calcium phosphates.

Cataions Na^{+}, K^{+}, Ca^{++}, Mg^{++}

The charge of the Cation and the size of the hydrated cation essentially govern the preferences of cation exchange equilibria. In summary, highly charged cations tend to be held more tightly than cations with less charge and secondly, cations with a small hydrated radius are bound more tightly and are less likely to be removed from the exchange complex. The combined influence of these two criteria can be summarized generally by the lysotrpoic series.

It indicates, from left to right, the decreasing strength of adsorption of the various cations. As such, the less tightly held cations are located furthest from the surface of colloids and are most likely to be leached away or further down the profile most quickly. Conversely, the most strongly adsorbed cations will tend to move the slowest down through the profile.

The proportion and kinds of cations adsorbed on soil mineral particles and organic colloids is also a function of the concentration of cations in the soil solution. If the concentration of a cation in soil solution is high, there is an increased chance or tendency for that cation to be adsorbed.

This is the reason that dissolved gypsum ($CaSO_4$) is added to ameliorate sodic soil. In this case, the addition of dissolved gypsum increases the concentration of calcium in the soil solution and this leads to an increase in calcium ions on the exchange complex at the expense of exchangeable sodium.

The major source of cations in soil solution are from mineral weathering (i.e. primary minerals), mineralization of organic matter and addition of soil ameliorants (i.e. lime, gypsum, etc).

Porosity, Bulk Density & Water Holding Capacity

Porosity of surface soil typically decreases as particle size increases. This is due to soil aggregate formation in finer textured surface soils when subject to soil biological processes. Aggregation involves particulate adhesion and higher resistance to compaction. Typical bulk density of sandy soil is between 1.5 and 1.7 g/cm³. This calculates to a porosity between 0.43 and 0.36. Typical bulk density of clay soil is between 1.1 and 1.3 g/cm³. This calculates to a porosity between 0.58 and 0.51. This seems counterintuitive because clay soils are termed *heavy*, implying *lower* porosity. Heavy apparently refers to a gravitational moisture content effect in combination with terminology that harkens back to the relative force required to pull a tillage implement through the clayey soil at field moisture content as compared to sand.

Porosity of subsurface soil is lower than in surface soil due to compaction by gravity. Porosity of 0.20 is considered normal for unsorted gravel size material at depths below the biomantle. Porosity in finer material below the aggregating influence of pedogenesis can be expected to approximate this value.

Soil porosity is complex. Traditional models regard porosity as continuous. This fails to account for anomalous features and produces only approximate results. Furthermore it cannot help model the influence of environmental factors which affect pore geometry.

Gypsum requirement

When pH of soil reach more than 8.5 and exchange complax of soil on more than qunatity of sodium in soil . Then gypsem requirment has been determine because these soil are called alkali barlle land and due to more exchangable sodium, growth of crops will not be up to the mark. For good production it is more requirement of amendments. For good production we ues chemical amendments (Gypsem and pyrites).

Chloride

The importance of chloride (Cl) fertilization of wheat in Uttrakhand I documented. Chloride is an essential micronutrient. Results have consistently shown that when soil Cl levels are less than 5-6 ppm (0-24" sample), most wheat cultivars will respond to Cl fertilization. Research also indicates that when wheat plant Cl concentrations are less than 0.10 - 0.12% (samples taken at boot stage), a response to Cl fertilization is likely on that field. The Kansas State University Soil Testing Lab now offers a soil Cl test and the following table shows how to interpret results and make Cl fertilizer recommendations.

Wheat, Corn and Sorghum		
Profile Soil Chloride		Chloride Recommendation
ppm	lb/a	lb Cl/a
< 4	< 30	20
4 - 6	30 - 45	10
> 6	> 45	0

CHAPTER 6

Problems associated with land environment And there remedial measure

Activity	Effect on soil properties	Effect on soil functions
Soil Compaction	Compaction changes the **physical** nature of The **chemical** properties of the soil are likely to be unchanged The **biological** properties of the soil are likely to be significantly compromised	**1. Platform for development** – soil is fulfilling this function soil, removing air and water **2. Environmental interaction** – compaction will remove soil's buffering functions **4. Biodiversity** – compaction significantly reduces the ability of soils to act as a habitat or to support other habitats **5. Raw materials** – compaction may result in the loss of sensitive raw materials such as peat **6. Cultural heritage** – compaction may damage any surviving archaeological or historic remains
Habitat creation	Habitat enhancement is likely to result in an improvement in the **physical** condition of the soil Habitat enhancement may require improvements in the **chemical** condition of the soil Habitat enhancement will result in improvement in the **biological** properties of soil	**1. Platform for development** – habitat creation implies part of the site will not provide a platform for development. **2. Environmental interaction** – all other things being equal, habitat creation, as a result of improvement in soil's physical and chemical properties, should result in an enhancement of soil's buffering role. **3. Food and fibre** – habitat creation will generally not involve food and fibre production, but provides the opportunity for this in the future. **4. Biodiversity** – habitat creation should result in enhancements in biodiversity. **5. Raw materials** – habitat creation is unlikely to have an effect on soil's role in providing a source of raw materials. **6. Cultural heritage** – habitat enhancement could have mixed effects on Cultural heritage.

Contamination	Contamination may result in indirect changes in soils' **physical** properties resulting from changes in its **chemical** and **biological** properties. Contamination will affect the **chemical** properties of the soil The **biological** properties of the soil are likely to be compromised, particularly as contaminant levels rise	**1. Platform for development** – this potential function is only likely to be affected where pollution reaches exceptional levels **2. Environmental interaction** – changes in the chemical composition of soils may affect its ability to provide environmental buffering **3. Food and fibre** – changes in chemical composition would affect soil's ability to provide food and fibre **4. Biodiversity** – changes in the chemical and biological properties of soil are likely to affect its biodiversity function **5. Raw materials** – pollution could affect sensitive raw materials such as peat **6. Cultural heritage** – changes in chemical composition could affect soil's ability to conserve elements of the cultural heritage, particularly the record held within soil itself
Restoration of minerals site to arable Agricultural land	The restoration process should result in a significant enhancement in the soil's **physical properties**, though these may remain of lower quality than before the construction stage. Re-establishing agricultural land will Restore the soil's **chemical** properties. It is possible that handling and movement by machinery may have resulted in some contamination and an alteration in its chemical properties. The **biological** properties of the soil are likely to be improved, though they may have been reduced by soil storage and subsequent handling during the restoration process.	**1. Platform for development** – this potential function is unlikely to be affected **2. Environmental interaction** – environmental buffering functions are likely to be improved, though are likely to remain at a lower level than before construction, and at a lower level than non-agricultural land. **3. Food and fibre** – restoration would improve soil's ability to support the production of food and fiber **4. Biodiversity** – it is likely that the soil's role in supporting biodiversity will be improved, though initially at least this is likely to be at a lower level than before the mineral development took place **5. Raw materials** – restoration should have no significant effect on soils' function in providing a source of raw materials. **6. Cultural heritage** – restoration should have no significant effect on soils' function in conserving elements of the cultural heritage

6.1Soil Erosion in Dehradun:

Because land degradation from water-induced soil erosion is a serious problem in India and only fragmentary information on factors affecting soil erosion is available, an attempt was made to prepare a countrywide map of soil erosion rates for land use planning. To prepare the map, available maps of soil, rainfall erosive, slope, land use, forest vegetation, degraded land, sand dunes, and irrigation were used. Soil loss data from various research stations, watersheds, and sedimentation of reservoirs also were used. Soil losses for a number of places were estimated using the universal soil loss equation. Based on these 21 observed and 64 estimated soil loss data points spread over different land resource regions of the country and superimposing eight above-mentioned maps, iso-erosion rate lines were drawn.

Annual erosion rate due to water is less than 5 Mg/ha/yr (2.2 tons/acre) for dense forest (above 40% canopy), cold desert regions, and arid regions of Dehradun. The areas revealing severe erosion---more than 20 Mg/ha/yr---include the Shiwalik Hills, northwestern Himalayan regions, ravines, shifting cultivation regions. In spite of limitations, this map will prove to be a handy tool for planners, watershed managers, and policymakers in developing appropriate land use for achieving sustained productivity.

