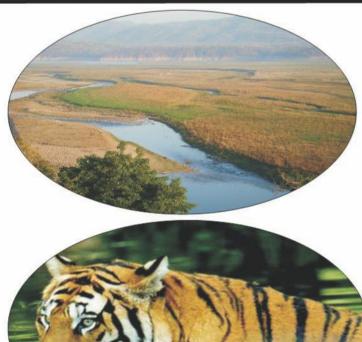


CENTRAL WATER COMMISSION (CWC) ENVIRONMENTAL IMPACT ASSESSMENT DIRECTORATE







REPORT ON **ENVIRONMENTAL EVALUATION STUDY OF RAMGANGA MAJOR IRRIGATION PROJECT**

Volume—I **MAIN REPORT FEBRUARY 2012**



Consultant AGRICULTURAL FINANCE CORPORATION LT HYDERABAD



List of Acronyms

Acronym	Expansion			
AFC	Agricultural Finance Corporation Limited			
AISLUS	All India Soil and Land Use Survey			
ASCI	Administrative Staff College of India			
BC	Backward Caste			
BHM	Bhoomi Samrakshana Adhikari			
BSI	Botanical Survey of India			
С	Centigrade			
CAT	Catchment Area Treatment			
CBIP	Central Board of Irrigation and Power			
CCA	Culturable Command Area			
CCF-H	Chief Conservator of Forests, Hills			
CGWB	Central Groundwater Board			
CI	Copping Intensity			
CTR	Corbett Tiger Reserve			
CWC	Central Water Commission			
DCCB	District Central Cooperative Bank			
Dg	Exiting Ground Water Draft for all uses			
Dgd	Exiting Ground Water Draft for Domestic use			
Dgi	Exiting Ground Water Draft for Irrigation			
DTW	Deep Tube Wells			
EIA	Environmental Impact Assessment			
El	Elevation			
EMP	Environment Management Plan			
FCC	False Color Composite			
FRL	Full Reservoir Level			
GCA	Gross Cultivated Area			
GEC	Groundwater Estimation Committee			
GEERF	Gujarat Ecological Education and Research Foundation			
GIS	Geographical Information System			
GoI	Government of India			
GoUK	Government of Uttarakhand			
GSI	Geological Survey of India			
GWav	Net Annual Ground Water Availability			
GWD	Ground Water Development			
ha	hectare			
HDI	Human Development Index			
HH	Household			
HYV	High Yielding Varieties			
IRI	Irrigation Research Institute			
IUCN	International Union for Conservation of Nature			
IUD	Intrauterine Device			
LULC	Land Use and Land Cover			
m	meter			

Acronym	Expansion
MCM	Million Cubic Meter
MoA	Ministry of Agriculture
MoEF	Ministry of Environment and Forests
MSL	Mean Sea Level
MT	Metric Tones
MW	Mega Watt
NCIWRDP	National Commission for Integrated Water Resource Development Plan
NGO	Non Government Organization
NH	National Highway
NPK	Nitrogen, Phosphorus, Potash
NWRC	National Water Resource Council
OBC	Other Backward Caste
OC	Other Caste
OFD	On Farm Development
ONGC	Oil and Natural Gas Commission
PHC	Primary Health Centre
PIM	Participatory Irrigation Management
PTW	Private Tube Wells
Qtl	Quintal
R & R	Resettlement and Rehabilitation
RCADA	Ramganga Command Area Development Agency
RIF	Rainfall Infiltration Factor
RS	Remote Sensing
RVP	River Valley Project
SC	Scheduled Caste
SDI	Shannon Diversity Index
SGWD	State Ground Water Department
sq km	Square kilometer
ST	Scheduled Tribe
STW	State Tube Wells
SYI	Silt Yield Index
ToR	Terms and Reference
UP	Uttar Pradesh
UPID	Uttar Pradesh Irrigation Department
USGS	United States Geological Survey
WLF	Water Level Fluctuation
WPR	Watershed Project Report
WQI	Water Quality Index
WRD	Water Resources Development
WTF	Water Table Fluctuation
WUA	Water User Association
ZSI	Zoological Survey of India

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EXECUTIVE SUMMARY

Major areas of Western and Central parts of Uttar Pradesh, the most fertile tracts of the country are irrigated through Upper and Lower Ganga Canals, Eastern Yamuna Canals and Agra Canals. However, since large tracts of the area were not receiving adequate irrigation and in order to bring the un-irrigated areas under irrigation the Ramganga project was conceived. The dam is constructed across Ramganga river and the dam is located 3 km upstream of the place where the river enters the plains near Kalagarh village.

This multi-purpose project was commenced during 1962 and was completed by 1974. The main objectives of the project was to bring an additional area of 5.90 lakh hectares under irrigation, control floods in 6 districts of Uttar Pradesh, supply of 5.5 cumecs of drinking water to Delhi besides generating 451 million units of power annually.

The objective of the study is to assess the environmental changes that occurred during and post construction phases after a detailed review of Environmental Management Plan (EMP) leading to formulation of redesigned EMP for the project as projects prior to the year 1978 were not having proper Environmental Management Plans. The study covered all components as per Terms of Reference (ToR) being R&R, Socio-Economic status, Agriculture, Bio-diversity, Irrigation and Drainage, Groundwater, Effects on Forest and Fauna, Land, Catchment Area Treatment Plan (CAT), and Public Health. The study covered catchment area spread in 313400 ha in Uttarakhand and the command area spread in 10 districts (now 17 districts) in Uttar Pradesh. The sample consisted of 15 minors, comprising of 11 minors in Lower Ganga Canal, 2 minors in Upper Ganga Canal and 2 minors from Agra Canal. The minor are under from middle and tail ends of the canal and 3 villages from each minor are covered for the survey. In each village 10 farmers were interviewed with a pre-structured schedule covering total of 450 farmers in command area and 250 farmers in control area. The data analysed consisted of both primary and secondary data. The pre-project year was taken as 1981 and compared with post- project year 2007-2008.

The report is presented in three Volumes, the First volume consisted of Main Report, the Second volume is earmarked for the Annexures and the Third volume presented Land use / Land cover maps of catchment and command areas of the project. The main report in volume-I is presented in 13 chapters. The first chapter is an introductory chapter, the last chapter (13th) gives conclusions and recommendations and the remaining chapters are allotted for discussion and findings in each area of study as described.

The description of the project area and the salient features of the dam are given in chapter II. The Ramganga dam is located in Kalagarh Village in Pauri Grahwal district of Uttar Pradesh. The structures consist of two earthen dams, the main dam is 127.6 m high and the saddle dam is 72.2 m high which is on one of the tributary called "Chuisot". The main objective of the project is to provide irrigation water to an additional area of 5.75 lakh hectares besides producing 451 million units of power with three units of 68 MW each.

Conclusions and Recommendations

The total cost of the project worked out to Rs. 165 crores. The reservoir has a live storage of 2195.5 M cum at RL 365.30 m. It was also aimed to provide 173.50 M cum of drinking water to Delhi Nagar Nigam. The construction activities were commenced in the year 1962 and completed in the year 1974.

The Effects on Rehabilitation studies revealed that on area of 8143 ha was submerged at FRL 365.30 m elevation and the entire area of submergence is forest land. The submerged area also included 5550 ha of Corbett National Park. As no habitats were submerged no compensation measures were found necessary. The only compensation to be provided was funds to forest department for construction of 84 km long road and rest house which were lost.

The study of Impact on Socio-Economic revealed that there is an overall increase with respect to all types of schools due to project as well improvement is student-turn-over and teach student ratio. The overall literacy has improved. There is marginal increase in growth of factories. The female labour as well as female cultivators increased by 53.4 per cent. The total population grew by 48.9 per cent in the command area districts. The commercial banks grew by 132 per cent and the expansion of credit had increased multifold. On the medical front growth of homeopathic institutions is seen after the conventional allopathic institutions. There is reduction in child and infant mortality.

The Effects on Agriculture revealed that the double cropped area had increased leading to higher cropping intensity to 156 per cent. Fast growth was evidently seen between 1975 and 1982. The area, production and productivity of all major crops increased.

The groundwater scenario revealed that the maximum depth to water table below ground level had increased in the command. However, on average there is lowering trend of groundwater at most of the places which requires detailed micro-level studies. Conjunctive use of water is recommended. There is no water logging and salinity in the area.

The submergence area was devoid of any archeological monuments or places of worship. The abutting Corbett Park is already a famous tourist spot and offers abundant scope for expansion of tourist activities.

The impacts on the forest flora and fauna are presented only as the present scenario comparisons are not possible due to lack of pre-project data. The existing scenario revealed that the forest in both catchment and command area of the project decreased. The herbs are conspicuous in grass lands. Shrubs dominate the free understory as well as in scrub forest area. The picture on the fauna revealed that the park comprises of 50 mammals species, 580 bird species, 25 reptiles species. The aquatic fauna especially the fish like Mahsheer have no convenient migration and breeding environment. The endangered fish species such as Mahsheer need special attention for their conservation.

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The impact on the command area development revealed large gaps to reach full potentially due to deficiencies in the distribution system. The command area due to project increased to 13.72 lakh ha with the additional area of 5.12 lakh ha now brought. It is seen that 100 out of 140 blocks require some sort of drainage systems. Excavation of earthen canals, lining and *osrabandi* was completed.

The changes in land use pattern revealed that crop land in catchment area is increased while forest land declined. Waste land is also increased while water bodies got decreased. Similar trends are observed in command area which is found to be detrimental to ecoenvironmental management of the area necessitating afforestation programmes and silvi pastoral development in both the areas.

Exclusive CAT plans were not developed at the time of project planning or during implementation. But the entire area was under centrally sponsored scheme of soil conservation. In view of these programmes the average annual sediment deposit came down and loses in the reservoir capacity, was brought down.

Though there was no environment management plan, the other programmes like soil conservation controlled the bad effects due to sedimentation. R&R was not necessary, compensatory afforestation was done partly by Forest Department. Muck management was planned and executed properly. Green Belt development is not felt necessary due to location advantages. There is a need to go for avenue plantation along the canal banks. Game fishing and other activities can be taken up to attract tourists. Keeping in view all the above aspects comprehensive recommendations are given at the end of the report, the important recommendations given included the following.

- Capacity building activities for livelihood enhancement in command area districts be taken up in order to bring new farm technology to the fields with the ultimate objective of increasing income and savings of the households.
- More employment opportunities may be created by establishing agro-processing units in the command area districts in order to tap the unexploited industrial potential of the area.
- Education of farmers on balanced usage of fertilizers (NPK) through extension activities in the command area districts shall be taken up through the Agriculture Department, GoUP.
- Simultaneously the concept of "organic farming" shall be taken up on pilot basis in selected pilot blocks in order to gradually wean away the farmers from using chemical fertilizers and also to improve the health of the soil in the command area districts.
- The status of improved breed especially in cattle needs urgent attention and cross-breeding programmes through artificial insemination have to be taken up on a large scale through public-private partnership in all the command area districts.



Conclusions and Recommendations

- Simultaneously fodder development schemes need to be taken up taking advantage of availability of increased water in the command area by bringing culturable waste lands in to cultivation.
- The Existing growth centers can be strengthened by installing "technology information centers" to link up the command area farmers to the extension network of the outside world.
- Construction of additional tube wells under both public and private sectors, after a
 detailed survey for fixing locations, in order to fully utilize the present ground
 water balance.
- Conducting of micro level studies for detailed geo-hydrological mapping and detailed inventory of all groundwater structures in all the command area districts except Etawah and Auariya.
- District wise conjunctive use plan as given in the report with a cost estimate of `301.19 crores to tap balance available water. The plan for installation of private tube wells may be implemented through agriculture finance programmes of commercial banks in the state of Uttar Pradesh.
- The construction of the tourist park at the dam site is to be speeded up. The proposed park shall have unique and attractive features to provide knowledge on eco-tourism as well as entertainment to all age groups including children like Boating, game shooting, game fishing, a children's park and a museum.
- In order to protect the endangered fish species particularly the Masheer the existing fish passages need to be modified to allow upstream migration throughout or alternately, new fish passages have to be planned in such a way that continuous migration of fish takes place from and in to the reservoir.
- Commercial fishing activity to fisherman can be developed at the two near-by barrages, one on the Ramganga River and the other on the Kho-river having pondages along with development fish-breeding centres near these areas for supply of fingerlings of selected species. A budgetary provision of `9.00 crore may be provided for this activity.
- Maintenance and repair work of field channels and distributaries have to be taken up immediately to ensure smooth flow of irrigation water especially to tail end fields. A budgetary provision of about `35.00 crore may be provided for this activity.



- The activity of strengthening of WUAs be entrusted to experienced NGOs and
 effective monitoring be done continuously till each WUA become confident and
 self-reliant.
- A detailed resurvey on catchments has to be conducted to identify all damaged engineering structures and take up maintenance works. A tentative budgetary provision of `25.00 crore may be earmarked for this activity.
- Compensatory afforestation in the remaining area of 5500 hectares has to be speedily taken up after identifying the degraded forest area in the vicinity with an approximate outlay of `45.00 crore.

Volume-I



1

Introduction



Backdrop

1.01 There has been a global rise in growth of population over the years, necessitating the urgent need for rapid development in all fields to meet the food and shelter requirements of the growing population. As a sequel to this situation, there has been an all-round development in industrialization and urbanization in both the developed and the developing countries. This rapid development is causing a serious concern in providing and maintaining pollution free environment. An analysis of the present situation has brought to light that industrialization and urbanization, particularly in the developing countries has been creating more stress on the natural resources due to over exploitation and associated depletion of plant and animal wealth. Keeping in view the biotic stress in the recent past, protection of natural environment has been gaining highest priority while planning for any development projects like River Valley Irrigation Projects, Road Projects, Industrialization, Power and Dinking Water Projects, etc.

1.02 It is an established fact that nature's stability is dependent on bio-diversity and environmental sustenance. Therefore, during the last couple of decades there has been a spurt in the awareness on the need for environmental protection and environmental management for improving the global ecology. Serious efforts are, therefore, being put in to conserve and regenerate the nature as the poor live in by 'Gross Nature Product' and the bio-mass developed in various forms in different regions along the hills, plains, rural areas and in other parts with dense human habitation. To meet the challenges of environmental pollution, the developed countries in the world have taken concrete steps and have established separate Departments / Ministries exclusively for this purpose. Falling in line with the developed countries, the Government of India (GoI) has established an exclusive Ministry of Environment and Forests (MoEF) for taking care of environmental protection needs. Safeguarding the interests of environment is taken care through proper identification of environmental impact and preparing suitable Environmental Management Plans while sanctioning establishment of industries, reservoirs / dams, railways, thermal power plants, etc. In other words, the Environmental Protection Act enacted by the Government of India (GoI) during 1986 governs any project having interference with the environment. The MoEF, GoI is, therefore, the nodal agency for sanctioning the environmental clearance for developmental projects after 1986.

Present Scenario

1.03 During the past two decades, efforts are being made for protecting the environment while implementing the River Valley Projects by insisting on formulation of a suitable Environmental Management Plan (EMP) after undertaking a detailed Environmental



Impact Assessment (EIA) study before construction of the project. While formulating irrigation development projects, the Government of India has initiated suitable measures for implementation of the EMP as well as Resettlement and Rehabilitation (R&R) Plan. Now the time has come to evaluate the implementation of the EMP in the completed project areas to assess the level of Environmental Impact and R&R and to make suggestions for furthering the environmental improvement through modified EMP redesigned for the project. With this in view the Central Water Commission (CWC) has entrusted the Agricultural Finance Corporation Ltd (AFC) the work of conducting a detailed post environmental evaluation of the Ramganga River Valley Project in Uttarakhand & Uttar Pradesh, constructed between 1962 and 1974 AD.

Objectives

1.04 The basic objective of the study is to assess the environmental changes that have occurred during construction and post construction phases of the project after a detailed review of the implementation of the Environmental Management Plan (EMP) leading to formulation of a redesigned EMP for the project.

1.05 In the light of the above, the present evaluation comprises the study of impact of the project on Resettlement and Rehabilitation; socio-economic status, agriculture, irrigation and drainage, bio-diversity, land environment, public health, water environment including groundwater, etc. Development of a modified EMP involving compensatory afforestation, green belt development, health systems, fisheries development, catchment area treatment, reservoir rim treatment, landscape restoration, muck disposal, ecological conservation etc. is also part of the post evaluation studies. The study would also identify the possible constraints and limitations in implementation of EMP for not having achieved desired outcomes in the post project scenario in consultation with project stakeholders and stakeholder institutions.

Scope

1.06 The present report, thus, focused on the status of EMP, and the study is undertaken based on the data collected now. The scope of study envisages assessment of changes that have occurred in the Environment due to the Project Construction and its operation. The under mentioned are the broad parameters for the study;

- The post environmental impact due to the project compared with the pre-project situation on land environment including changes in cropping pattern, overall development in the command area, improvement in production, etc.
- The post environmental impact of the project on water environment and the study of impact on reservoir due to sedimentation, etc.,
- Present impact on biological environment including changes in forest cover comprising of flora, fauna, aquatic life, endangered species, migratory birds etc and compare with the situation prevailed in the pre-project stage and effectiveness of wildlife conservation programs, etc., due to the involvement of National Park



- surrounding the Reservoir.
- The public health hazards during pre and post project conditions including drinking water supplies, health status, health services, occurrence of diseases, communication and transportation facilities, quality of life, etc.
- Study the impact on agriculture in terms of in cropping pattern, cropping intensity, improvements in production, etc.
- Analyze the impacts on drainage including identification of waterlogged and saline areas.
- The impacts on socio-economic conditions such as changes in literacy, employment, improvements in quality of livestock and poultry, development of industries, health care infrastructure etc.
- Effects of rehabilitation including amenities, infrastructure facilities, sanitation status, and living standards compared to the pre-project baseline.
- Impacts on archeological monuments, economically important minerals and places of worship submerged in the reservoir.
- Study catchment area treatment measures, progress, areas of soil erosion, sediment arrest study, and modified plan proposals.

1.07 The study also aims at assessment and evaluation of Environmental Management Plan (EMP) implementation in respect of

- Rehabilitation and Resettlement
- Compensatory Afforestation
- Greenbelt Development
- Catchment Area Treatment
- Reservoir Rim Treatment
- Landscape Restoration
- Ecological Conservation
- Fisheries Development

1.08 The objectives of EMP evaluation also include assessment of the outcomes of EMP vis-à-vis its conformance to anticipated outcomes and develop a modified EMP involving the above aspects. The CWC suggested detailed Terms of Reference (TOR) for the study and the same is presented in **Annexure - I.1**

Study Design.

1.09 Any new reservoir project is expected to cause impacts on the surrounding environment at the project site, command area, drainage etc. during construction phase and operation phase. Thus, the Environmental Impact Assessment (EIA) and formulation of necessary Environment Management Plan (EMP) form an integral part of reservoir projects where there is large-scale inundation of land due to submergence under the reservoir, and development of command area for irrigation.

1.10 The EIA for Water Resources Development (WRD) projects has been in practice since 1978 only. In addition, carrying out EIA for WRD projects costing more than ` 100



crore and subsequent preparation of EMP has been made mandatory as per the EIA Notification 1994. Thus, for the projects sanctioned prior to 1978 there was no stipulation for the preparation of comprehensive EIA and EMP studies. Therefore, the Central Water Commission (CWC), GoI, thought it would be worthwhile to get comprehensive studies carried out to analyze the environmental issues related to WRD projects implemented prior to 1978 also. Ramganga River Valley Project in Uttarakhand / Uttar Pradesh is one of such projects, which was sanctioned during 1961, requiring comprehensive studies on environmental issues.

Study Components

1.11 The main objective is the evaluation of the impacts after implementation of Environment Management Plan during the post-project period for the Ramganga River Valley Project. This exercise facilitates the Central Water Commission to redesign its strategy for implementation of EMP in similar irrigation projects as well as for facilitating further extension of its coverage in the area. With this focus, the study is designed for identification of key monitoring indicators through suitable verifiable measures. The grouping of the present study components are as under:

- Impact of Rehabilitation
- Socio-economic impacts in the project area
- Impact on Agriculture and Command area
- Impact on Groundwater and Drainage
- Impact on Archeological Monuments, Minerals etc. if any
- Impact on Flora and Fauna
- Impact on Public Health
- Changes in Land use Pattern including Catchment Area Treatment
- Impact of EMP implementation
- Constraints and Limitations of the study

Study Area for Evaluation

- 1.12 The Ramganga Command Area Development Authority was established in the year 1973-74 with the head quarter at Kanpur to have an integrated and comprehensive development of irrigated agriculture in the command Area of Ramganga. Initially Ramganga Command Area Project covered 10 districts namely Aligarh, Muthura, Agra, Etah, Mainpuri, Etawah, Farrukhabad, Kanpur, Fatehpur and Allahabad. Now these 10 districts have been restructured in 17 districts (**Annexure-I.2**). Ramganga Command Area Project was later on extended to additional six districts viz Saharanpur, Muzaffernagar, Meerut, Bulandshahar, Bijnor and Moradabad. This programme was woundup in the year 2002-03. The present study is restricted to only 10 districts (Now 17 districts) taken in first stage of the implementation of the command area project.
- 1.13 The terms of reference does not specifically provide the study area for evaluation of Environmental impacts due to project construction and its operation. However, as per



the scoping matrix given in the TOR it is presumed that the evaluation studies shall be carried out in the following areas:

- Area within 10 km radius from the periphery at the dam site and submergence area;
- Free draining catchment area at the dam site in Uttarakhand state;
- Command area of Ramganga Project in the 16 Districts of Uttar Pradesh; and
- Submergence area of the project

The area for study of impact evaluation is drawn according to the above presumption.

Approach and Methodology

- 1.14 Since, the above study components are multidimensional and multi-disciplinary in nature, the listing of monitoring and evaluation indicators along with verifiable measures are presented in **Statement I**. The comprehensive study is made duly comparing with the baseline data i.e., prior to the construction or during the construction of the project i.e., between 1962 and 1974 AD. The baseline data is procured to the extent of availability from various line departments of the Government of Uttarakhand and Uttar Pradesh. Data relating to the following environmental components are collected from both Primary and Secondary sources and analysed for the impact assessment.
 - i Land Environment including agriculture;
 - ii Water Environment including hydrological and groundwater studies;
 - iii Biological environment including flora, fauna and pici-culture;
 - iv Public health
 - v Socio-economic environment including Resettlement and Rehabilitation

Methodology and Sample size for Field Survey

Methodology

1.15 This study is based primary. The assessment of impact is based on with, without, and before methodology.

Sample Size

1.16 Out of all minors in Ramganga command area project, 15 minors were taken for this study. A random sample of 15 minors, eleven minors from lower Ganga canal, 2 minors from upper Ganga Canal and 2 minors from Agra Canal, was selected according to the designed area for irrigation in the Ramganga Command Area Project. Five minors from the head of the distributaries, 5 minors from the Middle and 5 minors from tail of the distributors were selected randomly. In each selected minor 3 villages (One village from head of the minor, one village from middle and one village from tail of the minor) were selected. In each selected village 10 farm households (six farm households from marginal category, 2 farm households from small and 2 farm households from other



categories of holding six groups) were selected. Thus, a sample of 450 farm households was taken for this study in the command area of Ramganga Project.

1.17 For control area, 25 such villages were selected having identical agro climatic conditions, adjoining to the project area. Ten farm households were randomly selected from each of the selected village. In this way, 250 farmers were selected for the study from the non-command area Accordingly 700 farmers have been interacted through a well-structured questionnaire of which 450 are from the project area and 250 from the control area having similar agro climatic conditions.

Tools used

- 1.18 For the Collection of primary data of this study two types of schedules were developed. The details of schedules are given below.
 - (i) Village Schedule
 - (ii) Farm household schedule
- 1.19 The data triangulated with the information generated based on the above study components are analysed in detail through various means by conduct of ground level investigations and by collection of secondary data relating to baseline status and present situation and discussions with officials at state, district and project levels. Collection of data from secondary sources i.e., from various line departments was undertaken to the extent possible. Topo sheets are collected to generate required maps through remote sensing and GIS technologies.
- 1.20 The primary data collection from the benefited households in the command area through conduct of detailed socio-economic survey of sample household is undertaken. Primary data relating to Village level information on various infrastructural facilities in benefited villages is also collected.
- 1.21 Since the Reservoir did not submerge any village, the need for collection of primary data from the affected households did not arise.
- 1.22 Utilization of toposheets to a scales of 1:50,000 is essential for studying the water sheds in the catchment area, command area and also the submergence area in addition of R.S. imageries for identification of land use/land cover/soil erosion status, water logged area through RS and GIS Techniques. A detailed monitoring and evaluation framework relating to Ramganga River Valley Project towards the evaluation of EMP Report is presented in **Statement I.**

Constraints and Limitations of the Study

1.23 Every study has certain limitations due to factors beyond the control of the study team. The limitations are more pronounced when the study on nature of impacts is taken



up after a long gap after completion of the project. In the case of present, study on Ramganga River Valley Project. It is to be mentioned and noted that the project was completed as far fact as 1974: i.e., approximately more than three decades ago. In addition to the large time gap is the fact of not having an environmental management plan before or during the project in place except some guidelines and precautions. In this background, the limitations of the study are reported as below:

- 1. Unduly large time gap between the completion of the project and undertaking of the study an impact due to which specific attribution of any indicator to the project effect is made difficult
- 2. The absence of EMP before or during the project constrained the study team to evaluate the present status only and there by give a fatten plan rather than to find out gaps and requirements.
- 3. In view of the large time gap, the primary survey of the benefited families could not be done with "pre and post" approach as the respondents could not exactly recall the situation prevailing more than 30 years ago.
- 4. In view of point no.3 "Pre and Post" approach was used for secondary level data where as "with and without approach" was used for primary level data collection. The results so obtained at both levels may therefore, not exactly reflect similarity through the overall trend reflected might be same.
- 5. As there was no computerized / electric data pertaining to years prior to 1990, certain indication has to be compared with in the available years.
- 6. In view of winding up of the office of the Command Area Development at Kanpur, the team has no access to some important and useful data on the project which was reportedly stacked up in old record rooms and not retrievable at this stage.
- 7. The access to remote sensising maps on catchment and command pertaining to the earlier years has also been difficult.
- 8. The present officials in the concerned departments like irrigation, agriculture, Ground water etc., could not provide the specific data for exclusive Ramganga command which is lying as a part and parcel of old Ganga canal system.
- 9. Lack of some direct data at the immediate concerning department office forced the team to rely upon various studies conducted by third party agencies and institutions especially on groundwater and catchment.
- 10. The Ramganga command could not be particularly delineated as the project water flows after joining with the old Ganga canal system.

Report Preparation

1.24 The study report is prepared in three volumes at the first volume consists of the detailed report along with recommendations, the second volume comprises of the Chapter-wise Annexures containing data used for analysis and the third volume comprises of the 'Atlas' incorporating all the RS imageries used in the study report. Necessary recommendations for improvement of the adverse environment situation prevailing at present are made duly preparing required modified Environment Management Plan with costs.



Chapterisation

1.25 The report is prepared in three volumes. The Volume-I consist main text and chapter plan for this volume is as follows.

Volume – I

- I. Introduction
- II. Project Area
- III. Effects of Rehabilitation
- IV. Socio-Economic Impact
- V. Effects on Agriculture
- VI. Impacts on Ground Water
- VII. Impacts on Archeological Monuments, Minerals and Places of Worship
- VIII. Impacts on Forests, Flora and Fauna
- IX. Impact of OFD Works
- X. Changes in Land Use Pattern
- XI. Status of Implementation of CAT
- XII. Evaluation of Environmental Management Plan
- XIII. Impact On Public Health, Drinking Water Supply, Communications and Quality of Life in General
- XIV. Conclusions and Recommendations

Volume-II consists the Annexures and Volume-III consists of Land use / Land cover maps and Groundwater scenario in command area.

The Team

1.26 The team constituted by AFC comprises of specialists drawn from various disciplines with experience in Environmental Sciences, Agronomy, Hydrogeology, Water Management, Forestry, Fisheries and Agriculture. The team also comprises of specialists relating to Remote Sensing and GIS techniques supported by adequate number of field level professionals to collect primary and secondary data, computerization, processing, analyzing and generation of reports.

Statement - I
RAMGANGA RIVER VALLEY PROJECT MONITORING AND EVALUATION FRAME WORK

Sl. No	Component	Monitoring and Evaluation Indicators	Verifiable Measures
1	Socio-Economic Impacts	 Details of status of schools / teaching staff, student turnover; 	• Educational institutions, students, teachers, students-teacher ratio.
		 Improvement in male - female literacy, evaluation of adult education programmes, provided if any; 	Adult literacy programmes if any and their impact.
		 Response to education provisions and assessment of constraints; 	Problems and constraints
		 List of post project occupational options that have arisen in the region and also make a statement what occupations are attributable to project benefits; 	Occupational diversification in the new locals
		• List all the new educational, cultural, recreational and commercial (markets, banks, etc.) institutions accessed that have come up in the post project situation and state how much of it is attributable to the project;	Development of cultural, recreational and commercial activities in and around the project area.
		 Compare the incidence of some important diseases in post and pre project situations; 	Prevalence of diseases in pre and post project conditions
		 Compare the health care infrastructure in the post and pre project situation; 	Health infrastructure related to dispensaries, clinics, hospitals, doctors, beds etc.
		Compare the Human Development	 Arrive at HRD index based on



Statement - I RAMGANGA RIVER VALLEY PROJECT MONITORING AND EVALUATION FRAME WORK

Sl. No	Component	Monitoring and Evaluation Indicators	Verifiable Measures
		Index (to the extent that the data is available) in the post and pre project situations.	socio-economic indicators
2	Effects on Agriculture	Improvement in Production	 Area under principle corps and total production. Productivity of principal crops
		 Changes in Cropping Pattern and improvement in cropping intensity due to the project on agricultural / horticulture / animal husbandry 	Crop diversification in post project situation
		 Improvement in quality of livestock and poultry 	 Improvement in livestock population
		 Assess agriculture cooperative and agriculture finance programmes if initiated 	 Development of cooperatives and farm productivity centers.
		 Details of the steps taken to prevent contamination of ground and surface water due to fertilizers, pesticides, runoff, etc. 	Use of manures, bio-fertilizers and other measures and impact on the environment
		Development of industry in command area	Existence of industrial units in command area
		Development in the command area	Command area development
3	Impacts on Groundwater	Quality and quantity of groundwater	Groundwater quality
		Changes in groundwater table in	Groundwater levels



Statement - I
RAMGANGA RIVER VALLEY PROJECT MONITORING AND EVALUATION FRAME WORK

Sl. No	Component	Monitoring and Evaluation Indicators	Verifiable Measures
		recharge zones.	
4	Impact on Drainage	 Increase in the waterlogged area and mapping of specific area 	Identification of waterlogged areas
		 Arriving at an understanding of how the waterlogging has increased 	Study of waterlogging
		 Estimation of increase in the salinity effected soils and mapping of the same. 	Identification of salinity in the command area
5	Impact on archaeological monuments, economically important minerals and places of worship	 List of the archeological monuments and places of worship that are restored as part of EMP, record their status and enlist reasons. 	Restoration of places of worship, archaeological monuments if any by the Government
		 List new places of worship and monuments that have come up during the post project period 	 New places of worship if any in the relocation settlements
		 List the new recreational opportunities that have come up in post project situations 	New parks, play grounds, etc.
		 List the pre-project and post project status of economically important minerals and the means and activities of harnessing the same. 	Mineral extraction by the Government and type of minerals
6	Impacts on Forests	 Assess changes in the forest cover, forest types; 	Changes in the forest cover in the new afforestation areas.



Statement - I RAMGANGA RIVER VALLEY PROJECT MONITORING AND EVALUATION FRAME WORK

Sl. No	Component	Monitoring and Evaluation Indicators	Verifiable Measures
		 Assessment of change in IVI & Shannon diversity index 	Comparison of IVI & SDI
		 Assess effectiveness of forestry programmes, contribution to sustaining local population needs (in eco development perspective); 	 Forest development programmes in sustaining livelihoods of the indigenous population
		 Contribution to economic activities related to medicinal plants in sustaining livelihoods of local population, if any 	Promotion of medicinal plants
		 Status of endemic and endangered species and evaluation of conservation programmes, if any. 	 Protection of endangered species in the new environment
7	Impacts on Fauna	 List terrestrial, avi and aquatic fauna 	Identification relevant species
		Assess changes in terrestrial fauna and their migratory patterns, if any	• Study the changes if any on migratory pattern of birds, fish, etc.
		Assess changes in avi fauna and their migratory patterns, if any	Study the changes if any on migratory pattern of birds, fish, etc.
		 Assess affectivity of wildlife conservation programmes, pisci- culture development programmes, and other activities contributing to sustaining local population 	Wild life conservation if any in the project area and other programmes implementation



Statement - I RAMGANGA RIVER VALLEY PROJECT MONITORING AND EVALUATION FRAME WORK

Sl. No	Component	Monitoring and Evaluation Indicators	Verifiable Measures
		livelihoods.	
8	Changes in Land use pattern	 Using image processing carry out land use / land cover classification and map on GIS; 	 Land use and land cover in pre and post project conditions
		 Using overlays identify new development triggering land use changes; 	 Land use changes in irrigation command
9	Evaluation of EMP Implementation	Assess and evaluate R & R, compensatory afforestation, green belt development, health systems, fish development, catchment area treatment, reservoir rim treatment, landscape restoration, much disposal; ecological conservation, free fuel provision plans, etc. in terms of	Implementation of EMP in the project on various components
		 Evaluate the outcomes of EMP, assess its conformance to anticipated outcomes, understand the departures if any; 	Impact of EMP and its performance on land, crop production etc.
		Develop a modified EMP involving compensatory afforestation, green belt development, health systems, fish development, catchment area treatment, reservoir rim treatment, landscape restoration, muck	Identification of gaps for preparation of EMP



Statement - I RAMGANGA RIVER VALLEY PROJECT MONITORING AND EVALUATION FRAME WORK

Sl. No	Component	Monitoring and Evaluation Indicators	Verifiable Measures
		disposal, ecological conservation, free fuel provision plans;	
		 Suggest any modifications / revisions to performance indicators and institutional measures; 	 Need based suggestions, for revision of performance indicators.
		 Identify needs in revisions to financial arrangements. 	 Financial indicators and arrangements
10	Status of implementation of Catchment Area Treatment (CAT) Plan	 Study the catchment area treatment measures suggested; 	 Vegetation and engineering measures undertaken
		 Progress of the bioengineering and civil works carried out so far; 	 Vegetation and engineering measures undertaken
		 Identify areas where soil erosion and sediment yield arrest has been successful; 	



Volume-I



2

Project Area



Introduction

2.01 The western and central parts of Uttar Pradesh in Ganga—Yamuna Doab are of the most fertile tracts of the Country. Major parts of this area were under irrigation through upper and lower Ganga canals, Eastern Yamuna canals, Agra canal and Ramganga pumped canal systems at the time of evolution of the Ramganga Project proposals. At that time, still large tracts of cultivable area in the Ganga—Yamuna doab were not having irrigation facilities due to certain constraints such as inadequacy of water in the existing irrigation systems. In order to harness the potentialities of Ramganga River, a tributary of Ganga, the Uttar Pradesh Government formulated proposals for construction of a dam across Ramganga River to provide irrigation facilities to the area leftover in the doab, besides achieving other multiple benefits. The dam is located at 3 km upstream of the place where the river enters the plains near Kalagarh village. Due to reorganization of the states, the dam and its catchment fall in Uttarakhand state while the entire command area to derive the following benefits is in Uttar Pradesh:

- Irrigation facilities to an additional extent of 5.90 lakh hectares in the Ganga– Yamuna basin yielding an extra 3.00 lakh MT of food grains in 16 Districts of Uttar Pradesh
- Generation of 451 million units of Power annually with the help of 3 units of 66 MW capacity each
- Control floods in the districts of Moradabad, Rampur, Bareilly, Shahjahanpur, Bijnor and Farukhabad of Uttar Pradesh.
- Supply 5.5 cumecs of water to Delhi Nagar Nigam for drinking water purposes.
- 2.02 Thus, the Ramganga River Valley Project was contemplated and implemented to achieve the above multiple benefits. The project construction commenced during 1962 and dam appurtenant works were completed in 1974. The Ramganga Reservoir created a beautiful lake submerging 55 sq. km of famous Corbet National Park.

The River

2.03 Ramganga River originated at a place known as "Diwali Khal" at an elevation of 2926 meters in the Himalayas where a temple of Lord Rama is situated. The River flows down in the form of two tiny currents from the above sacred place, thus, deriving its name as Ramganga. The river after emerging from a hill at Diwali Khal flows towards South up to Dhanian Ghat with an elevation of 1677 meters above Mean Sea Level (MSL). From there it flows down in south-west up to Burha Kedar to an elevation of 832



meters. The River then flows North-West to South-West directions upto Bhikia Sain, El 761 meters. Finally the river emerges out of hills at Kalagarh (EC 262 m), where the dam was constructed. The total length of the river course form its origin up to the dam site is above 158 km. The river further flows for a length of 212 km, though the districts of Bijnor, Moradabad, Rampur, Shajahanpur, Farukhabad and Hardoi before joining with Ganga River. The river has the following main tributaries up to the Ramganga Project Site:

1.	Ganges	2.	Binao
3.	Khatraun	4.	Nair
5.	Badangad	6.	Mandal
7.	Haldgad	8.	Sona Nadi

The total catchment area up to the dam site is 3134 sq. km.

Project Location

2.04 Ramganga River Valley Project's dam is situated about 3 km upstream of Kalagarh village in the District of Pauri Garhwal of the present Uttarakhand state. The geographical co-ordinates of the dam site are 29 ° 31' 13" North latitude and 78° 45' 35" Eat Longitude. It is about 110 km North East of Moradabad. Kalagarh is well connected by road via Ram nagar from Kashipur on NH-74 and via Kotdwara and Najibabad from Bijnar of Uttar Pradesh on NH-74. The nearest road point to the main dam site is Kotdwara, which is about 3 km. The nearest railway station is Dhampur, which is at a distance of 32 km from dam site. Two other railway stations viz., Ramnagar and Kotdwara are at a distance of 42 and 35 km respectively from Ramganga Dam site. Thus, project area is well connected with railways and road network. The District head quarters Pauri Garhwal is above 93 km by road.

2.05 The catchment area at the project site is bounded by the co-ordinates 29° 30' to 30° 07' North latitude and 78° 35' to 79° 35' East Longitude. Project location features of the area are shown in **Fig. 2.1.**

Project Components

2.06 The Discharge of the Ramganga River varies from 10000 cumecs during monsoon to about 5 cumecs during summer. The floodwater of the river averaging about 2400 million cubic meters annually were going waste since time immemorial, and causing floods in several parts of the state¹. To take advantage of these huge resources of water for irrigation and other development purposes, the Government of Uttar Pradesh sanctioned a multi–purpose project i.e., 'Ramganga River Valley Project' in the year 1961. The layout and the designs of the structures under went repeated modifications during the period 1949 to 1961 when the project was sanctioned. After the constitution of

¹ Project Report (1985-90), Ramganga Command Area Development Project, Kanpur.



the Board of Consultants in 1962, the Board again examined all the technical aspects of the project and suitable alternations and modifications were made as incorporated in the revised project of 1965 and 1972.

Thus, in its final stage² the project had the following components:

- 1. Diversion Tunnels
- 2. Main Dam across the river valley
- 3. Saddle dam on the rim of the reservoir
- 4. Chute spillway
- 5. Auxiliary spillway at saddle dam
- 6. Low Level Irrigation outlet
- 7. Power Intake structures
- 8. Power House and Filtration Plant
- 9. Switch Yard
- 10. Tailrace Channel
- 11. Drainage tunnel and Galleries
- 12. Architectural works and
- 13. Public Facilities

Diversion Tunnel: Two circular diversion tunnels of 9.45 m dia have been located on the right flank of the dam in such a manner that the length of the tunnels is shortest. The diversion tunnels have been designed to carry a flood discharge of 1 in 1000 years frequency (3286 cumecs at reservoir elevation of 338m). One of the tunnels would later on be used as power tunnels while the other one would be provided with irrigation outlets.

Main Dam Across the River Valley: The main dam across river Ramganga is an earth and boulder fill structure, the deepest foundation being at E1.244.4m and the height of the dam 127.6 m. the height has been provided so that the flood water of 28 out of 100 years shall be fully stored. In the remaining years, extra water shall be allowed to spill over a concrete chute spillway. The maximum base width of the dam is 637 m and crest length 360 m. A free board of 5.8 m has been provided.

Saddle Dam on the Rim of the Reservoir: The Saddle dam was required to plug three low saddles at elevation 340 m, 356 m and 345 m on left flank of the reservoir. It is also an earth and rocks fill structure. The deepest foundation is at E1.299.8 m and the height of the dam is 72.2 m. The maximum base width of the dam is 337 m with a crest length of 562m.

Chute Spillway: The Chute spillway and its control structures, with crest at E1.352.0m, are located on the right abutment of the Main Dam. The Spillway, having a designed discharging capacity of 7607 cumecs has been provided with 5 bays of 14 m each,

² Central Board of Irrigation and Power, History of Ramganga Project, New Delhi, March 1990.



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separated by 3.65 m wide piers. The bays are controlled by 14 m x 14.6 m high radial gates to permit storage up to E1.366.2m. The bed width of the chute flares from 84.6 m at crest to 120.16 m at the basin. a slope of 1 in 3 has been provided in the chute with a deep stilling basin for energy dissipation by formation of hydraulic jump. The Stilling Basin for the Chute Spillway also serves as the basin for the Irrigation Outlets.

Auxiliary Spillway at Saddle Dam: It is a chute type spillway located on the right flank of the Saddle Dam. It would come in operation when the flood exceeds the design flood i.e., 1 in 750 years. At reservoir elevation of 366.85m, the spillway has a design discharge capacity of 1541 cumecs. The Auxiliary Spillway has a crest at E1.359.5m with 3 bays of 14.0 m each having radial gates of size 14 m x 7.50 m. A flip bucket has been provided at the end of the outfall, due to the existence of some soft rocks at the outfall.

Low Level Irrigation outlets: Water from the reservoir shall normally be released through turbines. In the eventuality of any breakdown in the power plant, two permanent outlets, to give a discharge of 142 cumecs (at dead storage E1. of 317m) have been embedded in tunnel T-2, running under the Chute Spillway. The discharge is controlled by means of Butterfly and Howell Bunger Valves.

Power Intake Structure: Water from the reservoir enters the Power Intake structure and then passes through penstocks to run the turbines. The Power Intake at Ramganga Project is an unconventional structure, which provides emergency control at the intake. The arrangement comprises a cylindrical gate provided at the funnel shaped inlet of the tunnel and actuated by a hydraulic hoist fixed above the gate in a sealed chamber approachable at all times from the top of dam through a concrete lined tunnel. The gate is operated by two controls, one located at the top of the dam and the other in the powerhouse. The bottom sill of the structure has been kept at sufficiently low elevation, i.,e., 307.85 m to prevent air being sucked by vortex formation. The intake is located on tunnel-1 at a point where the upstream of the junction of intake shaft with the tunnel has been plugged. Penstock lining has been done starting from a place where the dam axis meets the tunnel. This lining extends to the exit of the tunnel where the main penstock of 7.925 m diameter is branched into three small penstock pipes, each of 4.11 m diameters. Penstock pipes have been connected to the turbines through regulating butterfly values. The three turbines running together require 236 cumecs of water for power generation.

Power House and Filtration Plant: The Power House is located on the Main Dam Toe, mostly on sand rock band. The Power station has been provided with three Francis Turbines of 66 MW each in a 66.225 m x 34.9 m structure. Approach to the powerhouse has been size kept at elevation 279.5 m through an elevator and a staircase, in the rear of erection bay and the rooftop of the structure serves as a parking place. A filtration plant of 50,000 liters/hour capacity has been provided on the left of the powerhouse for the supply of treated water to cool the glands of turbines and for drinking purposes.

Switchyard: While the switchyard for 132 KVA is located on pervious fill at an elevation of 279 m at the downstream toe of the dam adjoining the powerhouse, the 33



KVA switchyard has been housed at the roof of the powerhouse itself.

Tailrace Channel: For providing standing water cover to the draft tubes, tailrace channel has been provided with an inverted slope. The width of the channel at powerhouse is 49.785 m the bed level is 256.12 m at the toe wall. The riverbed has been lowered by about 3 m downstream of the powerhouse to provide a slope of 0.55m/km, to give extra head to the turbines.

Drainage Tunnels and Galleries: Adequate drainage arrangement in the abutments of the dam has been considered necessary. Drainage Tunnels on left and right abutments of Main Dam and on the left abutment of Saddle Dam have been provided in 1500 m length for release of seepage water expected through joints of sand rock and clay shale bands. In addition to the above, two galleries in the chute spillway have been provided, one in the control structure under the crest and another along the centre line of the chute. The drainage tunnels, 2.15 m high and of 1.5 m width are D shaped, having vertical sides and a semi – circular top.

Architecture: The project sites like that of Ramganga are symbols of development and prosperity of the country. The reservoir lake formed by the construction of dam further adds to the glory of this natural valley, which is famous for its beauty and wildlife. To make the place a public picnic spot, architectural treatment to works has been given.

Public Facilities: For execution of this gigantic project, temporary residential colony for workers, officials and officers was constructed with facilities of a hospital, market, bank, post officer and treasury. Water supply for the workers colony was provided through a filtration plant, which treated the raw water of the river, whereas in officers' colony, it has been provided directly through tube wells.

Water Utilization

The reservoir has a live storage of 2195.5 m Cum at RL 365.30 m utilizable for the development of command area of 5.90 lakh hectares and drinking water supplies to Delhi Nagar Nigam. The water available for utilization from the Ramganga reservoir is estimated to be 0.215 m ham annually. The water is being utilized for irrigating 5.90 lakh hectares of additional command area in the Ganga – Yamuna basins through a network of the existing canals and newly constructed canals relating to Ramganga Project. This added irrigation is spread over 16 Districts of Uttar Pradesh extending from Saharanpur to Allahabad³.

Water released from the reservoir through the powerhouse is used for irrigation in the areas down stream of Kalagarh. Separate irrigation outlets are also provided from the reservoir as an alternative arrangement to supply irrigation to command areas.

³ Out of these 16 districts, Six districts were divided into 13 districts. Thus, the total number of districts getting irrigation benefits of Ramganga Project is 23. The list of these districts is provided as an annexure to this report.



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2.09 Drinking water supply to Delhi Nagar Nigam to an extent of 5.5 cumecs is also taking place from the Ramganga Project. This works out to be 173.50 MCM. Thus, the existing water utilization under Ramganga River Valley Project is as follows:

Sl.No	Water Use for	Quantity of water in MCM
1	Irrigation purpose for 5.90 lakh hectares	2022.00
2	Drinking water supplies to Delhi Nagar Nigam	173.50
	Total	2195.50

General Features

- 2.10 As per the reorganization of the state of Uttar Pradesh made during 1995 the state has been bifurcated into two states viz., Uttarakhand and Uttar Pradesh. The dam portion of Ramganga River Valley Project and the entire catchment area of 3134 Sq km fall in the State of Uttarakhand while entire irrigated land of 5.90 lakh hectares is in Uttar Pradesh State.
- 2.11 The dam formed a deep and wide lake in the Patlidun valley. The reservoir was estimated to be filled up in 72 years out of every hundred years.

Catchment Area

Location: The catchment area of Ramganga Project's located in between 29°30' to 30°07' North Latitudes and 78°35' to 79°35' East Latitude. The catchment is distributed in the districts of Almora, Pouri Gharwal, Chamoli and Nainital of Uttarakhand State.

Area: The Catchment area (313400 ha) lies between E1.262 m and 2926m and is considerably below the perpetual snow line of the Himalayas. Names of the Subcatchment and their respective areas are given in **Table 2.1**

Table 2.1 Names and Area of Sub-Catchment of Ramganga					
Sl. No	Name of the Sub-catchments	Area in Sq km			
1	Upper Ramganga	696			
2	Gangas	506			
3	Binao	305			
4	Khatraun	118			
5	Nair	89			
6	Badangad	216			
7	Mandal	396			
8	Haldgad	296			
9	Middle Ramganga	117			

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	Table 2.1 Names and Area of Sub-Catchment of Ramganga					
Sl. No	Name of the Sub-catchments	Area in Sq km				
10	Sona Nadi	145				
11	Lower Ramganga (Rt)	114				
12	Lower Ramganga (Lt)	136				
	Total	3134				

Source: History of Ramganga Project, Volume1, Publication No.14, Central Board of Irrigation and Power, New Delhi, March 1990.

Characteristics: The Catchment area of Ramganga has horseshoe like shape with an area of 313400 ha. It is situated in hilly terrain in the middle and outer Himalayan ranges with a portion falling in the Shiwalik Hills, south of the Himalayas. The annual precipitation is about 150 cm. Major geological formation include Mica, Schist, Granite, Grass, Quartzite, State Shale and Quartzitic. Nearly 50 per cent of drainage basin is covered with forest and 30 per cent under cultivation on terraced fields and the remainder consists of grazing palutures, waste land etc.,

Topography: The Terrain of the catchment is steep to moderately sloping and mostly negotiable. The area is elongated in shape to above 113 km in length (North South) and 30 to 38 km in width (West East). The intermediate valleys sides are gentle sloping river terraces.

Physiography, Relief and Drainage: The catchment of river Ramganga originates in the middle of Himalayas in Chamoli Districts of Uttarakhand. It is horseshoe shaped comprising hilly terrain in the middle and outer Himalayan ranges and a portion falling in Shiwalik Hills, South of Himalayan ranges. Steep hills, deep and narrow valleys are the characteristics of the catchment. The area is well drained. The Ramganga River originates from Chandiyal Derta, (Gair Sain) and passes through Chakhutiya, Bhikiasain, Darchula and Kalagarh. The over all drainage pattern of the area is subdendritie and relief excessive. Ramganga River and other tributaries drained the catchments area of the project. A number of springs and winter snowfall on the high peaks of the region keep the river Perennial.

Climate: Diverse Climate conditions are observed because of the large variation in the altitude of the catchment area. The lower valley is usually hot and uncomfortable in the months of May and June, while the hilltops are generally cool even in June. Sharp frost is usual in the winter months. Even lower valley is full of mist in the morning during December–February.

Temperature: The average maximum temperature varies between 19°C (Dec-Jan) and 34°C (May). The average minimum temperature in the catchment area varies between 3°C (Jan) to 19°C (July), as observed in the years from 1996 to 2000. Month-wise Maximum and Minimum temperature for the period from 1996 to 2000 recorded at Ranikhet Forest Range is given in the **Graph 2.1.** (Annexure II.1).



Rainfall: The average annual rainfall observed in the period from 1996 to 2000 is 900 mm with total number of rainy days being 75. The annual rainfall varied between 550mm (1996) and 1237mm (1998). Maximum rainfall recurs during June to September, which worked out 62.7% of the total annual rainfall. Monthly rainfall data and rainy days recorded at Ranikhet Forest Range during 1996-2000 is given in **Graph 2.2.** (Annexure **II.2**)

Soils: The Soils in the catchment area generally comprise of light sandy soils, reddish clayey soils and clayey soils. The soils vary from shallow to deep and in valleys very deep, yellowish brown to dark brown and dark yellowish brown in colour. Calcareous and Non-calcareous soils are farmed in lime stone area.

Taxonomically, the soils of the area, viz. Eriti soils and mineral soils, have no diagnostic horizon other than the ochric epipedon. Mollisols are also mineral soils that have mallic epipedon and high base saturation. Incepti soils have orchric epipedon followed by a cambia of calice horizon within the central section.

Land Use / Land Cover

2.12 The Land use / Land cover in the catchment area during construction of the project as per All India Soil and Land use survey Ministry of Agriculture (MoA), GoI is given in **Table 2.2** and its graphical presentation in **Graph 2.3**.

Table 2.2 Land use / Land cover- construction period							
Classification Area (ha) Percentage							
Forests	62460	19.93					
Grazing / Grass Lands	55930	17.84					
Cultivated Lands	187370	59.79					
Water Bodies	4970	1.59					
Built up Lands and Settlements 2670 0.85							
Total	313400	100.00					

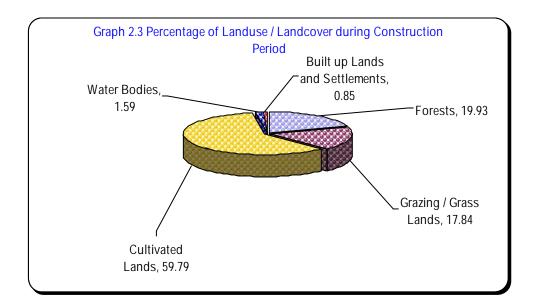
Source: All India Soil and Land use Survey, Ministry of Agriculture, Government of India, 2001.

Natural Vegetation

2.13 At high elevations, conifers namely Chir, Deodar, Kail and Fir are found. At low altitudes, broad-leaved species such as Sal, Jamin etc., are found. The forest usually consists of stunted and branchy Sal tress of very poor quality and density. Sal area usually mixed with species such as Bakli, Sain, and Kharik. Sal is associated with Chir. Natural grasslands are absent. The available grasslands have come in existence because of degradation of forests. Important species of grasses found are Euloleopsis binato, Meteropogan contort, Thamida Ansthera and Chrysopogan Spp.

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Water Resources and Irrigation

- 2.14 Number of natural springs and winter snowfall on the high mountain peaks keep the river and its tributaries perennial. There are no natural lakes or Tal in the catchment area above Kalagarh Dam.
- 2.15 Some areas of the catchment in the Upper Region are irrigated through Pucca hill channels, source being the Ramganga River and its tributaries. Very few ground water structures such as dug wells, and private tube wells are existing in the catchment. Water harvesting tanks and farm ponds were constructed under the project to provide life saving irrigation to crops.

Watersheds and Sub-Watersheds

2.16 The catchment area of Ramganga River forms part of Ganga river main basin. The total catchment area as per the project report is 313400 ha while as per the evaluation studies on soil conservation by ALSLUS later estimated it as 310725 ha. The total area was divided into 8 sub-catchments, 20 watersheds and 134 sub-watersheds. The priorities towards catchment area treatment and measures taken up will be dealt with else where in this report.

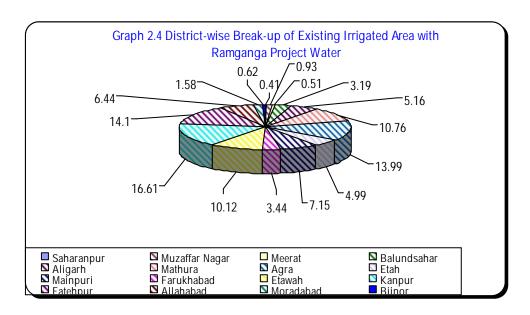
Command Area

2.17 Prior to the commencement of the Ramganga Command Area Development Project, the Cultivable Command Area (CCA) of the project was 15.14 lakh hectares and an additional area of 3.83 lakh hectares was added to this by construction of new channels. Thus, the total CCA of the project attained a level of 18.97 lakh hectares. The irrigation potential prior to the commencement of the project was 8.60 lakh hectares. The intensification of channels and construction of new channels has resulted in the creation



of an additional potential of 5.9 lakh hectares under this project. As such the pre–existing irrigation potential (8.60 lakh ha) coupled with newly created potential (5.9 lakh ha) has generated 14.5 lakh hectares of irrigation potential.

2.18 The District-wise break-up of the irrigated area under Ramganga project is presented in Table 2.3 and Graph 2.4. Nearly 17 percent of the contemplated command area is occupied by Kanpur district followed by Fathepur (14.1%), Agra (13.99%). The lowest i.e., 0.41 percentage is occupied by Saharanpur district. In the remaining twelve (12) districts area percentage ranged between 0.51 and 10.76.



, , , , , , , , , , , , , , , , , , ,	Table 2.3 District wise Break up of Existing Irrigated Area with Ramganga Project Water								
Sl. No									
1	Saharanpur	2420	0.41						
2	Muzaffar Nagar	5500	0.93						
3	Meerat	2990	0.51						
4	Balundsahar	18830	3.19						
5	Aligarh	30430	5.16						
6	Mathura	63450	10.76						
7	Agra	82570	13.99						
8	Etah	29420	4.99						
9	Mainpuri	42210	7.15						
10	Farukhabad	20310	3.44						
11	Etawah	59730	10.12						
12	Kanpur	98020	16.61						
13	Fatehpur	83220	14.1						
14	Allahabad	38020	6.44						

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Table 2.3 District wise Break up of Existing Irrigated Area with Ramganga Project Water						
Sl. No	Sl. No District Area (ha) Percentage					
15	Moradabad	9300	1.58			
16	Bijnor	3640	0.62			
	Total 590060 100					

Source: History of Ramganga Project Volume1, Publication No. 214, Central Board of Irrigation and power, New Delhi, March 1990

Canal System

- 2.19. Before formulation of Ramganga Project, the western and central parts of Uttar Pradesh in Ganga–Yammuna Doab were being irrigated by upper and lower Ganga canals, Eastern Yammuna Canal, Agra Canal and Ramganga Pumped and Canal Systems. The Upper and Lower Ganga Canals take off from Ganga River. These canals were irrigating large extents of Ganga–Yammuna doab. The Ramganga project was contemplated to provide irrigation facilities to large tracts of left over culturable area of the above doab.
- 2.20. Water released from Ramganga reservoir through the powerhouse flows down into the river to 25 km where a barrage of length 416.3m was constructed across the river. Water is diverted in to a newly constructed feeder channel at Harevelii from the barrage on the right flank, which is 74km long. The feeder channels with a head discharge of 135 Cumecs releases water into Ganga River opposite Gathmuketashar. The augmented supplies of the river Ganga are being picked up at Narora in Bulandshahar District of Uttar Pradesh and Utilized through Lower Ganga canal. Supplies to Lower Ganga canal area reduced at Goplapur and the water so saved now being utilized to new area of irrigation on the Upper Ganga canal and Agra canal systems. A subsidiary channel is feeding the old lift canal, at present by gravity flow.

Regional Geology and Seismicity SP

- 2.21 Structurally, the area of Ramganga River Valley is dominated by Phyllites and schists. Extreme northeast corner of the catchment is covered by Limestone, Quartizites and Grey wakes. Near the dam site the rocks of the catchment belong to the Lower, Middle and Upper Shiwaliks, which are capped by horizontally, deposited recent gravel terraces at different elevations. **Fig.2.2** shows the regional geology of the Ramganga project area, whereas **Fig 2.3** shows the major thrust and fault planes around the project area.
- 2.22 As per the sequence of rock formations in the Garhwal Himalaya region, the area has been subjected to intense compression in the geological part, resulting in the development of a number of thrust planes. All these thrust planes form structural trend of the Himalayas and dip in a North Easterly directions.



Seismic Status

2.23 As per the Geological surveys, the regional geological setting of the Ramganga River project would indicate that the following thrusts and faults have relatively lesser importance in terms of their magnitude and increasing distance from the project site. The information indicated in **Table 2.4.**

Tab	Table 2.4 Faults and Thrusts in the Ramganga Project area and its Vicinity					
Sl. No.	Fault Feature	Distances in Air Kilometers from the Project Site				
A)	Northern and Western Areas:					
1	Sarpdulli- Dhikala- Siwalik thrust	6-8				
2	Haldu-Parae fault and related inter Siwalik	8-16				
	fault					
3	Krol-Nahan thrusts of Krol Nappe	16-24				
4	Kodwara Tear Fault	16-24				
5	Bijni-Garhwal Thrusts of the Garhwal	24-32				
	Nappe					
6	Ganga Valley Tear Fault	64				
7	Tear fault	128				
8	Kalka Tear Fault	192				
B)	Southern Area:					
9	Kalagarh Thrust (Postulated and not proved)	3-5				
10	Possible Moradabad (Tear) fault (Not clearly indicated by aeromagnetic surveys)	16-64				
11	Moradaabd (Tear) Fault (Clearly indicated by aeromagnetic Surveys)	64-80				
12	Lucknow Fault	320				
13	Patna (Tear) Fault	960				

Source: History of Ramganga Project Volume1, Publication No. 214, Central Board of Irrigation and power, New Delhi, March 1990

- 2.24 In 1961, a temporary seismograph was installed at the Ramganga dam site by the school of Earthquake Research and Training, Roorkee, which picked up a number of minor tremors at a distance of 64-80 km and these are believed to have some relationship with the Moradabad Fault.
- 2.25 Summarizing the activity of various thrusts and Faults which occurred along the southern border of the outer Himalayas and in Gangetic alluvium are considered to be strongly suspect in terms of possible future seismic activity in the area,
- 2.26 Following values of earthquake acceleration were calculated by Geological Survey Authorities by various methods and practices are shown in **Table 2.5.**





Table 2.5 Grand Accelerations							
	Earthquake intensities on mm sca						
Sl. No	Details	VII	VIII				
I	On the basis of ground accelera	ations:-					
(i)	Gutenberg's Formula	0.07g	0.149 g				
(ii)	Nenmanns Formula	0.07g	0.135g				
(iii)	Kanai's Formula	0.04g	0.04g				
(iv)	Cornwells Formula	0.06g	0.11g				
II	On the basis of dynamic respon	ise of structure					
(i)	Hatenakes Formula	0.13g					
(ii)	Earthquakes spectrum curves	0.50g.					
III	Indian Standards	0.10g					
IV	Japanese practice	0.15g					
Source: Ce	entral Board of irrigation and Po	wer New Delhi Public	cation 214				

2.27 On the basis of the above, following seismic coefficients were approved by the Board of Consultants of Ramganga RVP during 1963 and adopted to safe guard against seismic forces

i	For the dam horizontal acceleration:	0.12g
ii	For the power plant and other concrete structures horizontal acceleration	0.15g
iii	For tunnels, intake towers – horizontal acceleration:	0.20g

2.28 The entire force was assumed to be in the horizontal direction only with no vertical component as per the latest practice at that time.

Submergence Area

- 2.29 Due to the creation of Ramganga reservoir across Ramganga River near Kalagarh, large area of National Corbett Park and reserve forest were submerged. As the reservoir is situated in dense forest area with no habitation, no dislocation of traffic, railroad, rehabilitation of villages or shifting of any industry occurred.
- 2.30 Ramganga reservoir submerged about 8143 ha at its FRL of 365.30 m above MSL. The reservoir extends to three valleys viz., Mandalti, Sona and Ramganga Rivers. Most of the submerged area was originally covered by Salwood plantations under reserved forests. No habitation or cultivated lands were submerged by the lake. However, an area of 55 Sq. km or 5500 ha of Corbett National Park, a sanctuary for wild animals, has been submerged. The reservoir has submerged 80 kms of Kutcha forest roads and one forest rest house at Bojhar of the forest department. Necessary funds were provided to the forest department for reconstruction of road away from the periphery of the reservoir and for construction of new rest house at 'Sinanoli' situated on Ram Nagar–Dhikala Road.
- 2.31 No provision was made towards compensatory afforestation in lieu of



Project Area

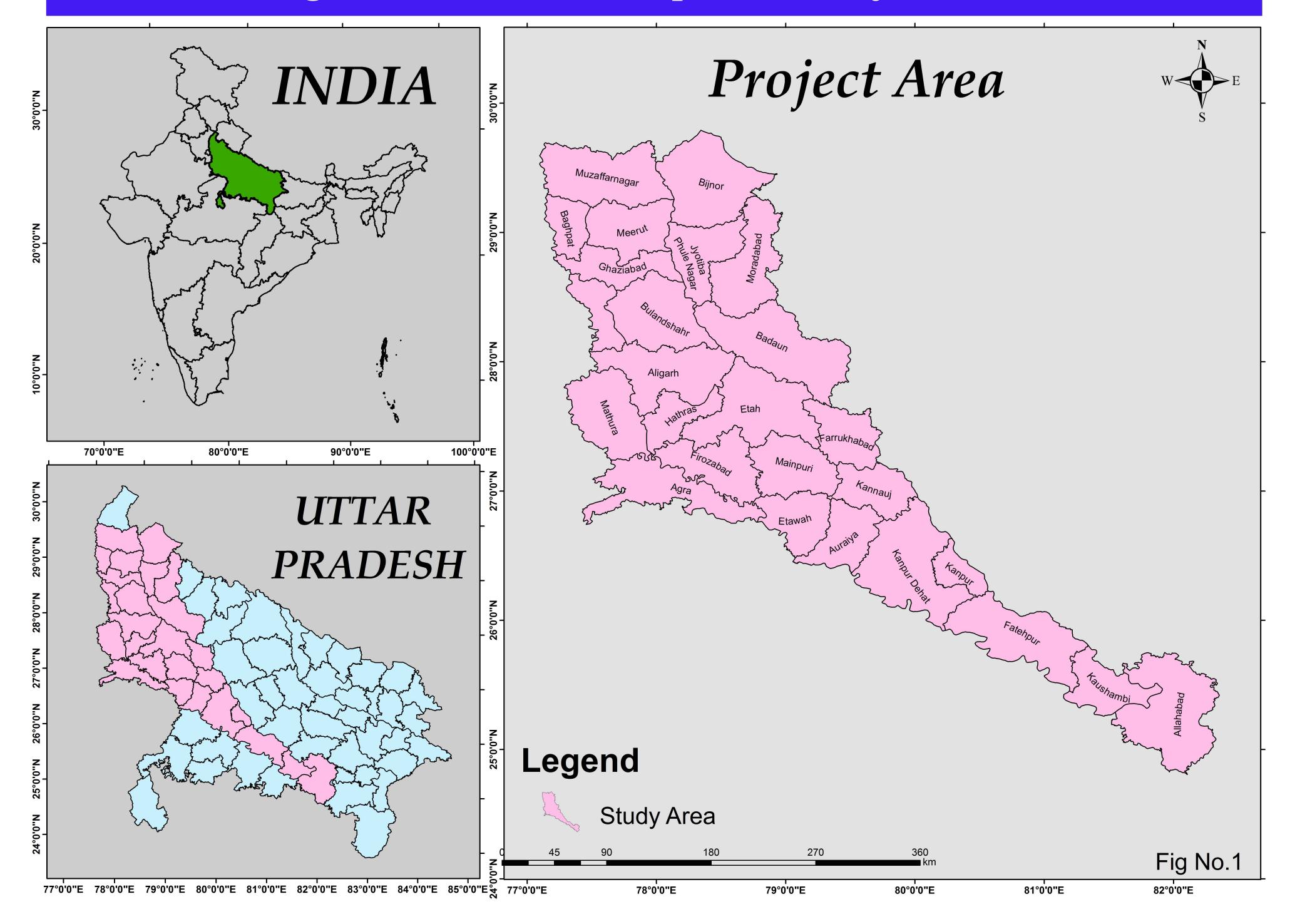
submergence of forestland as per the practice at that time. Before the formation of reservoir, surveys indicated that some washing carried out on Sona nadi section near Harhikund, produced minute quantities of gold (30 to 50 gms annually). Minor stringers of coal and carbonaceous matter were also found in the reservoir area. However, not all these deposits were considered economically important since the yields are very low. Therefore, no economical minerals other than the thick gravel terrace that could be used only as road metal were submerged under the reservoir.

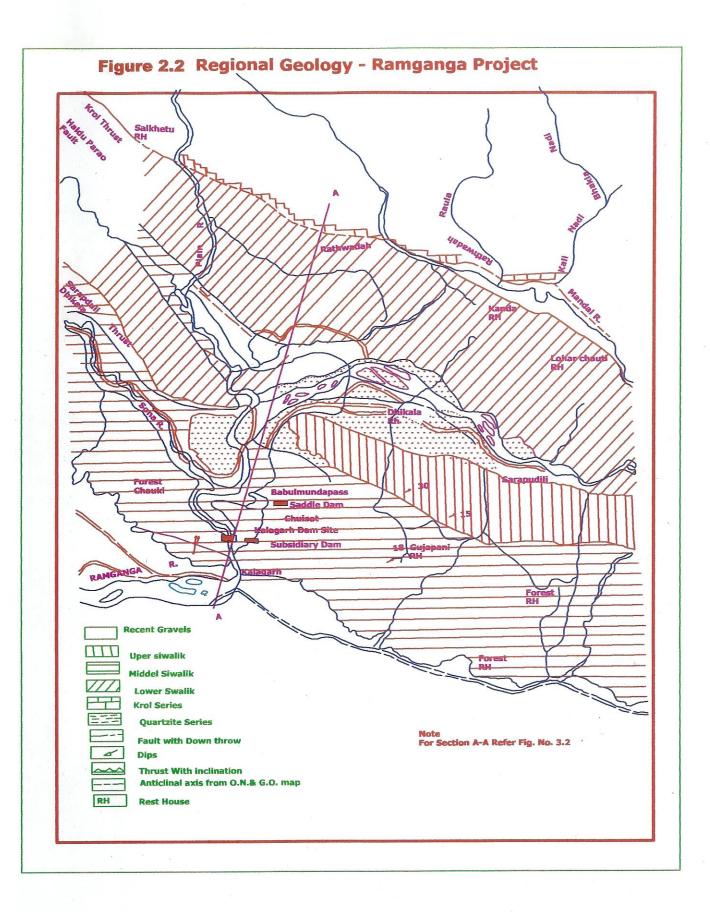
2.32 No places of worship, historical monuments etc., were submerged under the reservoir. The reservoir has a rim length of about 265 km, as per the FRL surveys conducted by Geologists of Geological Survey of India during 1967–1972. Since the forest was dense and partly covered by the Corbett National Park wildlife Sanctuary, reservoir rim treatment might not have been provided.

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Fig No.2.1 Location Map of the Project Area





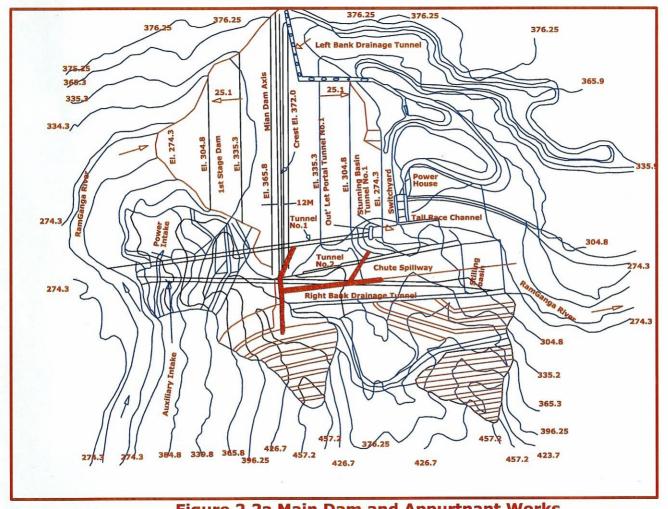


Figure 2.2a Main Dam and Appurtnant Works

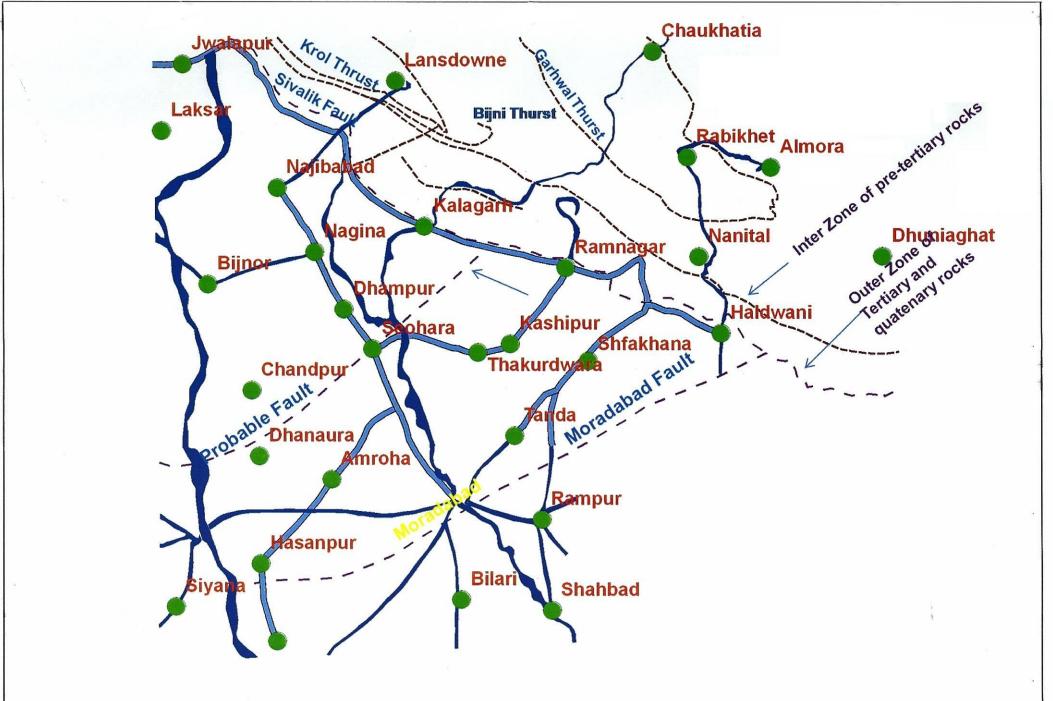


Figure 2.3 Major Thurst and Fault Planes around Ramganga Project Area

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3

Effects on Rehabilitation





EFFECTS OF REHABILITATION

Introduction

3.01 The demand for water and its related services increased with the growing population and rising economic status. Dams have been seen as an effective way of meeting water and energy needs. The reason behind construction of massive dams is to produce hydropower, as in some cases for irrigation, drinking water supply and flood control purposes. To maximize the positive impacts and mitigate the negative environmental, social and economic impacts, sustainability of water resource project is required. The increasing population and improved living standards create extra pressure for food production, industrialization and economic growth. Dams are not only engineering marvels but are progressive steps towards national economic development and flood hazard control.

Study Area

3.02 Ramganga Multipurpose River Valley Project is envisaged with the objective to exploit the potential of river Ramganga in Ganga main basin. The existing project was constructed near Kalagarh (V) of State (Erst while U.P) during 1962–1974. The project envisaged supply of irrigation water to an additional command area of 5.90 lakh ha in 16 districts of Uttar Pradesh, besides generation of 3 x 66 MW (198 MW) of power, flood control and fulfilling the drinking water needs of Delhi Nagar Nigam partially.

Submergence

- 3.03 Due to the creation of reservoir across river Ramganga an area of 8143 ha has been submerged at FRL 365.30m elevation. Entire area of submergence is under forests. An area of 5500 hectares of Corbett National Park was also submerged. Neither private lands nor habitations were submerged. Thus, no rehabilitation/compensation measures were found necessary and hence not taken-up. In as much as non-submergence of habitations or lands of private parties, the effects of Rehabilitations can be taken as nil.
- 3.04 No compensatory afforestation was effected in lieu of submergence of forestlands but funds were provided to the forest department for reconstruction of 84 km long road and a rest house, which were submerged in the reservoir.