Soil Erosion and Climate Change:

The consensus of atmospheric scientists is that climate change is occurring, both in terms of global air temperature and precipitation patterns. Warmer atmospheric temperatures associated with greenhouse warming are expected to lead to a more vigorous hydrological cycle, including more extreme rainfall events (IPCC, 1995). Karl and Knight (1998) reported that from 1910 to 1996 total precipitation over the contiguous U.S. increased, and that 53% of the increase came from the upper 10% of precipitation events (the most intense precipitation). The percent of precipitation coming from days of precipitation in excess of 50 mm has also increased significantly.

Studies on soil erosion suggest that increased rainfall amounts and intensities will lead to greater rates of erosion. Thus, if rainfall amounts and intensities increase in many parts of the world as expected, erosion will also increase, unless amelioration measures are taken. Soil erosion rates are expected to change in response to changes in climate for a variety of reasons. The most direct is the change in the erosive power of rainfall. Other reasons include: a) changes plant canopy caused by shifts in plant biomass production associated with moisture regime; b) changes in litter cover on the ground caused by changes in both plant residue decomposition rates driven by temperature and moisture dependent soil microbial activity as well as plant biomass production rates; c) changes in soil moisture due to shifting precipitation regimes and evapo-transpiration rates, which changes infiltration and runoff ratios; d) soil erodibility changes due to decrease in soil organic matter concentrations in soils that lead to a soil structure that is more susceptible to erosion and increased runoff due to increased soil surface sealing and crusting; e) a shift of winter precipitation from non-erosive snow to erosive rainfall due to increasing winter temperatures; f) melting of permafrost, which induces an erodible soil state from a previously non-erodible one; and g) shifts in land use made necessary to accommodate new climatic regimes.

Studies by Pruski and Nearing (2002) indicated that, other factors such as land use not considered, we can expect approximately a 1.7% change in soil erosion for each 1% change in total precipitation under climate change.

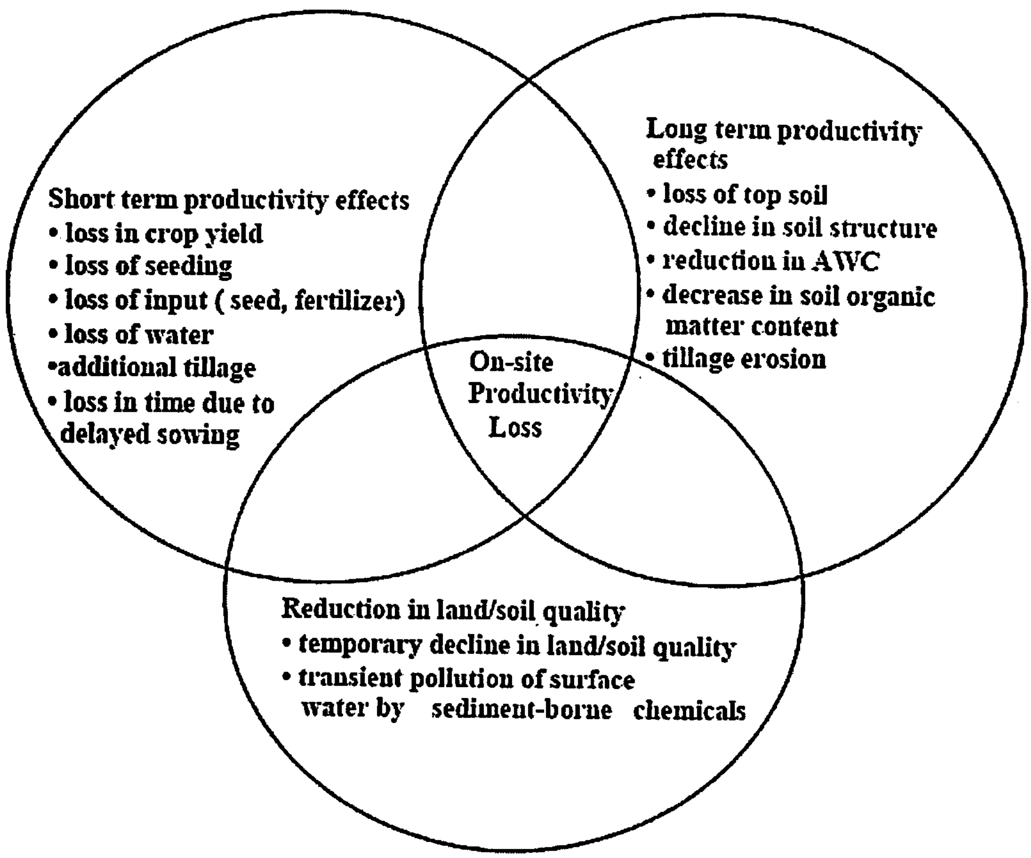


Figure1: On-site effects of soil erosion on productivity are due to short-term and long-term effects, and on decline in soil quality (Lal, 2001)

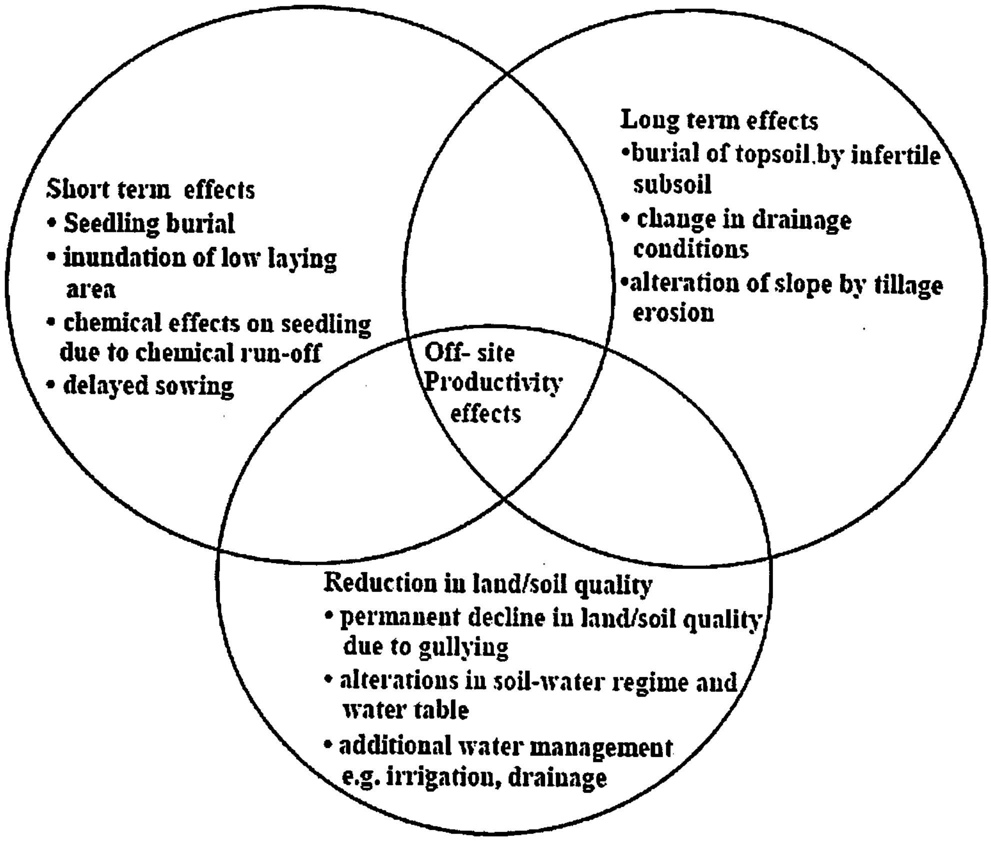


Figure 2: Off-site effects of soil erosion on productivity may be due to short-term or long-term and due to decline in land/soil quality (Lal, 2001)

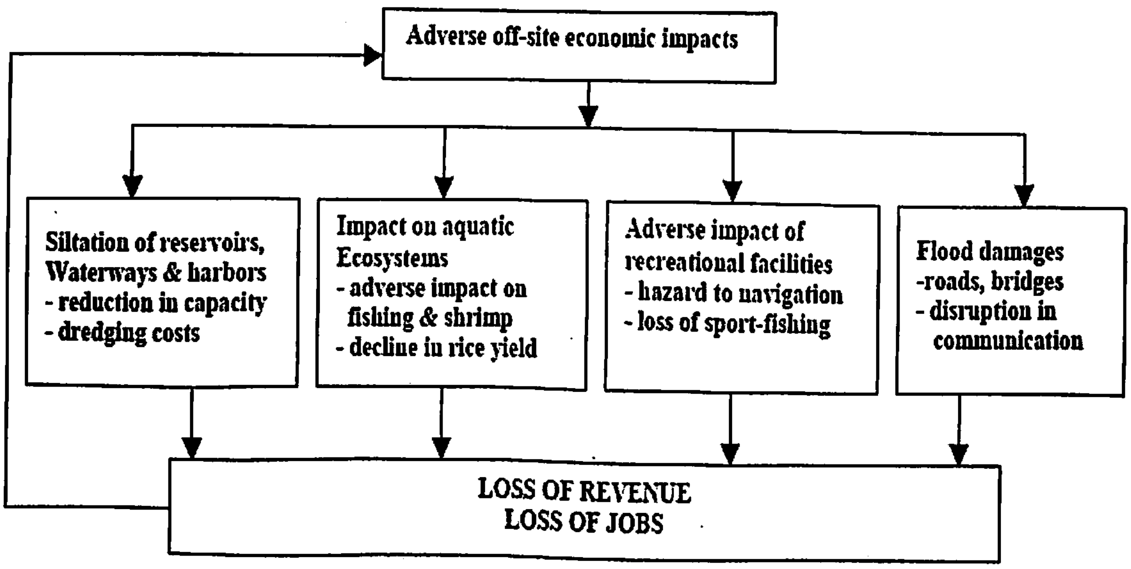
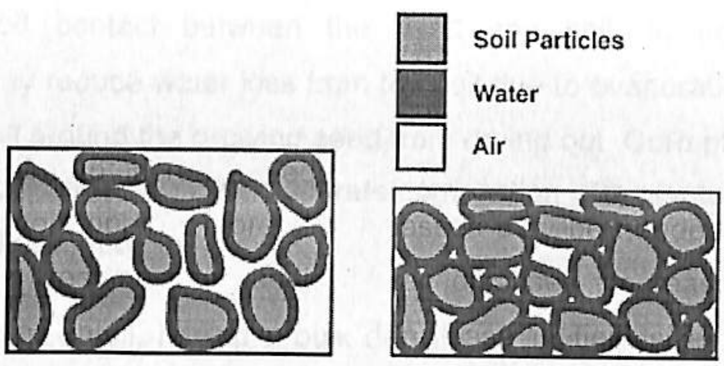


Figure 3: Off-site economic impact of soil erosion (Lal, 2001)

6.2 Soil compaction:

Soil compaction can be a problem on most Kansas soils. Compaction can reduce plant growth, reduce root penetration, restrict water and air movement in the soil, result in nutrient stresses, and cause slow seedling emergence. Ultimately, compaction can reduce yields. Soil compaction has become more of a problem in recent years due to increased equipment size and lack of crop rotations. In continuous mono-cropping, more tillage passes may be needed to control weeds and bury crop residue that could foster diseases. Increased vehicle traffic increases the potential for compaction. Increase in field size can contribute to compaction, too. Larger fields may contain more variation in soil conditions. When working a large field, some sections might be dry while others are still too wet. When fields are smaller, each field is in more uniform condition and tilled
Only when ready.



Non-compacted Compacted

To understand compaction, one must first understand the makeup of the soil. Soil consists of organic matter, minerals, and pore space. The mineral fraction of the soil is made up of a combination of sand, silt, and clay particles. These particles do not fit together tightly, but are surrounded by open pore spaces. This open space is important because it allows soil to hold air and water. Spaces between the particles are filled with air in dry soil, water in saturated soil, or both in moist soil. Soil compaction occurs when soil particles are pressed together, limiting the space for air and water. The amount of soil water is a critical factor in soil compaction potential. A dry soil, which has friction between the soil particles, is not easily compacted. Water acts as a lubricant between the particles, making the soil easier to compact. However, as soil water content increases, a point is reached where most pore spaces in the soil are filled with water, not air. Water cannot be compressed, so water between the soil particles carries some of the load of the soil, resisting compaction. Therefore, a very wet soil will not compact as much as a moderately moist soil.

CONSEQUENCES OF SOIL COMPACTION FOR PLANT GROWTH:

Soil compaction can have both desirable and undesirable effects on plant growth.

Desirable Effects

Slightly compacted soil can speed up the rate of seed germination because it promotes good contact between the seed and soil. In addition, moderate compaction may reduce water loss from the soil due to evaporation and, therefore, prevent the soil around the growing seed from drying out. Corn planters have been designed specifically to provide moderate compaction with planter mounted packer wheels that follow seed placement.

A medium-textured soil, having a bulk density of 1.2 grams per cubic centimeter (74 pounds per cubic foot), is generally favorable for root growth. [Note: a soil bulk density of 1.2 grams per cubic centimeters is comparable to a non-tracked soil after a secondary tillage operation.] However, roots growing through a medium-textured soil with a bulk density near 1.2 grams per cubic centimeter will probably not have a high degree of branching or secondary root formation. In this case, a moderate amount of compaction can increase root branching and secondary root formation, allowing roots to more thoroughly explore the soil for nutrients. This is especially important for plant uptake of non-mobile nutrients such as phosphorus.

Undesirable Effects

Excessive soil compaction impedes root growth and therefore limits the amount of soil explored by roots. This, in turn, can decrease the plant's ability to take up nutrients and water. From the standpoint of crop production, the adverse effect of soil compaction on water flow and storage may be more serious than the direct effect of soil compaction on root growth.

Figure 2. Nitrogen deficiency symptoms in corn.

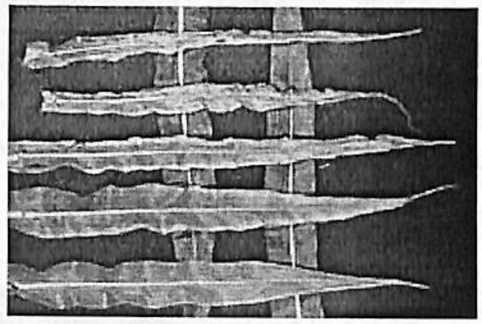


Figure 3. Potassium deficiency

In dry years, soil compaction can lead to stunted, drought stressed plants due to decreased root growth. Without timely rains and well-placed fertilizers, yield reductions will occur. Soil compaction in wet years decreases soil aeration. This results in increased denitrification (loss of nitrate-nitrogen to the atmosphere). There can also be a soil compaction induced nitrogen and potassium deficiency (**see Figures 2 and 3**). Plants need to spend energy to take up potassium. Reduced soil aeration affects root metabolism. There can also be increased risk of crop disease. All of these factors result in added stress to the crop and, ultimately, yield loss.

PLANT RESPONSE TO SURFACE COMPACTION:

The effect of compaction on plant growth and yield depends on the crop grown and the environmental conditions that crop encounters. In general, under dry conditions some compaction is beneficial, but under wet conditions compaction decreases yields. Response of various crops, including soybeans, corn, wheat, potatoes and sugar beets, to surface compaction has been studied in city. The results of these studies will be discussed by crop.

SOYBEANS

Research results indicate that the effect of surface compaction on soybean yields depends very strongly on weather conditions and on soil nutrient levels. The yield response from compacting the soil was greater during dry years and when the soil phosphorus tested low. The effect of surface compaction on yield was related to the rainfall amounts. When May - August rainfall was less than 14 inches, soybean yields were greater in the tracked rows. However, if the rainfall was more than 14 inches, yields from the tracked beans were less than the tracked rows. Possible reasons for the increased yields on the "wheel-tracked" treatment during the dry seasons include increased uptake of phosphorus, increased root branching, and reduced water evaporation from the plow layer. This provides more favorable water conditions for nutrient uptake.

CORN

Corn yields were reduced an average of 7.5% over the two-year period. Increased levels of soil fertility effectively overcame the yield loss due to compaction. The yield effects of increasing tire contact pressure on a clay soil in Quebec, Canada, were influenced by the May to September precipitation. When the precipitation was 21 inches, yield decreased as the compaction was increased. When the precipitation was 14 inches, corn yield first increased as compaction increased and then decreased as compaction was increased further. Thus, under dry conditions some compaction was beneficial but too much was detrimental to yield. Under wet conditions any amount of compaction decreased yields and the greater the contact pressure the lower the yields.

WHEAT

The effect of wheel traffic compaction on wheat yields on a clay loam at Morris depended on the April to June precipitation. Under dry conditions, the wheel-tracked area produced higher yields than the non-tracked area. However, as the precipitation increased, the non-compacted area resulted in higher yields than the compacted area.