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4

Socio-Economic Impact Including Changes in Literacy and Employment





SOCIO-ECONOMIC IMPACT INCLUDING CHANGES IN LITERACY AND EMPLOYMENT

Introduction

- 4.01 The irrigation projects aim at increasing the total cultivated area either by bringing more land under cultivation or by an increase in the intensity of cropping. An increase in cultivated area naturally offers more employment opportunities. It has been found that in general the irrigated areas employ more labour than the un-irrigated areas. Also, agriculture is labour intensive, particularly the low technology agriculture of the less developed countries including India. In addition to employment generation in agriculture, a multi purpose irrigation dam has potential to generate employment in other sectors also. For example, if a dam, in addition to irrigation, has an objective of hydel power generation, it can enhance labour demand in the fields of electricity production, distribution and management.
- 4.02 The improvement in employment opportunities would mean better income and enhanced capability of the people for higher levels of consumption and better quality of life. An upward movement in employment and incomes can also result in better improvement in local infrastructure and amenities, changes in distribution of income, changes in property values and asset possession of the household etc. It could also have an impact on the migration trend. That is, if the local demand for labour increase, it reduces the need for migration in search of employment. The changes in the field of agriculture also have a gender dimension, particularly in less developed countries where women constitute a significant portion of the farm labourers. Such changes could be in the form of enhanced employment and incomes for women, improved capacity and social status of women, better female literacy, demographic features like favorable female ratio etc.
- 4.03 As mentioned above, improvements in employment and incomes levels of the people normally result in improved infrastructure facilities and amenities. Needless to say that developments in infrastructures like road and communication, electricity supply, schools and other education facilities, health centers and recreational facilities etc., contribute to a better quality of life of the people. Hence, in an assessment of the socioeconomic impact of the irrigation project the above said factors have to be taken into account.
- 4.04 The Ramganga project has a multipurpose agenda that include four major objectives such as provision of irrigation facility, generation of power, supply of drinking



Socio-Economic Impacts Including Changes in Literacy and Employment

water to Delhi and control of floods in western and central Uttar Pradesh. However, the most important and largest agenda is the expansion of irrigation to a vast area of nearly six lakh ha of land in western Uttar Pradesh.

4.05 In the present context of Ramganga Project, any increase in irrigation potential brings perceptible impact in the socio-economic lives of the people living in the command area. The changes need not necessarily be uniform due to diversity of occupations as well as the capacity of the people to access and utilize the newly created resources. There would be direct benefits in the form of increased production and productivity and consequent higher incomes to the beneficiary community. As such, the standard of living of the people will change and various employment opportunities will also open up in the area. The people start having increased access to the quality education, better livelihood and higher assets creation. Health, nutrition standards and social status can also improve in the command area. On the whole, to a largest extent there could be a changed socio-Economic environment for the people in the area with enhanced prosperity, improved commercial and economic activities, educational, health and recreational avenues.

Objective of study

4.06 Keeping in view the above aspects, it is proposed to look into the following aspects of the socio-economic life of the people in the command area.

- 1. Employment generation due to project;
- 2. The status of schools/teaching staff and student turnover;
- 3. Improvement in male-female literacy, evaluation of adult education programmes provided if any;
- 4. Response to education provisions and assessment of constraints;
- 5. Post project occupational options that have arisen in the region and their relevance to the project impact
- 6. New educational, cultural, recreational access and commercial (Markets, Banks etc.,) facilities that have come up in the post-project situations and their relevance to the project impact.
- 7. Incidence of some important diseases in post and pre-project situations.
- 8. Health care infrastructure in the post and pre-project situations
- 9. Human development index (to the extent the data is available) in the post and preproject situations.

4.07 Thus, the study aimed at trapping the changed environment in respect of economic and commercial activities. The above socio-economic environment aspects are studied, analysed and presented based on the authentic secondary sources of information of command area districts of Ramganga project. In addition to above, primary data have also been collected from field on the lives of the people and benefits accrued in the command area of Ramganga project and presented.

Methodology

- 4.08 Ramganga project was commenced in the year 1962 and completed in year 1974. The water in the reservoir was impounded from the year 1975. By the year 1980-81, most of the infrastructural facilities of irrigation in the command area were completed and release of water regularized systematically. Hence, for study purpose the year 1980-81 has been taken as pre-project period.
- 4.09 Thus, the current study on socio-economic indices as envisaged above as per ToR covered pre-project situation. This pre-project situation is compared with the situation of the year 2007-08 (Post-project). The data pertaining to all the benefited districts in the command area is collected and presented in the Annexures and main findings are given in the running report. In order to eliminate aberrations, it is ensured that both the year for comparison in pre and post situations are normal years in relation to the rainfall. Whenever a particular data is not available as required, the data pertaining to immediate preceding normal year is used. Certain indices required specific and authentic data for comparison which is more authentic when it comes from the respective department. In such a case where data is not available, the comparison is not made and only post project situation is presented leaving the comparison for future.

Data Analysis

4.10 The secondary data is obtained from the Directorate of Economics and Statistics. Specific data regarding education facilities and health is obtained through the interactions with concerned department officials and through the publications released by them. The main indicator is split into sub-indicators to enable the study to go in depth and track the specific impact in the area. The secondary data so collected on various main and sub-indicators are tabulated in the pre-designed tables and inferences are drawn. The data is analyzed with simple arithmetical and statistical tools such as arithmetic mean, averages and percentages. The observations and findings are presented area-wise in the following paragraphs.

Employment Generation due to Project

4.11 The Ramganga Project was constructed departmentally by the Uttar Pradesh Irrigation Department. For the construction of the project various level of manpower was engaged for the purpose viz., engineers, technicians, skilled and un-skilled laborers and other staff. The data so collected through secondary sources revealed that the department staff deployed for the project work was as follows¹.

¹ Central Board of Irrigation and Power, "History of Ramganga Project" Valume-1, Publication no.214, New Delhi, 1990



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Socio-Economic Impacts Including Changes in Literacy and Employment

Engineer Officers : 250
Technical Staff : 500
Other Staff : 1500

Apart from above, a labour force of about 10,000 skilled and un-skilled workers (employed on work-charges basis for the duration of project only) was also engaged by Irrigation department.

Besides, training centre for training of mechanical staff and operators was established in the initial stages at the project site. In addition to this persons were also sent to other projects and specialized training centers for specialized training mainly in operation and maintenance of heavy earth-moving equipments. This greatly helped them in getting good employment abroad and in Indian Companies. About 3000 officials and workers employed full time for the maintenance jobs of the entire project².

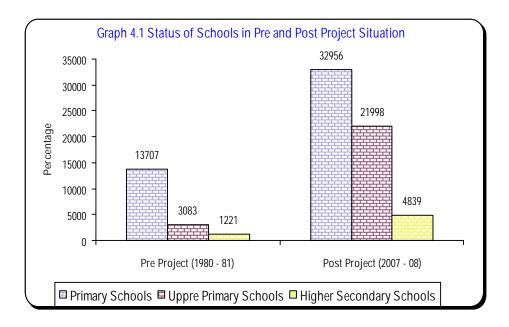
Status of Schools / Staff Strength / Student Turnover

4.12 There was an overall increase in the Ramganga project command area (Study area with reference to schools and teachers i.e., Primary, Upper Primary and Higher Secondary schools) as compared to pre-project period. In case of primary schools, the growth is 140 per cent over pre project situation. The upper primary schools have grown four fold during post-project duration (613%). Similarly, the growth of higher secondary stood at 296 per cent (**Table 4.1**). Even, number-wise, school physical and absolute growth stand for primary schools at 19249. The upper primary schools had an addition of 18915 and higher secondary schools added in post-project situation are 3618. This indicated that there is a significant and appreciable growth at all three levels of schools in the study area. The districts-wise details are presented in **Annexure IV.1**.

Table 4.1Status of Schools in Study Districts during Pre and Post Project								
	Situation							
Types of Schools Pre Project Post Project Absolute % Increase / Decrease / Decrease								
Primary Schools	13707	32956	19249	140				
Upper Primary Schools	3083	21998	18915	613				
Higher Secondary Schools 1221 4839 3618 296								
For Details Refer Annexure IV.1								

² Goel R.S. "Environmental Impacts of Ramganga Multi-purpose Dam Projects- A case study" paper appeared in Environmental Management in Hydro-Electric Projects Concept-1 Publishing Company, New Delhi, 2000.



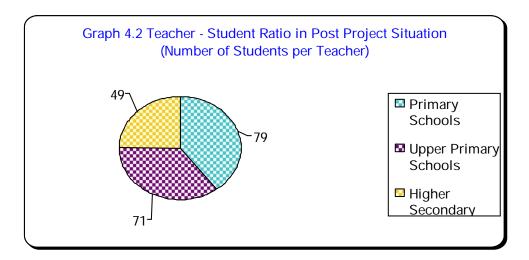


Teachers / Students and Student-Teacher Ratio

- 4.13 The pre-project data with reference to above is not available; hence the scenario of post-project situation of the command area districts is presented here under.
- **4.14 Primary Schools:** In the benefited districts of Ramganga command area, there are 70306 teachers covering 5596100 students. The teacher-student ratio stands at 79 students on an average. The lower ratio is seen in Etawah (54) and the highest ratio is observed in the district of Kaushambi (109) (Annexure IV.2).
- **4.15 Upper Primary Schools:** There are 31961 teachers in 15 districts in Upper primary schools covering 2284130 students. The teacher-student ratio stands at 71 students on an average. The highest ratio of 159 is observed in Agra district. The lowest ratio of 32 is seen in Etawah district.
- **4.16 Higher Secondary Schools:** There are 51080 teachers covering 2494991 students in the 15 districts of Ramganga project command area. The student-teacher ratio is observed to be 49 students on an average. The highest ratio of 115 is noted in Etah district and lowest ratio of 38 is seen in Kanpur Nagar district.
- 4.17 On the whole the teacher student ratio of primary, upper primary and higher secondary schools is 79,71,49 respectively (**Table 4.2**) indicating the ratio is better in Higher secondary schools as compared to primary and upper primary school. More pressure on teachers is observed in these two type of institutions (primary and upper primary). The details are presented in **Annexure IV.2.**

Table 4.2 Post - Project Teachers, Students Ration Scenario						
Types of Schools	No. of	No. of	Teacher -			
Types of Schools	Teachers	Students	Student Ratio			
Primary Schools	70306	5596100	79:1			
Upper Primary Schools	31961	2284130	71:1			
Higher Secondary Schools	51080	2494991	49:1			

For Details Refer Annexure IV.2



Total Literacy Mission and Literacy Rate

- 4.18 The total population of Uttar Pradesh State as per 2001 census stands at 16.60 crores. The literates amongst age group seven (7) years stand at 7.77 crores. Further, it is observed that the total literacy programme started in the state made good progress with the following objectives.
 - 1. To bring minimum competency in reading, writing and working knowledge in numbers
 - 2. To understand the state of livelihood and participate in income generating activities
 - 3. To learn new skills for livelihood
 - 4. To bring equality in women and protect environment and natural resources

Literacy in Uttar Pradesh State

4.19 The state started besides schools education, many literacy centers and brought noticeable improvement in literacy rate. The total literacy rate, as per Census of India, 1981, was 27.40 which rose to 57.38 in 2001 in the state of Uttar Pradesh. The details are depicted in the **Table 4.3**. The overall increase in literacy rate is about 30 per cent in the state as on 2007 over 1981.

Table 4.3 Total Literacy Mission: Achievement in Uttar Pradesh State									
State	1991 Literacy % *			2001 Literacy %**		% Literacy increase from 1981 to 2001			
	Total	Male	Female	Total	Male	Female	Total	Male	Female
Uttar Pradesh	27.4	38.9	14.42	57.38	70.23	42.98	29.98	31.33	28.56
Source:	* Statistical Abstract, Uttar Pradesh 1981and 2007								
	** htttp//upgov.nic.in.upinfo/cen01/cen01.hmtl								

Literacy in Command Area Districts

4.20 The total population of the command area districts affected by Ramganga Project stands at 2.34 crores (Pre-project) which grew up to 3.48 crores (Post Project). The literacy rate across these command area districts is compared in Pre and Post project situations as a percentage of total population.

Changes in Literacy Rate

4.21 It is observed that there is appreciable change in literacy rate among the command area districts of Ramganga project from pre to post project situations. The overall change of literacy rate in the region is noted to be 44 per cent. The percentage of literacy amongst male to total male population was 27.17 per cent and total of female literates was only 11.17 per cent which grew to 76 per cent and 50.0 per cent respectively in post project situation (**Table 4.4**).

Tab	Table 4.4 Literacy Scenario in Pre and Post Project Situations							
	Pre – Project Post - Project							
Over all Male Female Over all Males				Males Literacy	Female Literacy			
20.14	20.14 27.17 11.17 63.88 75.74 50.00							
	For Details Refer Annexure IV.3							

4.22 The changed scenario can be attributed to opening of more number of educational institutions and initiating total literacy programmes pursued by the Government in the command area districts. There is tremendous improvement in percentage of literates in post project situation. The percentage of literates (female) to female population was 11.17 per cent which has gone up to 50 per cent registering an absolute increase of 38.83 per cent due to the special thrust given to the girl child and women by the Government.

Response to Education Provisions

4.23 It is observed that the response to educational policy adopted by the State Government in enhancing the educational status of the targeted population was positive. The government had been making a lot of efforts to promote education in the state by



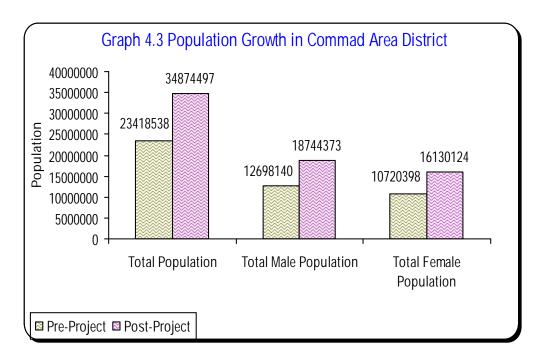
enhancing the education budget by multi fold year after year. The expenditure on the primary education and secondary education in 1980-81 was ` 17145 and ` 10972 respectively which increased to ` 775182 and ` 277891 lakh in 2007-08 (**Table 4.5**). This resulted in getting tremendous response from targeted group. In other words the growth of educational institutions and corresponding enhanced enrollment of students in post-project situation indicated good response to the initiatives made by the Government in this area. Besides, the overall increase of literacy rate of the targeted population from pre-project situation to post project situation can also be attributed to the educational environment created by the authorities in the command area.

Table 4.5 Expenditure on Education at the State Level								
		` in Lakh	1					
Educational Institution 1980-81 2007-08 Absolute Increase Increase								
Primary Education	17145	775182	758037	4421				
Secondary Education 10972 277891 266919 2433								
Source: Statistical Abstract, Uttar Pradesh								

Population Growth

4.24 In the study area districts of Ramganga project, the total population in pre-project situation was 2.34 crores which grew to 3.40 crores in Post-project period registering a growth rate of 49 per cent. Correspondingly the density of population per squire kilometer has increased from 482 to 717 with a percentage increase of 54 per cent. The male population has grown by 47.6 per cent and the female population by 50.5 per cent over the pre-project situation. The male-female ratio which was 100:84 during pre-project situation has gone up and stood at 100:86 in post-project situation indication the female growth indicating of 2.4 per cent that is to say for every 1000 males the female population is 860 in post-project which was 840 in pre-project situation indicating it is a positive change (**Table 4.6**). The details are presented in **Annexure IV.4**.

	Table 4.6 Population Growth in Project Command Area Districts								
CI No	Indicators	Pre-	Post-	Absolute	%				
Sl. No	indicators	Project	Project	Increase	Increase				
1	Total Population	23418538	34874497	11455959	48.9				
2	Total Area in sq kms	48613	48613	0	-				
3	Density of Population	482	717	262	54.3				
4	Total Male Population	12698140	18744373	6046233	47.6				
5	Total Female Population	10720398	16130124	5409726	50.5				
6	Male / Female Ratio	100:84	100:86	2	2.4				
	For Details Refer Annexure IV.4								

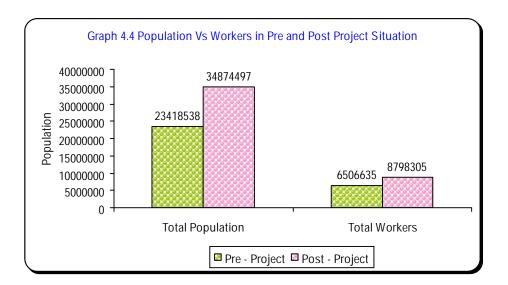


Population Vs Workers

4.25 As already discussed the population has grown by 49 per cent in post-project as compared to pre project situation in the study area. However, the growth in total workers is not commensurate with growth in population. It is about 35 per cent. Further, it is also noted that the percentage of workers to total population which was 28 per cent in preproject situation has reduced to 25 per cent in the post-project situation (**Table 4.7**). A detail of command area district-wise occupational categories of workers of pre and post project situations is presented in **Annexure IV.5**. The decline is a matter of concern. It has direct bearing on livelihood.

Table	Table 4.7 Population Vs Workers in Pre and Post Project Situation							
Sl. No	Project Situation	Total Population	Total Workers	% Workers to Population				
1	Pre - Project	23418538	6506635	28				
2	Post - Project	34874497	8798305	25				
3	Growth in percentage	49 %	35%					
	For Details Refer Annexure IV.4 & IV.5							





Occupational Changes

4.26 With reference to occupational changes occurred in the study area, the data analysis in this regard indicated mostly positive changes across the various categories of occupations. The details of these changes are shown in **Table 4.8**. From the table it is observed that the growth of female workers have registered a commendable growth across the various categories of occupation in the post-project situations as compared to male workers. Further, it is noted that the male cultivators had declined by 2.2 per cent in post project situation. Whereas, the female cultivators increased by 534 per cent. There were only 1.37 lakh female cultivators during the pre-project and the same had grown to 8.68 lakh during post-project indicating active involvement of women in agricultural avocation.

Table	4.8 Occupational Change Scenar	rio in Study	Area from	Pre to Post - Proje	ct Situation
Sl. No	Nature of Works	Pre - Project	Post - Project	Absolute Increase / Decrease	% Increase / Decrease
1	Total Cultivators	3418321	4078579	660258	19.31
2	Male Cultivators	3281267	3209643	-71624	-2.18
3	Female Cultivators	137054	868936	731882	534.00
4	Male Agri - Labours	863436	888829	25393	2.90
5	Female Agri - Labours	132568	188322	55754	42.05
6	Male Workers in HH Industry	291572	307857	16285	5.58
7	Female Workers in HH Industry	36922	112635	75713	205.06
8	Other Male Workers	1661501	2921300	1259799	75.82
9	Other Female Workers	102315	300783	198468	193.97
10	Total Male Workers	6097776	7327629	1229853	20.17
11	Total Female Workers	408859	1470676	1061817	259.70

4.27 Similarly, the growth of female agricultural laboures is to an extent of 42 per cent and the corresponding increase of male agricultural labourers is a mere three (3%) per cent again indicating active and more involvement of female folk as compared to male. Like-wise in household (HH) industry also female workers took active part and their involvement in it is noted to be multi-fold (205%) as compared to male folk whose increase was confined to only 5.58 per cent. The male workers had increased in other workers category to an extent of 76 per cent as compared to female who registed a growth of 194 per cent. Thus, it can be concluded that female workers on the whole have become more active and came forward in participating in improving and sharing financial burden of the family.

Status of Educational, Recreational Access and Banking Facilities

Educational Changes

4.28 The increase in primary schools is 140 per cent, Upper Primary schools is 613 per cent and higher secondary school is 296 per cent during post project period. The number of Universities in command area districts have grown to seven (7) and the number of Degree Colleges is 450 (Annexure IV.1). The growth of educational institution in the study area indicates the multifold increase in educational environment of Ramganga project command area by which the locals have got benefited by the on going educational programmes and simultaneous response from the targeted groups supplemented the growth.

Commercial and Banking

- 4.29 During the post-project situation the number of manufacturing factories has gone up from 2280 to 2815 registering the growth of 23 per cent. Though the increase of factories is 23 per cent, the employment of workers in the factories has declined by 15 per cent. It is a matter of concern. This might be possible due to restricted / controlled economical measures taken by the concerned manufactures. This decline needed to be addressed appropriately.
- 4.30 In case of banking it is observed that the number of scheduled commercial banks has grown from 868 to 2014 registering a growth of 132 per cent. The increase in volume of credit extended by the banks has gone up tremendously from a mere `386 crores during pre project period to `22122 crores in the post project period scenario (**Table 4.9**). The growth is nearly 5631 per cent which indicated an increased demand for manufactured products in the command area districts. This observation also indicates the process of growth in the area.

Table 4	.9 Existence	e of Factorio	, .	ment and C Command A	Cooperatives, S Area	chedule	d Banks and		
No.	of Factorie	s and Work	kers	N	No. of SCB Bar	nk and C	Credit		
Pre - I	Project	Post P	roject	Pre -	- Project	Po	ost Project		
Factorie s No.	Worker s	Factorie s No.	Worker s	Factorie s No. Outstandin g Credit No. (Crores) Outstanding Credit (Crores)					
2280									
	For Details Refer Annexure IV.6 & IV.7								

Cooperatives Credit

4.31 The Scenario of Cooperative Credit Societies has also changed during post project situation in the districts of Ramganga project command area. The figures pertaining to the number of cooperative credit societies and the loans advanced by these institutions are presented in **Table 4.10**.

Study Area	No of Cooperative Credit Societies		% Increase	Loans Ao (Lak	% Increase /			
/ UP State	Pre- Project	Post- Project	/ Decrease	Pre- Project	Post- Project	Decrease		
				Not	Not			
Study Area	1606	1370	-14.69	Available	Available	-		
UP State	8618	7479	-13.22	18894	214768	1036.6		
Note:* Figures pertain to UP State as a whole								
Source: UP s	tate cooper	ative Bank, I	Lucknow					

- 4.32 From the above table it can be noted that there is decline in number of societies at state level as well at command area district levels. These credit societies have come down from 1606 to 1370 registering a decline of 15 per cent in the study area and 13 per cent at state level. The information on loans advanced by these societies is not available for the study area. However, in the state as a whole, the loans advanced through these cooperative societies increased from ` 18894 lakh to ` 214768 lakh indicating impressive growth of 1037 per cent in advancing the loans.
- 4.33 Besides above, during post-project scenario, there are 11 DCCBs functioning in 11 districts at the rate of one each. The districts of Kannuaj, Auraiya, Kanpur Dehat and Koushambi are not having DCC Bank facilities. Similarly, consumer cooperative stores and cooperative federation except the districts of Kannuaj and Auraiya, all other districts of command area are also have these at the rate of one each in the command area districts (Annexure IV.8). In addition to above, other cooperative structure during post-project period that have come up included seven (7) sugarcane cooperative societies, 3800 milk cooperative societies, 917 housing cooperative societies and 56 marketing societies (Annexure IV.9).

4.34 The cinema houses have slightly increased from 150 (pre-project) to 178 during post project period. These details could be seen from **Table 4.11**. Some of the districts like Aligarh, Mathura have shown decline by 7, 3, and 5 respectively in absolute number. Three important tourist's spots at Mathura, Agra and Allahabad have developed attracting number of tourists to the state. For the last preceding 10 years during post-project, a record number of 93.68 lakh tourists visited these spots (**Annexure IV.10**).

	Table 4.11 Recreational Scenario of Study Area								
No of Cine	No of Cinema Houses Tourist Spot Tourists								
Pre-Project	Post-Project	Pre-Project	Post-Project	Visited					
150									

Health Care Infrastructure and Family Welfare Centers

4.35 With reference to above it is observed that there is an appreciable development in case of health care facilities created for people of the study area as compared to preproject situation. The details of infrastructural facilities established in the command area districts is given in the **Annexure IV.11** which presents over all changed scenario from pre to post project situation. The overall consolidated picture of the study area is given depicted in **Table 4.12**.

			T	able 4.	12					
	He	alth Care I	nfrastruc	ture &	Famil	ly Welfa	re Center			
Homeopatl	ny									
I	Pre-Project]	Post-Pi	roject		•	% Incre	ease	
Nos	Beds	Doctors	Nos	Bed	s D	octors	Nos	Beds	Doctors	
65	70	69	261	104		241	301.53	48.57	249.27	
Allopathy		,,							<i>,</i>	
I	Pre-Project		Post-Project			% Increase				
No. of			No. o	of			No. o	f		
Hospitals	/ No.	of Beds	Hospitals /		No. o	of Beds	Hospita	ıls /	No. of Beds	
Clinics			Clinics				Clinic	es		
642	1.	5425	965	;	11,	,288	50.13	3	-26.86	
Family We	lfare Cente	r								
I	Pre-Project]	Post-Pi	roject			0/ I a		
Nos				Nos			·	% Incre	ease	
	217				348			60.36		
For Details Refer Annexure IV.11										

Homeopathic Institutions

4.36 As compared to Allopathy, Homeopathy institutions have multiplied several times in post-project situation. This indicates that people are tilting towards homeopathic treatment. Thus, the homeopathic institutions have increased to the tune of 300 per cent from pre-project situation to post-project situation. In this regard data indicates that with



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the increase of these institutions, the bed facilities are also increased during post-project period. The bed strength of these institutions have gone by 49 per cent in post-project period. Like-wise placements of doctors had also gone up, almost by 250 per cent in post project situation. The overall scenario of homeopathy indicates its popularity which is slow but safe and steady.

Allopathic Institutions

The allopathy health care institutions have increased by 50 per cent in post project situation in the study area. During pre project period there were 642 Allopathic institutions with the total bed capacity of 15425. These institutions have gone up by 965 in number indicating increase of 50 per cent such institution in the command area. However, as the number of institutions increased, it did not keep the pace of adding bed facilities in these health centers. On the contrary the strength of beds has declined to the tune of 27 per cent from pre to post project situations. This indicates people are being treated through out-patient windows of the institution in most of the cases.

Family Welfare Centers

Establishment of family welfare centers in the study area are found to have gone up by 60 per cent during post-project period. There were 217 centers functioning during pre project situation which increased to 348 in numbers in command area districts indicating the focus and thrust given for family welfare programmes.

Family Welfare Programmes

The family welfare programmes viz., Sterilization and Intera-Uterine Device (IUD) at the state level has shown the growth of 120 per cent and 312 per cent respectively over to pre-project situation. This indicated the trend of progress (Table **4.13**). The data pertaining to pre-project period on these two variables is not available for the study area. However, the post project achievements of these two aspects have been presented in the **Table 4.13**. The Sterilization achievement at the state level is 172999 and in the study area it is 89797 which is 5.17 per cent of the state achievement. Similarly, in case of IUD it stands at 21 per cent. This indicates the efforts made by the concerned authorities in the study area.

	Table 4.13 Family Welfare Programme									
	F-W Programme	F-W Programme Pre-Project (1980 -81) Post-Project (2007-08) % Increase								
UP	Sterilization	78434	172999	120.5						
State	IUD	471891	1943474	311.8						
Study	Sterilization	N.A.	89497*	-						
Area	IUD	N.A.	417211*	-						

Source: Complied on the basis of Statistical Abstract, Uttar Pradesh.

*For Details Refer Annexure IV.12

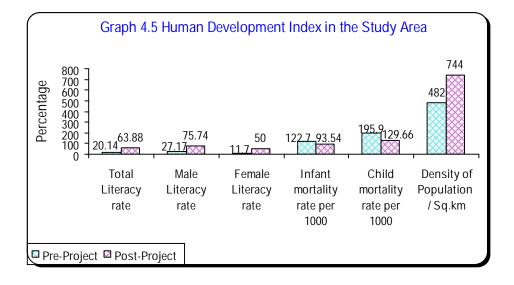


4.40 The scenario of incidents of important diseases in pre and post project situation of the study area is presented on the section of field survey results.

Human Development Index (HDI)

4.41 In order to compare the Human Development Index of post-project situation with pre-project, data of secondary source is used (**Table 4.14**) for the purpose and presented below:

	Table 4.14 Human Development Index in the Study Area								
Sl. No	Indicator	Pre- Project	Post- Project	Annexure for Reference					
1	Total Literacy rate	20.14	63.88	IV.3					
2	Male Literacy rate	27.17	75.74	IV.3					
3	Female Literacy rate	11.7	50	IV.3					
4	Infant mortality rate per 1000	122.7	93.54	IV.13					
5	Child mortality rate per 1000	195.9	129.66	IV.13					
6	Density of Population / Sq.km	482	744	IV.4					



4.42 The literacy indicators of HDI have improved in the study area which includes both male and female. It can be noted from the above table that total literacy rate has gone up from 20.14 per cent to 63.88 due to various educational and mass educational programmes initiated by the State Government. Further, it is observed that male literacy rate has gone up from 27.17 per cent to 75.74 per cent. In case of female literacy rate, it is interesting to note that it was only 11.7 per cent during pre-project situation which increased to 50 per cent in post project period indicating four fold improvements among women folk. This is an appreciable effort of the Government.

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- 4.43 With regard to infant mortality, it is observed that there is an improvement in reducing the mortality. The infant mortality brought down by 24 per cent in post project situation. The infant death rate was 128 per 1000 birth during pre project situation which come down to 93 in post project situation.
- 4.44 Similarly, the child mortality was also been brought down by 34 per cent during post project period. The child mortality used to be 196 per 1000 child which has decreased to 130 in post project situation. This indicates the concern authorities had taken all timely appropriate various family welfare measures as well prompt response and participation of targeted women folk in family welfare programme.
- 4.45 The density of population has gone up in the study area has increased from 482 sq km to 744 sq km during post project situation. This has direct bearing on the growth of population. The total population in pre project situation was 2.34 crores in the command area districts, which grew to 3.40 crores in post project situation registering a growth of 49 per cent.

Field Survey Findings

4.46 Hitherto the Socio-economic environment aspects have been presented and discussed based on the authentic secondary sources of information of Ramganga Project Command Area Districts. In the succeeding section of this chapter findings of field survey bases on a comparative study of command area and other command area are presented.

Demographic Profile of Sample Households

- **4.47 Family Size:** The data analysis of farm households pertaining to their demographic and population (**Table 4.15**) revealed that there is no difference between project area and control area relating to their family size being 7 in both the situations. The family size of sample households is considerably more than that of national average of 5.
- **4.48 Sex Ratio:** The sex ratio in project area is observed to be 830 female per 1000 male, while in control area it is 860 per 1000 male. It is to be noted here that the sex ratio of project command area districts as per secondary data during post project situation stood at 886 female per 1000 male. This indicated that the sex ratio of sample household is lower than the project command area districts. It is a matter of concern.
- 4.49 Further, it is interesting to note that the sex ratio among child population (below six years) is closely followed each other (male and female child) in both the project and control situations. It is a positive change due to better child health care and awareness in rural women.

	Table 4.15 Details of farm households members									
	(In Number)									
Sl.	A go group]	Project Ar	ea	C	ontrol Are	ea			
No.	Age-group	M	\mathbf{F}	Total	M	\mathbf{F}	Total			
1	Below 6 years	167	161	328	96	82	178			
1	Delow o years	(10.15)	(11.78)	(10.89)	(10.85)	(10.72)	(10.79)			
2	6 11 years	224	209	433	109	118	227			
	6-11 years	(13.61)	(15.29)	(14.37)	(12.32)	(15.42)	(13.76)			
3	11 14 voors	97	109	206	57	59	116			
3	11-14 years	(5.89)	(7.97)	(6.84)	(6.44)	(7.72)	(7.03)			
4	15 60 22200	1021	780	1801	557	449	1006			
4	15-60 years	(62.03)	(57.06)	(59.77)	(62.94)	(58.69)	(60.97)			
5	Above 60	137	108	245	66	57	123			
3	years	(8.32)	(7.90)	(8.13)	(7.45)	(7.45)	(7.45)			
	Total	1646	1367	3013	885	765	1650			
Total (100.0) (100.0) (100.0) (100.0) (100.0) (100.0) (100.0)							(100.0)			
Note:	Note:- Figures within parenthesis denote percentages									
Sour	ce: Field Survey		-							

4.50 Caste: The data analysis with regard to caste distribution of households revealed that the area is pre dominantly inhabited by the people of OBC (more than 50 per cent) followed by the general category of the social groups. The schedule caste consisted of only 16 per cent of the households. Tribal population is significantly absent in both Project area and Control area. The caste-wise details of farm households of the sample are given in the **Table 4.16.**

	1 abic 4.10 50c.	ial Status of Farm house	(In Number)	
Sl. No.	Social Status	Project area	Control area	
1	Scheduled Caste	72 (16.00)	39 (15.60)	
2	Scheduled Tribes			
3	OBC	234 (52.00)	149 (59.60)	
4	Others	144 (32.00)	62 (24.80)	
Total 450 (100.00) 250 (100.00)				
Note:- Figures within parenthesis denote percentages				
Source: Field Survey				

4.51 Literacy: As mentioned in earlier part of this chapter with regard to literacy mission in Uttar Pradesh in general and project command area districts in particular significant achievements were made during post – project situation. The total literacy rate during this period was noted to be 64 per cent in the command area districts. The data analysis of sample households also indicated a very good achievement in this area. On the whole, about 84 per cent of sample population of project area is found to be educated

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which include read and write aspects also. Based on the secondary data of command area districts it is noted that female population literacy rate to be 50 per cent. In the study area it is much more than that i.e., 75 per cent. This shows the overall literacy growth among the project area beneficiary population during the post project situation. However, there is a need to popularize the adult education mission in the area to further bring down the illiteracy. The details of education levels of farm households are presented in **Table 4.17**.

Table 4.17 Education level of farm household members							
(Percentage)							centage)
Sl.	Level of Education	Project Area			Control Area		
No.	Level of Education	Male	Female	Total	Male	Female	Total
1	Illiterate	8.22	24.98	15.75	5.78	20.17	12.43
2	Literate	2.34	4.09	3.13	3.32	7.01	5.03
3	Primary	25.20	30.30	27.49	22.14	26.47	24.14
4	Upper Primary School	18.05	18.67	18.33	19.56	20.46	19.97
5	High School	20.05	8.11	14.69	22.51	10.73	17.06
6	Intermediate	14.57	7.21	11.26	14.51	8.58	11.77
7	Graduate	7.82	4.34	6.26	8.86	4.15	6.68
8	Post-graduate	3.01	0.74	1.99	2.34	1.43	1.92
9	Others	0.74	1.56	1.10	0.98	1.00	1.00
Source: Field Survey							

Occupation: It is revealed that a little over 75 per cent in project area are cultivators. In control area 74 per cent are cultivators. This is followed by service (7%), non agricultural laborers (5%) and rest are found to be engaged in other avocations. Besides, it is also observed that about 9 per cent of head of households are found to be in 'non-working' category of occupation. More or less similar trends are observed among sample households in control area. The details of primary and secondary occupation of sample households are presented in **Table 4.18** for reference.

Table 4.18 Details of Occupation of Head of the family						
Sl.	Occupation	Project	t Area	Control Area		
No.	Occupation	Primary	Secondary	Primary	Secondary	
1	Agriculture	340 (75.55)	51 (11.33)	185 (74.00)	27 (10.80)	
2	Agriculture Labour	0 (0.00)	22 (4.89)	1 (0.40)	6 (2.40)	
3	Non agriculture Labour	21 (4.67)	54 (12.00)	6 (2.40)	34 (13.60)	
4	House wiefe	4 (0.89)	0 (0.00)	3 (1.20)	0 (0.00)	
5	Own business	6 (1.33)	18 (4.00)	8 (3.20)	10 (4.00)	
6	Service	31 (6.89)	3 (0.67)	22 (8.80)	2 (0.80)	
7	Others	9 (2.00)	6 (1.33)	7 (2.80)	2 (0.80)	
8	Non Working (head of family)	39 (8.67)	-	18 (7.20)	-	
	Note:- Figures within parenthesis denote percentages					

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Source: Field Survey

Membership of Agriculture Cooperative Society

4.53 About 24 per cent of households in the sampled villages of Project area and 22 per cent households of control area were the members of agriculture cooperative society. The farmers are taking advantage of the commercial banks and also the Regional rural banks for meeting their credit needs along with the cooperative societies. Nevertheless there is still significant share of private money lenders in the area. The contribution of SHGs was observed very nominal providing credit support for farm activities.

Economic Aspects

4.54 Type of Ration Card Holders: Distribution of ration cards among the population by the Government agency is also one of the indicators of the economic status of the individual family. The ration cards are of different type viz., Yellow, White and Pink in the State of Uttar Pradesh. The Yellow cards are issued to the above the 'Above Poverty Line' families while the White cards are issued to 'Below Poverty Line' families and Pink cards are issued to 'Antyodaya families'. The data analysis of sample households indicated that 68 per cent of this is above poverty line category in project area and about 72 per cent are in control area. The sample population which fell under 'Below Poverty Line' Category is noted to be 20 per cent in project and 16 per cent in control area. The data also indicated that 8 per cent of sample population belonged to Antyodaya families. The details of type of ration cards issued to the families of project area as well as control area are presented in the following **Table 4.19**.

	Table 4.19 Type of Ratio	on Cards of the farm	(In Numbers)	
Sl. No.	Type of Ration Cards	Project area	Control area	
1	Yellow	308 (68.44)	179 (71.60)	
2	White	90 (20.00)	39 (15.60)	
3	Pink	36 (8.00)	20 (8.00)	
4	No Card	16 (3.56)	12 (4.80)	
Total 450 (100.00) 250 (100.0)			250 (100.0)	
Note:- Figures within parenthesis denote percentages				

4.55 Dwellings: Possession of develing is also one of the indicators of economic status of the households. The sample data on this aspect revealed that little over 63 per cent of project sample households possessed Pacca houses while 57 per cent of control area sample households dwelled in this type of houses. About 22 per cent in project area and over 25 per cent of control area household were found to be dwelling in Semi-Pacca houses. The dwellers of Katcha houses are found to be least among all as only 14 per cent of project area and 17 per cent of control area fell in this type of category of houses.

Sanitary Habits

4.56 Sanitary Toilets: Having a toilet in the dwelling, in the past was considered as an uncultured practice. As the societies grow and developed slowly it is being accepted by the people to have a separate toilet with in the dwelling premises. Now it has become a symbol of status to have separate toilet in the dwelling itself. The sample data on it revealed that more than one third of (+30%) of the sample households have constructed separate toilets with in the dwellings. Otherwise rest of them still follows the traditional method of defecating in the open fields. Spending money on construction of separate toilet indicates rise of individual's social and economic status in the given society in the present context.

Dwelling Having Separate Toilets					
Sl. No	Particulars	Project Area (%)	Control Area (%)		
1	Constructed Separate toilets in living houses	30.33	31.732		
2	No Toilets / using open field toilets	69.33	68.28		
Source: Field Survey					

4.57 Assets Possession: Possession of household assets is also an indication of economic status of the family. The data collected on it presented in the **Table 4.20.** The data revealed that the household assets which are needed for comforts or for entertainment etc., have been accumulated at family level as per their economic status. These included chairs, trunks, clock, electronic items viz., radio, television-colour/black, stores, fans, cell phone, cooking stoves, scooter/motor bike, and bicycle etc. The situation of household assets is almost identical under project and control area situations.

	Table 4.20 Ownership of per 100 households					
			(Numbers)			
Sl. no	Items	Project Area	Control Area			
1	Wooden Cots	565	562			
2	Irons Cots	20	16			
3	Tables	45	49			
4	Chairs	258	259			
5	Steel Almirah	47	45			
6	Steel Trunk	101	106			
7	Wall Clock	80	81			
8	Radio	43	36			
	Television					
9	(i) Black and White	8	10			
	(ii) Colour	23	24			
10	Kerosene Stove	13	14			
11	L.P. Gas Stove	26	25			

	Table 4.20 Ownership of per 100 households				
	(Number				
Sl. no	Items	Project Area	Control Area		
12	Electric Fan	82	91		
13	Sewing Machine	14	9		
14	Bullock Cary	2	3		
15	Bicycle	111	116		
16	Scooter / Motor bike	24	28		
17	Telephone	2	2		
18	Cell Phone	81	80		
Source:	Field Survey				

Household Annual Income and Expenditure

4.58 It is very difficult task to collect and ascertain one's income and expenditure, particularly in rural area. Reliability of this data always has been at stake for its validation. It has its own limitations. However, to some extent, it gives some trend of this variable's behavior. With these limitations an attempt is made to ascertain the income and expenditure pattern of sample households of project and control study area.

Household Income

- 4.59 Average annual income of the Households of the project area has been recorded at the level of `120071.00 per annum from all the resources, as against `117964.00 per annum from the control area. Agriculture income under both the situations is the major component of the household income. Under both the situations around 51 percent of the total household income comes from crops.
- 4.60 It is also observed that the share of the income from the sale of milk of these households was 15 percent in the project villages as against 17 percent in the villages of the control area. The 'services' contribute to the extent of 17 percent of the total income under both the situations. The break up of the house hold income is presented in **Table 4.21**.

	Table 4.21 Average gross annual income of a household			
			(In Rupees)	
Sl. No.	Source of Income	Project Area	Control area	
1	Agriculture Production	61375	60456	
2	Agriculture labour	1401	1220	
3	Non-Agriculture labour	4954	4964	
4	Sale of milk	18060	20211	
5	Sale of animals	1007	1076	
6	Rent on land	53	660	
7	Service	21050	20335	





	Table 4.21 Average gross annual income of a household				
			(In Rupees)		
Sl. No.	Source of Income	Project Area	Control area		
8	Own business	4771	5252		
9	Others	7276	3790		
	Total 119947 117964				
Source 1	Source Field Survey				

Household Expenditure Pattern

4.61 The pattern of expenditure by the house holds indicates that on an average 25 percent 0f the expenditure is made on food items, majority of which is on food grains. This trend is similar for both the situations (**Table 4.22**)

	Table 4.22 Average annual expenditure of a household				
			(In Rupees)		
Sl. No.	Source of Expenditure	Project Area	Control area		
1	Food Grains	17614	17695		
2	Other food items	12396	12168		
3	Education	4695	6098		
4	Health	2632	2369		
5	Transport	2680	2569		
6	Fuel/Elect.	2403	2287		
7	Entertainment	466	375		
8	interest Charges	237	261		
9	Religions function	3315	3146		
10	Purchase of live stock	2319	2436		
11	Others	3496	2805		
12	Savings	66429	64481		
13	Investments	1328	1073		
	Total 120010 117763				
Source F	Source Field Survey				

Physical Environment of Study Area

- **4.62 Road Connectivity:** All most all sample villages have connectivity by road. Further, it is observed that during past most of the canal roads have also been repaired and re-improvised to all weather pacca roads indicating smooth accessibility to the villages in the project area.
- **4.63 Transport Facilities:** In this regard it is observed that 44 per cent sample villages have bus transport connectivity in project area whereas this facility is little bit more in control area (48%). Besides, Auto and Taxi services are found to be available in 53 per

cent project sample villages and the same in control area it confined to 36 per cent indicating better transport network in project area. Further, it is observed that rail connectivity is confined to control area which is covering only 8 per cent of the control sample area. Details of transport facilities are depicted in **Table 4.23**.

Table 4.23 The means of access and transport to the sample villages (Percent of the total villages)				
Villages				
Means of transport	Project Area	Control Area		
Bus Services	44.44	48.00		
Rail Services	0.00	8.00		
Autos / Taxi	53.33	36.00		
No services 2.23 8.00				
Source Field Survey				

4.64 Communication: The data on this revealed that electronic communication facilities (Telephone, Internet) have reached at the village level in both the situations (project and control area), however, the project area found to be better placed as compared to control area (**Table 4.24**). Besides this, 38 per cent project sample village are equipped with Branch Post Office facilities whereas the corresponding facility in control area in limited to 16 per cent villages. More Police Stations / Police Chouki are located in project area (13%) as compared to control (8%). Further, it is noted that about 80 per cent sample household now have access to the mobile phone facilities indicating improved economic status of the sample households in the study area.

Table 4.24 The means of communication to the sample villages (Percent of the total villages)			
Particulars	Project Area	Control Area	
Police Station + Police Chauki	13.33	8.00	
Branch Post Office	37.78	16.00	
Internet facility	4.44	4.00	
Public Telephone	22.22	16.00	
Private Telephone (Mobile Phone) 80.00 81.00			
Source Field Survey			

- **4.65 Electrification:** As regard the Electric Power Connection at the village level, it is noted that about 23 per cent of sample project villages are connected with domestic electric power as compared to control (15%). Though the electrification in the study area found to be poor, is compared to control area, project area is found to be better. Further, it is observed that more than one third of sample villages (Project and Control) have power supply for tube wells (**Table 4.25**).
- 4.66 The informal discussions held with sample households during the field survey revealed that the availability of the power supply in the study area irregular and wherever



it is available it may be for around 8-10 hrs a day. The respondents indicated their concern about it.

Table 4.25 Power connections and electric supply to the sample villages (Percent of the total villages)				
Items		Village		
Items	Project Area	Control Area		
Tube wells	33.70	36.50		
Allied agriculture industries	1.36	1.16		
Domestic 23.02 14.75				
Source Field Survey				

4.67 Educational Facilities: Status of educational institutions in the sample study area, the survey data revealed that all the sample villages have primary school facilities in both the situations (Project and Control). With regard to Upper Primary School facilities it noted that both the project and control sample villages almost more or less equally placed (Table 4.26). In case of having secondary schools, inter collages and degree collages, the project sample villages are found to be placed better as compared to control area villages. In this regard it is noted that 22 per cent Project area villages are equipped with secondary and inter collages. The corresponding percentage of having these institutions is found to be mere 8 and 4 per cent respectively indicating more educational institutions have come up in project area. It is to be mentioned here that the secondary sources data also indicated of multifold growth of primary, upper primary, and secondary schools to the tune of 140, 613 and 296 per cent respectively during post projects situations in the Ramganga Project Command Area districts. Besides Anganwadi institutions are found to be functioning in almost all sample villages.

Table 4.26 Educational Facilities in Project and Control Areas (Per cent of the Total Villages)					
Sl. No	Educational Institutions	Project Area	Control Area		
1	Primary Schools	100.00	100.00		
2	Upper Primary Schools	53.33	60.00		
3	Secondary Schools	22.22	8.00		
4	Inter Collages	22.22	4.00		
5 Aganwadi 88.89 100.00					
Source .	Field Survey				

4.68 Drinking Water Facilities: The major sources of the drinking water in the sample villages (project & control) noted to be from hand pumps followed by open wells (**Table 4.27**). Hence, the drinking water is not observed as a problem in selected sample villages. Every household has access to the drinking water either through hand pump or open well. Almost every village has 'India Mark II' hand pump installed as community drinking water resource at multiple places of the village. It is also noted that there is no piped or protected water supply in the sample villages in the situations.

Tabl	Table 4.27 Drinking Water Facilities in the Selected sample Villages (Percentages)			
Sl. No	Particulars	Project Area	Control Area	
1	Wells	26.67	20.00	
2	Tube / Bore wells	40.00	0.00	
3	Taps	0.00	0.00	
4	Tanks	0.00	0.00	
5	Hand Pumps	100.00	100.00	
6	River / Stream	0.00	0.00	
Source I	Source Field Survey			

Veterinary Hospitals

4.69 Incidentally no veterinary hospital was found in the area; however 18 percent villages of project area and 8 percent villages of the control area did have a veterinary dispensary.

Veterinary Infrastructure available in the sampled villages			
		(Percentages)	
Infrastructure	Project Area	Control Area	
Veterinary hospital	0.00	0.00	
Veterinary Dispensary	17.78	8.00	
Source Field Survey			

Community buildings (Panchayat Bhawan, Meeting hall, Community hall)

4.70 More than 60 percent villages of project area did have a properly constructed panchayat Bhawan whereas 44.44 percent had a Meeting hall. In control area only 64 percent villages are equipped with the Panchayat Bhawan, and only 24 per cent have Meeting Halls. In general, the selected village did process at least one of the community infrastructures, may it be Panchayat Bhawan or community Hall or Meeting Hall. There is no extension training unit in both the project area & control areas (**Table 4.28**)

Other Infrastructure

4.71 For availing the services of purchasing the chemical fertilizers and the pesticides or the disposal of the produce, although there are facilities available in un-organized private sector within the convenient distance of up to 5 km the farmers have to travel to considerable distances to reach an institutional seed/ fertilizer depot. As regards these facilities the villages of the project are better placed where 40 percent villages have market yards within the village. The 36 percent villages of the project area have a



Socio-Economic Impacts Including Changes in Literacy and Employment

fertilizer store and there is a seed store in 27 percent villages of the project area.

- 4.72 On the contrary in the control area, the market yards are there only in 20 percent villages and seed and fertilizer stores are only in 8 and 16 percent of the villages. Only 16 percent villages of the project area have a commercial bank and there are branches of cooperative bank and also the grameen bank in 4 percent villages of the project area. In selected villages of the control area there is no branch of cooperative bank. Only 8 percent villages have a grameen bank and the 4 percent have commercial bank.
- 4.73 As regards the industries the selected villages do not have any important industrial or agro processing unit. More than 80 percent villages have flour mill (Small Ata Chakki), 57 percent villages have a rice hulling unit. The number of oil mills (cottage type) is less in the control area (28 percent villages) and in only 44 percent villages of the project area. The details of the infrastructural facilities and the civic amenities in the selected villages are presented in **Table 4.28**.

	le 4.28 Availability of Infrastructure Facilities in Study Area (Percentages)				
	Source of irrigation	Project Area	Control Area		
(i)	Industries				
	Rice mill (Dhankutti)	57.78	56.00		
	Flour mill(Ata Chakki)	82.22	80.00		
	Oil mill	44.44	28.00		
	Others	0.00	0.00		
(ii)	Market Connectivity				
	Market Yard	40.00	20.00		
	Ration Shop	60.00	72.00		
	Seed supply store	26.67	8.00		
	Fertilizer store/Other	35.56	16.00		
(iii)	Other infrastructure				
	Panchayat building	62.22	64.00		
	Community halls	8.89	12.00		
	Agan wadi Centers	88.89	100.00		
	Meeting halls	44.44	24.00		
	Training Centers	0.00	0.00		
(iv)	Financial institutions				
	Commercial bank	15.56	4.00		
	Cooperative Credit bank	4.44	0.00		
	Grameena banks	4.44	8.00		
	Other	0.00	0.00		
	Other	0.00	0.00		

Health care Infrastructure

4.74 PHC: Only 20 percent villages of project area and 24 percent of the control area have a PHC in the village it self. In addition only 15.55 percent of the villages have either presences of ANM/Medium and elementary health care unit in the project area. On the other hand 20 percent villages of the control area are equipped with such facilities. The secondary source data analysis also indicated that in command area districts the growth of Allopathic institutions was slow. The growth of these institutions was confined to 50 per cent only from Pre-project situations to Post-project situation (34 years).

Water borne diseases

4.75 According to the response of the heads of the families of the sample villages there are a few (negligible) incidences of any water born diseases in the area. The water born diseases include Malaria, Gastroenteritis and the filarial. The details presented in **Table 4.29**, provide a view on this aspect.

	Table 4.29 Water borne Disease				
	(Number of members)				
Sl. No.	Water borne diseases	Project Area	Control Area		
1	Malaria	19 (0.64)	10 (0.61)		
2	Gastroenteritis	57 (1.89)	12 (0.73)		
3	Filarial	3 (0.10)	3 (0.18)		
4	River blindness	61 (2.02)	7 (0.42)		
5	No Water diseases	2873 (95.35)	1618 (98.06)		
	Total 3013 (100.0) 1650 (100.0)				
Note:- F	Note:- Figures within parenthesis denote percentages				

Source: Field Survey



Volume-I



5

Effects on Agriculture





EFFECTS ON AGRICULTURE

Introduction

- 5.01 The function of irrigation is to protect crops from unpredictable variations of rainfall by ensuring supply of water on demand or as per necessity. The irrigation system harnesses the surplus water during the monsoon to argument the quantum and duration of moisture available for agriculture even while the local rainfall is inadequate. Hence, irrigation helps to stabilize the yield of crops and enables low rainfall areas to be brought under higher yielding corps that require more and assured water supply. It also enables crops to be grown even during non-monsoon season. Such enabling factors contribute to higher production from a given extent of cultivated land and also to bring under cultivation more arable lands which are otherwise not cultivated due to lack of water and moisture. The assured supply of water and maintenance of appropriate soil moisture conditions are crucial for the plant's ability to absorb the nutrients for optimum realization of the potential of crops, particularly those of high yielding varieties.
- 5.02 It is an established fact that irrigation makes a significantly positive difference in productivity of crops (In the case of India, Dhawan estimated that almost 55 per cent of food production in the county can be attributed to irrigation. It is also estimated that in several arid and semi-arid regions irrigation boosted the production up to four times). Similarly, the beneficial impact of irrigation on overall cropping intensity has been underlined by many studies. It is observed that irrigation and rainfall are significant determinants of cropping intensity. The cropping pattern is another factor that is significantly influenced by irrigation and rainfall. It is widely observed that paddy, wheat, sugarcane and fruits and vegetables are getting a preference in irrigated areas, while coarse cereals, pulses, oilseeds and cotton are prominent in rainfed cropping. The cropping in general becomes more diversified in irrigated areas than that in un-irrigated lands. Such developments normally impact on livestock development, agri-industries etc.
- 5.03 The growing requirement of food and other agricultural products in the post-independence period in India resulted in huge investments, both public and private, in irrigation. According to the planning commission of India, the gross irrigated area has increased more than three times (from 23 m ha to 76 m ha) during the period from 1950 to 1995. The net irrigated area increased by about 45 m ha during the period. The irrigation potential created during the period was about 57 m ha, although the actual utilization was in the region of 48 m ha. It was the technology combined with substantial increase in irrigation that resulted in a quantum jump in food grains production during the Green Revolution period in the country.
- 5.04 The preceding paragraphs highlighted the positive effects of irrigation. However, experience suggests that irrigation can generate unwanted environmental consequences



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also. It is estimated that about one-third of the world's irrigated lands have reduced productivity as a consequence of poorly managed irrigation that has resulted in water logging and salinization. Irrigation inevitably leads to water table variations and often to problems such as water logging and salinization. It has been found that availability of irrigation water encourages over use of fertilizers of by farmers in their attempts to raise production levels. Excessive use of nitrogen fertilizers and pesticides results in groundwater pollution. The contamination of groundwater on a wider scale has serious adverse effects on human and animal life and the ecosystem. Thus, a study of the impacts of irrigation should include both positive and negative offshoots of an irrigation system.

5.05 The Ramganga River Valley Project aimed at bringing an additional area of more than 5 lakh hectares under intensive cultivation through improved irrigation facilities. It is expected that the improved irrigation would change the agricultural scenario of the command area. The changes could be in the form of adoption of high yielding crops, change in cropping pattern, an increase in cropping intensity and crop productivity. The developments in the agricultural scenario can have a positive effect on the allied activities like livestock development in the area. There will also be a scope for emergence of agrobased industries like cane crushing units and a simultaneous growth of business and commerce. It is therefore, proposed to study the impact of the project on the areas discussed in Terms of Reference (ToR).

5.06 In this context, it can be hypothesized that the project has resulted in:

- 1. Improvement in production;
- 2. Changes in cropping pattern and improvement in cropping Intensity due to economic rehabilitation programs on agriculture/Horticultural/Animal Husbandry.
- 3. Improvement in quality of Livestock and Poultry;
- 4. Improvement in agricultural cooperative and agricultural finance programs; and
- 5. Development of Industry in the command area.

Apart from the above, an analysis of the overall development scenario in the command area is also attempted in this chapter. The negative environmental consequences in the context of agriculture are also discussed towards the end of this chapter. However, other environmental issues are analysed elsewhere.

Methodology

5.07 The Effects on Agriculture are extracted using a two dimensional study. The published data on the reflective indicators as available from the authentic sources like the Hand Book of Statistics and Published reports of the Ramganga Command Area development authority are used for analysis and interpretation of the effects. The indicators are studied at pre and post project level. Since the post project period happened to be quite long, an intermittent period is also taken to observe the trend and make a more convenient and intelligible comparison. The pre-project period is taken for the year 1974-75, when the project benefits to command area have not commenced. The intermittent post project period is taken for the year 1982-83 over a gap of nearly a decade of

development. The latest available data for the year 2007-08 is compared against the above two for arriving at reasonable conclusions.

5.08 The second dimension study included primary data collected from the beneficiaries in the command area through a structured response sheet / schedule. The primary level data so collected and the secondary data extracted are tabulated and analyzed by using simple arithmetical and statistical tools to derive the required output for the study. Wherever required the block-wise data for command and other command blocks is extracted from the reliable and authentic sites of the state government department and the comparisons at project level is made between command and other command blocks. This effort had helped in understanding the real situation in the command area blocks during pre and post project situation vis-à-vis other command area blocks. The other command area blocks are those which received irrigation facilities even before the commissioning of Ramganga project through old Ganga Canal System. The study is confined to the areas enlisted in the introductory paragraphs as given in the Terms of Reference.

Changes in Land Use Pattern, Production and Productivity

5.09 The productivity of the major crops during Pre and Post-project periods is studied for assessing the impact of the project. Production changes due to change in land use pattern and the increase or decrease of area under specific crops are also studied. The study has focused on the changes in all the three areas namely Land use Pattern, Production and Productivity to understand the field level situation. For the purpose of this study, major crops in Kharif and Rabi area are taken and the project level impacts are studied. The crops considered for the assessment are rice, jowar, bajra, maize, wheat, sugarcane, groundnut and potato.

Land use Pattern in Command Area

5.10 The land use pattern in the command area is studied for three periods of time in order to understand the changes over a period. The data from the earlier study of the command area for land use pattern presented in the project report of the project development authorities, Kanpur for the years 1973-74 and 1982-83 are taken as the basis to compare further changes till 2007-08, the latest year for comparison. The command and other command area blocks are compared during post project to understand the status of command area. The essential indicators for land use are taken for the period under study and are presented in Annexure V.1 and Table 5.1. It is seen that the area under forest has gone up from 1.35 lakh hectares to 1.45 lakh hectares in 2007-08. The per centage area under forest to reported area had increased from 2.82 per cent to 3.03 per cent due to afforestation programmes after the project implementation. The barren and uncultivable land which stood at 3.20 lakh ha during 1974-75 had come down to 1.18 lakh ha. The percentage area of Barren & uncultivable land had come down from 6.68 per cent to 2.47 per cent due to land development programmes in the command area. The land put to non-agricultural use which was 8.05 per cent to total area during 1974-75 had increased to 10.18 per cent. An area of 2.31 lakh ha of cultivable waste land forming 4.82



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per cent of total area during pre-project came down to 3.06 per cent in the context of increased water availability after the project. The permanent pastures and other waste land had also come down from 0.54 per cent during 1974-75 to 0.42 per cent during post project period.

	Table 5.1 Comparison of Land Use Pattern in Command Area									
					(<i>A</i>	Area in ha)				
		% of area to Area Reported								
Sl. No	Land Use	1974-75	1982-83	2007	2007-08					
		1974-75	1902-03	N	C	Total				
1	Area Reported	4798380	4798380	4059258	739122	4798380				
2	Forest	2.82	2.69	3.4	3.5	3.03				
3	Barren & Uncultivable land	6.68	5.53	2.12	2.92	2.47				
4	Land put to Non- Agricultural Use	8.05	8.75	12.13	12.03	10.18				
5	Cultivable Wasteland	4.82	3.52	2.94	3.62	3.06				
6	Permanent Pastures	0.54	0.52	0.31	0.50	0.42				
7	Area in Shrubs	1.71	1.15	1.56	1.17	0.99				
8	Current Fallows	4.10	4.86	11.45	7.5	6.34				
9	Net Area sown	70.98	70.52	62.42	83.73	70.83				
10	Gross Command Area	94.76	100.76	100.74	112.19	110.42				

Note: C - Command Area: N- Other Command Area

Refer Annexure V.1 for further details

- 5.11 The current fallows registered an increase of 2.24 per cent during 2007-08 compared to 1974-75. The net area sown stood at 34.05 lakh ha forming 71 per cent to total area in pre project situation. The post project scenario for the year 2007-08 also presents a similar situation (71%) indicating no increase in the net area sown. However, the area sown more than once has increased from 11.41 lakh ha to 19 lakh ha during 2007-08. Consequently the gross cultivated area had increased from 45.47 lakh ha in 1974-75 to 60.43 lakh ha in 2007-08. The Gross cultivated area had increased from 94.76 per cent to 110.42 per cent during Post Project Period. Thus, the impact of the project can be seen from the increased areas coming under second crop in view of enhanced irrigation facilities from the Ramganga project.
- 5.12 The comparison of land use pattern between command area blocks and other command area blocks reveal that the percentage area under forests is more (3.59%) in command area than in other command area blocks (3.40%). The barren and uncultivable land is more in command area (2.92%) when compared to other command area (2.12%). Land put to non-agriculture use is almost similar in both command area blocks (12.03%) and other command area blocks (12.13%). A significant improvement is seen in the percentage of net area sown to total area which stood at 83.73 per cent, whereas the percentage of net area sown in other command area blocks stood at 62.42 per cent. Area

sown more than once in non-command area blocks stood at 38.04 pre cent. Whereas, the command area blocks shows a percentage of 39.82 per cent indicating positive impact of the project in command. The percentage of gross cultivated area is command standing at 112.19 per cent is far greater than GCA of other command blocks showing 100.74 per cent. The block-wise comparison between command and other command blocks is presented in **Annexure V.2**.

Cropping Intensity

5.13 Cropping intensity is the index of number of times crops are grown on a unit piece of land. It is expressed as a percentage of gross cropped area to net cropped area. The primary objective of Ramganga project was to supplement water to the erstwhile Ganga Canal System as well as to bring hither-to-parched lands to cultivation by supply of irrigation water through newly excavated canals and existing canals. The project aimed to bring 5.91 lakh ha additionally under this project while simultaneously aiming to increase the intensity of cropping in the proposed command area. The proposed cropping intensity after commissioning of the project was 167 per cent. The following discussion reveals to what extent the above objective has been realized.

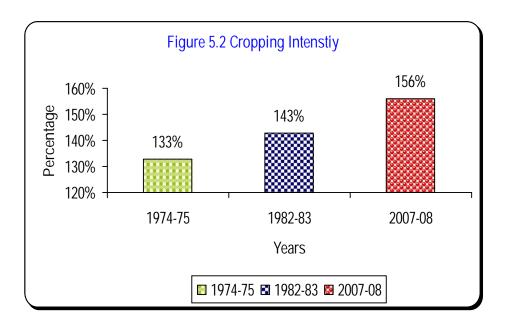


Table 5.2 Gross and net Cropped Area in Lakh ha								
Year	Net Cropped Area	Gross Cropped Area	CI					
1974-75 (Pre-project)	34.10	45.50	133 %					
1982-83 (Post-project)	33.90	48.40	143%					
2007-08 (Post-project)	34.00	53.00	156%					

5.14 The cropping intensity had gradually increased over a period in the command area blocks. The net copped area during pre-project (74-75) was 34.10 lakh ha and the gross cropped area was 45.50 lakh ha. The CI during pre-project period worked out to 133 per



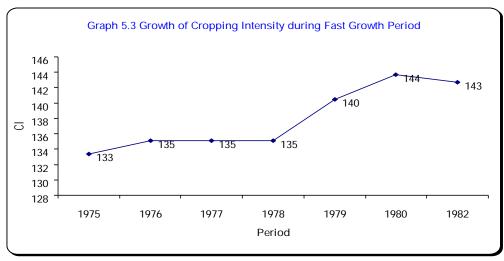
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cent. However, after commissioning of the project increased availability of water from Ramganga project enhanced the gross cropped area and consequently the cropping intensity. During 1982-83 the gross area increased to 48.40 lakh ha and the cropping intensity increased from 133 per cent to 143 per cent (10%). The latest figures for the year 2007-08 indicate an increase of gross cropped area to 53.00 lakh ha. The increase in cropping intensity is to the extent of 23 per cent i.e., from 133 per cent to 156 per cent. One of the important objectives of the project to increase intensity is thus successfully achieved. However, some more efforts are required to reach the targeted level of 167 per cent.

Trends in Cropping Intensity

5.15 A further study of trends in cropping intensity between the two periods of post-project is made to understand the nature and pace of growth in the command area districts after the commencement of Ramganga project. Two periods named for convenience as "Fast growth period" falling between 1975 and 1982 and "Slow growth period" falling between 1990 and 2008 are studied and presented in the following paragraphs.

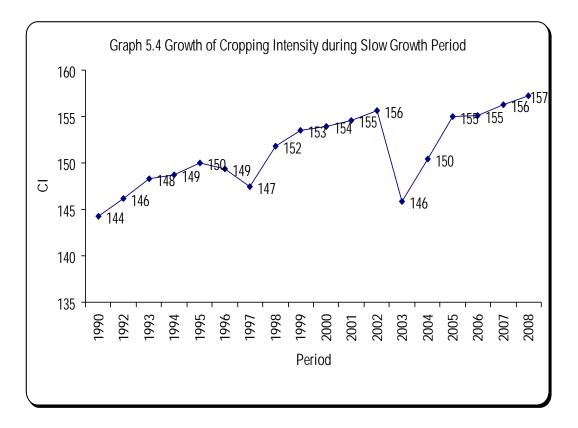
Fast Growth Period (1975-1982)



(Annexure V.3 for details)

5.16 As per the Graph 5.3 the cropping intensity in the command during 1975 was 133 per cent when the benefits of the project had just started flowing. The cropping intensity rose to 135 and stayed constant till 1978. The year of 1979 showed an appreciable growth in cropping intensity and touched 140 per cent which went up to 144 per cent during 1980 and slightly came down to 143. The overall growth in area in the fast growth period was 10 per cent. This has clearly proved that the supplementary irrigation by the project to the command area had resulted in brining additional areas in to the cultivation in the first few years of commencement of the project. The district-wise variations are presented in **Annexure V.3**.

The Slow Growth Period



- 5.17 The chart above depicts comparatively faster pace of growth during the first 10 year period commencing from 1990 to 2000. The cropping intensity which was at 144 per cent in 1990 has grown up to 154 per cent by 2000 showing a growth of 10 per cent in a span of 10 years. Thereafter, the period between 2000 and 2008 witnessed a very slow growth of only 3 per cent. During this period there was a sudden drop in cropping intensity to 146 per cent equaling 1992 level due to erratic climate resulting in abnormally low rainfall. During 2003 the actual rainfall received was only 408 mm against normal rainfall of 612 mm. In view of this the water levels in reservoir also fell down and consequently only 0.6269 million acre feet (MAF) of water was released against the normal releases ranging between 1.1136 MAF and 1.6340 MAF. The district-wise variations are given n **Annexure V.4** and **V.5**.
- 5.18 The above discussion takes us to suggest that the command area reached more or less a saturation level by the year 2000. The reasons for this level of saturation need to be probed further to arrive at solutions most suitable to the command area including development of conjunctive use of water.



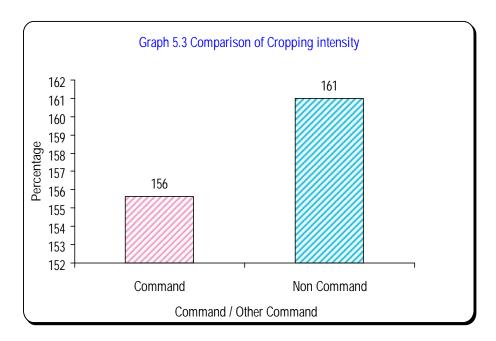


Table 5.3 CI in Command and Other Command Blocks							
in Lakh ha							
Year	Net Cropped Area	Gross Cropped Area	CI				
Command 2007-08	29.37	45.54	155				
Other Command	4.61	7.45	161				

Refer Annexure V.1 & V.2 for details

- 5.19 The available data for the 140 blocks of Ramganga command revealed that the net cropped area in command blocks is 29.37 lakh ha and gross cropped area is 45.54 lakh ha. The cropping intensity has reached a level of 155 per cent. The net cropped area in other command stood at 4.61 lakh ha with corresponding gross cropped area at 7.45 lakh ha. The cropping intensity reached 161 per cent.
- 5.20 It may be noted here that the other-command blocks have been receiving irrigation facilities for the past few decades before the project. The command blocks received irrigation water sufficiently only since 75-76. In this context the level of CI achieved in command (155%), which is almost near to other-command (161%), needs to be appreciated. However, this indicates scope for initiating some more efforts to reach the targeted level for cropping intensity.

Cropping Pattern and Crop Rotations

5.21 The major crops grown in the command area are rice, jowar, maize, bajra and moong in Kharif season and wheat, barley, pea in Rabi season besides sugarcane grown on annual basis. The objectives of the project to increase cropping intensity can also be achieved by changing crop rotations in the area. The mere fact that the area achieved higher cropping intensity proves that there has been a change in the crop rotations.

The following table examines pre and post-project changes in crop rotations.

	Table 5.4									
Sl. No	Pre-project crop Rotations	Sl. No	Post-project crop Rotations							
1	Paddy-wheat	1	Paddy-Wheat-Moong							
2	Bajra- pea	2	Paddy-pea-sugarcane							
3	Maize-potato-tobacco	3	Maize-potato-wheat-moong							
4	Maize-barley-gram	4	Maize-potato-Cucurbits							
5	Groundnut-Arhar	5	Chari-arhar-wheat							
6	Green manure-wheat	6	Maize-rye-wheat							
7	Cotton-sugarcane-ratoon-	7	Bajra-wheat-moong							
	fallow wheat									
8	Jowar-Arhar-fallow-Wheat	8	Maize-potato-sugarcane							

Crop Substitution

(Area in '000 ha)

	Tah	le 5 5 Area Und	er Major Crops (I		ect)					
Sl. No	Crops	Pre Project (1974-75)	Post Project (1984-85)	Post Project (2007-08)	% increase / decrease					
1	Rice	448	561	726	162					
2	Jowar	170	135	607	357					
3	Bajra	640	574	536	83					
4	Maize	378	302	650	172					
5	Wheat	1272	1652	2028	160					
6	Potato	70	127	245	350					
7	Sugarcane	93	70	53	56					
8	Groundnut	56	8	5	82					
	Source: Project Report & Hand Book of Statistics									

5.22 It is seen from the above tables that the project brought significant changes in the substitution of erstwhile grown crops. Cultivation of wheat, potato and rice had increased multifold. The increase in area of potato at 250 per cent was the highest followed by maize at 70 per cent, rice (62%) and wheat at 60 per cent. The decline in area of cultivation is observed in respect of bajra by 17 per cent, jowar by 65 per cent sugarcane by 44 per cent and groundnut by 91 per cent. Please refer to **Annexure V.6** for district-wise variations.



Production of Major Crops

(Production in '000 tons)

	Table 5.6 Comparison of production of Major Crops (Pre & Post)										
Sl. No	Crops	Pre-Project Production (1974-75)	Post-Project (1984-85)	Post-Project (2007-08)	% increase / decrease						
1	Rice	406	621	1541	279						
2	Jowar	110	123	77	30						
3	Bajra	526	581	838	59						
4	Maize	397	544	493	24						
5	Wheat	1402	3702	5815	314						
6	Potato	651	2425	5818	793						
7	Sugarcane	3277	2575	2760	16						
8	Groundnut	48	3	3	_						
	Source: Project Report and Hand Book of Statistics										

5.23 It is seen from the table above that all the major crops with the exception of Jowar and sugarcane have registered upward growth in production. Productions of Jowar came down by 30 per cent. During Pre-project, rice production in command blocks was 406 thousand tonnes which went up to 1541 thousand tonnes. Highest increase in production during post-project is seen in potato (793%) followed by wheat (314%) and Rice (279%). The project supplemented irrigation water to the command resulting in additional areas coming under cultivation of these crops due to crop substitution in Post-project scenario and also due the technological interventions by the Agricultural Department through their various yield increasing programmes. Please refer to **Annexure V.7** for district-wise details of production.

Area, Production and Productivity of Major Crops

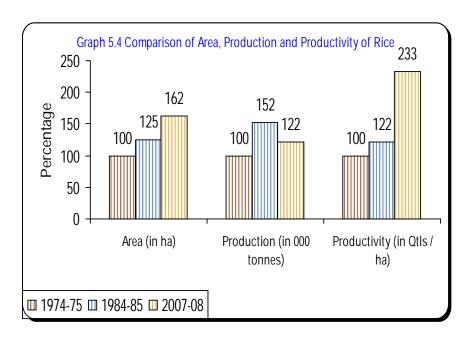
5.24 The Ramganga project brought in substantial changes in cultivation of major crops in command area. In view of increased availability of irrigation water, larger areas were brought into cultivation under these crops by crop substitutions as discussed earlier which resulted in enhanced production and increased productivity. The following paragraphs describe such changes brought in respect of 8 major crops.

1 Rice

Table 5.7 Comparison of Area, Production and Productivity of Rice

Sl.		Period						
No	Indicator	Indicator Pre Project		Post Project		Project		
110		1974-75	1984-85	% Increase	2007-08	% Increase		
1	Area (in ha)	448	561	+25	726	+62		
2	Production (in 000 tonnes)	406	621	+52	1541	+279		
3	Productivity (in Qtls / ha)	9.08	11.08	+22	21.26	+133		
	Refer Anneyure V & & V 9							

5.25 The table above as well as the following chart reveals that the area under Rice had increased by 25 per cent and 62 per cent in the post-project period compared to base year. The production had increased by 52 per cent and 279 per cent in subsequent years and the productivity of rice has increased by 22 per cent and 133 per cent during post-project period. The productivity of Rice which was 9.08 Qtl/ha had gone upto 21.26 Qtls/ha.



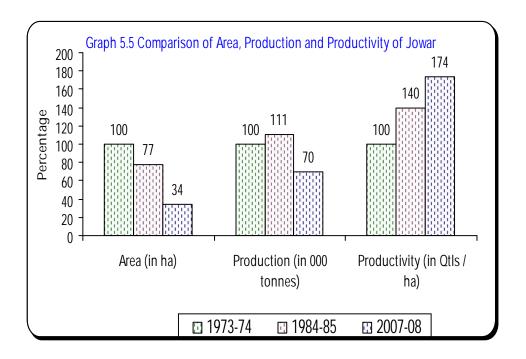
2 Jowar

Table 5.8 Comparison of Area, Production and Productivity of Jowar

		Period						
Sl.	Indicator	Pre Project	Pre Project Post Project		Post Project			
No		1973-74	1984-85	% Increase / Decrease	2007-08	% Increase / Decrease		
1	Area (in ha)	170	135	-20	60	-65		
2	Production (in 000 tonnes)	110	123	+11	77	-30		
3	Productivity (in Qtls / ha)	6.49	9.13	+40	11.29	+74		
	Please Refer Annexure V 8 to V 9							

5.26 It is seen from the table above and the following chart that the area under Jowar crop decreased by 20 per cent in the interim period and further decreased by another 45 per cent when compared to base year. The production levels though slightly gone up by 11 per cent during 84-85 have come down by 30 per cent during 2007-08. The productivity levels have improved per hectare from 6.49 Qts/ha to 11.29 Qtls/ha registering a growth rate of 74 per cent.