Wheat yields of non-compacted, fall-compacted, spring-compacted, and fall- and spring-compacted treatments were not significantly different. However, percent protein was significantly lower on the spring-compacted (12.9%) and fall- and spring-compacted (12.7%) treatments compared to the non-compacted treatment (13.6%) **(Table 2)**.

Research has shown that compaction generally decreased wheat and barley yields under wet conditions, while moderate compaction had little effect or slightly increased yields during normal precipitation patterns and increased yields under dry conditions. In all cases, severe compaction decreased yields.

Table 2. Timing effect of compaction on percent wheat protein in Dehradun

Treatment	% Protein
Non-compacted	13.6
Spring compacted	12.9
Fall and Spring compacted	12.7

Table 3. Effect of soil compaction on sugarbeet and total recoverable sugar yields, Dehradun

	Soil Properties Probe Resistance (lbs/inch2)	1979* and 1980 Average Tons/Acre	
		Beets	Sugar
Compacted	133	11.5	1.53
Non compacted	78	10.5	1.42

*Compaction increased yields because of a higher final stand (108 vs. 79 beets/100 ft. of row for compacted and non-compacted treatments respectively).

POTATOES

Because of the potato tubers growth pattern and its relatively confined root zone, soil compaction frequently has a detrimental effect on potato yields. There has been a good deal of research confirming lower potato yields due to compaction.

Deliberate packing of the soil in the Red River Valley decreased potato yields 54%. In a two-year study at Grand Forks, Minnesota, compaction reduced potato yields an average of 21%. At Morris, Minnesota, potato yields were reduced 35% because wheel traffic restricted tuber development.

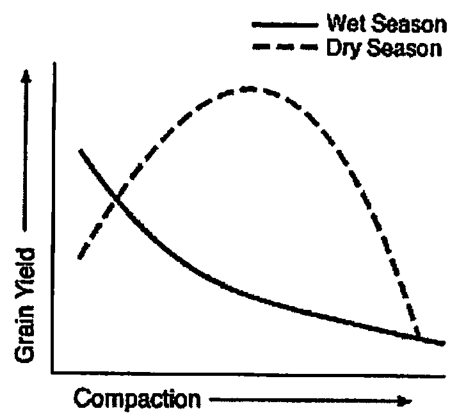


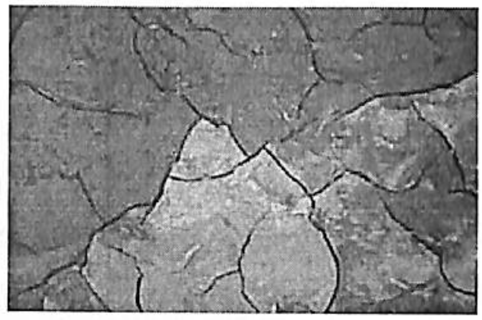
Figure : Effects of weather on crop yield response to compaction level

SUGARBEETS

The sugarbeet appears to be less sensitive to surface compaction if it does not interfere with plant emergence. The effects of surface compaction on yields in a North Dakota study are shown in **Table 3**. Although soil compaction increased beet sprangling, which causes problems at harvest, compaction had no effect on recoverable sugar or root yields in 1980. Compaction was created by repeated passes with a loaded, single-axle, dual-wheel truck (GVW 18000 lbs).

CAUSES OF SOIL COMPACTION

There are several forces, natural and man-induced, that compact a soil. This force can be great, such as from a tractor, combine or tillage implement, or it can come from something as small as a raindrop (Figure 5). Listed below are several types of soil compaction and their causes.



Raindrop impact - This is certainly a natural cause of compaction, and we see it as a soil crust (usually less than 1/2 inch thick at the soil surface) that may prevent seedling emergence. Rotary hoeing can often alleviate this problem.

Tillage operations - Continuous moldboard plowing or disking at the same depth will cause serious tillage pans (compacted layers) just below the depth of tillage in some soils. This tillage pan is generally relatively thin (1-2 inches thick), may not have a significant effect on crop production, and can be alleviated by varying depth of tillage over time or by special tillage operations.

Wheel traffic - This is without a doubt the major cause of soil compaction. With increasing farm size, the window of time in which to get these operations done in a timely manner is often limited. The weight of tractors has increased from less than 3 tons in the 1940's to approximately 20 tons today for the big four-wheel-drive units. This is of special concern because spring planting is often done before the soil is dry enough to support the heavy planting equipment.

Minimal Crop Rotation - The trend towards a limited crop rotation has had two effects: 1.) Limiting different rooting systems and their beneficial effects on breaking subsoil compaction, and 2.) Increased potential for compaction early in the cropping season, due to more tillage activity and field traffic.

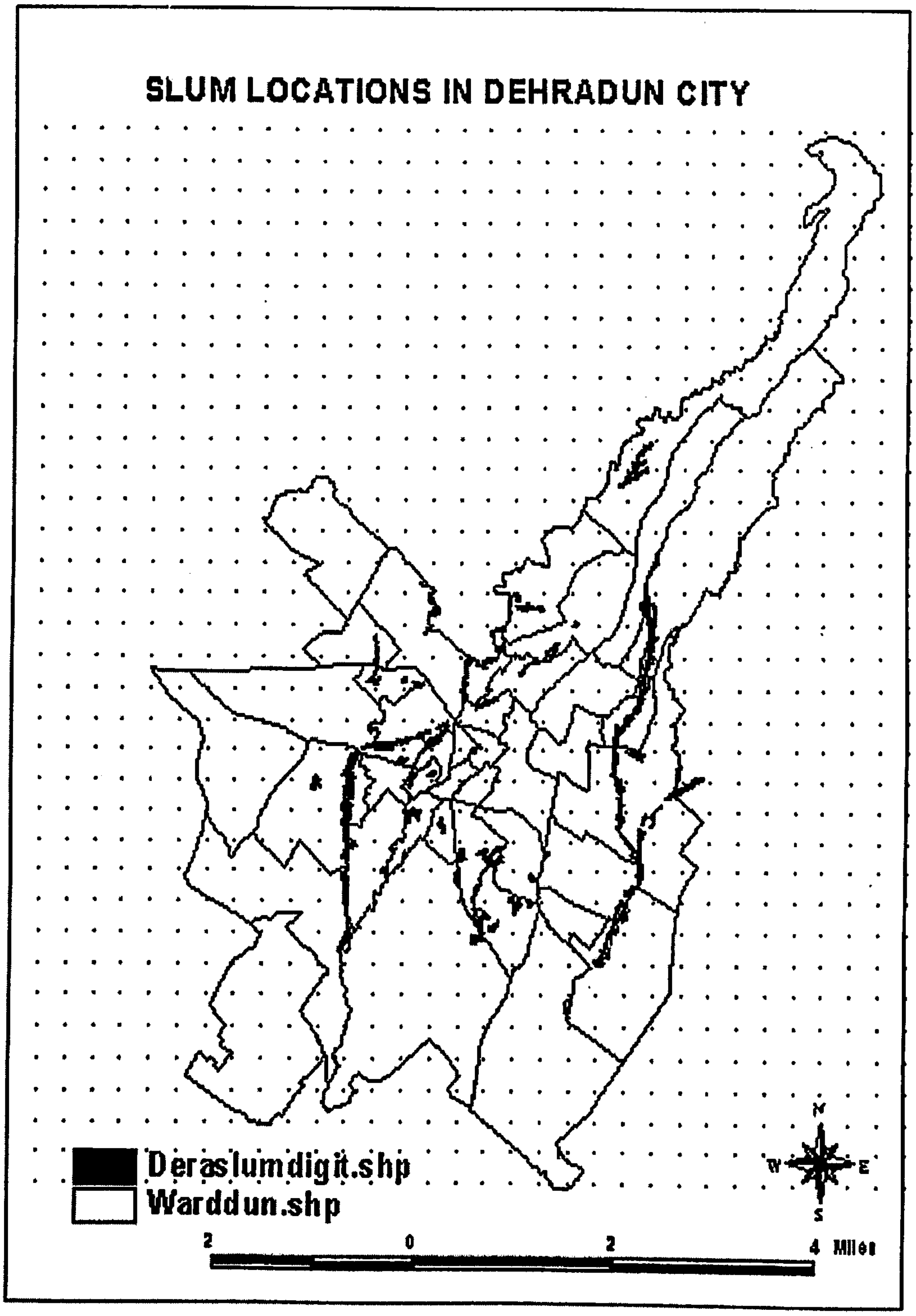
Preventing soil compaction

The best cure for compaction is to avoid it. Elimination of all compaction may be impossible, but there are Several management factors that can keep compaction to a minimum. The best management decision to Prevent compaction is to not work soils that are too wet. Check for wetness at the depth of tillage operation, Not at the soil surface. If the soil can be pressed into a ball that holds its shape, it is too wet. Tillage implement selection can be important in reducing the formation of tillage pans. Moldboard plows and disks are known to cause tillage pans. The shearing action of these implements has a tendency to smear the soil and seal it. They bury more residue than shank-type tillage tools. Other implements that shear soil and cause tillage pans are tools equipped with large, rigid sweeps. Operating these tools at the same depth for a few years without varying tillage passes will cause a compacted layer in the soil. Shallow compaction can be reduced by decreasing ground pressure, which can be accomplished by choosing larger tires, adding tires (using dual tires instead of singles, or triples instead of duals), or choosing a tracked vehicle. By adding duals or using a larger tire, more area is compacted due to the wider track but the intensity of the pressure is less. Operating at the proper tire inflation pressure is important in minimizing shallow compaction as inflation pressure is approximately equal to ground pressure. Radial tires have a larger footprint .That should reduce shallow compaction. An attractive feature of radial tires is that the footprint is longer and not wider than the same size bias tire. In this way, a radial tire achieves a larger footprint without compacting a wider track as it passes over the field. Radial tires also have greater load carrying capacities than equal size bias tires and can be operated at lower inflation pressures, which will result in less shallow compaction. Deep compaction can be minimized by reducing axle loads. This means Operating at lighter weights for two wheel drive tractors or possibly choosing a similarly powered mechanical front wheel drive or four-wheel drive tractor. Axle weight is not reduced by distributing the weight between more tires on the same axle or using tires with larger footprints. Also, carry only enough ballast on the tractor to pull the desired implements efficiently. Recent research shows that reducing ground pressure to a minimal value (less than 12 pounds per square inch) can reduce both shallow and deep compaction. Though these results may be disputed, it is a good idea to minimize both axle loads and round pressure. Additional research has shown that track-type tractors have a less detrimental effect on soil properties than equal-powered four-wheel-drive (4WD) tractors with bias ply dual tires. There are indications that 4WD tractors with properly inflated radial tires cause less compaction than track vehicles. By optimizing inflation pressure or using tracks rather than tires, compaction can be minimized.

6.3 Drainage condition in slum area in Dehradun city:

In the area under study, it has been observed that out of 1222 houses 643 houses (52.62%) don't have any drainage facility (table-3). Wherever drainage facility is available in 579 houses (47.38%) and all the drains are open drains. Out of seven slums in that area, four slums have very bad drainage condition particularly in Rishinagar where out of 212 houses, 193 houses (91.04%) are without any drainage. Only Aryanagar-1 and Chiriya Mandi have relatively better drainage condition. Wherever open drains are available, though either they are too narrow or half the portion is filled up with garbage.

The slums in Dehradun were formed by encroaching the major drainage channel, and flash flood may damage most of the slums located in this area. So, proper care, planning and management should be taken to mitigate the flood risk vulnerability in slums. The urban planner therefore, has to take these facts into consideration and also monitor the vulnerable areas for checking the growth and expansion of the slums. There open drainages come down in to Bindal River which is major cause of pollution.


SLUM LOCATIONS IN DEHRADUN CITY
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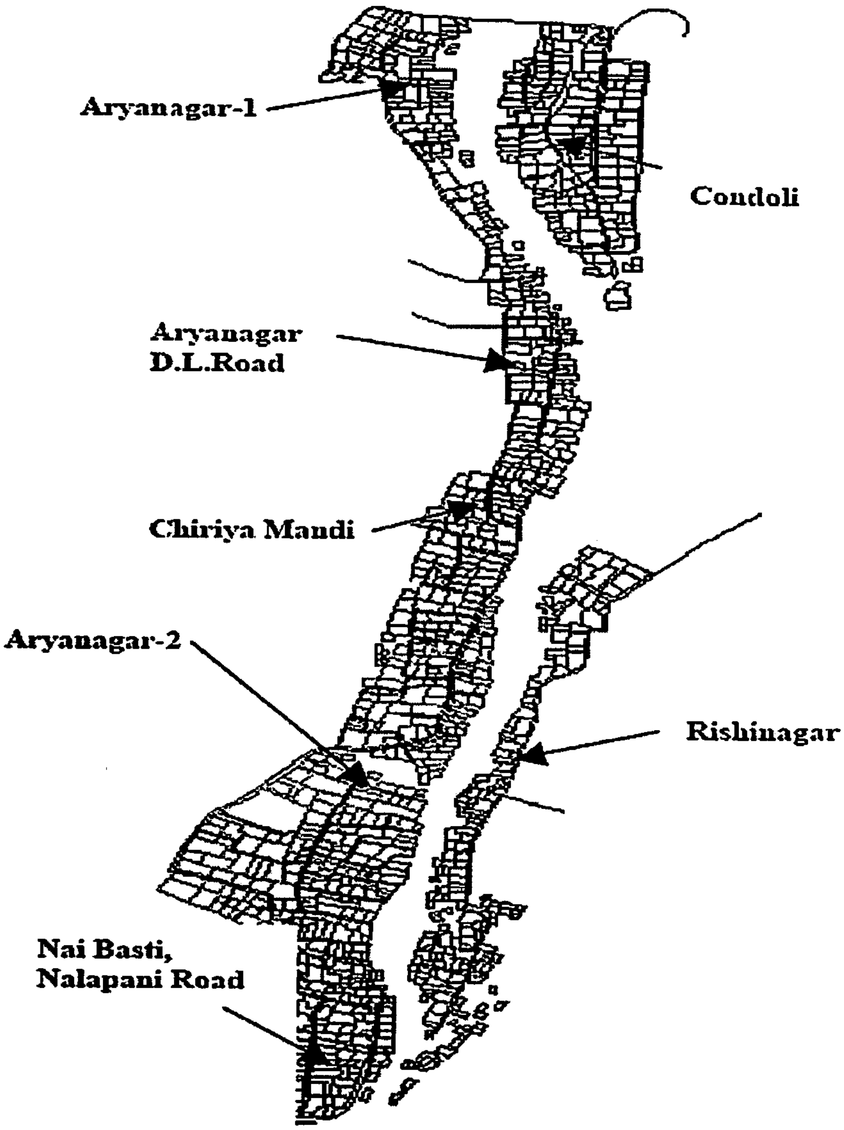


Figure 4: study area for drainage system in slum area of dehradun city

Remedial measure:

Solving drainage problems

Solving drainage problems in turf, tree and landscape plantings is not a difficult task if we understand the underlying *cause* of the problem and we are able to redirect the excess water to a lower area such as a drainage ditch, dry well or catch basin. It is much easier and less costly however, to correct soil drainage problems during the initial design and construction phases of a project rather than afterwards. Unfortunately, we often "inherit" poor drainage problems on many sites simply because essential soil testing to determine soil texture, structure, and drainage was not previously done.

Although *excessive* drainage can be a problem on some coarser textured sandy soils and slopes, poor drainage is a much more common landscape problem and is considered by many to be one of the biggest killers of landscape plants. Pore space (the air space between soil particles) controls soil drainage characteristics and in soils dominated by *large* pore space like sands and loamy sands, water moves rapidly. To help solve water retention problems in these excessively drained soils, managers will routinely incorporate organic matter in the form of peat moss or compost into the soil via tilling or topdressing. This will increase the water-holding capacity of the soil resulting in less drought stress for the plants. In poorly drained soils dominated by many *small* pore spaces (such as compacted soils or those with greater than 20 percent clay); however, water is slow to move, and soils easily waterlog causing root decline, root rots, and eventual death of all but the most tolerant wetland species.

Identifying poorly drained soils is not difficult if we know what to look for. Typical soil symptoms associated with poor drainage include surface puddling or ponding, blue/gray soil matrix colors, foul "anaerobic" odors, distinct soil mottles (grey/red/orange spots) within the top 24 inches of the soil surface, percolation rates less than 1 to 2 inches of water drop per hour, and surface and subsurface impermeable crusts, hardpans, corepans and or plowpans.