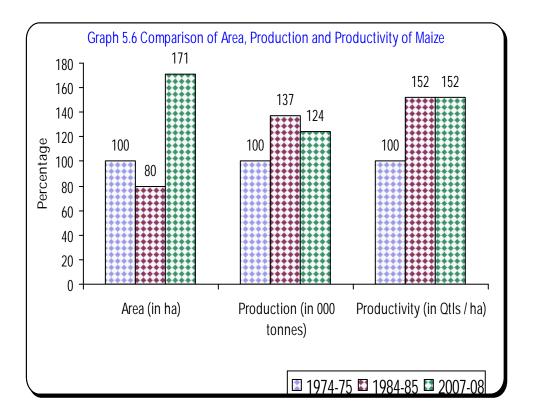


3 Maize

Table 5.9 Comparison of Area, Production and Productivity of Maize

		Period							
Sl.	Indicator	Pre Project Post Project		Post Project					
No		1974-75	1984-85	% Increase / Decrease	2007-08	% Increase / Decrease			
1	Area (in ha)	378	302	-20	650	+71			
2	Production (in 000 tonnes)	397	544	+37	493	+24			
3	Productivity (in Qtls / ha)	10.51	16.06	52	16.06	+52			
	Please Refer Annexure V.8 to V.9								

5.27 The table above and the following chart indicate that the area under Maize crop has come down by 20 per cent in 1984-85 and then shown an increase and went up to 650 ha of 71 per cent. However, the production levels have gone up by 37 per cent in 84-85 and came down to 24 per cent in 2007-08. The productivity has gone up from 10.51 Qtls to 16.06 Qtls / ha registering a growth of 52 per cent. Maize crop has shown growth in all the three areas namely area, production and productivity compared to the base year

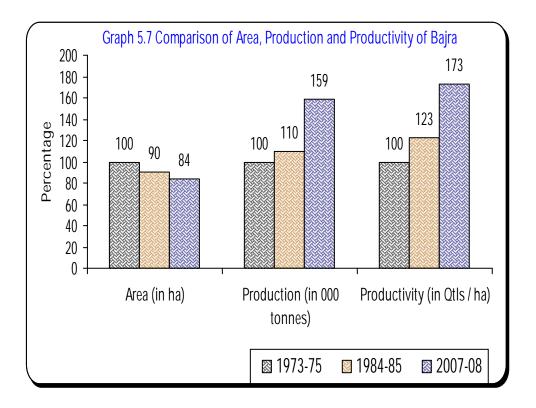


4 Bajra

	Table 5.10 Comparison of Area, Production and Productivity of Bajra								
		Period							
Sl. No	Indicator	Pre Project	Pos	t Project	Pos	st Project			
110		1973- 74	1984- 85	% Increase / Decrease	2007-08	% Increase / Decrease			
1	Area (in ha)	640	574	-10	536	-16			
2	Production (in 000 tonnes)	526	581	+10	838	+59			
3	Productivity (in Qtls / ha)	8.22	10.12	+23	14.26	+73			
	Refer Annexure V.8 to V.9								

5.28 The area under Bajra has came down by 16 per cent the production level have shown an increase from 526 thousand tonnes to 838 thousand tonnes showing a growth of 59 per cent during post-project period. The productivity per hectare has gone up from 8.22 Qtls / ha to 10.12 Qtls / ha during 84-85 and a further increase to 14.26 Qtls / ha during 2007-08 taking the growth rate to 73 per cent when compared to base year.

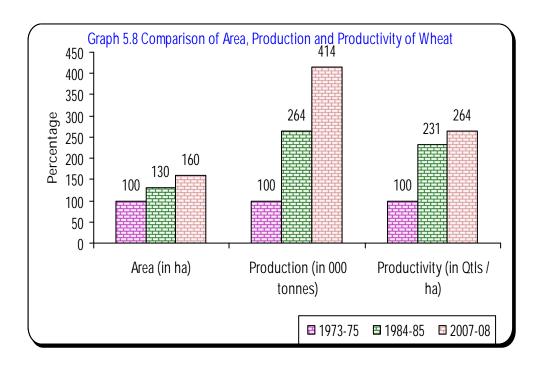




5 Wheat

	Table 5.11 Comparison of Area, Production and Productivity of Wheat								
Sl. No	Indicator	Pre Project	Pos	Period t Project	Post	t Project			
		1973-74	1984-85	% Increase / Decrease	2007-08	% Increase / Decrease			
1	Area (in ha)	1272	1652	+30	2028	+60			
2	Production (in 000 tonnes)	1402	3702	+164	5815	+314			
3	Productivity (in Qtls / ha)	11.02	25.5	+131	29.17	+164			
	Refer Annexure V.8 to V.9								

5.29 The area under wheat crop has shown an increase of 30 per cent during 84-85 and 60 per cent by 2007-08. The production level has gone from 1402 thousand tonnes to 5815 thousand tonnes registering a growth of 314 per cent over base year. The productivity has risen from 11.02 Qts/ha to 29/17 Qtls/ha during 2007-08 registering a growth rate of 164 per cent over base year. The wheat crop has experienced significant impact in all the three areas of production, area and productivity due to the project.

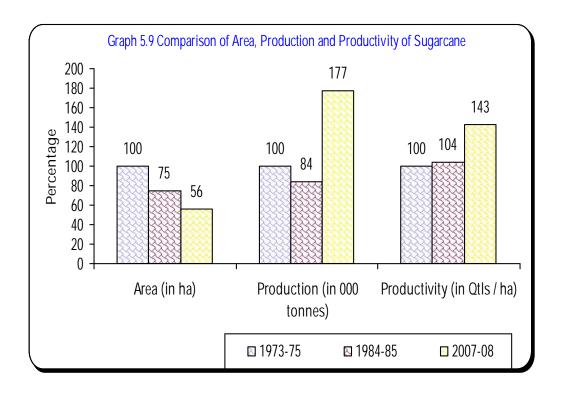


6 Sugarcane

	Table 5.12 Comparison of Area, Production and Productivity of Sugarcane									
			Period							
Sl. No	Indicator	Pre Project	Post	Project	Post	Project				
NO		1973-74	1984-85	% Increase / Decrease	2007-08	% Increase / Decrease				
1	Area (in ha)	93	70	-25	53	-44				
2	Production (in 000 tonnes)	3277	2760	-16	5816	+77				
3	Productivity (in Qtls / ha)	352.75	367.15	+4	505.67	+43				
	Refer to Annexure V.8 to V.9									

5.30 It is seen from the table and the following chart that the area under sugarcane had decline by 44 per cent over base period. However, the production levels which had gone down in 1984-85 by 16 per cent have picked up and reached a growth of 77 per cent. The physical levels of production had gone up from 3277 thousand tonnes to 5816 thousand tonnes. The productivity of sugarcane has shown a marginal increase of 4 per cent during 1984-85. However, the overall increase in productivity in 2007-08 has gone up to 505.67 Qtls/ha registering a growth of 43 per cent over base period.

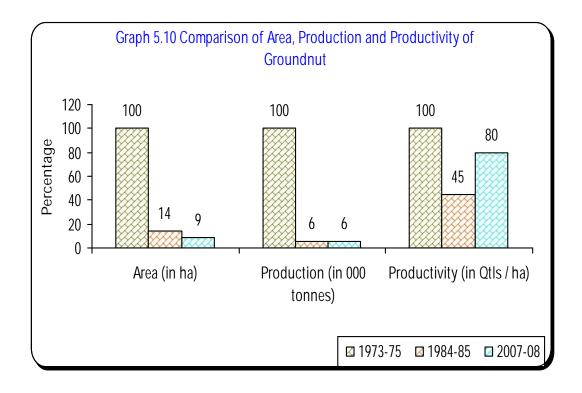




7 Groundnut

	Table 5.13 Compari	son of Area	, Production	n and Productiv	vity of Grou	ındnut
				Period		
Sl.		Pre Project	Post	t Project	Post I	Project
No	Indicator	1973-74	1984-85	% Increase / Decrease	2007-08	% Increase / Decrease
1	Area (in ha)	56	8	-86	5	-91
2	Production (in 000 tonnes)	48	3	-94	3	-94
3	Productivity (in Qtls / ha)	8.63	3.91	-55	6.98	-20
				Refe	er Annexur	e V.8 to V.9

5.31 The post-project scenario for groundnut crop when compared to pre-project as shown in table indicated decline in area, production as well as productivity. The area has drastically decreased by 91 per cent, the production by 94 per cent and the productivity by 20 per cent over base year. This indicates substitution of this crop with food grains as the area for rice and wheat had gone up after the project.

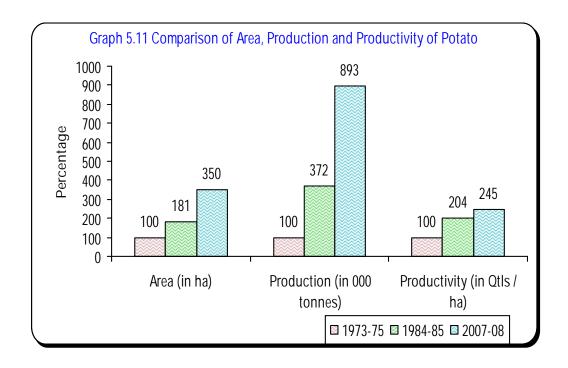


8 Potato

	Table 5.14 Compa	rison of Ar	ea, Product	tion and Produ	ctivity of F	Potato
				Period		
Sl.	Indicator	Pre Project	Post	Project	Post	Project
No	inuicator	1973-74	1984-85	% Increase / Decrease	2007-08	% Increase / Decrease
1	Area (in ha)	70	127	+81	245	+250
2	Production (in 000 tonnes)	651	2425	+272	5818	+793
3	Productivity (in Qtls / ha)	93.69	191.37	+104	230.33	+145
				Refe	er Annexur	re V.8 to V.9

5.32 Potato crop had tremendous impact due to Ramganga project in all the areas. The area under cultivation which was 70 thousand ha during 1974-75 has gone up to 245 thousand ha with a growth of 250 per cent. The production levels have shown remarkable growth of 272 per cent in 1984-85 and as high as 793 per cent during 2007-08. Like-wise the productivity of potato has zoomed by 145 per cent with an intermittent-rise of 104 per cent. The over all impact on potato crop is substantial like in wheat and rice.





Improvements in quality of Livestock and Poultry

5.33 A positive growth in Agricultural scenario in command area can bring about positive changes in the livestock population in the area. The increased water availability to the command area induces farmers to grow fodder crops and enhance livestock assets in the households. It is therefore decided to make an inventory of livestock in the pre and post project situations in order to track the improvement in this area. The following table gives in the total population of livestock in respect of important animals in pre and post project situations. The district-wise details are presented in the **Annexure V.10**.

	Table 5.1	17 Comparisor	of Livestock I	Population	
Sl. No	Type of Animal	1976-77	1980-81	2007-08	% Increase
51. 110	Type of Alliniai	Pre-project	Post-project	Post-project	Base Year
1	Cattle	908585	3454817	2766128	+204
2	She-Buffaloe	1717560	3530600	5867901	+241
3	Sheep	421850	399014	486783	+15
4	Poultry	582239	667323	1444245	+148
				Refer A	nnexure V.10

5.34 It may be seen from the table above that there has been an increase in all the types of animals during post-project period when compared to pre-project year. The cattle has increased by 204 per cent, she-buffaloes by 241 per cent; sheep by 15 per cent and poultry by 148 per cent. However, the cattle when compared to 1980-81 had declined in population by 6.77 lakh due to changes in the preferences of the farmers in command area to acquire she-buffaloes instead of cattle.

Quality of Livestock

5.35 Improvement of breed has been one of the prime objectives of the Animal Husbandry Department with the ultimate aim of increasing milk production. The improvement in quality of livestock is brought about by cross-breeding programmes through artificial insemination. The livestock census for pre-project years does not indicate the bifurcation of local and improvement breeds and hence pre and post project comparison is not possible. However, during the post project period the bifurcated data is taken for cattle in order to understand the present situation.

The following table indicates such bifurcation for the year 2007-08. The district-wise Break-up is given in the **Annexure V.11**.

Table 5.18 Compa	rison of Deshi and Cross Breed in G	Cattle Post-Project Situation (2007-08)
Type of Cattle	Total For Command	% Cross Breed Total
Deshi	814571	-
Cross Breed	126247	13
Total	940818	
		Refer Annexure V.11

5.36 Even without comparing pre-project situation the post-project scenario itself presents a dismal picture of presence of Cross Breed Cattle. It is only 13 per cent of the total cattle belong to cross-breed which indicates that lot of efforts need to be made to improve the quality of livestock in the command area. The position is comparatively better in Kanpur Dehat with 25 per cent of the cattle being improved breed followed by Aligarh (24%) and Agra (18%). The districts with least number of cross breed cattle happened to be Fatehpur (4%), Etawah (4%) followed by Auriya (8%) and Kannuj and Kaushambi (9%).

Table 5.19 Com	parison of Chang	ges in Quality of (Cattle between 19	93 & 2007
Type of Cottle	Total for	Command	Increase /	%
Type of Cattle	1993	2007	Decrease	70
Deshi	3332071	2592628	-739443	-22
Cross Breed	232416	348873	+116457	+50
Total	3564487	2941501	-622986	-17
			Refer Ann	exure V.12

5.37 A comparison made for quality of livestock between 1993 and 2007 as above reveals that the overall cattle population has reduced by 6.23 lakh during 2007. The deshi cattle is reduced by 7.39 lakh compared to 1993. However, due to some efforts made by the Animal Husbandry Department the Cross Breed cattle had improved by 1.16 lakh compared to 1993. It is seen that there has been conversion of Deshi to Cross Breed cattle to some extent leaving a large gap of efforts to be made in command area.



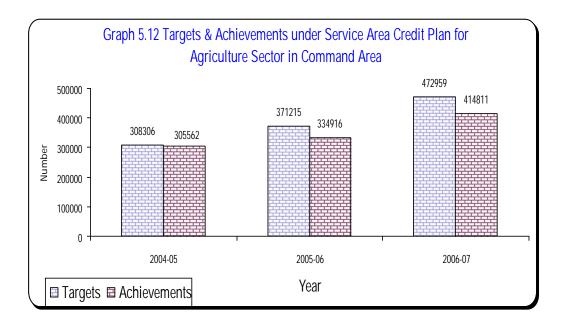
Agricultural Cooperative and Agriculture Finance Programs

The Need

- It is seen from various survey reports that about 34 lakh ha of command area suffer from salinity and sodicity. This area almost constitute one tenth of the net cultivated area of the command. In order to boost-up productivity the soils need to be corrected. A programme for reclamation of sodic soils was taken up under which the supply of soil amendments was subsidized to the extent of 75 per cent for small and marginal farmers and 50 per cent to other farmers. The balance of the cost would be met by the farmers either on their own or through the crop loans/term loans extended by financial institutions.
- 5.39 Like-wise other schemes for enhancing fertility status of this soils, included rectification of poorly drained soils, management of light textured soils through bunding and levelling and use of organic manures, reclamation of ravine soils for arresting soil erosion, and improvement of fertility status through application of balanced fertilizers.
- 5.40 While, some of the above mentioned programmes are partly subsidy based, some programmes require investments through farmers. The finance for agricultural purposes is provided by the financial institutions including commercial banks. The following paragraphs study the availability of short-term and medium term credit available for agricultural purposes during pre and post project situations.
- 5.41 In this context the target and achievements under agriculture sector for four years commencing from 2004-05 are examined as per Annexure V.13 in respect of command area districts. While, the annexure gives the district wise achievements the following Table indicate the gross portion in the command area.

Tab	le 5.20 Ta	rgets	and Ach	ievements	unde	r Service	Area Cred	dit Pla	an for
		A	Agricultui	re Sector i	in Con	nmand Ar	ea		
2	004-05		2	2005-06		2	006-07		2007-08
T	A	%	T	A	%	T	A	%	T
308306	305562	99	371215	334916	121	472959	414811	87	570278

As seen from the above table the finance for agricultural sector in the command area districts has been increasing in monetary terms. During 2004-05 the target for all command districts was `30.83 crores which had increased to `47.29 crores. The target for financial programmers during 2007-08 was scaled up to 57.03 crores. The achievement during 2004-05 was 99 per cent and during 2005-06 was 121 per cent exceeding the target. The excess demand was identified and the target was suitably enhanced during 2006-07 the achievement was 87 per cent. However, due to higher demand for subsequent year the target was again scaled up to `57.02 crores.



Cooperation

5.43 The Cooperative institutions used to play vital role during pre-project situation. There were 1268 Primary Agricultural Cooperative Credit Societies advancing short medium and long term loans for agricultural purposes at a lower interest. During 84.85 a sum of Rs. 53.85 crores was distributed in the command area of Ramganga. The coverage of farmer families under cooperative system was about 60 per cent leaving a gap 40 per cent. There after over a period the cooperative system had weakened and the credit gap was filled up by Commercial Banks and Regional Rural Banks. The co-operative sector occupied third portion after RBB's. The following **Table 5.21** gives a comparison of cooperatives between 1984-85 and 2007-08.

	Table 5.21 Con	parison of Progr	ress of Cooperativ	es
Sl. No	Name of Institution	No. of 1984-85	Societies / BBs 2007-08	Increase / Decrease
1	No of PACs	1268	1452	+184
2	No of Dt Cooperative Banks	10	11	+1
3	No of Dt Cooperative Federation	10	13	+3
4	No of Cooperative Marketing Societies	56	59	+3
			Refe	r Annexure V.1

5.44 The comparative table above reveals that there was an increase of cooperative institutions by 184 during the post project period. The increase in district cooperative



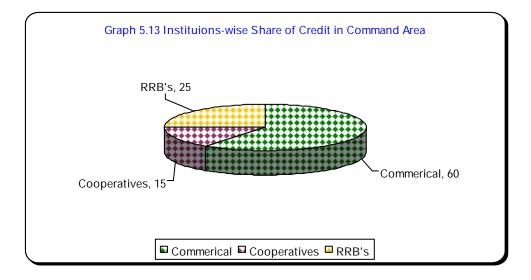
Effects on Agriculture

bank was a mere one and that of cooperative federations by three. There has also been improvement in cooperative marketing societies by three. The comparison of cooperative credit with other financial institutions is discussed in following paragraphs.

Institutions-wise share of Agriculture Credit Programs

5.45 The command area is served by a variety of financial institutions that meet the demand from the agricultural sector. The district-wise and institution-wise share of agriculture credit including both short term and medium term loans is presented in the **Annexure V.15**. The following table gives the overall picture of credit supply to the agricultural sector in the command area districts.

r	Гable 5.22 Institutions-wi	se share of	Credi	t in Comn	and D	istricts	
Sl. No	Type of Financial Institutions	Crop Loans	%	Term Loans	%	Total	%
1	Commercial Banks	2105	54	1333	71	3438	60
2	Cooperatives	568	14	316	17	884	15
3	RRB's	1237	32	220	12	1457	25
	Total	3910	100	1869	100	5779	100
					Refer	Annexure	V.15



5.46 It may be seen from the table above that Commercial Banks extend major (60%) share of agriculture credit in the command area districts followed by RRB's (25%). The least share of agriculture credit is contributed by cooperatives (15%). The share of cooperatives in term loans is better than RRB's. The cooperative's share stood at 17 per cent which is 5 per cent more than the RRB's in respect of term loans.

Development of Industry in the Command Area

5.47 Prosperity in the agricultural sector will have positive effects on the industrial and other sectors. Increased production of commercial crops would give scope for

establishment of processing factories in the vicinity. Availability of additional power would also encourage entrepreneur to establish new industries. The growth of new industries would increase the employment opportunities to both skilled and semi-skilled workers in the area. The study therefore aimed at understanding such developments in the following paragraphs.

5.48 Minerals: It is seen from the **Table 5.23** that the production of minerals had gone up in the state in respect of Bauxite, Diaspose, Dolomite, Silcasand and Limestone, though marginally.

T	able 5.23 Production of	of Minerals (Pro	duction (MT))
Sl. No	Name of Minerals	Pre-project	Post-project
1	Bauxite	90	Nil
2	Diaspose	1739	1381
3	Dolomite	49375	13725
4	Silcasand	188917	183794
5	Limestone	1033342	1250670
Source:	Compiled from Statist	ical Abstract-Utto	ar Pradesh

Manufacturing Factories

5.49 The manufacturing factories had gone up from 2280 to 3165 and the number of workers from 1.27 lakh to 1.38 lakh during the Post-project period.

Table 5.2 4	Factories and wo	orkers in Pre a	nd Post Project Situation
P	re-Project		Post-Project
No.	Workers	No.	Workers
2280	127787	3165	138102
Source: Co	ompiled from Stati	stical Abstract-	Uttar Pradesh

Industrial Estate

5.50 During the Post-project period 80 Industrial estates have developed and out of the allotted plots 1331 plots are established and developed in the State of Uttar Pradesh. About 0.10 lakh persons are employed and the total production from the industrial estates touched 313 crores (**Table 5.25**).

T 1 4 *		Table 5.25	D : .	1. TID Ct. 4
Industria	l Estate Developme	nt during Post	-Project perio	d in UP State
No of Estates	No of Plots	No of Sheds	Person	Production
	working	working	Employed	Value (Crores)
80	1331	616	10103	313.92



Growth of Factories and Employme

Table 5.26 Growth of factories and employment in the command area districts						
Sl. No	Particulars	Pre-project 1978-79	Post-project 2007-08	% Increase		
1	No of Regd factories	2280	3165	885		
2	Total Workers	127787	138102	10315		
Refer Annexure V.16						

5.51 It is observed from the table above that an additional number of 885 registered factories had come-up in the command area districts bringing additional employment to 10315 workers. The district-wise variations are given in the **Annexure V.16**.

Overall Development Scenario in Command Area

5.52 The overall development of any area is reflected through the infrastructure available in the area. The essential infrastructure includes better road linkages to vast areas, the corresponding connectivity through public transport, the communication networks and the extent of energization in the area. The multipurpose project of Ramganga has its impact on the overall development of the command area districts. A part of such development is presented in the Chapter titled Effects on Socio-Economic Development. The following paragraphs give the development scenario not covered in the socio-economic chapter.

Transport

Table 5.27 Growth of Link Roads and Transportation in Command Area							
Sl. No	Particulars	1977-78 Pre project	2007-08 Post Project	Increase	%		
1	No of Villages linked by Road	8713	12325	3612	70		
2	Railway Stations	271	328	57	21		
3	Bus Stations	1329	1740	411	30		

5.53 Transport facilities being one of the most essential features of overall development has shown positive growth as seen from the table. During the pre-project there were 8713 villages covered by road and in post project the number of villages linked by road had gone up to 12325 indicating a growth rate of 70 per cent in 30 years span of time. There were 271 railway stations existing during pre-project which were increased to 328 registering a growth of 21 per cent. The villages covered by Bus routes were 1329 during pre-project which had risen to 1740 showing a growth rate of 30 per cent. The overall development of Transportation facilities appeared to be satisfactory. The district-wise bifurcation is given in the **Annexure V.17 and Annexure V.18**.

Marketing

5.54 The number of regulated markets were only 70 during pre-project period which have gone up to 153 during post-project period thus, registering a growth of 118 per cent.

Communication

Table 5.28 Growth of Communication Facilities in Command Area							
Sl. No	Particulars	1977-78 Pre Project	2007-08 Post Project	Increase	%		
1	Post Offices	3013	3478	465	15		
2	Telegraph Offices	158	73	-85	-46		
3	PCO's	812	31459	30647	3744		
4	Telephone Connections	50950	659169	608219	1193		

5.55 It may be seen from the table above that the post offices have shown an increase of 15 per cent and the physical number grown to 3478. However, the telegraph offices are reduced during post-project by 46 per cent due to availability of latest alternate technology through mobile phones. The public call offices have enormously increased from 812 to 30647 reflecting a growth rate of 3744 per cent. Like-wise the telephone connections have multiplied significantly as more and more people are using telephones during post project registering a growth rate of 1193 per cent. There is more than satisfactory improvement in communication facilities during post-project.

Electricity

Table 5.29 Comparison of number of villages Electrified in Command Area							
Sl. No	Particulars	1977-78 Pre Project	2007-08 Post Project	Increase	%		
1	Number of villages electrified	6317	15629	9312	95		

5.56 The number of villages electrified had gradually grown since 1977-78. During pre-project only 6317 villages were electrified which had gone up to 15629 during 1980-81. However, the increase is visibly seen between 1980-81 and 2007-08. By the end of 2008 15629 villages were electrified. The percentage of electrified villages to inhabited villages touched 95 per cent showing overall development in these parameters of development (Annexure V.19).

Environmental Measures

5.57 It is already discussed in the earlier paragraphs that the ignorance of the farmers on balanced usage of fertilizers in the command area lead to excessive usage of NPK polluting the ground and surface water.



Effects on Agriculture

Fertilizer Consumption per hectare

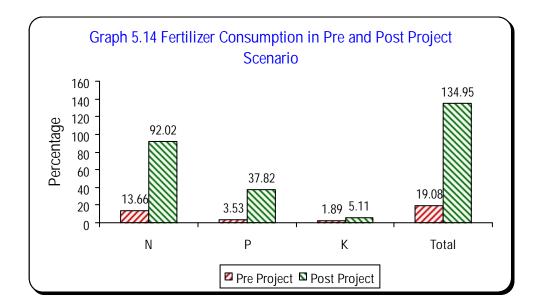
5.58 The following table gives the fertility status of the soils of command area. The soils are found low in nitrogen and phosphorus.

Table 5.30 Total NPK and Organic Carbon Status of Soils							
Soil Group	% of Organic carbon	Total Nitrogen %	Total P2o5 %	Total K ₂ o %			
Average for light texture soils	0.30	0.04	0.18	0.47			
Average for Medium texture soils	0.35	0.05	0.12	0.52			
Average for Heavy texture soils	0.39	0.06	0.16	0.55			
Source: Project report for Ramganga – 1985-90							

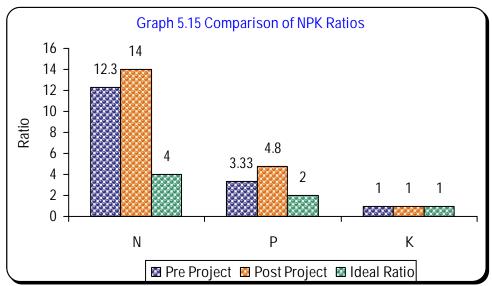
- 5.59 As per the tests conducted by the State Agriculture Department, the poor status of nitrogen is seen both in saline sodic soils which occupy more than a quarter of command area and coarse textured soils which occupy 1/3rd of the geographical area.
- 5.60 The major problem observed in maintaining the soil fertility is the ignorance of farmers in command area about the utility of balanced fertilization as recommended by the department. Once the irrigation potential is increased the tendency of the farmers appeared to be applying heavy doses of NPK than normally recommended.
- 5.61 The enclosed **Annexure V.20** gives the district-wise comparison of fertilizer consumption in pre and post project scenario. The following table gives the average for all districts in regard to fertilizer consumption.

in kg/hectare

g ,								
Table 5.31 Fertilizer Consumption								
D. A. L.	Pre-Project			Post Project				
Particulars	N	P	K	Total	N	P	K	Total
Average for all Districts in Command	13.66	3.53	1.89	19.08	92.02	37.82	5.11	134.95
Refer Annexure V.21								



5.62 It is seen from the above table that in the post-project period the NPK consumption had gone very high. Nitrogen application increased from 13.66 kg/ha to 92.02 kg/ha during this period. Similarly, the usage of phosphorous and potash increased to 37.82 from 5.11 kg/ha and from 3.53 kg and 1.89 kg/ha respectively. A further, comparison of NPK consumption status as given in **Annexure V.20** between 1980-81 and 2007-08 reveals that in all the command area districts the NPK ratio has been very high. During 2007-08 the highest NPK ratio of 39:11:1 is observed in Etah district and lowest ratio of 8:3:1 is seen in Kannuaj and Kaushambi districts. The ideal proportion recommended is 4:2:1 and the chart below indicate that there is a long way to go to reach the ideal level. The department of Agriculture has so far achieved partial success in convincing the farmers to reduce the fertilizer dosages.



5.63 It is a known fact that any fertilizer applied in excess is not absorbed by the plant and is leached out in drainage. This water mixed with fertilizer would pollute the



underground and other water bodies and therefore requires careful management.

- 5.64 The usage of nitrogen during pre-project was 13.66 kgs / ha which has gone up to 92 kgs during post-project. The phosphorous usage, which was 3.53 kgs / ha went up to 37.82 kgs/ha and that of potash to 5.11 kgs from 1.89 kgs. Besides, excessive usage, the ideal proportion of NPK 4:2:1 is also not practiced and the highest ratio of NPK usage touched 29:8:1. The excessive usage as well as imbalanced proportions of NPK has been the cause of pollution of ground and surface water in command area.
- 5.65 The Department of Agriculture had initiated a series of training and awareness programmes to the farmers on the beneficial effects of balanced usage of fertilizers. The programmes included laying down of demonstration plots and training of farmers. The demonstrations in the farmer's fields aimed at carrying proper techniques of balanced fertilization and other package of practices.
- 5.66 The number of villages adopted for this purpose was 3905 and the number of demonstrations planned was 7810 during one year. The per centage of achievement of these programmes physical terms is about 50 per cent. However, these programmes had an impact in changing the mind set of farmers. This is indicated from the NPK ratios in Kannauj (8:3:1) and Kausambi districts as well as in Farrukahbad (10:3:1) and Auriya districts (12:3:1) which are nearing the ideal ratio of 4:2:1. However, intensive efforts are required to reduce the dosages of nitrogen. In this direction effort towards promotion organic farming in lieu of chemical from of fertilizers will also yield the desired results. Simultaneously there is also need to advocate package of practices for each crop in the command area so that the excessive use of NPK are curtailed over a period gradually.

Findings of the Field Study

5.67 The field study in the command area districts was conducted to bring out the impact of the project on the local households. The status of the sample households is studied in comparison with the sample household situated in other command area. The other command area is the area which was receiving irrigation through the old Ganga canal system existing since a few decades before the commissioning of the Ramganga project. The presumption made for this type of study was "the pace of development in the new command under the old Ganga canal systems, which was expanded due to the probability of supplementary irrigation by Ramganga project had caught up with that of the area existing prior to this project". The results of the study revealed that the development in the Ramganga command villages though started late compared to villages in other command area no less inferior in terms of all most all the indicators taken up for study. The primary survey that strengthened the observations made through secondary level of data. The details of the study are presented in the following paragraphs under various indicators of performance.

Size of holdings:

5.68 The study sample consisted of 60 per cent farm households from marginal category 20 per cent from Small and 20 per cent farm households from other categories



in the project area as well as control area. The status of holding size in the Project area and control area is almost identical. Category-wise area operated by farm households in the project area and control area is almost identical (**Table 5.32**)

Table 5.32 Category-wise number of farm households selected and their holdings						
Sl. No.	Category	Proje	ct Area	Contro	Control Area	
SI. NO.	Category	Number	Area (ha.)	Number	Area (ha.)	
1	Marginal	270	0.557	150	0.562	
2	Small	100	1.366	50	1.435	
3	Semi medium	68	2.606	43	2.639	
4	Medium	12	4.613	7	4.592	
	Total	450	1.155	250	1.207	

Source: Field Survey

Note: No farm household large category was available in the sample village

Livestock

5.69 Live stock is not a commercial activity in the surveyed villages. The buffaloes are more preferred for milk purposes in both area (the project area and the control area). The buffaloes are being maintained by majority of the farmers. On an average a household possess two milch animals in both the area. After buffaloes and the cows next preferred animal for domestication is the goats which are sold for meat purposes.

In all the categories of livestock the improved breed is quite less and the details of the various livestock being maintained by the house holds are presented in **Table 5.33**.

5.70 The local breed dominates in the total population. The percentage of improved breed is better in cows than in she buffaloes in project area and the revolve is true in control area as far as improved breed is concerned. Even in calves the local breeds dominates indicating poor or in effective breed improved programs in both the areas, more so in project area.

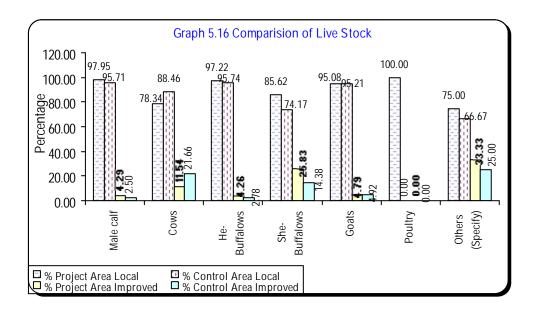
	Table 5.33 Details of Live Stock						
	(Number)						
Sl.	Sl.					ea	
No.	Occupation	Local	Improved	Total	Local	Improved	Total
1	Male calf	143	3 (2.05)	146	67	2 (4 20)	70
1		(97.95)	3 (2.03)	(100.00)	(95.71)	3 (4.29)	(100.00)



	Table 5.33 Details of Live Stock						
							(Number)
Sl.	Occupation	%	% Project Area		% Control Area		ea
No.	Occupation	Local	Improved	Total	Local	Improved	Total
2	Cows	123	34	157	92	12 (11.54)	104
2		(78.34)	(21.66)	(100.00)	(88.46)	12 (11.34)	(100.00)
3	Не-	70	2 (2.78)	72	45	2 (4.26)	47
3	Buffalows	(97.22)	2 (2.76)	(100.00)	(95.74)	2 (4.20)	(100.00)
4	She-	399	67	466	201	70 (25.83)	271
4	Buffalows	(85.62)	(14.38)	(100.00)	(74.17)	10 (23.83)	(100.00)
5	Sheep						
6	Goats	232	12	244	179	9 (4.79)	188
0		(95.08)	(4.92)	(100.00)	(95.21)	9 (4.79)	(100.00)
7	Poultry	15	0 (0.00)	15	0 (0.00)	0 (0.00)	0 (0.00)
/		(100.00)	0 (0.00)	(100.00)	0 (0.00)	0 (0.00)	0 (0.00)
8	Others	6	2	8	8 (66.67)	4 (33.33)	12
0	(Specify)	(75.00)	(25.00)	(100.00)	0 (00.07)	+ (33.33)	(100.00)

Source: Field Survey

Note: - Figures within parenthesis denote percentages



Cropping Pattern

5.71 The cropping pattern in the project area indicates that rice and wheat are the most predominant crops in the project area covering 17.63 and 39.81 per cent of the gross

cropped area. On the other hand the cropping pattern in the control area has bajra and the sorghum(the millets) and wheat as the most prominent crops covering 18.42 and 31.35 per cent of the gross cropped area under the millets(bajra and wheat). Thus the area has millet —wheat based cropping system. The situation indicates that there has been considerable OFD in the project area associated with the expansion of area of the crops which require comparatively more water and the irrigation. Cropping pattern of the Project area and control area is given in **Table 5.34**.

	Table 5.34 Cropping Pattern					
						(percentage)
CI No	Cwar		Projec	ct Area		Control Avec
Sl. No.	Crop	Head	Middle	Tail	Overall	Control Area
1	Paddy	20.2	17.92	14.74	17.63	8.9
2	Juar	3	2.62	1.66	2.43	3.24
3	Bajra	13.02	15.72	16.97	15.22	18.42
4	Maize	2.88	3.77	4.59	3.74	6.76
5	Arhar	2.28	3.02	2.71	2.67	4.33
6	Wheat	39.39	38.82	41.19	39.81	31.35
7	Bareley	0.42	0.44	0.23	0.36	0.41
8	Gram	2.2	1.19	1.6	1.67	3.61
9	Peas	0.19	0.08	0.31	0.19	0.86
10	Rapeseed Mustard	2.27	3.02	4.7	3.33	5.42
11	Other	14.15	13.4	11.3	12.95	16.7
Source F	ield Survey			·		

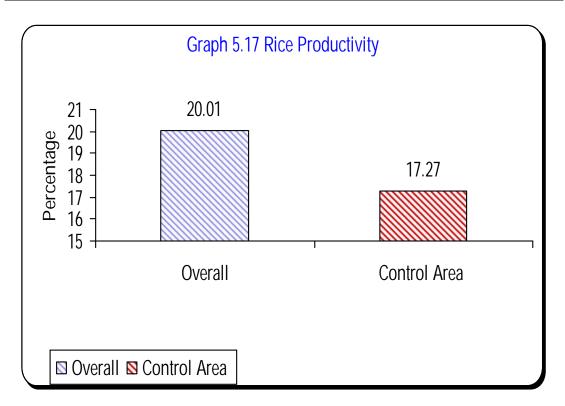
5.72 There is apparent shrinkage of those crops which require less water in the project area. These crops are barley, bajra and sorghum, pulses and oilseeds. Besides the significant increase in the area under rice and wheat crops and decrease in the area of millets, the cropping pattern does not indicate any significant difference in the project and the control area. The findings of the household survey also confirm the cropping pattern of secondary information for the project districts.

Productivity of crops

5.73 As regards the productivity of important crops in the villages of the project area and those in control area except for rice which is 20.01 Q/ha in project against 17.27 Q/ha in control area it does not show any significant difference. It is worth mentioning that after the withdrawal of the project, the transfer of technology is similar to other normal area and the districts are covered for all of the specified schemes with no specific focus on the activities undertaken by the project in the past. Crop-wise productivity is given in **Table 5.35**. The tail-end project area does not project differentiate values because of the supplementary irrigation received through Bore wells and tube wells.



	Table 5.35 Productivity of important crops					
				_	-	(Q/Ha)
Sl. No.	Coor		Projec	et Area		Control Area
S1. 140.	Crop	Head	Middle	Tail	Overall	Control Area
1	Rice	19.89	20.1	20.05	20.01	17.27
2	Bajra	19.41	18.1	18.78	18.74	18.6
3	Maize	17	18.73	20.08	18.83	19.4
4	Arhar	7.58	8.61	7.84	8.05	8.73
5	Wheat	29.37	28.6	26.82	28.24	27.57
6	Barley	21.82	24	20	22.29	20.8
7	Gram	8.9	8.53	7.81	8.46	11.15
8	Rapeseed Mustard	8.27	12.84	14.14	12.39	12.18
Source F	ield Survey					



The Technology Adoption

OFD

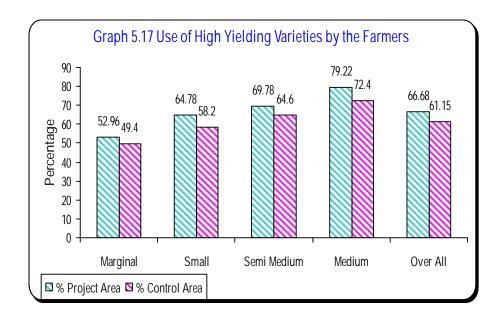
5.74 As a matter of fact the OFD had been the major component of intervention in the command area projects. The household survey did include important information about basic OFD, which are being handled by the farm households. The information collected reveals that about 12 per cent farm households in the project area and 8.62 per cent farm households in the control area do make furrows in their fields for the irrigated crops, which is evident from the **Table 5.36**. The situation needs improvement.

Table 5.36 Formation of Dead Furrows			
Category of farmers	% Project Area	% Control Area	
Marginal	17.62	11.48	
Small	22.00	16.40	
Semi Medium	7.09	6.60	
Medium	0.00	0.00	
Over all	11.68	8.62	
Source Field Survey	1		

Use of high yielding varieties

5.75 It is observed that the adoption of HYV seeds is being done only by the 61.15 per cent farmers of the control area as against 66.68 per cent of the farmers of the project area. The use of HYV seeds of the crop is directly proportional to the size of holdings in both the situations which is evident from **Table 5.37** indicating focus to be accelerated on marginal and small farmers.

Table 5.37 Use of High yielding varieties by the farmers			
Category of farmers	% Project Area	% Control Area	
Marginal	52.96	49.4	
Small	64.78	58.2	
Semi Medium	69.78	64.6	
Medium	79.22	72.4	
Over All	66.68	61.15	
Source Field Survey			





Use of improved seeds

The status of the use of the improved seeds, i.e. the use of certified or the truthfully labeled seed is being adopted by 67.61 per cent of the farmers of the project area as against 64.40 per cent of the farmers of the control area. It shows that there is considerably satisfactory position of the seed replacement ratio of the crops and the seeds are being replaced at least once in a period of five years. In this case also the replacement of seed, i.e. the use of quality seeds increase with the size of holdings of the farmers. Category-wise use of improved seeds by the farmers is presented in **Table 5.38**.

Table 5.38 Use of improved seeds by the farmers			
Category of improve seeds	% Project Area	% Control Area	
Marginal	53.00	52.00	
Small	64.56	61.40	
Semi Medium	71.56	68.80	
Medium	81.33	75.40	
Over all	67.61	64.40	
Source Field Survey			

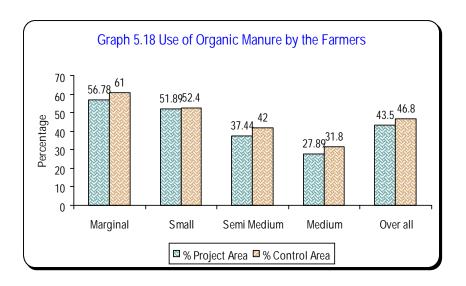
Chemical Fertilizers

The HH survey indicates that all farmers do use chemical fertilizers in their crops. However it is generally used in an arbitatory quantity without the consideration of nutrient requirements by any crop in any particular field. The farmers of the area as on the date do not have access for quick and efficient soil testing facilities in the area. Although the data on the use of individual or specific chemical fertilizers were not captured in the HH survey, it has been observed that the farmers are using more quantity of chemical fertilizers in Paddy and wheat crops only, that too more of nitrogenous fertilizers. There is a need for awareness camps to educate them on reduction of usage of chemical conducting fertilizers.

Organic Manures

The use of organic manures is, although being done by all the farmers, it is being practiced by more than 40 per cent farmers of both the situations. As a matter if fact the trend of use of organic manure under both the situations is much more practiced by the marginal farmers, who, due to their poor purchasing power spend less on chemical fertilizers. The trend of use of organic manures is inversely proportional to the size of holding, which is evident from the data presented in **Table 5.39**. Efforts are needed to promote organic farming practices.

Table 5.39 Use of Organic manure by the farmers			
Holding size group	% Project Area	% Control Area	
Marginal	56.78	61	
Small	51.89	52.4	
Semi Medium	37.44	42	
Medium	27.89	31.8	
Over all	43.5	46.8	
Source Field Survey			

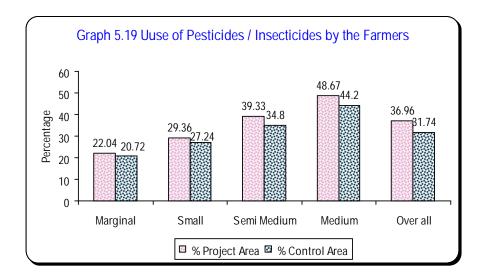


Use of pesticides

5.79 About 37 per cent farmers of project area and 31.74 per cent farmers of control area used pesticides / insecticides. As a matter of fact the use is limited to only rice and wheat and rapeseed mustard crops. The fact is evident from the **Table 5.40**.

Table 5.40 Use of Pesticides / Insecticides by the farmers				
Holding size group Area	% Project Area	% Control Area		
Marginal	22.04	20.72		
Small	29.36	27.24		
Semi Medium	39.33	34.8		
Medium	48.67	44.2		
Over all 36.96 31.74				
Source Field Survey				





5.80 According to the response of the households more of the medium and large farmers do use the pesticides and insecticides as they have not only larger area under cropping but also have multiple cropping that too with more of irrigation under irrigated conditions, these farmers are capable of investing comparatively more for the crop managed. Although the diversification among marginal and small farmers has also been also observed, they avoid using chemicals in their fields, till there is utmost necessity for doing so. No incidence of toxicity in the field due to residues of chemicals was reported during the study in any area.

Farm Mechanization

5.81 According to the households survey very few marginal farmers ever use the machines and other agricultural equipments and the situation is almost identical in both the situations, i.e. project area and the control area. The tend of mechanization increases with the size of holding as presented in the **Table 5.41**

Table 5.41 Adoption of mechanization by the farmers				
Holding size group Area	% Project Area	% Control Area		
Marginal	8.00	7.60		
Small	22.67	20.40		
Semi Medium	40.00	38.20		
Medium	54.11	52.40		
Over all	31.19	30.15		
Source: Field Survey				

5.82 On the basis of this survey it was observed that most common use of the agriculture machines and equipments are the use of the tractors for field preparations and the threshers for the threshing of wheat. Some of the medium and large farmers do use combined harvesters for the harvest of the wheat and paddy crops. Only 4 per cent farm household of the project area and 3.20 per cent farm household in the control area had the tractor. The details of agriculture implements are given in **Table 5.42**.

	Table 5.42 Details of Agriculture implements			
			(Numbers)	
Sl. No.	Particulars	Project Area	Control Area	
1	Tractor	18 (4.00)	8 (3.20)	
2	Power tiller	14 (3.11)	4 (1.60)	
3	Tiller	15 (3.33)	8 (3.20)	
4	Sprayer	6 (1.33)	2 (0.80)	
5	Yolk	9 (2.00)	3 (1.20)	
6	De-Corticator	0 (0.00)	0 (0.00)	
7	Harvester	3 (0.67)	2 (0.80)	
8	Duster	0 (0.00)	1 (0.40)	
9	Bullock Cart	4 (0.89)	9 (3.60)	
10	Others	0 (0.00)	0 (0.00)	
Source:	Source: Field Survey			
Note: - H	Figures within par	enthesis denote per	centages	

Adoption of Inter Cropping

5.83 Almost all the farmers in the area are cultivating the solo crops and the mixing of multiple or with other crops is minimum and to some extent it can be said to be negligible. Whatever intercropping with other main crops is being done, it can be seen only during Kharif (Rainy season) crops. Another significant observation is that the inter cropping is comparatively more being practiced in the control area. The most important crop for mixing in the area is the Red Gram (Arhar) with the less water loving crops like millets (sorghum and bajra) and the maize. Incidentally most of this area is mono cropped where only cultivation can be done only during Kharif. After the harvest of the main Kharif crops the red gram crop continues to remain in the field during Rabi season. This fact can be assessed by the **Table 5.43**.

Table 5.43 Adoption of inter cropping					
Crop mix % Project Area % Contro					
Juar + Redgram	5.95	9.50			
Bajra + Redgram	0.17	0.00			
Maize + Redgram	0.86	0.00			
Source: Field Survey					

Disposal of the produce

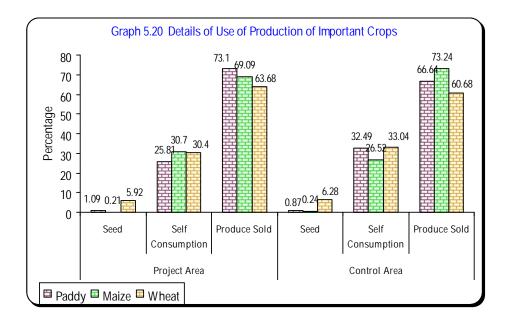
5.84 The area is the food surplus one and under both the situations farmers dispose more than 50 per cent of the produce either in the markets to or through commission agents or to other consumers directly. The agriculture marketing system is yet to be strengthened in both the environments (Project and the command) and less than 50 per centage villages have the market yards within the village or less than one km away. Many farmers keep some of the produce for the seed purpose but the quantity of such seed material has been found at a very low level, which ranges from 0.2 per cent for maize



Effects on Agriculture

(the minimum to around six per cent of the total produce for wheat and the pea (maximum). In control area slightly higher per cent of the produce is kept reserved for the seed purpose. Even than the extent of storage for seed purpose is still very low. These facts confirm that the farmers usually try to procure seed every year in large per cent. The details of use of production of important crops are given in **Table 5.44**.

Project Are Self Consumption 25.81 30.70 30.46 73.98 26.83	Produce Sold 73.10 69.09 68.53 25.53 70.70	Seed 0.87 0.24 0.90 0.97	Control Area Self Consumption 32.49 26.52 32.37 57.15	Produce Sold 66.64 73.24 66.73 41.88				
Consumption 25.81 30.70 30.46 73.98	Sold 73.10 69.09 68.53 25.53	0.87 0.24 0.90 0.97	Consumption 32.49 26.52 32.37 57.15	Sold 66.64 73.24 66.73				
30.70 30.46 73.98	69.09 68.53 25.53	0.24 0.90 0.97	26.52 32.37 57.15	73.24 66.73				
30.46 73.98	68.53 25.53	0.90 0.97	32.37 57.15	66.73				
73.98	25.53	0.97	57.15					
				41.88				
26.83	70.70	7 1 4						
	, 5.70	7.14	41.56	51.30				
33.05	63.56	3.16	28.42	68.42				
29.38	66.63	3.36	29.02	67.62				
30.40	63.68	6.28	33.04	60.68				
48.72	51.28	1.07	47.87	51.06				
25.55	67.66	5.26	22.37	72.37				
22.78	70.83	4.42	16.24	79.34				
33.72	65.59	0.16	23.70	76.14				
Gram 6.79 25.55 67.66 5.26 22.37 72.37 Peas 6.39 22.78 70.83 4.42 16.24 79.34 Ranseed 8.39 22.78 70.83 4.42 16.24 79.34								



Irrigation

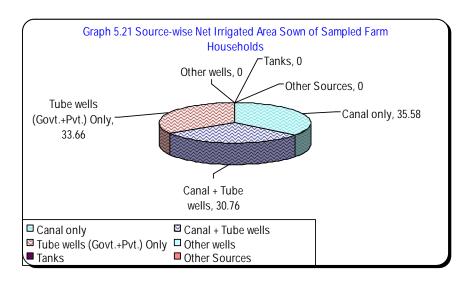
5.85 It would be evident from Table 4.14 that about 52 per cent area was being irrigated by tube wells in the project area. The canals alone contribute to only 20 per cent



of the entire irrigated area. Thus 47.42 per cent of the net irrigated area receives the canal water. In the control area 97.55 per cent area was being irrigated by tube wells.

5.93 As regards conjunctive use of the irrigation it is apparently successful only in the head and middle reaches of the canal. In the tail ends the dependency of irrigation is mostly on ground water. These facts are detailed in the **Table 5.45**.

Table 5.45 Source-wise net irrigated area sown of sampled farm households					
	T			(1)	Percentages)
Source		Proje	Control Area		
Source	Head	Middle	Tail	Over all	Control Area
Canal only	35.58	22.28	1.50	20.00	Not applicable
Canal + Tube wells	30.76	31.23	20.09	27.42	Not applicable
Tube wells (Govt.+Pvt.) Only	33.66	45.66	78.25	52.26	97.55
Other wells	0.00	0.83	0.00	0.27	0.61
Tanks	0.00	0.00	0.16	0.05	0.00
Other Sources	0.00	0.00	0.00	0.00	1.84
Source: Field Survey					

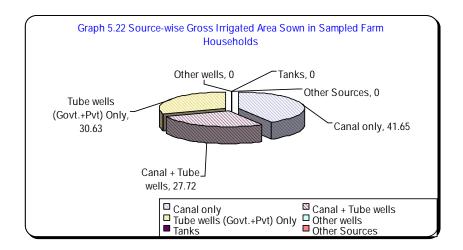


5.86 The situation regarding the gross irrigated area is also identical to the net irrigated area, where the pattern of the share of various irrigation resources is almost similar to the net irrigated area. The fact is detailed in **Table 5.46** for all the reaches of the canal command area and the control area both.

Table 5.46 Source-wise gross irrigated area sown of sampled farm households						
(Percentages)						
Course		Proje	Control Area			
Source	Head	Middle	Tail	Over all	Control Area	
Canal only	41.65 25.34		3.27	23.87	Not applicable	
Canal + Tube wells 27.72 30.15 21.46 26.55 Not application						



Table 5.46 Source-wise gross irrigated area sown of sampled farm households (Percentages)							
Project Area							
Source	Head	Middle	Tail	Over all	Control Area		
Tube wells (Govt.+Pvt) Only	30.63	43.74	75.07	49.25	98.32		
Other wells	0.00	0.77	0.00	0.26	0.56		
Tanks	0.00	0.00	0.20	0.07	0.00		
Other Sources 0.00 0.00 0.00 1.12							
Source: Field Survey			,				



The Groundwater

5.87 The ground water is depleting under both the situations (Project area and Control area). It is much more sever in the non control area. It is almost 9.2 Meters' below the ground level even during November to February, the period immediately after the rainy season and prior to the summers in the non command area (the control area). The extent of depletion in the ground water level compared to the rainy season is almost 13.23 Per cent in the project area as compared to 24 per cent in the control area. The details are presented in the **Table 5.47**

	Table 5.47 Average Ground water level in wells in the sampled villages						
			(Depth in mts)				
Sl. No. Duration Project Area Control Area							
1	March to may (Summer)	15.64	22.08				
2 June to October (Monsoon) 11.81 17.79							
3 November to February (Post Monsoon) 13.48 19.52							
Source F	Source Field Survey						

Water user groups

5.88 Water user group were not Constituted in any sampled village of the project area. As a matter of fact the PIM Act could be enacted in the state only during 2009 and is

being implemented in selected parts of the Shards Sahayak Canal System as a pilot in the state. The PIM Act has a provision of formation of the Kolaba (outlet) committees and the WUA's on each canal to maintain and manage the system and the water distribution. They are also expected to preplan prepare the cropping plan and the irrigation water needs during each season for the command of each kolaba and the minor. The water distribution schedules (Osranadi) are now days prepared by the UPID in consultation with the local farmers and the extension agencies, but the process has been only mere formality. The PIM Act provides the authority to the WUA's to work out their own osrabandi. Nevertheless the farmers in the area are not aware of the details of the ACT.

Measures taken to control contamination of ground & surface water due to fertilizers, pesticides, runoff, etc.,

The surface and groundwater in command area of the irrigation projects are 5.89 subjected to contamination due to excessive use of fertilizers and use of pesticides in the fields. The fertilizers and pesticides that are unabsorbed by the plants get mixed up with irrigation water. The poor drainage facilities in the fields makes the stagnated water infiltrate in to the ground polluting the groundwater table. The rich plant nutrients especially nitrogen and phosphorus cause 'eutrophication' of surface water some of the harmful effects of which are increase in production of alage and macrophytes, production of toxins by certain algae, infilling and clogging of irrigation canals with aquatic weeds, and noxious odour from decaying algae; and killing of fish. Surface water and the groundwater are being contaminated by heavy metals and high concentrations of these substances pose a threat even to the health of man and animals. Secondly use of pesticides which include herbicides, insecticides, fungicides, nematocides and rodenticides in high quantities cause damage to the loss of bio-diversity by threatening the eco-system. The toxic effects of pesticides are shown on the human and animal health when contaminated water is consumed by them. The control measures require a wide variety of initiatives through the implementation of soil and water conservation schemes on project basis as well as at the individual farmer's field level.

Reclamation of Sodic Soils

5.90 In this context Uttar Pradesh government has been taking up several measures one of which is the reclamation of sodic soils. This is one of the major initiatives taken up in the command area districts of Ramganga project with the help of EEC and World Bank. The Uttar Pradesh Sodic Lands (UPSL) reclamation project-I covered Aligah, Allahabad, Etah, Etawah, Fatepur and Mainpuri. The project was implemented from June 1993 to March 2001 covering an area of 68800 hectares. Through this project 250 km of Link drain, and 5570 km of field drains were constructed benefiting nearly 1.47 lakh small farmers. The second project on sodic reclamation covered Aligarh, Allahabad, Auriya, Bulandsahar, Etah, Etawah, Fatepur, Hathars, Kanpur, Kanpur Dehat, Mainpuri, covering about 1.50 lakh hectares of sodic land. This project was implemented from April 1999 to September 2007. The project components included on farm development and land treatment, improvement of drainage system benefiting about 1.33 lakh of small farmers and 24 thousand large farmers.



5.91 Likewise the Uttar Pradesh government also implemented sodic lands reclamation III. Project covering Allahabad, Aligarh, Auirya, Etah, Etawah, Farrukhabad, Fatepur, Firozabad, Kannauj, Kanpur Dehat & Nagar, Kaushambi and Mainpuri besides, other districts. Through this, it is estimated that 3.25 lakh farmers would get benefited.

Bhumi-Sena Yojana

5.92 The project having a duration of 3 years from 2005 to 2008 was executed in 17 districts with the main objective of treatment of water logged areas through proper drainage systems and development of banjar land. Under this scheme the sodic soils and water logged soils are treated to improve productivity and thereby incomes of farmers. It involved the community by formation of Bhumi Sena as an organized, disciplined and active force who were given training in land and water management, water harvesting, minor irrigation, etc.,

On-Farm Development Works

5.93 Poor drainage results in rise of groundwater table contaminated with excess fertilizers and pesticides. It also leads to water logging and salinization due to clogged canals. Ramganga project authorities had taken up soil specific on-farm development works in the command area. It was identified that atleast 100 blocks require proper drainage. Soil and topographical surveys were conducted in the command area to classify the type of land and type of treatment required. The soil survey was conducted in 4,36,0000 ha. Earthen irrigation channels to an extent of 1,99,607 km were constructed in the command area. Lining work was completed in about 19393 km till 2007-2008. Field drains which are essential to drain the excess water contaminated with pesticides was completed in about 9728 km. Water control structures in the shape of outlets, chutes, drops and siphons and culverts were developed and about 360997 such structures were provided. The construction of field drains effectively solved the water logging problems in the area. For restoration of saline and alkaline soils, supply of soil amendments like gypsum on subsidized basis was provided.

Conjunctive Use of Water

5.94 The project envisaged conjunctive use of water to control salinization. The irrigation planning was based on 60 per cent surface water and 40 per cent groundwater utilization. This would prevent secondary salinization and also control water logging in the fields. However, maintenance of the canals needs special attention especially after withdrawal of the project.

Balanced Use of Fertilize

5.95 Excessive use of fertilizers by the farmers in the command area badly affects the environment. It is seen that the farmers use excess nitrogen, phosphorus and potash and does not follow recommended doses. Therefore, the department of agriculture initiated a series of trainings and awareness programmes to the farmers on balanced use of

fertilizers and rational use of pesticides. Demonstration plots were laid in each village and farmer field schools were conducted in more than 4000 villages in command area. Organic farming is also promoted in select pockets to reduce consumption of chemical fertilizers.

Use Pesticides

- 5.96 During mid 1980 the pesticide consumption in the state was only 6600 M.T, it was the period when there used to be immense damage to the crops due to pests & diseases. The government started providing 50% subsidy on the cost of the chemicals and the pesticides during mid nineties; as a result the pesticide consumption rose to the level of 40,000 tons.
- 5.97 However no incidence of pesticide residues in the water were reported any where in the state. On the contrary some pesticides residues were observed in fruits, vegetables, & mustard, but not in water. On the other hand, there were observations regarding development of resistance in insect/pests for the chemicals used.
- 5.98 To combat this situation, Government of U.P. has launched massive programme of integrated pest-management (IPM) and also reduced the level of subsidy on the chemical pesticides from 50 % to 25% only. This step gave encouraging results and the pesticide consumption in the state, despite the increased gross cultivated area, came down to 13000 tons during 1995-96.
- 5.99 To encourage ecofriendly farming and mitigate the expected environmental pollution and the hazards, the IPM is being implemented as a major scheme and all the schemes of crop production in all the districts contain this aspect as a major component. The farmers are being provided with the bio pesticides and the bio agents at a subsidy of 90 per cent. It is reiterated that so far no incidence of residue of farm chemicals in irrigation or drinking water have been reported in the state

Chemical Fertilizers

5.100 For the purpose of appropriate application of the crop nutrients in the soil, already extensive training and education programme are being conducted by the government at district and the state level. For soil testing, there are 73 static soil testing labs in the state. 5.101 All the districts of the command area have at least one government soil testing lab where soil testing is done on a subsidized rate of Rs 7.00 per sample for all the major nutrients and Rs 30.00 per sample for the micronutrients.

Like the IPM, the government is now encouraging the appropriate nutrient management practices by adopting the integrated plant nutrient management (IPNM).

5.102 IPNM programme in the state aims at consolidating and coordinating the efforts of various agencies participating in the agricultural extension as the prime focus on balanced and only adequate nutrient use with appropriate supplementation by bio



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fertilizers and bio agents.

5.103 In UP the use of chemical fertilizer has not been excessive and is significantly very low in comparison to Punjab & Hariyana. Although it increased from a level of 4 kg/ha in mid 60's to 78 kg/ha in mid nineties and 103 kg/ha in 1995-96 it was much below the level of chemical fertilizer usage in neighbouring states of Hariyana (122Kg/ha.) and Punjab (170 Kg/ha) during those days.

Govt. of U.P. has started intensive & extensive training of farmers on following aspects:-

- 1. Soil testing & checking soil health with reference to the selected crop to be grown.
- 2. Use of only. balanced dose of fertilizers
- 3. The placement and timings of fertilizers-The farmers are advised to distribute the fertilizers usage in the crop for 3 to 4 applications instead of single application of entire quantity (Specially nitrogen-which is maximum in use & can pollute water as well)
- 4. The bio fertilizers are provided to the farmers at subsidized rates. On the other hand the seeds of green manuring crops like *Dhaincha* are being distributed to the farmers in all the districts of the state as well as in the districts of Ramganga command.
- 5.104 Under the programme of National Watershed Management efforts have been put in & steps taken to check the run off. It also helps in checking the farm residues to pollute the surface & ground water. There has not been any incidence of the water pollution due to fertilizer application in the state. The farmers are given extensive and the intensive training for controlling the run off of the field water by implementing the schemes like Integrated Watershed Management scheme, farmers' field schools, trainings and the demonstrations.

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6

Impact on Groundwater





IMPACT ON GROUNDWATER

Introduction

6.01 The sources of recharge to groundwater system include both natural and humaninduced phenomena. Natural sources include recharge from precipitation, lakes, ponds, rivers and other aquifers. Human induced sources of recharge include irrigation losses from canals and fields, leaking water mains, sewers, area irrigation of parks and gardens and other public amenities¹. The quantification of the rate of natural and human induced groundwater recharge is a pre-requisite for efficient groundwater resource management. Extensive research is available for qualification of groundwater recharge both due to natural and human induced systems² at macro-levels. In this chapter an attempt is made to assess the impact of Ramganga project on groundwater regim of the command area of the project. An attempt is also made to assess the quality of surface water and groundwater in the command area of the project. The conjunctive use of surface and groundwater in the command area of Ramganga is also analysed in this chapter. Further, the scope for development of groundwater and consequent increase in area irrigated is also analysed in this chapter. The main topics covered in this chapter are as follows:

- Groundwater scenario in Uttar Pradesh
- Quality of Ramganga Water
- Quality of Groundwater in command area
- Groundwater levels in command area
- Stage of Groundwater Department in command area
- Scope for Conjunctive use of Surface and Groundwater in the project area.

Groundwater Scenario in Uttar Pradesh

The geographical area of U.P. is 2,40,927 sq km with a population of 166.15 million (2001 census). Uttar Pradesh being the most populous state of the country faces

² R S Chaturvedi., "A Note on the Investigation of Groundwater Resources in Western Districts of Uttar Pradesh" Annual Report, U. P. Irrigation Research Institute, 1973, pp. 86-122, "Ground Water Estimation Methodology". Report of the Ground Water Estimation Committee, Ministry of Irrigation, Government of India, New Delhi, March 1984, 39 pp., "Ground Water Resource Estimation Methodology - 1997". Report of the Ground Water Resource Estimation Committee, Ministry of Water Resources, Government of India, New Delhi, June 1997., C P Kumar and P V Seethapathi, "Effect of Additional Surface Irrigation Supply on Ground Water Regime in Upper Ganga Canal Command Area, Part I - Ground Water Balance". National Institute of Hydrology, Case Study Report No. CS-10 (Secret/Restricted), 1987-88



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¹ Sophocleous M., (2004), GROUNDWATER RECHARGE, in *Groundwater*, [Eds. Luis Silveira, Stefan Wohnlich, and Eduardo J. Usunoff], in Encyclopedia of Life Support Systems (EOLSS), Developed under the Auspices of the UNESCO, Eolss Publishers, Oxford, UK, [http://www.eolss.net]

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problems like decline in water level, water logging conditions and ground water pollution. Therefore, it is imperative to plan the development of ground water in more scientific and planned manner for its economic utilisation without creating any environmental hazard.

Hydro Geological Set Up

- 6.03 Uttar Pradesh state is divided into four hydro geomorphic units. The hydro geomorphic characters of various units of U.P. are discussed briefly in following paragraphs.
- 6.04 Bhabher and Tarai: A thin stretch of Bhabher occurs south of Sub-Himalayan zone. To the south of Bhabher, Tarai belt of variable width (8-15 km) runs from northwest to south-east. Here, swampy conditions are found due to shallow ground water and spring line with fine-grained fluvial sediments. The ground water occurs under unconfined state in shallow zone, while the deeper aquifers below 50m depth are under confinement. Auto flow conditions are common in the belt.
- 6.05 Central Ganga Plain: This hydro geological unit is confined between Tarai zone in the north and marginal alluvial plain in the south. The Ganga Plain is characterized by low relief and enormous fluvial features. The general slope of the zone is to the south in upper reaches and south-east in the lower reaches. The average slope ranges from 15 to 50 cm/km. The shifting of rivers has been a common phenomenon. The rivers have degraded their own plain carving a new one. The extensive high land between the two rivers forms the older alluvial plains while the younger alluvial plain are confined to present day drainage network. Extensive exploration studies have indicated the presence of four aguifer groups within a depth of 700m below ground. The first shallow phreatic aquifer, within 50m depth is being utilised by the marginal farmers to construct tube wells / bore wells. The ground water is present under confined to semi-confined state in shallow aguifer while in the deeper aguifer, it occurs under confined state. The second aquifer, which occurs between the depths of 50 to 200m, is being extensively exploited to fulfill the irrigational need.
- 6.06 Marginal Alluvial Plain: All along the northern border of southern Plateau Region lies the marginal alluvial plain, spread over in parts of Mathura, Agra, Etawah, Jalaun, Hamirpur, Banda, Allahabad and Mirzapur districts. This zone constitutes the alluvial sediments brought down by northerly flowing rivers originating from the Plateau Region. The thickness of marginal alluvial plain is variable ranging from 50 to 200m. It comprises admixture of Kankar and clay with sand and gravel lenses. Ground water occurs under water table and semi-confined conditions. The marginal alluvial aquifer is capable of yielding 60-1500 lpm of fresh water at a draw down of 6 to 15m. The ground water quality poses a problem in localized patches.
- Southern Plateau Region: The region occupies extreme southern part of the state and is characterized by table I and punctuated with variety of land forms. The region is



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underlain mostly by Vindhyan sediments. The Precambrian crystalline are exposed over Betwa Basin. The ground water mostly occurs in the secondary porosity of hard rocks under unconfined state. The alluvial sediments occupy the existing valleys. The ground water in alluvial sediments occurs under unconfined state. Ground water prospects are rather low.

Ground Water Levels

- 6.08 Depth to water in any area is of great significance in deciding drilling depths, selection of pumping devices, crops to be grown and deciding areas for ground water storage/artificial recharge. The indiscriminate exploitation of ground water has led to depletion of storage and lowering of water levels in many parts on one hand and rise in water levels to critical limits on the other hand in parts of certain Canal Command areas. The management of ground water storage thus becomes essential to avoid any adverse impact. The Central Ground Water Board have established more than 1200 key observation wells as permanent hydrograph stations to monitor both the ground water quality and change in storage. The behavior of water table is observed four times i.e. January, May, August and November every year.
- 6.09 The water levels in Uttar Pradesh show a wide variation from less than 2 mbgl to more than 30 mbgl. In Bhabher area, the depth to water level varies from 8 to 35 mbgl., while in Tarai, it ranges from less than 2 to 10 mbgl. The central and eastern parts of the state shows a wider range of water levels varying from less than 2 mbgl as observed in Sharda Sahayak Canal Command area to more than 20 mbgl along the natural levees formed on either side of river Ganga. The water levels in southern parts (Plateau Region) vary from 2 to 30 mbgl. The deepest water levels are encountered in the ravinous tracts along the Yamuna and Betwa rivers in Hamirpur, Jalaun, Banda, Allahabad and Jhansi districts.
- 6.10 The western parts of Uttar Pradesh are characterized by deeper water levels ranging from 8 to more than 30 mbgl, as noticed in most of the districts. The water levels have shown significant declining trends over the last two decades due to over exploitation of the ground water resource.

Water Level Trends

6.11 Over exploitation of ground water, especially in western parts of Uttar Pradesh has led to decline in water levels over the past few years. The State Ground Water Department has categorized the blocks on the basis of level of development of ground water and water level trends. Out of 22 over exploited and critical blocks, 19 blocks are located in western parts of the state in districts of Agra, Aligarh, Baghpat, Bareilly, Badaun, Etah, Farrukhabad, Ferozabad, Jyotibaphulenagar, Moradabad and Saharanpur. The water level declining trends in these blocks are about 30 to 55 cm/year in either pre or post monsoon period or both. Out of 53 semi-critical blocks, 28 are located in western U.P. On the other hand, in the Canal Command areas, the water logging and related problems like salinization & degradation of soils are posing a threat.



Ground Water Resource Potential

- 6.12 As per the National Water Policy, development of ground water resources is to be limited to utilization of the renewable part of the naturally occurring ground water available in sub-surface domain. The present development policy, obviously forbids utilization of the secular reserve to prevent ground water mining. Precise assessment of replenishable ground water resources and its development in terms of area which can be irrigated in the framework of land availability, cropping pattern, etc. is, therefore, key to our plans to develop groundwater resources for various uses. The complexities of processes governing occurrence and movement of groundwater make the problem of ground water assessment somewhat difficult, as not only vast volume of data is required to be collected but also many disciplines of science have to be involved in a co-ordinated manner.
- 6.13 As a joint venture of the Central Ground Water Board and the Ground Water Department, U.P. have estimated replenish able ground water potential on district-wise basis, based on GEC 1997 Methodology and the estimates for U.P. The total groundwater availability in the state is assessed to be 8.08 million ham. The groundwater draft as per latest estimates (2007) is assessed to be 4.23 million ham. This draft accounts for about 52.32 per cent of total groundwater availability in the state. There are wide variations in the groundwater availability across the districts. The highest groundwater availability 0.31 million ha was in Lakshmipur district and the same was lowest at 0.036 million ham in Chitrakut district. The distribution of districts according to level of groundwater availability is presented in **Table 6.1**

Table 6.1 Distribution of District According to Groundwater Availability in UP (2004)					
Size Range (ham)	% in Total				
Up to 50000	3	4.29			
50001 - 100000	27	38.57			
100000 - 150000	25	35.71			
150000 - 200000	12	17.14			
200000 - 250000	0	0.00			
250000 - above	3	4.29			
Total	70	100.00			

- 6.14 The groundwater availability was over 250 thousand ham in three districts of Uttar Pradesh. They area Barabhanki, Lakhimpur Kheri and Sitapur. Two of these three districts viz., Barabhanki and Sitapur are in Central Uttar Pradesh Region and are outside the command of Ramganga. There are three districts viz., Chitrakut, Mahoba and Sant Ravi Das Nagar that have less than 50 thousand ham of groundwater availability. Two of these three districts are in Bundelkhand region, wherein the groundwater development is less than 50 per cent of available groundwater.
- 6.15 The groundwater draft as 2004 statistics was in the range of 50-100 thousand ham for majority (48.57%) of the districts in the state. There were only seven districts (10% of

total) where in the groundwater draft was over 100 thousand ham. On the other hand there were two districts viz., chitrakut and Mahoba wherein the groundwater draft was less than 10 thousand ham. Incidentally, both of these districts are in Bundelkhand region of UP (**Table 6.2**). At the state level about 53.32 per cent of available groundwater is developed for various uses. The distribution of districts according to the level of groundwater is presented in **Table 6.3**. The district-wise groundwater availability and draft are indicated in **Annexure VI.1**.

Table 6.2 Distribution of Districts According to Groundwater Draft in Uttar Pradesh (2004)					
Size Range (000 ham)	No. of Dist	% in Total			
Up to 10	2	2.86			
10-40	20	28.57			
40-50	7	10.00			
50-100	34	48.57			
100-130	6	8.57			
130-160	1	1.43			
Total	70	100.00			

Table 6.3 Distribution of Districts According to Groundwater of Draft in Total Availability Percentage					
Size Range	No. of Dist	% in Total			
Upto 25	11	15.71			
25 – 45	11	15.71			
45-65	33	47.14			
65-85	14	20.00			
85 above	1	1.43			
Total	70	100.00			

Need for Artificial Recharge

- 6.16 The natural ground water resources are depleting day-by-day with growing population coupled with increasing industrial and agricultural needs. Hydrograph Network Stations of CGWB have recorded a noticeable decline of ground water level of the order of 0.10 m/yr in many parts of U.P., particularly in western U.P., during last two decades.
- 6.17 The ground water levels are declining much faster in major urban settlements. Some areas of the state where poor quality of ground water is reported, needs special attention.
- 6.18 Any withdrawal of ground water from aquifers creates empty space, which is refilled during wet season in natural ecological setup. Excessive exploitation of ground water leaves larger spaces, part of which remains unfilled and lead to irreversible decline of ground water levels. Such spaces can be utilized to fill up through artificial recharge system to replenish ground water resources.
- 6.19 Ruthless deforestation and modification of hill slopes in catchment areas, have adversely affected the hydrological cycle of the region. Increased surface run off leaves little scope of infiltration in the watersheds, resulting in floods in down stream areas.



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Artificial recharge can be introduced in such watersheds to improve infiltration for the augmentation of ground water in hilly regions.

Quality o Ramganga Water

- 6.20 The Ramganga River originates in the outer Himalayas in Chamoli district of Uttarkhand. The river after flowing 125 km through hilly terrains emerges into plains at Kalagarh and finally joints River Ganga near Farrukhabad. The discharge of the river varies from 10,000 cumecs during monsoon to 5 cumecs during summer. Due to the typical pattern of rainfall being restricted to only 3 months during a year in the basin, the dry season flow in the River Ramganga is only a fraction of the total annual flow. Such low discharge rates call for extreme precaution and control of water pollution, during dry period in particular. It may be observed that in the upper stretch of the river. The natural flow is not affected since there are no hydro-electric or major irrigation projects on the river till it reaches Ramganga dam.
- 6.21 As per the survey and analysis of data by UP Irrigation Research Institute, Roorkee and Ganges Hydrological observation circle, CWC Varanasi, it was reported that the water quality in River Ramganga was quite satisfactory for promoting aquatic life and irrigation. Further, it was also reported that the water from Ramganga reservoir andriver water in the downstream of Kalagarh can be used for drinking purposes after nominal water treatment works³.
- 6.22 River plays an important role in the development of a nation and sustenance of life. They are being polluted due to speedy urbanization, industrialization and other developmental activities. Mohammad Alam and J.K. Pathank (2010)⁴ developed Water Quality Index (WQI) in terms of pollution level and quality of water of River Ramganga and studied the water quality of the river downstream of Kalagarh dam. This water quality index is based on eight physic-chemical parameters viz., pH, Biological Oxygen Demand, Dissolved Oxygen, Total Alkalinity, Total Hardness, Total Solids, Total Suspended Solids and Chloride. The river water was classified into permissible, slight, moderate and severs on the basis of pollution load at six sampling locations selected from downstream side of Kalagarh dam. The water of upstream side sampling stations was found to be between slight to permissible range of pollution while downstream sampling stations were extremely polluted. High pollution load in the downstream was observed to have been caused by the effluent drainage from sugar industry as well as electroplating units of brass industries located in Moradabad.