IMPROVING SOIL STRUCTURE:

Poor surface drainage in many landscape beds may be the result of excessive tilling, which many believe is the only way to "control weeds and aerate the soil." Ironically, excessive tillage does not improve drainage, but rather hinders it by destroying soil structure and the aggregated soil particles that help transport the necessary oxygen to a plant's roots. On these garden sites, correction of the problem involves reducing the number and frequency of tillage operations and incorporating a 1 to 2 inch layer of organic matter into the soil. This helps to aggregate and "glue" the finer clay particles into larger aggregates, creating more macropore air space and therefore improving aeration and drainage.

6.4 Planning on soil problems:

Control emissions to soil (provided these do not duplicate or conflict with conditions that are appropriate imposed through the relevant pollution control authorization or license). It is already good practice to use conditions to prevent emissions to air or water. Soil should be provided with the same level of protection;

1. Implement sustainable urban drainage systems (SUDs);
2. Manage the risk of flooding;
3. Encourage food and timber production at the local level (e.g. the provision of private
4. Gardens or allotments in new developments);
5. Ensure that soil is retained and re-used on site (taking account of appropriate measures for soil handling and storage) rather than being disposed of elsewhere,
6. Reflecting the emphasis on re-use of resources within the waste hierarchy (Minimize, re-use, recycle, recover, and dispose);
7. Encourage habitat enhancement in the landscaping of new developments;
8. Ensure that sufficient buffer zones are provided around sites designated for their
9. Nature conservation or archaeological importance;
10. Ensure adequate investigation, protection and conservation of archaeological
11. Resources, including the record of previous human activities and environmental change held within soil itself.

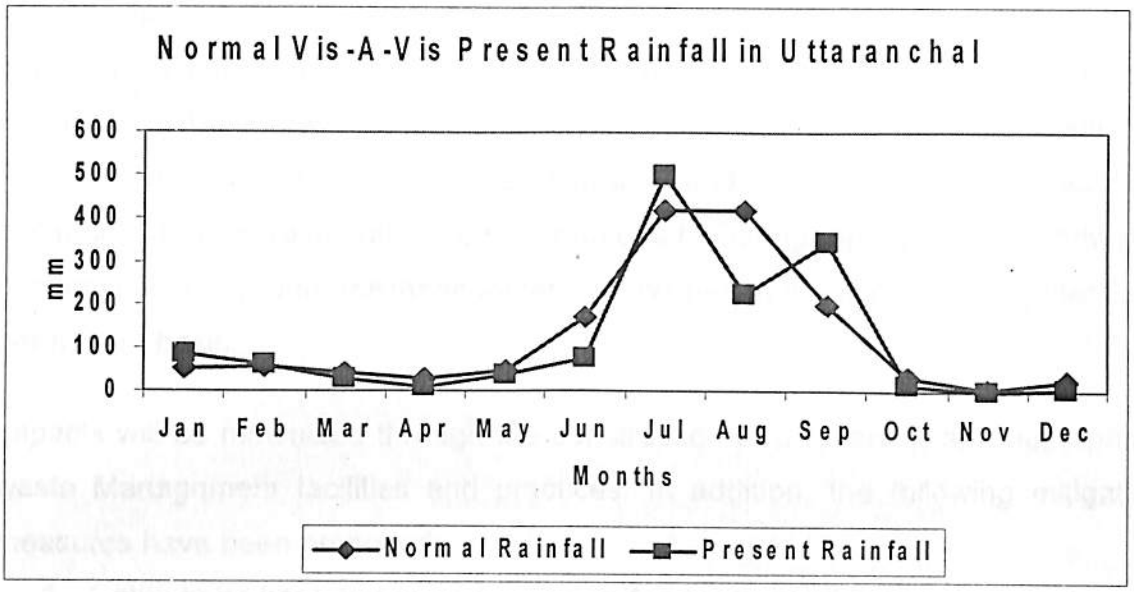
Conditions will of course depend on the scheme and site in question and should meet the tests laid down in government policy.

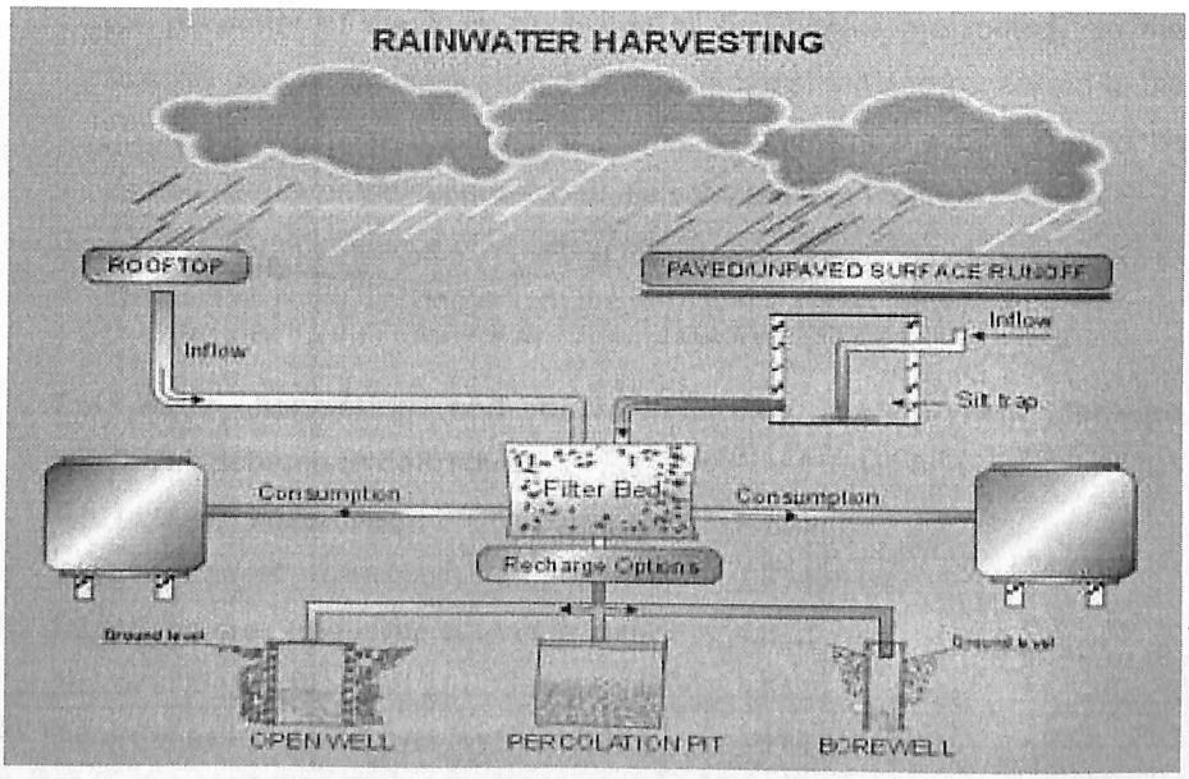
Rain water harvesting:

Water harvesting largely depends on rainfall and will, therefore, be more successful in areas where rainfall is sufficient and variability during the main monsoon season is not excessive. Besides rainfall, water harvesting depends on several factors including soil type as well as depth, vegetative cover and slope of the catchment area. For the water harvesting programmes to be successful, it is essential that moderately large catchments and sufficient storage capacity may be kept in mind. A 59 ha hilly catchment area situated in the vicinity of the village was surveyed in 1990. Fortunately an excellent site for construction of an earthen dam with a reservoir storage capacity of 13.7 hectare metres (ha m), was available very close to the village. The catchment area owned by the community was open to grazing and other biotic interference. Consequently most of the rainwater ended in runoff carrying with it huge amount of sediments and detritus. The catchment area, therefore, required intensive soil conservation measures to reduce the meanace of soil erosion, to save the reservoir from siltation and improve ecology of the watershed.

One of the main recommendations is to implement rainwater harvesting. The population of Dehradun demands 39 billion liters of water annually and the supplies in the city do not match the demand. However, Dehradun, spread over an area of 38.04 sq. km. and having an average annual rainfall of 2200 mm, receives over 84 billion liters water per annum in the form of rain. Tapping even 50 per cent of the rainwater should more than suffice.

The resulteo in the formation of a citizen's forum and the formation of working groups to deal with the problems that face the city. The forum will coordinate with the four working groups, dealing with water, pollution control, garbage management and higher education.





The working groups will explore possible inter-linkages between institutions to expedite rainwater harvesting. The various water harvesting technologies feasible for the hilly terrain of Dehradun. A draft action plan was formulated which proposed to involve the resourceful student community, technical experts, researchers and the Garwhal Jal Sansthan. Its target is to recharge abandoned ponds and build new ones. Reduction of infiltration of rainwater into the underlying aquifer may occur during the operation phase thus having a permanent effect on on the aquifer. As a result, surface runoff would increase and to mitigate this effect, the construction of a reservoir is being proposed. During operation, groundwater contamination through mismanagement of wastes may occur on a potentially permanent basis.

Impacts will be minimized through the construction of a reservoir and appropriate waste Management facilities and practices. In addition, the following mitigation measures have been proposed:

1. Cattle to be kept and reared under roofed areas at all times;
2. Impermeable surface and construction of a ditch of about 1m depth along the perimeter of the farm, such that all foul waters are routed into the existing cesspit. Cesspits should be double bottomed and connected to the public sewers. The construction of the cesspit and the ditch are to be carried out under the supervision of the competent authority;
3. No on-site/maintenance of vehicles; and
4. Connect all liquid discharge from the farm to the public sewer.

Rain-water harvesting and micro-watershed development through NWDPRA Scheme in dehradun

No. of Micro watershed	**- 158**
Area treated	**- 63495 ha.**
Increased area under life saving irrigation	**- 1250 ha.**
No. of Water harvesting structure	**- 5320**
Awareness -State/District level Training	**- 114**
Micro-watershed level training	**- 520**
SHG's formed	**- 568**
Users group formed	**- 437**
Corpus fund created	**- Rs. 50 lakhs**

MUNICIPAL SOLID WASTE SURVEY IN DEHRADUN CITY:

1. RECYCLABLE WASTE

AREA		DATE	DATE	DATE	DATE	DATE	DATE	DATE
CHAMAN VIHAR		13/02/08	14/02/08	15-2-08	16/2/08	17/2/08	18/02/08	19/0207
RECYLABLE (IN GRAMS)								
	WOODEN PIECE				100	60	10	
	PAPER	20	60	80	75	70	125	170
	TEXTILE			20	10		10	30
	THERMOCOLE				10	5		
	GLASS	30		45	30	50	30	
	RUBBER/ LEATHER		60	50	36			
	POLYTHENE BAGS	70	115	100	79	80	90	80
	PLASTIC				5	10	25	
	SCHOOL BAGS							
	METALS	10		15	25	30		250
	HUMAN HAIR							
	TOTAL	130	235	310	370	305	290	530

AREA	CLASS OF WASTE							
VASANT VIHAR								
	WOODEN PIECE							20
	PAPER	100	20	70	90	48	20	35
	TEXTILE	250	20	60	40	100	35	
	THERMOCOLE			10	2		20	15
	GLASS		25	40	60	70		85
	RUBBER/ LEATHER				30	30	15	20
	POLYTHENE BAGS	150	115	90	80	70	200	110
	PLASTIC		8	19	25	15	45	60
	SCHOOL BAGS							
	METALS				25			
	HUMAN HAIR							
	TOTAL	500	188	289	352	333	335	345
AREA	CLASS OF WASTE							
CHAMANPURI								
	WOODEN PIECE	60			70	50		50
	PAPER	40	60	50	30	60	75	45
	TEXTILE	60		40	40	100		70

	THERMOCOLE					10		
	GLASS				60	40	70	65
	RUBBER/ LEATHER	10	60	20	30	25		40
	POLYTHENE BAGS	55	110	90	70	40	30	45
	PLASTIC				9	15	10	5
	SCHOOL BAGS							
	METALS	10		25	20	25	35	20
	HUMAN HAIR							
	TOTAL	235	230	225	329	365	220	340

2. BIODEGRADABLE WASTE

	DATE	DATE	DATE	DATE	DATE	DATE	DATE	
	13/02/08	14/02/08	15/02/08	16/02/08	17/02/08	18/02/08	19/02/08	
CHAMAN VIHAR :	**BIODEGRADABLE (IN GRAMS)**							
FLOWER					10		5	
GREEN LEAVES	5		10		5	20	20	
GREEN MATTER	200		160	200	100			
VEGETABLES	250	755	350	270	210	150	170	
KITCHEN WASTE	390		160	140	300	530	250	
DEAD ANIMAL								
DRY BONE/DRY MATTER					50			
	845	755	680	610	675	700	445	
VASANT VIHAR :	**BIODEGRADABLE (IN GRAMS)**							
FLOWER	10		5	10		15	20	
GREEN LEAVES	20	15	10	15	10	40	30	
GREEN MATTER	30		80	50			60	
VEGETABLES	170	400	280	310	400	390	185	

KITCHEN WASTE	250	387	330	260	207	200	335	
DEAD ANIMAL								
DRY BONE/DRY MATTER								
	480	802	705	645	617	645	630	
CHAMAN PURI: BIODEGRADABLE (IN GRAMS)								
FLOWER					5		35	
GREEN LEAVES	20	5	15	25	15		40	
GREEN MATTER			80	55	110	220		
VEGETABLES	150	755	400	435	355	170	225	
KITCHEN WASTE			250	150	130	380	335	
DEAD ANIMAL								
DRY BONE/DRY MATTER								
	170	760	745	665	615	770	635	

3. INERT MATERIAL WASTE

	DATE	DATE	DATE	DATE	DATE	DATE	DATE
	13/02/08	14/02/08	15/02/08	16/02/08	17/02/08	18/02/08	19/02/08
CHAMAN VIHAR	**INERT MATERIAL (IN GRAMS)**						
SAND/EARTH/SOIL	25	20	10			10	25
STONE				10			
BRICK				10			
CERAMICS					20		
LIME							
	25	20	10	20	20	10	25
VASANT VIHAR	**INERT MATERIAL (IN GRAMS)**						
SAND/EARTH/SOIL	20	10	6		20	20	25
STONE					25		
BRICK							
CERAMICS				3	5		
LIME							
	20	10	6	3	50	20	25

CHAMAN PURI	INERT MATERIAL (IN GRAMS						
SAND/EARTH/SOIL	50	20	20	6	10	10	25
STONE			10		10		
BRICK							
CERAMICS							
LIME							
	50	20	30	6	20	10	25

QUANTIFICATION OF THE WASTE (BASED ON COLLECTION OF WASTE PER HOUSE)

280-400 gm per person (chamanpuri)
400-500 gm per person (Chamanvihar)
400-500 gm per person (Vasantvihar)

6.6 A Case Study on Physico - Chemical Characteristics of Ground Water and Soil Samples of Municipal Solid Waste Dump Yard.

The pace of urbanization in India has been rapidly increasing, with about 30% of the total population already living in urban areas. Studies predict that, by 2015 AD, over 50% of India's population will be urban and there will be over 50 cities with population excess of one million. Urbanization, along with increased industrialization and motorization, has severley damaged urban environment and health of people. To minimize these ill effects, it is necessary to have accurate, timely, reliable information and performance indicators that can indicate the status of health and environment in urban areas, which can be used to take corrective and preventive measures to improve the quality of urban life.

The distinctive character of urbanization is high density of population, high-energy consumption and huge generation of high quality wastes and effluents from both industries and domestic environment. The splendid achievements in the field of science and technology made triumphant progress in the urbanization. According to ministry of urban affairs, government of India estimated 0.5Kg (approximately) of waste generated per person per day.

The problem of municipal solid waste management has acquired alarming dimensions in our country especially over the last decade. Before that, waste management was hardly considered as an issue of concern as the wastes could be easily disposed off in an environmentally safe manner within the generation premises. However, with the passage of time, due to changinig life styles of people coupled with urbanization and industrialization the waste characteristics have altered making them a little tricky to be managed.

In this paper an attempt has been made to highlight the physico-chemical characteristics of ground water and soil samples around municipal dump yard and to assess whether the water is suitable for drinking purpose.