⁴ Mohammad Alam and JK Pathak, "Rapid Assessment of Water Quality Index of Ramganga River, Western Uttar Pradesh (India) using a computer programme Nature and Sciences, No.8, Vol.11 2010



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³ R.S.Goel, "Environmental Impacts of Ramganga Multi-Purpose Dam Project: A Case study" in Kamta Prasad and R.S. Goel (edit), Environmental Management in Hydro Electric Projects: Proceedings of the National Seminar Held at India International Centre, (New Delhi: Concept Publishing Company), 2000 P.159.

- 6.23 Further, it is observed that the pollution load in the stretch of River (Between Ramganga Dam and Moradabad or Farrukhabad) is very high during summer season mainly in view of the absence minimum ecological flows during the season. Discussions with the officials of Irrigation Department of UP indicated that no releases from Ramganga dam are taking place during lean season i.e., summer to take care of minimum ecological flows. This has aggravated the pollution of river water in the above cited stretches particularly during summer season.
- 6.24 The water quality analysis of Ramganga river water at three locations i.e., upstream of dam at the dam site and downstream of dams are presented in **Table 6.4**. Limits as per IS:10500 (1991) for drinking water are also presented for most of the parameters in this table. The water quality of Ramganga River, particularly at dam site and upstream of dam site are well within limits as per IS:10500 (1991) for drinking water. It is also observed that the water quality of river deteriorated downstream of the dam site mainly because of letting out the effluents of towns into the river without proper treatment.

	Table 6.4 Water Quality Analysis of Ramganga River During Post Monsoon Period 2009						
SI.	Parameter	Units	Sample I Surface water at upstream of Reservoir	Sample II Surface water at Reservoir	Sample III Surface water at Narora	Limits as per IS:10500 (1991) for Drinking Water	
1	рН		7.77	7.37	7.76	6.5-8.5	
2	EC	Micro mhos/ cm	162	134	324	1500/2000	
3	Dissolved Solids	Ppm	6.2	10.3	7.76	500 max	
4	Total Suspended solids	Mg/l	332	79	227.4	-	
5	Turbidity	NTU	2.0	2.5	10.2	5 max	
6	Total Hardness as CaCo ₃	Mg/l	20.8	57	143.2	300 max	
7	Alkalinity to phenolphthalin as Co ₃	Mg/l	Nil	Nil	Nil	200 max	
8	Allkalinity to methyl orange as Ca Co3	Mg/l	20.63	55	169.3	200 max	
9	Non carbonate hardness as CaCo3	Mg/l	10	20	24	-	
10	Calcium as Ca	Mg/l	15.8	21	103.6	75 max	
11	Magnesium as Mg	Mg/l	5.0	1	39.6	30 max	
12	Sodium as Na	Mg/l	4	4	19.2	-	
13	Potassium as K	Mg/l	1.1	1.8	5.2	-	
14	Chlorides as Cl	Mg/l	12	14	19.2	250 max	
15	Sulphates as So4	Mg/l	32.6	32.0	36.9	200 max	
16	Nitrates as No3	Mg/l	0.48	0.68	0.76	45 max	
17	Fluorides as F	Mg/l	0.16	0.10	0.12	1.50 max	
18	Phosphorous as P	Mg/l	0.02	0.02	0.09	-	
19	Manganese as Mn	Mg/l	0.001	0.002	0.004	0.05 max	
20	Iron as Fe	Mg/l	0.001	0.002	0.002	0.3 max	



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	Table 6.4 Water Quality Analysis of Ramganga River During Post Monsoon Period 2009						
Sl.	Parameter	Units	Sample I Surface water at upstream of Reservoir	Sample II Surface water at Reservoir	Sample III Surface water at Narora	Limits as per IS:10500 (1991) for Drinking Water	
21	Chromium as Cr	Mg/l	< 0.001	< 0.001	< 0.001	0.1 max	
22	Boron as B	Mg/l	< 0.001	< 0.001	0.001	1.0 max	
23	Zinc as Zn	Mg/l	< 0.001	< 0.001	0.004	5.0 max	
24	Copper as Cu	Mg/l	< 0.001	< 0.001	0.002	0.5 max	
25	Lead as Pb	Mg/l	< 0.001	< 0.001	0.003	0.1 max	
26	BOD (5 day at 25°C)	Mg/l	1.2	1.6	2.0	30.0 max	
27	SAR	-				_	
28	Dissolved Oxygen Demand	Mg/l	8.9	8.0	9.2	_	
29	Total Coliform	MPN/100 ml	1434	1413	4267	50	
30	Faecal coliform (Escherichia coli)	MPN/100 ml	463	510	1852	-	
Sou	rce: Based on the Lab reports for	the water sai	nples collected	d from the pro	oject area		

6.06. The water quality standards for different uses, prepared by National Institute of Hydrology (NIH)⁵ categorized water into five designated uses and classes. They are as follows:

Sl. No	Designated-Best-Use	Class	Criteria Water
1	Drinking Water Sources without conventional	A	1. Total Coliforms Organism MPN/100 ml shall be 50 or less
	treatment but after		2. pH between 6.5 and 8.
	Disinfection		3. Dissolved Oxygen 6 mg/l or more
			4. Biochemical Oxygen Demand 5 days
			20°C 2 mg/1 or less
2	Outdoor bathing	В	1. Total Coliforms Organism MPN/100 ml
	(Organized)		shall be 50 or less
			2. pH between 6.5 and 8.
			3. Dissolved Oxygen 5 mg/l or more
			4. Biochemical Oxygen Demand 5 days
			20°C 3 mg/1 or less
3	Drinking water source after	C	1. Total Coliforms Organism MPN/100 ml
	conventional treatment and		shall be 5000 or less
	Disinfection		2. pH between 6 to 9
			3. Dissolved Oxygen 4 mg/l or more
			4. Biochemical Oxygen Demand 5 days

⁵ http://www.nih.ernet.in/rbis/india_information/water%20quality%20standard.htm





Sl. No	Designated-Best-Use	Class	Criteria Water
			20°C 3 mg/l or less
4	Propagation of Wildlife and	D	1. pH between 6.5 to 8.5
	Fisheries		2. Dissolved Oxygen 4 mg/l or more
			3. Free Ammonia (as N) 1.2 mg/l or less
5	Irrigation, Industrial	Е	1. pH between 6.0 to 8.5
	Cooling, controlled Waste		2. Electrical Conductivity at 25°C micro
	disposal		mhos/cm Max 2250
			3. Sodium absorption Ratio Max.26
			4. Boron Max. 2 mg/l

Source: Anonymous, "Water Quality Requirement for Different Uses" (Roorkey: National Institute of Hydrology), (April 2011)

For each designated best use/class four main criterions were identified. As per this criterion the water of Ramganga River is classified as Class-C and its designated best use is drinking water with out conventional treatment but after disinfection. The criteria for designated best use of irrigation, industrial cooling and controlled waste disposal consisted the following:

• pH : between 6.0 to 8.5

• Electrical conductivity at 25°C : Max 2250

(micro mhos/cm)

Sodium Absorption Ratio
 Boron
 Max 26
 Max 2 mg / 1

The water quality analysis of Ramganga River on the basis of the above four criterion and data presented in **Table 6.4** indicated that the same is quite suitable for irrigation purposes, also.

Profile of Command Area

6.25 The command area is located between latitude 25° and 28° N, longitude 77° and 82° E and includes the districts of Agra, Aligarh, Mathura, Etah, Mainpuri, Farrukhabad, Etawah, Kanpur Nagar, Ramabai Nagar(Kanpur Dehat), Kashi Ram Nagar, Fatehpur, Kaushambi, Kannauj, Mahamaya Nagar (Hathras), Firozabad and Auraiya. These districts completely occupy the eastern and central portions of Ganga-Yamuna Doab. While part of some of these districts also lay out side this tract. Major part of Agra, about half of Mathura and Small portion of Etawah district also lie across river Yamuna bordering Rajasthan and Haryana State (**Figure 6.1 and 6.2**).

Physiography

6.26 The tract from Aligarh to Kaushmbi lying between the two great rivers is a wide expense of level alluvial plains with gentle slope in south east direction. The general



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elevation of land varies from 175 to 180 meters above mean sea level in the extreme west in Aligarh district to 100 to 105 meters at Kaushambi in extreme east. Normally the area is featureless except for the presence of a number of small rivers with raised sandy banks, ravenous area along the river Yamuna, some depressions forming chains of swamp, from which a number of small rivers or drainage channels originate. These drainage channels are rather sluggish streams with low regular channel flows but high banks. Land erosion along river Yamuna is wide spread and increases in intensity from north- west to southeast. In Etawah and Kanpur districts, these eroded areas have assumed formidable size, may be several kilometers wide with deep gullies. The tract on the western side of river Yamuna in Mathura and Agra districts presents a different appearance. In the western most parts of Agra and Mathura districts are found a chain of low rocky hillocks generally as isolated outcrops but at places as continuous formation. These ranges from part of Aravalli system but now here assume any considerable size. From some of the hillocks sand stone for building purposes is extracted. In the south of Agra district river Chambal form the boundary and along this river some of the worst dacoit infested and infamous ravenous areas with deep gullies have been formed.

6.27 The Ganga River on the northern borders of the two divisions has shifted to north at several places leaving low lying tracts with light soil. In Etah, Farrukhabad and Kanpur districts the change of river course is by several kilometers. However, in the old course a chain of water pools have formed and during rains surplus water from uplands is drained in this channel, which forms a regular stream by joining all the pools. The channel is known as Burhi Ganga. From the old high banks to the course of the main stream, the whole area is partially or at places completely affected by the fluvial action of the river making the whole tract precarious in nature. These areas are locally known as Diara and are met with along almost all the rivers draining this tract but the magnitude is not as extensive as along with the Ganga River. Other smaller rivers draining the central alluvial tract are Kali Nadi, Sengar, Rind and Pandu (**Figure 6.3**).

Climate and Rainfall

6.28 The climate of the project districts is characterized by delightful cold weather from November to February along with hot summer from March to June and the rainy season from July to October. The average normal rainfall of the area varies between 614.5 and 946.1 mm. Fatehpur receiving about 946.1 mm while and it goes gradually decreasing regularly as one goes west. Mathura district which lies in the extreme north westerly corner, receives the lowest rainfall of about 614.5 mm. There are also wide variations in rainfall in different portions of the individual district, the areas lying on the south western side receiving less rainfall and the differences in annual rainfall may be as wide as 100mm in some of the districts. Most of the rain precipitates during the four months beginning from the last week of June to the end of the September. Heavy down pours of 10-20 cm. in one day are not uncommon while there may be long breaks with completely rainless days during this period. The rest of the year is dry except for occasional light showers during winter months. Winter season starts at the end of October and continues till the end of February when the day temperature starts rising. December

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and January are the coldest months which are sometimes quite severe with occasional frosts. From March onwards the hot season starts and lasts up to Jun. Summer month are extremely hot, the day temperature crosses 38°C and sometimes touches as high as 48°C. Strong westerly hot winds blow throughout the day with dust storms occurring quite frequently, more so in the western districts where a lot of sand is carried from across the Rajasthan border and gets deposited in areas along the western borders at places forming extensive chains of sand dunes.

- 6.29 As the rains stop by the end of September or early October, the main winter crops (Rabi) are generally sown up to 15th November and some late varieties up to middle of December. During the growing season of these crops soil moisture depletes rapidly and the need of supplemental irrigation is felt during December. The soil moisture stress goes on increasing till the harvesting of the crops in March and early April. During the latter parts of the sowing season of winter crops atmospheric humidity is also lowest, the relative humidity percent may be as low as 40. The crops with no irrigation facilities suffer greatly unless there are a few winter showers. However, for optimum growth of the main crop like wheat three to four supplemental irrigations are essential to meet the soil moisture deficit.
- 6.30 The normal yearly / monthly rainfall data in mm. for Ramganga command area at various stations 2001-2006 is given in **Annexure VI.3**.

The normal rainfall in the command districts of Ramganga project is presented in **Table 6.5.** The Salient features of annual normal rainfall are as follows:

- ⇒ The highest rainfall has been recorded in Fathepur district followed by Kaushmbi, Ramabainagar, Aurriya, Farrukhabad, Kannauj, Etawah, Mainpuri, Etah, Aligarh, Agra and Mathura.
- ⇒ The highest rainfall months are June, July, August, September and October. The rainfall during the winter month of November to February is negligible and rather uncertain.

Table No. 6.5 Normal Rainfall in the Command Districts				
Sl. No	District	Rainfall in mm		
1	Aligarh	728.6		
2	Mathura	614.5		
3	Agra	742.1		
4	Mainpuri	743.7		
5	Etah	722.2		
6	Farrukhabad	810.2		
7	Etawah	789.3		
8	Kanpur Nagar	793.0		
9	Fatehpur	946.1		
10	Kaushambi	916.4		
11	Ramabai Nagar	817.6		



Table No. 6.5 Normal Rainfall in the Command Districts				
Sl. No	District	Rainfall in mm		
12	Auraiya	807.5		
13	Firozabad	708.8		
14	Kannauj	803.8		
15	Mahamaya Nagar	648.7		
16	Kashi Ram Nagar*	N.R.		

Geology

- 6.31 The area is part of the Indo-Gangetic alluvium as is clear from the Geo-hydrological map of U.P An indication regarding the depth of alluvium is given by two deep drillings done by the Central Ground Water Board at Panki near Kanpur, where the Bundelkhand granites have been encountered at a depth of about 580 meters while at Sainta near Allahabad bed rock has been encountered at a depth of about 230 meters only. The alluvium comprises of clay, kankar, silt, and sand of various grades and of different textures. The Indo Gangetic alluvium has been classified by Wadia (1961) and Krishnan (1960) under older and newer Alluvium. The older alluvium forming the higher lands is not generally flooded by rivers and the newer alluvium forming the lower land gets generally flooded by river year after year.
- 6.32 The sub- surface geological information is furnished by the study of geological cross sections as well as by the study of litho logs of state and private tube wells. A detailed fence diagram shows the underground aquifer configuration of the command area. However the detailed geological conditions in some of the districts are described in the following paragraphs. The fence diagram is shown in **Figure 6.4**.
- 6.33 Etah: There are two more or less continuous sand layers of fine to medium sand occur at a shallow depth. The second aquifer layer of medium to coarse sand occurs below 30 meters (100ft.). These two layers of sand are the main source of supply to the private irrigation works. The ground water in the first aquifer occurs under unconfined conditions while in second aquifer ground water occurs under semi–confined condition. At places, lenses of sand layers have also been encountered in the tube wells which form local aquifers with limited areal extent.
- 6.34 Mainpuri: The sediments that underlie this area up to depth of 150 meters principally comprise clay, sand of various grades and clay mixed with kankar. The subsurface distribution of the alluvial deposits in the area indicates that present day alluvial deposits in the area indicates that the present day rivers Yamuna, Kali, Sengar, Sirsa, Arind and Isan have been the chief agents of deposition during the development of the sedimentary sequence.
- 6.35 The first aquifer zone has generally been tapped for the construction of masonry dug wells and private cavity type tube wells at some places. Texturally this horizon varies from fine sand to medium grained sand. Ground water in this horizon is unconfined. The



next aquifer consists of a 15.5 m thick strip of medium to fine grained sand and is underlain by thick layer of clay with kankar which causes vertical leakage of water from top aquifer to lower aquifer. Ground water in this second aquifer occurs under semiconfined conditions. Beside these two prominent aquifer zones, there are some lenticular sand beds of small extent in Mainpuri, Ghiror Blocks. The lenses up to 45 m depths are of medium grained sand as pierced by S.T.W number.15 of Mainpuri group. The tube well pierces several thin lenses of sand having thickness of a couple of meters to 16 m. On the whole the top aquifer varying in thickness from 15 to 45 m can be very well utilized for the construction of masonry wells and shallow tube well which can yield sufficient water for minor irrigation.

- 6.36 Etawah: To study the sub surface geology of the district, the litho logs of some deep wells as well as some private shallow tube wells studied. The geological cross section depicts the sub surface geological conditions and aquifer position in the area. On the perusal of fence diagram, it is concluded that the top clay layer is thick towards Yamuna River. The first sand layer is encountered below 23 m which is more than 30 m thick. The sand is medium to coarse granite moram, which has been derived on disintegration of Bundelkhand Granite along Yamuna River. Aquifer at shallow depth occurs in from of lenses of fine sand below 45 m to 60 m depth a continuous sand layer of medium to coarse texture is encountered. Ground water in the area occurs under unconfined to semi confined conditions.
- 6.37 Kanpur: The sub surface geological information of the litho logs of state and private tube wells of the area indicates the aquifer disposition in the Kanpur districts. On the perusal of these sections, it is concluded that the top clay layer is thicker towards Yamuna River. The same layer is encountered generally below 15 m to 21 m in northern parts of the districts but along Yamuna River this depth is considerably greater. The maximum thickness of the aquifer is about 90 m as encountered in state tube wells. The aquifer material is mostly medium to coarse grained moram which has been derived on disintegration of Bundelkhand Granite along Yamuna River. Along Ganga River the aquifer material is composed of fine to medium grained sand. This aquifer is continuous throughout the district area. However, along Ganga River, this aquifer is divided into two or three horizontal layers by clay with kankar. Ground water in this aquifer occurs under unconfined to semi confined conditions.
- **6.38 Kaushambi:** The sub surface geological information furnished by the study of tube wells reveals that the private tube wells tap the aquifer below 30 m to 60 m. This aquifer is mostly composed of fine sand with some patches of course to medium sand. At some places kankar is also present. The aquifer is reliable and can supply sufficient water to private tube wells.
- 6.39 Aligarh: Top layer in the area consists of clay varying in thickness up to 20 m. Thereafter deposit of fine sand is encountered which is the main aquifer. This aquifer extends generally up to the depth of 45 m. below this there is again a clay layer followed by a fine sand aquifer. At some places inter lenses of clay layer exist in the sand aquifer. Thickness of the aforesaid aquifers varies widely from place to place.



6.40 Farrukhabad: The district is a part of indo gangetic alluvium comprises of clay, kankar, silt and sand of various grades and of different textures. This indo-gangetic alluvium has been classified by Wadia (1961) and Krishnan (1960) under older and newer alluvium. The older alluvium forming the higher land, is not generally flooded by rivers year after year. In brief geology of the area can be written as follows:

FORMATION AGE GROUP LITHOLOGY

Unconsolidated Quaternary Clay silt sand of various grades with kankar

- 6.41 The sub surface geological information is furnished by the study of geological cross section as well as by the study of litho logs of state and private tube wells. The geological cross sections reveal that up to depth of about 150 meters, the formation consists of alternate layers of sand and clay. The sand formations act as potential aquifers. The top aquifers behave as unconfined ones, while the deeper ones act as confined with leakage from top; the development of ground water is both by shallow and deep tube wells.
- **6.42** Fatehpur: At the top of there is a 5 to 7 meters thick surface clay layer followed by a 25–30 meters thick clay band after which sand formation occurs. These sand horizons act as top unconfined water table aquifer and sustain the shallow private tube wells.
- 6.43 Agra: Two distinct types of geological units are found in Agra district. South western part of the district is composed of red colored sand stone of Vindhyan age and rest of the area is covered by Indo-gangetic alluvium. A brief geological description of both the units is given below.
- 6.44 South Western Area near Fatehpur Sikri: This area is covered by the sand stone belonging to Vindhyan system. The rocks near the hillocks are covered by the thin layers of alluvium. The bedding is generally obscure. The colour of the sand stone in this area is red because of oxidation phenomenon in presence of iron (Fe) contents. The alluvium cover overlying these rocks comprises *in situ* or transported pieces of hard rocks. The sediments deposited in this area are not fully mature. The grade of sediments ranges from fine to very coarse and their admixture. After the study of their texture it has been concluded that they are *in situ*, their shape, size and roundness range from poor to good as one move towards the river Chambal. In this area ground water occurs in the fractures joints and fissures. In hard rock area where the bedding is perfectly marked ground water occurs along bedding planes.
- **6.45** Area towards River Yamuna: This area is covered by the great Indo Gangetic alluvium of the quaternary age. The gangetic planes are built up of various grades of sand, clay, kankar and their mixture. These layers have been deposited by the flowing



rivers during Pleistocene to recent period. These layers form the main water yielding horizons for private and state tube wells.

Soil of the Area

- 6.46 The soil of the area is alluvial in nature developed from the alluvium deposited by the two rivers, Ganga and Yamuna. The alluvial material owes its origin to the soft dolomite rock of Himalayas from which these rivers originate. The alluvium is very deep except for the riverine areas which receive sediments annually over the sandy beds and have very thin soil layers. At times the depth of alluvium exceeds a few hundred meters without any evidence of parent rocks. These alluvial soils vary considerably from location to location but all of them are essentially basic in character.
- 6.47 The nature of the soils differ widely from district to district but they have been broadly classified in to number of soil associations nomenclature on the basis of the river family which has contributed to the deposition and development of soils in individual districts. The soil associations recognized in each district in individual river system comprise of:
 - Riverine soils of khadar and the recent alluviums.
 - Soils of flat lands.
 - Soils of uplands.
 - Soils of low lands.
- 6.48 Although variations to soil characteristics in different district are very wide, the broad zonal features of the soils associations remain more or less the same. Soils on recent alluviums are accordingly grey to ash grey in color. Granular in structure, light in texture, slightly alkaline and of calcareous nature.
- The soils of the two river families differ markedly in morphological and chemical feature of the soil profiles as well as nature of parent material of the two formations. Accordingly where Ganga originates from Himalayan rocks, the Yamuna flows for a considerable distance over the basaltic rock region and on this account the recent alluviums of Yamuna are Colored black and are of a very fine texture soils profile showing marked uniformity at all depths. The soils are deep calcareous and exhibit remarkable swelling, shrinking and cracking when dry. They are difficult to till and a little over drying or moistening severely affects the crop growth in these soils. Such soils are found in the water shed of Yamuna in the district of Aligarh, Mainpuri, Etah, Kanpur, Etawah and to some extent in Allahabad. The flat land soils are devoid of homogeneity with depth and to large extent the characteristic black color recording in recent alluvium changes from grey to dark grey on the soil profile. The soils are loam to clay loam at the surface becoming heavier as a result of alleviation in sub soil or the alleviation horizon. The phenomenon of calcification and decalcification is very prominently displayed in the soil profile of the association and calcareous concretions in B horizon are invariably exhibited. The lowest horizon or the parent material is lighter in texture and less calcareous. The soils have a fairly high water holding capacity but the phenomenon of



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cracking and swelling is not evidenced on these soils being loam to sandy and obtain even sandy to gravelly texture. They have granular structure. Lime accumulation in the sub soil is not witnessed in the soils even through slight calcareous nature is occasionally displayed in this formation. The soils are freely drained and have excessive rate of percolation.

- 6.50 Reconnaissance soil survey work has been done by the state soil survey organization in eight out of sixteen districts of the command. The work led to the recognition of a number of soil association of each district on the basis of which the soil has been classified.
- 6.51 The broad differential characteristics of the soil association recognized in these districts are described. Further, soil association for whole of command is given in **Figure 6.5**.

Morpho-tectonic Setup

- 6.52 The area under study belongs to the Central part of the Gangetic Alluvial Plain. The main drainage is provided by south-easterly flowing Ganga River whose braided course in the area has a maximum width of 5 km near Fatehgarh. The major tributaries following through the northern Gangetic plain include Ramganga and Garra, having their confluence with Ganga at Bhojpur (1.5km.d/s of Fatehgarh) and Kannauj, respectively. In the southern part, the important tributaries of Ganga are Kali and Isan. The Gangetic plain can broadly be grouped into two major units of i) older alluvial plain which is largely unaffected by the fluvial action of the present rivers and forms the inter flue region between the major tributaries of Ganga, and ii) the Younger Alluvial Terraces and flood Plains, constituting the dynamic fluvial regime of the rivers in present times.
- 6.53 The older plain considered to have been formed by the ancient drainage system has an average gradient of 1 in 3400 towards southeast and elevation varies from 152 m to 140 m. above MSL. This plain is characterized by numerous depressions (presently occupied by tals) palaeochannels, oxbow lakes, etc. and incorporates diversified soil types constituting Usar lands. Yamuna River from the western boundary with number of tributaries. Fertile tracts and marshy zones (Agarwal & Iyer, 1984). The younger alluvial terraces in Farrukhabad area occur in paired forms with their levels remaining 1 to 9 m above the active flood plains. The latter is charactererised by stream channels, bars and islands which get submerged during rainy season. Lacustrine deposits comprising thin plastic clays occur in relict depressions and have been mapped west of Muhammadabad and Bijauri, east of Dahalia and west of Chanduiya by Bhartiya and Narayan, 1993, who have described the litho stratigraphy of the area as follows.

Unit Lithology

Ramganga, Ganga, Garra, Kali recent alluvium.

Ganga, Ramganga, Garra

Newer Alluvium

Light grey, fine to medium grained sand, laminated clay and minor silt. Fine to medium grained grey
Micaceous

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Unit Lithology
Terrace alluvium.
Dis-conformity
Silt clayey facies

Varanasi Older Alluvium Sandy facies **Newer Alluvium**

Sand with thin layers of silt and clay.

Polycyclic sequence of clay and silt with calcrete and ferruginous concretion.

Oxidized brownish micaceous sand and silt.

- 6.54 The Gangetic alluvial plain was formed as a peripheral foreland basin consequent to the collision tectonic processes of stresses. The geophysical survey and drilling carried out by ONGC indicated that the thickness of sediments in the basin is highly variable. Being maximum near the foot hills and gradually thinning out towards the peninsular margin. The thickness of alluvium of in the central part has been estimated to be about 600 m the tectonic frame work map by ONGC reveals the presence of major basement structures concealed below the alluvium with the area of present study falling in the 'Sarda Low'. North of Agra –Lucknow horst' the interpretation based on remote sensing data indicates the presence of prominent lineaments trending in NW–SW (Himalayan trend), NE–SW and ENE–WSW direction.
- 6.55 The gangetic plain between Mathura in the west and Varanasi in the east has experienced a total of 11 significant earthquakes between 1803 and 1966 (ISET Catalogue.1983) and is included in event of the region was that of Mathura–1803 (located 190 km from Farrukhabad) having a magnitude of 6.5 on Richter Scale. The event located nearest to Farrukhabad was that of Kanpur–1803.
- 6.56 The effect of the great Bihar–Nepal earthquake of January1934 measuring 8.3 on the Richter scale was distinctly felt in Farrukhabad, Fatehgarh and Kannauj (GSI Memoir vol.73, 1939). Under the influence of the earthquake, doors and windows rattled, hanging objects swung and walls of some buildings cracked.

Soil Characteristics with special reference to USAR soil

- 6.57 The main problem of USAR land is also observed in command area. An area of 3.5 lakh hectares is under saline and Sodic soil, which is nearly one tenth of the net cultivated area of project and constitute more than a quarter of states Usar land.
- 6.58 Actually deterioration of land on account of large scale irrigation project was started in the middle of nineteenth century. In 1976, Reh commission was set up to investigate into the causes of deterioration of soils of U.P which had previously been fertile. However, in the past greater emphasis has been placed on yield of crop without much consideration on improvement in soil conditions. Dr. Leather (A Scientist) showed that salts which were formed by the natural weathering of igneous rocks become evident on the surface layers under certain predisposing conditions like (a) Arid or semi arid climates (b) an impervious sub soil or hardpan and (c) temporary abundance of humidity, is the soil interspersed with dry periods. All such soil was termed as USAR. Royal commission on agriculture put the blame squarely on the failure to provide proper



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drainage before starting canal irrigation. According to R.C.A. drainage survey and drainage construction should from an integral part of all irrigation projects.

- 6.59 This usar formation is closely related with the ground water behavior and can be observed on the areas either side of canal. In the near vicinity of the canal the nature of sub surface soil does not permit percolation of canal seepage towards ground water reservoir causing water logging locally. The water table along canal varies from 2.00 meters to 5.00 meters. The salts in the water rise to the ground level due to capillary action with water and so not go back in the ground due to higher water table and hard clay pan giving rise to Usar formation.
- 6.60 The public concern about drainage congestion and salt accumulation were voiced a few years after the opening of the Upper Ganga Canal in 1854. Since, then much water has percolated into ground aquifers through five canals viz., from Ganga River, two from Yamuna River, from Sarada Sahayak system and from canals taking out from other tributoreis of the Ganga.
- 6.61 Following strong protests against canals in the wake of wet seasons during the 1880s, the Irrigation Department began to monitor groundwater tables in the Ganga-Yamuna Doab, where seepage from the canal system had raised groundwater levels in all canal commands. Recent losses from the Upper Ganga Canal, estimated on its along sections, are around 94.56 cumecs from welted area of 38.83 million km². As a result, 32 per cent of main canal discharge of 294 cumecs is lost to deep percolation (Singh 1983). Operational losses add up to 15 per cent taking total conveyance losses to 47 per cent the discharge at the head. Further more, the once efficient surface drainage system is so deteriorated that the best portion of rain water percolates to the ground aquifers. Consequently major parts of the central doab from Mainpuri to Allahabad suffer from waterlogging in the rain season. With the commissioning of the Ramganga project the total command of upper Ganga canal increased to 2 million ha of which 0.195 m ha are waterlogged.
- 6.62 Since the Usar reclamation is an intensive investment program, the soil amendments needed for the purpose are supplied on subsidized rates to the beneficiary farmers. Farmers in certain areas of the command use gypsum in potato and other crops to make soil friable. In some alkaline soils otherwise amenable to gypsum treatment a sub soil clay pan may be formed in course of time which should hinder drainage. Breaking of the pan layer by physical method is the only solution in such cases. Soils in the command area is given vide plate no.

Drainage Characteristics of Ramganga Command Area

6.63 Ramganga (west) river originate from Doothtali range in the district of Paurigarwal, Uttrakhand State of India. The river Ramganga flows to South west from Kumaun Himalayas. It is a tributary of the river Ganga, originates from the high altitude zone of 800 mt to 900 mt. Ramganga flows by the Corbett National Park near Ramganga,



Nainital district from where, it descends upon the plain area. Bareilly city is situated on its bank. There is a dam across this river at Kalagarh, Ramganga meet with river Ganga near NE of district Kannauj. The area overall belongs to central parts of Gangetic alluvial belt. The drainage is being provided by south- eastern flowing Ganga. The other major tributaries are Garra, Kali, Isan, etc. The streams within the command area form certain patterns depending upon the slope of the area underlying rocks structure as well as climatic conditions. The over all drainage in the area is dendritic as river channel follows the slope of the area (terrain). The important features found in the area are various meander courses. Abandoned channels above lakes etc., and also forming marshy / flood main area. The area is highly fertile alluvial plain with fine to medium grained sandy aquifer heaving high transmissibility.

Ramganga Water Distribution System

6.64 The Ganga, Yamuna doab is served at present by upper Ganga, Lower Ganga, Eastern Yamuna and Agra canal system. These systems at the time of their construction were designed to provide only protective irrigation. With the modern agricultural methods and high yielding variety of seeds the above system become inadequate to meet the requirement, thus felt necessary to increase the water potential in each of the above system.

6.65 The canal system catering to Ramganga command area gets water from Ramganga reservoir located at Kalagarh (Districts Bijnor) which has a capacity of 2400 Million cubic meters through the century old Ganga canal system viz. upper and lower Ganga canal system after remodeling them and extending the lower Ganga canal to eastern part of the command through the newly constructed west Allahabad branch. The water stored in Ramganga dam reservoir after passing through the power house reaches Ramganga barrage located 25 kms down streams, from where it is directed in to a feeder channel of 152 cusec capacity which joins river Ganga near Garmukteshwar about 8 kms upstream and finally this water is fed into the lower Ganga canal system for increasing the irrigation opportunities in the old and new areas lying within the approach of this canal system (**Figure 6.6**).

Occurrence of Groundwater

6.66 The ground water occurs in the command area under water table conditions. The shallow aquifers are under unconfined conditions while the deeper aquifer behaves as leaky to confined ones. The disposition of aquifers is clear from the 3-D fence diagram. The water is being monitored at about 664 hydrograph stations bimonthly. The depth to water table below ground level varies from 3.00 to 33.00 meters during May/June, while it varies from 1.5 to 31.0 meters in October/November. The shallow water table is witness in canal command while deeper water table is found near river especially on the left banks of river Chambal and Yamuna. The water level is at the lowest during the driest months of May–June. As the monsoon sets in after June, the level starts rising and reaches to the maximum value during the month of October/November after the monsoon month are over. However, as the canal water input and pump age from an area reflects



directly in rise or fall of water table. Variations are witnessed from the above trend. In the dry summer months the depth to water table is mostly between 4 to 6 meters. Except for the areas near river and in the areas which are out of canal command.

However, the observations at different hydrograph stations show the water table 6.67 below 2.00 meters bgl. in the command area, but in the area along canals the permeability of soil of these areas is very low and sub soil is having occasionally a thick kankar pan impregnated which is not due to high water table. Water at some places is spread from canals due to improper linings and unauthorized cutting of canals. Hence, water logging is only seasonal after rainfall and water spreading from canal causes temporary water logging. The trend of ground water level clearly show that the longitudinal flow of the ground water is from east to west. However, the main flow is perpendicular to river flow with a ground water mound in between two rivers. The slope becomes steeper towards Yamuna River followed by Chambal and Ganga rivers and other small rivers. It is further indicated that all the rivers are affluent and are fed from ground water.

District-wise and Block-wise data from 2000 to 2009 as obtained from State Ground Water Department; U.P is presented in **Annexure VI.4.**

Frequency Analysis of Hydrograph Stations

District wise frequency analysis for pre and post monsoon periods for all the 6.68 monitored hydrograph stations between the years 2000 to 2009 was carried out. The frequency analysis at a glance in the command area clearly indicates that although there is a marginal increase in the area falling in the depth range of 0-2 mgbl, the area falling in the depth range from 2-5, 5-8 and 8-11 mbgl, have decreased. As we proceed farther from the canal network especially in the tail reaches, the decadal trend depicts that the area falling in the depth range of 11-15, 15-20 and more than 20 mbgl, has increased tremendously, which indicates the effect of dwindling and erratic rainfall coupled with the gradual increase in dependence on groundwater irrigation on account of erratic and insufficient supplies from canals. Block wise annual rate of declining from 1996 to 2006 was estimated and found that overall trend of declining in various blocks of the districts is increasing. Block Sakeet (Etah), Dhat (Fatehpur) and Saifai (Etawah) was found with a declining trend of 50-60cms /yr. which is alarming and require an immediate strategy to arrest the declining trend. Further, out of total 148 blocks in the command about 103 blocks are showing the declining trend in the ground water levels. The decline was in the range of 10 cm per year to 50 cm per year. **Table 6.6** gives the distribution of blocks of Ramganga command affected by declining trend of Ground water along with range of decline.

Volume-I

Table 6.6 Distribution of Blocks of Ramganga Command Affected by Declining 'Trend of Groundwater According to Level of Decline (1996-2006)' Name of Blocks with Annual Decline in the range (cm/year)

District	Total Blocks	1-10	10-20	20-30	30-40	40-50	50-60
		Achhnera	Saiya	Vichipuri	Akola		
		Khair Garh	Khandauli	Etamdpur			
Agra	15	Jagner	Jaitipur	Fatehabad			
8		Shamshabad		Fatehpur Sikri			
		Bijauli					
Aligarh	12	Akrabad					
		Dhanipur					
Etah*		Sidhapura	Ganj Dundwara	Awagarh	Nidhauli Kalan		Sakit
(Including	1.5	Kasganj	Shitalpur				
Kashiram	15	Soron	Amapur				-
Nagar)		Jaithra					
		Patiyali					
		Eka	Sikohabad	Narkhi	Airaon		
Firozabad	9	Firozabad	Madanpur	Tundla			
		Khairagarh					
Mahamaya		Shapu	Hathras	Sadabad			
Nagar	7		Hasayan				
		**	Sasni				
	0	Kurawati	Barnahal				-
Mainpuri	9	Mainpuri Jagir					
		Chaumuha	Baldeo	Maat			
Mathura	10	Farah	Dardeo	Iviaat			
		Malwa	Bhitaura	Haswa		Airayan	Dhata
		Telyani	Devmai				
Fatehpur	13	Bahuwa	Hathgaon				
r accorp ar			Vijaipur				
			Khajuwa				
		Sarsawan	Chayal	Sirathu			
		Kaushambi					
Kaushambi	8	Kara					
		Manjhanpur					
		Newada					
		Achhalda	Ajeetmal		Auraiya		
Auraiya	7	Vidhuna	Bhagya Nagar				
		Erwa Katra					
Etowal	0	Basrehar	Chakar Nagar				Saifai
Etawah	8	Barpura	Bharthana				
		Jaswant Nagar					

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Table 6.6 Distribution of Blocks of Ramganga Command Affected by Declining 'Trend of Groundwater According to Level of Decline (1996-2006)' Name of Blocks with Annual Decline in the range (cm/year)

District	Total Blocks	1-10	10-20	20-30	30-40	40-50	50-60
			Barpur				
		Bidhnu	Kanyanpur	Bhitargaon	Ghatampur		
Kanpur Nagar	r Nagar 10	Chaubepur		Kakwan			
Kanpui Nagai	10	Shivrajpur					
		Sarsaul					
		Akbarpur	Malsa				
Ramabai		Maitha	Saidpur				
Nagar	10	Rajepur	Derapur				
Nagai		Jhinjhak					
		Rasulabad					
		Talgram	Kannauj				
V :	8	Chhibramau					
Kannauj	0	Saurikh					
		Umarda					
15	148	50	30	13	5	1	3

6.69 District-wise frequency analysis of hydrograph stations according to depth to water level during pre and post monsoon seasons for 2000 to 2009 is presented in **Annexure VI.5.** Year wise distribution of hydrograph stations according to depth of groundwater level during Pre and Post Monsoon seasons for the years 2000 and 2009 is presented in **Table 6.7.**

6.70 There are about 665 hydrograph stations, for which depth of water table during Pre and Post Monsoon seasons is collected in the command area of Ramganga project. However, the data is not being collected for all hydrograph stations during every year between 2000 and 2009. Therefore, this frequency analysis of depth of groundwater table is undertaken for the stations which have been monitored for about 10 per cent of these hydrograph stations, the depth of groundwater level during Post Monsoon season is below 2m. Most of these hydrograph stations are located in Aligarh, Auriaya, Etawah, Kannauj, Ramabai Nagar, and Mainpuri districts. For majority of the hydrograph stations the depth of water level is between 5 and 15m. More than 12 per cent of hydrograph stations recorded depth to water level to be over 20 m even during Post Monsoon season.

Table 6.7 Year-wise Distribution Hydrograph Stations According to Depth of Groundwater Level During Pre and Post

Monsoon Seasons in Ramganga Command (2000-2009)

	No of S	Station						Freq	uency	(in M	eter or	ly)				
Year	D	D	0-2	(Pre	2-5 ((Pre	5-8	Pre	8-11	(Pre	11-1	5 (Pre	15-20	0 (Pre	>20	(Pre
	Pre	Post	& P	Post)	& P	ost)	& P	ost)	& F	ost)	&]	Post)	&]	Post)	& P	ost)
2009	317	288	8	22	52	62	59	52	35	32	43	42	43	61	68	33
2008	583	600	11	95	91	133	140	102	99	73	94	83	79	59	41	30
2007	664	664	6	43	118	141	168	152	131	105	94	84	73	66	45	38
2006	646	652	3	62	135	153	183	147	110	103	106	92	61	50	34	31
2005	300	312	2	32	60	70	74	64	43	42	37	65	62	23	19	14
2004	306	311	4	25	68	72	67	60	47	40	38	35	65	64	19	14
2003	314	310	4	46	56	84	74	45	60	53	81	67	22	18	17	18
2002	289	298	2	26	56	53	82	65	79	88	31	28	19	18	15	11
2001	145	149	2	15	32	36	39	40	29	21	17	14	15	15	11	10
2000	264	264	1	20	64	76	63	49	86	72	21	18	19	13	10	9
Total	3828	3848	43	386	732	880	949	776	719	629	562	528	458	387	279	208
Average	382.8	384.8	4.3	38.6	73.2	88	94.9	77.6	71.9	62.9	56.2	52.8	45.8	38.7	27.9	20.8
% Total	100	100	1.12	10	19.1	22.9	24.8	20.2	18.8	16.3	14.7	13.7	12	10.1	7.29	5.41



Aquifer Characteristics

6.71 To determine the aquifer characteristics pump tests have been carried out by Central Groundwater Board (CGWB) and State Groundwater Department (SGWD) in the command area, the results of various aquifers and of yield characteristics are given in **Figure 6.7 and Tables 6.8 and 6.9.** The above tests which are mostly short duration tests show a wide variance in the value of transmissibility and storage coefficient. Moreover all these indicate that the aquifer is a confined one. In actual behavior and results of water balance studies clearly indicate the top shallow aquifer from which there is most of the ground water withdrawals, is an unconfined one. For this unconfined i.e. the specific yield lies within an average value of 0.07 to 0.12. At present for calculating the value of specific yield the recourse is being made to U.S.G.S. lab values which are as below:

Sl. No	FORMATION	SPECIFIC YIELD
1	Clay	0.02
2	Clay and Kankar	0.05
3	Sandy clay	0.07
4	Silt	0.08
5	Fine Sand	0.21
6	Medium Sand	0.26
7	Coarse sand	0.27

Tab	Table 6.8 Results of Short Duration Pump Test Conducted in Ramganga Command Area									
Sl. No	Place	Block	District	Test on	Transmi ssibility Co- efficient	Storage co- efficient	Hydraulic Conductivit y			
1	Viroh	Chaube pur	Kanpur	Open well	6558	-	-			
2	Dilipnagar	Chaube pur	Kanpur	Open well	6398	-	-			
3	Nauraikya khera	Chaube pur	Kanpur	Cavity P.T.W	-	1.56x10 ⁻⁴	5.78			
4	Devipur	Maitha	Kanpur	Cavity P.T.W	-	6.32x10 ⁻⁴	6.68			
5	Patara	Bhadau na	Kanpur	Cavity P.T.W	81.07	2.29x10 ⁻³	9.47			
6	Devipur	Maitha	Kanpur	Strainer P.T.W	412.88	13.18x10 ⁻³	41.28			
7	Achnera	Achnera	Agra	Cavity P.T.W	-	6.2x10 ⁻⁵	1.9			



Sl. No	Location	District	Depth in meter	Transmissibility in lt./day/mt,	Storage co- efficient	Agency conducting the test
1	Nagla Bhajua	Etah	238	6292128	-	C.G.W.B.
2	Sonai	Mainpuri	154	589866	-	C.G.W.B.
3	Mohamadpur	Mainpuri	203	1157332	-	C.G.W.B.
4	N.Sugar Research Institute	Kanpur	98	624000	-	C.G.W.B.
5	Panki	Kanpur	283	700000	0.0001	G.WD
6	Armapur Estate	Kanpur	418	2916000	-	C.G.W.B.
7	Kalyanpur	Kanpur	95	218600	-	C.G.W.B.
8	N.Sugar Research Institute	Kanpur	95	350600	-	C.G.W.B.
9	Sarai	Etah	91	1056000	0.003	G.WD
10	Khatauli	Etah	29	82400	0.079	G.WD
11	Arzi - Roomd	Agra	315	410660	-	C.G.W.B.
12	Asan	Agra	161	480561	-	C.G.W.B.
13	Kikkhra	Agra	183	143027	-	C.G.W.B.
14	Rajmargpur	Aligarh	74	84944	-	C.G.W.B.
15	Rajpur	Aligarh	75	615000	-	C.G.W.B.
16	Pendra	Aligarh	88	1004664	-	C.G.W.B.
17	Azadpur	Aligarh	62	1039104	-	C.G.W.B.
18	Atrauli	Aligarh	7	1341930	-	C.G.W.B.
19	Dharma Prem Nagar	Aligarh	75	1777364	-	C.G.W.B.
20	Badhauli	Aligarh	70	1045500	-	C.G.W.B.
21	Khairabad	Aligarh	85	1259276	-	C.G.W.B.
22	Sunpair	Aligarh	73	554607	-	C.G.W.B.
23	Bhojpur	Aligarh	110	1222743	-	C.G.W.B.
24	Panhera	Aligarh	75	1163863	-	C.G.W.B.
25	Kora	Aligarh	86	1769195	-	C.G.W.B.
26	Khersa	Aligarh	89	588088	-	C.G.W.B.
27	Hasanpur	Aligarh	77	1341930	-	C.G.W.B.
28	Hathras	Aligarh	73	484840	_	I.R.I
29	Hathras	Aligarh	49	486000GDP/ft	3.85×10^{-3}	I.R.I
30	Atrauli	Aligarh	61	553000	5.09×10^{-4}	I.R.I
31	Sasni	Aligarh	73	39100	5.8^{5x10}	I.R.I

C.G.W.B = Central Ground Water Board, G.W.D = Ground Water Department, I.R.I = Irrigation Research Institute, Roorkee



- In this method from strata charts of tube wells the value of specific yield is worked out as a weighted mean of the different strata. However, long duration pump test on shallow aquifer are being conducted to get the representative value of specific yield. The pump test conducted so for also reveal the heterogeneous nature of the formation and extreme complexity causing the very high local variation in places as close as 100 meter.
- On the basis of pump test performed by the GWD, it can be concluded that the values of storage coefficient varies from 10⁻³ to 10⁻⁴ in district Kanpur and hydraulic conductivity from 6.00 to 41.0 m/day in shallow aguifers. But as per the test conducted by G.W.D, and C.G.W.B, the transmissivity varies from 2 lakh liters/day/meter to 20 lakh liters/day/meter in deep tube well in Kanpur districts, whereas in Agra and Mainpuri it varies from 1.5 to 4.8 lakh/ liters/day/meter, and 5.9 to 11.6 lakh liters/day/meter, respectively in Aligarh and Etah. It shows a Variation from 4.00 to 17.00 lakh liters/day/meter. On average the values of aquifer parameters show a wide variation from place to place. The representative values of particulars area can be decided by performing more pumping test on deep to shallow aquifers.

Existing Sources of Irrigation

- The command area is irrigated by different sources. The state irrigation works consist of upper Ganga canal, Agra canal, lower Ganga canal system and state tube wells, while the private works consist of pump sets and shallow private tube wells. Prior to the establishment of the Ramganga command area development project, there was an irrigation potential of 8.60 lakh hectares. Additional of 5.12 lakh hectares was created as result of establishment of the project. For utilization of this newly created potential, 'On-Farm-Development Works' were carried out by Ramganga Command Area Development Authority (RCADA). Prior to the Ramganga Project the irrigation potential created in the Ganga-Yamuna doab was only 8.60 lakh ha and the potential created due to the project was 5.12 lakh ha. The utilization of potential created reached a maximum of 11.82 lakh ha during 1979–80. The potential utilized in the total potential created fluctuated between 77.77 per cent during 1984–85 and 86.22 per cent during 1979–80.
- As per recent assessment, the additional potential recharge due to water logged and shallow water table as on 31.03.2008 comes to be 60524.44 hect.mt. Maximum of this recharge is assessed to be in Mainpuri district with about 1906 ha and the minimum was in Kaushambi district (Table 6.10). District-wise growth of irrigation structures between 2004–05 and 2007–08 is presented in **Table 6.11.** The data presented in the **Table 6.11** indicated that these was sharp increase in deep tube wells (62.61%) and private tube wells, (6.74%) leading to heavy withdrawal of ground water. Consequently this resulted in higher level of groundwater utilization in the command area of the project. On the other hand there is marginal reduction in the number of state tube wells and PSs. The increase in deep tube wells was quite high in Auriaya, Fatehpur, Firozabad,



Kannauj, Kanpur Nagar and Kaushambi districts as compared to other districts. Similar pattern in the growth of private tube wells was observed during 2004–05 and 2007–08.

Tab	Table 6.10 Additional Potential Recharge in Ramganga Command Area as on 31.3.2008								
Sl. No	District Name	Potential Recharge in Water Logged & Shallow Water Level Area (ha.mt)	Potential Recharge in Flood Prone Area (ha. mt)	Total Annual Additional Potential Recharge (ha. mt)					
1	Agra	57.38	0	57.38					
2	Aligarh	188	0	188					
3	Auriya	6250.76	0	6250.76					
4	Etah	0	0	0					
5	Etawah	5369.54	0	5369.54					
6	Farrukhabad	2560.35	0	2560.35					
7	Fatehpur	2203.83	0	2203.83					
8	Firozabad	11733.32	0	11733.32					
9	Mahamaya Nagar	242.08	0	242.08					
10	Kannauj	752.85	0	752.85					
11	Kanpur Dehat	3556.67	0	3556.67					
12	Kanpur Nagar	1031.76	0	1031.76					
13	Kashiram Nagar	188	0	188					
14	Kaushmbi	19.8	0	19.8					
15	Mainpuri	19060.95	0	19060.95					
16	Mathura	7309.15	0	7309.15					
Tota	al Command	60524.44	0	60524.44					

District		2004-	2005		2007-2008				Growth from (2004-05) - (2007- 08)			
	S.T.W	D.T.W	P.T.W	P.S	S.T.W	D.T.W	P.T.W	P.S	S.T.W	D.T.W	P.T.W	P.S
Agra	351	507	67830	1749	248	602	68043	1749	-103	95	213	0
Aligarh	602	11	53637	67	595	11	58025	67	-7	0	4388	0
Auraiya	279	31	35441	2328	305	164	37220	0	26	133	1779	-2328
Etah	646	0	73236	0	602	0	77917	0	-44	0	4681	0
Etawah	312	61	35431	0	348	100	38734	0	36	39	3303	0
Farrukhabad	288	49	29393	0	313	80	31470	29	25	31	2077	29



Table 6	.11 Distr	ict-wise G	rowth of	Irrigati	on Struc	ture in Ra	amganga (Comma	nd Area	(2004-05)	- (2007-0	18)	
District		2004-2	2005			2007-2008				Growth from (2004-05) - (2007- 08)			
	S.T.W	D.T.W	P.T.W	P.S	S.T.W	D.T.W	P.T.W	P.S	S.T.W	D.T.W	P.T.W	P.S	
Fatehpur	527	360	39439	777	497	768	41335	777	-30	408	1896	0	
Firozabad	230	113	31324	0	237	265	32590	61	7	152	1266	61	
Kannauj	201	74	29553	960	213	226	31750	57	12	152	2197	-903	
Ramabai Nagar	249	1227	30944	176	255	1246	39093	176	6	19	8149	0	
Kanpur Nagar	291	1452	35040	166	298	2200	40151	166	7	748	5111	0	
Kaushambi	273	262	15378	17	282	1107	16673	17	9	845	1295	0	
Mainpuri	322	0	61332	4	321	0	63729	4	-1	0	2397	0	
Mathura	2	36	57783	422	2	36	59343	422	0	0	1560	0	
Mahamaya Nagar	130	5	32802	0	130	5	34857	0	0	0	2055	0	
Total	4703	4188	628563	6666	4646	6810	670930	3525	-57	2622	42367	-3141	

Source: Complied on the basis of information obtained from UP Groundwater Department

Note: * District Kashiram Nagar has been included in District Etah; STW = State Tube Wells, DTW= Deep Tube Wells, PTW= Private Tube Wells and PS=

Division wise number irrigation structures during 1992-93 to 1994-95 to 2004-05 and 2005-06 to 2007-08 are presented in **Annexure VI.6.** These details on district wise basis for the year 1994-95, 2004-05 and 2007-08 are presented in Annexure VI.7, VI.8 and **VI.9** respectively. The division wise and district wise area irrigated by various sources in the command districts of Ramganga project is presented in **Annexure VI.10**. This data indicates that there is continuous decrease in area irrigated by canals and consistent increase in area irrigated by groundwater sources. Thus, the dependence groundwater sources in the command area districts of Ramganga project had increased from 30 per cent to over 65 per cent. This was mainly because of reduced flows, into Ramganga Reservoir and subsequent reduction in supply of canal water particularly to middle and tail end farmers in the distribution system. These phenomena had been confirmed by the responses from command area farmers in middle and tail end area of the distribution system. The irrigation planning in the command of Ramganga project was based on 60 per cent dependence on canal water and 40 per cent dependence of groundwater resources. Further, the interaction with command area farmers during the field survey indicated that the canal water supply to middle and tail end farmers got reduced due to lack of proper maintenance of distribution network particularly in the head reach area and unauthorized withdrawal of canal water by breaching canal bunds. This ultimately resulted in rapid increase in shallow tube wells and state tube wells. The density of shallow tube wells in the command area blocks, as per latest (2004) date is presented in Figure 6.8 and 6.9, gives the density of state tubewells in the Ramganga



command area blocks during 2004. The immediate consequence of this scenario in the utilization of canal and groundwater was the water logging in the head reach area of the project and over exploitation of groundwater in the middle tail end area. The density of shallow tube wells and state tube wells as at the end of March 2008 is given in **Figures 6.8 and 6.9** respectively.

WATER POLICY

Laws and Regulatory system controlling Ground Water use:

6.77 Under India's constitution water is considered a 'State Subject' with legislation & administration substantially framed within the context of the State boundaries. The most comprehensive water policy statement issued at Govt. level is the "National Water Policy" adopted by the National Water Resource Council (NWRC). On the basis of provisions given in "National Water Policy", policy has also been issued by the State of U.P during June 1999. In which a provision for effective regulation on Ground Water Development & Management has been made. A specific need in the State is the enactment of Ground Water Legislation to enable better regulation & Management of ground water development & extraction. A model bill for ground water regulation was made available to State from Central Ground Water Board, Ministry of Water Resources' Govt. of India. On the Basis of which "A model bill to regulate & control the development of ground water and the matters connected there with" was prepared by the department and has been forwarded to Govt. of U.P. for approval by the State Cabinet. This legislation is to regulate the Ground Water development & extraction in the state and will be finalized at Govt. level, very shortly.

6.78 The state of Uttar Pradesh has not formulated any Ground Water Policy separately. However, National Bank for Agriculture and Rural Development controls the financing of private minor irrigation schemes through commercial Banks by adopting the guidelines of Ground water Estimation Committee 1997. It provide for categorization of development blocks on the basis of stage of Ground Water level as below:

The criteria for categorization of assessment units are as follows:

Sl.	Stage of Ground Water	Significant Lor	Significant Long Term Decline				
No	Development	Development Pre-Monsoon		Categorization			
		No	No	SAFE			
1	<=70%	Yes / No	No / Yes	To be re-asses			
		Yes	Yes	To be re-asses			
		No	No	SAFE			
2	> 70% and <= 90%	Yes / No	No / Yes	SEMI - CRITICAL			
		Yes	Yes	To be re-assessed			



Sl.	Stage of Ground Water	Significant Lor	Significant Long Term Decline			
No	Development	Pre-Monsoon	Post-Monsoon	Categorization		
		No	No	To be re-assessed		
3	> 90% and <= 100%	Yes / No	No / Yes	SEMI - CRITICAL		
		Yes	Yes	CRITICAL		
		No	No	To be Re-assessed		
		Yes / No	No / Yes	OVER -		
4	> 100%	1 68 / NO	NO/ Tes	EXPLOITED		
		Yes	Yes	OVER -		
		ies	i es	EXPLOITED		

Note: 'To be re-assessed' means that data is to be checked and reviewed. If the ground water resource assessment and the trend of long term water levels contradict each other, this anomalous situation requires a review of the ground water resource computation, as well as the reliability of water level data.

The Ground Water Department, U.P., has carried out Block wise ground water estimation for all districts, based on data as on 01.04.2004 and 31-3-2008. The commercial banks do not finance installation of any private minor irrigation works viz. private tube wells ,bore wells and electrification of pumps in the blocks categorized as overexploited and critical. Further, loaning with caution is continued in semi critical category blocks, whereas, there is no restriction in safe blocks. But there is no control over installation on M.I. works through private investment.

Methodology for Assessment of Dynamic Ground Water Resource (GEC 1997)

- 6.80 The present methodology which is in practice for groundwater resource assessment in India is known as 'Ground Water Resource Estimation Methodology -**1997** (GEC-1997)'. Watershed with well defined hydro-geological boundaries is considered as an appropriate unit for groundwater resource estimation in this methodology. In hard rock area the hydro-geological and hydrological units normally coincide, which may not be the case in alluvial areas, where the aguifers traverse the basin boundaries. Hence, watershed is recommended as assessment unit in hard rock area and block as assessment unit in alluvial areas.
- 6.81 In each assessment unit particularly in hard rock areas, hilly areas having slope more than 20 per cent are deleted from the total area of the unit to get the area suitable for recharge. Further, areas where the quality of ground water is beyond the usable limits should be identified and handled separately. The remaining area after deleting the hilly area (in hard rock region) and separating the area with poor ground water quality from assessment unit is to be delineated into canal command and non-command areas. Ground



water assessment in command and non-command areas are done separately for monsoon and non-monsoon seasons. Two approaches namely (1) Ground water level fluctuation method, (2) Rainfall infiltration factor method, form the basis for ground water assessment in GEC-1997.

6.82 The water level fluctuation method is based on the concept of storage increase due to difference between various input and output components. Input refers to recharge from rainfall and other sources and subsurface inflow into the unit. Output refers to ground water draft, ground water vapor transpiration, and base flow to streams and subsurface outflow from the unit. Since, the data on subsurface inflow/outflow are not readily available; inflow/outflow across these boundaries may be taken as negligible.

Recharge from rainfall is based on quantum of normal rainfall and rainfall infiltration factor in the area.

Groundwater Recharge Monsoon season

6.83 The resources assessment during monsoon season is estimated as the sum total of the change in storage and gross draft. The change in storage is computed by multiplying water level fluctuation between pre and post monsoon periods with the area of assessment and specific yield.

Monsoon recharge can be expressed as -

$$R = h X Sy X A + DG$$

Where.

h = rise in water level in the monsoon season, A = area for computation of recharge, Sy = specific yield, DG = gross ground water draft

The monsoon ground water recharge has two components—rainfall recharge and recharge from other sources. Mathematically it can be represented as —

$$R ext{ (Normal)} = Rrf ext{ (normal)} + Rc + Rsw + Rt + Rgw + Rwc$$

Where,

Rrf is the normal monsoon rainfall recharge. The other sources of ground water recharge during monsoon season include Rc, Rsw, Rt, Rgw, Rwc which are recharge from rainfall, seepage from canals, surface water irrigation, tanks and ponds, ground water irrigation, water conservation structures respectively.



The rainfall recharge during monsoon season computed by Water Level Fluctuation (WLF) method is compared with recharge figures from Rainfall Infiltration Factor (RIF) method. In case the difference between the two sets of data are more than ±20%, then RIF method figure is considered, otherwise monsoon recharge from WLF method is adopted. While adopting the rainfall recharge figures, weightage is to be given to WLF method over adhoc norms method (RIF method). Hence, wherever the difference between RIF method & WLF method is more than ±20%, data have to be scrutinized and corrected accordingly.

Non-Monsoon season

During Non-Monsoon season, rainfall recharge is computed by using Rainfall Infiltration Factor (RIF) method. Recharge from other sources is then added to get total Non-monsoon recharge. In case of areas receiving less than 10 per cent of the annual rainfall during non-monsoon season, the rainfall recharge is ignored.

Total annual ground water recharge

The total annual ground water recharge of the area is the sum-total of monsoon and non-monsoon recharge. An allowance is kept for natural discharge in the nonmonsoon season by deducting 5 per cent of total annual ground water recharge, if WLF method is employed to compute rainfall recharge during monsoon season and 10 per cent of total annual ground water recharge if RIF method is employed. The balance ground water available accounts for existing ground water withdrawal for various uses and potential for future development. This quantity is termed as Net Ground Water Availability.

Net Ground Water Availability = Annual Ground Water Recharge – Unaccounted Natural Discharge

Norms for estimation of recharge

GEC-97 methodology has recommended norms for various parameters being used in ground water recharge estimation. These norms vary depending upon water bearing formations and agro climatic conditions. While norms for specific yield and rainfall infiltration values are to be adopted within the guidelines of GEC-97, in case of other parameters like seepage from canals, return flow from irrigation, recharge from tanks & ponds, water conservation structures, results of specific case studies may replace the adhoc norms.

The gross yearly ground water draft is to be calculated for Irrigation, domestic 6.88 and Industrial uses. The gross ground water draft would include the ground water extraction from all existing ground water structures during monsoon as well as during



non-monsoon period. While the number of ground water structures should preferably be based on latest well census, the average unit draft from different types of structures should be based on specific studies or ad-hoc norms given in 'GEC-1997' report.

Stage of ground water development & Categorization of units

The stage of Ground water Development is defined by,

Existing Gross Ground Water Draft for all uses

Stage of Ground Water = -----X 100

Development (%) Net annual Ground Water Availability

Categorization of areas for Ground Water Development

6.89 The units of assessment are categorized for ground water development based on two criteria (a) Stage of ground water development, and (b) long-term trend of pre and post monsoon water levels. Four categories are – **Safe** areas which have ground water potential for development; **Semi-critical** areas where cautious ground water development is recommended; **Critical** and **Overexploited** areas where there should be intensive monitoring & evaluation. Future ground water development in this area be linked with water conservation measures.

6.90 The long term ground water level data should preferably be for the period of 10 years. The significant rate of water level decline may be taken between 10 to 20 cm. per year depending upon the local hydrogeological conditions.

Allocation of ground water resource for different utilization:

- 6.91 The net annual ground water availability is to be apportioned between domestic, industrial and irrigation uses. Among these, as per the National Water Policy-2002, requirement for domestic water supply is to be accorded highest priority. The requirement for domestic and industrial water supply is to be kept based on population as projected to the next 25 years. The water available for irrigation use is obtained by deducting the allocation for domestic and industrial use for next 25 years and ground water draft for irrigation, from the net annual ground water availability.
- 6.92 The tenth meeting of R&D Advisory Committee of Ground Water Estimation held on 17th Sept, 2008 at New Delhi, the following procedure was suggested in order to eliminate the confusion regarding negative availability of Ground Water Resource for future irrigation needs.

Net Annual Ground Water Availability = GWav Exiting Ground Water Draft for Irrigation = Dgi



Exiting Ground Water Draft for Domestic use Dgd Exiting Ground Water Draft for all uses Dg = Computed Value of allocation for domestic use Alld

(Based on projected population, fractional load and per capita requirement)

- Case 1, when GWav Dgi + Alld In such cases allocation for future domestic requirement = Alld
- Case 2, when GWav < Dgi + Alld In such cases Allocation for future domestic requirement = (GWav - Dgi) or Dgd, whichever is more.

Poor quality ground water

6.93 Computation of ground water recharge in poor quality ground water is to be done on the same line as described above. However, in saline areas, there may be practical difficulty due to non availability of data, as there will usually be no observation wells in such areas. Recharge assessment in such cases may be done based on rainfall infiltration factor method.

Apportioning of ground water assessment from watershed to development unit:

Where the assessment unit is a watershed, the ground water assessment is converted in terms of an administrative unit such as block. This is done by converting the volumetric resource into depth unit and then multiplying this depth with the corresponding area of the block.

Additional Potential Recharge:

Water logged and shallow water table areas:

In shallow water table areas, particularly in discharge areas, rejected recharge 6.95 would be considerable and water level fluctuation are subdued resulting in underestimation of recharge component. In the area where the groundwater level is less than 5 m. below ground level or in waterlogged areas, groundwater resources have to be estimated upto 5 m. bgl only based on the following equation

Potential ground water recharge = $(5-D) \times A \times Sp$. Yield Where,

> D= depth to water table below ground surface in pre-monsoon season in shallow aquifers. A = area of shallow water table zone.



6.96 This potential recharge to ground water is available only after depression of water level up to 5 m bgl. This is not an annual resource and should be recommended for development on a very cautious approach so that it does not adversely affect the ground water potential in the overall area.

Flood Prone Areas

- 6.97 Groundwater recharge from a flood plain is mainly the function of the following parameters:
 - i Area of flood plain
 - ii Retention period of flood
 - iii Type of sub soil strata and silt charge in the river water which gets deposited and controls seepage.
- 6.98 Since collection of data on all these factors is time taking and difficult, in the mean time, the potential recharge from flood plain may be estimated on the same norms as for ponds, tanks and lakes. This has to be calculated over the water spread area and only for the retention period.

Norms used for computation of Recharge Assessment and Draft Norms for Canal Seepage Factor

Sl. No	Canal Type (Unlined / lined)	Soil Type (Normal / sandy)	Seepage factor in hectare meters per day per million square meter of wetted area
1	Unlined	Normal Soil	15 to 20
2	Unlined	Sandy Soil	25 to 30
3	Lined	Normal Soil	3 to 4
4	Lined	Sandy Soil	5 to 6

The above norms strictly apply only for alluvial terrain in which the water table is also relatively deep.

6.99 The seepage factor in the case of canals in hard rock terrain is assumed to be the same as that given above for lined canals in normal soil, i.e., 3 to 4 hectare meters per day per million square meters of wetted area.



Norms	Norms for Return Flow Factor for Irrigation Water Applied by Surface Water Irrigation								
Sl. No	Canal Type (Unlined / lined)	Soil Type (Normal / sandy)	Seepage factor in hectare meters per day per million square meter of wetted area						
1	Paddy	< 10 meters	0.50						
2	Paddy	10 to 25 meters	0.40						
3	Paddy	> 25 meters	0.25						
4	Non- Paddy	< 10 meters	0.30						
5	Non – Paddy	10 to 25 meters	0.20						
6	Non – Paddy	> 25 meters	0.10						

6.100 The return flow factors as given above are applicable for rotational supply of irrigation water from the outlet. They are to be increased by another 0.05 if the supply of irrigation water from the outlet is continuous. For example, in the case of non-paddy with range of depth to water table being less than 10 meters, the return flow factor is to be taken as 0.35 (0.30+0.05) when the supply of surface water irrigation from the outlet is continuous. The return flow factor can be also adopted on the basis of results from documented field studies wherever they are available.

Norr	Norms for Return Flow Factor for Irrigation Water Applied by Ground Water							
		Irrigation						
Sl. No	Type of Crop (Unlined / lined)	Range of depth to water table below ground level (<10 mtr./10 to 25 mtr)	Return flow factor as a fraction					
1	Paddy	< 10 meters	0.45					
2	Paddy	10 to 25 meters	0.35					
3	Paddy	> 25 meters	0.20					
4	Non- Paddy	< 10 meters	0.25					
5	Non – Paddy	10 to 25 meters	0.15					
6	Non – Paddy	> 25 meters	0.05					

The return flow factors can be also adopted on the basis of results from documented field studies wherever they are available.

	Norms for Rainfall Infiltration Factor for Alluvial Terrain							
Sl.		Rainfall infiltration factor as a fraction						
No	Geographic Location	Recommended	Maximum	Minimum				
		Value	Value	Value				
1	Indo-Gangetic plains and inland areas	0.22	0.25	0.2				



For Hard rock Terrain

Sl.		Rainfall infiltration factor as a fraction				
No	Rock Type	Recommended Value**	Maximum Value	Minimum Value		
1	Semi-consolidated Sandstone	0.13	0.14	0.12		
2	Weathered Granite, Gneiss and Schist with low clay content	0.11	0.12	0.1		
3	Weathered Granite, Gneiss and Schist with Significant Clay content	0.08	0.09	0.05		
4	Consolidated Sandstone, Quartzite, Non-cavernous Limestone	0.06	0.07	0.05		
5	Shale's	0.04	0.05	0.03		
6	Massive Poorly Fractured Rock	0.01	0.03	0.01		

6.101 The recommended value of the 'Rainfall Infiltration Factor' alone as given above is to be adopted unless, results from documented field studies indicate that a value different from the recommended value can be used. Even in the latter case, the 'Rainfall Infiltration Factor' which is adopted has to be within the range of the maximum and minimum values as specified above.

6.102 The 'Rainfall Infiltration Factor' obtained on the basis of the norms as given above has to be increased by 0.02 for those sub units in which watershed development with associated soil and water conservation measures are implemented.

	Norms for Rainfall Infiltration Factor for Alluvial Terrain								
Sl.		Specific yield as a fraction							
No	Types of Alluvium	Recommended Value	Maximum Value	Minimum Value					
1	Sandy	0.16	0.20	0.12					
2	Silty	0.10	0.12	0.08					
3	Clayey	0.06	0.08	0.04					

For Hard rock Terrain

Sl.		Specific yield as a fraction				
No	Rock Type	Recommended	Maximum	Minimum		
		Value	Value	Value		
1	Karstified limestone	0.08	0.15	0.05		
2	Sandstone	0.03	0.05	0.01		
3	Weathered Granite, Gneiss and Schist with Low Clay Content	0.03	0.04	0.02		



Sl.		Specific yield as a fraction				
No	Rock Type	Recommended Value	Maximum Value	Minimum Value		
4	Limestone	0.02	0.03	0.01		
5	Weathered Granite, Gneiss and Schist with Significant Clay Content	0.015	0.02	0.01		
6	Shale's	0.015	0.02	0.01		
7	Massive Poorly Fractured Rock	0.003	0.005	0.002		

Norms Adopted in Resource Estimation as on 31-03-2008

1- Unit draft:

(a) For Irrigation Purpose

Unit draft for dug wells wherever existing has been taken as 0.5 ham while for shallow private tube wells and of state tube wells the unit draft have been taken on the basis of sample surveys.

(b) For domestic and industrial purposes

60 Lpcd dependency factor has been taken as 1.0 in all the blocks Future allocation has been estimated based on 60 Lpcd and considering dependency factor as 1.

2- Rate of Significant decline in water levels:

The rate of significant decline in water levels has been taken 20 cm/year in all the blocks.

Ground Water Resources Estimation

6.103 Groundwater resource estimation as on 31.3.2008 has been carried out with administrative blocks as ground water assessment units since the watershed wise required data was not available in hard rock areas. Due to lack of data on command, noncommand and poor groundwater quality areas, the resources could not be estimated separately and therefore have been estimated as one unit.

6.104 Since assessment unit and administrative unit are same, the categorization of ground water development is given on block level. Due to lack of data on poor ground water quality areas the resource could not be separately estimated. Depending on the availability of water level data 5 to 10 years data is used for computation of water level trend in the block. The salient features of Dynamic ground water resources for the State are given in the following Table.



Sl. No	Type of Assessment Unit	Blocks
1	Total no. of Assessment units	820
2	Base year of collection of Data	2007-08
3	Net Groundwater availability	6708931.65 Ham / 67.09 BCM
4	Gross Groundwater draft for all uses	4795421.78 Ham / 47.95 BCM
5	Stage of Groundwater development	71.48%
6	Balance available for future irrigation use (as on 31/03/2008)	1853803.00 Ham / 18.54 BCM
7	Additional Potential Recharge	968322.41 Ham / 9.68 BCM

Summary of categorization of blocks in the state of UP is as follows-

Sl. No	Category	No. of Blocks
1	Over-exploited	76
2	Critical	25
3	Semi-critical	117
4	Safe	602
	Total	820

6.105 Computation of recharge assessment and ground water draft has been done as per the recommendations of 'GEC-1997 Methodology' applicable for the state. The specific yield, rainfall infiltration factor and other relevant parameters have been adopted within the recommended ranges for different hydro-geological conditions. The groundwater recharge for 223 blocks has been estimated by Water Table Fluctuation approach (WTF) and for remaining 597 blocks it has been computed by comparing values estimated by WTF and RIF Method. The groundwater draft for irrigation has been estimated based on ground water abstraction structures as on 31-03-2008 and its unit draft estimated from sample survey / documented studies / recommended norms.

Additional Annual Potential Recharge

It has been estimated that about 968322.41 ham as the additional potential recharge which can also be utilized for future irrigation use.

Groundwater Movement and Hydrological Cycle

6.106 Groundwater constitutes one important portion of earth's water circulating system known as the hydrologic cycle. Water bearing formations of the earth's crust act as conduits for transmission and as reservoirs for storage of water. Water enters these formations from the ground surface or from bodies of surface water after which it travels slowly for varying distances. Until returned to the surface by action of natural flow plants



or man. The storage capacity of groundwater reservoirs combined with small flow rates provide large extensively distributed source of water supply. Groundwater emerging into surface runoff is low or nonexistent. Similarly, water pumped from wells represents the soil water sources in many regions during most part of the year.

6.107 Practically all groundwater originates as surface-water. Principal sources of natural recharge include precipitation, stream flow, lakes and reservoirs. Other contributions known as artificial recharge occur from excess irrigation and seepages in the saturated zone under the action direction determined by the surrounding hydraulic situation.

6.108 Discharge of groundwater occurs when water emerges from underground. Most natural discharge occurs as flow into surface water bodies such as streams lakes and oceans flow to the surface appears as spring. Groundwater near the surface return directly to the atmosphere by evaporation from within the soil and by transpiration from vegetation, Pumpage from wells constitutes the major artificial discharge of groundwater.

Concept of Safe Yield

6.109 The quantity of groundwater is limited and to provide maximum development of groundwater resources for beneficial use requires correct estimation of Safe Yield which is the amount of water which can be withdrawn without producing undesirable results or depletion of the groundwater table.

6.110 The "safe yield" of groundwater or the practical rates of withdrawing water from it periodically for human use may be estimated by assessing periodic inventories of the entire water supply of the area (its entrance into the area as precipitation stream flow or underground percolation) and its exist as evaporation, transpiration, runoff or underground leakage. For accurate estimation of "Safe Yield", the inventory should be based on long term data of inflows and out flows. The district-wise total recharge to groundwater resources and corresponding sage yields, which is estimated as 85 per cent of total recharge, as on 31st March 2004 and 2008 for Ramganga command area districts is presented in **Table 6.12**. The total safe yields of groundwater as at the end of March 2004 and 2008 for the Ramganga Command districts is estimated to be 10.67 lakh hm respectively. Fatehpur district accounted for maximum of the safe yield with 1.09 lakh hm and as on 31st March 2004. The same was maximum at 0.87 lakh hm as on 31st March 2008 in Mathura district.



Table 6.12 District-	Table 6.12 District-wise Safe Yields (ha.mt) as on 31.03.2004 & 31.03.2008 in							
the Ramganga Command Area								
District Name	Total Rec	harge as on	Safe Yield after 15%					
District Name	31.03.2004	31.03.2008	31.03.2004	31.03.2008				
Agra	96472.18	130337.22	82001.35	110786.63				
Aligarh	96278.57	106703.97	81836.78	90698.37				
Auraiya	73038.79	59410.51	62082.97	50498.93				
Etah	112881.41	68955.64	95949.19	58612.29				
Etawah	70835.43	67506.09	60210.11	57380.17				
Farrukhabad	64330.54	53470.69	54680.95	45450.08				
Fatehpur	129376.09	99296.07	109969.67	84401.65				
Firozabad	70536.72	70877.41	59956.21	60245.79				
Kannauj	71060.71	65585.05	60401.60	55747.29				
Ramabai Nagar	89107.99	76350.21	75741.79	64897.67				
Kanpur Nagar	92661.76	75627.48	78762.49	64283.35				
Kaushambi	41844.91	40786.76	35568.17	34668.74				
Mainpuri	85112.39	84397.78	72345.53	71738.11				
Mathura	97424.36	102497.91	82810.70	87123.22				
Mahamaya Nagar	64828.23	55985.11	55103.99	47587.34				
Total Ramganga	1255790.08	1157787.90	1067421.50	984119.63				
Source: Complied of	n the basis of in	formation obtain	ned from UP G	roundwater				

Water Scenario in the Ramganga Command Area of U.P

6.111 Sustainable development and efficient water management is an increasing challenge in many countries. Uttar Pradesh is the land of gangetic plain with vast fertile land, abundant surface & groundwater resources. There is also adequate precipitation during monsoon but urban as well as rural Uttar Pradesh in general surfers from inadequate water supply particularly during summer months. Increasing population, growing industrialization, ruthless deforestation and climate threats have adversely affected the hydrological cycle of various regions. Magnitude of demand is increasing due to population growth in some towns viz, Agra, Aligarh, Kanpur, Mathura. Piped water supply is available but availability and quality of water is very low. The command area is affected by acute water scarcity in rural areas with 30 per cent habitations receiving water less than the basic level of 40 lpcd as prescribed by Government of India. Rural water supply system range from traditional open wells and hand pumps to piped water supply scheme with treatment plants and private connections. Tube wells and hand pumps are the main source for drinking water of 86% of rural households in command area, the capital cost of these rural water schemes is fully subsidized by the government. The operation and maintenance cost, though theoretically chargeable to the Users, is almost fully subsidized by the Government. Maintenance of rural water supply systems is

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Department

not of high standards, with about one fourth of rural water supply systems out of operation at any given time.

6.112 Ground water in the command forms a major source of drinking water in urban as well as rural areas. More than 90 per cent of the rural population uses the groundwater domestic and other purposes. Quality of public health depends on the quality of drinking water and its source. Surface-water quality data show that surface-water pollution in U.P. is acute & widespread, caused mainly by sewage; groundwater quality is also believed to be low & deteriorating. Certain districts have patches of harmful contaminants. Fluoride limit in groundwater is considerably higher than the permissible limit in many areas. For instance many blocks of Aligarh and Agra districts have concentration exceeding 1.5mgl/l of fluoride. Endemic flourosis and other fluoride related problems that are related to the presence of fluoride in water; mainly groundwater is a public health problem in most districts villages. The excess fluoride ingestion by children in different villages and districts especially in Kanpur & Agra has resulted in dental & skeletal flour sis. Concentration of fluorine ranging between 1.5 ppm (parts per million) and 4 ppm of fluoride causes skeletal floursis. In highly contaminated areas, safe and efficient defluoridation techniques need to be developed depending on the chemical/composition of groundwater. Appropriate depending on the chemical composition of groundwater. Appropriate defluoridation of domestic/community filter should be adapted to health hazards.

6.113 The western part especially Aligarh, Mathura, Agra show a concentration of chloride in isolated patches whereas in parts of Etah the concentration is marginally higher than the permissible limits. Similarly Northwest of Fatehpur has marginally high chloride concentration. Non point sources of population from agriculture and other sources combined with point source pollution represent a major challenge for ground water management. Biological contamination although not mentioned in table pollute water during monsoon period and results in communication diseases like cholera, hepatitis, T.B, polio etc.

Major constraints with water in the state

- > Declining ground water level.
- Inadequate supply of drinking water as sources is drying.
- ➤ Quality of ground water of rivers, water bodies and ground water is deteriorating.
- > Systems are getting defunct due to poor maintenance.
- > Presence of hazardous pollutions.
- Little coordination between surface water and ground water development program.
- ➤ Increasing water demand from other sectors.
- Wastewater treatment, sewerage & sanitation are also in bad shape.



- ➤ Poor delivery of water, inadequate drainage & sewerage system results in high coping cost, environmental in monsoon months.
- 6.114 It is imperative to plan the development and management of water in more scientific and planed manner for its economical utilization without creating any environment hazards. Multiple problems may be dealt only with coordinated efforts by different stakeholders.

Groundwater Utilization by Exiting Works

6.115 The main utilization or draft of groundwater is on account of state tube wells, private tube wells, pump sets on boring and dug wells. The use for drinking water and industries etc. is insignificant as compared to above. Regarding state tube wells their discharge and actual running hours are known and draft has been worked out accordingly but as far as private minor irrigation is concerned, no details of actual discharge and running hours are available and the draft is based on following standard norms fixed by NABARD after some field surveys.

Sl. No	Works	Unit Draft (Hect. Meter)
1	Masonry well	0.5
2	Wells fitted with Persain wheels	0.9
3	Pump sets	1.4
4	Private tube wells	2.2

6.116 In spite of above standard norms in some blocks of districts the actual unit draft figures has been adopted based on the sample survey of minor irrigation works and micro study performed in the block.

Groundwater Scenario of Ramganga Command Area

6.117 Based on the standard norms and methodology explained earlier, the groundwater resource potential in terms of recharge, net draft, utilization and stage of groundwater development during 1995, 2004 and 2008 is estimated. These details are presented in **Table 6.13**. It is found that the minimum utilization in the year 2004 was 41.90 per cent in Etawah district and maximum utilization of 88.69 per cent was in Agra district during the year. In the year 2008 minimum utilization was 57.51 per cent in Etawah district while the maximum utilization of 96.99 per cent was in Agra district. The stage of groundwater development was more than 80 per cent in six districts during 2004 and 2008 and it was less than 60 per cent in four districts during 2004 and one district during 2008. Similar details for about 104 sample blocks from these districts are presented in **Annexure VI.11**.



Table 6.13	Table 6.13 District wise Feasibility in terms of Recharge, Net Draft Utilization and Stage of Groundwater Development during 1995, 2004 and 2008											
District	Recharge			Net Draft		Utilization		Stage of Ground Water Development %				
Name	1995	2004	2008	1995	2004	2008	1995	2004	2008	1995	2004	2008
Agra	83463.55	96472.18	88448.02	50156.79	85560.09	69498.91	33306.76	8082.78	17549.42	60.09	88.69	96.99
Aligarh	116392.91	96278.57	106703.97	68681.99	77840.15	83942.22	47710.92	15948.05	21139.91	59.01	80.85	78.66
Auraiya		73038.79	59410.51		41955.43	42119.29	30368.00	30368.09	16186.07		57.44	70.90
Etah	124564.46	112881.41	68955.64	58136.46	88429.70	60026.59	66428.00	21176.54	7795.86	46.67	78.34	87.05
Etawah	120366.32	70835.43	67506.09	32130.59	29688.84	38824.39	88235.73	40489.10	27963.01	26.69	41.91	57.51
Farrukhabad	100175.90	64330.54	53470.39	51795.10	47690.70	38346.86	48380.80	15565.10	13372.98	51.70	74.55	71.72
Fathepur	117247.39	129376.09	99296.07	45804.99	91241.00	82499.01	71442.40	36226.13	10524.85	39.07	70.52	83.08
Firozabad		70536.72	70877.41		56773.06	69356.35		11739.16	7129.63		80.49	97.85
Hathras		71060.71	55985.11		46018.80	49595.29		24000.06	6078.19		64.76	88.59
Kannauj		71060.71	65585.05		46018.80	42152.94		24000.06	22397.76		64.76	64.27
Ramabai Nagar	122553.00	89107.99	76350.21	56746.20	44002.81	55030.82	65806.80	44304.73	19633.87	46.30	49.38	72.08
Kanpur Nagar	17550.26	92661.76	75627.48	6265.97	62393.11	58687.69	11284.28	28628.99	15489.26	35.70	67.33	77.60
Kaushambi		41844.91	40786.76		25100.20	31327.89		15086.98	6633.27		59.98	76.81
Mainpuri	71209.36	85112.39	84397.78	37569.52	6942.67	69219.49	33639.84	12993.06	13686.96	52.76	81.82	82.02
Mathura	78415.66	97242.36	102497.91	40126.65	80064.96	78212.63	38289.01	14394.04	23436.03	51.17	82.18	76.31
Total	951938.81	1261840.56	1115898.40	447414.26	829720.32	868840.37	534892.54	343002.87	229017.07	469.16	1043.00	1181.44
Source: Comp	olied on the ba	isis of informa	ation obtained	from UP Gr	oundwater D	epartment						

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6.118 The groundwater resource potential in terms of net groundwater availability, groundwater draft for irrigation and drinking water and industrial use, allocation for domestic and industrial use during next 25 years and net groundwater availability for future irrigation development was computed for all the command area districts as at the end of March 2008. These details are presented in **Table 6.14**. The net groundwater availability for future irrigation development, after allocation for future after 25 years domestic and industrial supply, in the Ramganga Command Area districts is assessed to be 2.17 lakh hm. Maximum (0.28 lakh hm) of this future availability of groundwater for irrigation is available in Etawah district, while the lowest of 5.11 thousand hm is available in Agra district. The balance groundwater available is suitable for agriculture, drinking and industrial use except at few places. In various districts wise chemical quality as discussed in quality paragraph. Categorization of blocks with respect to groundwater development, pattern of groundwater development, quantum of water available for future use, pattern of groundwater withdrawal are given in the **Table.6.14** (**Figure 6.10 6.11**, **6.12**, **6.13 and 6.14**)

	Table 6.14 Ground Water Resource Potential of Ramganga Command As on 31.03.2008									
Sl. no	District	Net Annual Ground Water Availability In Ham)	Existing Ground Water Draft for Irrigation (In Ham)	Draft for Industrial & Domestic Water Use (In Ham)	Existing Gross Ground Water Draft for All Uses (In Ham)	Allocation for Domestic and Industrial Requirement Supply upto next 25 years (year 2033)	Net Ground Water Availability for Future Irrigation Development (in Ham)	Stage of Ground Water Developme nt (In %)		
1	2	3	4	5	6	7	8	9		
1	Agra	100337.22	86955.93	10363.10	97319.03	8261.59	5119.70	96.99		
2	Aligarh	106703.97	78875.38	5066.84	83942.22	6688.68	21139.91	78.67		
3	Auraiya	59410.51	39514.70	2604.59	42119.29	3709.74	16186.07	70.9		
4	Etah	68955.64	56738.79	3287.80	60026.59	4420.99	7795.86	87.05		
5	Etawah	67506.09	36384.62	2439.77	38824.39	3158.46	27963.01	57.51		
6	Farrukhabad	53470.69	35242.44	3104.42	38346.86	4855.27	13372.98	71.72		
7	Fathepur	99296.07	77334.57	5164.44	82499.01	11436.65	10524.85	83.08		
8	Firozabad	70877.41	65841.46	3514.89	69356.35	3411.14	7129.63	97.85		
9	Hathras	55985.11	45715.44	3179.85	49595.29	4191.48	6078.19	88.59		
10	Kannauj	65585.05	39386.25	2766.69	42152.94	3801.04	22397.76	64.27		
11	Kanpur Dehat	76350.21	51477.08	3553.74	55030.82	5239.26	19633.87	72.08		
12	Kanpur Nagar	75627.48	55356.81	3330.88	58687.69	4781.41	15489.26	77.6		
13	Kaushambi	40786.76	28264.90	3062.99	31327.89	5888.59	6633.27	76.81		
14	Mainpuri	84397.78	65470.39	3749.10	69219.49	5240.43	13686.96	82.02		
15	Mathura	102497.91	74600.85	3611.78	78212.63	4461.03	23436.03	76.31		
CN	AMGANGA MD TOTAL O: * District Kar	1127787.9	837159.61	58800.88	896660.49	79545.76	216587.35	79.51		

Note: * District Kanshiram Nagar has been included in District Etah.

Source: Complied on the basis of information obtained from UP Groundwater Department



6.119 There are wide variations in the level of groundwater extraction across blocks within a given district. In case of Uttar Pradesh, the blocks are categorized into four categories as viz., overexploited critical, semi-critical and safe criteria by the Central Groundwater Board. The district-wise listing of blocks in three categories i.e., overexploited, critical and semi critical is presented in **Table 6.15**. As per this list there are 24 blocks which are categoriesed as over exploited in Ramganga command area districts. These blocks accounted for about 16.77 per cent of total blocks in the command area of Ramganga project. Majority (25%) of these blocks are from Agra district, wherein the groundwater extraction is more than 96 per cent of annual recharge of groundwater. Six of the total 148 blocks in the command are of Ramganga project is categorized as critical and three of these blocks are in Fatehpur district. Another 29 blocks in the command are districts of Ramganga project are categorized as semi-critical with respect to groundwater extraction as at the end of March 2008. Thus, the major part of the future groundwater extraction may need to be from the balance 89 blocks, which are in safe category of groundwater extraction (**Figure 6.15**).

Table 6.15 District-wise Categorization of Blocks in Ramganga Command (As on 31-03-2008)								
CI No	District	Categorization of Block						
Sl. No	District	Over Exploited	Critical	Semi Critical				
1	2	3	4	5				
		Akola	Saiyan	Achhnera				
		Barauli Ahir	-	Jagner				
1	Agra	Bichpuri	_	Khairagarh				
1	Agia	Fatehpur sikari	_	-				
		Kandauli	_	-				
		Samsabad	_	-				
		-	_	Atarauli				
2	Aligarh	-	_	Chandaus				
2	Aligaili	-	_	Iglas				
		-	_	Khair				
3	Etah	Marhara	-	Jalesar				
	Ltan	Sakeet	-	-				
		-	Amauli	Airaya				
		-	Haswa	Bahuwa				
		-	Malawan	Bhitaura				
4	Fatehpur	-	_	Deomai				
7	1 attripui	-	-	Hathgoan				
		-	-	Khajuha				
		-	-	Teliyani				
		-	_	Vijayeepur				



Cable 6	5.15 District-wise	Categorization of I 31-03-20		ganga Command (A			
Ol Ma	District	C	Categorization of Block				
Sl. No	District	Over Exploited	Critical	Semi Critical			
1	2	3	4	5			
		Aron	-	Khairgarh			
5	Firozabad	Eka	-	Madanapur			
3	FIIOZabau	Narkhi	-	Shikohabad			
		Tundla	-	-			
		Hathras	-	Sahpau			
		Mursan	-	-			
6	Hathras	Sadabad	-	-			
		Sasni	-	-			
		-	-	Sujanganj			
7	Kannauj	Jalalabad	-	Kannauj			
/	Kaimauj	Telgram	-	-			
8	Kanpur Nagar	-	Ghatampur	-			
		Chail	-	Kara			
9	Kaushambi	Sirathu	_	Manjhanpur			
9	Kaushambi	-	_	Mooratganj			
		-	-	Newada			
10	Mainpuri	Barnahal	-	-			
10	Manipuri	Mainpuri	_	-			
11	Mathura	Nohjhil	Baldeo	Farah			
11	1viauiuia	Raya	-	Mat			
		-	-	Mathura			
	Total	24	6	29			

Source: Complied on the basis of information obtained from UP Groundwater Department

Quality of Ground Water

6.120 The categorization of blocks in the command districts of Ramganga project as at the end of March 2004 and 2008 had been this period. The results of these comparisons in six districts are presented in **Table 6.16** and consisted 12 blocks, which are reviewed during 2008. As per the categorization during 2004, there were 9 blocks in over exploited category and three in critical category. On the basis of review during 2008, the categorization of two critical blocks and one over exploited block were classified as safe. Similarly on over exploited category blocks in Hathras district was reclassified as semi-critical. The main reason for such reclassification was mainly due to assumption of water level decline at a higher level than actual observed during sample survey.



Command Area									
Sl. no	Districts	Blocks	Category 31-03-2004 31-03-2008		Stage of Development 31-03-2008	Reason for Change in Category			
1	2	3	4	5	6	7			
1	A	Barauli Ahir	Over Exploited	Over Exploited	174.15	No Change in Category			
1	Agra	Shamsabad	Over Exploited	Over Exploited	136.84	No Change in Category			
2	Etah	Marhara	Over Exploited	Over Exploited	155.48	No Change in Category			
2	Etan	Sakeet	Over Exploited	Over Exploited	115.80	No Change in Category			
3	Farrukhabad	Barhpur	Over Exploited	Safe	88.22	Unit Draft taken based on Sample Survey Result which is lower than norms and water level declining trend is considered 20 cm/year instead of 10 cm/year.			
		Kamalganj	Critical	Safe	87.46	Unit Draft taken based on Sample Survey Result which is lower than norms and water level declining trend is considered 20 cm/year instead of 10 cm/year.			
4	Firozabad	Firozabad	Critical	Safe	78.51	Unit Draft taken based on Sample Survey Result which is lower than norms and water level declining trend is considered 20 cm/yea instead of 10 cm/year.			
		Hathras	Critical	Over Exploited	115.36	Increase in Ground Water Withdrawal			
		Sadabad	Over Exploited	Over Exploited	109.08	No Change in Category			
5	Hathras	Hathras	Sahpau	Over Exploited	Semi Critical	88.18	Unit Draft taken based on Sample Survey Result which is lower than norms.		
		Sasni	Over Exploited	Over Exploited	108.76	No Change in Category			
6	Mathura	Nohjhil	Over Exploited	Over Exploited	124.71	No Change in Category			



- 6.121 Ground water is commonly tapped from phreatic aquifers (shallow aquifers) through dug wells and through springs, private tube wells and handpumps etc. The main objective of ground water quality is to get information on the distribution of water quality in the area. The distribution of the following constituents in ground water, tapping the unconfined aquifers as fallows:
 - 1. Electrical conductivity (750 3000 μ s/cm at 25°)
 - 2. Chloride (250 mg/liter)
 - 3. Fluoride (71.5mg/liter)
 - 4. Iron (71.0 mg/liter)
 - 5. Arsenic (>0.05mg/liter)
 - 6. Nitrate (>45 mg/liter)
- 6.122 The chemical quality of ground water is generally not very good in most part of the command area. The study indicates that the shallow ground water in part of Fatehpur, Etawah, Mainpuri, Etah and Aligarh has comparatively higher salinity than the remaining part. The chloride content above 250 ppm is generally not recommended for irrigation use. The worst affected parts having chloride more than 1000 ppm in the shallow aquifer are in Fatehpur, Aligarh, Agra and Mathura districts. The deep aquifer has salinity in part of Kanpur, Hamirpur and Fatehpur districts.
- 6.123 The distribution of total dissolved solid in shallow groundwater show that most of the aquifer in the unconsolidated sediments contain total solids less than 1000 ppm. The total solids more than 1000ppm are found in the groundwater of Fatehpur, Mainpuri, Etah, Aligarh and Mathura districts.
- 6.124 The bicarbonates in the shallow ground water are high ranging from 300 to 1000ppm. In most of the area the shallow ground water contain bicarbonate less than 500 ppm. It is only in part of Fatehpur, Etah, Mathura and Aligarh districts that the bicarbonate contents are extremely high.
- 6.125 The fluoride content in ground water was examined and it was found that in the year 2004, almost the whole of command area was affected by high fluoride concentration. More than 75% blocks of district. Aligarh, Mathura, Firozabad, Mainpuri, Kannauj, Etawah, Auraiya, Ramabai Nagar(Kanpur Dehat) are affected by higher % of fluoride. The arsenic problem has also been detected in district. Of Farrukhabad, Kannauj and Kanpur Nagar which is mainly due to various tanneries and perfume industries etc. higher % of Nitrate is over all present in the command area. If appears that the reason for high concentration of Fluoride, Arsenic and Nitrate may be due to the excessive use of chemical fertilizers insecticides, pesticides and improper disposal of municipal solid waste. District wise Fluoride and Nitrate affected blocks in the command area is given vide **Figure 6.16 and 6.17**.



The block wise problem with quality status of surface and groundwater is presented in **Annexure VI.12** (Figure 6.18).

Water Logging and Salinity

6.126 None of the districts falling within Ramganga command are experiencing waterlogging and salinity as per report of the Ministry of Water Resources (Group 1991) on waterlogging, salinity and alkalinity. During the site visits, it was made known that there is no problem of waterlogging, salinity and alkalinity in the lands irrigated under Ramganga command system. Firstly, the region falling in this command contains the sufficient gradient enough to have adequate drainage. Secondly there is no extensive irrigation for multiple crops in the command area due to the gap between demand for and supply of water for irrigation. The local public also informed that there is no water logging and soil salinity due to Ramganga project. The district wise wet land area statistics for pre and post monsoon period indicates that in pre monsoon period minimum of 0.12 per cent (Agra) to 2.51 per cent (Mainpuri) area is under wet land category, whereas during post monsoon period minimum 0.12 per cent (Agra) to 2.51 per cent (Mainpuri) area is under wet land area in the command area are presented in Tables 6.17 and 6.18. The tables indicate that the area as a whole is not affected by water logging and salinity.

Table 6.17 Wetland Area Estimates in the Command Area								
District	Total	Total No.		and Area Pre- Monsoon	Wetland Area Post-Monsoon			
District	Reported Area (ha)	of Wetlands	(ha)	% of Total Area	(ha)	% of Total Area		
Agra	399784	14	489	0.12	489	0.12		
Kanpur Dehat	511136	25	3022	0.59	3022	0.59		
Aligarh	502170	40	4244	0.85	4244	0.85		
Allahabad	727463	54	8816	1.21	9066	1.25		
Etah	443282	58	4841	1.09	4841	1.09		
Etawah	436650	51	4256	0.97	4703	1.08		
Farrukhabad	428059	59	4841	1.13	4841	1.13		
Fatehpur	421983	29	3917	0.93	3917	0.93		
Firozabad	236274	30	4196	1.78	4196	1.78		
Kanpur	104328	6	353	0.34	353	0.34		
Mainpuri	274058	62	6886	2.51	6886	2.51		
Mathura	399734	36	3518	0.88	3518	0.88		
The tables indicate that the area as a whole is not affected by waterlogging and salinity								



	Table 6.18 District-wise Waste Land in Ramganga Command Area									
Sl. No	District	Waterlogged and Marshy Land (Permanent)	Waterlogged and Marshy Land (Seasonal)	Land affected by Salinity / Alkalinity (Strong)	Land affected by Salinity / Alkalinity (Moderate)	Land affected by Salinity alkalinity (Slight)	Under utilized degraded notified forest land	Sands - (Flood Plain)		
1	Agra	0.68	0.47	0.2	16.01	0.25	22.72	0		
2	Aligarh	20.68	7.73	6.94	50.76	12.85	0	0		
3	Auraiya	0	9.95	3.16	100.67	4.82	0	0		
4	Etah	39.83	17.55	9.61	142.32	6.01	0	0		
5	Etawah	0	9.11	0.49	77.19	2.63	0	0		
6	Farrukhabad	0	102.94	0	60.2	5.86	0	0		
7	Fatehpur	22.07	26.81	5.31	119.88	62.78	0	52.6		
8	Firozabad	0.1	0.59	6.8	72.62	3.44	0	0		
9	Kannauj	0	5.97	12.34	110.05	3.35	0	0		
10	Kanpur Dehat	0	21.14	15.78	292.74	1.17	0	0		
11	Kanpur Nagar	0	6.25	0.9	37.36	22.61	0	0		
12	Kaushambi	4.22	2.01	75.97	19.25	7.83	0	5.8		
13	Mainpuri	0	6.68	8.32	122.69	29.52	0	0		
14	Mathura	12.05	3.11	0.57	9.98	0	12.17	0		
	Mahamaya			4.04	20 = 1		0			
15	Nagar	2.64	1.25	1.81	28.74	1.77	0.67	0		
	Total	102.27	221.56	148.2	1260.46	164.89	35.56	58.4		
Sourc	Source: Department of Land Records, Government of Uttar Pradesh									



Conjunctive Use of Water

6.127 The main objective of conjunctive use of surface water and ground water in a canal command is to optimally utilize water resources with a view to maximizing agricultural production per unit of water used without adversely affecting the environment. Various aims and objectives of the conjunctive use of water resources in an irrigation command have been enumerated by (CWC1995) and also by the National Commission for Integrated Water Resources Development Plan (NCIWRDP 1999).

6.128 Different strategies of conjunctive use can be employed in irrigation command (CWC, 1995) depending on the spatial and/or temporal utilization of surface-water and groundwater. Strategies also differ for the use of good quality water in conjunction with the saline water. Three strategies of conjunctive water use in an irrigation command are as follows.

Strategy 1: Allocating Parcels of Land Permanently to a Particular Use

6.129 Under this, separate areas of the command are permanently allocated for surfacewater or groundwater use. The areas at higher elevation where it is difficult to take the canal water could be some such areas where groundwater might be the sole source of irrigation. In this strategy that recharge from the surface-water application will supplement the groundwater and this will be utilized in an adjacent area allocated groundwater use.

6.130 This form of conjunctive use is effective where distance of the wells from the recharge area (surface irrigation) is so small the groundwater flow is sustained by the available gradient. This strategy is feasible in alluvial areas because of the appreciable movement of groundwater. In hard rock areas and in clay soils, this strategy may not be feasible.

Strategy 2: Integrating Surface Water and Ground Water in Time

6.131 In this strategy, surface and groundwater are allocated in time such that in monsoon season, only surface-water is used and in the non-monsoon time, only groundwater is used. Since the same area is irrigated with surface and groundwater at different times, groundwater can use the same field channels that carry surface water. If private source of groundwater extraction are not available in the command, then augmentation of tube wells are planned and operated in such a way that groundwater carriage over long distances is avoided.



Combination of Strategy 1 and 2: Space and time Integration

6.132 Under this strategy, some parcels of land are permanently allocated for surface water use, some parcels are permanently allocated for ground water use, and some parcels are supplied with surface water in one season and ground water in another, For parcels of land in which both ground and surface water are used, the intra-annual regime of use can vary from year to year to take advantage of stable regime of ground water.

Guidelines for Conjunctive use Planning

6.133 Recognizing the urgent need of conjunctive use, new projects which do not include conjunctive use of water are not recommended for Planning Commission's clearance. CWC (1995) gives general guidelines for planning conjunctive use. According to these guidelines, the quantification of water available for conjunctive use may have to be decided using appropriate methodologies. The steps include establishing a quantum ground water, water balance of the command area under "without conjunctive use project "conditions, delineate the area where groundwater development is to be taken up based on the depth to water table and potential of aquifers, deciding the additional recharge that would become available in the command area in "with conjunctive use project condition", deciding the planed quantity of ground water use so as not to lead to progressive lowering or rising of water table and deciding the quantum of groundwater use available for irrigation after considering the other (non-irrigation) use of the planned ground water use, taking into account quality limitations such as the presence of brackish water. However, detailed action plans to implement the guidelines have to be drawn by respective states considering local conditions.

6.134 CWC (1995) suggests the use of NABARD guidelines for establishing preliminary groundwater balance based on some rules of thumb for estimating recharge in command areas arising from seepage canals, field channels and tanks and return flow from irrigation fields. In addition to estimating net annual groundwater recharge. The report also stresses on taking into account's i) minimum necessary withdrawal in order to avoid large imbalance leading to large rice in groundwater table, and ii) maximum permissible withdrawals with a view to maintain ecology and not allowing ground water to deplete, unless such depletion is the likely to be beneficial due to the very high ground table or rising tendency in the "without conjunctive use project" condition itself. The guidelines for extraction of groundwater in command areas as percentage of additional recharge caused by the project are given in **Table 6.19**.

6.135 For the purpose of this table, a general long term rise or fall of more than 0.2m/year in case of alluvial condition and of more than 0.5 m/year in case of hard rock areas would qualify for classifying the trend as "rising" or "falling". In case accurate ground water regime worked out by specialists and tested and verified through modeling and field verification in both conditions is available, the maximum/minimum withdrawal



can be worked out on the basis of the water balance studies instead of these percentages. Detailed studies are desirable in special areas having salinity problems. Further, economic considerations would finally decide the quantum of surface and for ground water extraction.

Table 6.19 Guide line for Groundwater Extraction							
Depth of Ground water	Trend	Minimum necessary Additional withdrawal (%)	Minimum permissible withdrawal (%)				
Less than 2m	Rising	70	100				
Less than 2m	Generally steady	50	80				
Less than 2m	Falling	30	60				
2m to 6m	Rising	60	90				
2m to 6m	Generally steady	40	70				
2m to 6m	Falling	20	60				
More than 6m	Rising	50	80				
More than 6m	Generally steady	30	60				
More than 6m	Falling	0	4				

Conjunctive Use of Surface and Ground Water

6.136 Conjunctive water use refers to simultaneous use of surface water and ground water in order to meet the crop demand and as well as to have an equilibrium between two major components. Conjunctive management by contrast refers to efforts planned at the scheme and basin level to optimize productivity equality and environmental sustainability by simultaneously managing surface and groundwater resources. Since surface irrigation practices directly influence groundwater recharge, improved main system management is the key to conjunctive management of surface and ground water resources.

6.137 The planning for integrated and conjunctive use of surface and ground water resources calls for detailed investigations and studies regarding sub soil conditions of the basin in respect of its storability transmissibility and its interaction with surface water as well as adjacent areas. For promotion of good crop, adequate and timely irrigation is essential, which may not be ensured by a single resource and warrants judicious use of surface and ground water resource.



6.138 District wise plan for conjunctive use of water for the year 2007-08, considering 200 per cent cropping intensity, was prepared along with the crop wise water requirement (Annexure VI.13). After utilization of available ground water resources, net shortfall comes to 13.45 lakh ham, which can be met by installation of 2834 state tube wells and 79748 private tube wells in 15 districts of the command, bearing a total cost of Rs. 30119.6 Lakh.Net short fall in the command area and irrigation water requirement are given in **Table 6.20** and **6.21**. The proposed structures in the command in order to meet the 200 per cent irrigation and the cost envolved are given in **Table 6.22**.

Table 6.20 Short fall of Groundwater in Ramganga Command Area								
District Name	Total Water Requirement for 200% Irrigation	Groundwater available for Irrigation	Groundwater available for Irrigation	Net Short fall (As on 2008)				
	Hect.Mt.	Hect.Mt.(2004)	Hect.Mt.(2008)	Hect.Mt.				
Agra	401353.35	8082	5119.7	396233.65				
Aligarh	119230.10	15948	21139.91	98090.19				
Auraiya	68459.75	30368	16186.07	52273.68				
Etawah	71016.50	40489	27963.01	43053.49				
Kannauj	68573.20	24000	22397.76	46175.44				
Etah*	-26685.55	21176	7795.86	-34481.41				
Fatehpur	185278.50	36226	10524.85	174753.65				
Farrukhabad	71886.70	15565	13372.98	58513.72				
Firozabad	90334.10	11739	7129.63	83204.47				
Kanpur Nagar	115797.35	28628	15489.26	100308.09				
Ramababi Nagar (Kanpur								
Dehat)	142593.00	44304	19633.87	122959.13				
Kaushambi	85485.00	15086	6633.27	78851.73				
Mathura	144673.35	14394	23436.03	121237.32				
Mahamaya Nagar	66130.10	-380	6078.19	60051.91				
Total for Command	1604125.45	305625	202900.39	1401225.06				

Note: * District Kanshiram Nagar has been included in District Etah.

Source: Groundwater Department U.P

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Table 6.21 Irrigation Water Requirement and Groundwater Balance for the Year 1985 - 2004 - 2008 in Ramganga Command Districts

	Water R	equirement	Groui	ndwater	Change in Availability		
District Name	for 200%	6 Irrigation	Ava	ilable			
	(Hect.mt.)		(He	ct.mt)	(Hect.mt)		
	1985	2008	1985	2008	1985	2008	
Agra	282819	401353.39	38685	8082.78	5119.70	2963.08	
Aligarh	199542	119230.10	66539	15948.05	21139.91	-5191.86	
Etah	180354	-26685.55	71521	21176.54	7795.86	13380.68	
Etawah	191041	71016.50	50150	40489.10	27963.01	12526.09	
Farrukhabad	201415	71886.70	62649	15565.10	13372.98	2192.12	
Fatehpur	232655	185278.50	102288	36226.13	10524.85	25701.28	
Kanpur	313686	115797.35	93269	28628.99	15489.26	13139.73	
Mainpur	184449	213071.65	74174	12993.06	13686.96	-693.90	
Mathura	195730	144673.35	77083	14394.04	13436.03	958.01	
Firozabad		90334.10		11739.16	7129.63	4609.53	
Kannauj		68573.20		24000.06	22397.76	1602.30	
Ramabai Nagar		142593.90		44304.73	19633.87	24670.86	
Kaushambi		85485.00		15086.98	6633.27	8453.71	
Mahamaya		66120.10		24000.00	6070 10	17021 97	
Nagar		66130.10		24000.06	6078.19	17921.87	
Auraiya		68459.75		30368.09	16186.07	14182.02	

Source: Groundwater Department Uttar Pradesh



Table 6.22 Number of Groundwater Structures Proposed in Ramganga Command Area Assuming 200% Irrigation							
Sl. No	District Name	Balance Available (Hect.mt.) as on 31.03.2004	No. of S.T.W	No. of P.T.W			
1	Agra	8082	72	2021			
2	Aligarh	15948	142	3987			
3	Auraiya	30368	270	7592			
4	Etah	21176	188	5294			
5	Etawah	40489	360	10122			
6	Farrukhabad	15565	138	3891			
7	Fatehpur	36226	322	9056			
8	Firozabad	11739	104	2935			
9	Kannauj	24000	213	6000			
10	Kanpur Nagar	28628	254	7157			
11	Kaushambi	15086	134	3771			
12	Mahamaya Nagar	-380	0	0			
13	Mainpuri	12993	115	3248			
14	Mathura	14394	128	3598			
15	Ramabai Nagar	44304	394	11076			
	Total	318618	2834	79748			

Note: In case of S.T.W, 20% requirement has been assumed to be provided by S.T.W with a running hrs. of 1500/year with discharge rate of 150 m³/hr. In case of P.T.W, 80% requirement has been assumed to be provided by P.T. W, with a running hrs. of 800/year with discharge rate of 40 m³/hr. The total cost of creating the proposed structure shall be as follows:

(i) For State Tubewell 2834 x 5.0 (No. of STW x Rs.5.0 Lakh per Tubewell)

= 14170 Lakh

(ii) For P.T.W, 79747 x 0.20 (No. of PTW x Rs. 0.20 Lakh per P.T.W

= 15949.6 Lakh

Total Cost

= 30119.6 Lakh



Proposal for Conjunctive Use:

6.139 Considering the G.W.C (1995) guidelines for ground water extraction, further district wise ground water development may be planned as below:

- In the areas having ground water level up to 2 mt. bgl, with a rising trend further development of 70 – 100% of the ground water balance is recommended along with restricted use canal water.
- Areas having ground water level between 2-8 mt deep with a generally steady trend, further development of 50-80% of the ground water balance may be used.
- ➤ In the areas having ground water level >8 mt. showing a falling trend, further development of 0-405 is recommended.
- Areas having ground water level more than 8 mts deep with a falling trend should be provided by construction of Kharif canals in the Districts.
- > In Rabi part requirement may be met by Balance ground water and part through implementing ditch and furrow recharge techniques in the Agriculture field, along with reducing the intensity of tube-wells.
- For Zaid crops part Balance ground water may be utilized and intensity of the cropping should be slightly reduced.
- Number of Check Dams / Boundhies may be constructed in order to increase ground water recharge.
- > Springs/Drip irrigation should be encouraged in the area which are fully dependent an ground water
- Low water intensive crops should be adopted in areas of scarcity and declining water table.

Conclusion and Recommendation

6.140 The Ramganga project sites comprises of dam, area of reservoir and the staff colony area. All of these lie in forest area with no human habitation. No cropped area has been affected due to construction of the dam. There has been no dislocation or submergence of either rail or road traffic. There has been no shifting of habitation or dislocation of agriculture area. The reservoir submerged 4220 ha unirrigated and reserve forest land and 2500 ha plantations, 33 nos, of small buildings constructed in the forest and 60 km forest road and bridle paths were also affected by the project.

The salient conclusion and recommendation are as follows:

6.141 The command area is part of vast and fertile Gangetic alluvium composed of layers of sand, clay and kankar of varying thickness and grade, except for southern area of Agra district where sand stones are even exposed at surface. The top shallow aquifers behave as unconfined, while the deeper aguifers behave as unconfined to semi-confined.



The maximum depth to water table below ground level is generally between 4 to 6 mt. except for some reaches near Yamuna and Ganga rivers, where it goes up to a depth of 10 to 24 meters. The rise in water table after monsoon is generally of the order of about 2 meters on an average.

- 6.142 The area is irrigated by upper and lower Ganga canal system, Agra canal, state tube well and private minor irrigation works. The net groundwater balance potential as on 31.03.2004 &31.03.2008 is 3.43 lakh hectare meters. & 2.06 lakh hectare meters with a change of 1.36 lakh hectare meters between 2004 and 2008.
- 6.143 The water table in the area is monitored bimonthly at about 1072 places (Hydrograph Stations). This water level data clearly indicate that on average, there is lowering trend of groundwater at most of the places. Actually, the water level from 2000 to 2009 is showing a declining trend, which may be due to increased year by year groundwater drawls.
- 6.144 Based on the observed data for observations, the annual utilizable recharge has been estimated as on 31.03.2004 and 31.03.2008 as 12.62 &11.15 lakh hectare mt. out of which the existing draft 8.92 and 8.68 lakh hectare meters respectively. Thus, the total groundwater potential for future utilization is 34.30 & 2.16 lakh hectare meters. The stage of development rose from 69.53 to 78.76 per cent. Following works can be constructed considering the balance as on 31.03.2004.

1 State tube wells : 2834 2 Private shallow tube : 79748

wells

6.145 These figures are purely based on availability of groundwater according to existing surveys and other empirical norms. In case of actual construction, the availability of aquifer at reasonable depth and sufficient depth will be the main guiding factor. As such areas needing irrigation will have to be demarcated and surveyed in detail for pinpointing the exact siting and locations.

The average groundwater development utilization percentage of groundwater as on 31.03.2008 is 78.76 per cent for Ramganga command area.

- 6.146 The construction of above groundwater structures will fully utilize the present groundwater balance, thereby raising the irrigation intensity and cropping intensity. To further increase it, more surface irrigation will have to be introduced in the command area through construction of monsoon canals.
- 6.147 Micro level studies e.g. long duration pump tests, detailed geo-hydrological mapping, complete and detailed inventory of all groundwater structures including their



Impact on Groundwater

discharge and running hours, installation of more hydrograph stations and piezometers, etc. are urgently needed in all the command area districts except Etawah and Aurriya, where the exploitation of groundwater is below 60 per cent.

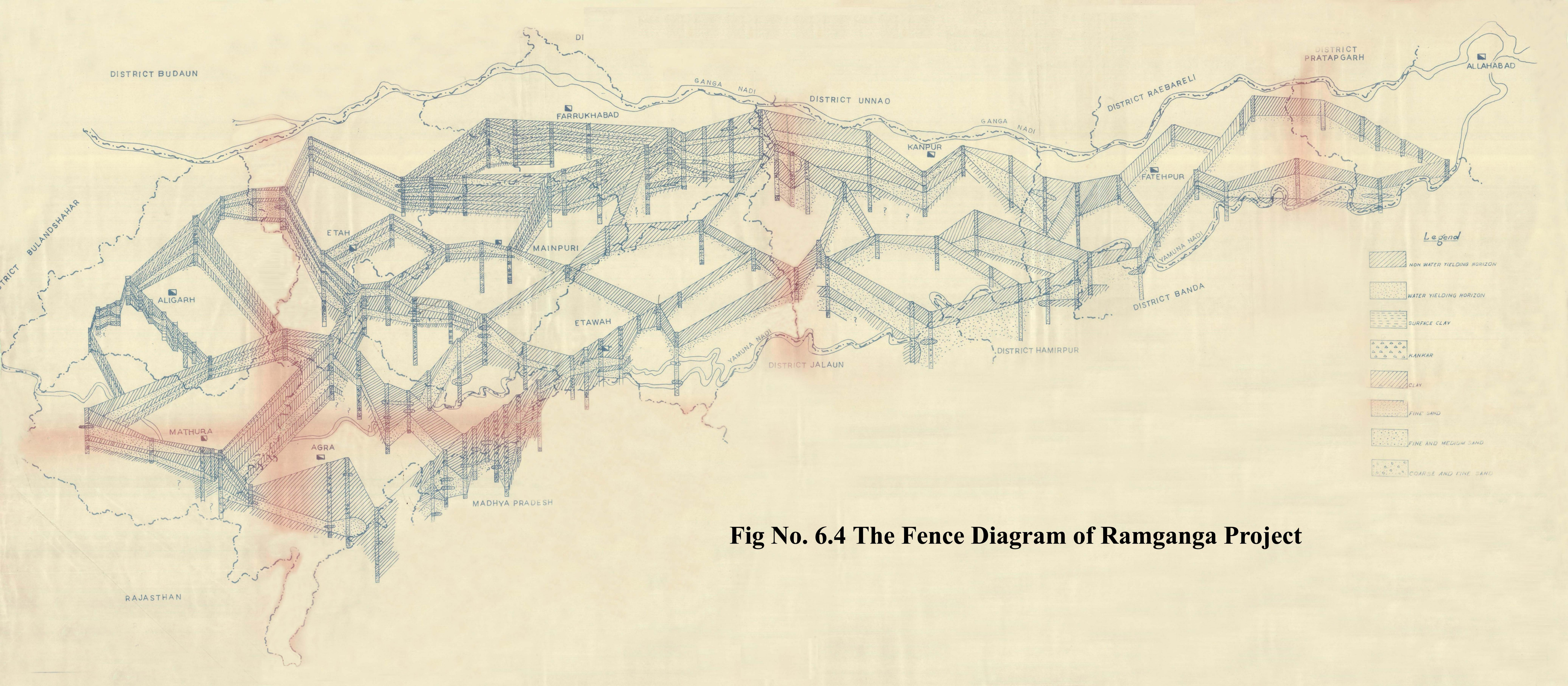
- 6.148 The pre-monsoon water table data does not show any water logging in the command area except a seasonal water logging along canal after rainfall or due to improper lining/cutting of canal banks. The waterlogged patches are very few isolated and localized.
- 6.149 The saline patches of Agra, Mathura, Etah, Mainpuri, Fatehpur and Kanpur need clear demarcation. In this area electrical resistivity surveys are recommended to ascertain the weathered zone of sweet water exist and at what depth and whether these can be exploited. The brackish water of this area is also recommended to be used after dilution with canal water. In some of the USAR area, chemical treatment is not the only solution for its reclamation. Topography, geology and hydrology play important role in it. Therefore, reclamation should be planned after sub surface geological mapping to demarcate the hard clay pans, the breaking of this hard clay pans causing enrichment of USAR formation is one of the main solutions for effective USAR reclamation.
- 6.150 In the districts of Etawah, Fatehpur and Kanpur the water table is deep and strata are poor. Drilling of exploratory tube wells is also recommended for pushing up the tube well program.
- 6.151 District wise conjunctive use plan has been proposed and is given in the earlier Para to maximize the agriculture production. The total project cost is Rs. 30119.6 lakh for ground water development.
- 6.152 Future exploitation of groundwater should be concentrated more in the areas having maximum depth to water table below 6.00 meters. The areas having deeper water table should have more of surface irrigation. In other words, conjunctive use of surface and groundwater should be planned in such a way as to have an optimal depth to water table at about 6 meters below ground level to avoid water logging and salinity problems.
- 6.153 With regular monitoring of the dynamic groundwater regime required consequent to more and more groundwater development and the availability and collection of more data.

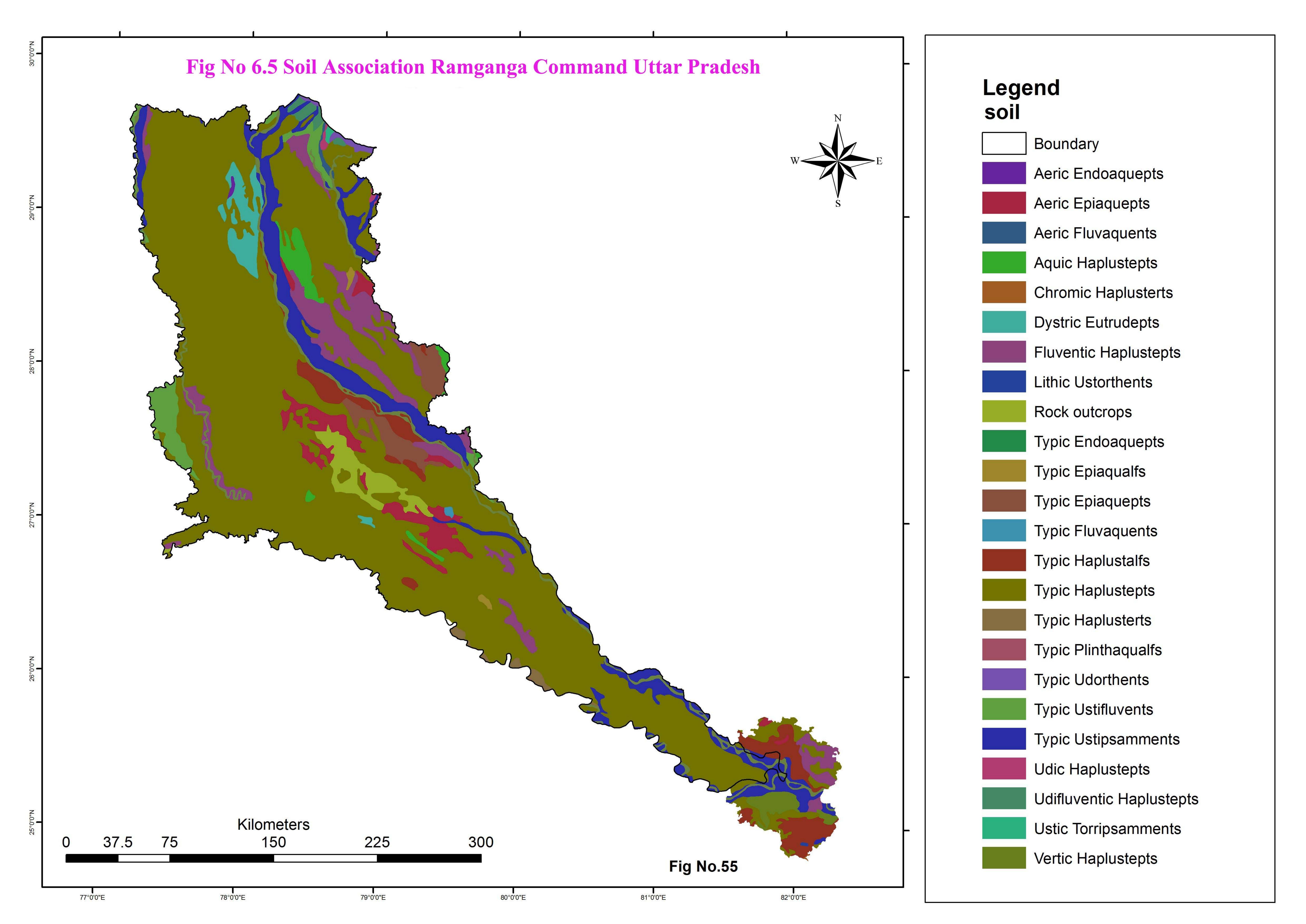


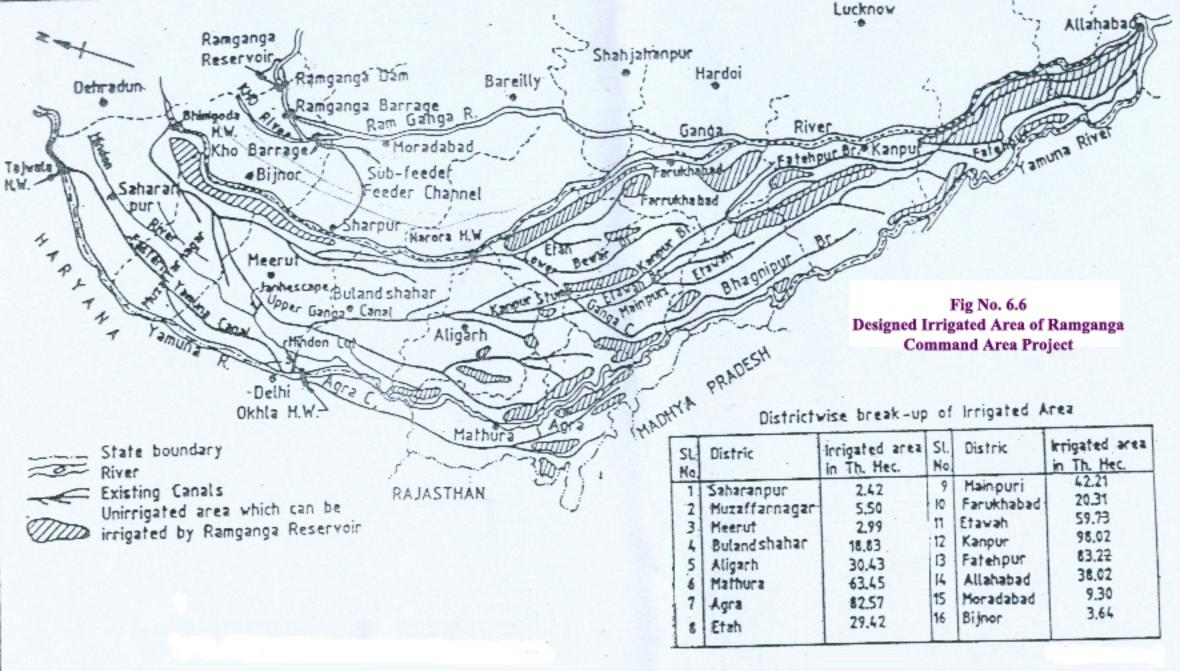
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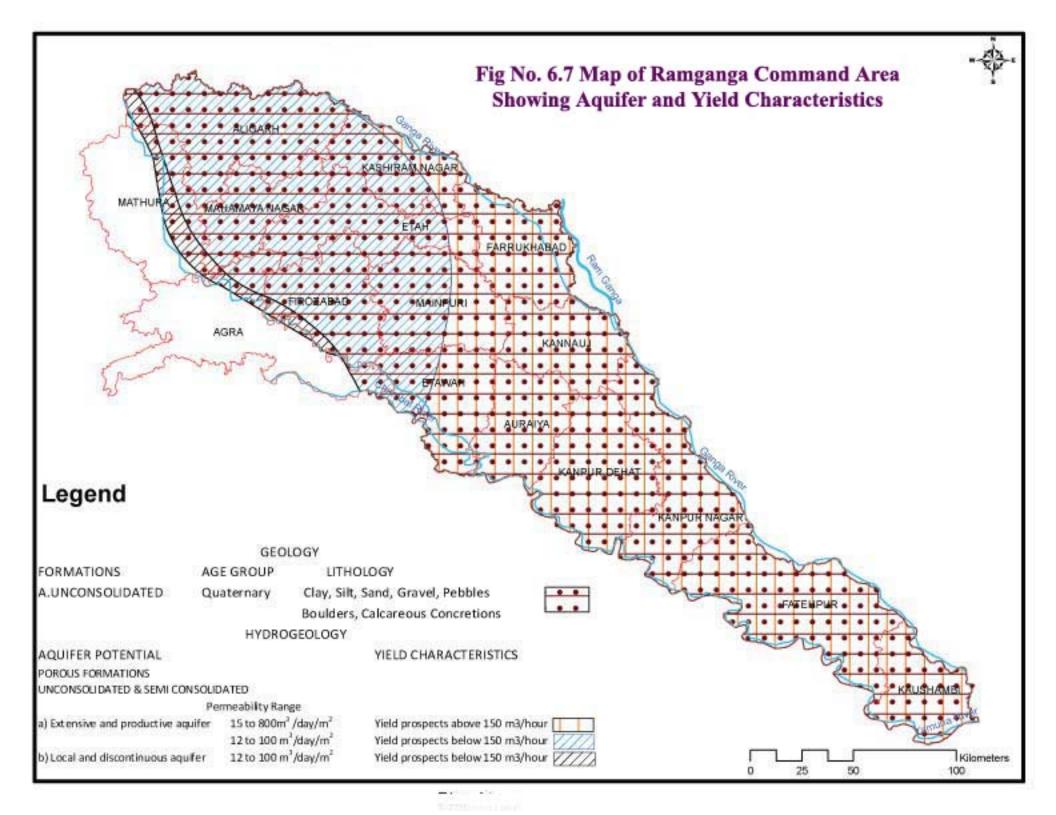
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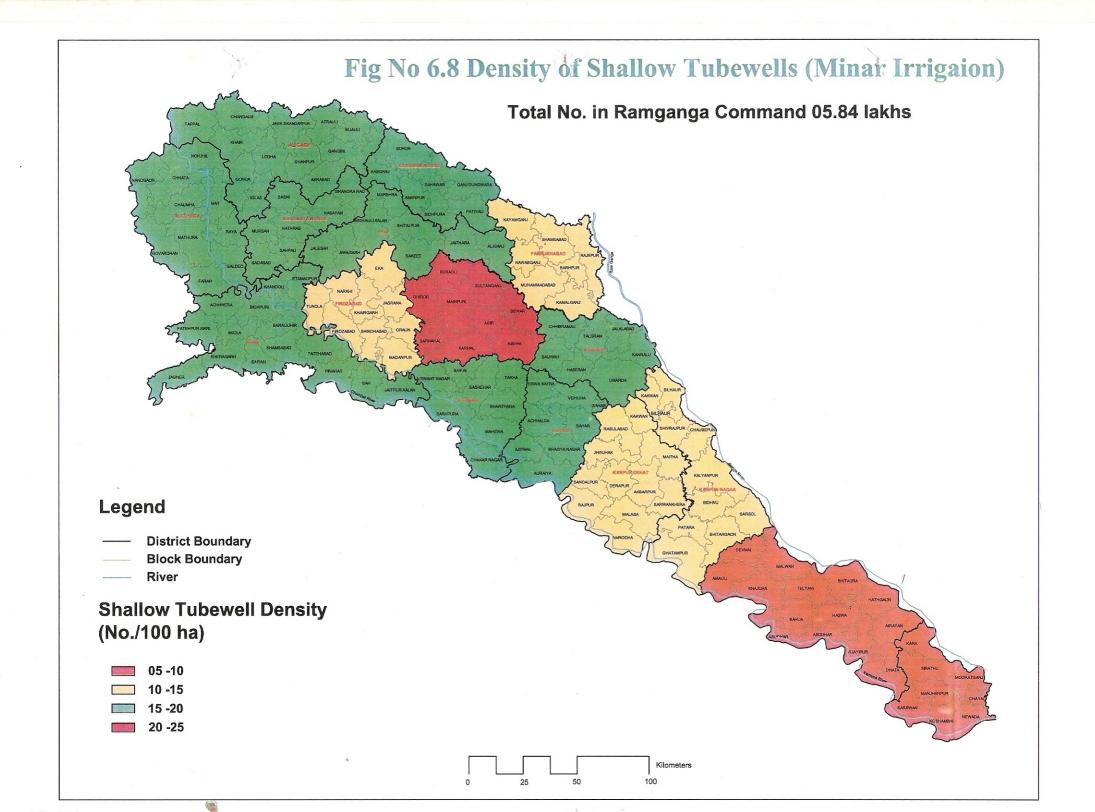












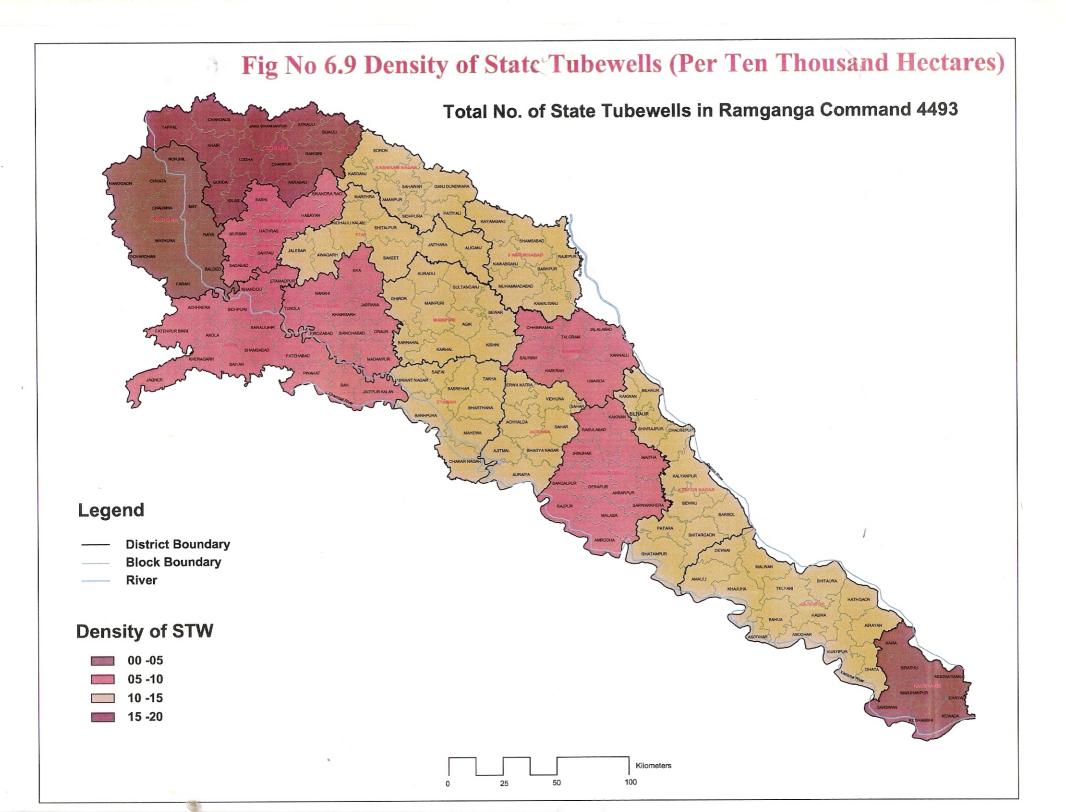
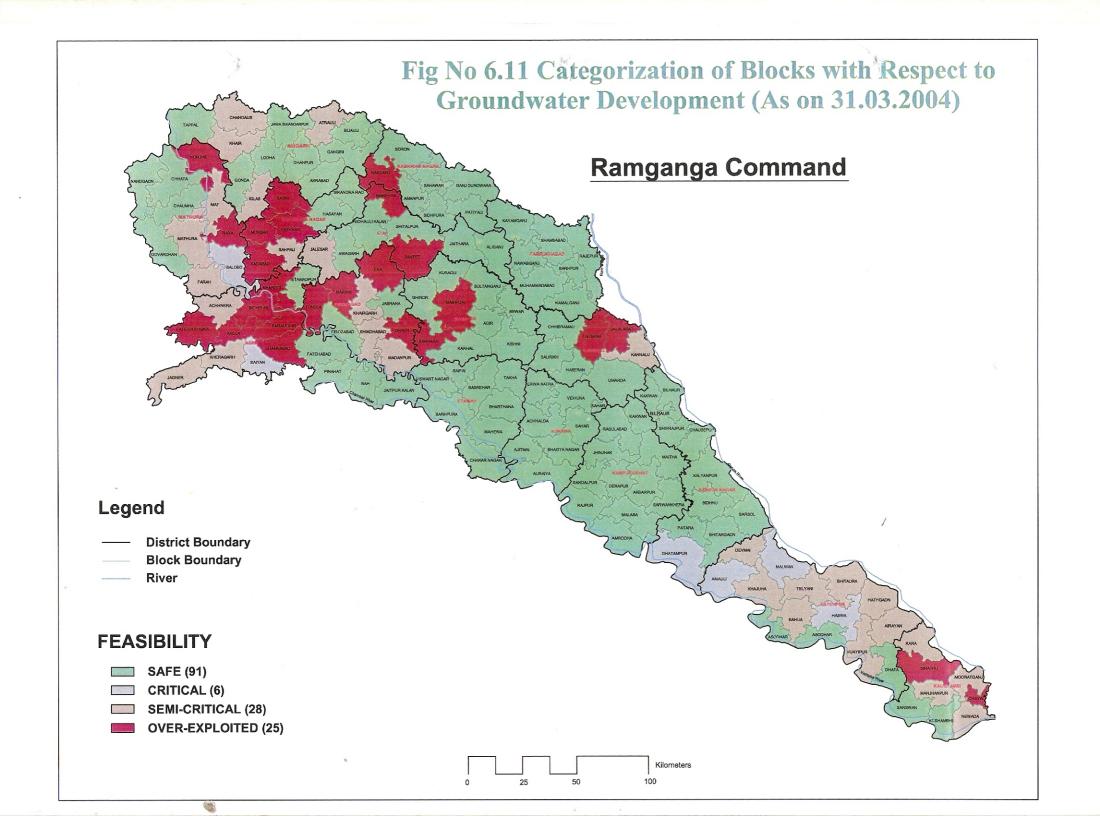
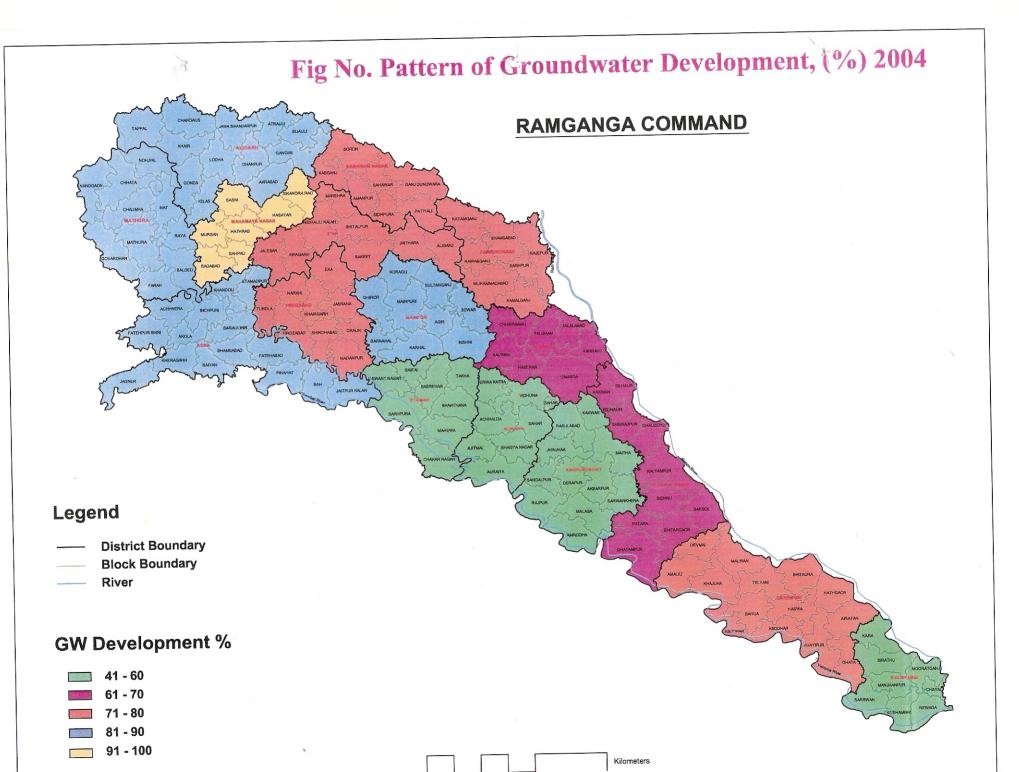
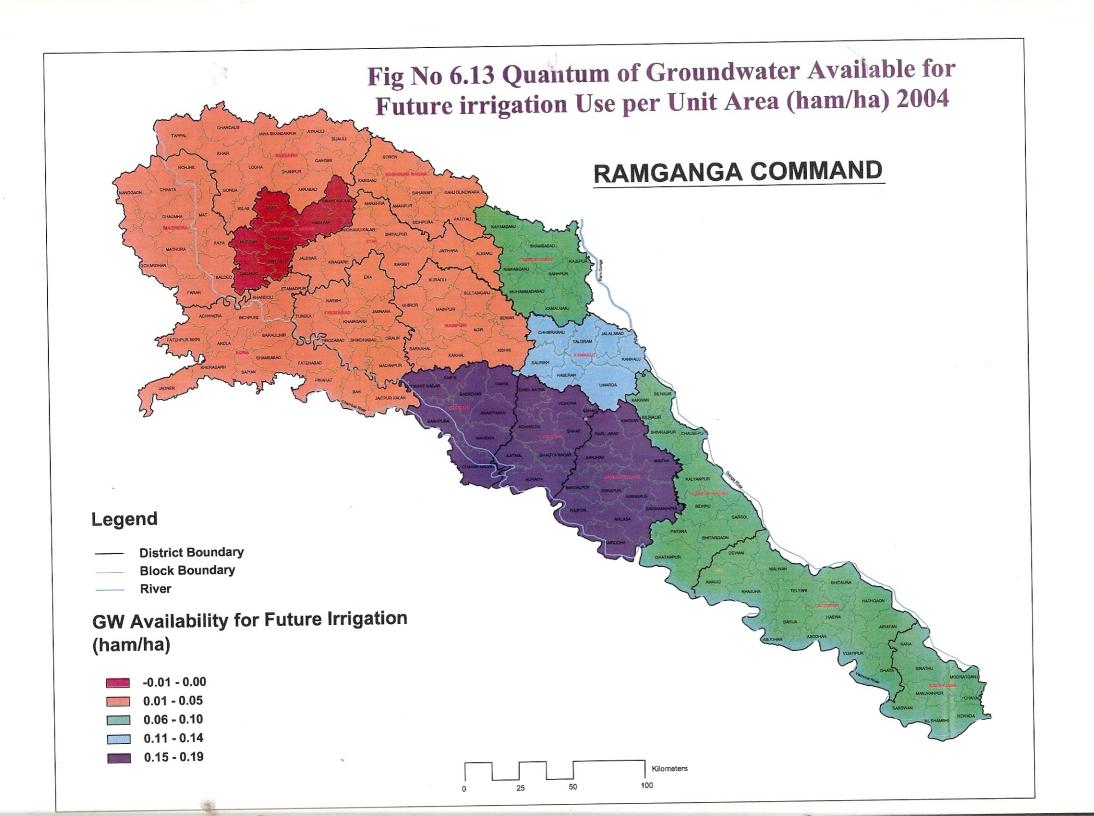
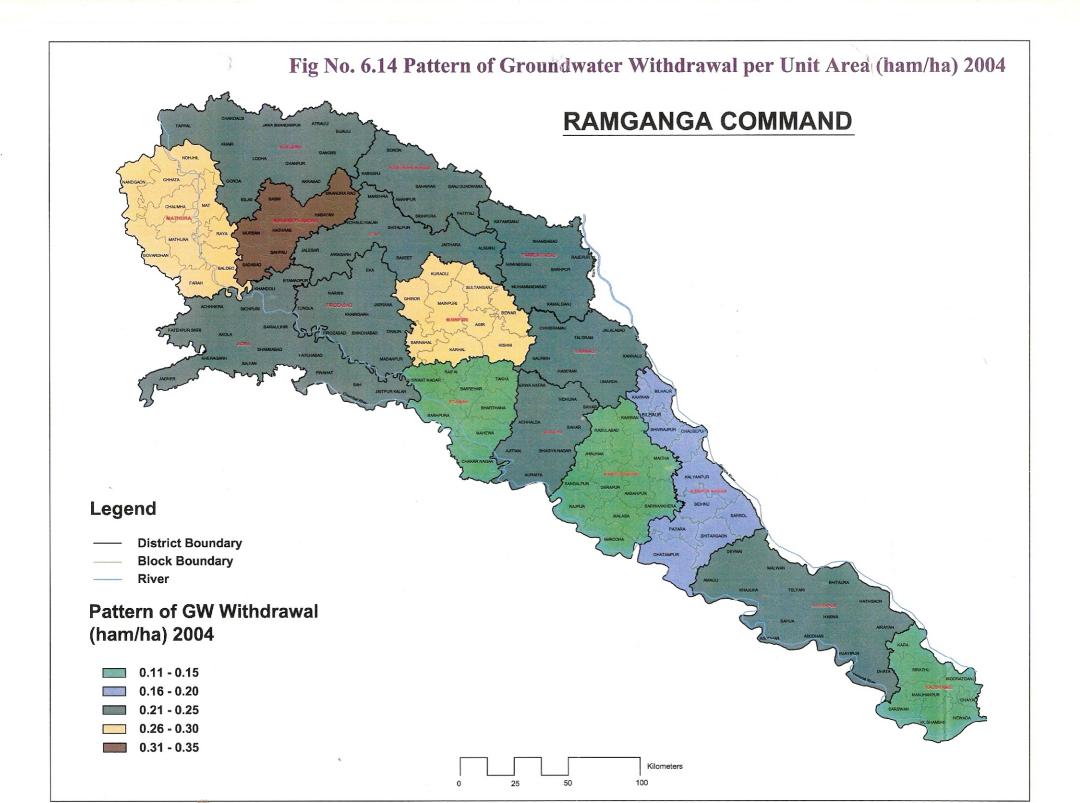


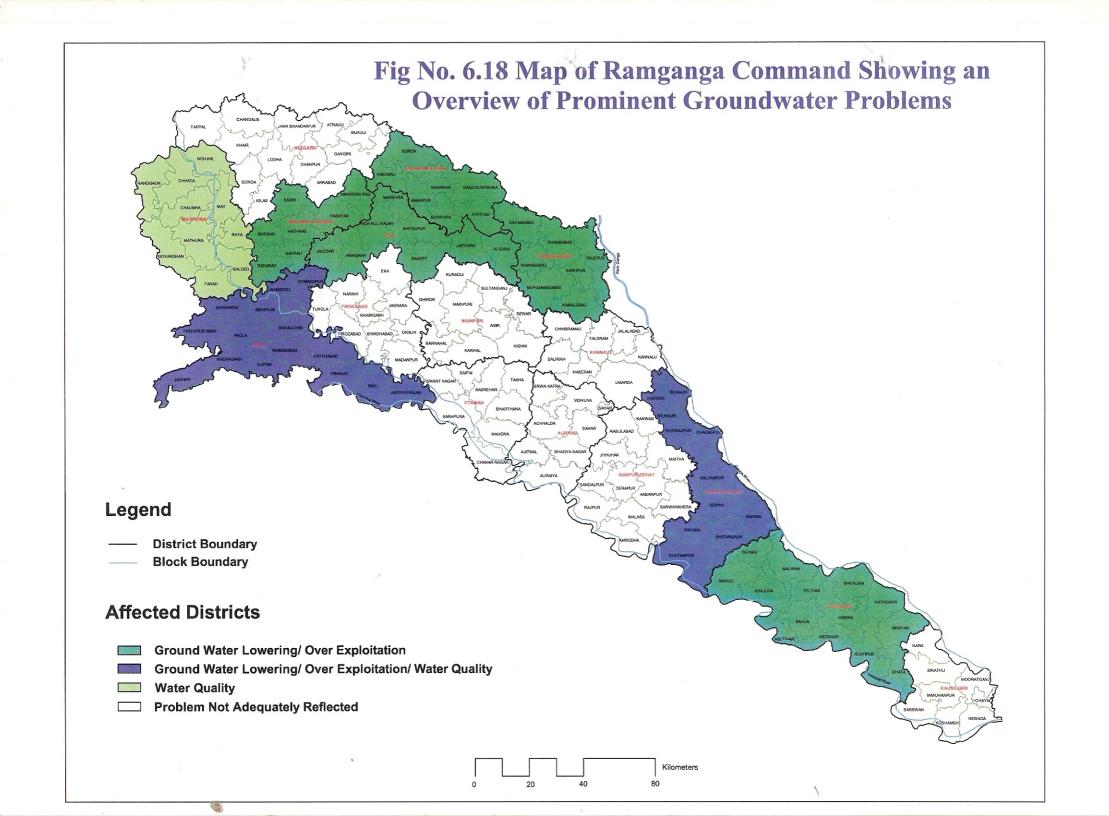
Fig No 6.19 Quantum of Groundwater Available for Future Use, per Unit Area (ham/ha) 2004 RAMGANGA COMMAND Legend **District Boundary Block Boundary** River **GW** Availability for Future Use (ham/ha) 0.01 - 0.05 0.06 - 0.10 0.11 - 0.15 0.16 - 0.20 Kilometers

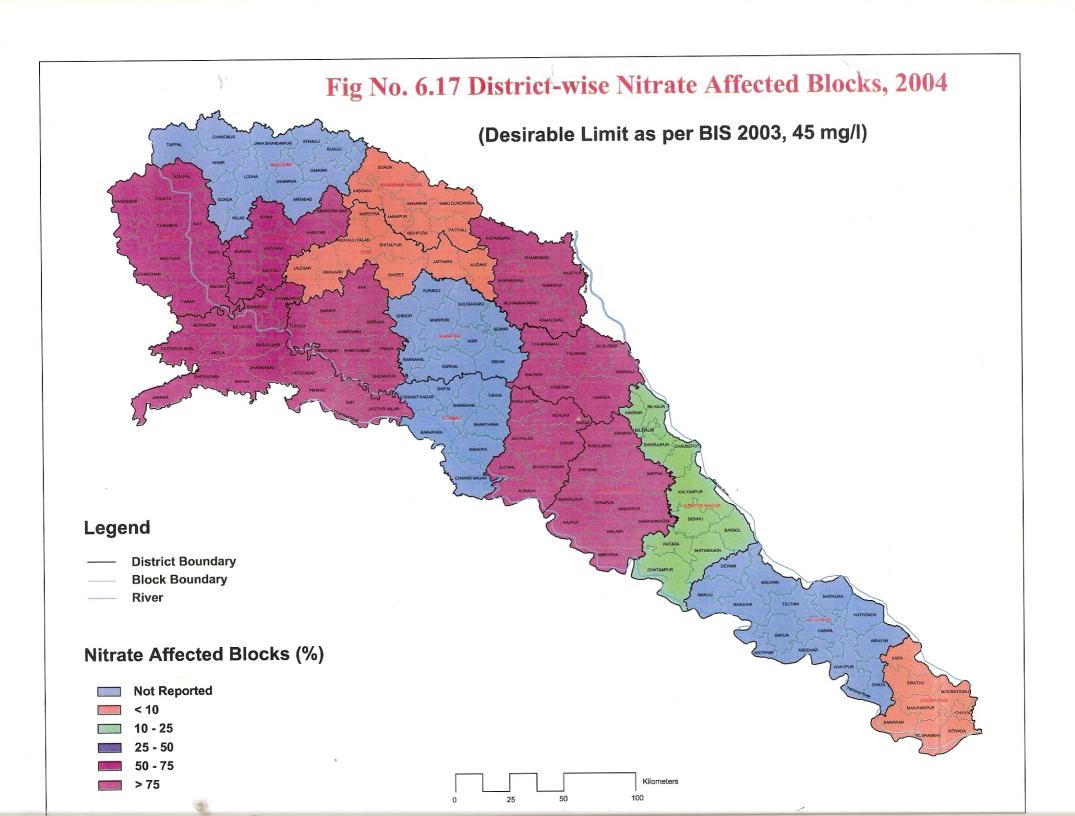


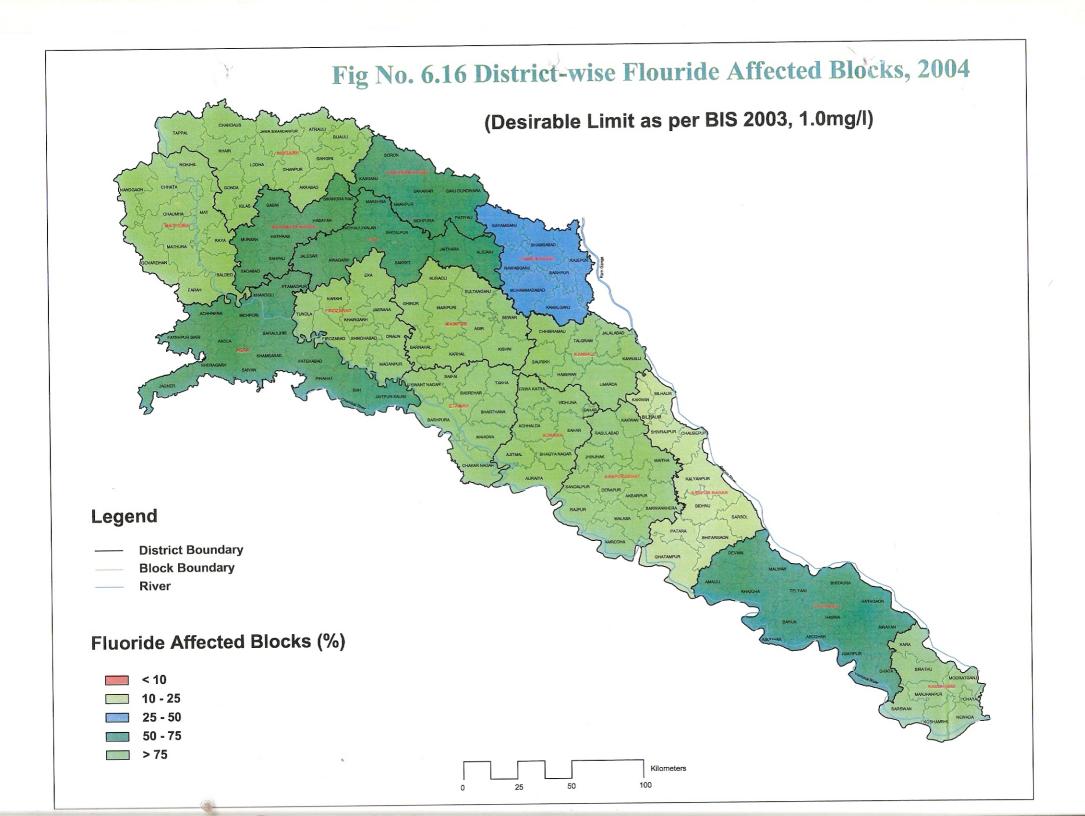


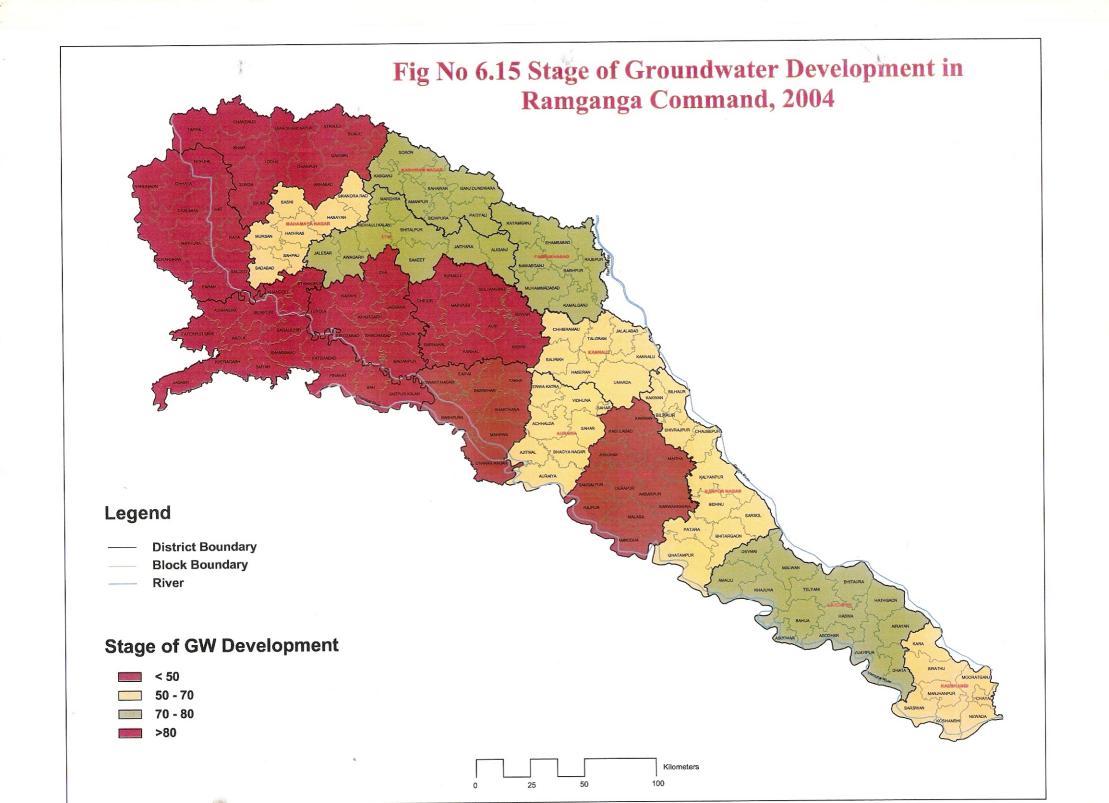












Volume-I



7

Impacts on Archaeological Monuments, Economically Important Minerals and Places of Worship



IMPACTS ON ARCHAEOLOGICAL MONUMENTS, ECONOMICALLY IMPORTANT MINERALS AND PLACES OF WORSHIP

Introduction

- 7.01 Ramganga Multipurpose River Valley project was constructed on Ramganga River near Kalagarh (v) in Uttarakhand state during 1962–1974. Water is impounded by construction of a dam across the river to fulfill the irrigation, power and drinking water needs of Uttar Pradesh as well as Delhi Nagar Nigam. Due to the barrier on the river an extent of 8143 ha was submerged at FRL 365.30 m elevation extending into the tributaries Sona and Mandalti. Neither habitations nor private lands were submerged and the entire land classified as forest land. The submergence included 3200 ha of Corbett National park also, and because of this reason the total area of submergence is under the control of forest department.
- 7.02 The submergence area was devoid of any archaeological monuments or places of worships. Hence, restoration of such monuments and places of worships did not crop up as part of EMP.
- 7.03 Prior to the formation of the reservoir, surveys indicated that some washings carried out on Sona Nadi section near Hathikund contained minute quantities of gold (30 to 50 gms annually). Also minor stringers of coal and carbonaceous matter were also found in the reservoir area. However, all these deposits were not considered economically important due to very low yields.
- 7.04 The Gim Corbett Park surrounding the Reservoir is a noted tourist resort with its Tiger Sanctuary and vast area of forest interspersed with lakes and water bodies. The eco-diversity of the park attracts rare migratory birds from across the continent seasonally and is a site of feast for bird watchers. The ponds and water bodies therein, offer scope for game fishing and boating. The site at the dam offers scope for development of an entertainment park for all age groups of tourists visiting the park.

Volume-I



8

Impacts on Forest Flora and Fauna





IMPACTS ON FOREST FLORA AND FAUNA

Introduction

8.01 The nature and mankind form an inseparable part of the 'life support system' comprising five elements viz., Air, Water, Land, Flora and Fauna. Of these, the two major components of the biological environmental are the Flora and Fauna. These components are well organized and inter dependant. They show various responses and sensitivities to outside influences. Nature's stability depends upon its diversity. Therefore, the need to assess the changes that have taken place in status of the plant and animal resources is a primary requirement even in the case of water resources development project constructed decades back.

8.02 The construction of a 127.5 m high earth and rock fill dam across the river Ramganga near Kalagarh was completed in early 1974. Its reservoir with a capacity of 2.49 x 10⁹ m³ was partially filled during the 1974 summer monsoon. It receives flood waters mostly from the rivers and streams located in the famous Jim Corbett National Park. The reservoir as well as of the catchment area lies in the Jim Corbett National Park while the water from the reservoir is used for irrigation, drinking and industrial uses in the upper and lowers Ganga Projects.

8.03 The catchment area of the River Ramganga at the dam site at Kalagrah is about 3.11 lakh ha. The entire catchment area of the project is located in Uttarakhand. The command area of the project is spread over 142 blocks in 17 districts of the state of Uttar Pradesh.

8.04 Several species of wildlife have become extinct in Uttar Pradesh. Among them are the Lion from the Gangetic plain and the Rhinoceros from the Terai Region. The fate of many species is uncertain, including the Tiger, Black buck, Serow, Musk deer, Swamp deer, Bustard, Pink-headed duck, Chir and Mural pheasants and Four-horned antelope. Although a determined enforcement of laws against poaching and hunting has yielded some results, the wildlife population today is alarmingly low. Gharials are poached for their skin. To preserve its wildlife the state has established one National Park; Corbett National Park and 12 game sanctuaries. The Corbett National Park is situated partly in Ramnagar and partly in the Kalagarh forest division. It is one of the showpieces of the State.

Impacts on Forests

The construction of dam across a river has impact on forest cover and species composition of forest areas both in the catchment and command areas of the project. The available forest type influence these impact also. Hence, an attempt had been made in this section to analyse the forest types, forest cover and status of introduced species, both in catchment and command areas of the project.

Forest Types

As indicated above the entire catchment area of the project lies in the State of Uttarakhand. Four major types of forests are found in Uttarakhand. They are alpine meadows in the extreme north, temperate forests in the Great Himalayas, tropical deciduous forests in Lesser Himalayas, and thorn forests in Siwalik Ranges and in parts of Tarai. The forest types in the catchment area of the project are mostly tropical deciduous and thorn forests. Tropical deciduous forests of sal, teak and shisham occur in the submontane tract. The thorn forest of dhak, babul and various bushes occur in few parts in the south of catchment.

8.07 The entire command area of the project lies in Uttar Pradesh. There are seven forest types in the state. They are tropical moist deciduous, Tropical Dry Deciduous, Tropical Thorn, Sub-Tropical Pine, Himalayan Moist Temperate, Himalayan dry Temperate and Sub-Alpine and Alpine forests. Conifers and sal are the important forest formations of the state. The central and western parts of the state, wherein the command area of Ramganga project is located is devoid of forest vegetation as they are mainly under agriculture. The available small patches of forest vegetation in the command area of the project consist of tropical dry deciduous and tropical thorn forest types.

Impact on Forest Cover

The forest cover of both catchment and command area consisted of dense forest, open forest showing ground exposed, dense shrubs, opens shrubs, showing ground exposed and grass lands. The forest cover of the catchment before the project is assessed to be 2.01 lakh ha. This area accounted for 64.82 per cent of the total catchment area. The area under forests decreased from 2.01 lakh ha during pre-project period (1970-71) to 1.92 lakh ha during 1978-79. The overall forest cover decreased by 9.87 thousand ha between 1970 and 1979. Similarly the decrease in forest cover between 1990 and 2008 was over 663.15 ha. The change matrix of forest cover between 1970-71 and 1978-79 and is presented in **Table 8.1**. Major reduction in the forest cover in the catchment area of Ramganga was due to the construction of the dam and its submergence area. The

¹ The construction of dam under the project was initiated during 1962 and was completed by 1994. Therefore, year 1990-71 had been considered as pre - project. The water impounding in Ramganga reservoir was stared during 1974 and hence the year 1978-79 is considered representative as post project period as far as catchment area is concerned.



reduction was in all types of forest lands. Due to the project, the grass land area got reduced by 2998 ha which accounted for about 12 per cent of total grass land area in the catchment. This ultimately resulted in shrinkage of habitat for herbious fauna in the Corbett Tiger Reserve.

	Table 8.1 Forest Cover Change Matrix of Catchment Area of Ramganga									
1970-71	1978-79 Assessment									
Assessm	Dense Forest	Thin Forest	Dense shrub s	Thin Shrubs	Grass land	Under Cultivati on	Agricult ural Land	Mixed Land use	Water bodies	Total
Dense Forest	118634									118634
Thin Forest		15635								15635
Dense Shrubs			13117							13117
Thin Shrubs				22241						22241
Grass land					21877					21877
Under Cultivati on						77985				77985
Agricult ural Land							8321			8321
Mixed land use								18994		18994
Water bodies									13921	13921
Total (1970- 71)	122312	16687	13681	23829	24875	77445	8022	18898	4976	310725
Net Change	-3678	-1052	-564	-1588	-2998	540	299	96	8945	0
% Change	-3.01	-6.30	-4.12	-6.66	12.05	0.70	3.73	0.51	179.76	

 $Source: Complied \ on \ the \ basis \ of \ information \ obtained \ from \ the \ Office \ of \ Divisional \ Forest \ Officer, \ Raniket \ and \ Ramnagar$

8.09 The forest cover in command districts of Ramganga is assessed to be 2.17 lakh ha consisting of 1.35 lakh ha of tree clad forest and 0.82 lakh ha of shrub forest. This forest area accounted for only 4.53 per cent of total geographical area of the command districts of Ramganga project. Within forest area tree clad forest accounted for over 62.19 per cent of total forest area in these districts whereas shrub forest accounted for only 37.81 per cent of total forest area in the command districts of Ramganga projects. The change



matrix of forest cover in the command area districts of Ramganga project between² 1974-75 and 1982-83 is presented in **Table 8.2**.

Table 8.2 Forest Cover Change Matrix of Command Area of Ramganga							
	1982-83 Assessment						
1974-75 Assessment	Forest and Shrub Area	Barren and Cultivable Waste land	Land put NA Use	Permanent Pastures	Other Fallow Land	Area Under Cultivation	Total
Forest and Shrub Area	184338						184338
Barren and Cultivable Waste land		434323					434323
Land put NA Use			419774				419774
Permanent Pastures				24735			24735
Other Fallow Land					3616625		3616625
Area under cultivation						189375	189375
Total (1974-75)	217478	501714	386173	25697	135610	3602498	4869170
Net Change	-33140	-67391	33601	-962	53765	14127	0
% Change	-15.24	-13.43	8.70	-3.74	39.65	0.39	

Source: Complied on the basis of information obtained from respective Statistical Handbooks of Uttar Pradesh

Between 1974-75 and 1982-83, there was reduction in Forest area and barren, permanent pastures and cultivable wasteland, while there was an increase in the area of land put to non-agricultural use, other fallow lands and area under cultivation. The reduction in forest area was about 15.24 per cent of total forest area during 1974-75. The increase in other fallow land is accounted for about 39.64 per cent of total area under other fallow land during 1974-75.

Introduction of Species

8.10 Introduction of new species in the catchment and command area districts of the project had been taking place through the undertaking of forestry programmes in the catchment area and command area districts of the project under soil conservation

² The OFD works in the command area of Ramganga Project were initiated during 1974-75. Therefore, the land use and land cover in the command districts of Ramganga is considered as pre-project scenario. Since, the OFD works in the area were completed by 1982-83, this year was considered as post project period. Therefore, the change matrix of forest cover is assessed between 1974-75 and 1982-83.





Study of Environmental Evaluation of Ramganga River Valley Project in Uttar Pradesh

programmes of Ramganga River Valley Project and other River Valley projects such as Yamuna RVP, Ganga RVP and Chambal RVP programmes. Besides plantations for ravine reclamation and soil conservation, industrial plantations for producing matchwood and timber were also undertakes in these area. Forest Development Corporations in both Uttarakhand and Uttar Pradesh were created to under plantation work through financial support from different financial institutions. Plantation activity got accelerated after leveling of Social Forest Programmes in both the states. The important plantation programmes include industrial plantation, and pulpwood plantation, economic plantation, rural fuel wood plantation, fuel and fodder plantation, energy plantation, etc. The new species introduced through these plantations include Eucalyptus, poplar.

Changes in Forest Based Livelihood

8.11 As the areas under consideration have forests capable of providing Bamboo or Timber or Amla or tendu leaf (Diospyros melanoxylon) or other minor fruit forest dwellers in general are dependent on forests. People residing close to forest areas are still dependent on forests for firewood and fodder. Except tribal families and forest dependent communities which live either in the forests or close to forests i.e. within walking distances from forests, others no longer depend on forests. Changes in livelihood are mainly on account of urbanization, increase in purchasing power owing to increase in earnings and income. Poverty alleviation programmes launched on a large scale particularly after liberalization, privatization and globalization (LPG Policy or the New Economic Policy) a shift from dependence on forest products industrial goods and services has reduced dependence on forests. However, in tourist spots such as the Jim Corbett National Park, some people still make their living by taking visitors on their pet elephants. Similarly in pilgrim centers people sell toys and models made of wood and some herbal products collected from forest areas. The tribal families that live inside the jungles are still be dependent on forests for their livelihood. Thus, the shift in livelihoods could be mainly due to overall economic development rather than due to the Ramganga project.

REET Flora and Fauna of the Project Area

8.12 Plant species found in the project areas are compared with the list of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in India (www.bsenvis.nic.in/citesplant.htm). None of the plants listed is included in Appendix II of CITES were found in the study areas. Further no endemic or endangered plant species have been reported from the Jim Corbett national Park also. The habitat of the command area under consideration is so common and widespread that it does not support any REET flora. The REET fauna reported from the catchments and command areas has been sown in **Annexures VIII.7 toVIII.9**. The Jim Corbett National Park and the Reservoir are rich in REET species. The REET species of the command area are clearly described in paragraphes 8.40 to 8.44 along with the pictures taken during survey. The conservation status of the birds has been verified with the Birdlife International's 2010

update of the IUCN Red List for birds from web sites www.birdlife.org and www.iucnredlist.org. Among the birds Sarus Cranes and Pea Cocks were quite frequent in some areas though not abundant. A list of REET birds reported from the Jim Corbett National Park is given in Table 8.5. Among the Mammals Small-clawed otter (Aonyx cinerea), Asiatic elephant (Elephas maximus), Leopard cat (Felis bengalensis), Indian pangolin (Manis crassicaudata), Sloth bear (Melursus ursinus), Leopard (Panthera pardus) and Tiger (Panthera tigris) belong to the REET category. Among the Reptiles, Crocodile, Cobra and Python belong to the REET category. Mahashir is a rare species of fish but it is reported be very common in Ramganga.

Probable impacts on Flora and Fauna:

- Change is a natural phenomenon. Probably there is nothing that is totally resistant 8.13 to change. Some changes may be induced by natural forces while others may be brought about by humans, human activities, technology and development. Construction of a dam and impounding of water in a reservoir are capable of bringing about major changes in land use and land cover as well as the human lifestyles. Probably with the introduction and large scale cultivation of exotic or native trees such as the Eucalyptus, Teak (Tectona grandis) Subabul (Leucaena leucocephala), Poplar (Populus deltoides), Australian wattle (Acacia auriculiformis), Bamboo (Dendrocalamus strictus) and Mangium (Acacia mangium) after 1984, the rural landscape has undergone a major change. Similarly, shift in cultivation and replacement of major crops by others have the potential to bring about a change in the floristic composition of the weeds. For instance, the weeds of a wheat crop are different from that of Paddy or Sugarcane field. Thus the changes that have taken place in the flora and fauna may be on account of introduction of exotic species or shift in agriculture or increase in biotic pressure or it may be on account of the Ramganga Project or their combinations.
- 8.14 The first and the foremost problem is the identification of a change and the cause for the same. In order to identify the changes, we need to know what the scenario was prior to Ramganga Project. Before attributing the specific changes to any particular activity, the changes brought out by others have to be eliminated. It is really a tough job and involves certain amount of presumption especially when there is no information regarding the situation at the time of undertaking the project or soon after the completion of the Ramganga Project. Unfortunately, the information and data relating to 1980s is scanty and fragmentary. Hence the report under consideration may reflect the present scenario and it may not really establish any strong link between the Ramganga Project and the change that may have taken place.
- 8.15 It is understandable that all the terrestrial flora of the area of submergence must have been lost while the terrestrial fauna may have migrated to safer surroundings. The flora and fauna of the Jim Corbett National Park was extensively studied by the B.S.I., Z.S.I and other research institutions. As such there is dependable published scientific information on the Wildlife of Corbett National Park. But the observations made by the survey teams in the peripheral areas of the Corbett National Park reveal striking



differences between what was widely reported and what really exists as of now. The core area of the Tiger sanctuary doesn't seem to have undergone any major change. Pending permission from the National wildlife board for carrying out nondestructive sampling and survey, the buffer areas of the sanctuary and the reservoir areas have been visited and the following information is compiled based on the survey undertaken.

Wildlife in Corbett National Park

8.16 Rated amongst the finest National Parks of India, the Corbett National Park has the privilege of being the first National Park of the country, developed and nurtured by late Jim Corbett in the year 1936. The Corbett National Park also enjoys the privilege of being the first National Park of India to be covered under the famous Project Tiger (Project Tiger was lunched to protect the diminishing tiger population in India in 1973). Located in the picturesque surroundings of lush green forests and a series of ridges running parallel to the valley, the park covers an area of 520.8 sq. km and is famous for its individualistic scenic beauty. The wildlife in Corbett National Park is quite rich and varied, difficult to be found in any other National Parks of India. Jim Corbett National Park is a paradise for wildlife and every naturalist and wildlife lover dreams of visiting this wonderful Park.

Flora of Corbett National Park

- 8.17 The different habitat types of Corbett i.e. mountains, Sal forests, chaurs, Khair-Sissoo forests and rivers have their distinct assemblage of plants. More than 600 species of trees, shrubs, herbs, bamboos, grasses, climbers and ferns have been identified in the Park. The important flora of the Corbett National Park comprises of the evergreen Sal (Shorea robusta) and its associate trees, the Sheesam (Dalbergia sissoo), the Kanju (Holoptelea integrifolia)-found extensively on the ridges-, the ber (Ziziphus mauritians), dhak (Butea monosperma), and bael (Aegle marmelos). Other important trees in the Corbett National Park are the occasional Simal (Bombax cieba), jhingan (Lannea coromandelica) and Khair (Acacia catechu) that blossom in the spring season, just before the starting of summer season. However, Simal (Bombax cieba) is easily the tallest, the largest and most abundant tree in Kalagar area along with the exotic Eucalyptus.
- 8.18 The Sal and the Sheesam, the two most important timber trees of north India are abundant in the Corbett National Park. But Teak (*Tectona grandis*) is now widely grown around the Park in the Catcment as well as in the command areas for its valuable timber. The green leaves of the rohini (*Mallotus philippinensis*), an associate of the Sal are hot favorite for wild elephants of the park. The dominant species of tree is evergreen Sal (Shorea robusta) and its associate trees which are found over 75 % of the total area. In a few areas pure stands of Sal are found. Trees like the Sheesam (*Dalbergia sissoo*), the Kanju (*Holoptelea integrifolia*) trees which can be seen scattered liberally all around its ridges, the ber (*Ziziphus mauritiana*), dhak (*Butea monosperma*), and bael (*Aegle marmelos*). Besides these, other varieties of flora in Corbett include the occasional simal

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(Bombax cieba), jhingan (Lannea coromandelica) and Khair (Acacia catechu) which bear flowers during summers just before the advent of the spring is found along the Ramganga River.

- 8.19 The most visible trees found in Corbett are Sal (Shorea robusta), Khair (Acacia catechu) and Sissoo (Dlabergia sissoo). Many other species that contribute to the diversity are found scattered throughout the Park. Chir pine (*Pinus roxburghi*) is the only conifer of the Park and is found on ridge-tops like Chir Choti but comes quite low in Gajar Sot. The upper reaches near Kanda have Banj Oak (Quercus leucotrichophora) growing which is essentially a Himalayan species. Kanju (Holoptelia integrifolia), Jamun (Syzygium cumini) and Aamla (Emblica officinalis) are found scattered throughout the lower areas while Tendu (Diospyros tomentosa) occurs in moist areas. Other major tree species are Bel (Aegle marmelos), Kusum (Schleichera oleosa), Mahua (Madhuca indica) and Bakli (Anogeissus latifolia). The main ornamental trees of the the forests in Corbett are Kachnaar (Bauhinia variegata) with pink to white flowers, Semal (Bombax ceiba) with big red blooms, Dhak or Flame-of-the-forest (Butea monosperma) with bright orange flowers, Madaar or Indian Coral (Erythrinia indica) with scarlet red flowers and Amaltas (Cassia fistula) with bright yellow chandelier like blooms. Some species of trees that do not occur naturally in the Park have been planted in and around the habitations. These include Teak (Tectona grandis), Eucalyptus, Jacaranda (Jacaranda mimosaefolia), Silver Oak (Grevillea robusta), Golden Parrot tree (Grevillea pteridifolia) and Bottlebrush (Callistemon viminalis) can be seen in and around forest rest houses.
- 8.20 Shrubs dominate the tree understorey as well as in scrub forest areas. There are several species of Ber such as *Ziziphus marutiana*, *Ziziphus nummularia*, *Ziziphus rotundifolia*, *Ziziphus xylopyra* and *Ziziphus oenoplea* in open areas. They provide food and habitat for many birds and animals. Maror phali (*Helicteres isora*) is an easily noticeable shrub. Its fruits are in the form of twisted spiralling pods. Karaunda (*Carissa spinarum* and *Cairssa carandas*), with pinkish-white flowers and sour fruit are found under Sal and other trees in open forests. Hisar (*Rubus ellipticus*) has yellow, juicy, mulberry-like fruits that are savoured by animals. Jhau (*Tamarix dioica*) is found along the Ramganga basin on sandy or rocky soil. *Colebrookia oppsitifolia* and *Adhatoda vasica* are widely found in nallahs.
- 8.21 The Palms include Khajur or Date-palm (*Phoenix dactylifera*) that occurs in open areas. *Wallachia densiflora* is a rare palm characteristic of Eastern Himalayas but is found in Corbett near Sultan. In some parts of Corbett the vegetation is dominated by bamboo forest. The main species is *Dendrocalamus strictus* having clustered stout stems and shining papery stem sheaths.
- 8.22 Herbs include many species of wildflowers belonging mostly to Pea (Fabaceae) and Aster (Asteraceae) families. They are conspicuous in grasslands or chaurs and in open areas. *Drymaria diandra* is a spreading annual herb with heart shaped leaves and occurs in moist shady places. Bhilmora (*Rumex hastatus*) and *Oxalis corniculata*, the two sour tasting herbs are used for making chutney. Other prominent species encountered in



Corbett are *Euphorbia hirta*, a hairy herb, *Indigofera liniofolia* with bright red flowers, Clover (*Oxalis corniculata* and *Oxalis latifolia*) with three leaflets, *Solanum surattense* and *Leonotis nepatafolia* (orange flowers and spiky round fruits).

- 8.23 Grasses form the largest group of plant species in Corbett with more than 70 species recorded. They occupy different habitats, especially chaurs. They include Kansi (Saccharum spontaneum), Themeda arundinacea, Baib or Bhabar (Eulaliopsis binata), Narkul (Arundo donax), Tiger Grass (Thysanolaena maxima), Khus Khus (Vetiveria zizanioides), Cymbopogon flexuosus (a tufted grass with pleasant aromatic leaves), Aristida cyanantha (found amidst boulders), Neyraudia arundinacea (with light brown inflorescence) and Heteropagon contortus (Spear Grass with conspicuous sharp blades that adhere to clothes and penetrate skin).
- 8.24 Woody climbers found in the park are *Milletia auriculata*, *Crypotepris buchanani*, *Porana paniculata* (dense canopy with profuse white flowers), *Clematis gouriana* (shrubby twiner with tendril like branches) and *Bauhinia vahlii* (flat rusty hairy pods, large leaves used for making pattal)
- 8.25 Epiphytes and orchids include both epiphytic and land Orchids. Epiphytes are plants that grow above the ground on other plants, and derive nutrients and water from rain, the air, dust, etc. They are found on Sal and other trees in the park. They include *Dendrophthoe falcata*, *Scurrula cordifolia*, *Vanda roxburghii* etc.
- 8.26 Another significant floral characteristic of the Corbett National Park is the 'chaurs'- a flat grassy blank full of herbs and short and tall grasses providing most of the grazing to the herbivores. The brakes of bamboo and thick shrub growth on the margins of the nullahs and ravines provide both fodder as well as cover to the wild herbivores of the Corbett National Park. Another important plant found along the nullahs is *Ardisia solanacea* (Myrsinaceae), which provide a source of life-giving water to all herbivores during the driest months of the year.
- 8.27 Non-flowering plants include ferns, mosses and lichens. Ferns occur in cool shady moist areas along streams. They include *Adiantum*, *Pteris*, *Ophioglossum reticulatum* (Snake-tongued Fern which occurs below Sal), Equisetum (found growing on sandbanks along streams). Many kinds of fungi are found on rotting trunks and accumulating debris. These include mushrooms, brilliantly patterned toadstools, and puffballs. The presence of lichens symbolizes good air and environment and many kinds of colorful lichens grow on mature tree trunks and boulders all over Corbett. Liverworts and mosses are found on moist trunks.
- 8.28 A list of trees and shrubs encountered in the catchment areas of Ramganga is given in **Annexure VIII.1**. List of perennial climbers / twiners /stragglers found in the command area are given in **Annexure VIII.2**. Bamboos and perennial grasses found in the catchment area are listed in **Annexure VIII.3**. List of Trees, Shrubs and Tall grasses



encountered in the command area of Ramganga project is depicted in **Annexure VIII.4**. Similarly, a list of non woody annual and perennial species recorded during different seasons in the catchment, and command areas of the Ramganga Project are given in **Annexure IX.5**. List of herbal products used in Ayurvedic and Unani Medicines and their plant sources is given in **Annexure IX.6**.

Conservation of Flora and Fauna

8.29 Corbett Park represents a scene of remarkable beauty. The grass lands are known as Chaurs. The largest grassland is Drikala Chauv. The best grass lands including Boyan and Beri got submerged under the Ramgana reservoir is 1974. This park was one of the nine Tiger reserves created at the launch of project tiger in 1973. The park at present stretches to an area of 520.82 sq km besides a buffer area added to an extent of 797.72 sq km.

The Rivers in Corbett National Park

- 8.30 The average five main rivers flowing through the park namely, Ramganga, Sonanadi, Mandal, Palain and Kosi. These rivers give survival for the flora and fauna of the park besides providing drinking water to animal species. Ramganga is the Main River and lifeline of the park. After maintaining near Garisain and traveling 100 kms further it enters the park. The River covers about 40 kms of the park and reaches Kalagarh where the main dam is constructed. The river has the famous fish like Mahseer, Malee, Rohu, Gomces, and Trout. The river is also the home for other aquatic species such as endangered gnarilals, mugger crocodiles, other and turtles. The winter season brings varied types of migratory and water birds from as far as Europe and Central Asia.
- 8.31 Amongst other river Sonanadi enter the park from north-west and joins Ramganga River at the reservoir. Mandal river joins Ramganga at Danunda. This form a vital breeding ground for endangered Mahseer Palain river enters from north and joins Ramganga about 3 km north of the reservoir. Kosi forms the eastern boundary of the park and is in habited by Mahseer and attracts migratory birds. The park also contains innumerable streams units-crossing the length and breadth and are main sources of water during pincer period. At many places they are covered with shrubs and become a shelter for animals including Tiger.

The Tiger Reserve and Eco-Tourism Development

8.32 The Reserve has a great variety of fauna an account of habitat diversity. The ZSI recorded over 585 species of resident and migratory bird also. The **Table 8.3** provide census of major fauna between 1993 and 1997.

Table 8.3 Census of Major Fauna in Corbett Tiger Reserve (1993, 1995 and 1997)					
Wild Species	1993	1995	1997		
Tiger	123	134	138		
Panther	100	110	109		

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Table 8.3 Census of Major Fauna in Corbett Tiger Reserve (1993, 1995 and 1997)						
Wild Species	1993	1995	1997			
Elephant	417	502	746			
Cheetal	36525	31919	-			
Sambar	5576	5695	5757			
Barking Deer	2262	2271	2229			
Hog Deer	292	294	477			
Bear	54	58	40			
Wild Bear	7670	7711	7906			
Ghariyal	224	123	283			
Mugar	118	119	301			
Ghoral	424	433	451			
Monkey	12663	12574	12764			
Langur	14091	14187	14300			
Blue Bull	-	313	466			
Source: Department of Forest, Government of Uttarakhand						

Table 8.4 gives the year-wise number of poaching case in Corbett Tiger Reserve between 1993-94 and 1997-98

Table 8.4 Year-wise Number of Poaching Cases in Corbett Tiger Reserve				
Year	Total Cases			
1993-1994	189			
1994-1995	261			
1995-1996	363			
1996-1997	350			
1997-1998	335			
Source: Department of Forest, Government of Uttarakhand				

8.33 It may be seen that the efforts to protect the tiger and other fauna resulted in increase of Tiger population and well as other like panther, elephants and sambar despite increasing cased of offence. The main focus of the management is an protection besides habitat and water management. Eco-tourism is another area of focus. Special projects for conservation of wildlife in the area of under operation under the regis of the indo-us sub-conversion and science and technology and wildlife institute of India in collaboration with us fish and wildlife service. These centres meet training, research and extension needs. The UP Forest Department has formulated guidelines an eco-development under the World Bank Aided Project ECO - development committee are formed in villages. These committees are exposed to participatory conservation methods through services of trainings and knowledge building tools and workshops. Workshops of various stakeholders were organized to develop an understanding and ensure / bio-diversity conservation. A store wall for 12 kms along with southern boundary of park was



constructed at a cost of 141 lakh with the help of Central Government. Some of the hurdles faced in management of the park are burning of some areas cutting for timber and poaching and unauthorized fishing which need to be tackled effectively.

Flora of Ramganga command area:

8.34 Construction of a dam and impounding of water in a reservoir are capable of bringing about major changes in land use and land cover as well as the human lifestyles. Probably with the introduction and large scale cultivation of exotic or native trees such as the *Eucalyptus*, Teak (*Tectona grandis*) Subabul (*Leucaena leucocephala*), Poplar (*Populus deltoides*), Australian wattle (*Acacia auriculiformis*), Bamboo (*Dendrocalamus strictus*) and Mangium (*Acacia mangium*) after 1984, the rural landscape has undergone a major change. Similarly, shift in cultivation and replacement of major crops by others have the potential to bring about a change in the floristic composition of the weeds. For instance, the weeds of a wheat crop are different from that of Paddy or Sugarcane field. Thus the changes that have taken place in the flora and fauna may be on account of introduction of exotic species or shift in agriculture or increase in biotic pressure or it may be on account of the Ramganga Project or their combinations. Gaint reeds (*Arundo donax*), *Phragmites karka*, *Saccharum spontaneum* and other wetland weeds have become prominent in many water logged areas.

8.35 List of non woody annual and perennial species recorded during different seasons in the catchment, and command areas of the Ramganga Project are given in **Annexure VIII.5**. List of herbal products used in Ayurvedic and Unani Medicines and their plant sources is given in **Annexure VIII.6**. Most of these medicinal plants, tubers and herbs are collected from the catchment and command areas of the Ramganga Project.

Status of the Fauna of the Catchment Area

8.36 According to a two year long survey conducted by a team of wildlife specialists, the wildlife in Corbett National Park comprises of about 50 mammal species, 580 bird species, 25 reptile species and 110 tree species. The varied wildlife in Corbett National Park ranges from large mammals to the lesser ones, the birds, the reptiles and amphibians, the fishes, the insects, the mollusks, the crustaceans and more. But the Corbett National Park is known for its ferocious yet handsome Royal Bengal Tigers. The park offers congenial environmental conditions for growth and survival of the Royal Bengal Tigers and its prey such as four species of Deer, Wild Boar and other lesser animals.

For convenience, the wildlife in the Corbett National Park is divided into the following categories:

8.37 The Mammals: In this category fall the Monkeys, Elephants, Antelopes, Deer, Wild Pig and the Predators such as the Royal Bengal Tiger or Indian Tiger. The other notable mammals in the Corbett National Park include Rhesus Macaques, Langurs,



Leopards, Jungle Cat, Leopard Cat, Fishing Cat, the Dhole (Wild dog), Jackals, Red Fox, Sloth Bear and Black Bear. The small mammals in the park constitute of Marten, Otters, Indian Civet, Mongoose, Black-napped Hare (Khargosh), Palm Squirrel, Indian Porcupine and the Long-eared Hedgehog Musk-rat. In addition, about eight types of bats have also been identified, which include the Flying Fox and the Indian Pangolin. The Corbett National Park also shelters a significant population of about 200 to 300 wild elephants.

8.38 The Corbett National Park also has a significant population of antelopes and deer. The four species of deer found in the park include Chital (the well-known Spotted Deer), the Para (hog deer), the Sambar (the largest Asiatic deer) and the Muntjac (barking deer), also called kakkar. The antelopes found in the Corbett National Park include the Nilgai and the Goat-antelopes. The park also shelters a significant population of omnivorous Wild Pigs and Wild Boars. A checklist of Mammals reported from the catchment area is given in **Annexure VIII.7**.

8.39 The Birds: Indian subcontinent is home to a large number of birds and also witnesses the influx of numerous migratory birds. However, since a couple of years, some of these birds are facing an immense threat of extinction. One of the major reasons for Indian birds being endangered is the loss of their habitat, because of deforestation and other human activities. The other reason is large-scale hunting of birds, leading to a rapid decline in their population. Of the 1,228 species of birds found in India, approximately 82 species have been listed as threatened in the IUCN Red List of Threatened Animals (IUCN 2006). Given below is a list of the endangered or threatened bird species of India, which are reported from the Jim Corbett National Park. A checklist of birds reported or recorded from the catchment area is given in **Annexure VIII.8**. List of Amphibians and Reptiles either observed or reported from the catchment and command areas of Ramganga Project is given in **Annexure VIII.9**. Butterflies, Moths and Honey bees reported from the catchment and command areas of Ramganga project is given in **Annexure VIII.10**. A list of threatened birds reported fom the Jim Corbett National Park is given in **Table 8.5**.

Table 8.5. List of threatened birds reported from the Jim Corbett National Park							
Common name	Scientific name	Status					
Pink-headed Duck	Rhodonessa caryophyllacea	May be extinct.					
Himalayan Quail	Ophrysia superciliosa	Not spotted					
Siberian Crane	Grus leucogeranus	Found in the park					
Sarus Crane	Grus antigone	Groups of two to five birds					
		were spotted in the command					
		area as well as in the Park.					
Jerdon's Courser	Rhinoptilus bitorquatus	Not found in the Park					
Forest Owlet	Athene blewitti	Not found in the Park					
White-bellied Heron	Ardea insignis	Not found in the Park					
Oriental Stork	Ciconia boyciana	Not found in the Park					



Table 8.5. List of threatened birds reported from the Jim Corbett National Park							
Common name	Scientific name	Status					
Greater Adjutant	Leptoptilos dubius	Found in the park					
White-headed Duck	Oxyura leucocephala	Not found in the Park					
White-winged Duck	Cairina scutulata	Not found in the Park					
Great Indian Bustard	Ardeotis nigriceps	Not found in the Park					
Bengal Florican	Houbaropsis bengalensis	Not found in the Park					
Lesser Florican	Sypheotides indica	Not found in the Park					
Nordmann's Greenshank	Tringa guttifer	Rarely found					
Rufous-breasted Laughing	Garrulax cachinnans	Not found in the Park					
thrush							
Cinereous Vulture	Aegypius monachus	Not found in the Park					
White-rumped Vulture	Gyps bengalensis	Rarely found					
Long-billed Vulture	Gyps indicus	Rarely found					

8.40 Corbett National Park is exceptionally rich in its avifauna. According to a survey conducted by the Zoological Survey of India team, Corbett National Park is a paradise for birds and bird lovers. About 600 bird species in the Corbett National Park that comprises of domestic as well as migratory birds including a variety water-birds and waterside-birds. The variety and the number of birds, the Corbett National Park offers, never fail to impress its visitors. Some of the most prominent birds found in the Corbett National Park are Cormorants, the Darter, the Grey Heron, Egrets, the Cattle Egret, the White-necked and Black-necked Storks, the Spot bill, the Large Pied Wagtail, White-capped Redstart, the Great Crested Grebe, Graylag Geese, White Storks, Black Storks, Sandpipers, Snipe, the Great Black-headed Gull, Ducks, Green Pigeons, Parakeets, Cuckoos, Hornbills, Barbets, Woodpeckers, Orioles, Drongos, Pies, Babblers, Thrushes, Mynas, Bulbuls, Warblers, Tailor Bird, Robins, Chats, Redstarts, Bayas, Finches, Indian Alpine Swift, Crested Swifts, the Dusky Crag Martin, Striated (or Red-rumpled) Swallows, the Indian Cliff Shallow, and the Wire-tailed Swallow. A visit to the Corbett National Park would surely be a rewarding experience for ornithologists as well as bird lovers.

For convenience, the birds of the Corbett National Park are divided into the following six categories:

i. Water-birds and Waterside-birds: The water-birds and the waterside-birds in the Corbett National Park comprises of both resident and migrant species. The commonly noticed resident species include Cormorants, the Darter, the Grey Heron, Egrets, the Cattle Egret, the White-necked and Black-necked Storks, the Spotbill, the Large Pied Wagtail and White-capped Redstart.

The migrant species of water-birds in the park include the Great Crested Grebe, Graylag Geese, White Storks, Black Storks, Sandpipers, Snipe, the Great Black-headed Gull, about 15 kinds of ducks, and a variety of Wagtails. Another occasionally noticed water-bird in the park is White or Rosy Pelicans.



ii. Birds of Prey: The resident birds of prey include Crested Serpent Eagle, the Blackwinged Kite, the Indian Shikra, the Himalayan Grey-headed Fishing Eagle, Himalayan Vultures and Lesser and Greater Spotted Eagles. Other resident birds (not very commonly found) are Hawk-Eagles, the Crested Honey Buzzard and the Black Eagle.

The migratory birds of prey include the Osprey, the Peregrine Falcon, the Booted Hawk-Eagle and the Steppe Eagle.

- **iii. Night Birds:** In this category come the owls, the nightjars and the thick-knees. There are over 18 kinds of owls identified in the Corbett National Park including the Spotted Owlet, Fish Owls, and the Scops Owls. The nightjars in the park include the Jungle Nightjar, the Franklin's Nightjar, the Stone Curlew and the Great Stone Plover.
- **iv.** Woodland Birds: In this category come the Green Pigeons, Parakeets, Cuckoos, Hornbills, Barbets, Woodpeckers, Orioles, Drongos, Pies, Babblers and Thrushes. Among the ground-birds (woodland) are the Peafowl, the Red Jungle fowl, and the White-crested Kalij Pheasant.
- v. Grassland and Open Ground Birds: The birds included in this category are the Black Partridge, Doves, Bea-eaters, Rollers, the Hoopoe, Shrikes, Larks, Mynas, Bulbuls, Warblers, Tailor Bird, Robins, Chats, Redstarts, Bayas and Finches.
- **vi. Air-Birds:** In this category belong the Swifts including the famous Indian Alpine Swift, Crested Swifts, the Dusky Crag Martin, Striated (or Red-rumpled) Swallows, the Indian Cliff Shallow, and the Wire-tailed Swallow. A comprehensive list of birds reported from the catchment cum reservoir area is given in **Annexure VIII.4**.
- 8.41 The Reptiles: The Ramganga River and the lake inside the Corbett National Park support a variety of reptile population. The park provides an ideal habitat for both the Gavialis gangeticus (Gharial is a Fish-eating Crocodile) and the *Crocodylus paulustris* (Mugger or Marsh Crocodile). Among the important reptiles found in the Corbett National Park are the Indian Python, Viper, the King Cobra, Krait, Cat Snake, the Wolf Snake, Common Monitors, Lizards, Tortoises, Turtles to name a few. List of Amphibians and Reptiles either observed or reported from the catchment and command areas of Ramganga Project is given in **Annexure VIII.9**.

Faunal diversity of the Command Area

- 8.42 The faunal diversity of the command area was really amazing. Among birds, Saurus cranes and Pea fowls were seen in good numbers very close to the villages and in croplands. Similarly, Nilghai and Sambar deer which are uncommon even in protected forests could be found in the midst of croplands of farmers.
- 8.43 Sarus Cranes (*Grus Antigone*) spotted during the field survey in January 2010. A total of six cranes were noticed in the filelds near Fatehpur. Similarly, Peacock and Pea



fowls (Pavo cristatus) were seen near Kanpur (10 Km from Kanpur). The Sarus Crane (Grus antigone) is a large non-migratory crane found in parts of the Indian Subcontinent, Southeast Asia and Australia. The tallest of the flying birds, standing at a height of up to 1.8 m (5.9 ft), they are conspicuous and iconic species of open wetlands. The Sarus Crane is easily distinguished from other cranes in the region by the overall grey colour and the contrasting red head and upper neck. They forage on marshes and shallow wetlands for roots, tubers, insects, crustaceans and small vertebrate prey. Like other cranes, they form long-lasting pair-bonds and maintain territories within which they perform territorial and courtship displays that include loud trumpeting, leaps and dance-like movements. In India they are considered symbols of marital fidelity, believed to mate for life and suffer the loss of their mates even to the point of starving to death. The main breeding season is during the rainy season, when the pair builds an enormous nest "island", a circular platform of reeds and grasses nearly two metres in diameter and high enough to stay above the shallow water surrounding it. Sarus Crane numbers have declined greatly in the last century and it has been estimated that the current population is a tenth or less (perhaps 2.5%) of the numbers that existed in the 1850s. The stronghold of the species is India, where it is traditionally revered and lives in agricultural lands in close proximity to humans. Elsewhere, the species has been extirpated in many parts of its former range. The presence of Sarus Cranes and the Pea fowls in the croplands close to human habitations is an indication that they are safe in the area.

8.44 The Indian Sarus Crane (Grus Antigone Antigone) is one of the five species of cranes occurring in India. Due to its peculiar preference for water-logged agriculture fields and open areas around human habitations, the bird faces special conservation issues. It is listed under the Schedule-I of WPA, 1972. Often Sarus cranes build nests on the ground in the paddy fields during the cultivation season. This not only takes a small area out of cultivation but also the nest itself is usually made up of grasses and paddy plants etc. This does affect the agriculture productivity adversely to a small extent. Further, intensive agriculture activities close to the nests may also adversely affect the nesting and breeding success of the bird. In Gujarat, which was second largest population of Sarus Crane, commendable conservation efforts have been made by the local peopleparticularly farmers with support provided by Sarus Nature Club (a local NGO) and the Gujarat Forest Department. Once a Sarus nest is spotted by the farmers in their field, they avoid cultivating that area. They also help protect the nests against other natural predators. In this process, they are also able to gather regular information about the behavior of the bird. This community generated information, understanding and sensitivity about the bird has formed the basis of the conservation programme involving local people. Out of the financial support provided by the Gujarat Forest Department for Sarus conservation, an incentive to the extent of Rs.1,000/- to Rs.1,500/- per nest is given to the farmers. The incentive is calculated on the basis of perceived loss to the paddy production due to Sarus nesting. In addition, a Sarus Crane conservation awareness campaign has been launched in the state by the Forest Department and various NGOs. The increase in Sarus Crane population from 1,380 in 2001 to 1,963 in 2007 by regular census exercise by GEER Foundation clearly demonstrates the success of the above mentioned conservation initiatives



8.45 Nilgai (*Boselaphus tragocamelus*) and Sambar (*Cervus unicolor*) which are classifed under the Vulnerable category by the IUCN were seen in a plantation of Mahua (*Madhuca longifolia*) by the side the road leading to Fatehpur. There were no forests and these wild animals were grazing amidst croplands where farmers and farm labour were working. The presence a healthy stock of about 30 animals in the midst of croplands reveals that there were no threats either from the predators or from the locals.

8.46 The Nilgai (*Boselaphus tragocamelus*), sometime called nilgau, is an antelope, and is one of the most commonly seen wild animals of central and northern India and eastern Pakistan; it is also present in parts of southern Nepal. The mature males appear ox-like and are also known as blue bulls. The nilgai is the biggest Asian antelope. The Sambar (Cervus unicolor) is a large dark brown, maned Asian deer. It attains a height of 102 to 160 cm (40 to 63 in) at the shoulder and may weigh as much as 546 kg (1200 pounds), though more typically 162-260 kg (357-574 pounds). The coat is dark brown with chestnut marks on the rump and underparts. The large, rugged antlers are typically rusine, the brow tines being simple and the beams forked at the tip. In some specimens the antlers exceed 101 cm (40 in). The name "Sambar" is also sometimes used to refer to the Philippine Deer (called the Philippine Sambar) and the Rusa Deer (called the Sunda Sambar). The name is also pronounced/spelled sambur or sambhur.



The Sambar deer (*Cervus unicolor*) under *Maduca longifolia* (Mahuva) Plantation near Fatehpur during January 2010





Nilgai (Boselaphus tragocamelus) spotted near Fatehpur in croplands.



A pair of Saurus cranes feeding in a small pond in the Command Area near Fatehpur

Threats to birds:

8.47 One of the major threats faced by birds is from the loss as well as deterioration of their habitat. Trees are being felled at a rapid pace to make way for human settlements as

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well as agricultural activities. Even aquatic habitats are being drained, plowed, filled in, and channelised. Last but not the least, the introduction of invasive plant and animal species is also altering the natural habitat of birds.

- 8.48 Birds are also facing increased competition from one another. Especially the native species of birds are finding it difficult to cope up with the exotic species.
- 8.49 The direct exploitation of birds by humans is reaching alarming proportions. Human activities, such as hunting and capturing birds, are leading to a rapid decline in the bird population.
- 8.50 Birds are highly sensitive to chemicals and toxins and can become fatally sick from inhaling them, either by eating or through their skin. It has been found out that, along with DDT, pesticides and oil spills, even herbicide spraying on lawns leads to death of the birds.
- 8.51 Even indirect pollution of the atmosphere is having an effect on the population of birds. Things like acid rain have been discovered to affect the population of forest birds. It washes away the calcium of the soil and decreases the amount of calcium-rich prey of the birds, affecting their diet and thus, their population.
- 8.52 The nesting, feeding, and roosting areas of birds have faced a lot of disturbance from the human beings, affecting their population.

Aquatic Flora and Fauna

- 8.53 A list of aquatic macro-phytes found in the catchment and command areas of Ramganga project is given in **Annexure VIII.11**.
- 8.54 Fish composition and fishery: Some 18 species of fishes belonging to four families such as cyprinidae, botinae, sisoridae and mastacembellidae have been recorded with fluctuation of fish species at different collecting sites (Gairsen, Chaukhutia and Masi) in the River. The percentage of species of fish has been obtained as Tor spp (7.33), Schozothorax spp. (10.7), Botia almorhae (13.76), Garra spp (11.92), Mastacemballus armatus (10.10), Puntius spp (5.50), Labeo dero(1.83), Barelius spp (1.83) and 19.26 percent of others when total numbers of fishes counted in the water. On weight basis Mahasheer (Tor spp) accounted for 31.25%, Schizothorax spp for 21.34%, Barelius spp for 8.60%, Botia almorhae for 7.19%, Garra spp for 5.21%, Labeo dero for 7.19%, Mastacemballus armatus for 8.60%, Puntius spp for 2.06% and other fishes by 9.5%. The catch per unit effort (CPUE) ranges from 201.0 to 550.0 gm|man|hr in the River. The ornmental fishes such as Botia almorhae, Puntius ticto, Puntius conchonius and Nemacheilus montainus may be used as the aquarium fish. The diversity of fishes of Ramganga reservoir is indicated in Annexure VIII.12.



Zooplankton of River Ramganga: Qualitative and quantitative composition of zooplankton and Zoobenthos of the River Ramganga is given in **Annexure VIII.13**.

Possible Changes Induced by the Ramganga Project on Flora and Fauna:

- Temporal and spatial changes are natural phenomena. Man made changes such as the changes in land use and land cover pattern, cultivation, introduction of exotic species etc have the potential to bring about major changes in structure and composition of biotic communities. It is often difficult to isolate the changes brought about directly by the project and its indirect consequences especially in the absence of any reference for comparison. As the catchment and reservoir areas are botanically and zoologically important from the point of biodiversity, there is reliable pre-project data mainly because most of the catchment and reservoir areas are in the Jim Corbett National Park. Impact Assessment of Bio-ecological Changes in the Faunal Patterns (Selected Groups) brought about by the Partial Submersion of Corbett National Park, as a result of Ramganga Multipurpose Hydel Project was carried out by Lamba and others between 1976 and 1979 under Man and Biosphere Programme, Department of Environment, Government of India. Detailed investigations could not be carried out by the present team in the Corbett National Park for want of permissions from competent authorities. It is appears that as far as the Park is concerned, the project seems to have played a useful role. Apart from providing a safe and suitable habitat for aquatic birds, fish and endangered reptiles like Crocodiles, the reservoir may have also exerted a major role influencing the microclimate of the area. Elephants were spotted enjoying bath in the reservoir. Tigers were caught by cameras of tourists while they were busy in fishing. Crocodiles were seen frequently basking on the banks of the reservoir. The reservoir has also created protection a barrier against illegal hunting from the Kalagar side. Thus there are no indications of any adverse impacts on the flora and fauna of the catchment area, especially the Corbett National Park.
- 8.56 As the consequences of the reservoir are generally limited to the reservoir and its vicinity, an attempt has been made to compare the flora and fauna of the project area with the surrounding areas. As far as the biological composition was concerned, terrestrial communities have been replaced by aquatic and semi aquatic communities in the reservoir area. Giant Reed (*Arundo donax*), Karkas (*Phragmites karka*), Munz (*Saccharum munja*), Kansi (*Saccharum spontaneum*), Barikapoor or Ula (*Themeda arundinacea*), Pula (*Imperata cylindrical* and *I. arundinacea*), Dab (*Desmostachya bipinnata*), Basa / Kamal (*Erianthus ravennae*) and *Baib* or Bhabar (*Eulaliopsis binata*) have become relatively more abundant and dominant in all wetlands and wastelands with at least partial waterlogging during the rainy season. The major difference relate to dominance of certain species on account of the formation of the reservoir.
- 8.57 As far as the fauna of the command area is concerned, quite unexpectly, Nilgai (Boselaphus tragocamelus) and Sambar (Cervus unicolor) among the mammals; Peacock (Pavo cristatus) and Saurus cranes (Grus antigone) were seen quite frequently in the command areas—far away from forests and in open croplands close to residential areas.



Based on the above, it may be concluded that the reservoir has not contributed to any undesirable changes on the fauna of the command area. However, on account of irrigation and the attendant problems of shift in cropping patterns, drainage patterns, waterlogging etc Giant Reed (*Arundo donax*), Karkas (*Phragmites karka*), Munz (*Saccharum munja*), Kansi (*Saccharum spontaneum*), Barikapoor or Ula (*Themeda arundinacea*), Pula (*Imperata cylindrical* and *I. arundinacea*), Dab (*Desmostachya bipinnata*), Basa / Kamal (*Erianthus ravennae*) and *Baib* or Bhabar (*Eulaliopsis binata*) have become relatively more abundant and dominant in all wetlands and wastelands with at least partial waterlogging during the rainy season.

Status of Golden Mahseer in the Tributaries of Ramganga

8.58 Globally golden mahseer (Tor putitora) is a threatened fish species. However, it is found to be common in the tributaries of Ramganga (Vidyadhar M Atkore, 2005). The tributaries of Ramganga viz., Khoh, Kolhu and Mandal serve as an excellent breeding grounds fro gold mahseer. The gold mahseer migrates upstream side of the river for breeding. The construction of reservoir at Kalagarh across Ramganga created a barrier for upstream migration of gold mahseer from the Ganga. For allowing migration of fish from and into reservoir, fish passage has been constructed. However, this fish passage is functional only during the surplusing of the reservoir and the reservoir got surplus flows very seldom i.e., once in ten to fifteen years.

8.59 For irrigation purposes, a feeder channel of length 82.5 km connecting the reservoir and the Ganga River. This channel served as on alternative route for fish migration between Ganga River and Ramganga Reservoir at Kalagarh. Further, this feed channel joins River Ganga on upstream side of the confluence of Ramganga with the River Ganga. Thus, it is a shorter course for fish migration. The major part of the river stretch of Ramganga from the Reservoir at Kalagarh and confluence of Ramganga with Ganga is having very high levels of pollution due to urban areas and industries on the banks of Ramganga. This problems got further aggravated due to absence any ecological flows into the river from the reservoir at Kalagarh. The lean reason flows in the river before the construction of Reservoir at Kalagarh was about 5 cumecs. As per norms at least 10 per cent of lean season flows need to be released into the river towards ecological flows. However, no such provision had been made in case of Ramganga reservoir.

Impacts on Forest, Flora and Fauna

Selected references:

- 1. Lamba B.S. Impact Assessment of Bio-ecological Changes in the Faunal Patterns (Selected Groups) brought about by the Partial Submersion of Corbett National Park, as a result of Ramganga Multipurpose Hydel Project Dam. Ist Stage (1976-1979). Man and Biosphere Programme, Department of Environment, Government of India.
- 2. Richard Grimmett, Carol Inskipp and Tim Inskipp 1998. Birds of the Indian Subcontinent. NHBS Environment Bookstore.
- 3. http://www.jimcorbettnationalpark.com/corbett_flora.asp
- 4. http://www.corbett-national-park.com/flora-in-corbett.html
- 5. http://www.wildlife-india.net/corbett/flora-corbett.html
- 6. http://www.uttarpradeshstat.com/forestandwildlife/13/stats.aspx
- 7. Vidyadhar M Atkore Conservation Status of Fishes in the Tributaries of Ramganga with special reference to Golden Mahseer (Tor putitora) Hamilton, Master's Degree in Wildlife Science, Wildlife Institute of India.



Volume-I



9

Impact of OFD Works





IMPACT OF OFD WORKS

Background

9.01 The core objective of any irrigation project is to take the stored water (Reservoir) up to the farmers' field. This necessitates laying a network of irrigation channels in the project command area so as to extend the irrigation facilities at the door step of farmers' fields. Thus, by utilizing the extended irrigation facilities, the farming community can increase their crop productivity by adopting improved package of practices. This ultimately improves their livelihood.

9.02 Ramganga Project happens to be the first scheme of the State of Uttar Pradesh to provide additional irrigation in the Ganga-Yamuna Doab. Once again it is to be mentioned here that the Ramganga River Valley Project as envisaged constructed during 1962 and 1974 including dam appurtenant works. In general, it is contemplated that with the commissioning of this irrigation project, agriculture production will get a boost. But, in other irrigation project it is experienced that this could not be realized. It was noted that potential created could not be realized mainly due to absence of field distribution system at the farmer's level. The task of developing water conveyance system beyond the outlets up to the farmer's fields was previously left to the farmers which they were not able to do so due to their obvious limitations. Thus, under the Ramganga Command Area Development it was contemplated to lay a network of irrigation channels so as to take the project's irrigation water up to the farmers' field in phased manner.

9.03 The canal system catering to the Ramganga Command Area gets water from Ramganga Reservoir located at Kalgarh, district Bijnor which has a capacity of 2400 million cubic meters, through the century old Ganga canal system viz., Upper and Lower Ganga canal system, after remodeling them, and extending the lower Ganga to eastern part of command through a newly constructed West Allahabad Branch. Thus, the task of construction of dam, barrages and canal system was undertaken by Irrigation Department. It is to be mentioned here that unless and until, the irrigation water is made available from the out – let to the fields of farmers, the command development objective remains unachieved.

9.04 To take irrigation water up to the farmer's fields, under the Ramganga Command Area Development, the On Farm Development (OFD) works were proposed and carried out in the entire cultivable command area in phased manner. Further, water management is site oriented and location specific programme. Soil and associated land features play important role in designing the type of OFD works to be executed there in.

Pag

Study of Environmental Evaluation of Ramganga River Valley Project in Uttar Pradesh

To take the irrigation water from out - let upto farmer's fields, a suitable and scientific water conveyance system is adopted for the purpose in Ramganga Command Area. The scientific approach adopted includes soil survey and Topographical / contour survey for planning and designing OFD works. Based on these surveys, as per requirement and need, construction of irrigation channels (earthen and lined), water control structures and field drain channels have been carried out in the culturable command area in phased manner. The status of implementation of OFD works in the command area of Ramganga project and consequent impact of the same are presented in the following paragraphs.

Organisation for Implementation OFD Works

9.06 The Ramganga Command Area Development Authority (RCADA) is the nodal agency for implementation of OFD works in the command area of Ramganga Project¹. The organizational hierarchy of RCADA includes broad spectrum of personnel from state head quarters to the field level. They are as follows:

- ⇒ State Level Organisation;
- ⇒ Command Headquarters Organisation;
- ⇒ Field Organisation for Execution of OFD Works;
- ⇒ Soil Survey Investigation Division;
- ⇒ Osrabandi Unit; and
- ⇒ Extension Staff

The state level coordination and monitoring of OFD works in command area is undertaken by Department of Area Development under Agricultural Production Commissioner. The department is headed by a Special Secretary. The command headquarter organisation is headed by a Commissioner-cum-Administrator who is an IAS officer. He is assisted by Additional/Joint and Deputy Directors and Additional/Joint heads of departments of Agriculture, Cooperation, Animal Husbandry, Irrigation besides Accounts, Establishment, Horticulture Publicity and Evaluation and Monitoring Divisions. The detailed organisation setup of Command Headquarter Organisation is presented in **Chart 9.1**.

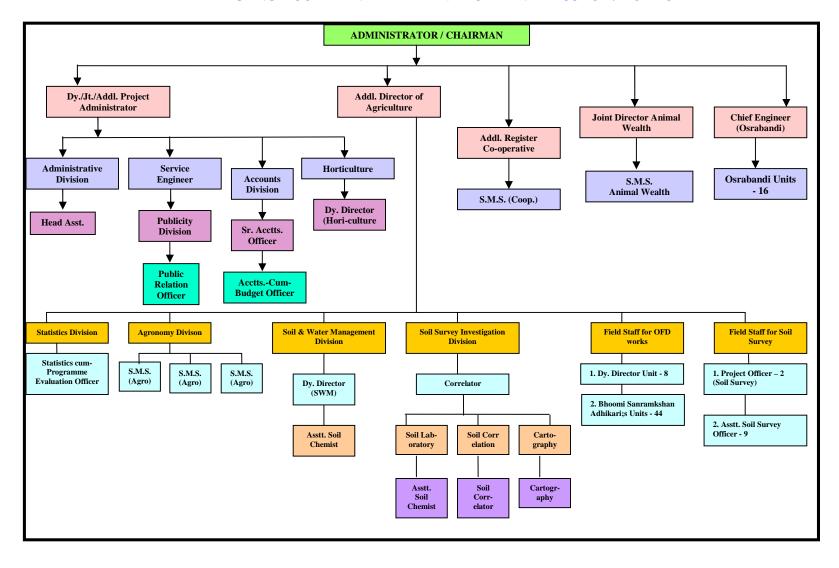
Command area development works are entirely field oriented. The basic field 9.08 work is to make land fit to receive irrigation water efficiently. These works in the field are implemented as state works and is headed by Soil Conservation Officer who is assisted by two technical assistants, three junior engineers, five soil conservation inspectors and twenty five assistant soil conservator inspectors along with necessary office staff.

Details of Organisation Structure for Implementation of OFD works in Ramganga Command Area is given in "Project Report: Ramganga Command Area Development Project", (Kanpur RCADA), PP 20-25.



Volume-I

Chart 9.1 ORGANISATIONAL SET-UP RAMGANGA COMMAND AREA DEVELOPMENT PROJECT / AUTHORITY





Impact of OFD Works

The work of soil conservation unit is supervised and monitored by Deputy Director of Agriculture and Soil Conservation who is a senior level officer of Agriculture Department and assisted by Technical Officer and Junior Engineer, drafts man and tracer besides clerical and accounts staff.

Soil Survey Investigation

- 9.10 Division includes soil testing and laboratory, cartography and correlation units and soil survey field staff. This division is responsible for preparing inventory of soil resource of the command area. There are 9 soil survey units spread over the command area with headquarters at Allahabad, Fatehpur, Kanpur (2 units), Etawah, Agra, Mainpuri, Etah & Aligarh. The work of soil survey units is supervised by two Project Officers stationed at Kanpur (5 units) and Agra (4 units). The soil survey units are headed by Assistant Soil Survey Officer and assisted by 4 Senior and 4 Junior Soil Surveyors along with the required ministerial staff. In this project the fundamental and applied aspects of soil survey are persuaded together through cartography, soil analytical works and correlation under the technical supervision of Correlator.
- 9.11 Warabandi/Osrabandi at the kulaba level envisages scientific and equitable distribution of available irrigation water among beneficiary farmers. The formulation and documentation in Warabandi prgoramme is carried out by Osrabandi units. Each such unit comprises of one Deputy Revenue Officer, Four Ziledars, Sixteen Amins, Sixteen Patrols and Five Munshis. About 16 units have been sanctioned. Osrabandi division is headed by Chief Engineer (Osrabandi) who besides supervising Osrabandi work is also responsible for effecting coordination with Irrigation Department for proper and timely operation of irrigation system preparation of roaters in different crop seasons, proper maintenance of canal system and drainage works.
- For translation of Agro-technique in action as well as better utilization of agriculture inputs for sustained agricultural production, five village Development Officers per block have been made available exclusively for command development activities besides regular extension staff of C.D. blocks. About 675 Additional V.D.Os. are working in the command area under the administrative control of C.A.D.A. Till the year 1984 these field officers were under the administrative control of the development blocks, but thereafter they have been transferred to soil conservation units under the control of Bhoomi Sanrakshan Adhikari. Consequently the command area authorities are now able to ensure the implementation of agricultural programme as well as imparting agricultural advisory services to the farmers falling with in the kulaba commands.
- 9.13 The RCADA was established immediately after the completion of dam works and canal network by Irrigation Department of Uttar Pradesh during 1973-74 to initiate OFD works in the command Area of Ramganga project. Major part of OFD works in the command of Ramganga project was completed by 1985-86

Pre-Project Status of Command Area

- 9.14 Prior to the commencement of the Ramganga Command Area Development Project, the Cultivable Command Area (CCA) in the Ganga-Yamuna Doab was 15.14 lakh ha and an additional area of 3.83 lakh was added to this through the construction of new channels. Thus, the total CCA in the area attained a level of 18.97 lakh ha. The irrigation potential prior to the commencement of the project was 8.60 lakh ha. The intensification of channels and construction of new channels has resulted in creation of additional irrigation potential of 2.40 and 2.72 lakh ha respectively. Thus, about 5.12 lakh ha additional irrigation potential has been created under the project. As such the pre-existing irrigation potential (8.60 lakh ha) coupled with the newly created potential (5.12 lakh ha) has generated 13.72 lakh ha irrigation potential.
- 9.15 There was large gap between the potential created and utilization of potential created. The listing of main problems in this regard is contained in the report prepared by RCADA (*op.cit.*, 1990). Most of these reasons fall into two main categories. They area as follows:
 - ⇒ Absence of field of distribution systems; and
 - ⇒ Man made problems such as unauthorized irrigation and breaking distribution structures
- 9.16 The main reason for absence of field distribution system was that the task of developing water conveyance systems beyond outlet upto farmer's field was previously left to the farmers and they were not able to do so because of their own limitations.
- 9.17 On the basis of the correlation studies conducted by the Agriculture Department, GoUP, 20 broad soil groups had been identified in the command area blocks of Ramganga project. On the basis of this study, land capability and soil and land irrigability classification has been assessed. Most of the area in the command area blocks of Ramganga project is in the irrigability classification of 3e or 3s or 3f. This classification indicates that area is suitable for irrigation with moderate constraints.
- 9.18 Poor drainage in conjunction with canal irrigation is likely to results in rise of groundwater table and consequent water logging an salinisation or deposition alkali in the soil. Drainage problem can be identified by observing stagnation of water over the land for considerable period, growth of water loving vegetation, deposition of salt or alkali in the soil, presence of a shallow water table, matting or glaying in the soil profile, stunted growth of trees/shrubs and shallow root development etc. Drainage problem can also arise because of unconsolidated substrate consisting of finer material or obstruction to natural drainage ways through construction of roads, bridges, railway lines or lands bordering natural drainage channels, lakes, unlined canals etc. On the basis of these considerations, the following soils were identified that required drainage in the command area of the project.



Soil Group No	Area in lakh ha
4	0.97
5	7.67
6	1.56
7	0.50
12	0.59
13	2.20
16	1.65
17	1.50
20	0.27
Total	16.50

- Geographically out of 144 blocks included in the CAD of project, about 100 of them require some sort of drainage to be established either in part or the whole of the block. However, fifty per cent would need drainage improvement in only part of the block area. Similarly, through the reconnaissance survey, 95 distributaries have been identified whose command areas require to be adequately drained for sustained agricultural use under irrigation. The major channels affected were be U.G.C., L.G.C. between the off takes of Bewar and Etwah Branches, Kanpur Branch, Fathepur Branch, Etawah Branch, West Allahabad Branch as it enters Fathehpur Branch.
- The extent and type of drainage needed differ with the soils but most of them suffer from water stagnation where surface drainage should be provided. Certain areas in Mathura district, particularly in soil group No.17 have high water table occasionally saline soils. In areas of fluctuating water table with good quality groundwater, shallow tubewells will improve drainage. In the event of seepage from canals, interception drains may be provided. Surface drainage requires free outlet and out falls, lack of which would many a time limit the intensity of drainage to be provided. In majority of cases mechanical measures will have to be integrated with suitable crop rotations and varieties of crops. The possibility of local collection and recirculation of water for irrigation should also be examined.
- An area of about 3.57 lakh ha occupied by soil group No.1 in the vicinity of the Gange and mostly located in the districts of Farrukhabad and Etah is regularly flood by the river. These areas constitute the Khadir tract and agriculture in these areas is quite precarious. Kharif crops are quite uncertain but Rabi and Zaid crops are taken without irrigation. Bunchise are sometimes concentrated to check flooding from the river.
- An area of roughly 3.2 lakh ha, is affected by salinity in the command area. The problem is concentrated mostly in the centre of the doab, stretching from Aligarh to Allahabad district where drainage problem is also acute. The soils are mostly saline alkali and alkali in nature and the salinity is due to excess soluble carbonates. The saucer shaped nature of the terrain with few natural outlets is conducive to water stagnation. The permeability of the soils is also very low and the sub-soil is having occasionally a thick

kankar pan impreggated with clay. Occasionally the water table is also high but the groundwater is of fairly good quality. Another patch of salt affected land occurs in the Mathura and Agra districts where the soils are mostly saline with a high groundwater which is also saline in character. These areas have different set of problems as compared to the salinity problem existing in the central region. Strongly affected soil groups are No. 5, 6 & 17, those which are only moderately affected by salinity problem are soil group No. 1, 4, 7 & 20.

Status of Implementation of OFD Works

9.23 The main pre-requisite for planning and implementation of OFD works in the command area of the project are soil survey and topographical survey. The progress under these two pre-requisites of OFD works between 1974-75 and 2007-08 are presented in the following paragraphs. The progress in implementation of OFD works between 1974-75 and 2007-08 is also presented in this section.

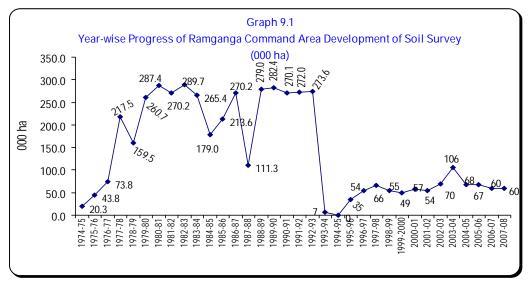
Soil Survey

- 9.24 Conduct of Soil Survey is one of the important aspects of the agriculture development. Based on Soil Survey results the land classification is carried out and strategies are formulated for land use. Besides, under the command area development, soil survey helps in laying of irrigation channels as well as lining of channels at venerable sections.
- 9.25 Thus, conduct of soil survey was made an integral part of the command area development programme and was initiated in the culturable command area of project right from beginning i.e., from 1974–75. In the initial three years (from 1974–75 to 1977) the progress was slow and on a average the soil survey carried out @ 4600 ha per year. However, thereafter it picked up the momentum and continued till 1993–1994. During this period, on an average it covered 237000 ha annually. From 1994–95 onwards the survey progress became slow till 2007–08 and survey ranged between 50000 and 60000 ha per year. The maximum soil survey work was carried out between 1978–79 and 1993–94. In all, till 2007–08 the soil survey conducted in the cultivable command area is 4360000 ha. The details of year-wise soil survey conducted in the command area are presented in **Graph 9.1.**

Topographical / Contour Survey, Planning & Designing

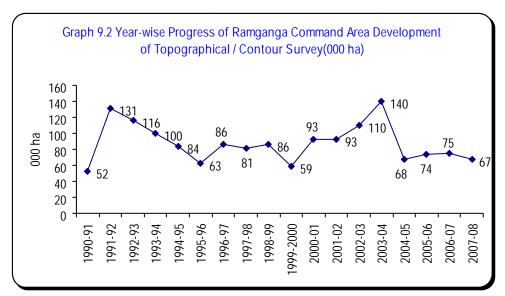
9.26 Water management is site oriented and location specific programme. Soil and associated land features play an important role in designing the type of various OFD components to be executed therein. This survey helps in planning and designing the blue prints for laying the irrigation channels (earthen & lining of channel), water control structures and field drains.





Source: Commissioner/Chairman & Project Administrator, Ramganga Command Area Development Project, Annual Report (1992-93 & 2007-08), Kanpur

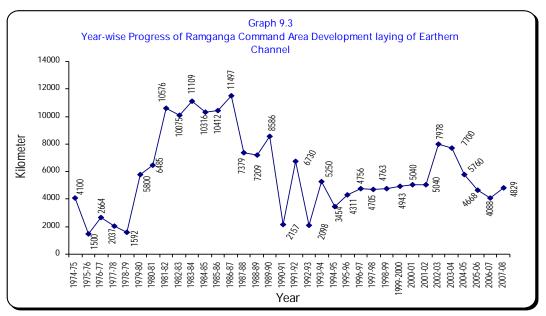
9.27 In this regard it is noted that from 1990-91 to 2007-08 (for which data is available) a total 1578000 ha of Ramganga project command area has been surveyed. This indicates that on an average 88000 ha of land was covered under the survey per year. Year-wise progress of this survey is presented in **Graph 9.2**. The graph indicates that the maximum survey was carried out during 1991-92 to 1993-94 and 2002-03 and 2003-04. Based on the survey results structure designs were developed and planned for the construction of irrigation channels, field drains and water control structures.



Source: Commissioner/Chairman & Project Administrator, Ramganga Command Area Development Project, Annual Report (2007-08), Kanpur

Construction of Earthen Irrigation Channels

9.28 The data on this revealed that so far (till 2007–08), in the Ramganga project Culturable command area, 1,99,607 km of earthen channels have been laid in the area as per the design and plan. On an average per year 5870 km length of earthen channels were constructed in 34years (1974–75 to 2007–08). The maximum construction of earthen channels was carried out between 1981–82 and 1989–90. During this period the work was executed which indicated 47 per cent of total length laid @ 10664 km/year. Thereafter i.e., from 1991–92 to 2007–08 the total earthen cannels length constructed was 88270 km @ 490 km per annum. During this period the highest construction work executed was 7978 km in 2003 and the lowest being 2098 km in 1993–95 (**Graph 9.3**).



Source: Commissioner/Chairman & Project Administrator, Ramganga Command Area Development Project, Annual Report (1992-93 & 2007-08), Kanpur

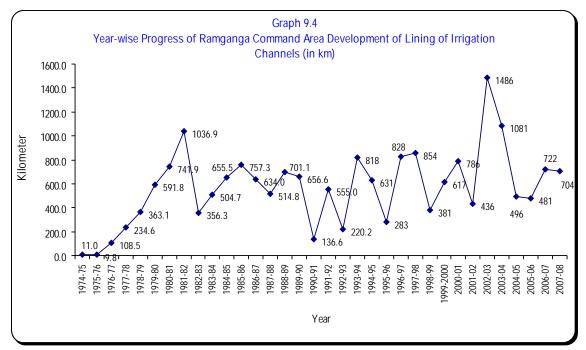
Lining of Irrigation Channels

- 9.29 It is estimated that 22 to 27 per cent water which flows through earthen irrigation channels is lost. Thus, there is a need to take appropriate action to stop this loss, as a good quantum of irrigation water goes waste, which would have been utilized for irrigation purpose. Therefore, to arrest this loss to the extent possible the project authorities had planned to undertake up to 10 per cent of total length of earthen field channels for its lining as per the needs at venerable sections.
- 9.30 The data collected on this aspect indicated that the channel lining work was initiate right from 1974–75 and the work progressed in different phases. Initially from 1974-75 to 1979–80 the lining work is found to be slow which covered 1,319 km in six years. Thereafter it picked up its pace. On an average per annum 645 km of lining work



Impact of OFD Works

was executed during 1980–81 and 2007–08. Further, data indicated that maximum lining work was in the years 1981-82 and 2003-2005. Till 2007-08 the total length of 19393 km lining of irrigation channels is found to be completed which is about 10 per cent of the total length of earthen irrigation channels laid (Graph 9.4).

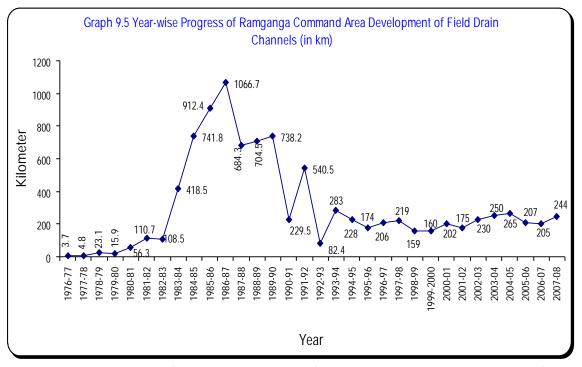


Source: Commissioner/Chairman & Project Administrator, Ramganga Command Area Development Project, Annual Report (1992-93 & 2007-08), Kanpur

Field drain channels

- 9.31 Stagnation of water in the crop field for more than required spell spoils the standing crop as well as it affects the capability of the field soils. Therefore, field drains are essential to remove excess irrigation and rainfall water runoff from the fields. Besides, they are also useful in removing the salts from salt affected areas/high water table areas.
- 10.32 Thus, under the Ramganga project Command Area Development Programme, it was proposed to construct the Field Drain Channels for the purpose mentioned above and executed. In all 9728.8km length of field drains have been laid in the cultivable command area of Ramganga project. Construction of field drains was initiated in the year 1976–77. The maximum field drain construction work was executed during 1984–85 and 1989–90 covering 50 per cent of the total field drains constructed till 2007–08 (Graph 9.5).

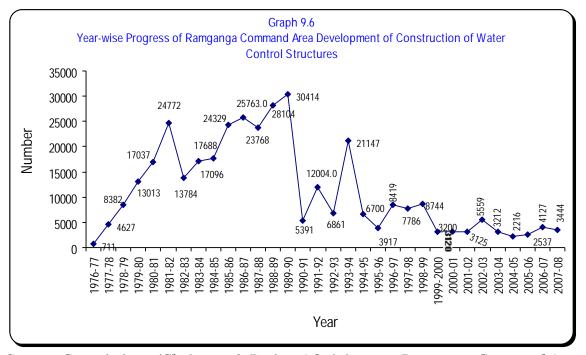
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Source: Commissioner/Chairman & Project Administrator, Ramganga Command Area Development Project, Annual Report (1992-93 & 2007-08), Kanpur

Construction of Water Control Structure

- 9.33 Water control structures are needed to regulate and make irrigation water available safely to fields avoiding soil erosion and wastage of water. The type of water control structure could be in the shape of outlets, chutes, drops, siphons, culverts etc., on both field irrigation and drainage channels. The numbers would differ from outlet to outlet depending upon the topography and need of the location.
- 9.34 In Ramganga project command area, so far (till 2007–08) 360997 such water control structures have been constructed to regulate and made available irrigation water safely to the farmer's field and arresting wastage of water. The maximum water control structures were constructed between 1979–80 and 1989–90 to the tune of 60 per cent of total structures constructed. During next decade (1990-91 to 1999–2000) 84,169 such structures were laid (23% of the total Structures). The details of year wise construction of water control structures depicted in the following **Graph 9.6**.

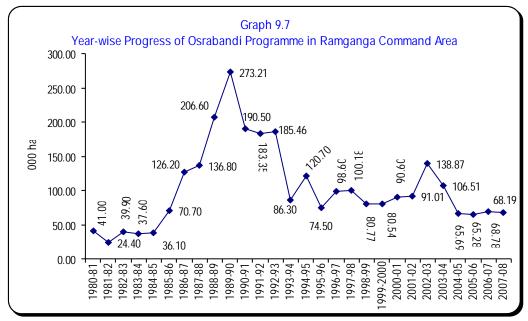


Source: Commissioner/Chairman & Project Administrator, Ramganga Command Area Development Project, Annual Report (1992-93 & 2007-08), Kanpur

Osrabandi

- 9.35 After creating needed facilities (OFD Works) in the project command area, the next step was to ensure efficient and equitable water distribution amongst the beneficiaries. To address this issue Osrabandi / Warabandi programme was initiated. This programme has been taken up in these canal outlets which have been saturated in respect of OFD works (laying of earthen channels, lining of irrigation channels, construction of field drain channels and water control structures. Osrabandi envisages scientific and equitable distribution of available irrigation water among beneficiary farmers. Osrabandi envisages scientific and equitable distribution of available irrigation water among beneficiary farmer's head and tails ender fields.
- The formulation and documentation under Warabandi programme is carried out by Osrabandi units. Each Osrabandi unit is comprises of Deputy Revenure Officer, Ziladars, Amins, Patrols and Munshis. This division is headed by Chief Engineer (Osrabandi), who besides supervising Osrabandi works, is also responsible for effective coordination with Irrigation Department for proper and timely operation of irrigation system operation of roosters in different crop seasons. Proper maintenance of canal system and field drain work.
- 9.37 At the local level the farmers groups (constituted as per the UP Area Development, 1976 Act) have been involved in equitable and timely distribution of irrigation water as per the roaster prepared by the Osrabandi unit.

9.38 The data on implementation of Osrabandi programmer in the Ramganga project Command Area indicated that from 1980–81 to 2007–08 in all, 28,88000 ha of land has been covered in phased manner. The year–wise progress of land coverage under Osrabandi is presented in **Graph 9.7.** Further, it is observed that the maximum area (1302000 ha) covered under Osrabandi among 1986–87 and 1992–93 (7 years). On average one lakh hectares of land was being covered under Osrabandi programme (**Graph 9.7**).



Source: Commissioner/Chairman & Project Administrator, Ramganga Command Area Development Project, Annual Report (1992-93 & 2007-08), Kanpur

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- 9.39 From the aforesaid, it could be concluded that all efforts have been made by the project authorities to take the irrigation water from canal outlets to the farmer's field by implementing the OFD works effectively. Further, it could be observed that the OFD works were carried out in phased manner, the achievements were made to the extent possible based on the year wise targets fixed.
- 9.40 The soil survey and topographical / contour survey in the entire CCA in Ganga-Yamuna doab helped to plan and implement various components of OFD works. The timely completion of these surveys was possible in view of establishing the exclusive organisation with necessary field setup.
- 9.41 The construction of field drains, it is reported, effectively solved the water logging problem in the command area of Ramganga project. It is also reported that the spread of conjunctive use of groundwater with that of surface water, especially in the command area of Ramganga project has substantially lowered the water table and helped



Impact of OFD Works

to contain water logging and secondary salinisation. The review of literature indicated that the water logging and salinity/alkalinity need to be tackled at two levels. These two levels are as follows:

- ⇒ There should be a systematic effort to assess the extent, nature and location of the waterlogged and saline/alkaline lands in the command area of a project; and
- ⇒ A phased programme should be drawn up to reclaim such lands in a cost effective manner.
- 9.42 The foregoing analysis clearly indicated that RCADA adopted the above cited strategy to tackle the problem of water logging and salinity/alkalinity. The project authorities had taken the advantages of the provisions in the Centrally Sponsored Command Area Development Programme for removal of water logging and restoration of saline and alkaline areas in the command of Ramganga project. The irrigation induced water logging problem in the command area of the project had been controlled by lining the irrigation channels in the venerable sections and excavation of field drain channels as per requirement. For restoration of saline/alkaline soils the supply soil amendments, at subsidized rates, such as Gypsum was undertaken under the project. Further, available good quality surface water in the command area helped to reach the saline/alkaline soils along with the application of soil amendments.
- 9.43 The secondary salinisation due to raising of groundwater table in the command area of Ramganga project was controlled through planned conjunctive water use in the command area of the project. In fact, the irrigation planning was based on 60 per cent surface water (canal water) and 40 per cent groundwater utilization. Further impetus to conjunctive use of groundwater and surface water was given with the state investment for sinking public tube wells.
- 9.44 Even though Osrabandi was planned to provide canal irrigation on rotation basis, the tail end farmer did not get expected qualities of canal water. This was mainly because the Osrabandi committees did not function effectively in water distribution and unauthorized drawl of water in head and middle reaches of the distribution system. Another main reason for such a scenario in the water distribution, was the poor maintenance of canal network and consequent absence of free flow water through main canals distributaries and minors of the project.

Farmers views regarding OFD Works

9.45 Participatory group discussions were conducted with the farmers of all the sample villages. A typical observation, which emerged from these discussions, is that the maintenance of the canals is highly unsatisfactory and irregular. The farmers of almost all the villages stated that after the withdrawal of the project even kulaba channels were not maintained. Some of the farmers stated that they did not receive any irrigation water for

the last about a decade. Non availability of water at tail end is found to be the common problem.

- 9.46 Further, the informal discussions held with sample households, particularly of Chakar nagar Block, Etawah district, revealed that despite the OFD works, the level of the fields & water remained non-compliable.
- 9.47 In nutshell, the withdrawal of the project with no follow up inbuilt programme led to the conversion of the project area, almost to the common area status. Thus there is no visible difference in the command and non command area.

Volume-I



10

Changes in Landuse Pattern





CHANGES IN LANDUSE PATTERN

Background

10.01 Anthropogenic changes in land use and land cover are being increasingly recognized as critical factors influencing global change. While, land use and land cover are often assumed to be identical, they are rather quite different. Land cover may be defined as the biophysical earth surface while; land use is often shaped by human, socioeconomic and political influence on the land. Remote Sensing (RS) integrated with Geographical Information System (GIS), provides an effective tool for analysis of land use and land cover changes at a regional level. The geospatial technology that combines the technology of RS and GIS holds the potential for timely and cost effective assessment of natural resources. The techniques have been used extensively in tropics for generating valuable information on forest cover, vegetation type and land use changes¹. Therefore, we have used RS and GIS to study Land Use and Land Cover (LULC) changes in the command and catchment areas of Ramganga project.

Methodology

10.02 Satellite Imageries of 1989 (LANDST TM), and 2008 (IRS P6 LISS-III) were used for change detection in the command catchment areas. The 1:50,000 Survey of India (SoI) topographical sheets were utilized in the preliminary processing of satellite data. A False Color Composite (FCC) was generated using the different bands of satellite data. The satellite imagery was refined or geometrically corrected using ground control points obtained from SoI toposheets and ground control points collected from field. Points such as the intersections of roads, river junctions, etc., were identified on the toposheets as ground control points. Using polynomial equation the scene was geometrically corrected and geo-referenced into latitude / longitude coordinate system using polyconic system. The pixel were re-sampled using maximum likelihood algorithm and the free catchment area of Singur project was extracted from the scale using catchment boundary maps in ERDAS Imagine 9.0 software. Sub-pixel image to map registration accuracy was achieved through repeated attempts. Histogram matching was done to correct the radiometric differences, if any. Using a ground control points, training sets were generated for different land cover and land use types and the image is classified based on a combination of visual and digital classification schemes. The entire study area i.e., frees catchment and command of Ramganga project was classified and different land use and land cover types were obtained.

¹ Pranjit KR Sarma, at.el. "Land Use and Land Cover Change and Future Implication Analysis in Manas National Park, India Using Multi-Temporal Satellite Data", Current Science, Vol. 95 No.2, 25th July 2008.



Land use / Land cover Classification System Adopted

10.03 Realizing the need for an up to date nationwide land use /land cover classification system, as a prelude a classification system with 24 categories was developed by National Remote Sensing Agency taking into consideration the existing land use classification adopted by Ministry of Agriculture. Revenue department, All India Soil and Land use Survey, etc., and the details obtainable from satellite imagery. The system developed was discussed with several user departments in the country and finally a 22 fold classification system has been adopted for nationwide land use / land cover analysis.

10.04 The land use classes adopted in the study are mainly based on 22 fold national classification system with slight modifications which were adopted keeping in view the specific project objectives, limitations of satellite data interpretation and presentation of maps on a limited size paper sheets. A brief description of classes included in the atlas is given below:

Built-up land

10.05 It is an area of human habitation developed due to non-agricultural use and that has a cover of buildings, transport and communication, utilities in association with water, vegetation and vacant lands.

Agricultural Land

10.06 Kharif Crop: These are the areas synonymous with the cropping season extending between June/July to September/October. The season coincides with the South West monsoon season. It is associated with rain-fed crops, limited or no irrigation and are mainly areas of irrigated paddy.

10.07 Rabi Crop: These are the areas synonymous with the cropping season extending between November/December to February/March. It is associated with areas under assured irrigation irrespective of the source of irrigation.

10.08 Zaid Crop: These are the areas cropped during the third season (summer) which are mostly associated with irrigated areas with fertile soils.

10.09 Double Crop / Area sown more than once: These are the areas which are cropped during two or more season in a year. They are often associated with irrigated area.

In the Legend the crop classes are shown as follows:

Single Kharif Crop : Areas which are sown only during Kharif season.

Single Rabi Crop : Areas which are sown only during Rabi season.

Single Zaid Crop : Areas which are sown only during Zaid season



Changes in Land Use Pattern

Double Crop (Rabi + Kharif) : Areas which are sown both in Rabi & Kharif Season

Double Crop (Rabi + Zaid) : Areas which are sown both in Rabi & Zaid Season

Double Crop (Kharif + Zaid) : Areas which are sown both in Kharif & Zaid Season

Triple Crop : Areas sown three times in a year i.e., in Rabi, Kharif &

Zaid Season.

10.10 Fallow Land: These are the lands which are taken up for cultivation but have been temporarily un-cropped for the current year.

10.11 Plantation: These are the areas under tree crops (Agricultural and Non-agricultural) planted.

Forest

10.12 These are the areas which are covered by land with tree canopy cover of more than 10 per cent and area of more than 0.5 ha. These include the tree growth for production, protection, multiple use or conservation. The term excludes stands of trees established for agricultural production (fruit free plantation) and trees planted in agroforestry. The legal extent of forest depends upon the process of notification.

Wastelands

10.13 Wasteland is described as degraded land which can be brought under vegetative cover with reasonable effort and which is currently underutilized and land which is deteriorating for lack of appropriate water and soil management or on account on natural causes.

10.14 Waterlogged/Marshy lands: This class mainly comprises of surface waterlogged lands whether natural (due to excessive rainfall, folding, local depression and poor topsoil conditions etc.,) or artificial (due to seepage from canal, over irrigation and construction activity etc). In the atlas perennial waterlogged areas & marshy lands (which have less occurrence & extent) have been shown as a single class.

10.15 Other Wastelands: This class comprises the gullied and ravenous lands, deteriorated lands with or without scrubs and salt affected lands.

Water Bodies

10.16 This class comprises areas with surface water, either impounded in form of ponds, lakes and reservoirs or flowing as stream, rivers and canals etc. The classification adopted for land use and land cover in the atlas is given below:

Land Use / Land Cover Class						
Sl. No	Sl. No Level - I Level					
1	Built up land	Built-up land/Settlement				
2	Agriculture land	Single Kharif Crop				
		Single Rabi Crop				
		Single Zaid Crop				
		Double Crop (Rabi + Kharif)				
		Double Crop (Rabi + Zaid)				
		Double Crop (Kharif + Zaid)				
		Triple Crop				
		Fallow Land				
		Plantation				
3	Forest	-				
4	Wasteland	Waterlogged/Marshy land				
		Other Wasteland				
5	Water Bodies	Water Bodies				
		River				
		Main Canal				
		Branch Canal				
		Distributory Canal				
		Minor Canal				

Other Classification Systems

10.17 It is worthwhile to mention here regarding the other classification systems in practice. National Commission on Agriculture classification (1950-51 and modified in 1976) gives land uses details under nine broad classes as given below:

Forest

10.18 Area under forests include all lands classed as forest under any legal enactment dealing with forests or administrated as forests, whether State owned or private and whether wooded or maintained as potential forest land. The area where crops are raised in the forest and grazing lands or areas open for grazing within the forests are included under the forest area.

Areas under Non Agriculture uses

10.19 All lands occupied by buildings, roads and railway or under water e.g. rivers and canals and other lands put to uses other than agriculture.





Barren and Uncultivable Wasteland

10.20 This covers all barren and uncultivable land like deserts, rocky, mountains etc., which can not be brought under cultivation unless at high cost, whether such land is in isolated blocks or within cultivated holdings.

Permanent pasture and grazing lands

These cover all grazing lands.

Miscellaneous tree-crops not included in the net sown area

10.21 Under this class is included all cultivated land which is not included in tree-crops under 'net area sown' but is put to some agricultural use.

Cultivable wasteland

10.22 These included all lands available for cultivation whether not taken up for cultivation or taken up for cultivation once, but not cultivated during the current year and last five years or more in succession; such lands my be either fallow or covered with scrubs and jungles which are not put to any use (May be isolated blocks or within cultivated holdings) land once cultivated but not cultivated for five years in succession is also included in this category at the end of the five years.

Fallow land other than current fallow

10.23 This refers to all lands which are taken up for cultivation but area temporarily out of cultivation for a period of not less than one year and not more than five years; the reasons for keeping lands fallow may be either poverty of cultivators or inadequate supply of water or malarial climate or silting of canal and rivers or non-remunerative nature of farming.

Current Fallows

10.24 This class comprises cropped areas which are kept fallow during the current year; for example, if any seeding area is not cropped again in the same year it is treated as current fallow.

Net Area Sown

This represents the area sown with crops and orchards counting sown more than once in the same year only once.

Changes in Land Use Pattern

10.25 USGS classification system developed by Anderson et.al (1976) and IIRS classification system developed by Singh *et.al* (1983) are other commonly used classification system. However, it is not advisable to compare the results generated based on two different classification systems to ascertain the inaccuracies in one system. Infact, many researchers believe that even a single classification system could give different result with different types of imageries and varying scales.

Ground Truthing

10.26 Before the preprocessing and classification of satellite imagery began, and extensive field survey was performed through out the Catchment area of Singur using Global Positioning System (GPS) equipment. The Global Positioning System has developed as an efficient GIS collection technology which allows users to compile their own data sets directly from the field as part of ground Truthing. Ground truth surveys are essential components for the determination of accuracy assessment for classified satellite imagery. This survey was performed in order to obtain accurate location point data for each land use and land cover classes included in classification scheme as well as for the creation of training sites and for signature generation.

Assessment of Changes in LULC

10.27 The total free catchment area of Ramganga project was classified and the following land use / land cover types were obtained.

- Crop Land-Single cropped area
- Crop Land-double cropped area
- Current Fallow land
- Agriculture Plantation
- Built Up Area
- Deciduous (Dry/Moist/Thorn)-Open
- Forest Blank

- Forest Plantation
- Scrub Forest
- Forest-Tree Clad Area
- Wastelands
- Water bodies-Reservoir/Tanks
- Water bodies-River/Stream

10.28 The above classification of LULC can be grouped into five main categories. They are as follows:

- ⇒ Crop land consisting of single crop land, double crop land current follows and agricultural plantations;
- ⇒ Forest land consisting of open forest, scrub forest, tree clad area, forest area and forest plantations;
- ⇒ Water bodies consisting of reservoirs, tanks, rivers and streams;
- \Rightarrow Built up land; and
- \Rightarrow Waste lands.





Changes in Catchment Area

10.29 The changes in land use / land cover of the catchment area of Ramganga project is assessed between 1970-71 and 1978-79 and 1990 and 2008. The changes between 1970-71 and 1978-79 is assessed on the basis of information obtained from the DFOs of soil conservation divisions at Ramnagar and Ranikhet, whereas the changes during the period of 1990 to 2008 were assessed on the basis RS Imagery analysis.

10.30 The changes in land use / land cover during 1970-71 to 1978-79 in Ramganga catchment is presented in **Table 10.1**. During this period the forest area of all types got reduced. The reduction was very steep in grass lands. On the other hand the area under cultivation and water bodies increased at the cost of forest area. The increase in the area under water bodies was very steep (179.76%) during this period. This was mainly because of the creation of Ramganga reservoir with a water spread area of about 8000 ha in the reserve forest area. The mixed land also registed an increase of 0.51 per cent, which may be mainly because of increase in built up area.

Table 10.1 Changes in Land Use / Land Cover in Catchments Area of Ramganga Project (1970-71 & 1978-79)								
Sl	Particulars	1970-71		1978-79		Change		
No.		Area in ha	%	Area in ha	%	in ha	in %	
1	Dense Forest	122312	39.36	118634	38.18	-3678	-3.01	
2	Thin Forest	16687	5.37	15635	5.03	-1052	-6.30	
3	Dense Shrubs	13681	4.40	13117	4.22	-564	-4.12	
4	Thin Shrubs	23829	7.67	22241	7.16	-1588	-6.66	
5	Grass Lands	24875	8.01	21877	7.04	-2998	-12.05	
6	Terraces Under Cultivation	77445	24.92	77985	25.10	540	0.70	
7	Agricultural Land	8022	2.58	8321	2.68	299	3.73	
8	Mixed Land	18898	6.08	18994	6.11	96	0.51	
9	Waterbodies	4976	1.60	13921	4.48	8945	179.76	
	Total	310725	100.00	310725	100.00	0	0.00	

Source: Complies on the basis of information obtained from Division Forest Officers, Soil Conservation Divisions, Ramnagar and Ranikhet

10.31 Changes in land use / land cover of Ramganga catchment area between 1990 and 2008 are presented in **Table 10.2**. These details in map form are presented in **Figures 10.1 and 10.2**. There were marginal changes in the land use and land cover of Ramganga catchment area during this period. These changes are analysed in the following paragraphs.

Changes in Land Use Pattern

Table 10.2 Changes in Land use / Land cover in Catchment Area of Ramganga Project (1990 & 2008)								
1990 2008 Chan								
Sl	Particulars	Area in		Area in				
No.		ha	%	ha	%	in ha	in %	
I	Crop Land							
1	Crop Land - Kharif Crop	4414.74	1.42	4327.33	1.39	-87.41	-1.98	
	Crop Land - More than two							
2	crop	11.51	0.00	11.51	0.00	0.00	0.00	
3	Crop Land - Rabi Crop	4509.14	1.45	4470.70	1.44	-38.44	-0.85	
4	Crop Land - Two Crop Area	1601.24	0.52	1668.02	0.54	66.78	4.17	
5	Fallow - Current Fallow	46537.17	14.98	47224.13	15.20	686.96	1.48	
6	Plantation - Agriculture Plnt.	14.94	0.00	12.51	0.00	-2.42	-16.23	
	Sub Total	57088.74	18.37	57714.21	18.57	625.47	1.10	
II	Forest Land							
7	Deciduous - Dense/Close	57139.08	18.39	57119.54	18.38	-19.54	-0.03	
8	Deciduous - Open	8743.24	2.81	8643.11	2.78	-100.12	-1.15	
9	Forest Blank	27.49	0.01	29.71	0.01	2.22	8.08	
10	Scrub Forest	25087.52	8.07	25213.76	8.11	126.24	0.50	
	Forest Evergreen/Semi					-		
11	Evergreen - Dense/Close	63322.86	20.38	62293.15	20.05	1029.72	-1.63	
	Forest Evergreen/Semi							
12	Evergreen - Open	57295.95	18.44	57576.19	18.53	280.24	0.49	
13	Tree Clad Open	26566.22	8.55	26643.75	8.57	77.53	0.29	
	Sub Total	238182.35	76.65	237519.21	76.44	-663.15	-0.28	
III	Wastelands							
14	Wastelands - Sandy Area	299.87	0.10	719.05	0.23	419.18	139.79	
	Wastelands - Barren and							
15	Rocky Land	788.81	0.25	967.20	0.31	178.39	22.61	
	Sub Total	1088.68	0.35	1686.25	0.54	597.57	54.89	
IV	Water bodies							
	Waterbodies -							
16	Reservoir/Tanks/Lankes/Ponds	10576.29	3.40	9969.87	3.21	-606.42	-5.73	
17	Waterbodies - River/Stream	3788.93	1.22	3835.46	1.23	46.53	1.23	
	Sub Total	14365.22	4.62	13805.34	4.44	-559.89	-3.90	
	Grand Total	310725.00	100.00	310725.00	100.00	0.00	0.00	
Sour	ce: Compiled on the basis of Ren	note Sensing	Imageries	with the help	of GIS T	Tools		

Crop Land: The crop land consisted six sub-categories. Two cropped area and current fallows increased whereas all other sub-categories decreased during the study period i.e., between 1990 and 2008. Crop land as a whole increased by 625.47 ha which accounted for only 1.1 per cent of total crop land in the catchment.

Forest Land: Area under forest in the catchment area of the project decreased by 663.15 ha which accounted for about 0.28 per cent of total forest land in the catchment of the project. Deciduous dense and open forest and scrub forest decreased whereas all other



categories of forest land increased. It appears that the increase in crop land was at the cost of forest land.

Wastelands: The area under wastelands consisting of sandy area and barren and uncultivable land increased by 597.57 ha during the study period in the catchment area of the project. The sand area increased at a faster rate as compared to that of barren and uncultivable land during this period.

Water Bodies: The water bodies in the catchment area of the project consisted of reservoirs, tanks, lakes, ponds and rivers and streams. The area under reservoirs, tanks, lakes and ponds decreased by about 606.42 per cent whereas area under rivers and streams increased by 46.53 ha (1.23%). The increase in the area under rivers and streams seems to have been induced due to change the course of Ramganga and its tributaries along with siltation during rainy season.

Changes in Command Area Districts

10.32 Initially command area of Ramganga project was spread over 10 districts of Uttar Pradesh. These districts are organized into 17 districts now. Additional command area to the extent of 0.78 lakh ha was identified in six districts in the western UP region. Thus, the command area of Ramganga project was spread over 16 districts of Uttar Pradesh. The OFG works in the command area of Ramganga were initiated during 1974-75 and were completed to large extent by 1982-83. Therefore, year 1974-75 is considered as preproject period whereas year 1982-83 is considered as post-project year. The initial changes in land use / land cover of command area districts is assessed on the basic of information collected from secondary sources, for years 1974-75 and 1982-83.

10.33 The changes in land use / land cover in ten command districts of Ramganga project during 1974-75 and 1982-83 are presented in **Table 10.3.** Area under forests accounted for only 4.47 per cent of total reporting area and decreased by about 33140 ha between 1974-75 and 1982-83. Majority of this decrease was due to diversion of forest land for non-agricultural use. Area under cultivation increased marginally during this period. Other fallow land increased from 1.36 lakh ha during 1974-75 to 1.89 lakh ha during this period. Only increase in area under cultivation and part of the decrease in forest land, are attributable to the changes due to the project. The other changes were not due to the project..

Tal	Table 10.3 Changes in Land use / Land cover in Command Districts of Ramganga Project (1974-75 & 1982-83)									
SI No.	Particulars	1974-75		1982-83		Change				
		Area in ha	%	Area in ha	%	in ha	in %			
1	Forest and Shrub Area	217478	4.47	184338	3.79	-33140	-15.24			
2	Barren and Cultivable Wasteland	501714	10.30	434323	8.92	-67391	-13.43			
3	Land put to Non- agricultural Use	386173	7.93	419774	8.62	33601	8.70			



Changes in Land Use Pattern

Ta	Table 10.3 Changes in Land use / Land cover in Command Districts of Ramganga Project (1974-75 & 1982-83)								
Sl No.		1974-75		1982-83		Change			
	Particulars	Area in ha	%	Area in ha	%	in ha	in %		
4	Permanent Pastures	25697	0.53	24735	0.51	-962	-3.74		
5	Area Under Cultivation	3602498	73.99	3616625	74.28	14127	0.39		
6	Other Fallow Land	135610	2.79	189375	3.89	53765	39.65		
	Total	4869170	100.00	4869170	100.00	0	0.00		

10.34 The Changes in land use / land cover in command area districts of Ramganga between 1990 and 2008 are presented in **Table10.4**. Map showing the land use / land cover of this area during 1990 is presented in **Figure 10.3**. Similar details during 2008 are presented in **Figure 10.4**. The land use / land cover wise changes during this period are presented in the following paragraphs.

Crop Land: The crop land consisting of cropped area, during Kharif, Rabi and Zaid, double cropped area, current fallows and agricultural plantations in crop land during this period was about 8.84 thousand ha which accounted for 0.14 per cent of total cropped area during 1990. The area under Kharif crops, current fallows and agricultural fallows, decreased whereas area under Rabi crops, double cropped area, Zaid crop increased. This was mainly because of variations in rainfall pattern during these two years and delayed monsoon during 2008.

Built up Land: Built up land consisting of rural built up land, urban built up land and mining and industrial area increased from 4.04 lakh ha during 1990 to 4.14 lakh ha during 2008. Thus, the built up land increased by 5952 ha during this period. The rural and urban built up land accounted for major part of this increase. This is mainly due to the increasing demand for shelters due to population growth.

Forest Land: The forest land in the command districts of Ramganga project accounted for only 2.06 per cent of total reporting area during 1990 and 1.97 per cent during 2008. Thus, there was a reduction in forest area to the extent of 7030 ha during this period. This reduction was mainly due to reduction in natural/semi natural grass lands. This may be attributed to expansion of villages and towns as this is mostly associated with settlements.

Waste Lands: Wastelands consisting of waterlogged areas, barren land, salt affected lands and scrub land accounted for 6.62 per cent of total reporting area during 1990. The share of these wastelands decreased to 6.59 per cent during 2008. The net reduction in wastelands during this period was 1981 ha. Majority of the reduction was due to reduction of waterlogged areas and salt affected lands. This may be attributed to massive reclamation programmes launched by GoUP for reclamation of waterlogged and salt affected lands. Initially, between 1985-86 and 1998-99, the availability of fresh water from the project for leaching of salt affected lands has also contributed for reclamation of salt affected lands.

Table	10.4 Changes in Land Use		n Comma		Kamganga		
Sl. No	Particulars	1990		2008		Chan	
		in ha	in %	in ha	in %	in ha	in %
I	Crop Land		1		- 00		
1	Crop Land-Kharif Crop	631792.71	8.56	516584.98	7.00	-115207.73	-18.24
2	Crop Land-Rabi Crop	1533610.06	20.77	1654659.80	22.41	121049.73	7.89
3	Crop Land-Two crop area	3498667.54	47.39	3506427.30	47.50	7759.75	0.22
4	Crop Land-Zaid Crop	6792.74	0.09	7517.58	0.10	724.84	10.67
5	Fallow-Current Fallow	422304.08	5.72	418104.46	5.66	-4199.62	-0.99
6	Plantation-Agriculture Plnt.	70136.00	0.95	68851.42	0.93	-1284.58	-1.83
	Sub Total	6163303.14	83.49	6172145.53	83.61	8842.39	0.14
II	Built Up Land		·	,	,	'	
7	Built Up land Rural	291762.25	3.95	296126.79	4.01	4364.54	1.50
8	Built Up-land Urban	102189.85	1.38	107455.35	1.46	5265.50	5.15
9	Built Up-Mining / Industrial area	9878.51	0.13	10100.44	0.14	221.93	2.25
	Sub Total	403830.61	5.47	413682.58	5.60	9851.97	2.44
III	Forest Land	100000000		110002400	0.00	7 00 017 1	
10	Deciduous Dense/Closed	25341.93	0.34	25093.54	0.34	-248.39	-0.98
11	Deciduous –Open	42402.55	0.57	41752.34	0.57	-650.21	-1.53
12	Forest Blank	94.21	0.00	105.38	0.00	11.17	11.86
13	Forest Plantation	391.80	0.01	376.86	0.01	-14.95	-3.81
14	Scrub Forest	34622.16	0.47	34658.80	0.47	36.64	0.11
15	Tree Clad Area	4258.39	0.06	4278.53	0.06	20.14	0.47
16	Natural/Semi natural grassland	45091.90	0.61	38906.87	0.53	-6185.03	-13.72
- 10	Sub Total	152202.93	2.06	145172.31	1.97	-7030.62	-4.62
IV	Waste Lands		J		J_		
17	Water logged area	20408.68	0.28	18230.49	0.25	-2178.19	-10.67
18	Barren Rocky	57199.57	0.77	57218.13	0.78	18.56	0.03
19	Salt affected land	151286.63	2.05	149348.48	2.02	-1938.15	-1.28
20	Scrub land	259860.57	3.52	261976.65	3.55	2116.07	0.81
	Sub Total	488755.46	6.62	486773.75	6.59	-1981.71	-0.41
V	Water Bodies	100700110	5.02		5.57	1,01.71	0.11
21	Canal/Drain	24889.13	0.34	24816.87	0.34	-72.26	-0.29
22	Reservoir/Tanks-Dry	609.67	0.01	591.97	0.01	-17.70	-2.90
23	Reservoir/Tanks- Perennial	17834.01	0.24	19210.90	0.26	1376.89	7.72
24	River/Stream	130795.70	1.77	119826.76	1.62	-10968.94	-8.39
	Sub Total	174128.51	2.36	164446.50	2.23	-9682.01	-5.56
	Grand Total	7382220.66	100.00	7382220.66	100.00	0.00	0.00
	Compiled on the basis of Re						

Water Bodies: Water bodies consisting of canal/drains, reservoirs/tanks-dry, reservoirs/tanks-perennial and rivers/streams accounted for about 2.36 per cent of total reporting area during 1990 and got reduced to 2.23 per of total reporting area during 2008. The net reduction in the area under water bodies between 1990 and 2008 was about 10968.94 ha. Majority of this reduction was due to reduction in the area under rivers / streams. Further, the reduction in the area under rivers and streams was mainly due to siltation of rivers



Changes in Land Use Pattern

and streams. The changes in the course of rivers, which are very common in command area districts of Ramganga project, have contributed for reduction in area under rivers and streams in these districts. Further, the dry river course is either brought under plantation or at places under cultivation.

8.35 The district-wise land use / land cover maps for all the command area districts during 1990 and 2008 are presented in Volume-III vide **Figures 6 to 51**.

Map Overlay Analysis

10.36 Two main methods of data analysis for assessing changes in land use and land cover are adopted in the study. They are as follows:

- Calculation of the area is hectares of the resulting land use and land cover types for each study year and subsequently comparing the results; and
- Map overlay operation

10.37 A comparison of land use and land cover statistics assisted in identifying the percentage changes, trend and rate of change between 1989 and 2008. A map overlay operation identifies the actual location and magnitude of change. There are many Change Detection Algorithms that can be employed in change detection analysis. In this study "Image Differencing" has been used to carryout the analysis. Image differencing involves subtracting the image of one data from that of another. The subtracting results in changes that have taken place over the period of time. An important aspect of change detection is to determine what is actually changing to what i.e., which land use class in changing to other. This information will reveal both desirable and undesirable changes and classes that are relatively stable over time. This information will also serve as a vital tool in management decisions. The process of map overlay involves a pixel to pixel comparison of the study year image through overlay. For the purpose of this analysis six main land use classes have been considered. They are as follows:

- Agricultural Land
- Forest Land
- Water Bodies Reservoir / Tanks
- Water Bodies Rivers / Streams
- Built-up Area, and
- Waste Lands

10.38 The map over lay for the catchments area of the project is presented in **Fig. 10.3.** In all the land use in about 2043.48 ha of catchments area changed and there were 12 types of changes in the land use categories. The different type of land use changes are indicated in **Table 10.5.**

10.39 The changes from Forest to Agriculture Land and Water Bodies-Tanks and Reservoirs to Waste Lands are the two prominent changes in the land use of the project's catchments area. These two changes accounted for about 50 per cent of the total change in the catchments area of the project. Mostly the change of forest area to agricultural land during this period occurred in the upper reaches of the catchments area. The conversion of forest to water bodies took place in the lower reaches of the catchments area. It is also observed that major changes have occurred in the forest area and water bodies. The reduction in forest area in favor of Agriculture Land, Waste Land, Water Bodies-Tanks and Reservoirs, and Water Bodies-Rivers and Streams was observed in 1030.52 ha of area of the catchments during this period. The area under rivers and steams got reduced in some reaches of the catchments area mainly due to encroachments and subsequent conversion of the same to crop lands. It is also observed that the increase in area under rivers and streams was due to meandering of rivers and streams and subsequent widening of the river course, particularly in the plain areas of the catchments area. (**Table 10.5**)

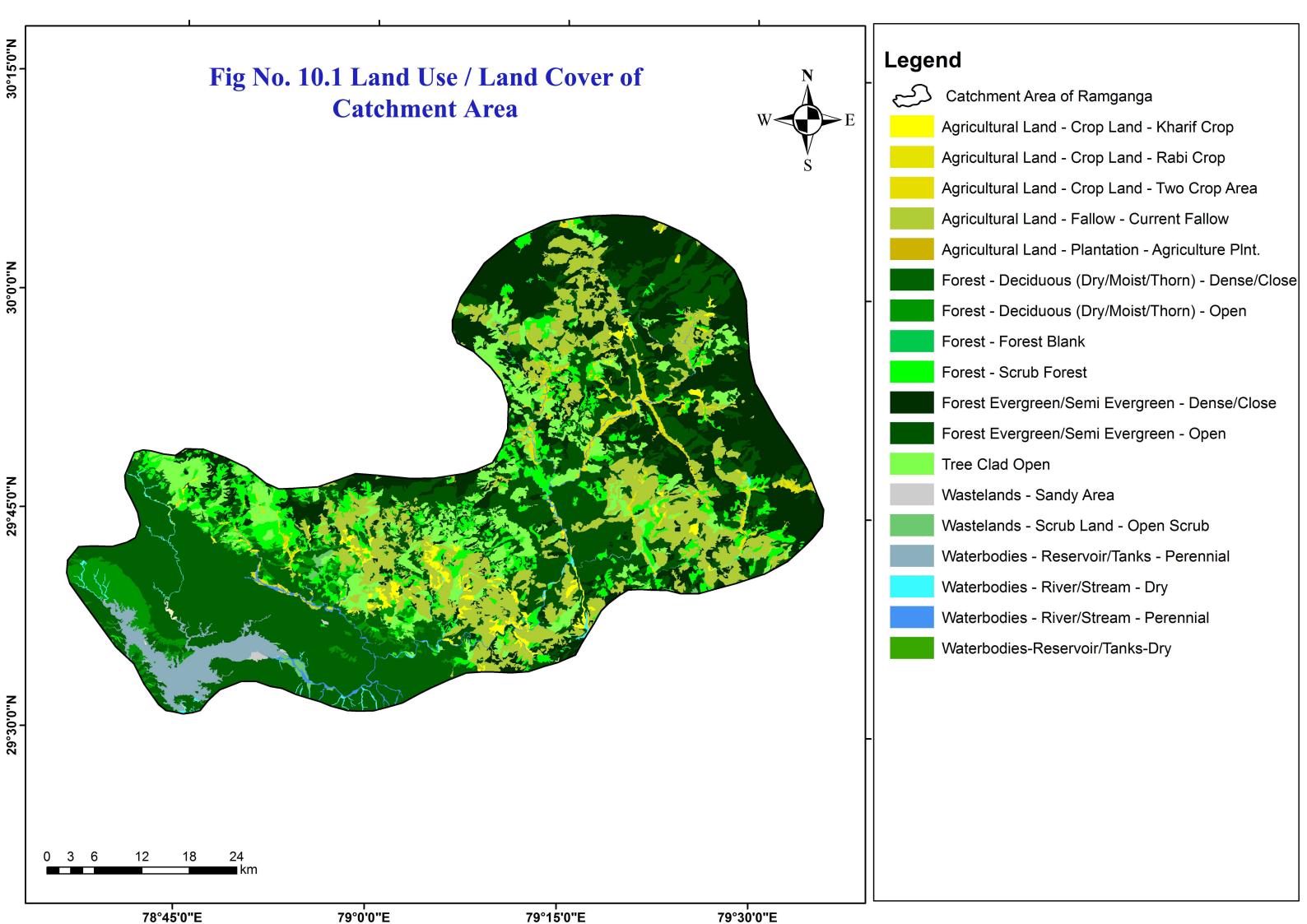
	Table 10.5: Change in Land Use and Land Cover Categories in the Catchments area of Ramganga Project (1990-2008)								
Sl No	Change Particulars: Change From To	Area in ha	% in Total						
1	Agriculture land to Rivers and Streams	33.00	1.61						
2	Forest to Agriculture Land	609.24	29.81						
3	Forest to Waste Land	153.85	7.53						
4	Forest to Water Bodies-Tanks and Reservoirs	130.46	6.38						
5	Forest to Water Bodies-Rivers and Streams	136.97	6.70						
6	Waste Land to Water Bodies-Rivers and Streams	49.31	2.41						
7	Water Bodies-Tanks and Reservoirs to Forests	256.95	12.57						
8	Water Bodies-Tanks and Reservoirs to Waste Lands	414.14	20.27						
9	Water Bodies-Tanks and Reservoirs to Rivers and Streams	49.31	2.41						
	Water bodies-Rivers and Streams to Agriculture								
10	Land	60.60	2.97						
11	Water bodies-Rivers and Streams to Forests	95.62	4.68						
12	Water bodies-Rivers and Streams to Waste Lands	87.03	4.26						
	Total	2043.48	100.00						

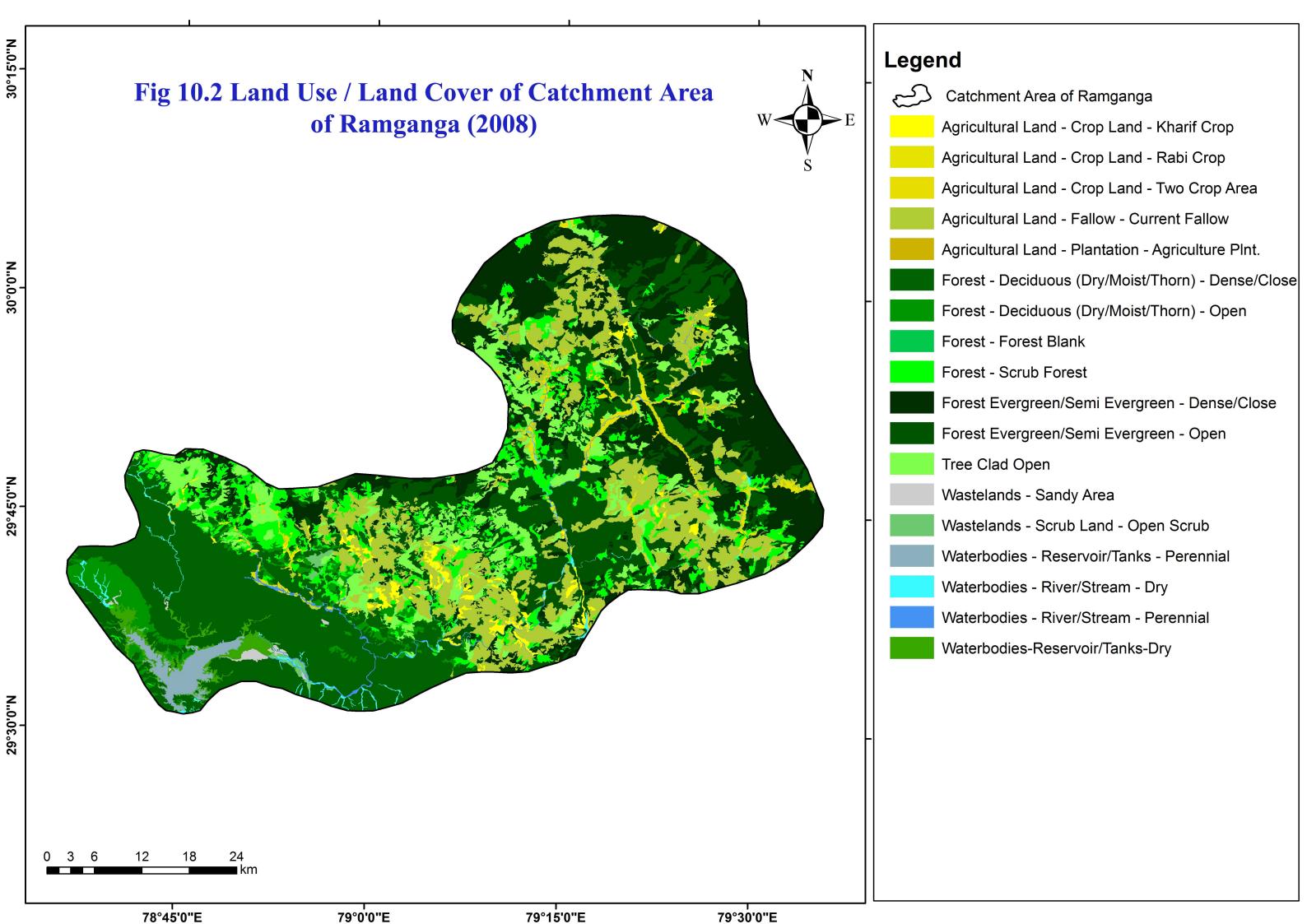
10.40 The changes in land use and land cover in the command districts of Ramganga project are analysed and presented in **Table 10.6. Figure 10.4** indicate the location of various changes that have taken place in the command area districts of the project during this period. The changes in land use and land cover of command districts of the project occurred in an area of 51057.72 ha. The conversion of the banks of rivers, streams and canals to crop land is the major change (35.75% of total change) that has taken place in the command districts of the project. Further, conversion of various categories of land to

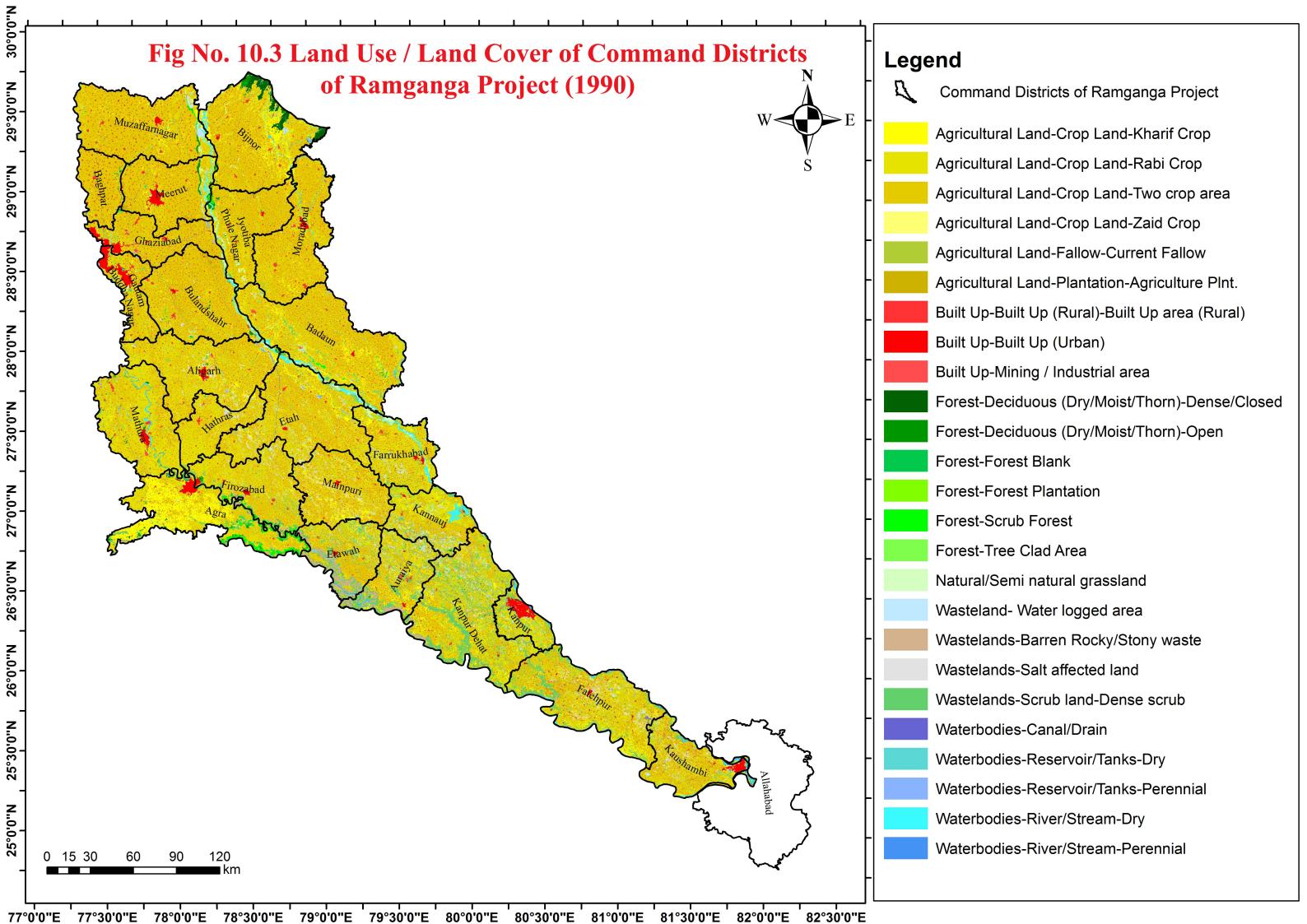
Changes in Land Use Pattern

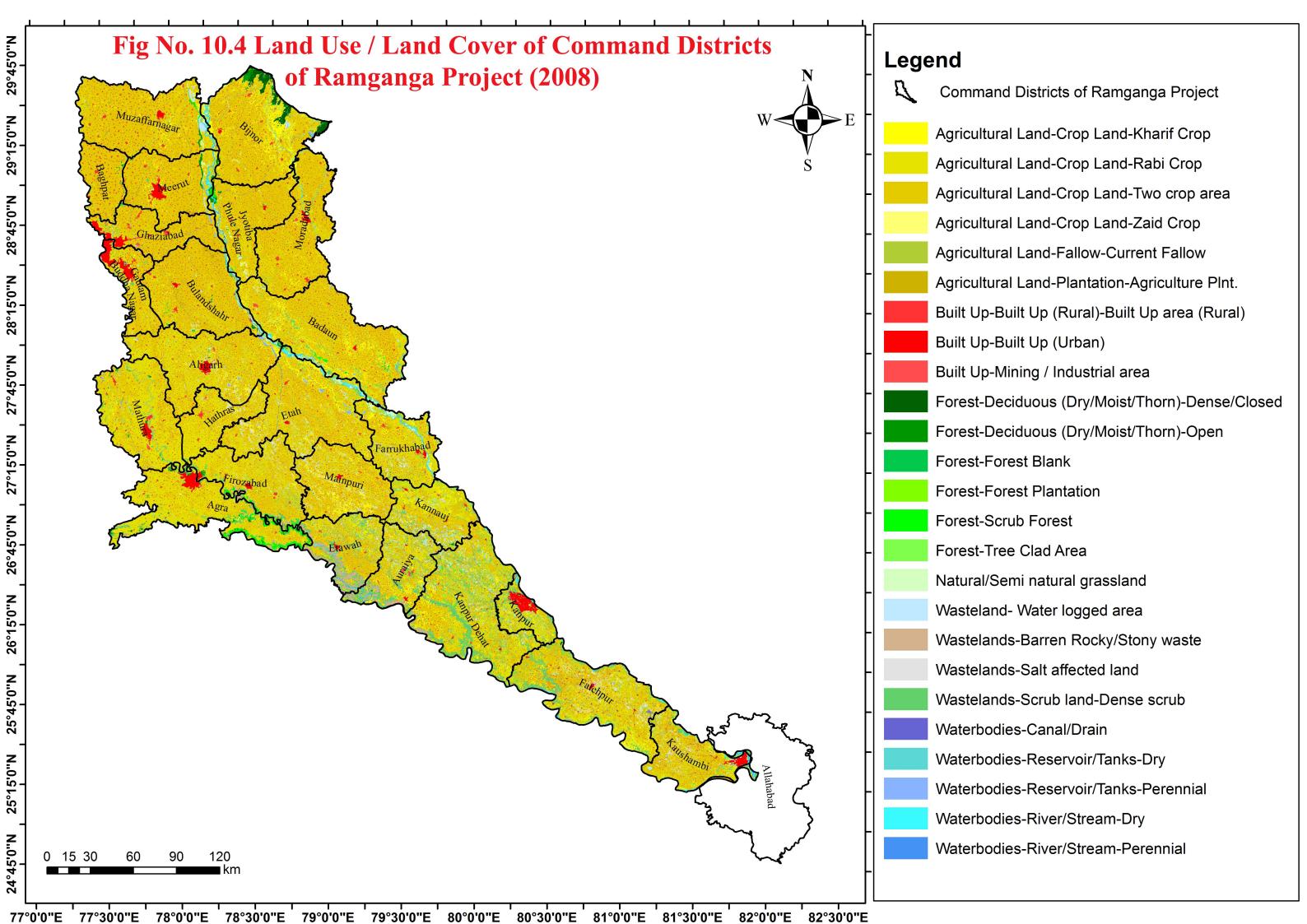
built up land accounted for about 19.05 per cent of total change in the land use categories of the command area districts of the project. There is an overall reduction in the area under forests, waste lands and water bodies such as rivers, streams and canals, while there was an increase in the land under cultivation, built up and water bodies such as tanks and reservoirs during this period in the command area districts of the project. Most of the changes in land use have occurred in the north western parts of the command area district.

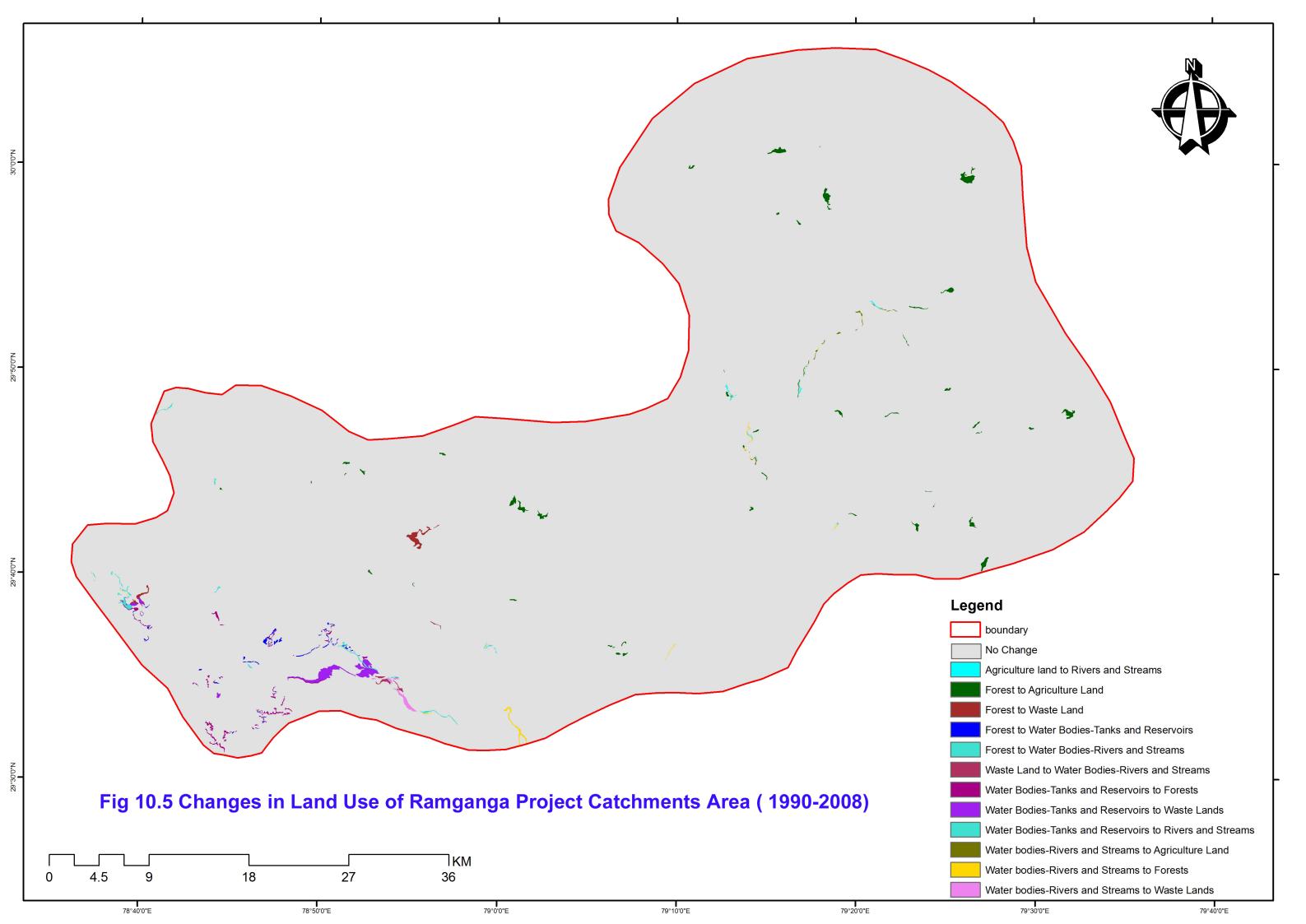
Table 10.6: Change in Land Use and Land Cover Categories in the Command Area of Ramganga Project (1989-2008)							
SI No	Change Particulars:	Area in ha	% in Total				
	Change From To						
1	Agriculture land to Built up Land	9533.26	18.67				
2	Agriculture land to Waste Land	631.24	1.24				
3	Agriculture land to Water Bodies-Tanks and Reservoirs	2140.88	4.19				
4	Agriculture land to Water Bodies-Rivers, Streams and Canals	2849.18	5.58				
5	Forest to Agricultural Land	1046.82	2.05				
6	Forest to Waste Land	235.93	0.46				
7	Forest to Water Bodies-Rivers, Streams and Canals	2849.18	5.58				
8	Waste Lands to Agricultural Land	6601.82	12.93				
9	Waste Lands to Built up Land	195.49	0.38				
10	Water bodies-Tanks and Reservoirs to Agriculture Land	724.15	1.42				
11	Water bodies-Rivers, Streams and Canals to Agricultural Land	18250.73	35.75				
12	Water bodies-Rivers, Streams and Canals to Forests	1304.47	2.55				
13	Water bodies-Rivers and Streams to Waste Land	4694.57	9.19				
	Total	51057.72	100.00				

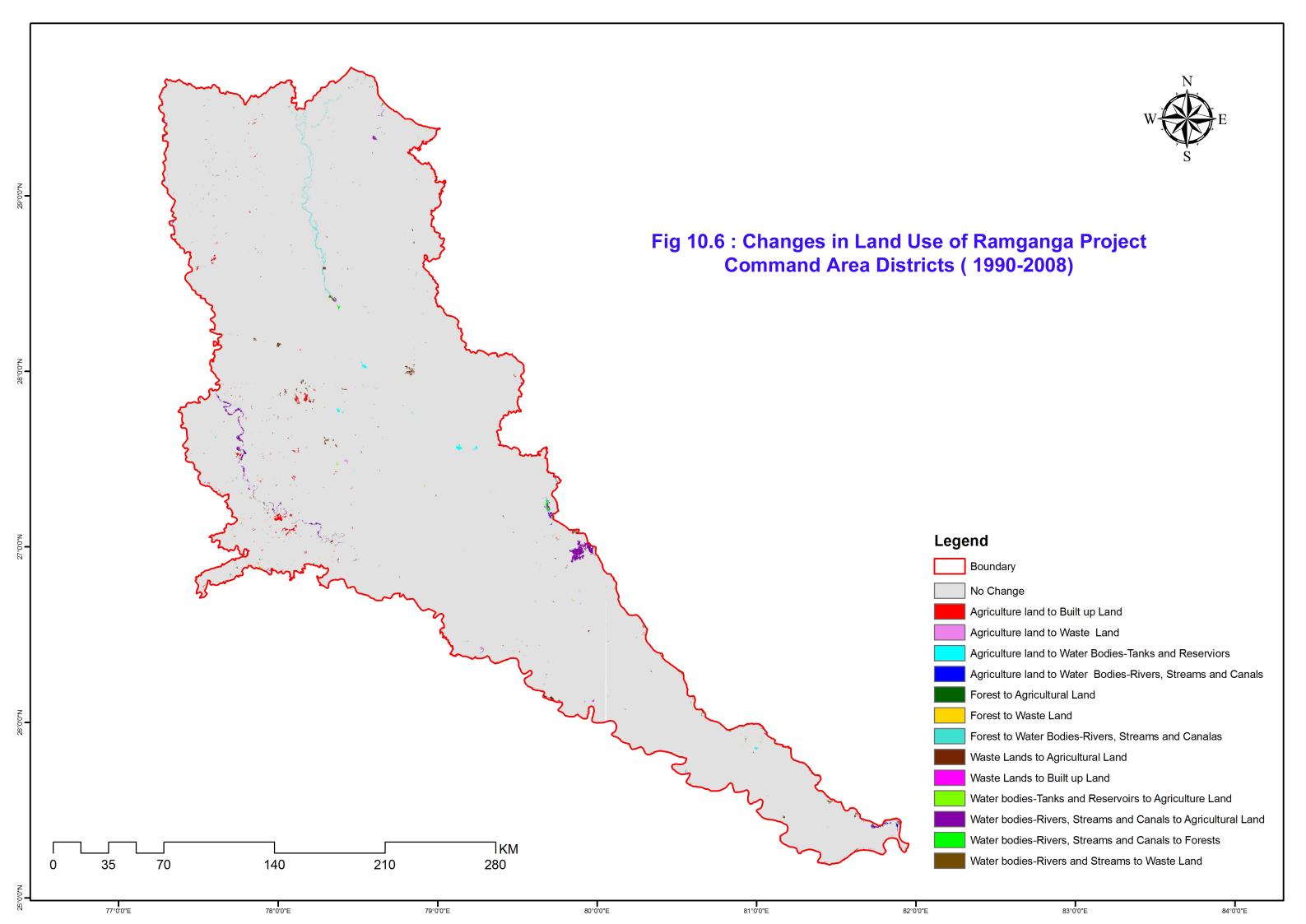












Volume-I



10

Changes in Landuse Pattern





STATUS OF IMPLEMENTATION OF CATCHMENT AREA TREATMENT (CAT) PLAN

Introduction

11.01 Ramganga sub basin is a part of Ganga basin. This River Valley Project was proposed and implemented in the catchment of Ramganga near Kalagarh by construction of a dam, in Pauri Garhwal district in Uttarakhand state during 1962–1974. The total catchment area at the dam site was estimated to be 3134 sq km at the time of preparation of project report. At the time of preparation of plan for soil conservation measures in this catchment, the same was reassessed to be 3107 sq km.

11.02 Centrally sponsored scheme of soil conservation in the catchment areas of River Valley Projects was initiated during Third Five Year Plan with the following objectives.

- Reducing salvation of the reservoir by treating catchment areas;
- Preventing catchment degradation and enhancing its productivity;
- Ensuring adequate irrigation water to command areas; and
- Providing employment opportunities in rural areas.

Ramganga River Valley Project, one of the centrally sponsored schemes, also aimed to achieve the above objectives.

11.03 No separate Catchment Area Treatment (CAT) Plan was prepared at the time of preparation of project report or during its implementation. But under the above cited centrally sponsored scheme of soil conservation, the CAT plan was implemented with 100 per cent central assistance comprising 50 per cent as grant and 50 per cent loan to the connected states.

Necessity of CAT Evaluation Study

11.04 Evaluation study relating to catchment area in a project is crucial. It helps in assessing the effectiveness and efficacy of the programme implementation (soil conservation) in attaining the set objectives, finding reasons for shortfall, if any and suggesting further appropriate measures to overcome the gaps.

11.05 The Administrative Staff College of India (ASCI) carried out the evaluation study¹ of soil conservation scheme in Ramganga River Valley project during 1990-91. In

¹ ASCI, "Evaluation Report of Soil Conservation Scheme: River Valley Projects – Ramaganga (UP) and Sutlej (HP), (Hyderabad ASCI), 1991.

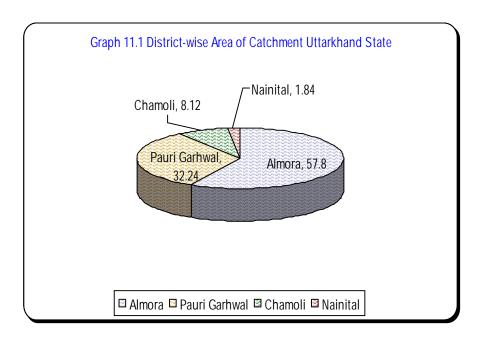


order to bring out the effect of the scheme of soil conservation, a sample study was also made by Agricultural Finance Corporation Limited² in two saturated sub-watersheds in the Ramganga catchment area during 2000–2001 as per the directions of the Departments of Agriculture, GoI.

Catchment Area Profile

11.06 The catchment area of Ramganga river at Kalagarh dam is spread in four districts of Uttarakhand and lie between co-ordinates 29° 30' and 30° 07' North latitude and 78° 35' and 79°35' East longitude in the middle and outer Himalayas. District wise distribution of catchment area of the project is presented in **Table 11.1**. Majority (58%) of the cathement area is in the Almora district Pauri Garhwal district accounted for about 32.24 per cent of total catchment area with over 1.00 lakh ha. Nainital district accounted for only 1.84 per cent of total catchment area with 5.70 thousand ha (**Graph 11.1**).

Table 11.1 District wise areas of Catchment Area of Ramganga Project							
Sl. No	Name of the District	Area (ha)	Percentage to Total Area				
1	Almora	179607	57.80				
2	Pauri Garhwal	100175	32.24				
3	Chamoli	25245	8.12				
4	Nainital	5698	1.84				
Total 310725 100.00							
Source: Office of Soil Conservation, Forest Division, Ranikhet, (Uttarakhand and Uttaranchal state)							



² AFCL, "Report on Evaluation of Soil Conservation in the Catchment of Ramganga under River Valley Project in Uttarakhand" (Lucknow: AFCL, November 2001).





Topography

11.07 The terrain is steep to moderately sloping and mostly negotiable. The area is elongated in shape. The intermittent valley sides are gently sloping river terraces. The altitude of the catchment varies between 270 m and 3100 m above mean sea level.

Physiography, Relief and Drainage

- 11.08 The catchment of Ramganga river that originates in the middle of Himalayas in Chamoli district of Uttarakhand, is horseshoe shaped containing hilly terrain in the middle and outer Himalayan ranges and a portion falling in Shiwalik hills, South of Himalayan ranges. Steep hills and deep and narrow valleys are the characteristics of the catchment. Due to such formation, the catchment is well drained. The drainage map of the catchment is shown in **Fig. 11.1**
- 11.09 The Ramganga River originates at an altitude of 2926m from Chadaliyal Derta (Gairsain) and passes through Chakhutia, Bhikiasain, Darchula and Kalagarh habitations. The overall drainage pattern of the area is sub-dendritic and relief excessive. The area is drained by tributaries like, Gangas, Binao, Khatraun, Nair, Badangad, Mandal, Haldga, Sona nadi besides Ramganga River. Number of natural springs and winter snowfall on the high peak of the region keep the river perennial. However, the river flows during summer are lowest.

Geology

11.10 Structurally, the area of Ramganga river Valley project has been dominated by phyllites and schists. Extreme north east corner of the catchment is covered by Limestone, Quartzites and Grey wakes near the dam site. The rocks of the catchment belong to the lower, middle and upper Shiwaliks which are capped by horizontally deposited recent gravel terraces at different elevations.

Soils

- 11.11 In general, soils vary from shallow to deep and in valleys very deep. In terms of colour of soils, they have yellowish brown to dark brown and dark yellowish brown. Coarse to fine textured skelatal soils are found in the catchment area of the project. Calcareous and non-calcareous soils are found in limestone areas. Coarse to medium textured very shallow to moderately deep soils are mostly affected with severe erosion. Soils of river terraces, predominant plains and forest areas are less erosive and contribute relatively lesser amount of silt yield into the river.
- 11.12 Soils under moderately dense to dense forest cover are brown to very dark grayish brown medium textured and have a thick layer of leaf litter and organic matter on the surface. These soils are less erosive by virtue of their characteristics, and their vegetation. Taxonomically, the soils of this area are Entisols, Mollisols and Inceptisols.

Land Use / Land Cover

11.13 The land use and land cover of the catchment area as per the latest information (2008) is assessed on the basis of SoI toposheets and RS imageries. The land use / land cover analysis of catchment area of Ramganga project is carried out as per seventeen fold classification. The land use / land cover of catchment area of Ramganga project is presented in **Table 11.2**. Of the total catchment area of the project, forests (including grass lands) occupy about 68.65 per cent. Agricultural land accounts for about 18.57 per cent of total catchment area. Agricultural lands are mostly contained to valleys and to some extent the adjoining sloppy lands while the forests are at higher elevations. Forests in this hilly terrain, besides catering the basic needs like fuel, timber and fodder of the local people, also act as a check to soil erosion and run-off and play an important role in the eco-system of the area.

rabie	11.2 Land use / Land cover in Catchment Area of				
Sl No.	Particulars	2008			
		Area in ha	%		
I	Crop Land				
1	Crop Land - Kharif Crop	4327.33	1.39		
2	Crop Land - More than two crop	11.51	0		
3	Crop Land - Rabi Crop	4470.7	1.44		
4	Crop Land - Two Crop Area	1668.02	0.54		
5	Fallow - Current Fallow	47224.13	15.2		
6	Plantation - Agriculture Plnt.	12.51	0		
	Sub Total	57714.2	18.57		
II	Forest Land				
7	Deciduous - Dense/Close	57119.54	18.38		
8	Deciduous - Open	8643.11	2.78		
9	Forest Blank	29.71	0.01		
10	Scrub Forest	25213.76	8.11		
11	Forest Evergreen/Semi Evergreen - Dense/Close	62293.15	20.05		
12	Forest Evergreen/Semi Evergreen - Open	57576.19	18.53		
13	Tree Clad Open	26643.75	8.57		
	Sub Total	237519	76.44		
III	Wastelands				
14	Wastelands - Sandy Area	719.05	0.23		
15	Wastelands - Barren and Rocky Land	967.2	0.31		
	Sub Total	1686.25	0.54		
IV	Water bodies				
16	Waterbodies - Reservoir/Tanks/Lankes/Ponds	9969.87	3.21		
17	Waterbodies - River/Stream	3835.46	1.23		
	Sub Total	13805.3	4.44		
	Grand Total	310725	100.00		



11.14 As per the study carried out by Administrative Staff College of India (1991), indiscriminate cutting of trees, excessive grazing and lack of conservation practices in crop lands have destructed the eco system in some form or the other in the catchment area of the project. About 63 per cent of the forest area in the catchment is under the control of forest department while the balance is under the local administrations i.e., revenue department and village panchayats.

Forest Management

11.15 Forest Management in the Ramganga catchment area and in Uttar Pradesh state in general started about 120 years back during British administration. In early 1850s boundary of each village was demarcated which included forest areas. In these demarcated forest areas of each village, local people had rights for grazing and extracting wood for house construction, making implements and also to meet the fuel requirements. As result of this provision a large areas were destroyed mostly for local needs. An attempt at improving forest management was made for the first time during the period 1878-1893, when boundaries of different forest tracts were re-demarcated and forests away from villages and well stocked areas were declared as protected forests, restricting the rights of villagers. Changes in this policy took place number of times and the existing forest policy in the State of Uttar Pradesh was promulgated during 1964.

Forest in the state were grouped into three broad categories (AK Singh 1985)³. They are as follows:

- State Forests:
- Community Forests; and
- Private Forests

Further, on the basis of the legal status the forest, the department has categorized forests into three board divisions and is as follows:

- Reserved Forests:
- Protected Forests: and
- Unclassed Forests

Implementation of Soil Conservation Programme

11.16 All the soil conservation activities both in the agricultural and non-agricultural lands were executed up to 1980 by the Forest Department only. Thereafter the activities in agricultural lands were entrusted to the Department of Agriculture, while Forest Department continued the activities, in the non-agricultural areas. Again with effect from 1995-96 these works in the entire catchment were entrusted to Forest Department. The Forest Department however continued to be the nodal agency for the implementation of the RVP programmes.

³ Singh AK et. al. "Forest Resources, Economy and Environment", New Delhi: (Concept Publishing Company), P.85



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Demarcation of Priority Watersheds

11.17 The area requiring treatment in each of the RVP catchment is very extensive and need huge investments and time for coverage under the programme. However, as the resources in terms of technical personnel and finances were limited, the Government of India (GoI) took a policy decision in 1974 to identify the critical watershed areas which are contributing relatively higher quantities of silt, within each catchment so that on a priority basis the soil conservation programme can be implemented in such watersheds. The task of demarcation and identification of critical watersheds has been assigned to the All India Soil and Land Use Survey (AISLUS) Organisation, Department of Agriculture, GoI.

11.18 The AISLUS did a rapid reconnaissance survey of the catchment to delineate the area into sub-watersheds and identify the critical areas. The Ramganga catchment, extending over 3.10 lakh ha, was divided into well demarcated watersheds and sub-watersheds to assess the intensity of soil erosion in each of these units expressed in terms of Silt Yield Index (SYI). The factors like physiography, land use, soil characteristics, rainfall pattern, vegetative cover etc., were considered for determining the SYI value and weight age values assigned to each unit indicated the potential of erosion or expected soil detachment from the particular unit area. A basic weight age factor 10 indicated areas where silt yield was negligible or where even periodic deposition was expected.

11.19 In Ramganga catchment AISLUS developed eight different weightage values for varying physiographic conditions as shown below⁴.

Category	Physiographic Conditions	Weightage Value
A	Area under relatively dense forest	12
В	Area under thin forest showing the ground exposed	14
C	Area under relatively dense shrub	13
D	Area under thin shrub vegetation showing the ground exposed	15
E	Area under grass-lands	13
F	Area under cultivation in terraces on steep slopes and in valley bottom	12
G	Area under cultivation on steep slopes with terraces in bad conditions or areas abandoned from cultivation and subject to erosion	18
Н	Area under mixed land use with about 50 per cent of the area under good terraces and remaining under bad terraces shrub vegetation	16

⁴ Report No. 168 1975 of AISLUS Organisation, Department of Agriculture, Ministry of Agriculture, GoI. The AISLUS resurveyed the area in 1987-88.



Volume-I

11.20 Ramganga catchment is delineated into 135 sub-watersheds and these are grouped into five categories based on the SYI value, namely very high, high, medium, low and very low. The sub-watersheds in the category of very high and high are considered as critical areas and are considered as priority areas for implementing soil conservation measures under the RVP scheme.

The number of sub-catchments, watersheds and sub-watersheds in the entire catchment of Ramganga project area are as below.

Sub-catchment : 8
 Watersheds : 20
 Sub-watersheds : 135

11.21 The distribution of these sub-watersheds according to priority, decided as per SYI values, in Ramganga catchment is presented in **Table 11.3**.

Table	Table 11.3 Distribution of Sub-watersheds According to Priority Classification in Ramganga Catchment Area							
Sl. No	Priority Category	SYI	No. of Sub-watersheds	Area (ha)				
1	Very High	>1100	15 (11.11)	35,726 (11.50)				
2	High	1000-1099	31 (22.96)	68,657 (22.10)				
3	Medium	900-999	46 (34.08)	1,02,581 (33.00)				
4	Low	800-899	23 (17.04)	53,434 (17.20)				
5	Very Low	< 800	20 (14.81)	50,327 (16.20)				
	Total		135 (100.00)	3,10,725 (100.00)				

Note: Figures in the parentheses are percentages in Total

Source: Complied on the basis of information obtained from Report of All India Soil and Land Use Survey Organisation, New Delhi, Agri No.1358

11.22 Out of the total 135 sub-watersheds, 15 sub-watersheds accounting for 11.11 per cent of total sub-watersheds were in very high priority category and 31 sub-watersheds (22.96%) were in high priority category. Maximum (34.08%) of the total sub-watersheds were in medium priority categorization. On the basis of this priority categorization, it was decided to undertake soil conservation works in very high and high priority sub-watersheds. These sub-watersheds (36) accounted for about 23.60 per cent of total area of the catchment with 104383 ha of land in these two category sub-watersheds.

Organisation: Forest Sector

11.23 The principal Chief Conservator of Forests; who heads the forest department is in overall change of all the programmes of the forestry sector in the state. However, the Chief Conservator of Forests, Hills, (CCF-H) located at the state capital, Lucknow, was exclusively in charge of the development programmes in the Himalayan region, including the RPV scheme of Ramganga project.

Status of Implementation of Catchment Area Treatment (CAT) Plan

- 11.24 CCF-H was assisted by two Additional Chief Conservators of Forests, one located at Dehradun and other at Nainital. Each of these officers have four conservator circles, inc-charge of various activities in their respective regions. The Ramganga RVP scheme falls within the jurisdiction of Conservator of Forests. Timber Supply Circle, Nainital.
- 11.25 The forest sector activities of RVP Ramganga scheme are executed through two forest divisions located in Ranikhet and Ramnagar, each headed by a Divisional Forest Officer. The Ranikhet division was established in 1962 and the Ramnagar division in 1972.

Organisation: Agriculture Sector

- 11.26 The Director of Agriculture is in overall charge of all the agriculture production programmes in the state, including the soil conservation activities in the RVP catchment. The Director at state level is assisted by an Additional Director of Agriculture (Soil Conservation). However, in view of the importance of the development of the Himalayan region, there was a separate Additional Director of Agriculture located at Paurii, District Garhwal, who is directly incharge of all the developmental and production programmes in the eight districts of the hill region, including RVP Ramganga Scheme.
- 11.27 For executing the soil conservation works in the catchment area of Ramganga, one soil conservation sub-division was established at Ranikhet. This sub-division was headed by Bhoomi Samrakshana Adhikari (BSA) and functioned under the supervision of the Soil Conservation Division at Almora. The Almora division has eight sub-watersheds, of which only one, at Ranikhet executed the soil conservation works in the agricultural lands under the RVP Ramganga scheme.
- 11.28 The soil conservation sub-division, Ranikhet had 25 field working units, each under the charge of an Assistant Soil Conservation Inspector (ASCI), who prepared plans and after their approval by BSA got the works executed in the priority watersheds. For every 5 ASCIs, there was one Soil Conservation Inspector, who guided, monitored and supervised the field works.

Catchment Area Treatment Measures Implemented

11.29 Even in the absence of catchment area treatment plan for Ramganga river catchment up to Kalagarh dam, soil conservation measures were implemented in the priority watersheds. The works were carried out by Forest department up to 1979–80 and from 1995–96 on wards. The works were entrusted to the state agricultural department in the gap period between 1979–80 and 1994–95. The catchment area treatment measures were taken up in the 15 very high and 31 high priority sub-watersheds. Out of the above, 12 very high and 19 high priority watersheds were reported to be saturated, by 2000. As per the latest (2009) information provided by the Forest Department, Government of Uttarakhand (GoUK), all 15 very high priority and 31 high priority watersheds were saturated.



Soil Conservation Measures Undertaken

- 11.30 In the hilly areas, the soil and other atmospheric parameters prevailing in the area are very refractory and required immediate and urgent attention to protect them from further deterioration, priorities were, therefore, sorted out accordingly duly taking into people's requirements.
- 11.31 Afforestation on Civil and Panchayat lands of the villages formed the major share of the soil conservation works under Ramganga RVP. Planting of fruit tress, leveling of agricultural fields construction of minor engineering structures such as check dams, retaining walls, spurs etc., were other important soil conservation activities which were undertaken in the sub-watersheds. In addition, constructions of water harvesting tanks, farm ponds, agro forestry etc., were other activities, which were also undertaken.
- 11.32 Horticulture and land leveling was main works under taken on private lands for which selection of beneficiaries was made by local staff of the Forest Department. Fruit trees were supplied free of cost while 50 per cent of cost of land leveling was given as subsidy.

Non-Agricultural Land

- 11.33 Non-agricultural lands in the Ramganga catchment are mainly community lands, where soil conservation works like afforestation, check dams in gullies, spurs on small streams etc., are completed. Such lands have very little soil depth and are deficient in plant nutrients and consequently are difficult to be afforested. Before taking up afforestation and other works the concerned gram sabhas in the case of civil forests and van panchayat in the case of panchayat forests pass a resolution and place the specific area at the disposal of forest department.
- 11.34 Initially, these demarcated areas are enclosed by construction of a wall along the boundary of the area with the locally available stones. Planting is done in pits dug with a spacing of about 1 to 2 meters, depending on the soil depth. The number of plants per ha ranged between 1000 and 2000.
- 11.35 The choice of species varied according to the elevation of the area. Deodar (Cedrus deodara), Surai (Cupressustorulosa), Pangar (Aesculus indica)and Acacia Mollisima are planted above 1700 m altitude, while chir pine (Pinus roxiburghii) is the species of choice in areas between 1000 and 1700 m altitude. Species like Bank, Kharik (Celtisaustralis), Padam (Pruna carasoides), Bhimal (Crewia oppsitifolia), Acacia mollissime, RItha (Sapindus murkorossi) are also mixed with chir pine to the extent of about 20 per cent at appropriate sites at lower altitudes. In the valley Khair (Acacia catechu), Tun (Toona ciliate) and Semal (Bombax ceiba) are planted. Maintenance of the plantation is done in the second and third year.
- 11.36 Once afforested, the areas are protected by forest department and retained under their supervision until the trees grow to a height of 5 to 7 feet and beyond the reach of the



Status of Implementation of Catchment Area Treatment (CAT) Plan

browsing cattle. But the villagers have free access to the areas to cut grass for feeding the cattle. Established plantations of about 10 to 15 years of age are handed over to the respective Gram sabhas / Forest Panchayats, to enable them to release fresh area for afforestation.

11.37 Small engineering structures, which are part of the soil conservation works, are constructed according to the requirements of site. Normally, more emphasis is laid on small dry stone check dams.

Forest Plantations

- 11.38 Plantations were raised either by sowing of seeds or by planting of cutting or nursery raised seedlings. For plantings, pits of size 30 cm x 30 cm x 45 cm were dug in appropriate number. In the beginning, for some years, the number of pits dug per ha was 500, which were increased to 1000. The choice of species varied according to local factors such as altitude, slope, moisture condition, existing vegetation and the demand of the local people.
- 11.39 Among the conifers, Chir Pine is the most common species, which is planted in areas between 1000 and 1700 m altitude. Deodar and Surai are planted at higher altitude. Some of the broad-leaved species, which were planted mixed with conifers, are:
 - Banj
 - Bhimal
 - Eucalyptus
 - Mulbury
 - Amaltas
 - Sissoo

- Kharik
- Acacia Mollissima
- Tun
- Ritha
- Silver oak

- Padam
- Rubinia
- Bakain
- Siris
- Jamun

11.40 In almost all the plantations, efforts were made to plant the broad-leaved species, which have multiple uses such as fuel and fodder, along with conifers to have mixed forest crop.

Agriculture Lands

- 11.41 In agricultural lands, terracing was done in areas upto 30 per cent slope. Water harvesting structures, for irrigation through diversion channels were also created wherever possible. In some of these terraced areas, horticulture crops were planted.
- 11.42 The expenditure on afforestation by forest department in public lands and all soil conservation works benefiting the community like check dam, nalla bunding etc., was borne by the Government only. However, for soil conservation works in privately owned agricultural lands, the beneficiary has to contribute 50 per cent of the total cost and the other 50 per cent was treated as subsidy on the cost of works, subject to a maximum of `



2500 per ha. The 50 per cent contribution by the beneficiary may be as labour input for completion of the works. The same principle is followed in construction of water harvesting structures. For horticultural plantations a sum of `1200 per ha is spent at an estimated rate of `6 per plant, for a maximum of 200 plants per ha. A subsidy of `3 per plant is given, and the balance 50 per cent is contributed as labour input by the beneficiary.

Agro Forestry

11.43 Under this programme, villages were grouped and were supplied with nursery-raised seedling for planting on boundaries of their agricultural and vacant fields free of cost. These seedlings were supplied to a leading farmer of the group.

Grazing Land of the Villages

11.44 The left over community lands of the villages consists of mainly Agave, Euphoribia, Kath—mahwa, Timla, Titmulia, Sakina, Hinsalu etc., No Silvipastoral model has been adopted anywhere in the sub-watersheds and the waste lands of the villages have been left over without doing any pastural development works.

Horticultural Plantations

11.45 Planting of fruit tress was undertaken on individual lands. Fields, which were leveled under the soil conservation scheme and sloping fields having more than 25 per cent slopes, were given priority. Not more than 200 plants per hectare were planted. The fruit plants needed for this work was raised in the departmental nurseries of the Forest Department. The beneficiaries were supplied with the saplings at the nearest road point free of cost during the rainy season. The work of planting was left to be done by beneficiaries themselves. Irrigation was not ensured and protection of the saplings from browsing was also not made. The programme of fruit trees plantation was started during 1962 – 63 and was completed to a major extent by 1996–97. The fruits plants distributed for planting were;

- Apple
- Orange
- Pomegranate
- Plum
- Walnut
- Leech

- Khumani
- Malta
- Mousami
- Nashpati
- Lukat

- Adu
- Lemon
- Guava
- Mango
- Kathal

Year of Initiation and Completion of Works

11.46 Soil conservation works in the concerned sub-watersheds consisting of afforestation, horticulture, land leveling of agricultural fields, engineering structures etc., were undertaken by the Nodal Department. The Line Departments extended need based support. The soil conservation works in the catchment area of Ramganga were initiated during 1962-63 and were completed by 2009-10.



Physical Targets and Achievements

- 11.47 No long-term projects were prepared for soil conservation works in the Centrally Sponsored Ramganga RVP, when the works were started in the year 1962-63. Only annual work plans were prepared on year-to-year basis for the whole Soil Conservation Forest Division and funds were demanded on the basis of the works proposed. If for one reason or the other, the amount sanctioned / allotted for the concerned year was less than the demand made, physical targets for the different works were reduced accordingly to match the funds allotted.
- 11.48 However, in the year 1992-93, Watersheds Project Reports (WPRs) were prepared for a period of 5 year for high and very high priority sub-watersheds and various programmes were implemented accordingly from 1993-94, the first year of the WPR.
- 11.59 Hence for the purpose of target of various works for the selected sub-watersheds during the period from 1962-63 to 1992-93, the work done have been taken the target also, i.e., physical target and achievements were the same.

Impact of CAT Implementation

- 11.60 Integrated watershed management aimed at minimizing the sedimentation of reservoir and ecosystem conservation of the catchment area is the prime objective of the CAT plan, which can be further elaborated as follows:
 - Soil conservation through biological and engineering solutions to reduce sediment load into the reservoirs;
 - Ecosystem conservation through improvement in water retaining properties of soils and increase vegetative cover;
 - Fulfill fuel and fodder requirements of the local people; and
 - Integration of the CAT plan with social and economic activities of the local people though employment generation and community participation.
- 11.61 The systematic sedimentation surveys of reservoirs in India were planned by Central Board of Irrigation and Power (CBIP) in late 1950s, under the Fundamental and Basic Research Scheme applied to River Valley Projects financed by Ministry of Irrigation and Power, GoI. Ministry of Irrigation, GoI directed, on the basis of recommendations of the Reservoir Sedimentation Committee, the State Government to conduct sedimentation surveys of reservoirs once in every five years.
- 11.62 The sedimentation surveys for Ramganga reservoir have been conducted by Irrigation Research Institute, Roorkee in the years 1974, 1978, 1981, 1986, 1988, 1977 and 2008. With regard to other aspects, two studies, one each, were conducted by



Agricultural Finance Corporation Limited (2001) and Administrative Staff College of India (1991). The impact of catchment area treatment in this report is based on review and summarization of various studies carried out in this regard.

Impact on Sedimentation of Reservoir

11.63 For Ramganga Project catchments following number of raingauge stations were considered.

1. 2. 3.	Maintained by project authorities Maintained by Tehasils Maintained by forest department	Nos : 8 : 2 : 4
		14

11.64 For observation of meteorological elements, a laboratory was established at Kalagarh to measure the maximum and minimum temperatures, evaporation, relative humidity, wind velocity etc.

Silt Surveys

11.65 Four silt posts were installed at Kalagarh, Sarpadulli, Merchula and Baher Bari for evaluation of silt load prior to project construction. Forty-three numbers of silt gauges were established in the reservoir area to determine the quantity of silt that would get deposited in the reservoir.

Precipitation

11.66 Ramganga river drains the catchments area of Patli Dun Valley experiencing an average annual precipitation of 1552 mm. On the basis of the available records from 1955 to 1974 at the time of project formulation, the annual precipitation was observed to be varying from 654 mm to 2436 mm. Maximum occurred in 1973 and the minimum of 654 mm occurred in 1974. Mean annual runoff was arrived as 2683 M cum.

Sediment Load Observations

- 11.67 The life of a reservoir depends on the quantity of sediment brought and deposited by the incoming stream. Suspended silt observations were started for the Ramganga River at Kalagarh site from 1958 duly collecting and analyzing silt samples.
- 11.68 In view of the inadequacy of data, sediment load for estimating the life of the reservoir at the rate of 4.25 ham / 100 sq km per year was adopted. The figure was arrived based on Khosla' Theory of Sedimentation of Reservoirs, although as per observation at Kalagarh, it worked out to 13.87 ham / 100 sq km / year. It was suggested



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by the control board to form a Soil Conservation Board to take effective measure for reduction of silt load at the reservoir. Soil conservation programme was already initiated as a Centrally Sponsored Scheme in 1962. As per the design, about 185 years will elapse before the reservoir gets silted up to dead storage level at the sedimentation rate of 4.25 ham / 100 Sq. Km / per year. From the observed sediment load of 13.87 ham / 100 Sq. km per year, the life of reservoir works out to 93 years.

Sedimentation Surveys of Ramganga Reservoir

- 11.69 The reservoir created by the Ramganga River extends in the valleys of Ramganga, Sona and Mandalti rivers upto Dhiklala. The sediment movement depends upon the type and nature of catchments, geology, shape and slope of the terrain, rainfall, climate, vegetation cover, human activities etc.
- 11.70 Review of the past research on reservoir sedimentation reveals that no universally adopted method for identifying the appropriate factors for sedimentation exists for its control. The problem of excessive rate of sedimentation in reservoir is a direct consequence of accelerated soil erosion arising from the reduction in vegetative cover due to increase in deforestation, overgrazing and intensive as well as extensive cultivation in the catchments. The estimation of the rate of sedimentation as well as the distribution of sediment deposits in the reservoir is a most important aspect of the design of storage reservoirs.
- 11.71 The increase in the capacity of the reservoir, noticed later, was due to the increase in the volume of saddle dam portion when it was actually surveyed in 1986 for the first time. Its capacity was worked out as 225.22 MCM against 102.85 MCM assumed at the time of project formulation. The last sedimentation survey has been carried out during 2008. The overall capacity is since corrected as 2590.72 M cum in place of 2449.60 MCM.
- 11.72 From the test results of the reservoir bed material samples, it is inferred that the material comprises predominantly Silty sand (SM) with samples of Silty Clay (ML–CL), Silt (ML) and Sand (SP). **Table 11.4** indicates the capacities of the reservoir at FRL 365.30 m for different years.

Table 11.4 Capacity of Ramganga Reservoir for Different years								
Year /		R	iver					
Capacity in M Cum at F.R.L 365.3	Ramganga Main dam Portion	Ramganga Saddle dam	Portion	Sona	Mandalti	Т	otal	
1974	1626.67	102.85 (assumed)	243.94*	662.93	57.15	2449.6	2590.72	
1978	1595.19	102.85 (assumed)	237.70*	640.8	57.15	2396	2530.85*	
1981	1565.38	102.85 (assumed)	233.02	625.11	53.67	2347.2	2477.18*	
1986	1595.82	225.22	-	617.63	54.44	2492.		
1988	1609.89	222.95	-	620.29	55.74	2508.0		
1997	1594.75	218.08		612.92	54.5	2480.25		
2008	1587.19	213.47	-	605.5	50.31		2456.47	

Source: Complied on the basis of information obtained from Irrigation Research Institute, Roorkee.

Corrected values

Average rate of Silting in 34 years =
$$\frac{2590.72-2456.47}{34} = \frac{134.25}{34} = 3.95 \text{ M Cum / years}$$

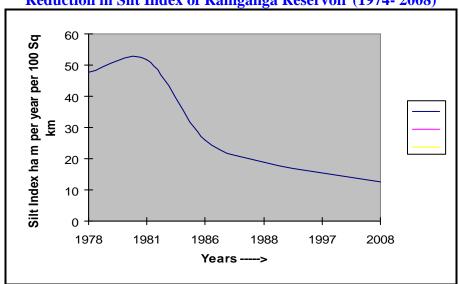
Silt factor

$$=$$
 $\frac{3.95 \times 100 \times 100}{3134}$ $=$ 12.60 ha m /100 sq km/year as against 4.25 ha /100 sq km/ year 3134

Average Siltation wr to
$$2008 = 2508.01 - 2480.25 = 2.38$$

Silt Factor =
$$\frac{2.38 \times 100 \times 100}{3134}$$
 = 7.59 ha m / 100 sq km / year

- 11.73 The silt factor is calculated as 12.60 ha m/100 sq km per year as against 4.25 ha m/100 sq km per year assumed at the time of project formulation. However, the silttation is decreased with reference to 2008. The silt factor is only 7.59 ha m/100 sq km / year.
- 11.74 **Table 11.5** shows the silt index calculated for different years of hydrographic surveys. This also confirms the reduction in silt index in a span of 34 years, which was highest in the year 1978. Due to the soil conservation works taken up briskly there after, there is reduction in silt index. The average annual sediment deposit came down from 14.97 M cum in 1978 to 2.38 M cum in 2008. **Graph** showing the reduction in silt index is in presented in **Graph 11.1**.



Graph 11.1 Reduction in Silt Index of Ramganga Reservoir (1974- 2008)

11.75 Siltation or the loss of capacity has been tabulated the **Table.11.6**. It is clear that the siltation is reduced after 1978 i.e., only 0.82 per cent of capacity lost in the span of 10 years, which can be attributed to the different soil conservation works taken up in the priority zones of the catchments. Rate of siltation between two consecutive periods reduced from 47.76 ha m /100 sq km / year between 1974 and 1978 to 12.60 ha m / 100 Sq km/ year between 1997 and 2008.

11.76 **Table 11.7** elaborates the storage capacity in dead storage zone and live storage zones in different parts of the reservoir, which shows a very little loss of capacity in the live storage zone as compared to the loss of capacity in the dead storage zone.

Table – 11.5 Sediment Data of Ramganga Reservoir								
Year of Survey	Sediment Deposit	Sediment Deposit (Cumulative)						
(Pre-Monsoon)	Total Mcum	Total Mcum To date to 1974 (M cum Average Annual sediment deposits (M cum)		Silt index ha. M per year 100 sq km				
1974	-	-	-	-				
1978	59.87	59.87	14.97	47.76				
1981	53.67	113.54	16.22	51.75				
1986	(-) 15.73	97.81	8.15	26.01				
1988	(-) 15.10	82.71	5.91	18.85				
1997	27.76	110.47	4.8	15.31				
2008	23.78	134.25	3.95	12.6				

Note: All data has shown above for pervious years of 1978 to 1977 are reproduced on basis of old T. M. issued. Source: Irrigation Research Institute, Roorkee



	Table – 11.6 Siltation in Ramganga Reservoir									
Name	of the Reser	voir: Reservoir	(i) As	(i) Assumed rate of Silting: 4.25 ha. m / 100 sq km/ year						
			(ii) Ca	atchments	Area: 313	34 Sq km				
SI.	Year of	Corrected	Silt deposited between two			Rate of Silt deposited between two consecutive Survey		Loss o Capacity		
No	Survey	Capacity in M cum	consecutive surveys M cum	in Year	M cm? Year	Ha m/100 Km2/Year	M cum	% with original Capacity	Remarks	
1	2	3	4	5	6	7	8	9	10	
1	1974	2590.75	-	-	-	-	-	-		
2	1978	2530.85	59.80%	4	14.97	47.76	59.9	2.31	2.31% in a span of 4 years	
3	1988	2508.01	22.84	10	2.28	7.27	82.7	3.13	0.82% in a span of 10 years	
4	1997	2480.25	27.76	9	3.08	9.83	110	4.25	1.12% in a span of 9 years	
5	2008	2456.47	23.78	10	2.38	7.59	134	5.18	0.91% in a span of 10 years	
Source	ce: Compute	d on the basis of	information obt	ained fron	n Irrigation	Research In	stitute,	Roorkee	-	

Table – 11.7 Live and Dead Storage Capacity of Ramganga Reservoir (1997 and 2008											
Sl. No	Item	Ramganga (M cum)		Sona (M cum)		Mandalti (M Cum)		Saddle Dam (M Cum)		Total Capacity of Reservoir/ (M Cum)	
		1997	2008	1997	2008	1997	2008	1997	2008	1997	2008
1	Dead Storage Capacity	167.68	160.98	30.67	25.13	0.00	0.00	11.46	10.02	210.11	196.43
2	Live Storage Capacity	1427.07	1426.21	582.23	580.35	54.50	50.31	206.32	203.15	2270.14	2260.04
3	Gross Capacity at FRL 365.3 m	1594.75	1587.19	612.92	605.50	54.50	50.31	218.08	213.47	2480.25	2456.47
Source: Computed on the Basis of Information obtained from Irrigation Research Institute, Roorkee.											

Successful Sediment Yield Arrest

11.77 Catchments Area treatment measures in the catchments area of Ramganga RVP were being carried out since 1962–63 itself i.e., form the commencement of the construction of the project. Various measures such as Forest plantations, Agro forestry, and Horticultural plantation, land leveling and engineering works were taken up under the centrally sponsored Soil Conservation programmes as already discussed earlier.

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- 11.78 The results of the above programme can be viewed in terms of sediment yield arrest. As already discussed under sedimentation surveys in this chapter the following conclusions can be drawn.
- 11.79 The results of the sedimentation studies conducted in different years draws the following conclusion.
 - 1. The reservoir as a whole is losing its capacity at the rate of 3.95 MCM per year which is about 0.15 per cent of its initial capacity.
 - 2. The total capacity of the reservoir is reduced by 23.78 MCM between 1997 and 2008, which are only 2.38 MCM per year and 0.09 per cent of the original capacity.
 - 3. The average silt index has been calculated as 15.31 ha m / 100 sq km / year of the catchments against the assumed value of 4.25 ha m / 100 sq km / year as per the project.
- 11.80 This sediment yield arrest can be attributed to the various treatment measures in the catchments area, which has also resulted in the saturation of the sub-watersheds.

Benefits of CAT Implementation

- 11.81 One of the main objectives of CAT plan is to enhance the productivity of degraded agricultural lands by adoption of integrated approach in the catchment areas. The AFCL study (2001) concluded that the implementation of CAT plan in the catchment area of Ramganga project resulted in the following changes:
 - The cropping intensity increased by about 5 per cent due to the implementation of CAT plan in the catchment of Ramganga project; and
 - Due to increased soil moisture during post-project period the productivity of almost all the crops grown in the area increased by about 2.50 to 10.00 per cent.
- 11.82 The above indicated changes in the catchment area of Ramganga project resulted in many economic benefits to the society at large. The impacts of these developmental activities in the catchment resulted in the following additional tangible benefits.
 - Benefits from Forestry; and
 - Benefits from Fruit crops
- 11.83 The implementation of CAT plan in Ramganga catchment increased the forest and trees cover. This is one of the major environmental benefits of CAT plan implementation in the catchment of Ramganga. Further, this has also improved the



habitat for Tigers in the Corbett National Park.

11.84 All the soil conservation works in the Ramganga catchment are land based and were executed in remote villages. The labour required for executing works were by and large mobilized from within the area and were paid either on task based or on daily wage basis. This obviously led to generation of additional employment in the areas where soil conservations works were implemented. The employment generated can be broadly divided into two categories. They are as follows:

- ⇒ Casual Employment; and
- ⇒ Regular Employment

11.85 Casual Employment: The man power is needed for execution of the soil conservation works which is a one time activity and is called casual employment. The extent of employment depends on the type of activity and the extent of area covered each year.

11.86 Regular Employment: Regular Employment is of recurring nature which is over and above the normal employment available in the area. The soil conservation works executed require regular annual maintenance. Further, the resources increased the tempo of work. The man power required for these, created additional and regular employment in the remote villages.

11.87 The afforestation works that generated casual employment include raising the nursery for the seedings, fencing the area demarcated for afforestation works and digging the pits or trenches. Similarly, in agricultural lands where terracing is the major activity, the entire earth work needed for developing the terrace is done by manual labour. For development of horticulture, in addition to developing the area into terraces, the area is prepared for plantation and suitable fruit species were planted in the area.

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12

Evaluation of Environmental Management Plan (EMP)





Introduction

12.01 The Central water Commission, GoI, intended to initiate comprehensive Environmental Evaluation Studies of Water Resources Development (WRD) projects implemented prior to 1978. The main objective of these studies is to analyze the outcomes from the implementation of the Environmental Management Plan (EMP) prepared prior to the construction. It is also intended to suggest additional measures necessary to mitigate negative environmental impacts due to the project, if any. Ramganga River Valley Project across Ramganga River in Uttarakhand (erstwhile Uttar Pradesh) near Kalagarh Village in Pauri Grahwal district is one of such projects. The Ramganga Project was planned and designed much before the Ministry of Environment and Forests guidelines of 1979 for environmental impact assessment of river valley projects were prescribed.

12.02 The construction of Ramganga Project started in the year 1962 and was completed in 1974. The project comprised construction of 127.5m high earth and rock fill main dam, a 71.35m high earth rock fill saddle dam, 82kms long feeder channel, remodeling of 4265kms of existing canals and construction of 2141kms of new channels1. This is multipurpose project with anticipated objectives like irrigation of 5.75 lakh ha in U.P State, generation of power to a tune of 3 x 66MW and fulfilling the partial of drinking water needs of Delhi Nagar Nigam.

12.03 Regarding environmental issues which are of prime importance for a river valley project, no environmental management plan was prepared prior to the project construction. However, the project authorities were directed to implement a centrally sponsored River Valley Project with main aim of soil conservation in the catchment area. The RVP in catchment was implemented with a view to reducing the sedimentation loads into the reservoir to the rates of sedimentation adopted in the designs. But for the above, there was no EMP to compare with the present status and assess the impact.

12.04 Generally the EMP of a River Valley Project needs to address the following issues having impact on the environment.

- Resettlement and Rehabilitation
- Compensatory Afforestation

¹ R.S Goel, 'Environmental Impacts of Ramganga Multipurpose Dam Project'. A case study, published in 'Environmental Management in Hydro Electric Projects' edited by Kanta Prasad & R.S.Goel, Concept published company, New Delhi, 2000.



Environmental Management Plant (EMP)

- Catchment Area Treatment
- Management of Muck Disposal
- Reservoir Rim Treatment
- Green Belt Development
- Public Health Management
- Bio-diversity Management including Fisheries Development

12.05 Further, the Ramganga project has the potential to strengthen the development of eco-tourism in the major part of Ramganga river valley particularly in the Jim Corbett National Park. Incase of Ramganga river valley project, in spite of absence of EIA study and subsequent preparation EMP, the project authorities nevertheless have taken up certain steps to mitigate the negative environmental impacts due to the project. Therefore, here an attempt is being made to look into the present status in respect of above mentioned aspects/indicators.

Resettlement and Rehabilitation

12.06 The cause and consequences of Ramganga project resulted in submergence of Jim Corbett Park Forest area. The project sites comprised of dam area, submerged area of reservoir and the staff colony area. All these lie in forest area with no human habitation. No private cultivated land was affected due to construction of the dam. There has been no dislocation or submergence of either rail or road traffic. There has been no shifting of habitation or dislocation of agriculture area. Hence, rehabilitation of the oustees and the resettlement issue did not crop up.

12.07 However, reservoir submerged 4220 ha of un-irrigated reserve forest land and 2500 ha of forest plantations. Beside this 33 small buildings constructed in the forest and 60kms forest roads and bridle paths were also affected by the project. 11 such buildings are still under use on the reservoir rim. The value of the submerged forest land, buildings and roads has been settled between U.P. Irrigation and Forest Departments for payment of compensation on then prevailing market rates. Out of the 33 buildings affected, one was inspection house; three range quarters and rest were the forest guards' posts. The depreciated cost of `2.12 lakh was paid for by the project to the Forest Department for construction of new buildings in lieu of the old ones. In place of 60kms long roads and bridle paths, the project paid for constructions of 93kms long periphery roads on the rim of reservoir for exporting the forest products².

Compensatory Afforestation

12.08 As per Forest Conservation Act 1980, the compensatory afforestation needs to be undertaken either in degraded forest land or in suitable Government land. The norms for compensatory afforestation are as follows:

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² I bid.

• The compensatory afforestation needs to be undertaken in the area equivalent to the area of forest needed for the project, if suitable government land is identified for the same.

or

• Compensatory afforestation in degraded forest land need to be undertaken in an area equivalent to double the forest area needed for the project.

12.09 In case of Ramganga Project, the submergence area at FRL 365.30m is broadly confined within the left and right flanks of forest area. The gross area of submergence as per the report is 8143 ha including water bodies. The entire area around the submergence periphery is the forest area. The forest area submerged due to project consisted of reserve forest with salwood plantation to a major extent, un-irrigated lands, plantations lands, buildings constructed in forest, forest roads and bridle paths, dam seat, power house, head race tunnel, tail race tunnel, project colony etc, accounted for 8143ha. It is to be mentioned here that apart from reserve forest, 2500 ha of forest plantations affected. The plantation affected by the formation of reservoir was replenished in the adjoining area as compensatory afforestation was undertaken by the project proponents in lieu of the forest area diverted for the purpose of Ramganga project. Thus, the forest area diverted for the purpose of Ramganga project with necessary compensatory afforestation is assessed to be 5643 ha including river course in the forest area.

- 12.10 Thus, it is proposed to raise compensatory afforestation outside the National Park. As per the Forest Conservation Act 1980 "compensatory afforestation in degraded forest land need to be undertaken in an area equivalent to double the Forest area needed for the project". Compensatory afforestation in degraded forest to the tune of 11,286 ha (twice the area of 5643 ha), outside the Corbet Nation Park is yet to be undertaken in lieu of forest area diverted for the purpose of the project.
- 12.11 As the project area falls in the state of Uttarkhand, as such the State Forest Department of Uttarkhand, be referred to identify lands preferably degraded lands in the catchment area for compensatory afforestation for which the cost be born by the project authorities.
- 12.12 This proposal of compensatory afforestation would fulfill largely the goal of compensating of forest already submerged. Besides, these plantations sites would also fulfill the need based purposes of treating the catchment area of the reservoir in preventing silting of the reservoir and soil run-off as the plantation sites are proposed in the catchment zone.

Cost Estimation

- 12.13 The cost estimation for compensatory afforestation, in general will have three main components viz.,
 - Cost of Afforestation



³ ibid.

Environmental Management Plant (EMP)

- Cost of Deforestation
- NPV cost

12.14 The cost of afforestation would be the rate recommended by concerned State Forest Department for an area of 11,286 ha. The cost of afforestation is assessed to be about `75,000/- per ha. Thus, the total cost for compensatory afforestation is assessed to be `846.5 lakh ha. The item-wise cost of compensatory afforestation is presented in **Annexure XII.1**. Cost of deforestation does not arise since the reservoir was already formed 35 years ago and hence not proposed at this stage as the land was already transferred to the proponents before the project construction. NPV cost also does not arise as per the reasons mentioned above

Catchment Area Treatment

- 12.15 The catchment area of Ramganga river upto Kalagarh dam extends to four districts of Uttarkhand state and lies between Longiture 70°35' and 80°15' East and latitude 20°30' to 30°10' North. The area lies between 263 m and 2932 m elevation and falls mostly in the middle and outer Himalayan ranges below the permanent snow line. The total catchment area of this river is 32,493 sq km. Steep hills with deep and narrow valleys are the characteristic features of the catchment. The catchment area of Ramganga river upto dam site is 3107 lakh ha. The catchment is spread over in four districts of Almora, Grahwal, Chamoli and Nainital of Uttarkhand State. Of the total catchment area, forest occupies about 57 per cent, grassland account for 8 per cent and agricultural land about 30 per cent. The average annual sedimentation rate in Ramganga reservoir was assumed as 13.32 MCM in the DPR.
- 12.16 In the absence of catchment treatment plan, the project authorities were directed to implement centrally sponsored scheme of soil conservation in the catchment area. The catchment area treatment under the centrally sponsored River Valley Project in the catchment of Ramganga project was implemented in prioritized sub-watersheds between 1962 and 6006-07. The prioritization of sub-watersheds was based on the methodology developed by All India Soil and Land Use Survey. As per latest information (2007), all the prioritized sub-watersheds in the catchment of Ramganga project were saturated with necessary treatments. The soil conservation scheme was initiated in 1962 in the project catchment covering an area of 42,000ha up to 1988. An area of 34,508ha on non-agriculture lands was treated with afforestation works along with treatment of 7,416 ha agriculture land and 2,338 ha horticultural land in catchment by that year.
- 12.17 The details of catchment area treatment aspects covered under the project are being presented in the chapter entitled "Status of Implementation of Catchment Area Treatment".

Management of Muck Disposal

12.18 Muck generated due to construction works (dam foundations, tunnels, Power house, Appurtenance works etc.,) has to be disposed safely without disturbing the

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existing environment. Safe disposal of muck generated is one of the important aspects of environment management under River Valley Projects.

- 12.19 The muck disposal sites are to be selected based on site inspections and available best conditions of the land availability, land stability, accessibility from the portals, sloping pattern, minimum vegetative and tree cover, river bed condition etc., Thus, the location of dumping areas to be located at a safe distance from construction sites and High Flood levels have to be taken into consideration. It has to be planned amicably.
- 12.20 In this regard it is reported that the work was typical in nature and required good planning. Hence, it was observed that the excavation and disposal of excavated material was planned to the extent possible. The excavation work was done by drilling and blasting and by sipping where benches were available. Collection and dozing of the excavated material was done by tractors and also manually. The excavated material was lifted by trucks and trolleys and disposed off in the downstream nala beds / selected sites. Besides, wherever possible donkey labour was also utilized. To avoid delays, mechanical disturbances / hurdles and safe disposal of excavated material, repair of dozers and trucks were carried out at sites only.
- 12.21 Wherever possible, the excavated rock was stock piled in the space available within the vicinity, which were used later on in the saddle dam fill or any other construction work. In general, excavation works were taken up during summer season and completed before commencement of monsoon season. The muck management was planned amicably and executed taking into consideration environments concerns.

Reservoir Rim Treatment

The reservoir rim treatment, in general, becomes necessary subject to

- Its location is in landslide prone zone;
- High soil erosion with denuded forest in the offshore area of reservoir; and
- Heavy gully formation in the offshore area of the reservoir
- 12.22 The Ramganga dam was constructed on the Ramganga River which was located 3km from village Kalagarh of Bijnor district of Uttar Pradesh State. The construction of this dam has created a beautiful lake which lies in the midest of famous Jim Corbett National Park. The total area submerged under reservoir is 80 sq km. Out of this Park submerged area accounted for 55 Sq kms and the rest of the area submerged belonged other reserve forest. The water spread area is 8100 ha at FRL 365.30m. The total length of periphery is about 265km extending into the valleys of Sonanadi, and Maldalti Rivers which are two of the main tributaries of Ramganga River. The foreshore area of the reservoir is surrounded by thick forest. The reservoir does not lie in landslide prone zone as it is in the midst of Corbett Park. No gully formations have been reported in foreshore area of the reservoir as it is surrounded by dense forest.

12.23 Taking into consideration the factors mentioned above, no Rim Treatment Plan was prepared nor implemented.

Green Belt Development

- 12.24 In order to mitigate and minimize the environmental impacts arising due to construction of project from air pollution, noise pollution, and soil erosion etc. Green belt development around the project sites can provide solution to this effect. The tree plantation on foreshore prevents soil erosion and movement of silt towards reservoir form the catchment area to some extent. The trees are also useful as perches to the water birds by laying their eggs and help in their breeding. Foreshore plantations also help in maintaining ecological balance in nature.
- 12.25 As mentioned in preceding paragraphs, the outer area of reservoir is surrounded by dense forest, there is no need for any new plantations. Besides, the CAT also taking care of soil erosion and arresting of silt, as designed, to the extent possible. Existence of Corbett Park taking care of avian breeding issues as well as in maintaining ecological balance of the area. Thus, there is no need to have new plantations in the area.
- 12.26 Further, it is observed that Ramganga Project was the first major project in the combined State of Uttar Pradesh (Now Uttarakhad and Uttar Pradesh) which was taken up through departmental manpower employed by Irrigation Department. The project work commenced 1962. This necessitated planning for construction of a large number of houses for all categories of staff and labour to accommodate them, which ultimately resulted in construction of residential and non-residential buildings. The construction work of these colonies was completed in 1968. It is to be mentioned here that along with house construction, tree plantation work was initiated in the colony areas simultaneously. During the field visit by the study team which included colony visits also, revealed existence of green cover in the colony areas with the grown up trees giving beautiful look.
- 12.27 There is ample scope for development of "Green Belt" along the main canals and distributaries, in the command area of the project. However, no provision was made for this activity under the project. Therefore, there is a need to have avenue plantations along the canal banks which needs to be planned. The total length of main canals and distributaries excavated in the command area under the project is assessed to be 2141 km. In addition, a feeder channel of length 82 km was excavated to divert water from Ramganga Reservoir to Ganga River and thereafter to the command area. Thus the total length of feeder channel, main canal and distributaries created under the project is 2223 km. Further, the field visits indicated that about 1100 km of these canals will be available for green belt development. Under green belt development the plantation can be undertaken on both sides of the canal. The Green Belt development along the main canals and distributaries can be developed up to a length of 2200 km. It is proposed to undertake avenue plantation of a width of 8 m on both sides of the canal. Therefore, the total area available for canal bank plantation is assessed to be 1760 ha (2200 x 8/10). The cost of

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avenue plantation per ha is assessed to be `2600 (**Annexure XII.2**). Thus, the total cost of avenue plantation is assessed to be `457.60 lakh.

Health Management

- 12.28 Taking care of health aspects of the manpower who are involved in project management and construction, is one of the important issues of environmental management.
- 12.29 To this, effect, it is noted that health care of the project staff and their family members was planned well. The study revealed that appropriate steps were taken to extend needed medical health service to the project staff. A medical hospital was established in new colony area. The hospital was named as 'Ramganga Dam Hospital'.
- 12.30 This hospital has both out-patient and in-patient treatment facilities. The hospital was equipped with all adequate facilities viz., first aid, hospitalization for occupational injuries and family care for the project employees. The hospital was having full-fledged medical team to take care of health problems of project staff. Adequate health care facilities were provided in the labour colonies during the construction phase.

Fisheries Development

- 12.31 The water spread area is 8143 ha and there should have been a large scope for development of Fisheries in the reservoir. But no Fisheries development is permitted by the forest department on commercial basis in the reservoir due to the proximity of Corbett National Park. The reason is that the Fishermen and others may encroach the National Park which will be harmful to the ecology such as flora and fauna in the park. However, 'Game Fishing' activity can be initiated, as lot of tourist visits the 'Park' on regular basis. Migration of fish from the downstream of the river into the reservoir is ruled out in view of the massive 127.50 meters high dam and absence of Fisheries passages.
- 12.32 Pisiciculture is feasible on the upstream of the barrage diversion wear on the Ramganga River. The barrage is located 24 km downstream of the main dam and does have small poundage where fish stocking can take place. Secondly there is another barrage on Kho River a tributary of Ramganga confluencing below the diversion weir, fishing activity can also be developed at this site which also has small poundage for stocking of fish.

Eco-Tourism

Angling Resorts in Tiger Habitat

12.33 Even though the tourist visits to reservoir had not been allowed due to the anticipated problems of poaching in the Corbett Tiger Reserve (CTR), under an agreement signed in 2004, four angling resorts were set up, in the heart of the CTR - this



Environmental Management Plant (EMP)

is private land but surrounded by CTR, and on the banks of the protected Ramganga river. Different angling associations were given rights to two km of the Ramganga for angling of mahseer, which included catching the fish and releasing them back as part of an 'eco-tourism' approach. Initially, the lease was supposed to be for less than 10 years, but it was eventually signed for 30 years.

12.34 The model, while good in theory (that each resort protect 'their' two km of the river Ramganga and employ local youth) has become a problem of nightmarish proportions. For one, most lodges are flouting existing laws. One of the parties involved in Jamoon reportedly erected a prefabricated structure-contravening law and rules-next to its luxury tents. Another serious concern is that the presence of these lodges has pushed up prices of other land in the village. Most land has been bought by private parties, and other resorts are coming up. Jamoon, once a tiger nursery-a rich breeding area for tigers, now has bike races-quad biking and zorbing. The peace of the forest is shattered by racing very noisy bikes on 'adventure' tracks built on the river bed. In the protected Ramganga river you can dive, go kayaking, and rafting.

Too many tourists chasing too few tigers

12.35 Corbett sees over two lakh visitors annually. Figures given by the CTR authorities say that 150 vehicles with about 600 people are allowed in everyday. And there is accommodation for over 3,000 around the reserve. This means there is intense pressure on park officials. Every morning there is mayhem at the booking office-and a former park director complained that "too much attention and time of park officials and staff is diverted towards tourism."

12.36 This increasing disturbance has led to conflict even within the park. In May 2005, a tigress with four young cubs attacked, and injured, a canteen worker. Though it is not allowed for anyone to leave their rooms after nine, by which times the restaurants and canteens must also be shut; apparently the victim was requested by some tourists to deliver some food around midnight, when he was attacked by the tigress. Current tourism activities and infrastructure are impinging on tiger and elephant corridors.

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IMPACT ON PUBLIC HEALTH, DRINKING WATER SUPPLY, COMMUNICATIONS AND QUALITY OF LIFE IN GENERAL





IMPACT ON PUBLIC HEALTH, DRINKING WATER SUPPLY, COMMUNICATIONS AND QUALITY OF LIFE IN GENERAL

13.01 Ramganga project benefited additional command area of 5.90 lakh hectares spread over 17 districts of Uttar Pradesh. Newly irrigated areas will have some impact on the public health due to waterborne and vector-borne diseases if efforts to expand health care facilities are not improved as per the requirement. This chapter discusses the occurrence of diseases and the health infrastructure facilities provided in the command area to contain the spread of diseases in the project area. The position of water supply in the area and the conditions of water logging in the area if at all existing is studied to understand the impact through occurrence of diseases. The effort made by the state government in improving the overall quality of life in general is also discussed.

Health Infrastructure

13.02 It is seen from the secondary source of data already presented in **Annexure IV.11** to **IV.13** in **Chapter IV** that there has been an appreciable development in the area of provision of health care facilities during the post project situation.

13.03 The health care institutions have gone up in the post project situation, both in respect of Allopathy and Homeopathy institutions. However, comparatively the increase in homeopathic institutions is significant indicating change in preference of the people in these districts. Correspondingly the number of beds in Allopathic institutions is reduced by 26 per cent. Uttar Pradesh Government has been giving focus on family welfare and lot of awareness campaigns for child and mother care has been taken up. The family welfare centers are also expanded by 60 per cent to cover more areas in the command area districts of Ramganga project.

Incidence of Diseases

13.04 A comparison between two periods in respect of occurrence of important water-borne / vector-borne diseases is possible when data is available for both the periods. In the case of Ramganga project the pre-project period data on occurrence of diseases was not available to the study team and hence a trend analysis is made from the given data for 3 years and is presented in **Table.13.1**.

Table 13.1 State Level Occurrence of Important Diseases							
	Malaria			Filarial		Japanese's B Encephalitis Virus	
Year	No of Patients	Platelet Activating Factor	Death	No of Patients	Malaria Attributed Fever	No of Patients	Death
2004	85868	2142	0	7999	1088	1030	228
2005	105302	3149	0	7613	619	5581	1593
2006	91566	1875	0	5738	725	2073	476
2007	81580	1989	0	5791	637	2675	577
Source: http://uphealth.up.nic.in							

13.05 It is seen that the malaria has been effectively controlled in the state since 2004 which is evident from the absence of deaths due to the disease. As number of deaths is nil same trends can be safely inferred for the districts under Ramganga Command Area. The number of patients suffering from filarial disease was also brought down. The number of patients and deaths due to Japanese's B Encephalitis Virus disease after going up in 2005 has again been brought down.

Water-Borne and Other Diseases: State level

13.06 The **Annexure XIII.1** gives the trend for three years in respect of certain waterborne diseases and others. It is seen that the number of patients treated for acute diarrhea diseases including cholera had gone up in 2010 compared to 2007 in Uttar Pradesh. However, it is less than the case in 2009. The number of deaths due to the above disease had gone up to 164 in 2010 from 116 in 2007. The number of deaths due to Diphtheria area brought to nil from 1 in 2007. The number of patients treated for whooping cough had drastically declined in 2010 to 1159 from 7045 in 2007. The number of deaths in all these years was zero. However, deaths due to pneumonia have increased alarmingly to 238 in 2010 from a mere 33. Likewise the deaths due to enteric fever also increased to 125 from 25 in 2007. The viral hepatitis appears to have been treated effectively by brining down number of deaths from 11 to 3. Similar efforts are seen in regard to meningitis where the number of deaths has been brought down to 5 in 2010 from 124 in 2007.

Water-Borne and Other Diseases: District Level

13.07 A comparison of water-borne and other important vector-borne diseases is made for the Ramganga command area districts with the available data for two years (i.e.,) 2009 & 2010 provided by Health Department, GoUP. The averages for 16 districts of Ramganga command are compared with the state averages as a whole to find out the intensity and spread in these districts and presented in **Table.13.2**.

Table 13.2 Disease-wise Average Number of Patients Treated and Number of Deaths								
Name of	2009				2010			
Disease as per	Patients Treated		Death		Patients Treated		Death	
standard definition of case	State Average	Ramganga districts Average	State Average	Ramganga districts Average	State Average	Ramganga districts Average	State Average	Ramganga districts Average
Acute Diarrhoeal diseases (including gastro enteritis and Cholera)	6392.44	4185.88	2.24	0.81	5861.14	5296.69	2.31	0.56
Diphtheria	0.59	0.19	0.00	0.00	1.42	2.81	0.00	0.00
Whooping Cough	182.31	79.63	0.00	0.00	16.32	6.63	0.00	0.00
Pneumonia	1405.93	1305.56	3.04	1.31	1070.18	1121.38	3.35	0.94
Enteric Fever	916.85	995.19	1.01	0.38	943.46	1362.94	1.76	0.00
Viral Hepatitis	22.92	23.63	0.11	0.13	24.97	11.50	0.04	0.00
Meningococcal Meningitis	0.90	2.88	0.14	0.25	0.61	0.88	0.07	0.19
Refer Annexure XIII.1, 2 and 3								

13.08 It is seen from the above table that in respect of diarrhea diseases including cholera, the average number of patients treated at state level stood at 6392 where as for the districts under study the average stood at 4185. The average number of deaths for the state as a whole recorded 2.24 and the average number of deaths for the 16 districts of Ramganga command stood at 0.81 indicating that the command area districts stood far below averages of the state due to effective health care measures taken in these districts. Likewise the average number of patients treated as well as average number of deaths due to all other diseases for the command area districts of Ramganga stood far below state averages as seen from the above table. Data in regard to pervious years or pre-project year is not available and hence similar trend could not be worked out.

Reproductive and Child Health (RCH) Indicators District-wise

13.09 District level household survey-III was carried by the Ministry of Health and Family Welfare, GoI during 2008-09. RCH indicators are assessed at the district level. Some important RCH indicators for Ramganga Command Area districts are presented in **Table 13.3**.

Table 13.3 District-wise RCH indicators for districts in Ramganga Command Area						
District	% Mother received at least one TT injection	% Institutional Deliveries	% Full Vaccination	% Contraceptive Use		
Aligarh	69.3	32	45.9	34.5		
Hathras	47.4	29.1	48.4	42		
Mathura	58.4	39.8	31.8	33		
Agra	54	36.3	35.7	28.8		
Firozabad	65.3	25.7	41.2	23.5		
Etah	46.7	20	23.6	26		
Mainpuri	91.8	20.8	39.6	37.9		
Farrukhabad	33.4	13.4	37.3	29		
Kannauj	44.5	14	44.1	33.4		
Etawah	47.4	26.5	49.3	31.2		
Auraiya	46.8	14.4	47	36.4		
Kanpur Dehat	32.1	21.8	63.3	46.1		
Kanpur Nagar	79.8	41	78.2	52		
Fatehpur	46.3	15.6	45.9	27.1		
Kaushambi	48.1	14.3	33	32.2		
Allahabad	53.1	25	37.4	42.3		
Source: District Level Household Survey (DLHS)-III, Uttar Pradesh						

13.10 Government of Uttar Pradesh has been making efforts to bring awareness in the public regarding mother and childcare during pre and post pregnancy periods. The above **Table.13.3** indicates district-wise performance in extending health care facilities to mother and child. The highest percentage (91.8%) of mothers receiving at least one TT is observed in Mainpuri district and the lowest percentage (32.1%) is found in Kanpur Dehat. Kanpur Nagar stood high (41%) in institutional deliveries whereas Farrukhabad registered low percentage of institutional deliveries (13.4%). Full round of vaccinations were given in Kanpur Nagar for 78.2 per cent of the newly born child and in Etah district the lowest number of children (23.6%) received full vaccination. 52 per cent of the population in Kanpur Nagar use contraceptives whereas a lowest percentage (23.5%) use contraceptives in Firozabad.

Occurrence of Diseases in Sample Households

- 13.11 The occurrences of some important water-borne and vector-borne diseases are shown in the **Annexure XIII.4**. District-wise for 3013 sample households surveyed as part of this study.
- 13.12 The total number of malarial cases reported during 2009-10 in 12 districts stood at 19 out of 3013, gastroenteritis 57, Filarial-3 and river blindness for 61 cases. There are no malarial cases reported in Mathura, Etah and Mainpuri and in other districts the number is negligibly small. Except Agra and Kaushambi districts where the number of reported

cases of filaria is just 2 and 1, other districts have not reported any filarial cases. Not a single case of river blindness is reported in Fatehpur. Overall it is seen from the survey that the water-borne and vector-borne diseases are in control.

Drinking Water Scenario

13.13 Ramganga project envisaged supply of 5.5 cumecs of drinking water to Delhi. The following study analyzed the supply and demand positions of drinking water in Delhi and the share of Ganga water in the overall supply position. A study conducted by "rainwater harvesting.org" in the year 2002 revealed that the city at the moment requires 3324 millions liters of water per day (MLD) while it gets around 2034 mld. Delhi being situated on the banks of river Yamuna, the city is mainly supplied by this river along with Ram beas water (Bhakra) barrage and the Ganga water. The total water supply from all these three sources accounted to 1150 MCM of which 60 per cent is available from Yamuna River. The groundwater availability is 290 MCM per year. The bifurcation of supply of drinking water is given in the following table.

Water Resources of Delhi Jal Board					
S. No	Source	Quantity (MGD)			
1	Yamuna	210			
2	Ganga	100			
3	Bhakra storage	240			
	Sub total (Surface Water)	550			
4	Ranney Wells / Tube wells	81			
	Total 631				
Source: Economic Survey of Delhi – 2001-02					

The current potable water requirement for Delhi is estimated at 828 millions Gallons per day (MGD) and the supply from all the sources is 631 MGD leaning still a gap of 197 MGD.

13.14 It may be seen from the above that out of total water of 631 MGD supply from different sources, the water from Ramganga stand at 100 MGD (i.e.,) 15.84 per cent, the rest coming from other sources as shown above. In view of the shortage of water for Delhi city itself is felt, the project has not planned for any en-route supplies to the villages falling in the supply line.

¹ http://www.rainwaterharvesting.org/index_files/about_delhi.htm June, 2011



Impact on Public Health

Communication, Transport and Other Infrastructural Facilities leading to Quality of Life

13.15 The development in the areas of communication, transport and infrastructure facilities, leading to quality of life are elaborately covered in **Chapter V**: Effects on Agriculture and **Chapter IV**: Socio-Economic Impact based on he secondary data sources from authentic publications and primary source of data through field survey of sample households.

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14

Conclusions and Recommendations





CONCLUSIONS AND RECOMMENDATIONS

Background

14.01 Ramganga River is a tributary of river Ganga. Ganga is the largest river in the State of Uttar Pradesh. The upper and lower Ganga canals with respective discharge capacities of 297.4 cum/s and 156.4 cum/s irrigate large areas of Ganga—Yamuna Doab. However, the water from these two canals is not sufficient to irrigate the left over large tracts of cultivable area. In order to harness the potentiality of Ramganga tributary, the Uttar Pradesh government constructed a dam across this river at 3 kms upstream from the place where it enters the plains. The dam site is bounded by Siwalik ranges of Himalayan region.

14.02 The Ramganga dam is situated in Kalagrah village, in Pauri Grahwal district of Uttar Pradesh. The dam is located at latitude 29° 31'13" and longitude 78°45'35" east. The structure consists of two earthen dams, one 125 km high on the main river and the other 72.2m high saddle dam on one of its other tributaries calls 'chuisot'.

14.03 The main objective of the project is to provide irrigation to an additional area of 5.75 lakh hectares by means of a network of existing and newly constructed canals. Seventeen districts of UP extending from Saharanpur to Allahabad are benefited by the project. The project also aimed at producing additional three lakh tones of food grains in the region. A power house with an installed capacity of 198MW comprising of 3 units of 68MW each was located at the toe of the dam. These power houses jointly are expected to produce 451 million units of additional power every year. The project also aimed at controlling floods in the districts of Morabad, Rampur, Bareilly, Saharanpur, Bijnor and Farrukhabad of UP. Lastly it envisages supplying 5.5 cumecs of drinking water to Delhi Nagar Nigam.

This multi-purpose river valley project consisted of the following components.

- 1. Diversion Tunnels
- 2. Main Dam across the river valley
- 3. Saddle dam on the rim of the reservoir
- 4. Chute spillway
- 5. Auxiliary spillway at saddle dam
- 6. Low Level Irrigation outlet
- 7. Power Intake structures
- 8. Power House and Filtration Plant
- 9. Switch Yard
- 10. Tailrace Channel



Conclusions and Recommendations

- 11. Drainage tunnel and Galleries
- 12. Architectural works and
- 13. Public Facilities

14.04 The total cost of the project worked out to `165 crores. The Reservoir has a live storage of 2195.5 M cum at RL 365.30m which utilized to irrigate an additional area of 5.75 lakh hectares besides providing 173.50 M cum of drinking water to Delhi Nagar Nigam. The construction activities under the project commenced in the year 1962 and completed in the year 1974.

14.05 The basic objective of this study is to assess the environmental changes that have occurred in the Post-Project scenario, after reviewing the implementations of Environmental Management Plan in order to draw out, a redesigned EMP for the project based on evaluation of present status of the environment in the catchment as well as the command area of the project.

14.06 The study was conducted by collecting data from the authentic secondary sources and through a primary level survey of sample households drawn form head, middle and tail regions of the canal. The environmental impacts were studied using "before and after" as well as "with" and "without" "approaches". A sample of 450 households from the project area and 250 households from control area (non-command) are studied. The conclusions arrived and the consequent recommendations made in each area of study are presented in the following paragraphs.

Summary of Conclusions

Effects on Rehabilitation

14.07 The creation of reservoir across Ramganga River submerged an area of 8143 ha at FRL 365.30 m elevation. Entire area of submergence is forestland. The submerged area included 5550 ha of Corbett National Park. However, neither private lands nor habitations were submerged. In view of this no rehabilitations/compensation measures were found necessary in this project. Likewise no compensatory afforestation was effected except providing funds to forest department for reconstruction of 84 km long road and a rest house which were submerged in the reservoir.

Socio-economic Impact

14.08 There is considerable increase in all the fields like School, Bank, Hospital, Literacy, Occupation etc. when compared with pre and post project period situation. As compared to pre-project period it is found that there is an overall increase with respect to quantity of all types of schools as well as improvement in teacher-student ratio. The overall literacy rate in the Command Area has improved multi-fold and significantly the female literacy rate has improved almost equally with that of male literacy rate due to the thrust given to the weak gender in all the programmes. The population grew by 4 per cent and compared to male, the growth of female populations is marginally high. Considerable changes are seen in the occupations which grew positively in all the sectors under study. The change is particularly significant in respect of female cultivators with an increase of 534 per cent as well as female labourers and female workers in household industry.

14.09 The role of Cooperative has declined during post project period. There was a marginal increase in growth of factories but the Commercial Banks grew by 132 per cent. There has been expansion of credit registering an astonishing growth of 5631 per cent. However, the role of cooperatives declined during post-project period. The tourist's spots had increased slightly. In the health sector it is observed that homeopathic institutions gained more popularity showing higher growth after the conventional allopathic institutions. The family welfare programmes picked up a faster pace during post-project period. The Human development index has positive growth in the literacy, and reduction in infant and child mortality during post-project period. The primary level analysis also brought out similar findings

Effects on Agriculture

- 14.10 After construction of this project there was an excellent progress in the field of Agriculture. The area sown more than once has tremendously increased after the project, thereby leading to an appreciable increase in cropping intensity. There was a shift from low irrigation required crops to high irrigation intense crops during post-project. There was considerable increase in production and also productivity of all major crops. The area, the production and the productivity of all major crops increased substantially.
- 14.11 Simultaneously the consumption of NPK fertilizers has increased causing concern due to excessive and imbalanced usage necessitating corrector measures now. Though there is overall increase in all types of livestock population, the growth of improved breed is significantly low compared to Deshi breed requiring corrective measures.
- 14.12 The growth of industries is not so significant in the command. But the growth of infrastructure especially with reference to rural transport, rural power and communication has been excellent. The marketing scenario needs improvement.
- 14.13 The primary level analysis also corroborated with the findings of secondary data analysis by establishing more or lees a near equality between project command area and other command area. Overall the pace of growth in project command area has been much faster than the growth in other command areas.

Impacts on Groundwater

14.14 The command area is part of vast and fertile gangetic alluvium composed of layers of sand, clay and kankar of varying thickness and grade. The top shallow aquifer behaves as unconfined while the deeper aquifer behaves as unconfined to semi confined. The maximum depth to water table below ground level has increased in the command due

Conclusions and Recommendations

to the project. However the water level data clearly indicate that on average there is lowering trend of groundwater at most of the places in view of increased drawls year after year prompting strongly for conjunctive of water hence forth. In this regard micro level studies in detail are urgently needed in all the commend area districts, except in Etawah and Auriya. There is no water logging and salinity in the area due to the project. This was mainly because the withdrawal of groundwater for irrigation kept pace with recharge due to the project. The short term water logging particularly in the vicinity of canals had been corrected with the help of state tube wells.

14.15 The chemical quality of groundwater in general not very good in most part of the command area. Salinity is more in majority of the districts so also chloride and arsenic contents. There has also been high fluoride concentrates in more than 75 per cent blocks of 10 districts.

Impacts on Archeological Monuments, Minerals and Places of Worship

14.16 The submerged area was devoid of any archeological monuments or places of worship. Hence, restoration of same does not arise. The minute gold deposits are not considered economically important. The Corbett Park abutting the catchment and the reservoir is already a tourist spot and offers abundant scope for expansion of tourist activities near and around the dam.

Impacts on Forest, Flora and Fauna

- 14.17 The report on impact on Forest Flora and Fauna reflected the present scenario in catchment and command area rather than impact due to the project in view of scanty and fragmentary data available for pre project situation. The core area of the tiger sanctuary in the Corbett Park does not seem to have undergone any major change.
- 14.18 The observation revealed that the forest area in both catchment and command area of the project decreased. More than 600 species of trees, shrubs, herbs, bamboos, grosses, climbers and ferns have been identified in the Corbett National Park. The sal and the sheesham, the timber trees of north India are abundant in the park. Teak is also widely grown. Shrubs dominate the tree under storey as well as in scrub forest area. The herbs are conspicuous in grass lands or chaurs and in open areas. More than 70 species of grasses are recorded. Besides the above the woody climbers, the epiphytes and orchids of different species are also found along with non-flowering plants including ferns, mosses and lichens.
- 14.19 The status of fauna of catchment area reveals that varied wildlife of the park range from large mammals to the lesser once, the birds and the reptiles etc. According to a two year long survey, the park comprises of 50 mammal species, 580 bird species, 25 reptiles species and 110 tree species. The famous Royal Bengal Tigers abode in the park. There are also 19 bird species threatened for existence. The faunal diversity of the command area is amazing. Surprisingly Nilghai and sambar deer which are uncommon even in

protected forests could be found in the midst of crop lands of farmers. The aquatic fauna especially the fish like mahseer, have no convenient migration and breeding environment due to barriers for tree movement. It is therefore concluded that there are no adverse impact on the flora and fauna of the catchment area as well as the command area. On the other hand the project seems to have played a useful role in providing an enabling environment to the flora and fauna. Particularly in Corbett National Park however, the endangered fish species like mahseer need special attention.

Impact of Command Area Development

- 14.20 It is seen that there are still gaps to be filled-up to reach full potentiality as envisaged in the project. The full potentiality could not be reached due to certain deficiencies in the field distribution system at the level of beneficiary farmers. In view of the limitations of the farmers to develop their own systems, the irrigation department contemplated to lay a network of canals under 'OFD' works in a phased manner. The status of such on farm development works (OFD) so taken up are presented in this chapter.
- 14.21 It is observed that suitable and adequate, technical and administrative staff and monitoring network at all levels was provided to take up OFD works in command area. In all about 5.12 lakh hectares of additional irrigation potential was created under the project taking the overall potentiality to 13.72 lakh hectares.
- 14.22 The command area is classified as type three indicating suitability of the area with moderate constraints. Based on soil classification 100 out of 144 blocks require same sort of drainage system. Salinity is another problem observed in large part of command. The status of OFD works revealed that soil surveys were completed in the entire through at a slow pace. The topographical surveys were also completed in the command to develop designs for canals. The excavation of earthen channels and lining as per plan was completed. The Osrabandi was also completed.
- 14.23 However, during interaction with frames it has emerged that for the part few years, after withdrawal of the project the canal maintenance works were not taken up due to which the availability of irrigation water especially to the tail end areas had become a major problem.

Changes in Land Use Pattern

14.24 The changes in land use and land cover in the catchment area are carried out between 1970-71 and 1978-79 and 1990 and 2008. Whereas the same analysis for command area is carried out between 1974-75 and 1982-83 and 1999 and 2008. The crop land in catchment area increased whereas the area under forest decreased. Further, the wasteland increased whereas water bodies decreased. Similar trends were observed in the land use and land cover of catchment area during 1974-75 to 1982-83 and 1990 and 2008. The changes in land use and land cover of command area districts was assessed during

Conclusions and Recommendations

1974-75 to 1982-83 and 1990 to 2008. The changes in land use and land cover of command area districts was similar to those observed in the catchment area of the project. Thus it has been observed that the changes in land use and land cover in the study area i.e., catchment and command area of the project were detrimental to eco-environmental management of the area. Therefore, there is an urgent need to take up afforestation programme and silvipasture development in both catchment and command areas of the project. These activities may need to be undertaken with active participation of people living in the area and support of non-governmental organizations.

Catchment Area Treatment Plan

14.25 Exclusive catchments area treatment plan was not prepared at the time of preparation of project report or during its implementation. But centrally sponsored scheme for soil conservation was under implementation. The terrain in the catchment area is steep to moderately sloping. It is in a horseshoe shape containing hilly terrain in the middle and outer Himalayan ranges. The overall drainage pattern of the area is subdendrite and relief-excessive and is drained by a number of tributaries. The soils of the area are less erosive and contribute relatively lesser amount of silt yield. The soil conservation works were executed by both forest and agriculture department at various periods. There are 14 rain gauge stations. The sediment data revealed a sediment load of 13.7 ham / 100 sq km per year and the life of the reservoir thus worked out as 93years. The silt studies revealed reduction of siltation after 1978 due to soil conservation works taken up briskly. Afforestation on civil and panchayat lands of the villages was taken up. Leveling and construction of minor engineering structures was also taken up in subwatersheds. Forest plantations were raised in the catchment. Horticulture plants of various species were planted on individual lands.

14.26 In view of the various soil conservation programmes as above the average annual sediment deposit came down and the loss in the reservoir capacity was brought down. The ratio of siltation in the catchment was also successfully brought down. However, due to floods the structures so created in catchment got damaged needing repair and maintenance works.

Assessment and Evaluation of Implementation of Environmental Management Plan (EMP)

14.27 Ramganga Project was constructed much before the issue of guidelines by Government of India for environmental impact assessment of river valley project. However the project authorities were directed to implement centrally sponsored scheme of soil conservation in the catchment area in the priority watersheds to control sedimentation of the reservoir.

14.28 The study looked in to the status of various aspects covering EMP. The study revealed that no rehabilitation and resettlement plan was necessary as there was no submergence of habitations. Work on compensatory afforestation in lieu of submerged

forest area was done partly and the remaining area is proposed to be taken up in the proposed EMP. The cost of afforestation would be at the rate recommended by concerned forest department. There is no need to incur cost on deforestation / land acquisition. The catchment area treatment plan is discussed separately. The study revealed that the muck management was planned and executed properly taking care of all the related environmental issues. In view of the unique location of the reservoir abutting the forest no Rim treatment plans were found necessary. Likewise the green belt development is also not essentially required due to the location advantage. Plantations were taken up in and around the staff colonies. However, there is need to go for avenue plantations along the canal banks. Health facilities to the staff are satisfactory. Fisheries development can be taken up at two places near the two barrages which offer good scope for providing livelihood to fishermen. Game fishing can be taken up at the Corbett Park as a tourism development activity.

Recommendations

14.29 Keeping in view the various observations and findings of the study on environmental impact assessment of Ramganga project, the following specific recommendations are made and presented area wise in the succeeding paragraphs.

Effects of Rehabilitation

14.30 Since, the most of the submergence area comes under forest, no Rehabilitation has been taken place. Funds may be provided for Developing of infrastructure of forest area and also it should be well protected.

Socio-economic Impact

- 1. Educational programmes with special emphasis on functional literacy to farmers shall be taken up in the command area districts. More qualified teachers need to be posted.
- 2. More employment opportunities may be created for enhancement of livelihood in command area. Capacity building activities for livelihood enhancement in command area districts be taken up in order to bring new farm technology to the fields with the ultimate objective of increasing income and savings of the households.
- 3. More employment opportunities may be created by establishing agro-processing units in the command area districts in order to tap the unexploited industrial potential of the area.
- 4. Efforts to decrease the student teacher ratio need to be taken up by posting qualified teachers in primary and secondary schools.



Conclusions and Recommendations

- 5. The existing PHCs shall be strengthened by ensuring regular Doctors at these centers and by providing basic infrastructure and inputs at the center to address basic health issues. As far as the treatment for important diseases like Malaria, Filaria etc is concerned still there is lot of scope for improvement.
- 6. Family welfare programmers with focus on male sterilization programmes be taken up through proper education of the target group.

Effects on Agriculture

- 1. Education of farmers on balanced usage of fertilizers (NPK) through extension activities in the command area districts shall be taken up through the Agriculture Department, GoUP,
- 2. Simultaneously the concept of "organic farming" shall be taken up on pilot basis in selected pilot blocks in order to gradually wean away the farmers from using chemical fertilizers and also to improve the health of the soil in the command area districts.
- 3. The growth of live stock population has to be improved. The status of improved breed especially in cattle needs urgent attention and cross-breeding programmes through artificial insemination have to be taken up on a large scale thourgh public-private partnership in all the command area districts.
- 4. Simultaneously fodder development schemes need to be taken up taking advantage of availability of increased water in the command area by bringing cultivable waste lands in to cultivation.
- 5. The Existing growth centers can be strengthened by installing "technology information centers" to link up the command area farmers to the extension network of the outside world.
- 6. Industries should also to be improved so that the local population will get employment opportunities
- 7. Regulated markets for Rice, Wheat, and Potatoes which are grown abundantly need to be developed for ensuring minimum support prices to sustain the interest of cultivators in these crops.

Impacts of Groundwater

14.31 After coming up of this project the ground water table has considerably increased. There is good number of tube wells available in this command area which is being maintained by State & Private tube well authorities. The quality of groundwater in general is not good in most part of the command area. There is no water logging and

salinity in the area. Number of check dams may be constructed in order to increase the groundwater recharges. Others specific recommendations are as follows:

- 1. Construction of additional tube wells under both public and private sectors, after a detailed survey for fixing locations, in order to fully utilize the present ground water balance.
- 2. Conducting of micro level studies for detailed geo-hydrological mapping and detailed inventory of all groundwater structures in all the command area districts except Etawah and Auariya.
- 3. Conducting of electrical resistant surveys in Agra, Mathura, Etah, Mainpuri, Fatehpur and Kanpur.
- 4. Usage of brackish water after diluation with canal water in the above districts.
- 5. Besides chemical treatment of the polluted water, reclamation shall be planned after sub-surface geological mapping to demarcate the hard clay pans for enrichment of VSAR formations.
- 6. Drilling of exploratory tube wells in the districts of Etawah, Fathepur and Kanpur where water table is deep.
- 7. District wise conjunctive use plan as given in the report with a cost estimate of `301.19 crores to tap balance available water. The plan for installation of private tube wells may be implemented through agriculture finance programmes of commercial banks in the state of Uttar Pradesh.
- 8. Future exploitation of groundwater should be concentrated more in the areas having maximum depth to water table below 6 meters.

Impacts an Archeological monuments, and development of Eco-Tourism

- 1. One Corbett Park is noted as a tourist resort with Tiger sanctuary. The construction of the tourist park at the dam site is to be speeded up. The proposed park shall have unique and attractive features to provide knowledge on ecotourism as well as entertainment to all age groups including children like Boating, game shooting, game fishing, a children's park and a museum.
- 2. Trekking and mountaineering sessions for tourists can be thought of at the near by hill rock in the reservoir.

Impacts an Forest Flora and Fauna

- 1. In order to protect the endangered fish species particularly the Masheer the existing fish passages need to be modified to allow upstream migration throughout or alternately, new fish passages have to be planned in such a way that continuous migration of fish takes place from and in to the reservoir.
- 2. Active supervision and watch and ward need to be increase to curb unauthorized poaching and cutting of timber and other offences being committed on as flora and fauna, if necessary by posting additional staff at the park. Local youth may also be employed on reward basis for this activity.
- 3. Natural habitats for the Tiger and other fauna have to be developed by abundantly growing timber woods and shrubs along the streams in the park.
- 4. The participatory conservation training centres have to be strengthened by conducting regular awareness and training programme to the local people on conservation of flora and fauna
- 5. Commercial fishing activity to fisherman can be developed at the two near-by barrages, one on the Ramganga River and the other on the Kho-river having pondages along with development fish-breeding centres near these areas for supply of fingerlings of selected species. A budgetary provision of `9.00 crore may be provided for this activity.

Command Area Development

- 1. Maintenance and repair work of field channels and distributaries have to be taken up immediately to ensure smooth flow of irrigation water especially to tail end fields. A budgetary provision of about `35.00 crore may be provided for this activity.
- 2. The pilot project initiated in 2009 for Participatory Irrigation Management is now to be extended to the entire command area. New water users associations are to be formed for each village and all the command area farmers are to be involved in identification of problems and finding solutions at filed level or referring the same at other levels.
- 3. The activity of strengthening of WUA's be entrusted to experienced NGOs and effective monitoring be done continuously till each WUA become confident and self-reliant.

Catchment Area Treatment

- 1. A detailed resurvey on catchment has to be conducted to identify all damaged engineering structures and take up maintenance works. A tentative budgetary provision of `25.00 crore may be earmarked for this activity.
- 2. The survey also may identify additional works to be executed wherever, necessary to arrest future siltation.

Environment Management Plan

- 1. Compensatory afforestation in the remaining area of 5500 hectares has to be speedily taken up after identifying the degraded forest area in the vicinity with an approximate outlay of `45.00 crore.
- 2. Avenue trees along the main canals and distributaries have to be planned and executed with participation of all the water users. Each water user to plant at least one tree, "one user-one tree".