Chapter 7

Conclusions and Recommendations

7.1 CONCLUSIONS:

1. Development and Industrializations of Dehradun city is mainly cause of land effect.
2. Waste management in Dehradun is quite well.
3. During sampling of soil, earth surface of Dehradun city is identified that it is very stony i.e. Sahastra dhara road, Jogiwala, Haridwar by-pass road etc.
4. Land environment basically consist of built up area, i.e. building, roads, industries, business area, park etc. and natural feature vegetation cover, soil and water inside urban activity zone.
5. Effect of pesticides and fertilizers is slightly low on the surface of agricultural land.
6. Development plan policies should highlight the importance and non-renewable nature of soils, providing criteria in policies against which development proposals may be considered and providing a framework for enhancement;
7. Development briefs and other forms of supplementary guidance should include recommendations on the coverage and evaluation of effects on soil;
8. EIA screening and scoping procedures, as well as the assessment process itself, should consider fully the effects of developments on soil;
9. The assessment and after-use of previously developed sites should include Consideration of soils;
10. The development control process, including the use of planning conditions and agreements, should reflect fully the range of effects (both positive and Negative) on soil during construction, operation and decommissioning;
11. The knowledge base relating to soil should continue to grow through training, survey, monitoring and state of the environment reporting;

7.2 RECOMMENDATION:

Development plans should aim to provide a comprehensive approach to the protection and enhancement of soils. The basis of such an approach is set out in the following Points. These relate to the following:

1. It reccommended that soils should have equal status with the air and water in environmental legislation.

2. Soil issues should be considered during the process of developing plan policies. Soil should be included as a criterion within the statutory process.

3. Plans should include 'high level' plan policies on soil, setting out a commitment to the protection and enhancement of soils as part of a wider, sustainable approach to planning and development.

4. Strategic development plan proposals (for example relating to new settlements or urban expansion) should include consideration of the likely effects on soils and soil functions.

5. 'Soils' should be included as a criterion within more detailed development plan policies (e.g. for waste or minerals).

6. Outline guidance should be provided for developers to ensure that soil is considered as a factor throughout the design and implementation of a project:

Case Study on Environment Impact Assessment

Case Study on Environment Impact Assessment of Satpura Basin, Madhya Pradesh (Land Environment)

Sampling locations for Soil Quality Monitoring

Sr.No.	Sampling location
1.	Lohagdua
2.	Sajkuhi
3.	Pandupiparia
4.	Khedapai
5.	Linga village
6.	Damna
7.	Itawa
8.	Chopna
9.	Hirapur
10.	Punji

Table 1: Soil Texture in the Study Area

Sr. no.	Sampling location	Particle Size Distribution (%)			Textural Class
		Total Sand	Silt	Clay	
1.	Lohagdua	74	16	9	Sandy loam
2.	Sajkuhi	65	27	8	Sandy loam
3.	Pandupiparia	61	25	14	Sandy loam
4.	Khedapai	79	13	8	Sandy loam
5.	Linga village	67	24	9	Sandy loam
6.	Damna	66	25	9	Sandy loam
7.	Itawa	30	55	15	Slit loam
8.	Chopna	22	54	24	Slit loam
9.	Hirapur	24	51	25	Slit loam
10.	Punji	46	43	11	Loam

Table 2: Physical characteristics of soil

Sr. no.	Sampling Location	Bulk Density (gm/cm^3)	Porosity (%)	Water Holding Capacity
1.	Lohagdua	1.50	47	36
2.	Sajkuhi	1.30	57	36
3.	Pandupiparia	1.57	43	31
4.	Khedapai	1.39	41	30
5.	Linga village	1.30	48	38
6.	Damna	1.31	53	38
7.	Itawa	1.51	53	30
8.	Chopna	1.41	53	52
9.	Hirapur	1.39	40	32
10.	Punji	1.41	49	44

Table 3: Chemical characteristics of Soil

Sr. No.	Sampling location	pH (1:1)	EC Ds/m	Ca^{++}	Mg^{++}	Na^{+}	K^{+}
				meq/l			
1.	Lohagdua	7.6	0.11	2.81	0.85	0.43	0.11
2.	Sajkuhi	7.4	0.07	0.62	0.63	0.41	0.05
3.	Pandupiparia	7.6	0.21	0.67	0.62	0.43	0.09
4.	Khedapai	7.3	0.37	1.78	0.18	0.57	0.57
5.	Linga village	7.1	0.76	4.24	4.55	0.54	0.80
6.	Damna	7.5	0.54	4.37	1.29	0.43	1.09
7.	Itawa	7.4	0.21	1.43	1.20	0.50	0.18
8.	Chopna	7.3	0.25	1.60	1.03	0.50	0.10
9.	Hirapur	7.3	0.48	1.53	0.64	0.40	0.50
10.	Punji	7.5	0.64	3.75	0.93	1.46	0.86

Table 4: Cation Exchange Capacity of Soil

Sr. No.	Sampling Location	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CEC	ESP
		(cmol (p^{+}) kg^{-1})					
1.	Lohagdua	5.01	3.03	0.07	0.02	13.3	0.33
2.	Sajkuhi	5.7	3.5	0.07	0.01	10.7	0.4
3.	Pandupiparia	12.7	3.8	0.07	0.03	16.2	0.21
4.	Khedapai	4.1	4.6	0.07	0.05	14.9	0.30
5.	Linga village	5.3	3.0	0.40	0.20	10.6	2.10
6.	Damna	5.5	3.3	0.80	0.30	10.2	3.90
7.	Itawa	8.1	4.3	0.40	0.08	14.2	1.50
8.	Chopna	18.4	6.4	0.07	0.06	27.3	0.13
9.	Hirapur	14.1	4.8	0.07	0.05	22.2	0.20
10.	Punji	12.9	4.0	0.07	0.01	22.7	0.20

Table 5: Fertility Status of Soils

Sr. No.	Sampling location	Organic carbon	N	P_2O_5	K_2O
			(kg/ha)		
1.	Lohagdua	0.31	269	1.19	113.4
2.	Sajkuhi	0.16	175	7.15	116.1
3.	Pandupiparia	0.62	400	1.19	110.9
4.	Khedapai	0.70	371	2.38	169.5
5.	Linga village	0.80	526	7.15	197.6
6.	Damna	1.56	553	2.38	132.9
7.	Itawa	0.31	276	1.19	121.9
8.	Chopna	0.94	437	3.57	112.2
9.	Hirapur	0.62	348	2.38	160.9
10.	Punji	0.64	539	4.76	104.9

Prediction of Impacts Land environment:

In order to predict the environmental impacts due to drilling mud reject pits and emergency produced water impoundments, laboratory studies were carried out by simulating field conditions. The studies included investigation of leaching potential of possible hazardous constituents from these two sources.

Subsurface soil were collected from the block and experiments for investigations of leaching potential of drilling mud and produced water were carried out in laboratory. Since pH and alkalinity can directly affect the solubility of many parameters, especially the metals, the comparison of two gave some indication of the mobility of the metals. Generally solubility of metal decrease with increase in pH and increase in buffering capacity. On application of the drilling mud and produced water on soil under study, this was found to be true as soil were alkaline in nature. The transportation of ions revealed that Na, Cl and metals would tend to be slightly elevated in subsurface soils close to the mud pits or emergency produced water impoundments, however, most parameter will not migrate any significant distance away from the disposal storage facilities. Na, Cl were the only ions to show definite vertical migration through subsurface soils, specific conductance was used as the characteristics of zones with elevated ions.

As a result these characteristics, the potential for leaching of constituents from mud pits is hypothetically negligible. In mud pits migration of constituent will be dominated by surface runoff rather than by percolation of precipitation downward through the relatively impermeable drilling mud clay.

Evaluation of Impacts

The type of soil available in the study region has silt and clay in equal proportion followed by sand and gravels. The soil color varies from golden yellow to brown to light black. It is moderately productive. Since the erosion occurs in the rainy season the washing of nutrients minerals humus etc. the use of produced water in this region will help to restore the productivity of the land to some extent so that the crop and other plantation could be resistive and green cover in this region can be established. As far as soil environment is of concern the effect will be positive.

Environment Management Plan

Soils in the region have moderate infiltration rates amenable to ground water pollution. Considering this fact and moderate ground water quality, every precaution would be taken to avoid spillage of chemicals on soils to avoid any deterioration of groundwater quality and danger to soil microbial population in soils which are sensitive to hydrocarbon. Solid non-degradable wastes will be disposed in designated disposal sites. Such sites shall be identified in consultation with Madhya Pradesh Pollution Control Board.

The earth cutting generated at drill site will be mostly inorganic in nature and can be used either for land filling or road making. These solids could be collected and transported to identify sites. If this is uneconomical separate drying pits may be made at a corner of drill site.

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Comments: