Annual Report

1996-97

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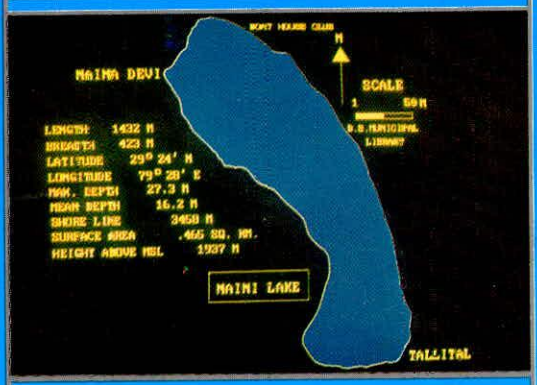
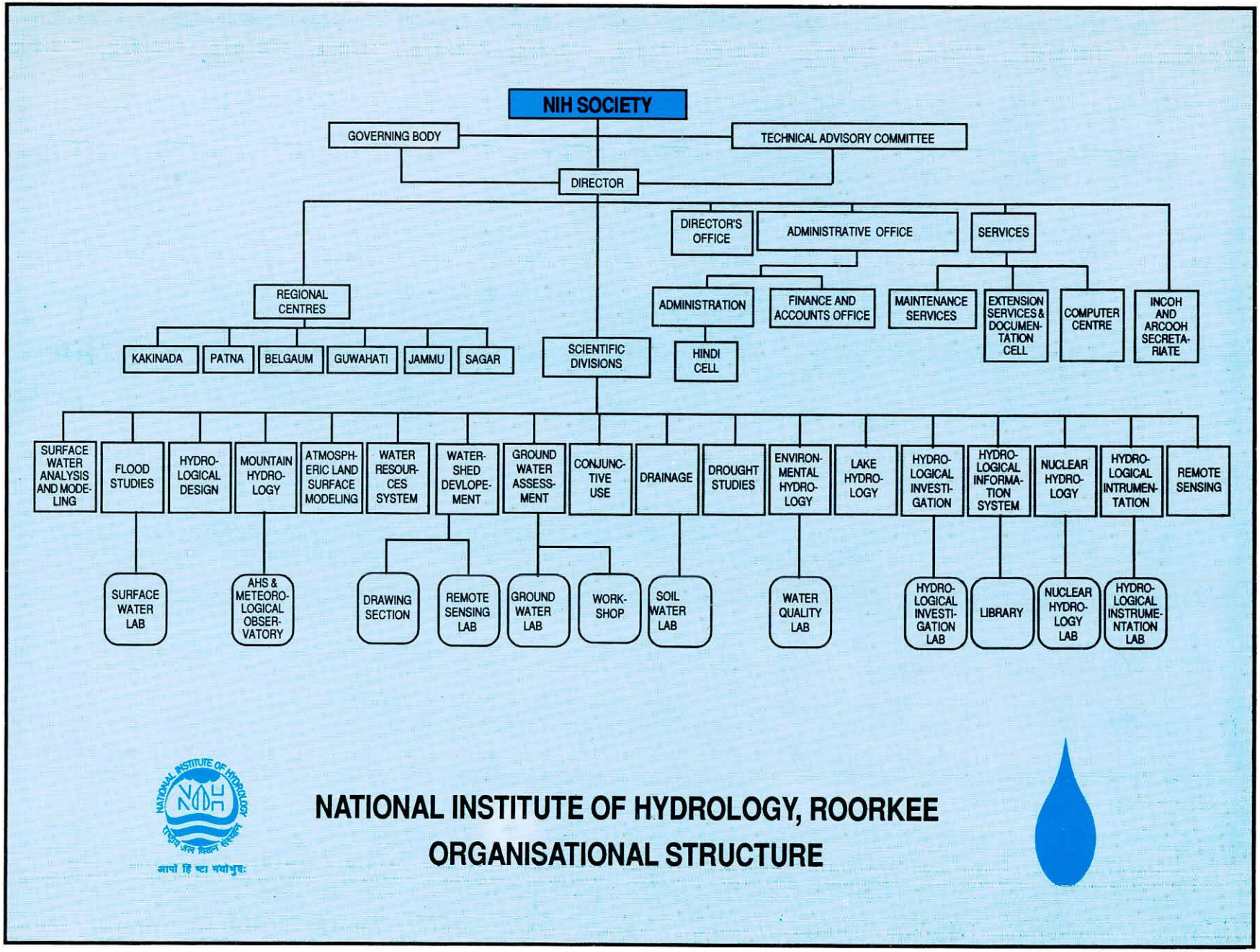
National Institute of Hydrology

Roorkee - 247 667 (U.P.) India

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ORGANISATIONAL STRUCTURE

ANNUAL REPORT

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NATIONAL INSTITUTE OF HYDROLOGY
ROORKEE - 247667 (U.P.) INDIA

Contents

Director's Report

It gives me immense pleasure to present the Annual Report for the year 1996-97 highlighting the activities and achievements of National Institute of Hydrology (NIH), the premier organisation in the field of hydrology in the country. The Institute continued to pursue studies and R&D activities in the thrust areas of hydrology with emphasis on technology transfer and demand driven research. The Institute also endeavoured to develop and carefully nurture a policy of description, prescription and demonstration. Realising the role of technology transfer and development of hydrology at field level for engineers in States, a strong programme in technology transfer has been envisaged. The activities of NIH have received further impetus during the year for strengthening input for studies and research at the regional centres by provision of additional equipment and staff.

Realising the importance of hydrology in the assessment, development and management of the water resources of the country and to achieve excellence in hydrological research, the Government of India had set up the National Institute of Hydrology at Roorkee in the year 1979 as an autonomous society under the Ministry of Water Resources (the then Ministry of Agriculture and Irrigation). The Institute through its contributions by way of basic and applied research and technology transfer has been fulfilling its role as an apex organisation in hydrology for the last 18 years.

During the year 1996-97, the Institute continued to provide necessary leadership and guidance to the various organisations in the hydrology and water resources sector in the country and provided necessary support to the state organisations on various technical matters.

The Institute has conducted studies and research covering various aspects of hydrology as per the approved work programme under 18 scientific divisions at the headquarters. The five regional centres at

Belgaum, Guwahati, Jammu, Kakinada, Patna and the newly established regional centre at Sagar functioned effectively. In the regional centres as well as at the headquarters, studies and research were conducted involving use of available data as well as computers supported by field investigations and laboratory analysis. With the facilities like large range of high capacity PCs, work stations and portable machines, the Institute has been involved in the advanced hydrological analysis on data bases and simulation studies through models. Based on the studies, the institute brought out 86 technical and scientific reports in the form of technical reports, case studies, status reports, user's manuals and training reports. These reports are being circulated to Central and State Government organisations, Academic and Research institutions and individual experts.

The Institute continued to pursue its objective of research in various facets of hydrology. The work of the Institute has been broadly classified into 3 categories, surface water, ground water and hydrologic observation and instrumentation. The studies and research carried out by the scientific divisions progressed well and activities related to development of new procedures, software, manuals and guidelines and development of indigenous instruments for hydrologic measurements have provided useful outputs. Some of the important areas covered included - development of software for regional studies and for estimation of seepage losses in a canal, dam break studies, GIS based studies, pollution adhesion on sediments, lake studies, water quality studies, glacier studies and ground water modelling studies.

To meet the diverse hydrological needs of this vast, great country, the Society of the Institute has recommended setting up of eight regional centres. Till the year 1994-95, the Institute had established five regional centres at : Belgaum (for Deccan Hard Rock Region), Guwahati (for North Eastern Region), Jammu (for Western Himalayan Region), Patna (for Ganga Plains Region), and Kakinada (for Deltaic and East Coast Region). Keeping in view the large size of Ganga Plains, the Society had approved establishment of 6th Regional Centre at Sagar. This centre was established in December 1995. It is heartening to report that the work in all the six centres progressed satisfactorily and number of new facilities in terms of computers, automatic weather stations and GIS softwares were added. I am happy to report that the office and residential buildings at Patna Centre have been completed and the construction work at Kakinada is at advance stage. All the centres, on the advise of the concerned states and Regional Coordination Committees took up relevant field and computer based studies which are progressing as per the scheduled programme.

Besides conducting studies and research in various areas identified by the working groups and recommended/approved by the Technical Advisory Committee and Governing Body, the institute has also conducted research under sponsored projects and consultancy projects having emphasis on research & development component. These were either sponsored or referred to the Institute by various Central and State Ministries/organisations and public sector undertakings. During this year, 5 sponsored projects were completed, work on 6 projects which were started earlier progressed satisfactorily and 3 new projects were taken up.

The scientists and scientific staff of the institute were encouraged to contribute technical papers to national and international journals and participate in seminars and symposia. During the year under report, 118 papers were published/accepted for publication in international and national journals and proceedings of conferences.

The project on "Development of Capabilities for Hydrological Studies in Frontal Areas" assisted by United Nations Development Programme (UNDP) has been under operation in the institute for the last five years. It has provided assistance for developing facilities and capabilities in frontal areas of hydrology through equipment, visits of consultants, study tours by senior scientists, and training of scientists of the institute at reputed institutions abroad. The activities of the project progressed satisfactorily during the year.

Besides procuring sophisticated equipment during the year, the Institute was also benefited by visits of 4 consultants and 2 scientists of the Institute were trained abroad.

The Hydrology Project for peninsular States of India has been approved by the Ministry of Water Resources for funding by the World Bank. The project aims at strengthening the sector of hydrological observations and related data by way of research, equipment, training, software etc. The Institute has been entrusted with the responsibility of training the field engineers in some areas related with hydrology with emphasis on software for data entry and processing. During the year, six training course of two weeks duration each were organised by the Institute at Roorkee with a view to provide training to field engineers. The Institute has also drawn up a program for the next two years in consultation with Project Coordination Secretariate in the Ministry of Water Resources.

In pursuance of its objectives of promoting hydrological activities and applications in the country, the Institute has been actively involved in transfer of advanced methods and techniques to the field organisations by organising short duration workshops on various topics of hydrology at Roorkee and in the States. The emphasis has been to impart training to field engineers and hydrologists, in use of appropriate methodologies involving the use of computers and the software for the advanced techniques of hydrological analysis and modelling used/developed at the Institute. During the year, 8 workshops were organised at Roorkee and 7 workshops were held in various States.

The Institute also provides the Secretariates to the Indian National Committee on Hydrology (INCOH) and Asian Regional Coordinating Committee on Hydrology. The Secretariates worked effectively in coordinating and promoting hydrological activities and hydrological research during the year. Nine State-of-Art reports were prepared and released during the year which covered number of important facets of hydrology. The Secretariate also monitored fourteen on-going research schemes and with the effective coordination of the Secretariate number of new schemes were launched. The quarterly newsletter of ARCCOH was brought out regularly during the year and was well received by national and international organisations.

I am happy to inform that considerable infrastructural facilities in the form of buildings, equipment etc. were developed during the year. The Institute procured number of high speed, large memory computers, UPS and Server etc. for enhancing the capabilities for scientific work. The construction work at the staff colony and the campus of the Institute at Roorkee have progressed satisfactorily and number of residential quarters in the colony and the second laboratory block in the campus were completed. The work on Wing 'C' (third wing) of 2nd Laboratory Block is almost complete and M/s Rashtriya Pariyojna Nirman Nigam Ltd have been entrusted with the construction of an Auditorium with a seating capacity of 350. The work on the construction has already started and the target date of completion is July 1998.

The institute thus continued to progress towards the fulfillment of its objectives namely to undertake, aid, promote and coordinate studies in various aspects of hydrology. It is the institute's endeavour to further strengthen and consolidate the achievements to take up further studies and research as well as other appropriate activities under the directions and guidance of the Society of National Institute of Hydrology. The Institute fully supports the policy that scientific and technological research must contribute more effectively to national prosperity and to improvements in quality of life. This has been well demonstrated that the Institute is already well advanced in this respect as it:

- *has a well founded programme of hydrological research that is addressing to both applied and basic research*
- *has developed and implemented and continues to develop scientific techniques that are essential not only to hydrological sciences but have wider applications for optimal development, conservation and management of water resources*

- *has been endeavouring to build bridges between research and field users of this research by providing increased emphasis on technology transfer.*
- *has made significant advances with its scientific achievements since its inception.*

I am sure that this report will give a glimpse of the working of the Institute and the contributions made in the field of hydrology during the year. There is, however, no place for complacency and the Institute remains dedicated to the task of providing scientific R and D inputs for water resources development and management in the country. I am sure that the Institute will continue to attain higher levels of achievements in the years to come

(S M SETH)
DIRECTOR

Performance During the year at a Glance

- The Institute has carried out a number of studies to fulfill the objectives laid down while setting up the Institute and those highlighted in the National Water Policy document.
- The studies and research were carried out under the eighteen scientific divisions at Roorkee and at six Regional Centres as per approved work programme.
- The Institute has prepared a user friendly, interactive software package for design flood estimation for large catchments using deterministric approach.
- The Institute has also prepared a Users Manual for Estimation of Seepage from a Canal.
- Some new procedures for hydrological analysis and indigenous automated hydrological instruments were developed by the Institute. These procedures and instruments are being applied and tested respectively.
- Based on the studies conducted during the year, 86 technical reports were prepared by the Institute.
- The scientists and staff of the Institute have published 39 papers in national and international journals and 26 papers have been accepted for publication.
- 44 papers prepared by scientists and other scientific staff have been included in the Proceedings of national and international conferences/seminars/symposia.
- As part of technology transfer programme 15 workshops were organised at Roorkee and in states wherein about 371 engineers and scientists were trained on computer oriented approach for analysis in specialised areas of hydrology.
- 5 Consultancy/sponsored projects were completed during the year and 9 projects are under progress.
- Laboratories at Headquarters and Regional Centres were strengthened by procuring equipment through UNDP Project and Institute funds received under Government of India grants. These equipment are being used for carrying out various laboratory/field oriented studies as per work programme.
- 2 scientists were trained abroad under UNDP project and 4 consultants visited the Institute and its Regional Centres.
- The Institute has organised two Brain Storming Sessions on 'Hydrological Problems of Hard Rock Region" and "Hydrological Problems and Perspectives in Western Himalayan Region at Belgaum and Jammu.

- The studies and research carried out by the Institute have received national and international recognition.

- The Institute actively participated in Hydrology Project taken up by Government of India. The Institue is the nodal agency for providing training to field engineers and is responsible for training of trainers. During the year, 6 training courses were organised under the project.

- The office building and other works at the Eastern Deltaic Regional Centre, Kakinada were completed during the year.

- The construction of third wing of second Laboratory Block progressed satisfactorily and it is expected to be completed by November 1997.

- The staff colony of the Institute being constructed on Roorkee-Hardwar road is progressing well and drainage, water supply, internal roads and 68 residences have been completed.

1.0 Introduction

1.1 General

The National Institute of Hydrology has been functioning as a premier Institute in the area of hydrology in the country since December 1979. It was established with Headquarters at Roorkee by the Government of India as an autonomous society aided by the Ministry of Water Resources, Government of India.

The NIH Society is headed by Union Minister of Water Resources as its President and the Union Minister of State for Water Resources as its Vice-President. The Ministers-in-charge of Irrigation in the States (for ten States to be nominated by the President of the Society), the Secretaries of different Ministries in the Govt. of India concerned with water and related areas; and experts in hydrology and water resources are members of the Society. The membership of Society is 47 including the President and it reviews the progress and performance of the Institute in its meeting held atleast once a year. The Society has a Governing Body with a total membership of 14 including the Secretary, Ministry of Water Resources, Govt.of India as the Chairman. The functions of the Governing Body are to look over the administration, performance and utilisation of funds of the Society by drawing annual and supplementary budgets; allocate funds for various purposes and determine agreements with other organisations either in India or foreign for joint endeavours. The Institute's research and other technical activities are monitored and guided by the Technical Advisory Committee (TAC) with 15 members including the Chairman, Central Water Commission as its Chairman.

In order to deal with the specific hydrological problems of different regions of the country and for providing effective interaction with the states, the Institute started setting up Regional Centres since 1987. The Regional Centres for Hard Rock region, North Eastern region and Western Himalayan region were established at Belgaum, Guwahati and Jammu respectively during the seventh plan period. In 1991, one Regional Centre for Ganga Plains at Patna in Bihar and one for Deltaic and East Coast region at Kakinada in Andhra Pradesh were set up. One more Centre for Ganga Plains at Sagar in Madhya Pradesh has been setup in December 1995.

Keeping in view the requirements for hydrological research in the country for a period of five years, the TAC and Governing body of NIH had approved the areas of study and research for the Institute for the IXth plan period. Based on this, annual programmes are formulated and considered by the working groups and the TAC.

Director of the Institute is appointed by the Government of India and is the Principal Executive Officer of the Scciety. The staff of the Institute comprises of scientists, supporting scientific & technical staff and administrative staff. The Institute has highly qualified staff. Out of the 74 scientists in position in the Institute and its regional centres, as on 31.3.1997, 23 have Ph.D degree and 51 have ME/M.Tech. degree.

1.2 Objectives

The main objectives for which the National Institute of Hydrology has been established are :

i. to undertake, aid, promote and coordinate systematic and scientific work in all aspects of hydrology;

ii. to cooperate and collaborate with other national, foreign and international organisations in the field of hydrology;

iii. to establish and maintain a research and reference library in pursuance of the objectives of the society and equip the same with books, reviews, magazines and other relevant publications; and

iv. to do all other such things as the Society may consider necessary, incidental or conducive to the attainment of the objectives for which the Institute has been established.

As per the guidelines given to NIH, the time devoted for basic and applied research activities should be atleast 60%, consultancy not more than 20% and technology transfer activities not more than 20% of the total time of scientists and scientific staff.

1.3 Activities During the Year

The Institute's activities are being carried out at the Headquarters and its 6 Regional Centres. During the year, the scientists and scientific staff of the Institute have published large number of technical papers in international and national journals, and proceedings of international and national conferences and symposia. Reports on studies and research covering several topics have been prepared.

Work on development of indigenous hydrological instruments with automated data acquisition facility is continuing satisfactorily. The instruments developed by the Institute earlier are being tested under field conditions with the assistance of concerned government departments and their performance is being monitored and evaluated for further improvement.

Under the technology transfer programme besides publication and circulation of technical reports, the Institute organises five day workshops on different topics relevant to field engineers. During the year, the Institute has organised 15 workshops on Application of Remote Sensing and GIS in Hydrology; River Basin Modelling and Analysis; Hydrological Modelling of Mountainous Watersheds; Design Flood Estimation; Hydrology of Watersheds; Brainstorming Session on Hydrological Problems and Perspectives in Western Himalayan Region; Brainstorming Session on Hydrological Problems of Hard Rock Region; Brainstorming Session on Hydrological Problems and Perspectives of Lower Gangetic Plains, etc.. These workshops were organised at Roorkee and in various States.

The Institute is also assisting several organisations in the country for solving various complex and typical field problems through sponsored projects and consultancy projects. During the year 1996-96 apart from continuing the work on the 6 ongoing projects, the Institute has taken up 3 new sponsored/consultancy projects entitled

(i) Exploration of Construction of Infiltration Gallery inside the Bed of River Yamuna at Agra;

(ii) Hydrology of Myntdu Leska Hydro Electric Project in Meghalaya;

(iii) Integrated Hydrological Study for Sustainable Development and Management of Two Hilly Watershed in UP.

Besides this, the Institute also completed 5 sponsored projects which were taken up in earlier years.

Under the aegis of the Indian National Committee on Hydrology and with a view to disseminate hydrological knowledge in the country, the Institute brought out nine State-of-Art reports in emerging and thrust areas of hydrology. These reports contributed by national experts were released on different occasions and were received by the hydrologic community with great interest. These reports are being circulated in India and abroad.

The UNDP funded project on "Development of Capabilities for Hydrological Studies in Frontal Areas" was started in the year 1991 and is progressing satisfactorily. The Project has mainly four components - training of scientists, study tours by senior scientists, visit of consultants and procurement of equipment. The progress on all the four components was as per schedule and 2 scientists were sent for training abroad, and 4 consultants visited the country during the year under report.

The Hydrology Project for peninsular rivers of India was finalised by Ministry of Water Resources for funding by the World Bank. The Institute has been entrusted with the responsibility of training the field engineers which is one of the important components of the project. The project is being implemented by five Central Govt. organisations and Irrigation Departments of eight peninsular States. During the year 1996-97, six two-weeks Training Courses under this Project were organised.

The Institute has in general, worked with the objectives of effectively contributing to water sector in the country through basic and applied research in various areas of hydrology. The progress made during the year 1996-97 on various ongoing and newly initiated projects, and a brief account of academic and other activities alongwith the statement of accounts is presented in the following sections.

2.0 Committees and their Activities

2.1 Society

The National Institute of Hydrology Society is the apex body of the Institute and meets at least once a year. It reviews the progress and performance of the Institute and gives such directions as it may deem fit to the Governing Body and the Institute towards the attainment of the objectives enunciated in the Memorandum of Association of the Society. The membership of the Society as revised in March 1996 is given in Appendix I.

The 17th Annual General Meeting of the Society was held at New Delhi on 26th November 1996. The Society reviewed the work carried out by the Institute during 1996-97 (upto Nov. 1996), approved the annual report and audited accounts for the year 1995-96 and approved the budget for the year 1997-98.

2.2 Governing Body

The Governing Body is the executive body of the Institute to pursue and carry out the activities as per objectives laid down by the Society. The Governing Body exercises all executive and financial powers of the Society. The Governing Body is expected to meet at least twice in a financial year. The membership of the Governing Body as revised in March 1996 is given in Appendix II.

During the year 1996-97, the 49th and 50th meetings of the Governing Body were held at New Delhi on 11th October 1996 and 26th March 1997 respectively. Several decisions concerning administrative and financial matters of the Institute were taken. Annual report and audited accounts for the year 1995-96 were considered and recommended for approval. The revised budget for 1996-97 and budget proposals for 1997-98 were also considered and recommended for consideration by the Society.

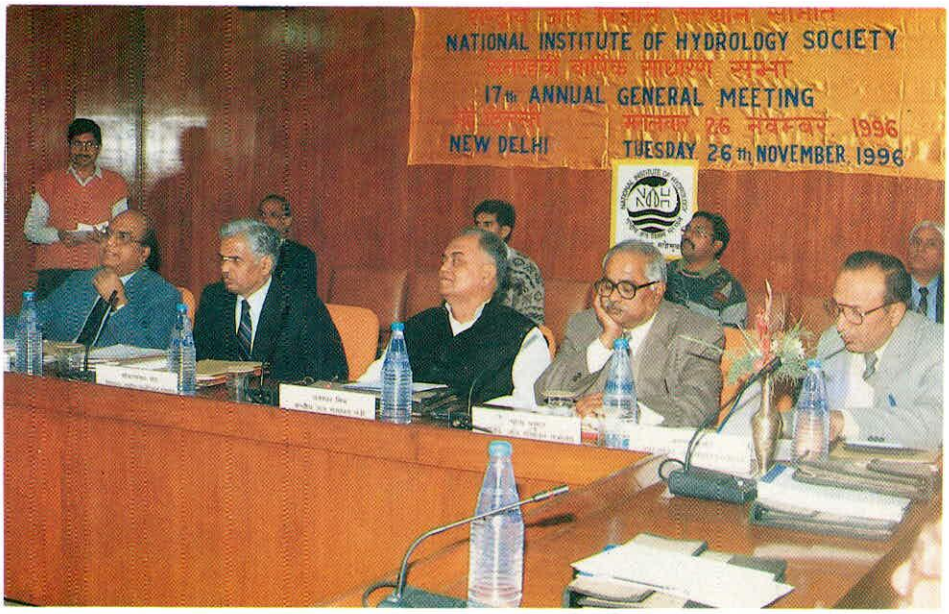
2.3 Standing Committee

The Governing Body has constituted a Standing Committee under the Chairmanship of the Additional Secretary (Water Resources), Government of India, to consider the financial and administrative matters pertaining to NIH. The Standing Committee has the powers to approve the matters referred to it by the Governing Body on behalf of the Governing Body and the decisions of the committee are reported to the Governing Body.

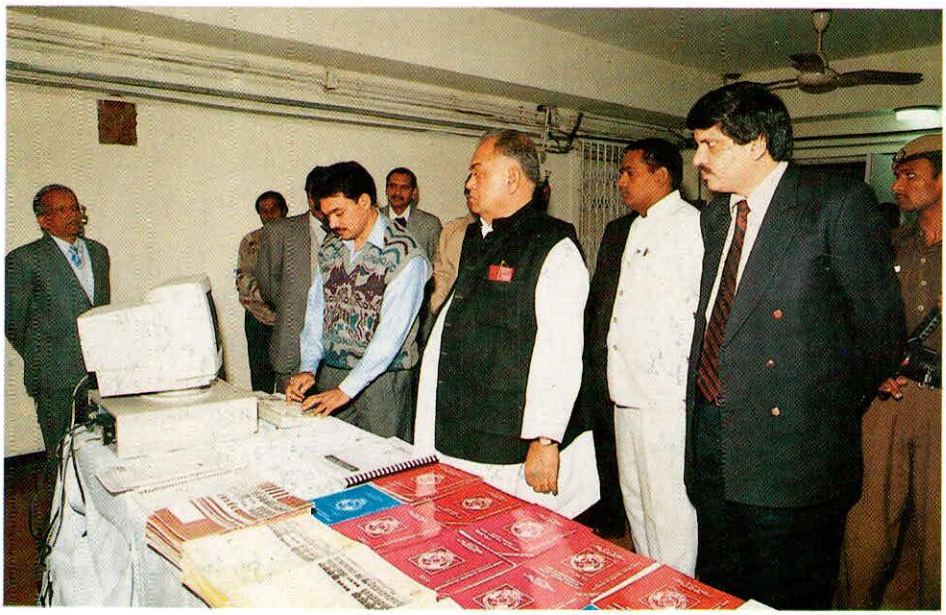
The 23rd meeting of the Standing Committee of the Governing Body of NIH was held at New Delhi on August 26, 1996. A number of issues pertaining to administrative financial matters and career prospects of staff were discussed and decisions were taken.

2.4 Coordination Committee with University of Roorkee

The 20th meeting of Coordination Committee of NIH - UOR was held on June 3, 1996 in University of Roorkee. The committee reviewed the progress of scientific interaction between the Institute and various departments of the University. The Committee was also apprised of the progress of construction activities of the NIH campus and the NIH Staff Colony undertaken by UOR as deposit work.



Seventeenth Annual General Meeting of NIH Society in progress.



Shri Janeshwar Mishra, Hon'ble Union Minister of Water Resources and President of NIH Society being shown around the exhibition on the occasion of the NIH Society Meeting at New Delhi.

2.5 Technical Advisory Committee

The Technical Advisory Committee (TAC) carries out technical scrutiny of research programmes of the Institute and recommends priorities. It is also responsible for carrying out technical scrutiny of plans drawn up for five years and the individual schemes submitted for external assistance and expansion of the Institute. The constitution of TAC, as revised in March 1996 is given in Appendix III.

The 36th meeting of TAC was held on March 3 1996 at New Delhi. The progress of work programme of the Institute for the year 1996-97 was reviewed at this meeting and work programme for the year 1997-98 was considered and approved.

2.6 Working Groups

The Working Groups consider and advise the Institute on the programme of studies to be taken up by the various scientific divisions and review the progress of work. The reports prepared by the divisions are sent to the concerned Working Group members and other experts for their comments and suggestions and after suitable inclusion of these suggestions, the reports are printed and circulated to user agencies.

There are three Working Groups for the Institute namely

(i) Surface Water Group which deals with the following divisions :

Surface Water Analysis and Modelling, Flood Studies, Hydrologic Design, Mountain Hydrology, Atmospheric Land Surface Process Modelling, Watershed Development, and Water Resources System divisions.

(ii) The Groundwater Working Group deals with :

Groundwater Assessment, Groundwater Modelling and Conjunctive Use, Drainage, Drought Studies, Environmental Hydrology and Lake Hydrology divisions.

(iii) The Hydrological Observation and Instrumentation Working Group deals with :

Hydrological Investigations, Hydrological Information System, Nuclear Hydrology, Hydrological Instrumentation and Remote Sensing Application divisions.

Experts in specialised fields from various field organisations (from Central and State Governments) and academic institutions are members of the Working Groups. The constitution of the three Working Groups is given in Appendix IV.

The 6th meeting of the Working Group for Surface Water Group of Divisions was held on December 30, 1996 at Roorkee. The 6th meeting of the Working Group for Ground Water Group was held on December 24, 1996. The 6th meetings of the Working Group for Hydrological Observation and Instrumentation Group was held on December 17, 1996. During these meetings each Working Groups reviewed the progress of studies and research under the work programme for the year 1996-97 for the divisions under the group, scrutinised the work programme of the Institute for the year 1997-98 and made recommendations for consideration/approval by the Technical Advisory Committee.

2.7 Regional Coordination Committees

To ensure effective coordination between the regional centre and the various academic and field organisations engaged in water resources research and development and to advise the regional centre in all technical and scientific matters, the Society has approved constitution of a Regional Coordination Committee for each Regional Centre.

Regional Coordination Committees for each of the six Regional Centres of the Institute at Belgaum, Guwahati, Jammu, Kakinada, Patna and Sagar have been constituted. Experts from field organisations and academic Institutes of the region covered by the Regional Centre are members of the Regional Coordination Committees with Director, NIH as its Chairman. The membership of the 6 Regional Coordination Committees is given in Appendix V.

The 8th meeting of Regional Coordination Committee (RCC) for Deccan Hard Rock Regional Centre,Belgaum was held on 24 October 1996 at Belgaum; the 6th meeting of RCC for Ganga Plains Regional Centre at Patna was held on September 6, 1996 at Patna; the 7th meeting of RCC for Western Himalayan Regional Centre, Jammu was held on 13 March, 1997 at Jammu; the 6th meeting of RCC for North East Regional Centre, Guwahati was held on September 3, 1996 at Guwahati; and the 6th meeting of RCC for Deltaic Regional Centre at Kakinada was held on August 27, 1996 at Kakinada, and 7th meeting of RCC for Deltaic Regional Centre at Kakinada was held on March 25, 1997 at JNTU, Hyderabad.

2.8 Indian National Committee on Hydrology (INCOH)

The Indian National Committee on Hydrology (INCOH) was constituted by the Ministry of Water Resources in the year 1982. It is an apex body with the responsibility of coordinating the various activities concerning hydrology in the country. The committee has Chairman, Central Water Commission as its Chairman with members drawn from Central, and State Governments as well as experts from academic and research organisations besides a few members drawn from non-governmental professional associations. The committee gets a feed back from states and coordinates activities at state level through state coordinators. The Secretariate of INCOH is with NIH. The committee has successfully fulfilled its role and made important contributions for hydrological activities in the country during the past 15 years.

The committee has two expert panels on Surface Water including Water Resources System and Ground Water including Water Quality assisting the committee in preparation of state-of-art reports in thrust areas of research in hydrology and in identifying thrust areas of research for taking up systematic studies under Grant-in-aid scheme of MOWR. The INCOH has three sub-committees to look after :

(i) publications of INCOH,

(ii) providing support to seminars, courses and workshops, and

(iii) for initiating, considering, coordination and monitoring of research schemes of MOWR.

The INCOH normally meets twice in a year. The meetings of each panel and sub-committee also take place twice a year. In all there are about 10 meetings a year. During the year 1996-97, the INCOH held one meeting on June 7, 1996 at New Delhi, and took important decisions regarding coordination of hydrological activities in the country. In this meeting, the progress of on-going research projects was also discussed.

The Committee sponsored 28 seminars/ symposia during the year. Out of these, 2 activities were of international nature. The Eighth National Symposium on Hydrology with the focal theme of "Coastal Hydrology" is proposed to be organised at Calcutta during 11-12 April, 1997. One meeting of Research Committee was held on 6 Dec. 1996 wherein decisions were taken to recommend the research projects for funding by Ministry of Water Resources. Nine state-of-art reports were prepared and released.

During last year, the programme of IHP-V (1996-2001) of UNESCO was received by the Secretariate. The Secretariate had sent copies of IHP-V document to all the members of INCOH, requesting their participation in the programme.

Director, NIH was elected as one of the Vice-Chairpersons of IHP Bureau for representing Asia Pacific Region and chaired one Session of the IHP Council. This is the first time since launching of IHP by UNESCO in 1975 that India has this honour of being represented on the Bureau as Vice-Chairperson for IHP of IGC.

2.9 Asian Regional Coordinating Committee on Hydrology (ARCCOH)

Among various recommendations made at the meeting of the IHP National Committee of North, East, Central and South Asia in 1977, it was resolved that a committee at Asia level, to be named as Asian Regional Coordinating Committee on Hydrology (ARCCOH), be formed for ensuring regional cooperation within the framework of the IHP/UNESCO. It was also resolved that

Government of India be requested to provide secretariate to ARCCOH. Upon such a request from the UNESCO, the Government of India agreed to provide secretariat to ARCCOH through secretariate of the Indian National Committee for IHP, now named as the Indian National Committee on Hydrology (INCOH) with secretariate at NIH.

The Secretariate has been bringing out a quarterly newsletter for the last 9 years. The newsletter includes the news concerning the hydrological activities in the region and also includes the activities performed by the member countries. The newsletter also carries information about the various International Conferences/ Seminars/Symposia and Courses etc. To a limited extent new developments and new publications brought out in hydrology are also listed. The newsletter is circulated to all the member countries in the region (Indonesia, Japan, The Republic of Korea, Democratic People's Republic of Korea, China, Malaysia, Papua New Guinea, Philippines, Thailand, Bangladesh, Burma, Afghanistan, Islamic Republic of Iran, Republic of Maldives, India, Nepal, Mongolia, Sri Lanka, Pakistan, Bhutan,) and to about 600 other organisations in the country and abroad. Besides bringing out of the newsletter, the committee also interacts with UNESCO for Major Regional Projects and other related activities. The activities of ARCCOH Secretariat progressed satisfactorily during the year 1996-97.

3.0 Research and Development Activities

During the IXth Plan period, following thrust areas/ specific problems are to be taken up by the Institute for R&D activities :

- Disaster studies including droughts and floods
- Reservoir operation and real time forecasting
- Lake and reservoir sedimentation studies
- Watershed development studies
- Snow and glacier studies
- Hydrologic studies modelling (surface water, ground water, and water quality)
- Water yield (surface water and ground water)
- Water balance
- Conjunctive use of surface and ground water
- Artificial recharge and water conservation
- Urban hydrology
- Risk based hydrological design including dam break problems
- Optimization and simulation studies for water resources planning and management
- Hydrological instrumentation & hydrological data processing
- Impact of environment/climate change on hydrological parameters
- Waterlogging and drainage (surface water and ground water)
- Hydrodynamics and hydrochemistry of water bodies
- Hydrological soil classification and soil erosion
- Investigation for project planning including remote sensing and GIS techniques
- Investigation for ground water prospecting including nuclear techniques
- Geomorphological studies

3.1 Scientific Activities

During the year under report, studies and research were carried out under the 18 problem oriented scientific divisions at the Headquarters, Roorkee and at the six Regional Centres of the Institute. The 18 Scientific Divisions are :

- Hydrologic Design
- Surface Water Analysis and Modelling
- Flood Studies
- Mountain Hydrology
- Ground Water Assessment
- Ground Water Modelling and Conjunctive Use
- Drought Studies
- Drainage
- Water Resources System
- Environmental Hydrology
- Atmospheric Land Surface Process Modelling
- Lake Hydrology
- Nuclear Hydrology
- Hydrological Investigations
- Hydrological Instrumentation
- Hydrological Information System
- Remote Sensing Applications
- Watershed Hydrology

The programme of studies and research as proposed by the Institute for each of the divisions for the year 1996-97 was considered by the working groups and approved by the TAC. Some of the important areas of studies & research taken up during 1996-97 are :

- Software development for design flood estimation
- Development of regional flood frequency relationship
- Dambreak studies
- Development of models for snow and rain-fed basins
- Glacier studies
- Snow cover mapping using satellite data
- Data storage and retrieval system for hydrological data
- Reservoir operation policy
- Estimation of seepage from a canal
- Analysis of flow to a multiaquifer well
- Regional low flow analysis
- Ground water droughts
- Two dimensional unsaturated flow
- Transport of pollutants
- Ground water quality studies
- Water quality monitoring network
- Nainital lake studies - application of isotopic methods
- Compilation of hydrologicl information
- Development and testing of hydrologic and hydrometeorologic instrumentation
- Application of nuclear techniques
- Soil erosion assessment by GIS techniques
- Distributed hydrologic modelling using remotely sensed data
- Application of Geographical Information Systems (GIS) for hydrologic modelling

Brief description of some of the important studies is given below :

i. Relationship between Frequency of Rainfall and Frequency of Flood for a Catchment of Upper Narmada and Tapi Subzone-3(c)

Relationship between frequency of rainfall and frequency of flood has been studied for a catchment defined by Bridge No.253 of the Upper Narmada and Tapi Subzone 3(c) using various methods involving frequency analysis of rainfall and frequency analysis of peak floods computed from the annual maximum excess rainfall of design storm duration. The analysis has been carried out based on available (somewhat limited) rainfall data. It is seen from the results that the floods are under estimated by about 5% for the return periods of 2 to 200 years by frequency analysis of floods as compared to the frequency analysis of rainfall.

The flood estimates have also been compared with the regional flood frequency methods used in the study, viz. SREV1, SRGEV and SRWAKE based on 'at site and regional data'; and RGEV method based on 'regional data' alone. Flood estimates obtained by these methods show a deviation of -5.4% for SREV1, 0.4% for SRGEV, -1.4% for SRWAKE and 7.5% for RGEV methods for the return period of 50 years. Percentage deviations for flood estimates by the SRWAKE method, for the return periods of 50, 100 and 200 years are -1.4%, 1.2% and 2.8% respectively; which show that the flood frequency estimates obtained by SRWAKE method are very close to the flood frequency estimates obtained by the method based on frequency of rainfall [RAIN(CS)].

While conducting sensitivity analysis, when peak of the regional unit hydrograph is increased by 20%; the flood estimates for 2 to 200 return periods increase with respect to flood estimates computed with actual peak of the unit hydrograph by 11.5% for RAIN(CS) and 10.5% for FLOD methods. When peak of the regional unit hydrograph is decreased by 20%, the flood estimates decrease by 14% for RAIN(CS) and 13% for FLOD method.

ii. Development of Regional Flood Frequency Relationships and Flood Formulae for various sub zones of zone-3

A comparative regional flood frequency study has been carried out using annual maximum peak

flood series data of the small to medium size catchments defined by the bridge sites for the seven hydrometeorological subzones of zone 3. Extreme value type-I (EVI) distribution, following modified USGS method as well as probability weighted moments (PWM) fitting method; General Extreme Value (GEV) and 5 parameter Wakeby (WAKE) distributions fitted by PWM, utilizing :

(i) at site data,

(ii) at site and regional data combined, and

(iii) regional data alone,

have been considered. The homogeneity of the various subzones has been tested by the USGS homogeneity test. A regional relationship between mean annual peak flood and catchment area has also been developed for each of the subzones for computation of mean annual peak floods for the ungauged catchments.

Descriptive ability of the various methods has been tested based on the goodness of fit criteria viz.

(i) average of relative deviations between computed and observed values of annual maximum peak floods (ADF),

(ii) efficiency (EFF) and

(iii) standard error (SE).

Performance of various methods has also been evaluated based on the predictive ability criteria viz.

(i) bias (BIAS),

(ii) root mean square error (RMSE), and

(iii) coefficient of variation (CV)

computed from samples of different sizes drawn from generated EVI, GEV and WAKE populations by considering 1000 replications of the computation procedure for each sample size. The data of two catchments in each subzone viz second smallest and second largest in size have not been used for estimation of parameters of the flood frequency distributions as these catchments have been treated as ungauged for computing the at site mean annual peak flood values and testing the predictive ability of the various methods. The regional flood frequency curves have also been developed for the combined zone 3 considering the mean annual peak flood data of the 101 bridge sites out of total 115 bridge sites of the 7 subzones in combined form. Effect of regional heterogeneity is studied by comparing the growth factors of various subzones and combined zone 3.

The relationship between mean annual peak flood and catchment area for each subzone has been coupled with respective regional flood frequency curves of the GEV distribution, and regional flood formulae have been derived for the various subzones and combined zone 3. The developed regional flood formulae have also been expressed in the form of Dicken's formula and revised Dicken's coefficients have also been computed. For estimation of floods of different return period for gauged catchments, the regional flood frequency curves developed for each subzone together with at site mean annual peak flood may be used; while for ungauged catchments, the regional flood formulae developed for the respective subzones may be adopted.

iii. Flood Estimation for Large Catchments Using Deterministic Approach Package

Flood estimation is one of the most important components of water resources project planning, design and operation. Unit hydrograph theory may be used to estimate the flood for the small catchments up to the size of 5000 sq. km. with reasonable accuracy. However for the catchments having area more than 5000 sq. km. the principles of unit hydrograph cannot be applied considering catchment as a single unit. A network model could be developed wherein the flood hydrograph is computed for each sub-catchment and the combined contributions from each sub-catchment are routed through the respective river reaches using an appropriate flood routing techniques to estimate the flood for the large size catchment.

An interactive software package incorporating such aspects through options for various methods of flood routing and unit hydrograph derivation has been prepared by the Institute. The package also includes options for calibration of unit hydrograph parameters for the various sub-catchments and for calibration of routing parameters for different river reaches from the historical records. A user manual describing in brief methodologies adopted for various options for

demonstrating the applications of the software package for the various options with the help of illustrative examples alongwith sample input and output is being finalized.

One of the main feature of the package is availability of online help on any option selected at any stage.

Any particular option selected leads to execution of that option. The option can be executed either by selecting the data file from the list of data files which are displayed on the VDU or can be executed directly. In the later option, data and result file's name are to be supplied by the user. Provision is also made for crating, editing, viewing, deleting, renaming or plotting of a file. For the options where is is appropriate to create a plot file, it is created and its name is displayed during the execution of the programme. It can be viewed under the plot option of the package.

To create a data file for flood estimation for large catchment, interactive screen is displayed which asks the user to supply the information step by step, needed for the creation of full set of information for the catchment network. This package also provides for naming a working directory so as to facilitate smooth working and keeping the result and data files in a separate directory.

This software can be easily installed on any IBM compatible MS-DOS microcomputer, with at least a 80286 processor, 640 Kb core memory. Option for either color or monochrome monitor selection, depending on the availability in computer, has also been made.

iv. Development of a conceptual model for snow, glacier and rain fed catchments

Streamflow in the rivers originating from the Himalayas comprises of the contribution from rain, snow and glaciers. A substantial contribution to flow is derived from snow and glaciers into these rivers. Each component of streamflow plays important role in the management of water resources including reservoir operation and streamflow forecasting. To understand the hydrological behaviour of the Himalayan basins, an understanding of rainfall-runoff, snowmelt and glacier melt processes is required. Topographical influence on precipitation distribution is another important problem in the Himalayan basins and further adds to the complexity of the hydrological modelling of these basins. It has been pointed out that energy balance approach cannot be adopted for the estimation of snow and glacier melt in the Himalayan basins because data required for application of such methods are not available. In the present work, keeping in view the sparse network, availability of data and topography of the Himalayan basins, a structure of a simple conceptual model is proposed. The model is based on the area-elevation characteristics of the basin and utilizes the relationship describing temperature lapse rate and orographic precipitation distribution. Because there is difference in the melt rate of snow and ice under the same environment, therefore, separate computation of snowmelt runoff and glacier melt runoff are suggested. The contributions from various sources is added together and accounting of losses is made. The routing of surface and sub-surface flow is proposed using concept of linear cascade reservoirs. The structure of the model is described and details of associated hydrological processes and parameters to be adopted for such a model are discussed.

v. Melt Water Storage Characteristics of the Dokriani Glacier

Basic characteristics of the glacier melt runoff including melting conditions in the accumulation and ablation areas of the glaciers are described. A detailed review of the storage and drainage delaying characteristics of the glacier is presented. In order to study the storage and delaying behaviour of the Dokriani glacier, continuous streamflow measurements were made near the snout of this glacier. Selected fair weather hydrographs were analysed. It was observed that in about mid July maximum glaciermelt runoff near the snout was recorded between 1800 and 1900 hours whereas minimum flow was obtained between 0700 and 0800 hours. The mean travel time of melt water from ablation area was determined to be about 5-6 hours.The time-lag for the melt water from the accumulation area would be several times higher than this time-lag. Baseflow varies very slowly in comparison to the diurnal flow from the glacier. The value of ratio of

maximum and minimum streamflow from the glacier varied between 1.40 and 1.50 indicating considerable runoff during the night time also. Impact of changes in accumulation and ablation area on the hydrological response of the glacier is also discussed.

vi. Users' Manual for Estimation of Seepage from a Canal

The seepage from a canal, which is hydraulically connected with an aquifer, is governed by the difference between the hydraulic head at the canal periphery and the hydraulic head in the aquifer in the vicinity of the canal, the hydraulic conductivity and anisotropic characteristics of the porous medium in which the canal runs, canal cross section, and geohydrological boundary of the aquifer. Considering the fact that influent seepage from a canal is zero for zero potential difference and a finite quantity for infinite potential difference, the relationship between influent seepage and potential difference has to be non-linear. A non-linear relationship between influent seepage and potential difference has been proposed by Rushton and Redshaw. In this user manual, the two parameters of the non-linear relation for influent seepage have been derived in terms of reach transmissivity constant, hydraulic conductivity, width of the canal at the water surface, and maximum depth of water in the canal. Using this manual unsteady influent seepage from a canal in a homogeneous isotropic aquifer of infinite areal extent can be computed. Some specific result has been presented in nondimensional form. The data required for the computation are :

i. canal cross section,

ii. maximum depth of water in the canal,

iii. depth to water table,

iv thickness of aquifer,

v. hydraulic conductivity and

vi. storage coefficient.

The results presented in the manual show that the seepage rate from unit wetted surface area of a canal depends on width of the canal and can not be taken as one unique value as being assumed currently. The seepage rate from unit surface area for canal of small width is higher than that from a canal of larger width, all other parameters remaining same. The other governing factor is the potential difference which needs to be considered during computation of seepage.

vii. Analysis of Flow to a Multi-Aquifer Well : A Numerical Approach

Existence of multi-aquifer system are common in a sedimentary basin. A well drawing water from more than one aquifers that have good quality of water, increases the yield of the well and in most of the cases is economical. In most of the studies done so far, pumping from only one layer has been considered. In very few analytical studies, pumping from more than one aquifer has been dealt.

In the present study, unsteady flow towards a fully penetrating well screened in both the aquifers of a two-aquifer system separated by an aquitard has been analyzed. The aquifers are considered to has different hydraulic characteristics. A three dimensional groundwater flow model developed by USGS has been used to generate the unit pulse coefficients. Utilizing these unit pulse coefficients, methodology has been developed for obtaining the contribution of each aquifer and drawdown in the aquifer.

viii. Numerical Algorithm for two Dimensional Unsaturated Flow

'Unsaturated flow' in soils is the flow occurring through the pore spaces which are not completely filled with flowing fluid. Actual field conditions under which unsaturated flow occurs, are difficult to be expressed in mathematical term. These conditions are

i. heterogeneous character of soil,

ii. variation in the degree of saturation,

iii. variation of hydraulic conductivity with degree of saturation, etc.

The partial differential equation describing the unsaturated flow, even in idealized case of homogeneous soil, is badly nonlinear, and the analytical solution for one dimensional case is not available. Hence, numerical techniques have been used by many investigators for the solution of one

dimensional problems. In actual situation, the unsaturated flows are mostly two dimensional. Very few attempts have been made towards the solution of two dimensional problems. These solutions lacks verification on field/laboratory data.

In this study, a numerical algorithm for solving the two dimensional unsaturated and unsteady flows in soils has been developed.

ix. Development and Verification of Regional Low Flow Equation for Middle Narmada

The term low flow is broadly used to describe stream flows that are significantly below average or below normal flow levels. Reliable estimation of low stream flows is necessary to investigate drought characteristics of the basin and to describe the capability of a stream to supply requirements for river navigation, municipal and for industrial supplies, liquid water disposal, irrigation and maintenance of suitable conditions for aquatic life. The important characteristics in the study of low stream flow are the magnitude, frequency and duration. Regional models are developed relating the flow characteristics with climatological, hydrogeological and morphological factors for estimation of low flow characteristics for ungauged sites.

In this study, a regional hydrological model has been developed for estimating low flow characteristics at ungauged sites of Narmada basin using climatological, hydrological and morphological variables. The model is developed by relating the low flow characteristics with other variables of nine sub-basins of Narmada. It is seen from correlation analysis that the variables like drainage area, slope of maximum stream length and percentage clay in soil could be the prime independent variables which could be related to the flow characteristics. Normal monsoon and non-monsoon rainfall did not show the correlation with ten day flow duration characteristics. Mean annual minimum flow characteristics of flow indicated the correlation with base flow index and the rainfall of December month. Factor analysis indicated the highest ranking of the independent variables in the model are drainage area followed by slope of maximum stream length and percentage clay in soil the model showed the adjusted coefficient of determination greater than 0.95. The mean annual minimum flow model indicated the highest ranking of base flow index followed by rainfall of December month. The models explains the adjusted coefficient of determination greater than 0.91. The verification results of both the flow characteristics are also studied.

x. Studying the Characteristics of Ground Water Droughts Using Kriging Method

Ground water drought events are derived by taking a truncation level through the periodic records of ground water depth. An increase of truncation level means decrease in the availability of ground water at a well site, the truncation level can be used to reflect the severity of a ground water drought.

It is of interest to investigate whether a given drought at a certain level of severity will be prolonged and advance to the next higher levels of severity. The conditional probability that a drought occurring at a truncation level will advance to higher truncation level is estimated to express the property of drought severity.

The regionalization analysis has been conducted assuming that the conditional probabilities estimated at selected well are regionalized variables. Contour lines of conditional probabilities for each truncation level were constructed to express their spatial variability in the region.

xi. Automated Mapping of Snow Cover Using IRS-1C data

Snow is an important phase of the hydrological cycle and is of much importance in India because of the presence of mighty snow clad Himalayas. A number of models have been developed for simulation and forecasting of snowmelt runoff. Data requirement of these models is quite high and conventional ground measurement in snow covered areas can not meet these requirements because of various shortcomings like frequency of observations, point measurement not representative of large areas, hostile climate conditions and inaccessibility of areas. Since last two decades, remote sensing techniques have offered excellent synoptic and

repetitive overviews in various spectral channels of electromagnetic spectrum which has served as a spatial data base for snow related studies.

The Indian Remote Sensing Satellite, IRS-1C was launched in the year 1995. The LISS-III sensor of this satellite has higher spatial resolution, i.e. 23.5 m. In addition, a spectral channel in the wavelength range 1.55 - 1.8 um has been added in the sensor while the channel below 0.52 um has been dropped. The new channel is highly useful for discriminating snow covered areas from clouds. In the present study, the information of the new channel has been utilized for determining the snow cover area in the Spiti sub-basin of the Satluj river basin. A procedure, developed by Dozier has been utilised for automated mapping of snow cover area in a basin. It is found that the Dozier's algorithm is highly useful for the remote sensing data of LISS-III sensor. However, it was observed that because of the deficiency of satellite information below 0.52 um, it is not possible to directly identify snow in shadowed areas of mountains or clouds. Digital Elevation Model (DEM) for the area has been developed and an indirect way of predicting snow is shadowed areas and areas under cloud cover have been suggested.This method is based on the combined use of digital image analysis techniques (Proximity analysis) and the DEM.

xii. Operation Policy for Tawa Dam

Simulation models are used to represent a system and to predict the behaviour of the system under a given set of conditions. Simulation models are limited to predicting system performance for a user specified set of variable values. An optimization procedure may involve iterative executions of a simulation model, with the iterations being automated to various degrees.

In this study, rule curves based policy has been adopted for the conservation regulation of Tawa dam. Rule curves are developed for three levels such as upper rule level, middle rule level (critical for irrigation), lower rule level (critical for water supply and upstream use). The generalised simulation model (NIH model) developed by Water Resources System Group is used to simulate the system operation and to refine the rule curves. A number of simulation runs have been carried out by adjusted rule curves and the final rule levels have been arrived to satisfy the target demands to the maximum extent possible. The current operating policy (SLOP) is also simulated and the results are compared with the optimized rule curves based policy.

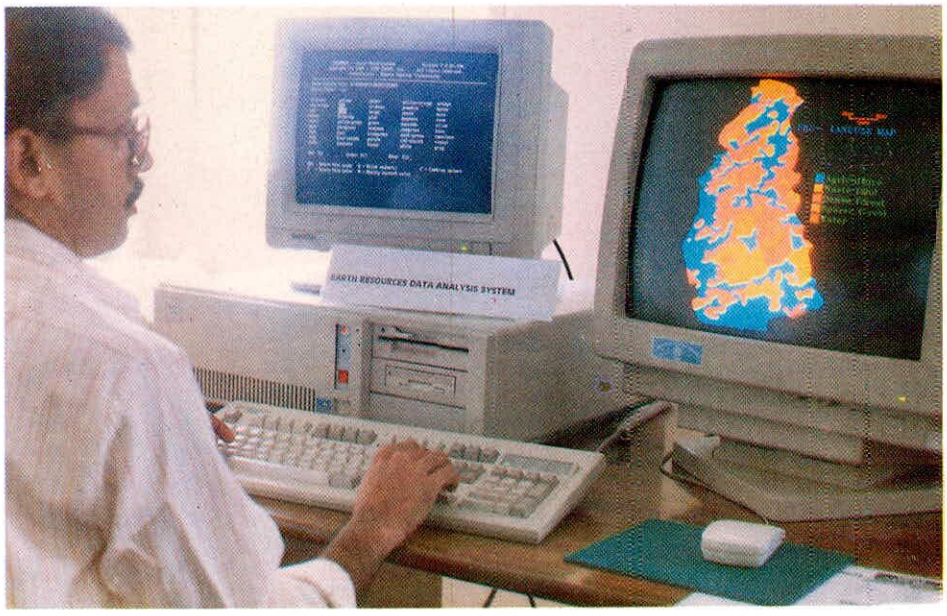
xiii. Water Quality Monitoring Network Design of Narmada River Basin

Assessment of water quality conditions over a wide area with respect to time and space requires a monitoring activities to be carried out in a network. The location of a permanent sampling station is probably the most critical factor in a monitoring network which collects water quality data. If the samples collected are not representative of the water mass, the frequency of sampling as well as the mode of data interpretation and presentation becomes inconsequential.

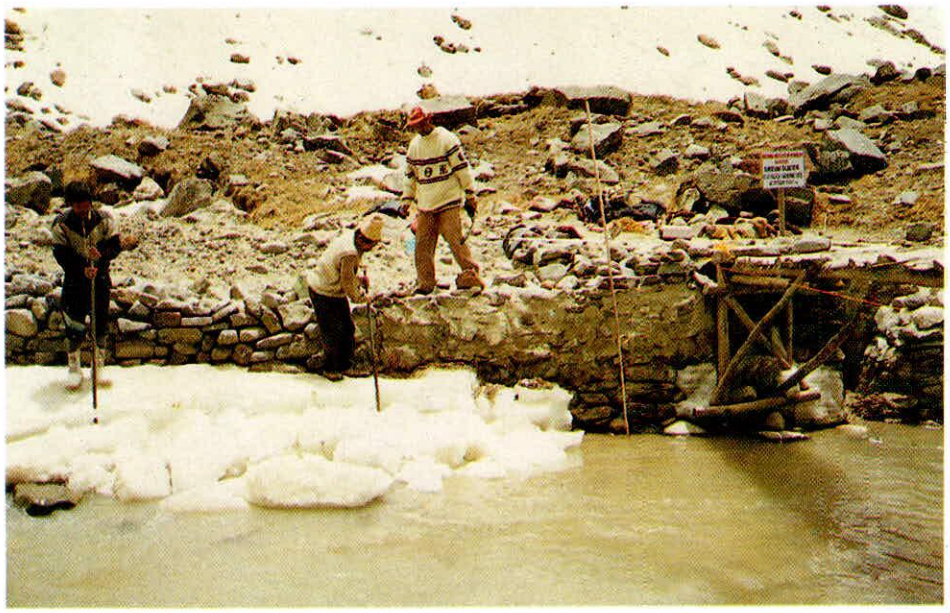
Besides the economic considerations, there are three levels of design criteria of sampling station location. The macrolocation deals with river reaches in the river basin, the specific features within a river reach and the third level deals with the representative location points within a rivers' cross-section. The Sharp's procedure which is widely used for selecting locations is used for locating sampling points in the Narmada river basin.

The sequential water sampling sites were identified in the search for a pollution source using four different criterias e.g. tributaries, BOD, NPK and pesticides. Only four levels of hierarchy have been used in the study. However, it was found that for the detection of single pollution source, sampling stations of the seventh level of hierarchies should be used.

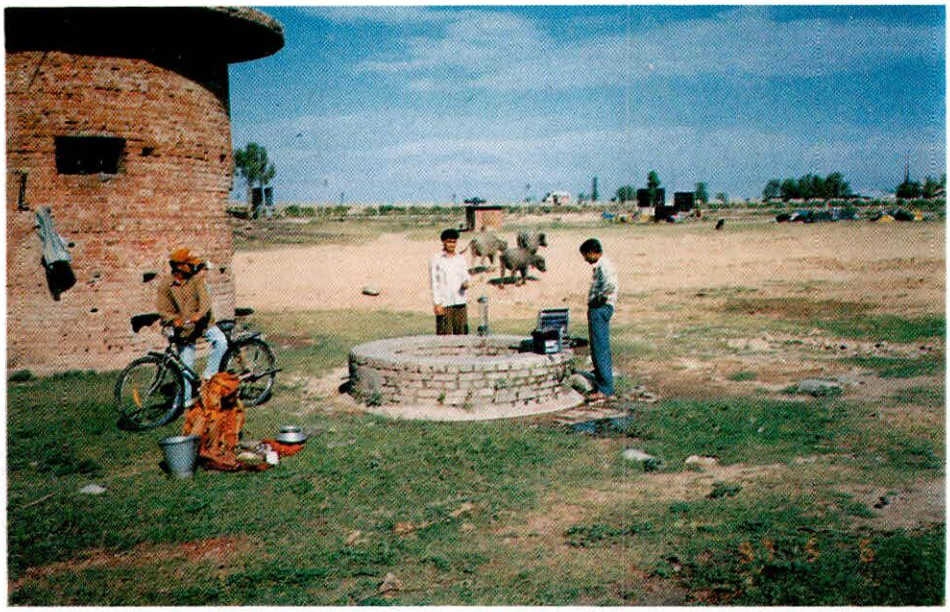
Each of the our networks presented namely tributary, BOD, NPK, and pesticides based differs somewhat but it share a common approach towards the selection of reaches in which to sample. It must be emphasized that locations of sampling stations determined are not to be strictly applied. Therefore, an engineering judgment is required to locate a monitoring site which satisfy most of the technical requirements while minimizing the financial requirements. It is suggested that the proposed monitoring network may be used as guidelines in pin-pointing the appropriate sampling sites.



Scientist working on Geographical Information System Package



NIH Expedition Team to Dokriani Glacier Removing Snow from the Stream for Accurate Discharge Measurement.



Ground Water Quality Monitoring from Shallow Well in Progress.

An Indian Lake infested with Water Hyacinth.

Further, it is observed that the present monitoring sites being monitored under GEMS/ MINARS are self-sufficient as far as the middle and upper basin is concerned. But it certainly needs improvement in the downstream portion of the basin particularly for controlling the pesticides, nutrient related problems in the lower basin having very high pollution loadings of pesticides and NPK.

xiv. Adsorption of Metal ions on Sediments

Adsorption is one of the most important processes in water quality control, it may determine the fate and transport of pollutants in the aquatic environment. The adsorption of lead and zinc ions on the bed sediments of river Kali in western Uttar Pradesh, India has been studied. The role of the coarser sediment fraction (210-250 um) has been elucidated and compared to those of the clay and silt fractions. The parameters controlling the uptake, viz., initial metal ion concentration, solution pH, sediment dose, contact time and particle size have been evaluated. The adsorption and metal ions increases with increasing initial metal ion concentration. The optimum contact time in which equilibrium is attained was found to be 45 min for both the metal ions. The extent of adsorption increases with an increase of pH. The adsorption of metal ions on the sediments follows two phases, a linear phase of adsorption followed by a flat plateau section. Further, the adsorption of metal ions increases with increasing adsorbent doses and decreases with adsorbent particle size. The two geochemical phases, namely iron and manganese oxide, act as the active support material for the adsorption of two metal ions.

xv. Groundwater Quality Evaluation in Doon Valley, Dehradun

The ground water quality of Doon valley, Dehradun has been studied during 1996 to examine the suitability of water for drinking and irrigation purposes. Twelve water samples representing the shallow ground water of the valley were collected during pre-monsoon and post-monsoon seasons and analyzed for various constituents, viz., pH, conductance, total dissolved solids, alkalinity, hardness, chloride, sulphate, phosphate, sodium, potassium, calcium and magnesium. The data was analyzed with reference to BIS and WHO standards, ionic relationships were studied, hydrochemical facies were determined and water types were identified. The results of the study provide information needed for ground water quality management in the valley. The values of sodium adsorption ratio indicate that ground water of the area falls under the category of low sodium hazards. An attempt has also been made to classify the quality of ground water on the basis of Stiff, Piper trilinear and U.S. Salinity Laboratory classifications. As per the Stiff classification, majority of the samples were found to be of calcium bicarbonate type. In the Piper trilinear diagram, majority of the ground water samples of the study area fall in the Ca-Mg-HCO3 hydrochemical facies. As per the U.S. Salinity Laboratory classification of irrigation water, the water is fit for irrigation purpose.

xvi. Study of Sedimentation Pattern of Lake Nainital, district Nainital, Kumaun, UP

The neotectonic Lake Nainital is the only source of drinking water supply to the city of Nainital. Publications in the recent past inferred accelerated sedimentation threatening the very existence of lake. Water balance studies carried out using conventional methods indicate that 40% to 45% of the total volume of water generated due to rainfall in the lake catchment contributes to lake quickly in the form of direct precipitation fall on the lake surface area and surface runoff. Total inflow from Naina Devi drain comes out approximately 1.67 m in terms of depth w.r.t. lake surface area. The total losses of water from the lake due to pumping, evaporation and discharge through sluices are about 41,96,164 m cube in 1994 and 52,79,603 m cube in 1995, which in terms of depth are equal to 9.06 m and 11.39 m in the year 1994 and 1995 respectively. The net balance of subsurface inflow and subsurface outflow has been determined as 2,29,619 m cube in 1994 and 9,76,332 m cube in 1995, which is equal to 0.5 m and 2.10 m depth of water in the lake respectively. This variation in subsurface inflow and outflow is due to variation in amount and intensity of rainfall. These values strongly indicate that the ground water contribution to the lake is a major component.

The predicted life of the lake is between 82 years to 490 years by the earlier investigators

using the bathymetric sounding data, collected manually. In the present study, environmental Pb210 and Cs137 dating techniques have been used to estimate the lake life. Estimated age comes to be 2163 ± 77 years (Cs137) and 2479 ± 312 years (Pb210). Critical analysis of lake sounding data implies that the validity of the data is questionable.Radiometric dating of sediment cores from appropriate areas in lakes/ reservoirs provides precise record of sedimentation rate.

The details of water balance and sedimentation rate/pattern including estimation of life of lake Nainital using conventional and isotopic methods have been discussed in the present report at a great length.

xvii. Water Level Monitoring Devices

Several types of models, right from a simplest one to the very sophisticated water level monitoring devices are available in the indigenously made as well imported. These water level instruments work on different principles and accordingly the sensing and recording devices are used. Now-a-days, the sophisticated water level monitoring instrument consists of a water level sensor, data recording or storing devices and also data transmitting facilities. Keeping in view the importance and utility of water level monitoring device, an effort has been made to compile the information about the different types, principles of use, different indigenous and imported models, present status of use and availability in India as well as abroad, how to use, install, precautions during the use and maintenance including the recommendations to improve the status of these devices in the country, in this report.

xviii. GIS Based Rainfall-Runoff Modelling of a Small Catchment

In this study, application and grid scale sensitivity of TOPMODEL have been undertaken for the Hemavati basin in Karnataka. Digital Elevation maps of watershed at 20, 30 and 50 m grid spacing were prepared to study the grid scale sensitivity of TOPMODEL. The study results indicate that the TOPMODEL can simulate rainfall runoff process of the Hemavati at Sakleshpur reasonably well.

xix. Estimation of Soil Erosion and Sediment Yield using GIS

In the present study, the GIS techniques have been utilized for spatial discretization of a catchment (Nagwa, Bihar) into grids having uniform soil erosion characteristics. For each grid cell soil and land use parameters for RUSLE were determined and stored in digital layers in ILWIS GIS. Surface erosion is then calculated within an individual grid cell using RUSLE procedures by overlay and map calculation (Mcalc) functions available in ILWIS. Next, the eroded sediment is routed to the catchment outlet by rationally accounting for the process of sediment delivery.

3.2 Technical Publications

Based on the studies and research conducted by the various scientific divisions a number of reports have been published under different categories. A number of individuals and organisations have been provided with the reports on request. The list of such organizations is given in Appendix VII. The list of scientific and technical reports prepared during 1996-97 is given in Appendix VIII.a. The list of all publications brought out by the Institute since inception is given in Appendix VIII.b.

The scientists and the scientific staff of the Institute have published a number of technical papers in English and Hindi in the national and international journals. The scientists have also published papers in the proceedings of the national and international seminars and symposia organised in India and abroad. The list of papers published/ accepted for publication during the year 1996-97 is given in Appendix IX.

4.0 Regional Centres

India is a big country with significant diversities in climatic and hydrologic conditions. In order to carry out systematic and scientific studies for solution of the various hydrological problems of the different regions, it is necessary to sub divide the country into a number of homogeneous hydroclimatic regions.

The National Institute of Hydrology after completion of initial phase of establishing itself as a premier Institute in hydrology in the country and after carrying out eight years of fruitful computer and theoretical oriented studies, started to diversify its activities for taking up laboratory and field oriented studies. With this objective in view, the country has been divided into eight hydrological regions. Though it was very well realised that for a country of the size of India, eight regions are also very large geographical units, for the sake of administrative convenience and viability at the beginning it was thought appropriate to establish regional centres for the following eight regions in a phased manner :

i. Deccan Hard Rock Region
ii. West Coast Region
iii. Deltaic and East Coast Region
iv. Ganga Plains Region I Covering rivers north of Ganga
v. Ganga Plains Region II Covering rivers south of Ganga
vi. Arid and Semi-arid Region
vii. Western Himalayan Region and
viii. North Eastern Region

The establishment of three regional centres of NIH during the seventh plan period at Belgaum (Karnataka), Guwahati (Assam) and Jammu (J&K) for the Deccan Hard Rock Region, for the North Eastern Region and for the Western Himalayan Region respectively was approved by Ministry of Water Resources, Government of India. These three centres were established in July 1987, August 1988 and January 1990 respectively.

Realising the need and importance of the Regional Centres, the Government of India approved the establishment of three more regional centres of NIH during the eighth plan period at Patna (Bihar) for the Ganga Plains Region I, at Sagar (Madhya Pradesh) for the Ganga Plains Region II and at Kakinada (Andhra Pradesh) for the Deltaic and East Coast Region. The two centres at Patna and Kakinada were established in June 1991 and September 1991 respectively and the regional centre at Sagar was established in Dec. 1995.

For each of the Regional Centres, Regional Coordination Committees have been constituted to advise on the programme of studies and research, and to ensure effective coordination between the regional centres and the various academic and field organisations of the region who are engaged in water resources research and development.

A brief description of activities of these centres is given in following sections and the list of scientific and technical reports prepared by these Centres during the year 1996-97 is given in Appendix VIII.a.

4.1 Deccan Hard Rock Regional Centre, Belgaum

The first of the regional centres, catering to the problems associated with hard rock areas in the country, was established in 1987 with its office

at Belgaum in Karnataka state. The areas covered under this regional centre include Karnataka, parts of Andhra Pradesh, Tamilnadu, Madhya Pradesh and Maharashtra.

The Regional Coordination Committee and Technical Advisory Committee of the Institute had suggested certain work programme to be carried out by each Regional Centre on long term basis. The areas defined for the Hard Rock Region are as follows :

1. Representative basin studies.
2. Hydrological modelling
3. Development of regional flood formulae
4. Conjunctive use studies
5. Preparation of hydrology year book.
6. Reservoir sedimentation studies
7. Hydrometeorological network improvement
8. Environmental hydrology
9. Watershed development studies
10. Hydrological studies of tanks
11. Drought studies.

Regional Coordination Committee meetings are normally held twice a year subject to the convenience of the host State organisation. Work programme for each year is decided and progress is monitored at these meetings, after discussions with the members, and invited representatives of Central and State Govt. agencies of the hard rock region. During the year one meeting was held on October 24, 1996.

The regional centre over the years has developed fairly good facilities in the areas of remote sensing, water quality analysis, soil testing, and computer related analysis including GIS.

Following studies have been completed during the year :

i. Modelling of an Indian Estuary using 2-Dimensional Finite Element Model (FEM)

FESWMS-2DH, developed by United States Geological Survey (USGS), is a numerical model which uses FEM to solve a system of 2-D hydrodynamic equations to simulate any shallow surface water body. In this study, the model was calibrated and used to simulate the hydrodynamics of Cochin estuary, which lies along Kerala coast, under the combined action of wind, tides and fresh water inflows. Calibration was done using pre-monsoon tide data and the velocity was measured at 11 points in the estuary. Model parameters like roughness coefficient and eddy viscosity were adjusted. Calibrated model was used for pre-monsoon and post-monsoon tides and it was seen that the results are comparable with the observed pattern.

ii. Measurement of Surface Soil Hydraulic Properties for Malaprabha Command Area

Estimation of soil properties for a region is very essential, since the conversion of rainfall to runoff is governed by the soil type and its properties. It also controls the amount of water which recharges the groundwater resources. Major hydraulic soil properties to be evaluated at the soil surface are soil texture, infiltration rate, saturated hydraulic conductivity, soil moisture and retention capacity. In this study, the results of experiments conducted to estimate soil properties in Malaprabha command area which lies in Belgaum and Dharwad districts of Karnataka have been given. Disk permeameter was used to estimate insitu infiltration, conductivity and pore characteristics. Pipette analyses are conducted to determine the soil texture and pressure plate apparatus was used to establish the soil moisture retention curve.

iii. Tank Studies in Belgaum District

Irrigation and water supply tanks are common in Southern India. However, the capabilities of tanks are not optimally utilised. This study has been taken up to analyse the functioning of Rakascope water supply tank, which serves Belgaum town. Distribution of yearly yield has been estimated using Gauss, Log-normal, Gumbel, Pearson type-III distributions and linear, power, logarithmic, and exponential rainfall-yield correlations have been tested to get the appropriate relationship. Some suggestions regarding the optimum use of the tank are also given.

iv. Groundwater Quality Modelling in Nargund Navalgund Area

Groundwater quality scenarios of worst affected region of Nargund-Navalgund area of Malaprabha command are simulated though a three dimensional finite difference code SWIM III. Simulations were carried out for the steady state condition, which can be extended to other areas and transient conditions also, subject to availability of more and more information. The possibility of conjunctive use of groundwater and surface water provides encouraging result.

v. Groundwater Modelling in Ghataprabha Subbasin

In the present study, a three dimensional two layered finite difference model has been generated for Ghataprabha subbasin. Model has been calibrated and validated using USGS Modular Three Dimensional Finite Difference Ground Water Flow Model (MODFLOW). Various existing and proposed groundwater development scenarios have been simulated to recommend solution to ground water problems at selected locations.The model can be used in its present form or with possible future refinement in addressing several groundwater issues of the region.

vi. Analyses of Surface and Groundwater Flow Processes in Western Ghat of Dakshina Kannada District

Dakshina Kannada district is facing acute water problem during the dry season as most of the wells dry up though it experiences as high as 4000 mm of rainfall every year. In this regard effort has been made to find out the reason for the scarcity of water during April and May by the following analyses :

(i) Rainfall-runoff-analysis,

(ii). Groundwater recharge using groundwater balance approach,

(iii). Soil hydrology properties such as permeability, infiltration and soil moisture retention,

(iv). Groundwater level analysis and

(v). Rainfall-runoff modelling

During the year, the scientists and staff of the Regional Centre published/accepted for publication ten papers and attended 6 workshops /training courses.

Dr Lee McDonald, Colorado University, USA visited the centre as UNDP consultant. Dr Bonnel, Unesco Expert, Unesco, Paris visited the centre as Unesco consultant.

Procurement of one Automatic Weather Station has been finalised under the ongoing Unesco sponsored project of Karnataka Forest Department.

4.2 North Eastern Regional Centre, Guwahati

The North-Eastern Regional Centre (NERC) covering the region comprising of seven NE states, Sikkim and Eastern hilly region of West Bengal, was established at Guwahati in August 1988. Since its inception, the centre has been actively interacting with the various water resources organisations in the states covered under the region while carrying out its studies and activities within the frame-work of recommendations of the Regional Coordination Committee for the centre in the areas of representative basin studies, remote sensing studies water quality studies, floods, watershed management etc.

The region is the highest rainfall zone of the country (1000 - 24000mm). Flood is one of the most devastating natural calamities in this region. It is a land of numerous unstable rivers (overloaded with sediments due to severe earthquakes, landslides & erosion), narrow valleys, steep slopes in fragile formations, heavy rainfall with long monsoon season, large hill population, high seismicity. Many such factors which create the problems of flood, drainage congestion and bank erosion, are further accentuated by increasing flood plain encroachment and greater developmental and other activities both in the plains and the hills. Degradation of watershed and deforestation further compound the adverse situation.

Over the years the regional centre, for carrying out the studies and research, has created facilities like Water Quality Laboratory, Soil Laboratory, Remote Sensing Applications

Laboratory and instrumentation and monitoring of small watershed. For basic research, it has also established one representative basin at Dudhnai and various hydrometeorological equipment have been installed in a meteorological observatory. As an important activity, an Automated Weather Station capable of continuously recording automatically ten weather parameters has also been imported from Australia under UNDP project and currently installed at Guwahati (finally to be shifted to representative basin).

The centre has three modern PC machines (one PC 386 and two PC 486). The peripherals include a high resolution monitor for imagery analysis (ILWIS), a digitizer, 2 dot matrix printers and a plotter. It has also one lap top PC 486 for use with Automated Weather Station.

Following studies have been completed during the year :

i. Hydrological Soil Classification of Dudhnai :

Hydrologic soil classification is essential for accurate estimation of runoff. The soil parameters, generally considered in hydrologic analysis are effective soil depth, soil texture, clay contents in surface and sub-surface layers, soil structure in surface and sub-surface layers, infiltration rate, soil permeability and soil drainability. The present study attempts to classify soils of the representative basin Dudhnai based on these parameters determined mostly by field investigations. Statistical methods for analyzing data are also attempted. The study forms a part of overall representative basin studies at Dudhnai.

ii. Implementation of HEC-II Model at Digaru :

HEC-II model is used for calculating water surface profiles for steady gradually varied flow in natural or man made channels. Its computational procedure is based on the solution of the one dimensional energy equation with energy loss due to friction evaluated with Manning's equation. The model capabilities include flood plain management and evaluation of flood way encroachments, assessing the effects of channel improvements and levees on water surface profiles etc. The study has been taken up at Digaru discharge site being maintained by CWC.

iii. Water Quality Monitoring Studies for Greater Guwahati, Pt-2 :

Considering the rapid growth of population and imbalance in eco-system, it has become very important to monitor the quality of ground water for various uses. In this study an attempt has been made to highlight the water quality problems of drinking and irrigation water of Greater Guwahati. The main objective of the study was to see the suitability of water for various designated uses. The water samples of Guwahati District wells were collected and analysed for physical and chemical parameters.

iv. Flood Plain Mapping of Phulbari Area :

A study for mapping flood plain of Phulbari area, one of the acute erosional problem areas around outfall of the river Jinjiram into the Brahmaputra in Meghalaya and Assam was suggested by CWC at the Regional Coordination Committee meeting. Accordingly, the study was carried out with active cooperation of CWC. In this study Indian Remote Sensing satellite data procured from NRSA has been utilised for flood plain mapping of the study area. Ground truth verification was also made in May 1997 in a joint visit with CWC. The results would be useful in supplementing the required information for a much awaited anti-erosion project at Phulbari.

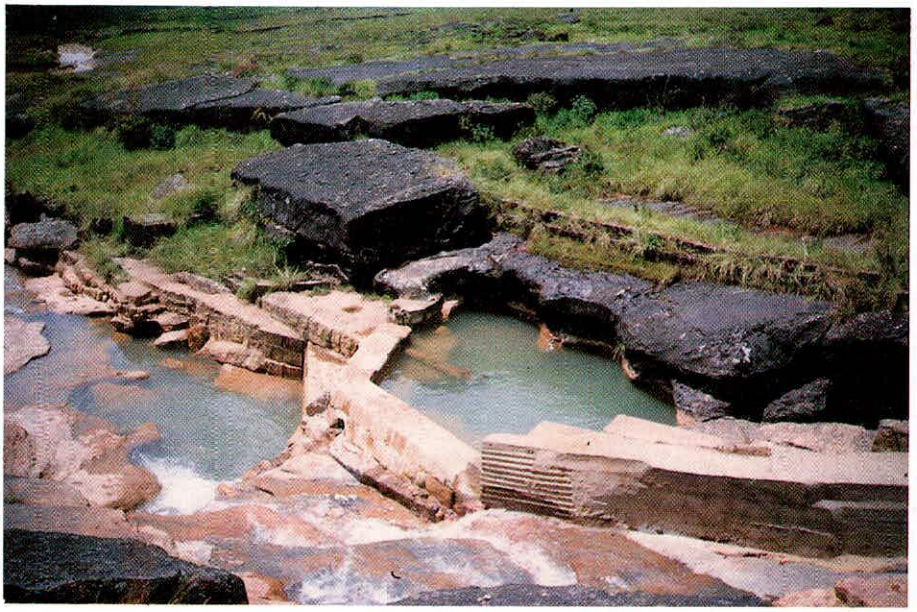
v. Hydrogeomorphological Studies at Digaru Sub-Basin

The study while reviewing the various works and elements about application of quantitative geomorphology in hydrology, attempts to estimate some of the important geomorphological parameters of Digaru sub-basin.

During the year, the scientists and staff of the Regional Centre published /accepted for publication 6 papers and participated in 7 training courses.

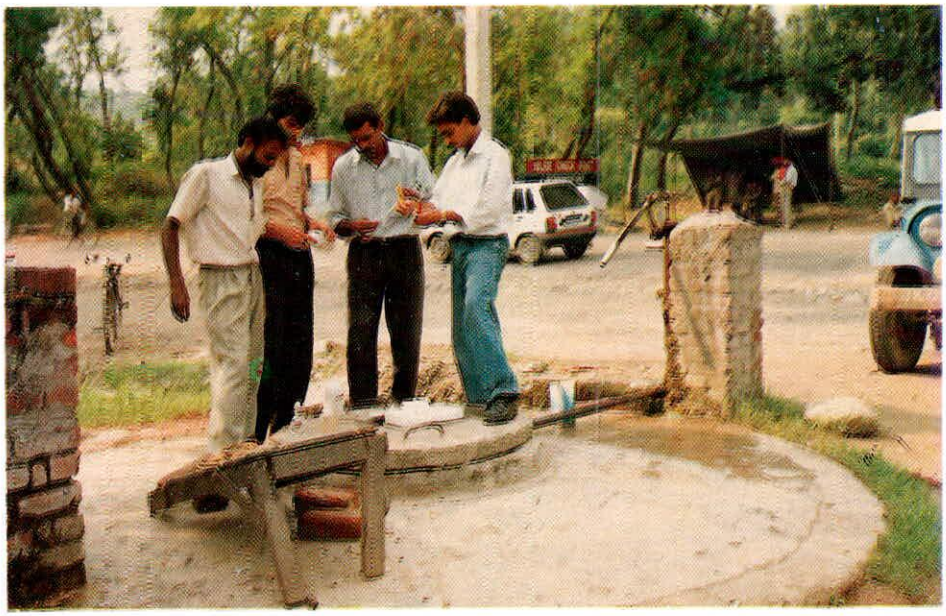
The Sixth Regional Coordination Committee Meeting was held on 3rd September 1996 at Guwahati.

Regional Coordination Committee Meeting of North Eastern Regional Centre in progress.



Water Conservation Technique in vogue in North Eastern Region.

Brain Storming Session Organised by
Western Himalayan Regional Centre of the Institute at Jammu.



Ground Water Quality Monitoring in Kathua District, J&K.

4.3 Western Himalayan Regional Centre, Jammu

The regional centre at Jammu was established in the year 1990. The states of J&K, Himachal and hilly parts of western UP constitute the western Himalayan region. The entire region is marked with steep mountains which largely influence the climate and weather conditions of north west India. The Himalayan mountains in 3 ranges run from Kashmir to the North eastern states. These include the grater, middle and outer Himalayas. The region receives rain and snow during winter and also the south west monsoon. The origin of some of the major river systems like Indus and Ganges lies in the western Himalayas.

The physiography, geology, climate and landuse pattern in western Himalayas have several hydrological problems. The thrust areas of studies and research at the regional centre which have been identified, include :

1. Snow and glacier melt modelling
2. Flash floods during monsoon season
3. Soil erosion and sedimentation in reservoirs.
4. Effects of forest cutting and watershed management
5. Lake hydrology
6. Water quality studies
7. Network improvement and instrumentation
8. Education and training of personnel

Good laboratory and field capabilities have been developed at the centre. These include remote sensing/GIS applications, water quality and soil laboratories. In the water quality lab. about 16 parameters such as conductivity, dissolved oxygen, Biochemical Oxygen Demand, Ph, Total Dissolved Solids, temperature, turbidity etc. can be measured. The remote sensing applications lab. includes a FCC printer, digitizer and Erdas/GIS system. The soil lab. includes permeameters, neutron probes, tensiometers, sieve shakers and infiltrometers. An automatic weather station (since 1995) and a manual hydrometeorological observatory (since 1992) have been set up at Tissa (HP) as a part of representative basin studies.

During the year following studies were carried out :

i. Soil Physico-chemical Analysis of Basantar Catchment, J&K :

Based on land use pattern the Basantar Catchment was divided into four categories, i.e. barren, forest, grass and agriculture. The soil samples were collected at eleven locations from each land use category and the samples were analysed for specific gravity, permeability, porosity, moisture content, organic matter, percent carbon, EC, pH at the Regional Centre's soil laboratory. Moisture retention capacity of soil at various pressures (1/3, 1, 3, 5, 11 bar) using pressure plate apparatus and grain size distribution of soil by mechanical sieve analysis were conducted. Infiltration tests were also carried out at all these landuse categories using double ring infiltrometer. The results have been compiled in the form of a report.

ii. Impact of Industrial Effluent of Ground Water Quality : A case study of Balal Nalla, Near Jammu, J&K :

This study involves temporal monitoring of the water quality in the Nalla and adjoining wells. In this context, detailed field survey of the Nalla cross sections and well locations were carried out. Monthly water sampling has been carried out from the selected wells as well as from Balal Nalla for physico-chemical analysis (e.g., temp., pH, EC, TDS, hardness, Ca, Mg, Na, K, HCO3, Cl, SO4, NO3, Po4, F). In order to monitor contamination in ground water wells due to effluent flowing in the Nalla, a questionnaire was prepared and a survey was also conducted to identify the health problems of the people who are using water for domestic purpose. The study has provided useful informataion on water quality in the region.

iii Variation of Ground Water Quality in Jammu and Kathua District, J&K :

This study was continued on similar lines as in the previous years. During this year, sampling sites were reduced to 37 from 54 and water sampling was carried out for premonsoon and postmonsoon periods. Physico-chemical analysis

(e.g., temp.,pH, EC, TDS, hardness, Ca, Mg, Na, K, HCO3, Cl, SO4 , NO3, PO4, F) of water samples was carried out using standard methods. The suitability of water of the wells was evaluated for domestic and irrigation purposes.

iv. Water Quality Monitoring and Evaluation of Mansar Lake, J&K :

During this year, water samples were collected to monitor depth wise variation in water quality of the lake. The sampling was done quarterly using standard water sampler. Various physico-chemical parameters were determined using standard methods to evaluate lake water quality and its fitness for domestic and irrigation purposes. Dissolved oxygen and bio-chemical oxygen demand were also determined. This year, sudden fish mortality was noticed in the lake during winter and this phenomenon has attracted attention of other agencies also to find possible reasons of the fish mortality. In this regard literature is being collected.

v. Micro-Watershed Studies at Rui, Samba, Jammu :

During this year, instrumentation of the existing watershed was improved. A new trapezoidal weir and a well for stage recorder was constructed at the downstream site of the microwatershed. Two types of raingauges, e.g., ORG and SRRG were also installed. Rainfall, runoff and sediment data were collected during monsoon period and were analysed.

vi. Representative Basin Studies at Baira Watershed, HP :

During this year, erosion and sedimentation studies were initiated for Balsio sub watershed, a tributary of Baira Nalla watershed, above Tissa, HP, using Water Erosion Prediction Project (WEPP) model developed by USDA-Agricultural Research Service, The scientists and staff of the Regional Centre published/accepted for publication 6 papers and attended 3 seminars/symposia/ training courses.

The 7th meeting of the Regional Coordination Committee meeting was held in March 13, 1997 at Jammu.

4.4 Ganga Plains North Regional Centre, Patna

The Ganga Plains North Regional Centre was opened at Patna in May 1991. The centre, has been provided with 4 acres of land by Government of Bihar in WALMI Complex Patna. A few residential quarters have been constructed in the campus. The main building of the Centre is also nearly completed, however, office of the Centre is presently housed in two residential quarters as a temporary arrangement till the office building is completed in all respects.

The Ganga Plains comprise of mainly UP, Bihar and West Bengal besides other states in North India. All the important rivers in the region originate mainly from different mountain ranges of the Great Himalayas. The rivers are perennial in nature and bring enormous silt from their catchment areas because of natural activities such as land slides, soil erosion due to rainfall and other human activities.

The region frequently suffers from floods and at times also due to drought. Flood has been controlled to a great extent by taking recourse of an extensive network of embankment along different river courses. Sharda Sahayak Canals, Gandak Canals and Kosi Canals are important canals in the region. DVC is also located in the region. The important water projects are Gandak Projects, Kosi Project and DVC Project. The area between the Great Himalayas and the river Ganga is flat. The water table is shallow. The flood embankments, canals, railway lines, roads etc. have disturbed the drainage system. This has aggravated the problem of flooding, drainage congestion and water logging. Nearly 9 lakh hectares of land in Bihar are water logged and forty lakh hectares are flood prone. In Ganga plains there is hardly any location for having a dam. There is problem of erosion and shifting of river courses also. In West Bengal, there is special problem of sea erosion. Keeping all these issues in a view this regional centre was established in Patna almost in the middle of the region.

The Regional Coordination Committee has identified the following areas for study by GPRC in consultation with different Departments.

1. Representative basin study
2. Hydrology water year book
3. Reservoir sedimentation studies
4. Hydrometeorological network design
5. Remote sensing application
6. Drainage and water logging studies
7. Flood plain mapping
8. Reservoir water balance
9. Erosion and sedimentation studies
10. Morphological studies.

Following studies have been completed during the year :

i. Study of Mokama Group of Tals (Part I)

The Centre has prepared a status report under the work programme of 1995-96 compiling all information of the Tal area incorporating, particularly, hydrological features of the area, landuses pattern, various remedial measures taken so far for management of Tal areas, and upto studies conducted by various organisations. This background information fulfill the requirement to take up further study in the light of finding out an appropriate solution of the problems. Objective of this study is to develop a management model for the water logged area. Using remote sensing data and with the help of GIS, premonsoon and post-monsoon scenarios of the Tal areas have been analysed. Considering the water logged area as a storage reservoir having inflows from various tributaries and outflow/backwater flow to/from the river Ganga, the problem is being dealt with. It is attempted to use an optimization model with the objective of minimization of water logged area under the constrains of check over the inflow from different tributaries.The long term output of the study will decrease water logged area, alternately, will increase cultivatable area during monsoon period. It will also help to create irrigation potentiality to the upper reaches of the tributaries.

ii. Application of FESWMS 2DH Model for Flow Computations of a Flood Plain Area

Floods are very common phenomena in the lower Gangetic plains. During the flood period, velocity and flow vectors, and water surface elevation contours do not follow the conventional flood concept and the assessment of all these components is an area of research. A two dimensional finite element surface water model with depth and vertically averaged velocity components as dependent variables allows the user with great flexibility in defining geometric features such as the boundaries of a water body, channels, islands, dikes and embankments. The FESWMS 2DH has been used to model many types of steady and unsteady surface water flows. A report was earlier prepared using FESWMS 2DH model for simple channels, flow in a strongly curved channel bend, flow in a meandering channel and flow in a single opening bridge crossing in the year 1995-96. The objective of the study is to simulate surface water flow (steady and unsteady) of a flood plain area where the flow is essentially two dimensional in a horizontal plain.

The FESWMS 2DH model has three distinct but related programs; DINMOD - the data input module, FLOMOD - the depth averaged flow analysis module, and ANOMOD - the output analysis module. All the three modules of the model would be used to compute variability of longitudinal and lateral flow hydraulics (velocities and water surface elevations) in a flood plain area.The input data required for the analysis are ground surface elevations, current velocity, water surface elevations, channel or overbank surface roughness and regularity, water temperature, wind velocity and latitude.

The model provide the information and plots of two dimensional velocity and unit flow vectors, ground surface and water surface elevation contours. Time history graphs of velocity, unit flow or stage (water surface elevation) at a computation point can be produced.

iii. Characteristics Study of Rainfall-Runoff pattern for Punpun Basin

The Centre has prepared hydrological year book, hydrological data book, rainfall-runoff modeling, flood plain mapping, rain gauge network design etc. for the Punpun basin. These reports include almost all the available hydrological information of the basin. Some of the information like landuse pattern, flood inundation area,

precipitation gauge density, curve number etc. had already been studied. Change in landuse pattern over a period of time and construction of various pattern over a period of time and construction of various floods control and irrigation structures, and other man-made activities have a considerable impact on the pattern of the rainfall and runoff characteristics in a basin, a well known fact, but the changes of pattern of rainfall and runoff which largely depend upon local hydrologic conditions of the basin, because of mans' influence on the hydrologic regime is an area of concern and need to be studied.

The methodology of the present study has primarily three steps namely :

(i). Time series analysis of rainfall-runoff to determine the changes of a pattern;

(ii). Using remote sensing data and GIS, temporal changes in land use has been determined; and

(iii). Effect of landuse changes on characteristics of rainfall-runoff has been attempted.

The study provides typical rainfall-runoff pattern in the basin indicating the man's influence on hydrologic regime and also gives a list of the effects of landuse changes on rainfall-runoff pattern.

iv. Arsenic Pollution in Ground water - A Status Report

The arsenic pollution in ground water in West Bengal has been described as the World's biggest calamity. Eight districts within the Bhagirathi-Hoogly river basins covering an area of 37,493 km sq. with more than 4.5 million people are affected by the arsenic pollution. The source of occurrence of arsenic has been reported to be of geological formation of source material. Occurrence of iron-pyrite and the change of geo-chemical environment due to over-exploitation of ground water or excessive fluctuation of ground water table have been thought to be the reason of decomposition of pyrites to ferrous sulphate, ferric sulphate and sulfuric acid. However, no definite explanation regarding the source of arsenic could be given. The concentration of arsenic is mostly dominant in the intermediate layer and are being spreaded over the time and space in the linear track starting from Malda district towards South 24-paraganas district. The interest feature of arsenic pollution is that it has a positive correlation with the iron concentration.

A number of research organisations and departments are involved in monitoring the menace of arsenic pollution in ground water in West Bengal. Different agencies have taken this problem as a challenge and on the way to develop appropriate technologies for removal of arsenic from water. However, unless reason and sources of arsenic pollution are found out, and thereby an appropriate scientific management with a view to protect the spreading of arsenic pollution is thought, it would be difficult to combat the problem and the risk as well. A proper watershed management and conjunctive use of surface and ground water may perhaps be an approach. The report addresses compilation of information about arsenic pollution in ground water experienced by many countries in the world and problems in eight districts West Bengal in particular. The science of arsenic pollution and the state-of-art of arsenic removal have been discussed. Some immediate remedial measures have also been suggested.

The scientists and staff of the centre have published/accepted for publication 8 papers and participated in 5 seminars/symposia and training courses.

The Sixth Meeting of Regional Coordination Committee was held on September 6, 1996 at Patna.

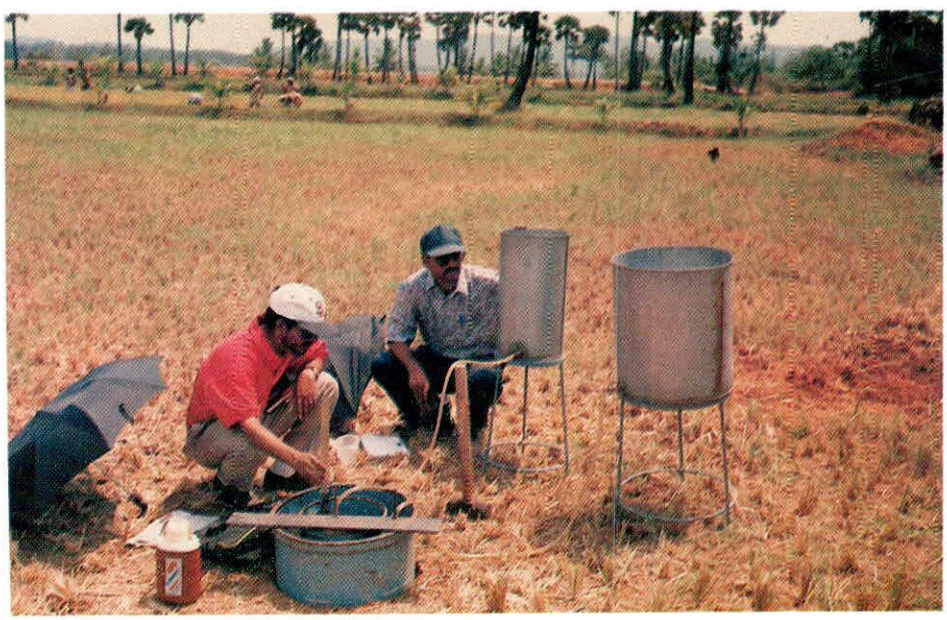
4.5 Deltaic Regional Centre, Kakinada

With a view to deal with the region specific hydrological problems in a better way, the 5th Regional Centre of NIH started functioning from 9th September, 1991 in the coastal city of Kakinada which is the headquarters of East Godavari District in Andhra Pradesh. The Regional Centre has been allotted 4.05 acres of land in Kakinada by the Andhra Pradesh State Government on long term lease basis. The activities of this regional centre pertain to studies and research in the eastern coastal and Deltaic region of the country. The jurisdiction of the regional centre extends from Cauvery delta in Tamilnadu to coastal region of

Shri Jagdanand Singh, Hon'ble Cabinet Minister for Water Resources, Bihar releasing the Proceedings of Brain Storming Session on Hydrological Problems and Perspective in Lower Gangetic Plains held at Patna

Office Building of Ganga Plains North Regional Centre, Patna.

Seventh Regional Coordination Committee Meeting for Deltaic Regional Centre, Kakinada in progress.



Infiltration Tests being conducted at Suddagedda Basin, AP.

West Bengal covering partly the states of Tamilnadu, Andhra Pradesh, Orissa, West Bengal and the union Territory of Pondicherry.

Every year the highly populated coastal and deltaic region of the east coast of the country is subjected to the fury of nature in the form of floods and related problems. The major hydrological problems being faced in the region are flash floods due to intensive cyclone storms in medium sized rivers catchments, drainage congestion of streams in the flat coastal plains and the associated problems of inundation and water-logging. In the tailend reaches of the deltas and along the coastal areas enormous growth and uncontrolled increase in aquaculture is disturbing the natural equilibrium of the sensitive environment. The lands are being dug upto 3-4 meters deep leading to landward development of salt water intrusion. The scarcity of drinking water is another growing problem as the water being collected in surface tanks for drinking purposes is turning into brackish water.

The centre has established a Water Quality Lab having capabilities for physical analysis and chemical analysis i.e. volumetric analysis of groundwater /surface water samples. The laboratory is also having water level recorder, water samplers, turbidity meter, BOD incubator, UV-spectro photometer, flame photometer with Na and K filters, etc.

The Computer Centre has three personal computers (PC-386, PC-486, and one Pentium) with its accessories. ERDAS (Earth Resources Digital Analysis System) software is available for digital image processing of the remotely sensed data. A Calcomp Digitizer is provided for digitizing the maps. The Remote Sensing cell has premonsoon and postmonsoon IRS LISS II satellite imageries (FCC) on 1 :250,000 scale of DRC Region for the year 1989. Light Table with co-ordinate measuring system and magnifying lenses are used for carrying out the visual interpretation studies.

The field investigation facilities include two sets of double ring infiltrometers to measure the infiltration rate of soil in the field, electric resistivity meter for measuring the resistivity of the soil, and two sets of current meters for measuring the velocity of the flow of the stream.

To establish the hydrometeorological observatories in the representative basins, three sets of observatory equipment have been procured comprising of ordinary raingauge, automatic ringauge, pan evaporimeter, stevenson screen. The Hydrometeorological observatory has been established in the deltaic Regional Centre site at Kakinada.

During the year, the Centre has completed the following studies :

i. Daily Rainfall-Runoff Modelling of Sagileru River using HYSIM

HYSIM, a hydrologic simulation model which is developed in UK is applied for the first time in India. This model is used for simulating the daily flows of river Sagileru which is a tributary of Pennar river. The modelling was carried out for a drainage area of 2486 sq km at Nandipalli gauging site by considering the entire catchment as a single unit.The model calibration and validation were performed for independent sets of data by adopting the split data approach for the available data of four years. The results of study were quite encouraging. It is observed from the results that the model reproduced the flow hydrographs to a fair degree of accuracy. However, before making a general conclusion on the model's applicability, it is recommended that the model performance should further be assessed by applying it to a few more Indian catchments.

ii. Daily Rainfall-Runoff Modelling of Brahmani river upto Rengali Reservoir

The study aimed at modelling the daily runoff of river Brahmani at Rengali Reservoir.The Rengali reservoir constructed across the river in Orissa is a multipurpose reservoir providing flood control in the river delta, power generation and irrigation. Forecasting of river flows at the dam site is, therefore, required for operation of the reservoir during high flows periods. Keeping in view the large catchment area (25250 sq km), the basin for modelling purpose has been subdivided in two subbasins viz., upper and lower subbasins. The upper subbasin taken upto Bolani gauging site at 290 kms of the river (catchment area - 16900 sq kms) is treated as a nominal subbasin as the recorded flows for the subbasin are available. The

lower subbasin having a catchment area of 5350 sq kms is considered between Bolani and the dam site. A hydrologic simulation model, HYSIM which is a very versatile model having 22 hydrologic and 10 hydraulic parameters was used to simulate the daily runoff from the lower subbasin and to route them along with the recorded flows from upper subbasin to the dam site. The model calibration and validation was performed for two different sets of data of 3 years each. The model has provided excellent simulation results and is recommended for simulation studies of river Brahmani and its tributaries.

iii. Analysis of Surface Runoff and Base flow at Ariyanyakipuram Anicut, Tambraparani basin, Tamil Nadu

The analysis of surface runoff and base flow has been carried out at Ariyanyakipuram Anicut, Tambraparani basin, Tamil Nadu for a period of 13 years (1983-1995). The analysis shows that the contribution of the base flow at Ariyanyakipuram Anicut was observed to be more. Further the annual catchment water balance model has been applied to simulate annual surface runoff and base flow at the Anicut. The model has been calibrated for a period of 8 years (1983-90) and validated for 5 years (1991-95). The model is able to simulate surface runoff more accurately than base flow. The model has also established the relation between precipitation and surface runoff , and runoff and base flow coefficient functions at Ariyanyakipuram Anicut and these functions may be useful to water departments to understand the surface runoff and base flow runoff processes at the Anicut.

iv. Estimation of Infiltration Rates in Suddagedda Representative Basin, East Godavari District, AP

Suddagedda basin is adopted as a representative basin of east flowing rivers of medium sized basins in the east coast of India by the Institute. The basin soils may be broadly grouped into clay loams to clay, sandy loam and forest loamy skeletal soils. As a part of experimental studies in the basin , total 28 infiltration tests were conducted using double ring infiltrometers. Using the experimental data, the average infiltration rates of various soil groups were obtained. The correlation coefficient between observed data and fitted Horton equation varied between 0.83 to 0.99. The average infiltration rates in clay loams to clay, sandy loams and forests and loamy skeletal was 2.05, 3.94 and 2.12 cm/hr respectively. The highest average initial infiltration rate (30.3 cm/hr) and average final infiltration rate (4.7 cm/hr) were observed in forest and loamy skeletal soil and lowest average initial infiltration rate (19.4 cm/hr) and average final infiltration rate (1.31 cm/hr) were in agricultural lands. According to land use classification the highest average infiltration rate was obtained in barren land (6.5 cm/hr) and lowest rate in agricultural land (2.5 cm/hr). A map showing the spatial distribution of average infiltration rate in the Suddgedda basin was prepared.

v. Conjunctive use Studies in Pennar Delta Canal System and Groundwater Balance for Southern Channel Command Area in AP

The pertinent data from village level of the southern channel command area of Pennar delta system in Nellore district of Andhra Pradesh was utilised and analysed to arrive at the groundwater balance of the system. With a view to take up the conjunctive use practice in southern channel command area for Pennar delta canal system, water balance components were estimated on a seasonal basis for monsoon and non-monsoon seasons from 1989-1993. The crop water requirements were estimated for this period to find out the system demand. Various supply and demand components were accounted for in the study area using suitable techniques based on the availability of the observed data. From the water balance equation, rainfall recharge during monsoon season is estimated to find out relationship between rainfall amount to recharge coefficient for the area.

The scientists and staff of the Regional Centre published/accepted for publication 8 papers and participated in 5 training courses.

Rashtriya Pariyojana Nirman Nigam Ltd (RPNN) is constructing new office complex. The progress of construction was nearly 75% as on 31st March, 1997.

The 7th Meeting of Regional Coordination Committee was held on March 25, 1997 at Jawaharlal Nehru Technological University (JNTU), Hyderabad.

4.6. Ganga Plains South Regional Centre, Sagar

The Regional Centre, Sagar has started its functioning from 1st December 1995. This Centre has been named as Ganga Plains South Regional Centre of National Institute of Hydrology located at Sagar (MP) in a private rented building. This centre has been set up to carry out research studies in different aspects of hydrological problems of basins/sub-basins of north flowing rivers, namely Banas, Chambal, Kalisindh, Dhasan, Ken, Son and their tributaries, which are ultimately joining to river Ganga.

The jurisdiction of Ganga Plains South Regional Centre covers major part of Bundelkhand region of Central India; which falls in northern part of Madhya Pradesh, Southern part of Uttar Pradesh and some part of the South East Rajasthan state. This region is rich in mineral resources, like limestone, diamonds, phosphorite, bauxite, dolomite, gypsum and building stones such as masonary stone, slab stone, granites and river sands etc.

Regional centre Sagar and its area of jurisdiction falls under semi-arid to sub-tropical climate. This region regularly experiences severe drought conditions due to frequent failure of rains and poor agricultural yields. This region received average annual rainfall of about 1173 mm. The ground water levels in this region varies from 3 to 8 meters during post monsoon and it goes very deep during summer season (March-June). The humidity during summer months decreases upto 11 to 13%. The irrigated area in this region may be about 5 to 6% only. The major portion of this region falls under rainfed agriculture. Most of the tributaries of major rivers in this region have no flow (or dry) after February. Also the major rivers like Son, Ken, Dhasan, Kalisindh, etc have very low flows during summer months. Also the major water storage structures/dams are lacking in this region

The Regional Centre is well equipped with personal computers like one pentium, one PC-AT486 and one PC-AT386 for taking up various mathematical modelling studies in the field of hydrology and water resources. In addition, one small laboratory comprising of various instruments to carry out water quality measurements and to conduct field experiments related to soil-water interaction has been established at the centre. One automated weather station has also been installed at a suitable site near the office of Regional Centre, Sagar in order to collect various hydrometeorological real time data.

During the year the Centre has completed three studies :

i. Interpolation of Groundwater levels in Sagar District using Kriging method.

ii. An Overview of Prevailing Hydrological Conditions in Sagar District and

iii) Groundwater Quality Monitoring and Evaluation in Sagar District.

A hydrochemical study of the ground water of district Sagar has been carried out during 1996 to examine the suitability of water for drinking and irrigation purposes. Thirty five water samples representing the shallow ground water of the region were collected during pre-monsoon and post-monsoon seasons in the month of June and November 1996 respectively. Various parameters, viz., pH, conductance, total dissolved solids, alkalinity, hardness, chloride, sulphate, phosphate, sodium, potassium, calcium and magnesium, have been determined for each sample. The data was analysed with reference to BIS and WHO standards, ionic relationships were studied, hydrochemical facies were determined and water types were identified. The results of the study provide information needed for ground water quality management in the region.The values of sodium adsorption ratio indicate that ground water of the area falls under the category of low sodium hazards.

The ground water of the region has also been classified on the basis of stiff, piper trilinear and U.S Salinity Laboratory classifications. These classifications allowed to characterize the samples of ground water according to their hydrochemical facies and their quality for agricultural use. Majority of the samples of the study area fall in the Ca-Mg-HCO, hydrochemical facies. The ground water is acceptable for irrigation purpose.

The Institute has plans to establish remaining two regional centres at Goa and Udaipur for Western Coastal Region and Arid and Semi-arid Region respectively during the 9th plan period so as to cover all the eight regions as originally envisaged. The proposal is under consideration in the Ministry of Water Resources.

5.0 Staff and Facilities

The Institute has 18 scientific divisions and 4 units of administration, finance, maintenance, and extension services. The Secretariate of Indian National Committee on Hydrology (INCOH) is also attached to the Institute. Besides these, the Institute also has six Regional Centres.During the sixth plan period (1980-85) the Institute had a sanctioned strength of 121 posts and 20 posts of INCOH (out of which only 14 posts were released). Out of the 173 posts sanctioned during the 7th plan (1985-90) only 157 posts were released. Thus out of these 314 posts only 292 posts have been released and remaining 22 posts have been abolished and 11 Group B, C and D posts have been upgraded by Ministry of Water Resources (MOWR) . During the 8th plan (1992-97) 118 posts were provided in four schemes approved by the Standing Finance Committee of MOWR. However, out of 118 posts only 34 posts of scientists and 3 posts of Drivers have been released under 8th plan schemes, till 31st March 1997. Further, as per the Government of India's requirement for cut of 10% posts in sanctioned strength, out of 292 (Non Plan) posts, 9 posts have been abolished. The total sanctioned strength is thus 283 (non-plan) + 37 (plan) posts.

The status of staff as on 1.4.1996 and 31.3.1997 is given in Appendix X.

5.1 Scientists

During the year, the following scientists have joined the Institute.

1. Dr B K Purendara, Sc B
2. Shri Vemu Screenivasulu, Sc B
3. Smt Archana Sarkar, Sc B
4. Dr Shive Prakash Rai, Sc B
5. Shri Hemant Singh, Sc B
6. Shri P K Mahapatra, Sc B
7. Dr C Keshava Rao, Sc B
8. Shri Sudheer K P., Sc B
9. Shri Vivekanand Singh, Sc B
10. Dr Baldev Prasad, Sc B
11. Shri Jiweshwar Sinha, Sc B
12. Shri R V Galkate, Sc B
13. Shri C Rangaraj, Sc B
14. Shri Chandernath Chatterjee, Sc B

During the year, the following scientists have been promoted :

1. Dr A K Bhar, Sc F
2. Smt Deepa Chalisgaonkar, Sc E
3. Shri R P Pandey, Sc C
4. Shri S V Vijaykumar, Sc C
5. Shri A K Lohani, Sc C

At the end of the year (March 31, 1997) the Institute had 74 scientists.

The name and qualifications of scientists in position as on March 31, 1997 are given below :

DIRECTOR

S M Seth	B.E. (Civil Engg.); M.E. (Dam Design, Irrigation Engg. and Hydraulics), University of Roorkee, Roorkee; Ph.D., Victoria University, Manchester, UK

SCIENTISTS

G C Mishra	B.Sc.(Civil Engg.); M.E.(Soil Mechanics & Foundation Engg.), Indian Institute of Science, Bangalore; Ph.D., Indian Institute of Science, Bangalore.
P V Seethapathi	B.E.(Civil Engg.); M.Tech. (Dam Construction & Water Power Engg.); IIT Kharagpur; Ph.D., IIT Kharagpur.
K S Ramasastri	M.Sc. (Tech.) Meteorology & Oceanography); Ph.D., University of Roorkee, Roorkee
K K S Bhatia	B.E. (Civil Engg.); M.E. (Hydraulics & Hydraulic Structures), Birla Institute of Technology and Science, Pilani; Ph.D., IIT Bombay
A K Bhar	B.E.(Civil Engg.); M.E. (Hydrology), University of Roorkee, Roorkee; Ph.D., University of Roorkee
B Soni	B.Sc. (Ag.Engg.); M.Tech. (Soil & Water Conservation Engg.), IIT Kharagpur; Ph.D., IIT Kharagpur
B C Patwari	B.E. (Civil Engg.), M.E. (Water Resources Development), University of Roorkee, Roorkee
A B Palaniappan	B.E. (Civil Engg.); M.S. (Hydraulic Engg.), IIT Madras; Ph.D., University of Roorkee, Roorkee
R D Singh	B.E. (Civil Engg.); M.E. (Civil Engg.), University of Roorkee, Roorkee; M.Sc. (Hydrology), Ireland
S K Jain	B.E. (Civil Engg.), M.Tech. (Hydraulics & Water Resources), IIT Kanpur; Ph.D., University of Roorkee, Roorkee
V K Choubey	M.Sc. (Applied Geology); P.G. Diploma (Remote Sensing), IIT Bombay; Ph.D., Jawaharlal Nehru University, Delhi.
Bhishm Kumar	M.Sc. (Physics); Ph.D. (Physics), University of Roorkee, Roorkee.
N C Ghosh	B.E. (Civil Engg.); M.Tech. (Water Resources Engg.), IIT Kharagpur
S V N Rao	B.E. (Civil Engg.); M.Tech. (Hydraulics & Water Resources Engg.), KEFC, Surathkal
Deepa Chalisgaonkar	B.E. (Electronics); M.E. (Computer Science), University of Roorkee, Roorkee
Avinash Agarwal	B.Sc. (Agril.Engg.); M.Tech. (Irrigation Drainage), G.B. Pant Krishi Evam Praudyogic Vishwavidyalaya, Pant Nagar; M.S.,University of Guelph, Canada
S K Singh	B.E. (Civil Engg.); M.E. (Hydraulics & Irrigation Engg.), University of Roorkee, Roorkee
C P Kumar	B.Sc. Engg.(Civil Engg.); M.E. (Hydraulics Engg.), University of Roorkee, Roorkee
Rakesh Kumar	B.E. (Civil Engg.); M.E. (Hydraulics & Irrigation Engg.), University of Roorkee, Roorkee
V C Goyal	M. Tech. (Applied Geophysics); Ph.D., University of Roorkee, Roorkee.
D S Rathore	B.E. (Civil Engg.); M.Tech. (Remote Sensing); IIT Bombay
P K Majumdar	B.E. (Civil Engg.); M.E. (Water Resources Development), University of Roorkee, Roorkee

Jai Vir Tyagi	B.Sc. (Agril Engg.); M.Tech. (Soil & Water Conservation Engg.), IIT Kharagpur
S K Mishra	B.E. (Civil Engg.); M.Tech. (Hydraulics & Water Resources), IIT Kanpur
Sudhir Kumar	M.Tech.(Applied Geology); Ph.D.,University of Roorkee, Roorkee
R R Mehrotra	B.E. (Civil Engg.); M.E. (Hydrology), University of Roorkee, Roorkee
Pratap Singh	M.Sc. (Physics); Ph.D., University of Roorkee, Roorkee
C K Jain	M.Sc. (Chemistry); Ph.D., University of Roorkee, Roorkee
S K Jain	B.E. (Civil Engg.); M.E. (Soil Dynamics), University of Roorkee, Roorkee
Anil Kumar	B.Tech. (Civil Engg.); M.E. (Hydraulics & Irrigation Engg.), University of Roorkee, Roorkee
V K Dwivedi	B.Sc. (Engg.); M.Tech. (Civil Engg.), IIT Kanpur; M.E. (Civil Engg.), University of Alberta, Canada
B Chakravorty	B.Sc. (Agri.Engg.); M.E. (Hydrology), University of Roorkee; M.S. (Hydrological Engg.); Delf
M K Goel	B.SC. Engg (Civil); M.E. (Irrigation & Hydraulics), Punjab Engineering College, Chandigarh
Aditya Tyagi	B.E. (Civil Engg.); M.E. (Environmental Engg.), University of Roorkee, Roorkee
Hemant Choudhary	B.E. (Civil Engg.); M.Tech. (Water Resources Engg.); IIT Bombay
M K Shukla	B.Tech. (Agril.Engg.); M.Tech. (Soil & Water Engg.), JNKVV, Jabalpur
D K Agarwal	B.Tech. (Ag.Engg.); M.Tech. (Soil & Water Conservation Engg.), IIT Kharagpur; Ph.D., IIT Kharagpur
A V Shetty	B.E. (Civil Engg.); M.Tech. (Hydraulics & Water Resources); Mangalore University, M.Sc. (Hydrology), Ireland
Ramakar Jha	B.Tech. (Agri.Engg); M.Tech. (Soil & Water Conservation Engg.), G.B. Pant Krishi Evam Praudyogic Vishwavidyalaya, Pant Nagar
M K Jain	B.Tech. (Agril.Engg.); M.Tech. (Soil & Water Conservation Engg.), JNKV, Jabalpur
S K Goel	B.E. (Civil Engg.); M.E. (Hydraulics & Irrigation Engg.), University of Roorkee, Roorkee
Chandra Mohan T.	B.E. (Civil Engg.); M.Tech. (Hydraulic Engg.), University of Kerala
S V Vijayakumar	B.E. (Civil Engg.); M.Tech. (Hydraulics & Water Resources), Mangalore University
R P Pandey	B.Tech. (Agril.Engg.); M.Tech. (Soil & Water Engg.), JNKVV, Jabalpur
A K Lohani	B.Tech. (Agril.Engg.); M.Tech. (Water Resources Dev. & Management), IIT Kharagpur
S D Khobragade	B.E. (Civil Engg.); M.Tech. (Water Resources Dev. & Management), IIT Kharagpur

B Venkatesh	B.E. (Civil Engg.); M.Tech. (Hydraulics & Water Resources), Mangalore University
Y R S Rao	B.E. (Civil Engg.); M.E. (Hydrology & Water Resources Engg.), Anna University, Madras
Omkar	B.Tech. (Agril.Engg.); M.Tech. (Soil & Water Conservation Engg.), IIT Kharagpur
A K Keshari	B.E. (Civil Engg.); M.Tech. (Civil Engg.); Ph.D., IIT Kanpur
S R Kumar	B.E. (Civil Engg.); M.E. (Water Resources), DAV Indore
Vijay Kumar	B.Sc. (Agril.Engg.); M.Tech. (Water Resources Engg.), IIT Delhi; Ph.D., IIT Delhi
A R S Kumar	B.E. (Civil Engg.); M.E. (Hydrology & Water Resources Engg.), Anna University, Madras
P K Bhunya	B.E. (Civil Engg.); M.Tech. (Water Resources Dev.& Management), IIT Kharagpur
S K Verma	B.E. (Civil Engg.); M.E. (Hydraulics & Irrigation Engg.), University of Roorkee, Roorkee
Daya Ram	B.Tech. (Civil Engg.); M.E. (Environmental Engg.), University of Roorkee, Roorkee
V S Jayakanthan	B.E. (Civil Engg.); M.Tech. (Remote Sensing), Anna University, Madras
M V Rao	B.E. (Civil Engg.); M.Tech. (Water Resources Engg.), Regional Engineering College, Warangal
R D Mehta	M.Sc. (Maths); M.Sc. (Hydrology), Ireland; Ph.D., University of Roorkee, Roorkee
B K Purandara	M.Sc. (Geology); Ph.D., Cochin University of Science and Technology
Vemu Sreenivasulu	B.Tech. (Civil Engg.); M.Tech. (Water Resources Engg.), Regional Engineering College, Warangal.
Archana Sarkar	B.E. (Civil Engg.); M.E. (Civil) - Computer Aided Design, University of Roorkee, Roorkee
Shive Prakash Rai	M.Sc. (Geology); Ph.D. (Hydrogeology and Geomorphology), Kumaun University, Nainital
Hemant Singh	B.E. (Civil Engg.); M.E. (Hydraulics), University of Roorkee, Roorkee
P K Mahapatra	B.Sc. Engg. (Civil Engg.); M. Tech. (Hydraulics and Water Resources), IIT Kanpur
C Keshava Rao	M.Sc. (Chemistry); M.Phil. (Environmental); Ph.D. (Analytical Chemistry), Sri Krishnadevaraya University, Anantapur
Sudheer K P	B.Tech. (Agril Engg.); M.Tech. (Soil and Water Conservation Engg.), IIT Kharagpur
Vivekanand Singh	B.Sc. Engg. (Civil Engg.); M.Tech. (Hydraulics and Water Resources), IIT Kanpur
Baldev Prasad	B.Tech. (Civil Engg.); M.Tech. (Water Resources), IIT Bombay; Ph.D. IIT Bombay
Jiweshwar Sinha	B.Sc.Engg. (Civil Engg.); M.Tech. (Hydraulics & Water Resources), IIT Kanpur

R V Galkate	B. Tech. (Agril. Engg.); M.Tech. (Soil and Water Conservation Engg.), IIT Kharagpur
C Rangaraj	B.Tech. (Agril. Engg.); M.Tech. (Hydraulics and Water Resources), IISc. Bangalore
C. Chatterjee	B.Tech. (Agril. Engg.); M.Tech. (Soil and Water Conservation Engg.), IIT Kharagpur

5.2 Scientific and Technical Staff

At the end of the year under report (31st March 1997) the Institute had 106 scientific and technical staff.

5.3 Other Supporting Personnel

At the end of the year (31st March 1997), the Institute had 81 other supporting personnel including one Senior Administrative Officer, one Finance Officer, one Documentation Officer and two Section Officers.

Resignation/Reversion :

Shri V K Lohani, Sc C who was pursuing Ph.D. degree in Hydrological Aspects of Drought at Virginia Polytechnic Institute and State University, USA has resigned and relieved from NIH during 1996.

Shri Y P Singh,Senior Accounts Officer, CDA Meerut, who joined the Institute on deputation basis as Finance Officer on 1.2.1993 has been relieved from his duties wef 28.1.1997 consequent upon his posting on reversion from deputation on completion of the tenure at this Institute.

With great sorrow it is reported that Shri Mam Chand, Attendant expired during the year.

5.4 Awards and Higher Degrees

- Shri Rakesh Kumar, Sc C and Dr S M Seth, Director have been awarded Brijmohan Lal Memorial Medal award for 1995-96 for the technical paper on" Application of SHE Model to Ganjal Sub-basin of river Narmada" by Institution of Engineers (India) during 11th Indian Congress held at Bangalore on Dec. 20-23, 1996.
- The Institute has been awarded Chal Vaijyanti Cup for the year 1995-96. Dr S M Seth, Director, NIH received the award from the Hon'ble Union Minister for Water Resources, Government of India at the function held on 10 September 1996 at New Delhi. The Trophy is for use of Hindi langauge in the Institute.
- Dr S M Seth, Director has been elected as one of the Vice-Chairpersons representing Asia Pacific Region and chaired one session of the International Hydrology Programme (IHP) Council. This is the first time since launching of IHP by Unesco in 1975 in India has this honour of being represented on the Bureau as Vice-Chairperson for IHP of Intergovernmental Council of Unesco.
- Shri A K Bhar, Sc E has been awarded Ph.D. degree from the Department of Earth Sciences, University of Roorkee, Roorkee.
- Shri Vijay Kumar, Sc B has been awarded Ph.D. degree from the Department of Civil Engineering, Indian Institute of Technology, Delhi
- Shri P K Majumdar, Sc C has been awarded Jalvigyan Puraskar 1996 by ISH, Pune
- Shri Tanvear Ahmad, Senior Research Assistant has been awarded Master of Hydrology degree from the Department of Hydrology, University of Roorkee, Roorkee.
- Shri M K. Sharma, J. E. (Civil) has been awarded M.E. Hydrology from the Department of Hydrology, University of Roorkee, Roorkee
- Cash awards for those who rendered meritorious services among the Group B, C and D staff in the Institute were given on 15th August 1996 for the year 1995-96. The list of awardees is given in Appendix-XI.

b. Guidance of ME/M.Tech. dissertations/ theses

- Dr G C Mishra, Sc F guided a Ph.D. thesis on "Design of Weir on Permeable Foundation" of Shri A A S Mohamed Salem, Department

of Civil Engineering, University of Roorkee, Roorkee.

- Dr G C Mishra, Sc F guided a Ph.D. thesis on "Mathematical Modelling of Springflow" of Shri A K Bhar, Department of Earth Sciences, University of Roorkee, Roorkee.

- Dr S K Jain and Shri M K Goel guided a M.E. thesis on "Application of Geographic Information System and Remote Sensing in Study of a Canal Command Area" of Shri M L K Sreshtha, WRDTC, University of Roorkee, Roorkee

- Shri V C Goyal, Sc C guided MCA thesis on "Software for Directory & Buyer's Guide of Hydrological Instruments" of Ms Vandana Sharma, Kanya Gurukul Mahavidyalaya, Dehradun (constituent College of Gurukul Kangri Vishvavidyalaya, Hardwar)

- Shri S V Vijayakumar, Sc C guided ME thesis on "Water Balance Studies of Nalayapuram Anicut Left Branch Canal in Srikakulam District, AP" of Shri P Ravikumar, Jawaharlal Nehru Technical University, Hyderabad.

5.5 Deputation Abroad

- Shri A R Senthil Kumar, Sc B was deputed to University of Braunschweig, Germany under UNDP Project fellowship training programme for 4 (22.10.96 to 21.2.97) months for advance training in the area of Data Processing and Analysis

- Shri Omkar, Sc B was deputed to University of Idaho, Fullman, Moscow, USA under UNDP Project fellowship training programme for 4 months (10.10.96 to 9.2.97) for advance training in the area of Forest Hydrology.

5.6 Higher Studies

The following scientists and staff continued/ were deputed for higher studies on full-time/part-time basis :

1. Shri S K Goel, Sc B is pursuing Ph.D. degree in Agricultural Engineering - Hydrology at University of Idaho, USA (since 1.3.1993).
2. Shri Anil Kumar, Sc C is pursuing Ph.D. in Hydrological Response of a Watershed at Hongkong University of Science and Technology, Hongkong (since 28.9.1995).
3. Dr Pratap Singh, Sc C is pursuing Post Doctoral Research work in Snowmelt Modelling at University of Agriculture, Vienna, Austria (since 4.10.1995).He has completed his research work in September 1996 and returned back to NIH, Roorkee.
4. Shri M K Shukla, Sc C is pursuing Ph.D. in Mathematical Modelling of the Salt Movement in Unsaturated Zone at University of Agriculture, Vienna,Austria (since 4.10.1995).
5. Shri A K Dwivedi, Senior Technician is pursuing M.E. Hydrology at University of Roorkee, Roorkee (since 23.6.1993).
6. Shri S K Jain, Sc C is pursuing Post Graduate Studies in Hydrology in the University College, Galway, Ireland (since 23.9.1996)

5.7 Laboratories

Since the year 1984-85, the Institute has embarked on a programme for carrying out field and laboratory oriented studies in addition to the computer based studies and research. The following seven laboratories are operational at the Institute :-

- Water Quality Laboratory
- Remote Sensing Applications Laboratory
- Ground Water Laboratory
- Service and Instrumentation Laboratory
- Hydrological Investigations Laboratory
- Soil Water Laboratory
- Nuclear Hydrology Laboratory

Water Quality Laboratory

The Water Quality Laboratory is fully equipped to monitor physical, chemical and bacteriological parameters in various water bodies like rivers, lakes, aquifers, canals etc. Presently, the laboratory has facilities and capabilities to determine about 50 parameters which includes

major and minor ions, trace elements, pesticides, organic compounds and bacteriological parameters, with different degree of accuracy.

Some of the advanced equipment available in the laboratory include Atomic Absorption Spectrometer with FIAS, Gas Chromatograph, Flow Injection Analyzer and Total Organic Carbon Analyzer.

During the year, studies on ground water quality monitoring and evaluation were carried out in different regions. Adsorption of metal ions were studied on the bed sediments of a highly polluted river in western Uttar Pradesh to demonstrate in real terms the importance of coarser fraction of sediments in controlling metal pollution. Transport of pollutants in different soil media is being studied through laboratory scale column experiments. The facilities of the laboratory were extended to the regional centres and other divisions of the Institute for their research and studies. In a limited way, the facilities of the laboratory are also being used for the analysis of water samples received from out-side agencies.

Remote Sensing Applications Laboratory

The laboratory has been functioning as a central technical facility since 1989. The laboratory is equipped with sophisticated instruments and software necessary to carry out visual and digital analysis of remotely sensed data. During the year 1996-97, modernisation of this laboratory was taken up. Upgrade of Integrated Land and Water Information System (ILWIS) 1.3 to WINDOWS based ILWIS 2.1 is being carried out. Also VGA based Earth Resources Data Analysis System (ERDAS) is being upgraded to WINDOWS NT based ERDAS IMAGINE system under UNDP project. Procurement of unrestricted ungridded toposheets in 1 :25,000 scale for all India coverage have been done from Survey of India, Dehradun.

During the year 1996-97, ILWIS and ERDAS systems were used for various studies which include soil erosion assessment in Nagwa catchment in Bihar, topography based rainfall-runoff modelling of Bhaintan catchment in Tehri Garhwal, rainfall-runoff modelling of Ramganga and Kolar catchments using a GIS based distributed modelling approach, land use/land cover mapping of upper Narmada basin, irrigation scheduling of a canal command area using GIS, geomorphological parameter estimation of various bridge catchments for GIUH studies and preparation of time-area diagram of a basin using digital elevation model (DEM), etc.

Ground Water Laboratory

The ground water laboratory is having equipment for measurement of particle size analysis, permeability, infiltration rates, soil density etc. During the year 1995-96, Mastersizer for particle size analysis through laser diffraction technique), Unsaturated permeameter and Wide range pF meter were procured.

During this year, the facilities of the laboratory were used for a number of laboratory experiments (particle size analysis, permeability, density and other soil properties) in connection with the sponsored projects e.g Subsurface Drainage Investigations in Stage II of IGNP at RD 838, sponsored by CAD, Government of Rajasthan; Hydrological Studies for the Proposed Gas Based Power Project at Kayamkulam, Alleppey District, Kerala sponsored by NTPC; and Hydrological Studies of Lake Nainital, sponsored by Department of Environment, Uttar Pradesh.

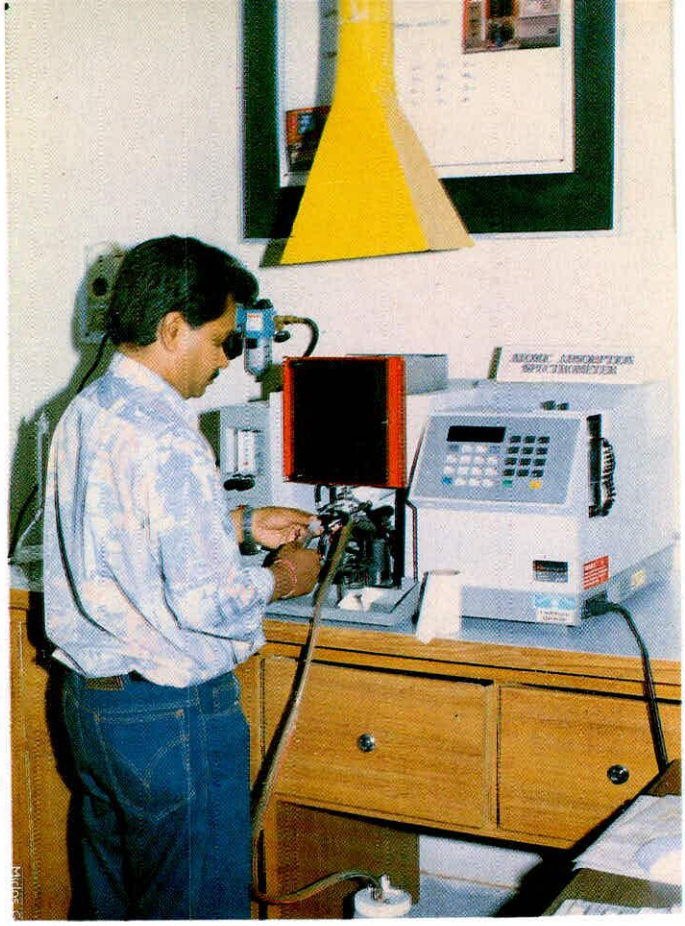
Hydrological Instrumentation Laboratory

This laboratory is fully equipped with electronic instruments and electronic components for developing hydrologic instruments. Presently the laboratory is involved in development of following instruments :

a). Weighing Rain Gauge :

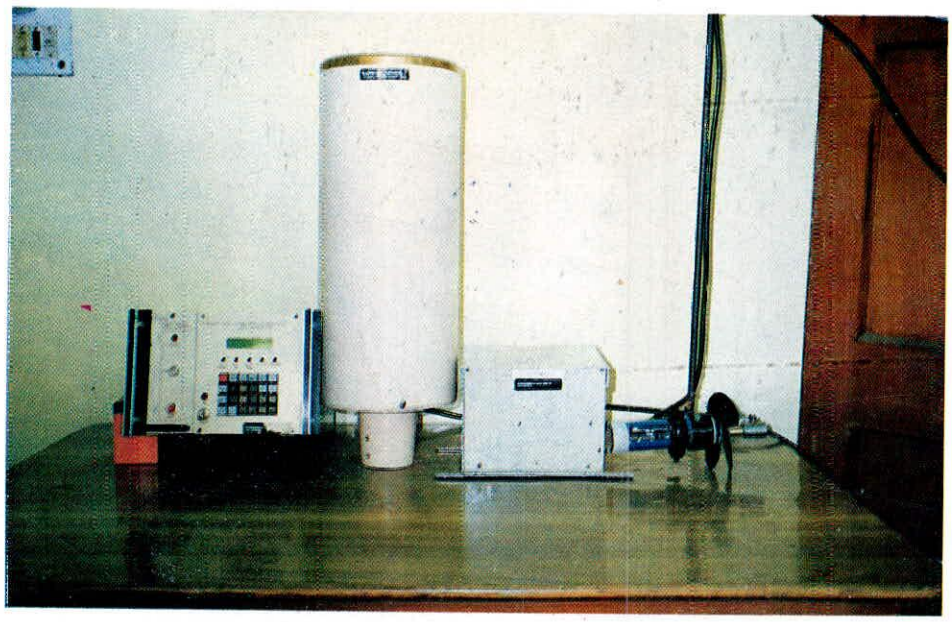
The earlier developed weighing rain gauge (WRG) was tested and compared with other available rain gauges(e.g. ORG and SRRG) in April, 1995 using an in-house designed rainfall simulator facility. The WRG was later installed in the Institute campus in December 1995 for field testing. The observations obtained from the WRG were compared with those from the SRRG during the rainstorm of Feb. 9-10, 1996.

During the year 1996-97, the weighing rain gauge was further tested and the data compared with other available rain gauges in the Institute campus.



Section of Water Quality Laboratory at the Institute.

Section of Ground Water Laboratory at the Institute.



A View of complete set up of Data Logger, Weighing-cum-Tipping Bucket Type Rainfall Sensor, Water Level Sensor and Suspended Sediment Sampler developed by Institute indigenously

Visiting Trainee Officers being shown Soil Moisture Extraction Unit in Nuclear Hydrology Laboratory

b). Soil Moisture Instrument for Ground Water Recharge Studies

The load-cell based automated snow gauge collects the catch through a 50 cm x 50 cm metal sheet platform. The electrical output of the load cell, corresponding to the weight of the accumulated snow, is fed to a micro-controller based data logger where the snow water equivalent (in mm) is recorded, alongwith the date and time, in the solid state memories. The instrument, alongwith an imported ultrasonic snow height sensor, was installed and tested at Dhanaulti (elevation 2400 m) in Western UP Hills, and tested for about three months during December 1995 to Feb. 1996.

c). Multi-Electrode Set-up :

During the year 1996-97, a field set up for multi-electrode measurements was installed in the Institute's campus and data collected during the year.

Hydrological Investigations Laboratory

The laboratory has equipment for carrying out a number of hydrological investigations. Some of the important equipment are electronic infiltrometer (developed at NIH), Guelph Permeameter, Tensiometer, Turbidity meter, Digital Thermometer, Altimeter, Water Samplers, Water Level Recorder and Current Meters. With the help of these equipment infiltration studies have been carried out in Narmada basin between Umar river and Sher river in Narsinghpur District of Madhya Pradesh during 1996-97.

Soil Water Laboratory

The Soil Water Laboratory has capabilities for measurement of various hydrological soil parameters like infiltration rate, soil moisture, hydraulic conductivity as well as field saturated hydraulic conductivity, soil texture, soil water retention curve, soil salinity and various soil and water parameters. For soil moisture measurement, tensiometer of varying length, gypsum block and oven are available. Hydraulic conductivity in the Lab. can be determined by ICW permeameter. Field saturated hydraulic conductivity is measured by Guelph permeameter. Soil moisture retention curve is measured by Pressure Plate Apparatus. Sieve analyzer and particle size analyzer are available for determination of grain size distribution. During the year, soil parameters of sub basin of Narmada basin between Baru river and Sher river in Narsinghpur District of Madhya Pradesh from twelve sites have been measured. For the twelve sites, insitu field saturated hydraulic conductivity at 22 points in first two layers have been measured. Samples were collected for measurement of soil moisture retention curves and for soil classification. Soil classification of Mandla district of Madhya Pradesh have also been carried out. Measurement of hydraulic conductivity of second layer by auger hole method in the stage II of IGNP (RD 838) were carried out and soil samples were collected for determination of soil moisture retention curves, soil texture and soil salinity etc.

Nuclear Hydrology Laboratory

The laboratory is equipped with the instruments such as Ultra Low Level Liquid Scintillation System, Normal Liquid Scintillation System, Multichannel Gamma Ray Spectrometer, Geolog Rate Meter, Neutron Moisture Probe, Neutron Moisture Density Probe, Ultrasonic Depth Indicator, Tritium Enrichment Unit facilities for tritium and carbon dating of ground water, CO-2 sample preparation lines, and Soil Moisture Extraction Unit. These equipments are being used for the field investigations and laboratory analysis for the study soil moisture movement and estimation of recharge to groundwater, surface water and ground water interactioin and lake studies using isotopes, etc.

During the year 1996-97, Dr R J Drimmie, UNDP consultant from University of Waterloo, Canada visited the Nuclear Hydrology Laboratory and provided training to the staff to utilise the facilities in an efficient manner with the required quality control of laboratory procedures. Studies on water balance, sedimentatioin and identification of recharge sources for lake Naini in district Nainital using isotopic techniques have been carried out. The study of recharge to ground water due to rainfall and irrigatioin in Narmada basin using tritium tagging technique is also in progress.

5.8 Technical Facilities

The Institute has the following central technical facilities for use by the various scientific divisions :

i). Computer Centre

The Computer Centre of the Institute was established in 1982 with VAX-11/780 computer system, to give more emphasis on computer oriented research. Now the Centre has many computers like VAX-3200, ALPHA processor based workstations (DEC-2000/300 and DEC-255) and different categories of PCs. To increase the computation capabilities, additional peripherals like digitiser, scanner, colour printer, laser printer etc. have been procured.

A Local Area Network (LAN) has been setup in the Institute to connect with PCs located at various places with the server and workstations. This LAN is being expanded to cover more area.

A number of softwares, including ARC/INFO package, have been procured. A computer course for Database Managers was also organised under ongoing Hydrology Project.

Order has been placed for VSAT terminal for providing INTERNET facilities in the Institute.

ii). Automated Hydrologic Station

The Institute has an Automated Hydrologic Station (AHS) procured from Switzerland under the first UNDP project and an Automated Weather Station received under the WAMATRA -II project. The hydrometeorological data on rainfall, temperature, humidity, wind speed and direction, solar radiation, sunshine are recorded continuously. Hydrological data on soil moisture (conductivity), percolation, soil temperature, weight of the lysimeter are also recorded at an interval of 30 minutes. The data are automatically collected and are being used for further hydrometecrological and hydrological analysis.

iii). Workshop

The workshop not only helps in carrying out the works entrusted by the maintenance unit but also renders help to scientists in developing prototypes of automated hydrological instruments. During the year the workshop has been used for fabricating current meter, solenoid valve for the Nuclear Laboratory and fencing around the water tank of the Institute. Office furniture - like small and big racks, and tree guards, etc have also been fabricated in the workshop

iv). Library

As laid down in the objectives of the Memorandum of Association, the Institute since its inception has been in the continuous process of building a good technical library with latest publications in the area of hydrology and water resources. The Library has so far procured 9585 books on the various disciplines of hydrology and water resources, computers and electronics. Out of these 1362 books were transferred to the libraries at the Regional centres of NIH. Besides 3410 technical reports and technical papers were made available by other organisations. The library also has 442 manuals of computer software, 1975 maps,41 microfiche and 305 Indian and foreign standards. The library is subscribing to 34 Indian Journals and 40 Foreign Journals. Three of the Indian Journals are in Hindi. Some books in Hindi were also procured during the year.

5.9 Construction Works

The construction activities at the main campus of the Institute and the staff colony of the Institute have progressed satisfactorily during the year.

A. Work Completed During the Year :

i) NIH Campus :

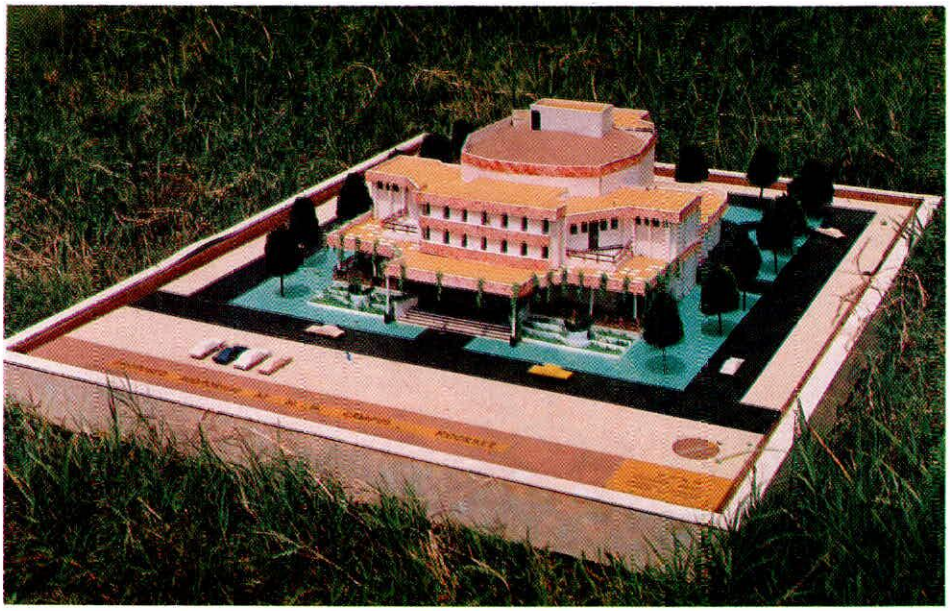
a. The Wing 'B" of the Second Laboratory Block which was completed during the year has been occupied with the establishment of 5 laboratories.

b. One hundred kilo litres overhead water tank was completed and has been put to use.

ii) NIH Staff Colony :

a. The construction of two blocks of Group 'D' staff (24 residences) have been completed.

b. All internal roads have been laid.



A Model of the Proposed Institute Auditorium.

Two Blocks (12 residences) of Scientists' Residences under construction in Institute Staff Colony.

c. Erection of street lights is completed.

d. Earth filling, sewerage and drainage works are completed.

e. 200 kilo litres overhead water tank was completed.

f. Two blocks of Sc. E & F residences (8 residences) were constructed.

g. Two blocks of Sc. B & C residences (12 residences) were completed.

B. Work in Progress and Schedule of Completion

i) NIH Campus :

a. Construction of Wing-C of Second Laboratory Block : Started in December 1995 and was scheduled to be completed by University of Roorkee in December, 1996. Because of non-availability of cement etc. construction is delayed. Presently 60% work is completed and building may be handed over by December, 1997.

b. Construction of Auditorium : The construction of an auditorium with a seating capacity of about 300 persons has been entrusted to M/s RPNN Ltd. The drawings and plans have been finalized. The construction is proposed to start in May, 1997 and the building is scheduled to be completed by July 1998.

ii) NIH Staff Colony

a. Transit Block : This building was started by University of Roorkee in December 1995 but because of very high water table the foundation design was changed. Presently also the construction is stopped because of high water table. The building is scheduled for completion by August 1998.

b. Reception-cum-Guard Room-cum-Gate : The work was started by University of Roorkee in July 1996, however, because of some internal problems enough progress could not be made. It is proposed to hand over the work to some other agency for expeditious completion.

c. Sub-station and Pump House : The work was started by University of Roorkee in July 1996, however, because of some internal problems enough progress could not be made. It is proposed to hand over the work to-some other agency for expeditious completion.

C. New Works

a. Two Blocks of Scientist B and Scientist C Residences : The work has been entrusted to M/s RPNN Ltd. in January, 1997 and it is expected that this will be completed by August 1997.

b. Internal Water Supply Network : The work has been entrusted to M/s RPNN Ltd recently. The date of completion has been fixed as July 1997.

Regular meetings are being held with the officers of University of Roorkee and M/s RPNN Ltd, Delhi for monitoring the progress of construction works.

D. Construction Works at Patna :

The construction activities at Ganga Plains North Regional Centre (GPNRC) have been completed. These include two residences for senior scientists, 4 residences for middle and junior level scientists and an excellent office building. During the year, these works were completed and street lighting, internal roads etc were also completed. Some minor internal works are in progress.

E. Construction Works at Kakinada :

The construction works for the Regional Centre at Kakinada were entrusted to M/s RPNN Ltd, Southern Zone as a deposit work. So far, boundary wall, laboratory sheds were completed and physically handed over. Presently, the laboratory sheds are being used to house the office of the Regional Centre also besides housing the laboratories. The construction of the Administrative Building is also nearing completion and presently the flooring is being carried out. It is expected that building would be ready for occupation by the end of May, 1997. The land developmental activities, street lighting and construction of roads are also entrusted to M/s RPNN Ltd. and the works are to be started shortly.

6.0 Consultancy and Sponsored Projects

From the inception, besides regular R and D work, the Institute has been carrying out studies referred to it by the various State and Central Government organisations on consultancy basis. Their number has been kept under a reasonable limit with a view to provide more weightage to research activities. Some research projects were sponsored and funded by Government organisations. The list of consultancy/ sponsored projects on which the Institute worked/ and is working during the year is given in Appendix VI. During 1996-97, studies were carried out in the following consultancy/sponsored projects.

CONSULTANCY/SPONSORED PROJECTS COMPLETED DURING THE YEAR :

6.1 Sabarmati System Studies

This project has been sponsored by the Narmada and Water Resources Department, Government of Gujarat. Sabarmati system is a multipurpose multireservoir system which serves for flood control as well as for irrigation and domestic and industrial water supply. Integrated regulation of the reservoirs in the system upto Ahmedabad city has been studied for various conservation purposes and for flood control. For each storage structure, optimum rule curves have been derived. Dharoi reservoir is the main control location for flood control at Ahmedabad. A software and a flood control policy have been developed to assist the operator at the dam site for deciding the safe release from the dam at any time. In addition a conceptual model has been calibrated for forecasting inflows at the dam site.

The project has been completed during the year 1996-97 and the final report of the project entitled, "Sabarmati System Studies", was sent to the Govt. of Gujarat in March 1997.

6.2 Assessment of Impact of Irrigation Application in a Part of IGNP Stage II Command Area Underlain by Hydrologic Barrier

This consultancy project has been referred by Command Area Development, Indira Gandhi Nahar Pariyojana (IGNP), Bikaner, Rajasthan. The study area includes the command areas of Pokharan lift and Phalodi lift canals. The following aspects have been studied under the project :

(i) The impact of different water allowances and evolution of water table under different delta,

(ii) the amount of water which will infiltrate through the hard pan and join the aquifer underlain by the hard pan,

(iii) design of the drainage system to control the water logging in the project area including cost estimate of the drainage and their benefit cost ratio, and

(iv) conjunctive use in hard pan and non hard pan areas.

The evolution of water table for different deltas has been studied using both water balance approach and detailed groundwater modelling of the study area. The hydraulic conductivity of hard pan was determined by Packer tests. For the ground water modelling study, the area has been discretized into 14 rows and 28 columns and two layers and evolution of groundwater table have

been obtained at all grid centres upto the next 20 years and 40 years respectively for lower and higher deltas. The progressive development of water logging condition with time has been obtained. The flow through hard pan has been obtained using analytical approach.

Lumped water balance study has been carried out to find the impact of different water applications. Design of sub-surface drainage and economic analysis has been made. Quantity of dissolved salts in the irrigation return flow which will appear in the long run has also been studied.

The final report has been submitted to the sponsoring authorities in three volumes. Volume-I deals with the lumped water balance study, Volume-II pertains to the groundwater modelling of the study area, and Volume-III takes into account subsurface drainage system and economic analysis.

It has been concluded that provision of subsurface drainage is necessary to contain the water level beyond one metre below ground surface. Provision of subsurface horizontal drainage is found to be beneficial. With provision of such drainage, there is scope to increase the intensity of irrigation.

The study has been completed and the final report has been submitted in September 1996.

6.3 Subsurface Drainage Investigations in Stage II of IGNP (RD 838)

This consultancy project has been referred by Commissioner, Area Development, Indira Gandhi Nahar Pariyojana (IGNP), Bikaner, Rajasthan. The study area includes the command areas of IGNP Main canal at RD 838. The following aspects were proposed to be studied under the project.

(i) determination of hydraulic conductivity (in-situ and laboratory), grain size distribution, bulk density, and chemical analysis of soil and water;

(ii) water balance of the study area,

(iii) identification of the cause of waterlogging, and

(iv) design of subsurface drainage (spacing, depth and filter).

During the year 1995-96, drainage coefficients were determined through water balance. Field and intercepting drains were designed. The optimal spacing and depth of field drains have been found.

During the year 1996-97, the hydraulic conductivity (in-situ and laboratory), grain size distribution, and chemical characteristics of soil and water have determined. Based on the drainage coefficient and hydraulic conductivity of soil, the drainage system has been designed.

The study has been completed and the final report has been submitted.

6.4 Preparation of Zonal Plan under UNDP-GEF Project on : Optimizing Development of Small Hydro-resources in Hilly Regions of India.

The Institute is jointly participating with the Alternate Hydro Energy Centre, University of Roorkee, Roorkee for a Project entitled, "UNDP-GEF Hilly Hydro Project - Zonal Plan". Under this Project, the Institute is involved in various activities which include delineation of potential sites for small hydro power schemes in the Himalayan Region and taking up hydrological studies for the evaluation of the dependable flows at the delineated potential sites.

During the year 1996-97, a software was developed to compute the dependable flows for gauged and ungauged sites. The regional flow duration curves were also developed for the delineated sites in the Himalayan region. The dependable flows were computed using the developed flow duration curves for various sites.

The study has been completed and a draft report has been submitted to the Sponsoring Agency for comments. The final report will be submitted after incorporating the comments.

6.5 Dam Break Studies of Pulinchintala Multipurpose Project

This project was sponsored by the Environmental Protection Training and Research Institute, Hyderabad. The Pulinchintala Project is a multipurpose project providing benefits in the sector of irrigation, power generation, pisiculture and tourism. The project is located in Andhra Pradesh on the river Krishna near Pulinchintala village, at around 85 km upstream of Prakasam Barrage in Bellamkonda Manual, Gander District. The project envisages construction of masonry dam at 159 metres on left side, 91.50 meters on right side for no overflow section, spillway of 616.42 metres and earth dam of 422.08 meters on left side.

In order to make available timely supplies during the transplantation period i.e. June and July it is proposed to form a terminal reservoir with capacity of 45 TMC near Pulinchintala village in Gander District across river Krishna. The flows available at the reservoir are only from the catchment below Nagarjuna Saga Dam. No interstate problems are involved in this scheme. The Pulinchintala reservoir after construction will serve as a balancing reservoir for making available timely supplies to the Krishna Delta.

The objectives of the sponsored project included :

1. To assess the dam break flood magnitude for hypothetical failure scenarios
2. To study the down stream movement of the flood wave caused by Dam failure
3. To delineate the area of flood inundation caused by the failure of the Dam

During the year, the work has been completed and result submitted to the Environmental Protection Training and Research Institute, Hyderabad.

ON - GOING CONSULTANCY PROJECTS :

6.6 Study of Interaction of Surface and Groundwater for River Ganga from Narora to Kanpur

This consultancy project has been referred and sponsored by Investigation and Planning Division of Water Resources Department, UP. The purpose of the study is to find the exchange of flow rate between River Ganga and the adjacent aquifer between Narora and Kanpur during the lean flow period. The data required for the study has been supplied by the sponsoring agency. The mathematical model for interaction of river and multiple aquifer system has been formulated. The expression for computing the river resistance parameter has been derived. An interim report has been prepared to the Project Authorities. The study is under progress.

6.7 Hydrogeological Studies at Jhamarkotra Mines

This project has been referred by Rajasthan State Mines and Minerals Ltd. with the objective to carry out ground water modelling to suggest the network of pumping wells to achieve the required drawdown in the Jhamarkotra Mines area in Udaipur district of Rajasthan. The following aspects were proposed to be studied under the project :

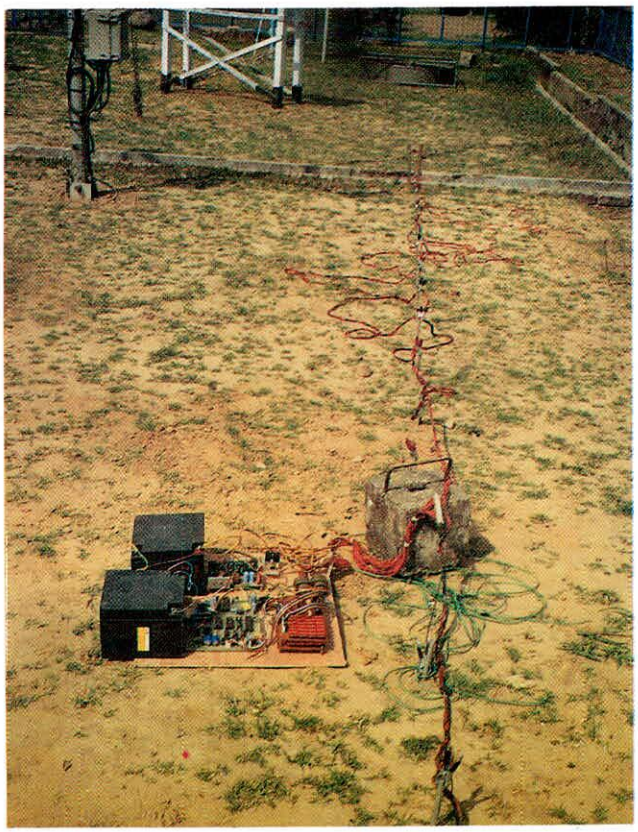
(i) identification of source of recharge to the water bearing rockphosphate and ground water potential zones,

(ii) a total water management plan, design and the effective dewatering wells to achieve drawdown of 15 m per annum,

(iii) computer aided ground water model of the area,

(iv) regional effect of mine dewatering on groundwater regime in the area, and

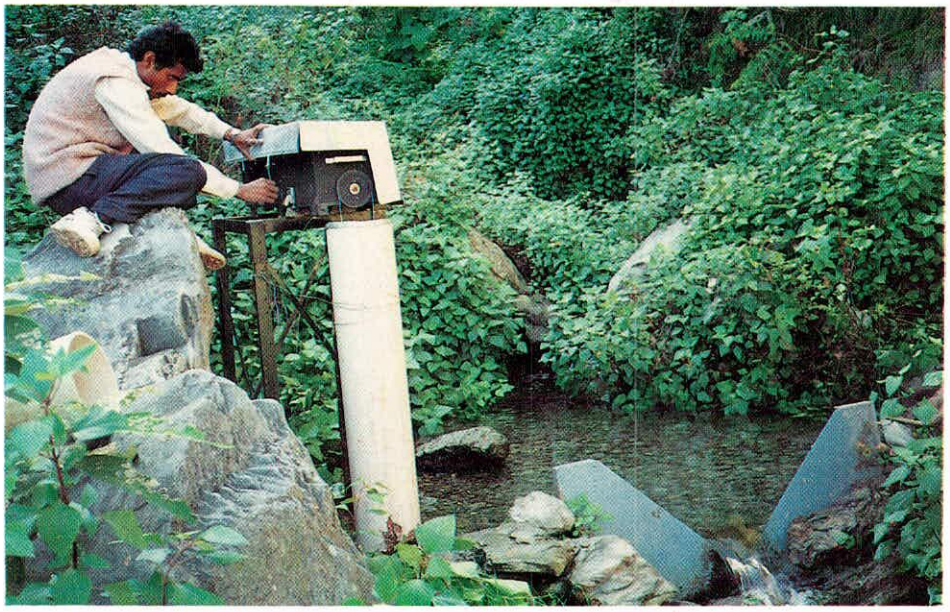
(v) any remedial measures to stop/reduce water ingress to the pit.



Field Testing of Soil Moisture Instrument Developed at the Institute

Field Testing of Weighing Type Snow Gauge at Dhanaulti, UP

EM Conductivity Measurements on the Bed of River Yamuna under Agra Project



Installation of Automatic Water Level Recorder at Discharge Measuring Site in Danda Watershed under DST Sponsored Project.

During the year 1995-96, the determination of distributed aquifer parameters using an optimization based numerical technique has been carried out. The source of water to the mines has been identified as rainfall recharge. The studies indicate that there is no sub-surface flow from adjoining area. Locations for installation of tubewell were suggested to RSSML. The tubewells have been found to be suitable for achieving drawdown of 15 m.

During the year 1996-97, the study is under progress and likely to be completed by next year.

6.8 Indigenous Development of data logger and sensor unit for watershed hydrology

This project has been sponsored by National Land Use and Conservation Board, Division of Soil Conservation, Ministry of Agriculture, Government of India. A data logger based on powerful micro controller 8031 has been developed with the external assistance of M/s MICRON , Roorkee. This data logger has the provision to use one raingauge having one tipping bucket system, one weighing system, one temp. sensor including solenoid valve; and one water level sensor based on optical shaft encoder technique and four suspended sediment-cum-flow velocity sensors. Provision has also been made to use solar penal for charging DC 12V, 24AH battery for the uninterrupted working of the data logger. The data of rainfall, water level/stage and suspended sediment can be stored in a memory module at preselected time interval and data can be transferred on to the PC directly in the field or it can be transferred to PC in the laboratory by replacing the memory module from the data logger. The development of the data logger has been completed and it is under testing.

The typical rainfall sensor, water level sensor and suspended sediment-cum-flow velocity sensors have been developed at NIH. Efforts have been made to remove all the problems presently being faced in such equipment/sensor available in the national or international market. These sensors have been successfully tested in the laboratory with the data logger referred above. The provisions have been made in the software to make the sensors fully automatic in order to remove all the manual errors also.

The draft of the final report was submitted to the authorities of Ministry of Agriculture, Government of India, New Delhi in March 1996. No comments have been received so far from the Ministry of Agriculture, Govt of India and the status of the project during the year 1996-97, is the same as in 1995-96. This project has been completed from practical point of view but, as desired by sponsors the testing of datalogger with sensor units are to be done by some external agency for which the instructions are awaited from the sponsoring authorities.

6.9 Hydrological Studies of Lake Naini, District Nainital

This project has been sponsored by the Directorate of Environment , Government of Uttar Pradesh, through Naini Lakes Development Authority, Nainital. The study of water balance, sedimentation rates/pattern, hydrodynamics and pollution aspects of Lake Naini were proposed to be carried out using conventional as well as advanced technique. The Institute has completed the study of water balance, sedimentation rate/ pattern and the estimation of useful lake life using isotope techniques. The hydrodynamics and poluttion aspects of the lake are being studied. The following actions have also been taken :

i. An interim report-I covering various aspects hydrological aspects of lake Naini including preliminary studies carried out was submitted to the Department of Environment, Government of UP, Lucknow in 1994.

ii. On the basis of the studies carried out in the year 1994-95, 1995-96 and 1996-97 an interim report-II was prepared covering the details of the progress of various studies was also submitted to the project authorities.

iii. The sedimentation rate has been computed using conventional and sediment dating technique. The life of the Naini lake has been predicted 2200 years as computed with the sediment dating technique against the life predicted by the earlier investigator of PWD which ranges from 80 to 380 years.

6.10 Temporal Distribution of Glacial melt runoff of Dokriani Glacier and its Relationship with Meteorological Parameters.

The project is sponsored by Department of Science and Technology, Government of India. Glaciers and snow are reservoirs of fresh water and the melt from them reaches the Himalayan rivers during spring when the contribution from other sources is at its lowest. However, during summer the melt-rates increases and together with rain could cause flooding in some years. Also because of the unstable soil, steep slopes and high velocities of the flows the sediment carried by the melt streams is high and causes not only silting of the reservoirs downstream but is also known to damage the turbines of hydroelectric power stations. Study of the hydrological aspects of the glaciers and their melt is, therefore, very vital.

Though glaciers have been known as a source of water since long, very few studies on the hydrological aspects of the glaciers have been done. For the last ten years scientists in the Institute have been involved in studies of the hydrological aspects of glaciers.

The hydrological studies of Dokriani glaciers have been undertaken by the Institute in much greater detail, through this project sponsored by Department of Science and Technology. Unlike in HP, the glaciers in west UP receive rainfall almost daily during the pre-monsoon and monsoon season. The runoff due to melt and rain is thus a complex process and identification of discharge due to glacier melt, therefore, requires skill and experience. Based on the studies carried out by NIH during 1994 and 1995 it was seen that the melt discharge is more during the months of July and August.

The objective of this project is determination of total melt water yield from the Dokriani glacier and its distribution with time. It involves collection of the meteorological and hydrological data near the snout of the glacier for a period of 3 years during summer period. Every year a team of National Institute of Hydrology visits Dokriani glacier and collects required data for establishing relationships between glacier melt runoff and meteorological parameters.

A standard hydrometeorological observatory has been set up at about 4000m altitude. This observatory is equipped with the following instruments : Ordinary and self-recording raingauge; Evaporimeter; Thermograph; Hydrograph; Maximum & minimum thermometer; Dry and wet bulb thermometer; Anemometer; Wind vane; and Sunshine recorder.

For continuous monitoring of glacier melt runoff an automatic water level recorder was installed in 1995 at the gauging site near the snout. In addition to the use of floats for velocity determination a propeller type pigmy current meter was also used for the measurement of velocity. Suspended sediment samples were collected at specified timings. Two years work under the project has been completed and third year's work is under progress.

6.11 Development of Instruments for Automation of Irrigation Scheduling and Groundwater Recharge Monitoring Using Soil Moisture Measurements.

This project was sponsored by the Ministry of Agriculture, Government of India for development of an insitu instrument for soil moisture measurements.

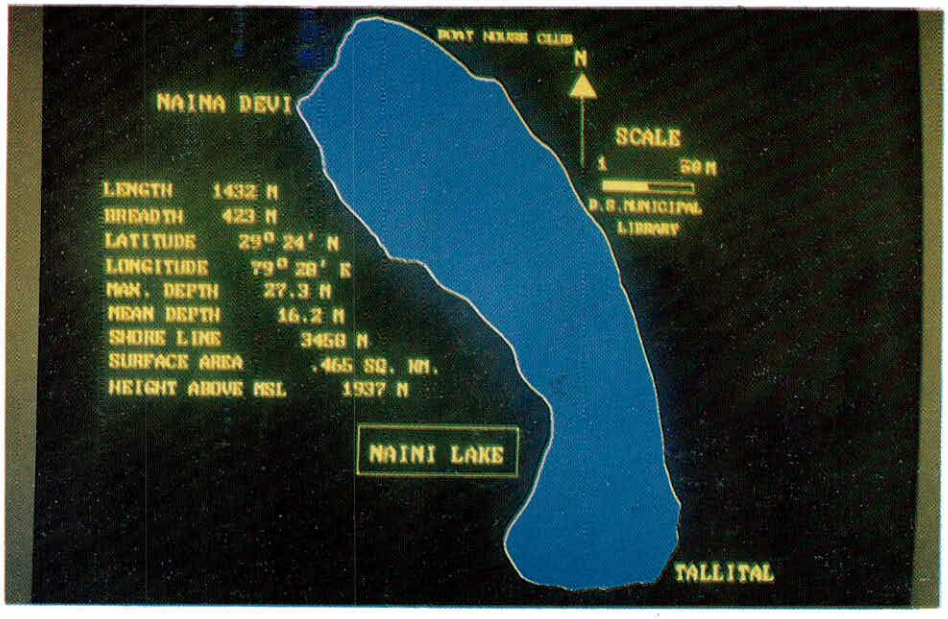
Under this project, a power converter section to pass a near DC current in the soil and the electronic circuitry for multi-electrode measurements were developed during the year.

Further work is in progress for finalising the fabrication of other circuitry.

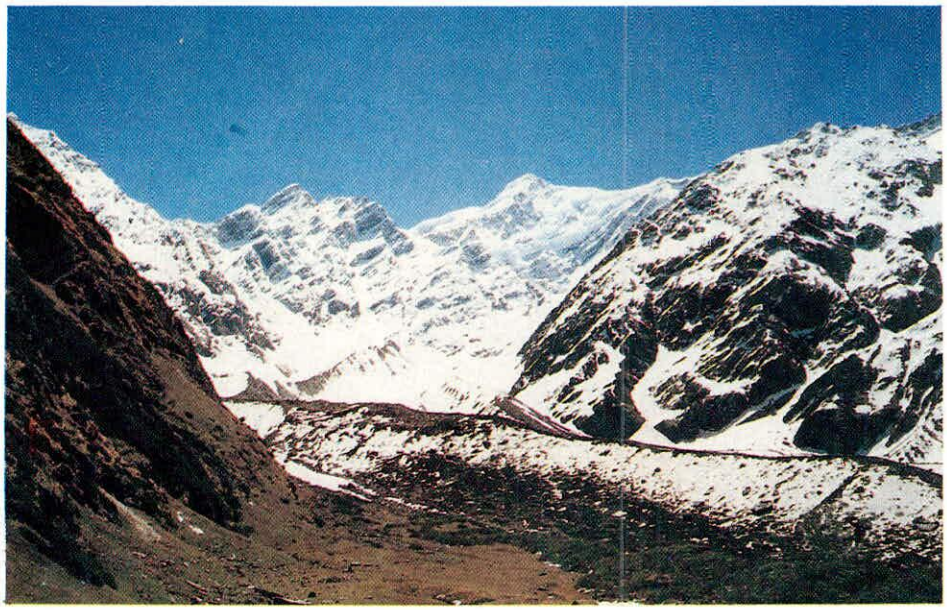
6.12 Exploration of Construction of Infiltration Gallery Inside the Bed of River Yamuna at Agra

This project has been sponsored by Uttar Pradesh Jal Nigam, Agra. The city of Agra, with a population of more than one million, is situated on the right bank of river Yamuna. The drinking

A Team from Ministry of Agriculture holding discussions with Director regarding Sponsored Projects.



A Map of Nainital Lake Generated by Remote Sensing Technique.



A View of Garhwal Himalayas - The Dokriani Glacier being Studied by the Institute can be seen in the Centre.

Discharge Measuring Site established by the Institute on the Dokriani Glacier.

water supply to Agra city is mainly through water drawn from river Yamuna. The water of the river is highly polluted, which is also used as a receiving body for the waste water disposal from Delhi, Faridabad, Mathura and also from Agra itself.

Agra Jal Sansthan has a water works complex on the right bank of the river Yamuna, which draws water from the river through a channel. A huge amount of money for chemicals are spent to treat this polluted surface water to make it potable. Therefore, it has become necessary to tap good quality sub-surface water for drinking water supply. Most of the ground water present around Agra city is brackish in nature and is not good for drinking. Considering the brackish nature of groundwater and thin layers of aquifer intracalated with clay layers, only feasible way to get good quality water is by tapping the sub-surface water through radial collector wells/infiltration gallery in the bed of river Yamuna.

The objective of this project is to study the feasibility of construction of infiltration gallery in the river floodplain near both water works (existing and new) at Agra, to provide good quality sub-surface water from the bed of river Yamuna.

The first interim report has been prepared and submitted to the Project Authorities in Feb. 1997.

6.13 Hydrological Studies of Myntdu Leska Catchment

On the request of Meghalaya State Electricity Board, Govt of Meghalaya a consultancy project on Hydrological Studies of Myntdu Leska catchment, where the department had proposed a Hydro Electric project in 9th plan, was undertaken by the Institute. All available data were collected and a formal proposal with detailed terms and conditions was prepared and sent to Meghalaya State Electricity Board.

Preliminary frequency analysis was carried out with the available data. Further processing and analysis of data is in progress.

6.14 Integrated Hydrological Study (Instrumentation, Investigations and Modelling) for Sustainable Development and Management of Two Hilly Watersheds in U.P.

The Department of Science and Technology-sponsored project involves hydrological investigations in two small hilly watersheds located in Tehri-Garhwal District (UP), representative of the mountainous subhumid agro-ecological region in the Western Himalayas. Both these watersheds are of 1,000 ha area approx., and are about 10 kms apart. One of the watersheds has received treatment under watershed management scheme (operated by the UP Govt and local NGOs) whereas the other watershed is an untreated one, thereby making available an ideal set of paired watersheds. Some baseline data (mostly on socio-economic aspects) has already been collected under the previously operated scheme in these areas.

Using an integrated approach of hydrologic instrumentation, field investigations, and remote sensing and Geographical Information System (GIS), the project envisages to evolve appropriate model for integrated and sustainable development in the two watersheds. This would provide techniques and methodologies which could be used as a guide to the behaviours of other small mountainous watersheds where only basic hydrometeorological data might be available.

The specific objectives of the project include the following major indicators, besides being aimed as a pilot project for demonstration to the interested users (e.g. students, academicians, researchers, administrators, NGOs) :

1. Erosion and sediment control strategies
2. Changes in land use and vegetative cover
3. Rainfall-runoff studies
4. Soil and water conservation (including springs rejuvenation) strategies
5. Hydrologic simulation modelling
6. Devise mechanism for people's participation in sustainable development of small watersheds.

The equipment installed in one of the watersheds (Danda watershed) during 1996 included

(i) 90 V-notch and ;monthly water level recorder,

(ii) weekly SRRG,

(iii) weekly thermohygrograph.

Hydrometeoro-logical data and maps were collected from available sources. geological (structural), geophysical (resistivity and EM), soil, water quality, topographic, and hydrological and hydrometeorological surveys were carried out in the area. Besides, contour map and DEM of the Danda watershed were prepared, and isohyetal map of rainfall for the Tehri District was prepared.

Soil surveys were carried out to determine the soil types in the study area. The survey included determining soil, depth, slope, texture and erosion condition. Soil samples were collected from various locations in Danda Gram panchayat area and analysed to determine pH, EC, sodium, potassium, calcium, magnesium, nitrate, sulphate, phosphate and chloride.

Discharge measurements have been carried out for the springs in this area. The spring discharge data show that the natural water availability of spring water is not enough to meet the villager's daily requirements during the summer season. Water samples from the various springs in the area were collected and analysed. Further investigations are under progress.

7.0 International Collaboration

7.1 Developing Capabilities for Hydrological Studies UNDP Assisted Project

The project for Developing Capabilities for Hydrological Studies assisted by UNDP under the Third Country Programme has been in operation in the Institute since November 1991. The project was originally for a period of 5 years and was extended subsequently for 6th year. Accordingly, various activities under the project have been phased to achieve desired rate of progress.

The areas of hydrology which are being developed through the project are as follows :

- Hydrological Instrumentation
- Deltaic Hydrology
- Nuclear Hydrology
- Hydrometeorology
- Lake Hydrology
- Catchment Hydrology
- Data Processing and Analysis
- Snow Hydrology
- Mountain Hydrology
- Remote Sensing Applications
- Environmental Hydrology
- Forest Hydrology

The infrastructural facilities which are being made available to the Institute through the Govt. of India counterpart contribution are being further strengthened through the following components provided under the project :

- Visit of consultants in the twelve areas
- Study tours of senior scientists
- Training of scientists abroad on fellowship in the specialized areas
- Procurement of equipment

Under the Project the strengthening of the following laboratories, centres and facilities was taken up :

- Hydrological Instrumentation Laboratory
- Nuclear Applications Laboratory
- Remote Sensing Application Laboratory
- Water Quality Laboratory
- Surface Water Laboratory
- Ground Water Laboratory
- Computer Centre
- Laboratories at the Regional Centres
- Observatories in the Representative Basins under Regional Centres.

The componentwise status of the project implementation up to the end of March 1997 is as follows :

a) Thirty visits of consultants have been made so far in the areas of Forest Hydrology, Data Processing and Analysis, Environmental Hydrology, Lake Hydrology, Hydrometeorology, Snow Hydrology, Catchment Hydrology, Remote Sensing, Nuclear Hydrology, Hydrological Instrumentation, Mountain Hydrology, etc. The consultants during their visit, normally for a period of one month, interacted with the scientists of the Institute who were identified to work in the respective areas and also with field engineers

and academic faculty through workshops and informal discussions. In some cases the consultants were also taken on field visits to facilitate the scientists to obtain the views of the consultants on the latest methods of data collection and sampling techniques. During the year 1996-97, five consultant's visits were made. The details of the consultant's visits are given in Appendix XII-a.

b) Twenty scientists at the level of Scientists B and C received training at the Institutes of excellence in the advanced countries like USA, UK, Canada, France, and Australia in the areas of Hydrometeorology, Snow Hydrology, Catchment Hydrology, Deltaic Hydrology, Data Processing, Nuclear Hydrology, Remote Sensing Applications, Environmental Hydrology, Forest Hydrology, and Mountain Hydrology. The scientists prepared Status Reports in the respective areas of their training as a pre-requisite for the training to acquire adequate and latest knowledge in the subject area before proceeding on specialized training. The job description for the training period of 4 months for the trainee scientist was prepared in consultation with the supervisors in the host institutes to meticulously follow the work assignment. During 1996-97, two scientists were trained. After their return from training the scientists submitted reports on their training. The details of the training of scientists are given in Appendix XII-b.

c) The Project Director, two Project Coordinators and seven senior scientists at the level of E and F have gone on study tour upto the end of March 1997. These study tours have been undertaken to cover general areas of hydrology as well as the specific areas under the project viz. Forest Hydrology, Hydrometeorology, Environmental Hydrology, Data Processing, Mountain Hydrology, Catchment Hydrology, and Lake Hydrology. After return from the study tour, a report on the tour is submitted indicating the possible places of training for the scientists, equipment to be procured, possible consultants and details of technical interaction. The countries which were visited under the study tours so far include China,Japan, Thailand, Australia, Canada, USA, Switzerland, Sweden, Germany, UK, The Netherlands, and France.

Under the Project US $ 1.490 million have been provided for procurement of equipment. Out of which equipment worth US $ 447,167 was procured during the year 1996-97. The equipment procured so far has been made operational in the various laboratories at Roorkee and regional centres at various locations and are being used for laboratory and field oriented studies The list of major equipment procured under the Project during 1996-97 is given in Appendix XII-c.

7.2 Hydrology Project

A reliable and easily accessible data base providing historical records for all aspects of the hydrological cycle is essential for planning and management of water resources particularly for long term planning and real time management of the water resources. Keeping this objective in view a Hydrology Project was formulated for the peninsular rivers in India. The project with World Bank Credit 2774-IN was launched in September 1995. The Credit Development agreement was signed by the World Bank on 22nd September for six years operation (1995 - 96 to 2000-2001) and Credit effectiveness of the project began on 20 December 1995.

Five Central organisations including the Central Water Commission, Central Ground Water Board, National Institute of Hydrology, Central Water and Power Research Station and the India Meteorological Department and eight states of the peninsular India namely Andhra Pradesh, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa and Tamilnadu are participating in the project.

The main role of National Institute of Hydrology (NIH) in the 'Hydrology Project' is to strengthen and expand Institute's capabilities for training to serve the important training objectives in the Hydrology Project namely

(i) Data collection and processing procedures

(ii) Use of computers and software for water data management and

(iii) Skills in the use of specialised laboratory and field equipment.

Besides organising advanced computer courses for Data Base managers and Data Base supervisors,

Director in a Meeting with Hydrology Project Mission Experts

Hydrology Project Experts with Course Participants and Institute Faculty.

a major responsibility of the institute would be to provide training of trainers (TOT) in the required skills through short courses run at Roorkee and in the states. NIH would also advise the states on the content of the training courses which would be subsequently run in house by the state agencies. In addition, NIH would also organise courses for senior level officers from the states on selected specialised topics for application to field problems.

The activities undertaken by the NIH under the Hydrology Project so far are :

a. Organising Training Courses

b. Participating in the courses/workshops being organised by other organisations

c. Study tour by Director, NIH to Paris

d. Actions for procurement of computers and equipment

During 1996-97, the institute had proposed to organise a total of seven courses out of which the following six courses were organised :

1.	Computer Course for Data Base Managers	30 July - 09 August, 1996
2.	Course on Software for Surface Water Data Management	19-30 August, 1996
3.	Course on Software for Ground Water Data Management	07-18 October, 1996
4.	Hydrology of Reservoirs	09-20 December, 1996
5.	Hydrological Modelling	20-31 January, 1997
6.	Dam Break Flood Studies	20 Feb.- 06 March, 1997

Scientists of the Institute participated in the following workshops organised by other organisations under the Hydrology Project :

1. Three Scientists of the Institute participated in the "Two Day Workshop on Hydrology Project Procurement Policy" held at CTU, Pune during 3- 4 July 1996.

2. Two Scientists of the Institute attended the "Two Day Training Programme on Establishment of Data Centre"organised by the India Meteorological Department at Pune during 8-9 October, 1996.

3. One Scientist and one Senior Research Assistant participated in the "Water Quality Standardization Workshop" held at Hyderabad during 9-10 December 1996.

4. One Scientist attended the "Two Day Workshop on Project Management" at Hyderabad during 12-13 December, 1996.

5. Two Scientists participated in "Two Day Training Planning Workshop" at New Delhi on 16-17 December, 1996.

6. One Scientist, one Section Officer and one Upper Division Clerk of the Institute participated in the "Two Day Workshop on Hydrology Project Procurement Policy" held at CSMRS, New Delhi on 6-7 January 1997.

7. One Scientist participated in the "Workshop on Groundwater Monitoring" held at Bangalore during 28-30 January, 1997.

8. Dr S M Seth, Director, NIH participated in the 12th meeting of the Inter-Governmental Council and IHP meeting and IIIrd UNESCO-IAHS Kovacs Colloquium at Unesco, Paris during September 1996 as a Government of India representative.

Scientists of the Institute have been nominated to function as members of the following committees :

i. Procurement Committee of CWC

ii. Procurement Committee of CGWB

iii. Hydrology Data User's Group of Surface Water CWC

iv. Hydrology Data User's Group of Groundwater of CGWB

8.0 Technology Transfer and Mass Communication

The transfer of technology developed or implemented by the Institute is an important objective and activity of NIH. To fulfill this objective the Institute has been organising short duration workshops on various topics of hydrology at Roorkee and in the States. From time to time the Institute is also organising National, Regional and International Courses, Seminars and Symposia. The Institute is also disseminating the methodologies developed at the Institute through publication and circulation of reports, manuals and publication of technical papers.

8.1 Organisation of Workshops

Technology transfer activities form an important component of the Institute's activities besides publication and circulation of reports of studies and research. The Institute has been organising short duration (5 day) workshops dealing with specific areas in hydrology for transfer of relevant theoretical background as well as methodologies including computer programmes to field engineers of Central and State Government organisations in the country. The workshops on any new topic are first organised at Roorkee where the participants are given the complete course material including listing of computer programmes and were provided with opportunities of working on the computer using field data. On specific requests and response from the concerned State organisations, the workshops are then organised in States. The workshops on the flood frequency analysis, unit hydrograph techniques, design storm and design flood, processing and analysis of rainfall data, application of remote sensing techniques, and other topics of hydrology have been organised in a number of States. The Institute is continuing the technology transfer programme and adding new topics for organising short duration (five days) training workshops for the benefit of the States as in earlier years.

During the year,workshops were organised in Karnataka Maharashtra, Andhra Pradesh, J&K, Bihar, and Roorkee. The details are given in Appendix XIV.

Scientists and engineers from several Central and State Government organisations, academic institutes participated in the workshops. The workshops/courses were well received and appreciated.

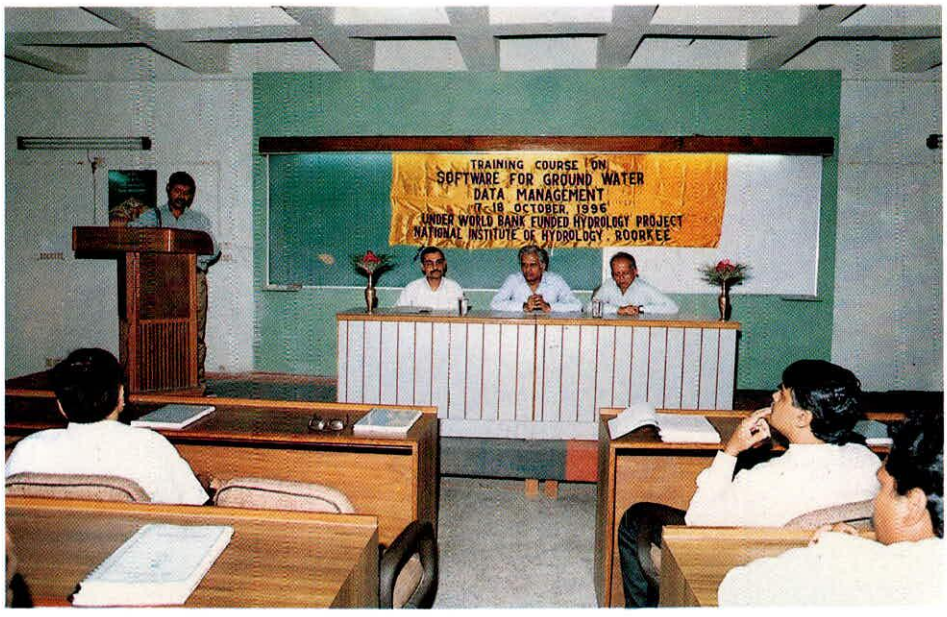
8.2 Organisation of Brain Storming Sessions

During the various meetings of Indian National Committee on Hydrology and its research committee, an urgent need was felt to discuss about the various hydrological and water resources problems of the region and some specific areas. Such Brain Storming Session may lead to identification of thrust areas, need for research in these areas and may ultimately lead to preparation of useful research projects which could be processed by the INCOH for Ministry of Water Resources funding. Accordingly the following Brain Storming Sessions were organised :

1. Brain Storming Session on Hydrological Problems and Perspectives of Lower Gangetic Plains

The one day Brain Storming Session on "Hydrological Problems and Perspectives of Lower Gangetic Plains" organised by the Ganga Plains North Regional Centre of National Institute of

Director Delivering Inaugural Address at the Dam Break Flood Studies Workshop.



A View of the Dias at the Training Course on Software for Ground Water Data Management.

Hydrology was held on January 3, 1997 at the Water and Land Management Institute (WALMI), Patna. About 55 official delegates and invited guests from Uttar Pradesh, Bihar and West Bengal participated in the activity.

The activity was inaugurated by Shri Jagdanand Singh, Hon'ble Minister for Water Resources, Bihar as the Chief Guest. About 90 people attended the Session. 14 invited scientific papers covering various aspects of 'Hydrological Problems and Perspectives of the region' prepared by the different organisations were received and these were discussed in two technical sessions :

i) Surface Water Hydrology, and

ii) Groundwater Hydrology and Environmental Aspect.

In order to achieve the goal of the brain storming session, an open discussion session with specific agenda was held wherein experts and delegates were discussed about the highlighted problems of the region and other issues. This session was chaired by Director, National Institute of Hydrology.

As outcome of the activity, following thrust areas of research have been recommended :

i. Floods and Hazards of Floods

ii. Water Logging and Drainage

iii. Water Quality and Water Pollution

iv. Erosion and Sedimentation

v. Water Assessment and Availability

vi. Hydrological Network Design and Data Management

vii. Disaster Preparedness System

viii. Coastal Problems

ix. Public Awareness Programme

x. Watershed Management

2. Brain Storming Session on Hydrological Problems of Hard Rock Region

One day Brain Storming Session on "Hydrological Problems of Hard Rock Region", organised by the Hard Rock Regional Centre, National Institute of Hydrology, Belgaum was held on 15 March 1997 at the Institution of Engineers (Local Centre), Belgaum. About 30 delegates and invited guests from the various organisations of the region participated in the activity.

The Brain Storing Session was inaugurated by Dr C D Naganagoudar, Principal, KLES College of Engineering and Technology. Mr Venkat Rao, Engineer-in-Chief, WRDO, Bangalore was the guest of honour. Dr G C Mishra, Scientist F and Technical Coordinator (Regional Centre Belgaum) presided over the function. About 50 participants attended the function. Six invited scientific papers covering various aspects of hydrological problems of the Hard Rock Region were received from different organisations and were presented in the technical session. In order to achieve the goal of the brain storming session, a discussion session was arranged, wherein experts and delegates discussed about the technical papers presented, the highlighted problems of the region, and other issues.

As an outcome of the session, following thrust areas of research have been recommended :

i. Quantification of regeneration flow in canal command

ii. Waterlogging and salanisation control in canal command

iii. Rainwater conservation through watershed management and peoples' participation

iv. Solution to drainage problem in black cotton soils

v. Artificial recharge study

vi. Revitalization of failed and low yielding bore holes by hydrofracturing

vii. Study of failure of wells

viii. Design and spacing of bore and dug wells

ix. Development of regional flood formulae

x. Groundwater contamination control

3. Brain Storming Session on Hydrological Problems and Perspectives in Western Himalayan Region

The Brain Storming Session on Hydrological Problems and Perspectives in Western Himalayan Region was inaugurated by

Hon'ble Minister for Works and Estates, J&K, Jenab G M Shah ji. A key note address was delivered by Director, National Institute of Hydrology. A number of technical papers related to the problems of the Western Himalayan Region and their solutions, were presented in two technical sessions.

As an outcome of the session, following thrust areas of research have been recommended :

i. There is a need to develop a better understanding of hydrological processes for Western Himalayan Region.

ii. The existing status of hydrological network and data availability has to be critically reviewed particularly in the remote and high altitude areas and suitable steps be taken for establishment of networks of minimum density.

iii. There is a need to develop capabilities in the region for sustainable development and management of water resources and their conservation.

iv. Suitable R&D programmes have to be taken up at appropriate levels for systematic studies of effect of natural and human activities on hydrologic regime such as deforestation, loss of biodiversity, use of fertilizers, pesticides, industrial pollution and urbanization.

v. There is a need to properly document the existing status of surface and groundwater quality and develop methodologies for their monitoring and prediction.

vi. New technologies like GIS, RS, telemetry should be used and technology and expertise should be acquired at various levels through training and transfer of technology.

vii. Suitable mechanism has to be evolved for coordinated effort for sustainable development and management of water resources in this region involving participation of Government and non-Government as well as research and academic organizations/individuals and experts.

viii. Snow and glaciers are an important source of water resources in this region, particularly in lean season and there is a need to properly understand and model their melting process for assessment and forecasting.

ix. Systematic studies of lakes (particularly high altitude lakes) should be initiated.

x. Serious attempts are needed to increase public awareness regarding key issues of water, its quantity and quality, and to involve all sections of society, particularly women in provision, management and safe-guarding of water.

8.3 Publication of Newsletter

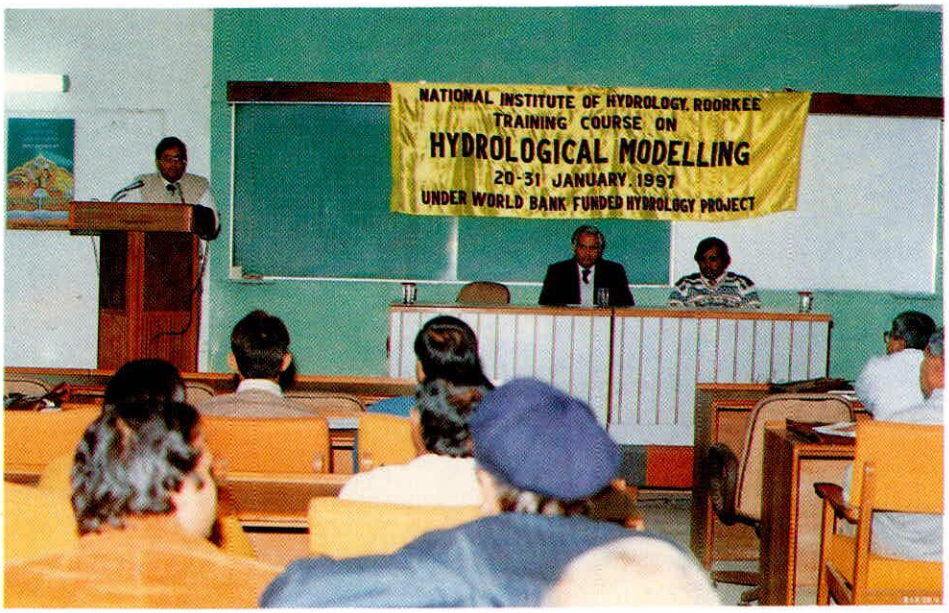
The half-yearly Newsletter of the Institute 'Jalvigyan Samachar' was published regularly. The Newsletter contains abstracts of studies and research carried out by the Institute and information on the activities of the Institute. News on the activities relating to Hydrology and Water Resources from other organisations is also published. The newsletter is circulated to about 500 Central and State Government organisations and academic and research institutes dealing with hydrology and water resources.

8.4 Preparation of Water Science Series

Water Science Series on 'Monsoon' written by Dr D S Upadhyay from India Meteorological Department, New Delhi and 'Soil Water Plan Relationship' written by Dr G S Rajput, Professor, Agricultural University, Jabalpur have been published.

8.5 State of Art Reports

In pursuance of its objectives to prepare and periodically update the state of art in different branches of hydrology and disseminating the same, the Indian National Committee on Hydrology which is attached to the Institute had taken up a programme of requesting experts to prepare state of art reports in various facets of hydrology. The topics and experts are identified by the Panels of INCOH



Dr K S Ramasastri, Project Coordinator, Hydrology Project Addressing the Participants at the Training Course on Hydrological Modelling.

Participants and Faculty of the Training Course on Software for Surface Water Data Management.

and are recommended to INCOH for final decision.The status of various reports since inception of this activity is as below :

S. No.	Title of the State of Art Report	Prepared by
1.	Long Term Base Flow Studies	Shri T S Raju Dr G C Mishra and Dr A G Chachadi
2.	How to Conduct River Surveys	Dr V P Thergaonkar and Shri A M Deshkar
3.	Current Status and Prospects and of Rain-Water Harvesting	Dr H N Verma and Dr K N Tiwari
4.	Surface Drainage Aspects of Agricultural Areas	Dr G P Malhotra
5.	Research in Soil and Water Conservation in India with Special Emphasis on Watershed Management	Dr V V Dhruva Narayana
6.	Reservoir Sedimentation	Prof. R J Garde
7.	Natural Ground Water Recharge Estimation Methodologies in India	Shri B P C Sinha and Shri S K Sharma
8.	Water Supply for Industrial and Domestic Use	Shri Paritosh C Tyagi
9.	Real Time Reservoir Operation	Dr D K Srivastava UOR Roorkee
10.	Wastewater Treatment with Aquatic Plants	Prof. S A Abbasi
11.	Prevention and Control of Soil Erosion	Dr V N Sharda, Dehradun
12.	Ground Water Pollution Studies in India	Shri B P C Sinha, New Delhi
	Printed During the year 1996-97 :	
13.	Infiltration and its Simulation	Dr V N Sharda and Dr S R Singh
14.	Surface Water Quality Modelling	Dr Vijay Joshi Nagpur
15.	Integrated Planning of River Basin System and Management	Prof. Hari Krishna, New Delhi
16.	Impact of Siltation on the Useful Life of large Reservoirs	Dr R S Varshney, Ghaziabad

9.0 Hindi - Official Language

9.1 Progress in Use of Hindi

In accordance with the Official Language Policy, the annual programme of the Institute for the year 1996-97 was oriented to implement the various provisions stipulated thereunder with all dedication. The Institute contributed significantly during the year towards the furtherance of the cherished objectives enshrined in the Constitution for implementation of the Official Language Policy. Most of the communications with Central and State Government Departments/Offices located in region A and B were made in Hindi. Most of the official work of the Administration, Finance and Maintenance Branch of the Institute was also done in Hindi.

Three workshops of one day duration each were organised by the Hindi Cell for the administrative and clerical staff of the Institute. The main aim of these workshops was to make the employees familiar with the use of computer softwares in Hindi. Training for use of "Akshar" and "Sulekh" softwares in Hindi was given to the employees. In one of the workshops, training for use of multi-language software was also given which has facilities to work on computer in almost all major languages of India.

A major achievement during the year was the organisation of an Essay Competition for the undergraduate students of various colleges in India. The aim of this activity was to enliven the awareness about different aspects of water among the present day youth of the country. The information was widely circulated to different colleges under sixty universities. Essays in Hindi on any of the four topics, as mentioned below, were invited :

a. Water Conservation

b. Water and Environment

c. Water and Its Role in the 21st Century

d. Water as a National Resource

During the year, the telephone directory of the Institute was revised and prepared in the Hindi language. Further, a volume containing the technical papers (in Hindi) prepared by the scientists and scientific staff of the Institute in the last six years was also compiled. The third issue of the annual publication "Pravahini" was brought out wherein articles in Hindi were contributed by the staff of the Institute.

For increasing awareness among the masses about the various aspects of hydrological problems, pamphlets in Hindi on different topics are prepared from time to time. A pamphlet entitled, "Drought - What, Why and How" (in Hindi) was prepared and released during the year.

Last but not the least, it is worth mentioning that based on the performance of the Institute for the furtherance, promotion and use of the Hindi language, the Ministry of Water Resources, Government of India, honoured the National Institute of Hydrology, Roorkee with the CHAL VAIJYANTI CUP for the year 1995-96. The trophy was received by the Director on September 10, 1996 in New Delhi.

9.2 Rajbhasha Karyanvayan Samiti

The Official Language Implementation Committee of the Institute held 3 meetings and

A view of the Dias at the Inaugural Function of Hindi Week Celebration.

tock important decisions regarding implementation of Hindi in day to day official proceedings and activities.

9.3 Publications in Hindi

The publications brought out by the Institute in Hindi during the year are as follows :

a. Pravahini (Literary in-house annual magazine)

b. Telephone Directory - In-house directory of the telephone numbers covering the Institute, and important numbers of the University of Roorkee, and the Roorkee City

9.4 Hindi Week Celebrations

Various programmes for the promotion of Hindi were organised in the Institute during the Hindi Week i.e. 09-13 September 1996. In the inaugural function, the Chief Guest was Shri B N Asthana, Chief Engineer, Irrigation Design Organisation, Roorkee. Dr Yogendra Nath Sharma 'Arun', Principal, Government College, Pilibhit, also attended and addressed the function. Most of the employees of the Institute participated enthusiastically in the various activities during the week. An exhibition of Hindi books was also arranged on this occasion.

The activities during the week included essay writing, Hindi typing, Sulekhan, Hindi quiz, Kavita Path and Debate Competitions etc. The topic of the essay competition was "Water Related Problems of the Country and their Solution". The topic of the debate competition was "The Arrival of Multinational Companies is Harmful for the Country". Prizes to the winners of the various competitions were distributed in the valedictory function.

10.0 Other Activities

10.1 Hydrology Terminology

The Institute had earlier prepared Hydrology Terminology Vol-I with 395 hydrological terms in eight Indian languages namely Bengali, Gujarati, Hindi, Kannada, Malayalam, Marathi, Tamil and Telugu. The pan Indian Terminology, for these hydrological terms was prepared. This publication was released in the year 1993-94 and circulated to various organisations. It has been found very useful.

Based on the encouraging response to this work, the work for preparation of Hydrological Terminology-II has been taken up. This work was initiated in the year 1995-96. For this volume, 605 terms were selected and their definitions were prepared.The terms, alongwith their definitions, were sent to the eight concerned states for obtaining their equivalents in respective state languages. Water Resources Departments of the concerned states have finalized the equivalents in their respective languages.

During the year 1995-96, the coining of equivalents in four languages viz., Hindi, Tamil, Marathi and Gujarati was completed. During the year 1996-97, the equivalents of hydrological terms in three more languages, Bengali, Kannada and Telugu were received and are now due from Kerala state only. After receiving the equivalents from all the concerned states, a week-long meeting of the water resources experts and language experts will be held for the finalisation of the terminology. The work is being carried out in collaboration with the Commission of Scientific and Technical Terminology, New Delhi.

10.2 Awards

NIH has instituted two awards for encouraging studies and research in hydrology and operational hydrology.

Through an endowment provided by M/s Hoysala Group of Companies, Bangalore, NIH has instituted an award in honour of Prof. Bharat Singh, former Vice-Chancellor, University of Roorkee. The BHARAT SINGH AWARD with a cash prize of Rs.10,000 is given biennially to engineers, technocrats and scientists for outstanding research work carried out in the area of hydrology and water resources. So far, the award has been given for the years 1987, 1989, 1991, 1993. The meetings of Judging Committees for National Hydrology Award (1994) and Bharat Singh Award (1995) were held on 26.8.1996 and 3.3.1997 respectively.

The Institute has also instituted another award known as 'The National Hydrology Award' which is given to eminent engineers, technologists and scientists working in the area of operational hydrology or those who have made significant contributions for promoting hydrology.

The list of awardees of both these awards is given below :

(A) NATIONAL HYDROLOGY AWARD - 1987

1.	Shri V B Patel Secretary (Water Supply) Govt. of Gujarat Gandhinagar	Gold Plated medal and a cash prize of Rs.4000/-
2.	Shri K Sreeramakrishnaiah Officer on Special Duty Telugu Ganga Project Cuddapah-516 004 (AP)	Silver medal and a cash award of Rs.2000/-
3.	Dr A Krishnan National Fellow (ICAR) University of Agriculture Science, Bangalore	Certificate of Merit and a cash prize of Rs.1000/-

(B) NATIONAL HYDROLOGY AWARD - 1988

1.	Dr S M Seth Scientist F, NIH, Roorkee	FIRST AWARD	Rs.4000/- and a plaque
2.	Shri R S Prasad Chief Engineer NWDA, New Delhi	SECOND AWARD	Rs.2000/- and a plaque
3.	Shri A K Chakraborty Scientist SF and Head of WR Division IIRS, Dehradun	Certificate of Merit and a cash prize of Rs.1000/-	
4.	Dr B S Thandaveswara Asstt. Professor Hydraulics & WR Engg., IIT Madras	Certificate of Merit and a cash prize of Rs.1000/-	

(C) NATIONAL HYDROLOGY AWARD - 1989

1.	Prof. Jaswant Singh Shere-e-Kashmir University of Agri. Sc. & Tech.,Jammu	FIRST AWARD	Rs.5000/- and a plaque
2.	Shri C P Sinha Bihar State Irrigation Commission, Patna	SECOND AWARD	Rs.3000/- and a plaque

(D) NATIONAL HYDROLOGY AWARD - 1990

1.	Prof. S A Abbasi C.P.C. & B.E., Pondicherry -605 014	FIRST AWARD	Rs.5000/- and a plaque
2.	Dr K K S Bhatia Scientist F NIH Roorkee	SECOND AWARD	Jointly awarded Rs.3000/- and a plaque to each
3.	Dr P M Modak IIT Bombay- 400 076		

(E) NATIONAL HYDROLOGY AWARD - 1991

1.	Shri Prakash Bahadur	FIRST AWARD	Rs.4000/- and a plaque
2.	Shri R S Saksena	SECOND AWARD	Rs.2000/- and a plaque

(F) NATIONAL HYDROLOGY AWARD - 1992

1.	Dr Neelamraju Hanumantha Rao Indian Agricultural Research Institute, New Delhi	FIRST AWARD	Rs.4000/- and a plaque (Operational Hydrology)
2.	Dr D V L Narasimha Rao B-1/399, First Floor Janakpuri, New Delhi	SECOND AWARD	Rs.2000/- and a plaque (Operational Hydrology)

(G) NATIONAL HYDROLOGY AWARD - 1993

1.	Dr V K Choubey Scientist E, NIH, Roorkee	FIRST AWARD	Rs. 4000/- and a plaque (Operational Hydrology)
2.	Dr S N Rai National Geophysical Research Institute, Hyderabad	SECOND AWARD	Rs.2000/- and a plaque (Operational Hydrology)
3.	Shri B P Singh Water Resources Dept., Patna	Certificate of Merit and a cash prize of Rs.1000/-	

(H) NATIONAL HYDROLOGY AWARD - 1994 (To be awarded)

1.	Shri Y V Dharma Rao	Award for Rs. 10,000/- and a plaque

(A) BHARAT SINGH AWARD - 1987

1.	Shri J F Mistry	} Jointly awarded the
2.	Dr B H Briz Kishore	} Bharat Singh Award (Rs.5000/-) each

(B) BHARAT SINGH AWARD - 1989

1.	Dr R S Varshney	} Jointly awarded the
2.	Shri V B Patel	} BHARAT SINGH AWARD (Rs.5000/-) each

(C) BHARAT SINGH AWARD - 1991

——NIL——

(D) BHARAT SINGH AWARD - 1993

1.	Dr A S Chawla	BHARAT SINGH AWARD Rs.10,000/-

(E) BHARAT SINGH AWARD - 1995 (To be awarded)

1.	Dr Subhash Chander	BHARAT SINGH AWARD Rs.10,000/-

10.3 Distinguished Visitors

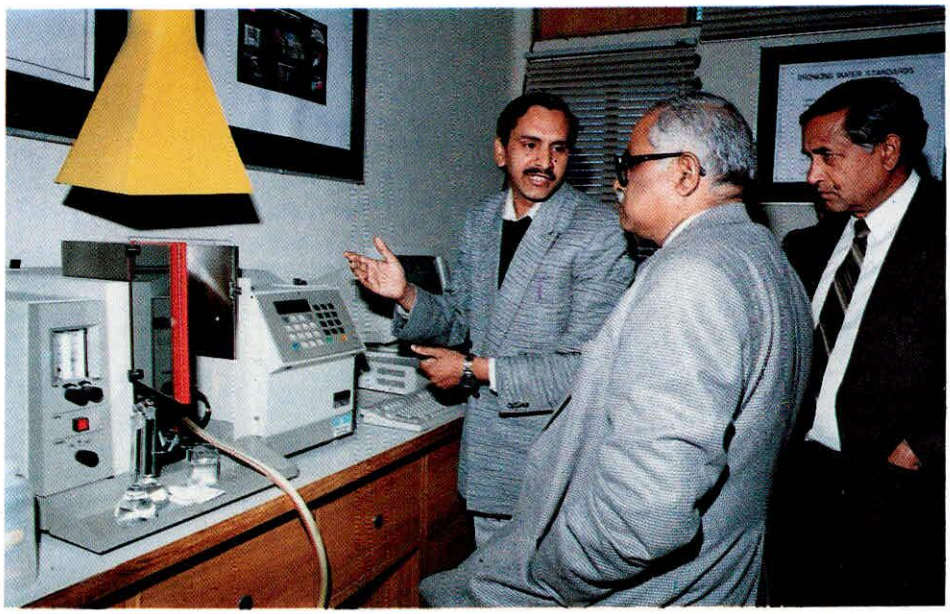
Since hydrology and water resources development is important for so many human activities, there are many organisations and individuals benefiting from R&D in hydrology. These are spread throughout Government, public and private services, agriculture, industry, environment and academicia. The Institute also hosts regular visits of post-graduate and undergraduate students from Universities and colleges.

During the year, the Institute had the privilege of welcoming Shri Mata Prasad, Secretary (WR) & Chairman, Governing Body of the Institute who visited the Institute and held discussions with scientists of the Institute.

The following distinguished visitors visited the Institute during the year in connection with meetings and interaction with the Institute.

Name and Address	*Date of visit*	*Remarks*
Prof. R D Verma 119/209, Mansarovar, Agrawal Farm Jaipur-302020	23.04.96	I am glad to visit NIH.
Shri Darshan Singh Chief Engineer, UP Jal Nigam Ghaziabad	31.05.96	-
Shri Gyan Sagar Superintending Engineer, UP Jal Nigam Roorkee	31.05.96	A good learning seat in water resources
Shri Y P Yadav Ministry of Agriculture, 102 B, Shastri Bhavan New Delhi-1	08.07.96	-
Mr G Honore German Project Coordinator Indo-German Project Watershed Management, B-4/1, Vasant Vihar New Delhi - 110057	09.07.96	Very competent and motivated scientists
Dr Rolph Wurbs UNDP Consultant Texas A&M University, USA	09.07.96	-
Dr L A Mandalia Programme Specialist in Water Sciences, UNESCO, Regional Office, 8 Poorvi Marg New Delhi-110 057	26.07.96	
Shri Indra Raj Joint-Commissioner, Ministry of Water Resources, Shram Shakti Bhavan, Rafi Marg New Delhi -110 001	02.08.96	

Name and Address	*Date of visit*	*Remarks*
Shri Y V Dharma Rao Retd. CE, CWC & World Bank Consultant Hydrology Project, New Delhi	02.08.96	-
Prof. P G Sastry World Bank Consultant, Hydrology Project New Delhi	02.08.96	-
Mr E Korsten World Bank Consultant, Hydrology Project New Delhi	02.08.96	-
Prof. H J M Ogink World Bank Consultant, Hydrology Project New Delhi	02.08.96	-
Mr Lee MacDonald Dept. of Earth Resources, Colorado State Univ., Ft. Collins, CO 80523, USA	16.08.96	Very impressive collection of scientists/facilities
Brig. K K Talwar Commandant, BEG & Centre Roorkee	23.08.96	Very educative and informative visit. Highly impressed with the work being done.
Dr Pande B B Lal Principal M M M Engineering College Gorakhpur	06.09.96	One of the best and most informative institutions on hydrology, the world over that I have visited.
Dr Robert J Drimmie Dept. of Earth Sciences University of Waterloo, Waterloo, Ontario, Canada N2L 3G1	01.10.96	A very informative visit. It will soon be the best Isotope Lab. in India.
Shri P K Mishra Superintending Engineer, Irrigation Dept. Govt of Orissa, Bhubaneswar	08.10.96	-
Prof. S C Goyal Vice-Chancellor (Retd) 1, Residency Road Jodhpur 342 001	05.11.96	I was extremely glad to speak and discuss with Dr Seth some glaring problems of Rajasthan. I am impressed with the work being done at this Institute.
Shri S S Sandhu District Magistrate Hardwar	05.11.96	It was a real pleasure and enlightening to visit this Institute.
Dr G N Kathpalia Consultant UNESCO New Delhi	15.11.96	It was a pleasure to have discussion with the Director & staff on UNDP Project on Hydrology. Very good progress has been made and future plans are insight.



Shri Mata Prasad, Secretary, Ministry of Water Resources and Chairman, Governing Body of NIH being shown the Atomic Absorption Spectrophotometer in the Water Quality Laboratory.

The Trainee Officers of Water Resources Development and Training Centre, University of Roorkee, on a visit to Nuclear Laboratory.

Name and Address	*Date of visit*	*Remarks*
Dr J K Singh Prof. and Head Soil & Water Conservation Engineering Dept. College of Technology Pantnagar	15.11.96	I was pleased with the nice dealing of the Director and his staff
Dr Bernard Kenney WHRI, Saskatoon, Saskatcheltan Canada-575 3R4	20.11.96	Wishing the best in your Lake studies.
Shri Ashok Parthasarathi Secretary Ministry of Non-conventional Energy Sources, New Delhi	30.11.96	My congratulations to everyone at NIH on the good work being done
Shri Ajit K Gupta Head, Power Group Ministry of Non-conventional Energy Sources, New Delhi	30.11.96	-do-
Dr P Saxena Director Ministry of Non-conventional Energy Sources New Delhi	30.11.96	-do-
Dr T Prasad Director Centre for Water Resources Studies, Patna	06.12.96	-
Air Vice-Marshal Dr N Natarajan Director Institute of Management Studies, Roorkee, UP	30.12.96	Very invigorating discussions with Dr S M Seth, Director. Look forward to greater interaction.
Prof. Hoshin Vijay Gupta Dept. of Hydrology University of Arizona Tucson, Arizona, 85721, USA	06.01.97	I am thoroughly enjoying the interaction with the scientists here. Thank you very much for the hospitality.
Prof. R J Garde CWPRS, Khadakwasla Pune-411 024	11.03.97	
Dr Charles E Reeve H.R. Wallingford, UK	18.03.97	Very positive interaction. I have high hopes for future collaboration.

10.4 Qaumi Ekta Week

The week from 19-25 November 1996 was celebrated as Fund Raising and Communal Harmony week to coincide with Qaumi Ekta Week by the Institute. Keeping in view the objectives of this programme, i.e. to foster the spirit of patriotism and national integration, on 22nd November 1996 the National Integration pledge was administered by Director NIH to all staff of the Institute. The 22nd November was also celebrated as Flag Day. On this occasion, the flags, stickers etc. were distributed among the employees of the Institute. During the observance of Fund Raising, Communal Harmony Week and Flag Day, funds were collected from the staff members of the Institute through generous contributions and donations made by them for the purpose of utilisation of physical and psychological rehabilitation of children rendered orphans and destitutes in communal violence and to sensitize the people about the paramount need for Communal Harmony. The funds so collected were remitted to the Secretary, National Foundation for Communal Harmony, New Delhi.

10.5 Recreation Club

NIH Recreation Club was very active during the year. It had organised number of social, literary and recreational activities. Some of these are described below :

A Deepawali Mela was organised on 27th October 1996 in NIH campus which was a grand success. Samudayik Samta Pakhwara was celebrated from 20 August to 5 September 1996 in which various activities like debate, kavita path, essay writing etc. were organised. The winners were given attractive prizes.

A picnic was organised for the NIH staff including their family members on 18.4.97 to Lachhiwala and Robert Caves.

Vishwakarma Pooja was organised on 17 September 1996.

On the occasion of Deepawali, crackers were distributed amongst the NIH staff at concessional rates.

Indoor and outdoor annual games were organised for the NIH staff. Various sports items have been procured during the current year. Prizes for the games held on 26 January 1996 were also distributed in the current year.

11.0 Finance and Accounts

During the year under review, Ministry of Water Resources, Government of India provided an amount of Rs.245.00 lakhs and Rs.178.00 lakhs as Grant-in-Aid to the Institute under Plan and Non-Plan heads respectively. The actual total expenditure during the year under review after taking into account the amount carried forward from the previous year was Rs.4,22,96,303.99 (Rs.2,44,79,517.29 under Plan and Rs.1,78,16,786.70 under Non-Plan). The accounts were audited by M/s P N Bahri & Co., Dehradun. The Auditor's report alongwith audited accounts is given at Appendix XV.

An addition of Rs.1,78,05,028.80 has been made to the fixed and current assets of the Institute during the year as under :

ASSET FUND ACCOUNT

Sc A	Increase in fixed assets		(+)	72,49,268.91
Sc B	Decrease in Works in Progress		(-)	
Sc C	Increase in Deposits		(+)	25,910.00
Sc D	Increase in Advances		(+)	1,13,76,416.89
Sc F	Decrease in Prepaid		(-)	6,96,392.00
	Sub Total			1,79,55,203.80
Less :				
Sc G	Increase in Deposits			
Sc E	Increase in Liability	1,50,175.00		
	Sub Total	1,50,175.40	(-)	1,50,175.00
	Total increase in assets fund A/c			1,78,05,028.80
(a)	Increase in Current Assets Fund			1,05,55,759.89
(b)	Increase in Fixed Assets Fund			72,49,268.91

12.0 Acknowledgements

Under the directions and guidance of the President of the Society, the Vice-President of the Society, the Chairman, Governing Body, the Chairman, Technical Advisory Committee, the Chairman, Standing Committee and the Members of the Society, Governing Body and TAC, the institute has achieved very good progress in all spheres. The support and cooperation is gratefully acknowledged from UNDP, UNESCO, World Bank and Department of Economic Affairs. The Institute records its appreciation to Officers of the Ministry of Water Resources for their cooperation and help. Central Water Commission, India Meteorological Department, University of Roorkee and several other Central and State Government organisations provided all help and guidance. The significant achievements of the Institute during the year under report would not have been possible without their help. The Institute also acknowledges the advice and cooperation received from Members of the Working Groups, Regional Coordination Committees, the Scientists and Engineers from various academic and research organisations.

The Institute is thankful to various State Government organisations who have invited the Institute for organising short duration workshops in the States for the benefit of their in-service engineers and technical personnel. The Institute is also grateful to various Central and State Government organisations and public sector undertakings who have provided the opportunity to the Institute to solve various real life problems through consultancy and sponsorship.

Director also deeply appreciates the devotion, hard work, enthusiasm and initiative exhibited by the staff and the scientists of the Institute without which the present growth and achievement would not have been possible.

13.0

Appendices

Appendix-I

NATIONAL INSTITUTE OF HYDROLOGY SOCIETY

PRESIDENT

Union Minister
for Water Resources
Government of India
New Delhi

VICE-PRESIDENT

Minister of State
for Water Resources
Government of India
New Delhi

MEMBERS

Minister in Charge
of Irrigation
Govt. of Andhra Pradesh
Hyderabad

Minister in Charge
of Irrigation
Govt. of Maharashtra
Mumbai

Minister in Charge
of Irrigation
Govt. of West Bengal
Calcutta

Minister in Charge
of Irrigation
Govt. of Orissa
Bhubaneswar

Minister in Charge
of Irrigation
Govt. of Himachal Pradesh
Shimla

Minister in Charge
of Irrigation
Govt. of Punjab
Chandigarh

Minister in Charge
of Irrigation
Govt. of Tamil Nadu
Chennai

Minister in Charge
of Irrigation
Govt. of Madhya Pradesh
Bhopal

Minister in Charge
of Irrigation
Govt. of Meghalaya
Shillong

Minister in Charge
of Irrigation
Govt. of Uttar Pradesh
Lucknow

Member (Irrigation)
Planning Commission
New Delhi

Shri M S Billore
Former Secretary, MP Irrigation Dept.
65 Ravindra Nagar
Old Palasia
Indore

Prof. S K Sinha
Director
Indian Agricultural Research
Institute
New Delhi

Dr B S Mathur
Dept. of Hydrology
University of Roorkee
Roorkee

Shri Paritosh Tyagi
Former Chairman, Central Pollution
Control Board, 48 B, Green View
Apartments, Sector 15 A, NOIDA
Ghaziabad

Dr R S Varshney
Former Secretary General, ICID
8/127 Sector 3, Rajendra
Nagar (Sahibabad)
Ghaziabad

Secretary to Govt. of
India
Ministry of Water Resources
New Delhi

Secretary to Govt. of
India
Ministry of Science and
Technology
New Delhi

Secretary to Govt. of India
Ministry of Urban Development
New Delhi

Secretary to Govt. of
India
Planning Commission
New Delhi

Vice Chancellor
University of Roorkee
Roorkee

Prof. B L Deekshatulu
Former Director, National
Remote Sensing
Agency, Balanagar
Hyderabad

Dr J Venkateswarlu
Former Director, CAZRI
26 SBI Colony, (1st
Venture) New Bakaram
Hyderabad

Dr R D Verma
Former Professor
M R Engg. College
Jaipur

Dr S Vedula
Dept of Civil Engg.
Indian Institute of
Science
Bangalore

Dr V C Kulandaiswamy
Former Vice-Chancellor,
IGNOU, 23 MGR Road, Kala
Chetra Colony, Basant Nagar,
Chennai

Secretary to Govt. of
India
Ministry of Energy
New Delhi

Secretary to Govt. of
India
Ministry of Agriculture
and Cooperation
New Delhi

Secretary to Govt. of India
Ministry of Environment and Forest
New Delhi

Financial Advisor
and Joint Secretary
Ministry of Water Resources
New Delhi

Chairman
Central Water Commission
New Delhi

Member(D&R)
Central Water Commission
New Delhi

Chairman
Central Electricity Authority
New Delhi

Director General
India Meteorological Department
New Delhi

Chairman
Central Pollution Control
Board
New Delhi

Joint Secretary (Admn.)
Government of India, Ministry of
Water Resources
New Delhi

Commissioner (ER)
Govt. of India
Ministry of Water Resources
New Delhi

Additional Secretary
to Govt. of India
Ministry of Water Resources
New Delhi

Chief Engineer,
Hydrology Studies Organisation
(HSO), Central Water Commission
New Delhi

Chairman
Central Ground Water Board,
Faridabad

Director General
Geological Survey of India,
Calcutta

A representative of Indian
National Committee on
Hydrology (INCOH) to be
nominated by Chairman, INCOH

Commissioner (PP)
Govt. of India
Ministry of Water Resources
New Delhi

Commissioner (PR)
Government of India
Ministry of Water Resources
New Delhi

Member Secretary

Director
National Institute of Hydrology
Roorkee

This constitution was approved by the Society of NIH at its Special General Meeting held on 16th November, 1995.

Appendix-II

GOVERNING BODY

CHAIRMAN : Secretary to Government of India
Ministry of Water Resources,
New Delhi

VICE-CHAIRMAN : Vice-Chancellor
University of Roorkee
Roorkee

MEMBER SECRETARY : Director
National Institute of Hydrology
Roorkee

MEMBERS

Advisor (Irrigation & CAD)
Planning Commission
Yojna Bhawan New Delhi

Chairman
Central Water Commission
New Delhi or Member (D&R),
CWC as his alternate

Additional Secretary (WR)
Ministry of Water Resources
New Delhi

Financial Advisor and
Joint Secretary (Finance)
Ministry of Water Resources
New Delhi

Secretary (Irrigation)
Govt. of Uttar Pradesh
Lucknow

Representative of Govt. of
Assam not below the rank of
Chief Engineer

Representative of Govt. of
Karnataka not below the rank
of Chief Engineer

Representative of Govt of
Jammu & Kashmir not below
the rank of Chief Engineer

Representative of Government
of Bihar, not below the rank
of Chief Engineer

Representative of
Government of Andhra Pradesh,
not below the rank of Chief Engineer

Representative of Government
of Madhya Pradesh, not below the
rank of Chief Engineer

This constitution was approved by the Society of NIH at its Special General Meeting held on 16th November, 1995.

Appendix-III

TECHNICAL ADVISORY COMMITTEE

1.	Chairman, Central Water Commission	Chairman
2.	Member (D&R), Central Water Commission	Member
3.	Chief Engineer, Hydrology Studies Organisation (HSO), Central Water Commission	Member
4.	Director, National Institute of Hydrology	Member
5.	Chairman, Central Ground Water Board	Member
6.	Representative of India Meteorological Dept.	Member
7.	A Professor of University of Roorkee, Roorkee	Member
8.	A Professor engaged in research in water resources areas from one of the IITs	Member
9.	A Professor engaged in research in water resources areas from one of the State Universities	Member
10.	Director of one of the Water Technology Centres	Member
11.	Expert of Hydrology in Individual capacity	Member
12.	Expert of Hydrology in Individual capacity	Member
13.	Head of one of the State Hydrology cells	Member
14.	Expert from Non-Government Scientific Organisation in the field of Hydrology	Member
15.	Scientist F (to be nominated by Director) National Institute of Hydrology	Member

Note :-

Members at Sr.No. 8 to 14 will be nominated by the Chairman, Governing Body for a period of three years.

This constitution was approved by the Society of NIH at its Special General Meeting held on 16th November, 1995.

Appendix-IV

WORKING GROUPS

Constitution of Working Group for Surface Water

(Surface Water Analysis and Modelling, Flood Studies, Hydrologic Design, Mountain Hydrology, Atmospheric Land Surface Process Modelling, Watershed Development, and Water Resources System divisions)

Chairman :

1. Director, National Institute of Hydrology

Members :

2. Chief Engineer (Hydrology)/Director (Hydrology RS), Central Water Commission
3. Chief Engineer (BPMO)/Director (Reservoir operation), Central Water Commission
4. Nominee of India Meteorological Department
5. Nominee of National Water Development Agency
6. Nominee of Central Water and Soil Training and Research Institute, Dehra Dun
7. Nominee of Indian Institute of Technology, Delhi
8. Nominee of University of Roorkee
9. Nominee of Irrigation Department, Uttar Pradesh
10. Nominee of Irrigation Department, Gujarat
11. Nominee of CWRDM, Kozhikode, Kerala
12. Nominee of National Centre for Medium Range Forecasting New Delhi
13. Nominee of Indian Institute of Tropical Meteorology, Pune
14. Dr S Vedula, Indian Institute of Science, Bangalore

Convener :

15. Scientist F, NIH (to be nominated by Director, NIH)

Constitution of Working Group for Ground Water

(Groundwater Assessment, Drainage, Groundwater Modelling & Conjunctive Use, Drought Studies, Environmental Hydrology, and Lake Hydrology divisions)

Chairman :

1. Director, National Institute of Hydrology

Members :

2. Nominee of Central Groundwater Board
3. Nominee of Groundwater Department, Andhra Pradesh
4. Nominee of Groundwater Department, Gujarat
5. Nominee of Groundwater Department Uttar Pradesh
6. Nominee of NABARD
7. Director (Water management), Central Water Commission, New Delhi
8. Nominee of National Geophysical Research Institute, Hyderabad
9. Nominee of Department of Environment, New Delhi
10. Nominee of Central Pollution Control Board, New Delhi
11. Nominee of U P Department of Environment, (UP), Lucknow
12. Nominee of Central Arid Zone Research Institute, Jodhpur
13. Nominee of Central Soil Salinity Research Institute, Karnal
14. Nominee of University of Roorkee, Roorkee
15. Dr R D Verma, Former Professor, M R Engg College, Jaipur

Convener :

16. Scientist F, NIH (to be nominated by Director, NIH)

Constitution of Working Group for Hydrological Observation and Instrumentation

(Hydrological Investigation, Hydrological Information System, Nuclear Hydrology, Hydrological Instrumentation, and Remote sensing Application divisions)

Chairman :

1. Director, National Institute of Hydrology

Members :

2. Nominee of Central Water and Power Research Station, Pune
3. Chief Engineer (RM)/ Director (RD), Central Water Commission, New Delhi
4. Nominee of Space Applications Centre, Ahmedabad
5. Nominee of India Meteorological Department, Delhi
6. Nominee of Indian Institute of Remote Sensing, Dehra Dun
7. Nominee of A P Engineering Research Lab., Hyderabad
8. Nominee of U P Irrigation Research Institute, Roorkee
9. Nominee of BARC, Mumbai
10. Dr B P Singh, Nuclear Science Centre, New Delhi

Convener :

11. Scientist F, NIH (to be nominated by Director, NIH)

Appendix-V

CONSTITUTION OF REGIONAL COORDINATION COMMITTEE OF NIH REGIONAL CENTRES

1. DECCAN HARD ROCK REGIONAL CENTRE, BELGAUM

Chairman

Director, NIH

Members

1. Deputy Director General (Agrometeorology), India Meteorology Department, Pune
2. Chief Engineer, Central Water Commission, Hyderabad
3. Director, Central Ground Water Board, Bangalore
4. Chief Engineer, AP Irrigation Deptt., Hyderabad
5. Chief Engineer, WRDO, Karnataka Irrigation Department, Bangalore
6. Chief Engineer, Maharashtra Irrigation Department, Pune
7. Professor, Soil Science Agriculture University, Dharwar
8. Chief Engineer (Groundwater), Tamilnadu

Member Secretary

Head, Regional Centre

* In absence of Director, NIH, his nominee not below the rank of Sc. F will chair the meeting of RCC.

2. NORTH EASTERN REGIONAL CENTRE, GUWAHATI

Chairman

Director, NIH

Members

1. General Manager, Brahmaputra Board, Guwahati
2. Chief Engineer, Assam Irrigation Deptt., Guwahati

3. Chief Engineer, West Bengal Irrigation Dept., Calcutta
4. Chief Engineer, Mizoram Irrigation Dept., Tripura
5. Advisor, (I, FC&WS), North Eastern Council, Shillong
6. Chief Engineer, Central Water Commission, Shillong
7. Director, NE Region, Central Ground Water Board, Guwahati
8. Prof. M M Das, Assam Engineering College, Guwahati

Member Secretary

Head, Regional Centre

* In absence of Director, NIH, his nominee not below the rank of Sc. F will chair the meeting of RCC.

3. WESTERN HIMALAYAN REGIONAL CENTRE, JAMMU

Chairman

Director, NIH

Members

1. Chief Engineer, Jammu & Kashmir Irrigation & Flood Control Department, Jammu
2. Chief Engineer , HP Irrigation Deptt., Shimla
3. Chief Engineer (WR), UP Irrigation Deptt., Lucknow
4. Representative of Forest Research Institute, Dehradun
5. Director, SASE, Manali
6. Joint Commissioner (Indus), MOWR, New Delhi
7. Prof. M N Kaul, Deptt. of Geography, University of Jammu, Jammu
8. Representative of CWC to be nominated by Chairman, CWC

Member Secretary

Head, Regional Centre

* In absence of Director, NIH, his nominee not below the rank of Sc. F will chair the meeting of RCC.

4. DELTAIC REGIONAL CENTRE, KAKINADA

Chairman

Director, NIH

Members

1. Chief Engineer, Andhra Pradesh Irrigation Department, Hyderabad
2. Chief Engineer, Orissa Irrigation Deptt., Bhubaneswar

3. Chief Engineer, Govt of Tamilnadu or his nominee
4. Professor Engineering College, Kakinada to be nominated by the Principal Kakinada Engineering College
5. Dr S R Singh, Director,Water Technology Centre, Bhubaneswar
6. Director, Centre for Water Resources,Anna University, Madras
7. Director, State Ground Water Board, Hyderabad
8. Representative of NRSA, Hyderabad to be nominated by Director, NRSA

Member Secretary

Head,Regional Centre

* In absence of Director, NIH, his nominee not below the rank of Sc. F will chair the meeting of RCC

5. GANGA PLAINS NORTH REGIONAL CENTRE, PATNA

Chairman

Director, NIH

Members

1. Chief Engineer, Central Water Commission, Patna
2. Chief Engineer, DVC, Maithon
3. Representative of Chairman, GFCC, Patna
4. Director, (Hydromet), IMD,Patna
5. Chief Engineer, (Irrigation and Waterways), Calcutta
6. Chief Engineer & Director, WALMI, Patna
7. Chief Engineer (WR), UP Irrigation Deptt., Lucknow
8. Chief Engineer (Monitoring), Water Resources Department, Bihar

Member Secretary

Head, Regional Centre

* In absence of Director, NIH, his nominee not below the rank of Sc. F will chair the meeting of RCC.

6. GANGA PLAINS SOUTH REGIONAL CENTRE, SAGAR

Chairman

Director, NIH

Members

1. Chief Engineer or Nominee,Ganga Basin Irrigation Department, Rewa, MP
2. Chief Engineer or Nominee, Ground Water Survey, Water Resources Department, Maharana Pratap Nagar, Bhopal, MP

3. Director or Nominee, MP State Remote Sensing Centre, Bhopal, MP
4. Director or Nominee, Central Ground Water Board, BP Arera Colony, Bhopal , MP
5. Chief Engineer or Nominee, Central Water Commission, Jaipur, Rajasthan
6. Chief Engineer or Nominee, CDO, BODHI, Bhopal, MP
7. Professor, Indira Gandhi Govt. Engg. College, Sagar (MP) [to be nominated by Principal of College]
8. Chief Engineer or Nominee, Rajasthan Irrigation Department (located at Kota).

Member-Secretary

Head, Regional Centre

* In absence of Director, NIH, his nominee not below the rank of Sc. F will chair the meeting of RCC.

Appendix-VI

CONSULTANCY/SPONSORED PROJECTS ON WHICH THE INSTITUTE WORKED/AND IS WORKING DURING THE YEAR 1996-97

	Title of the Project	Sponsoring Authority	Duration	Date of of start	Principal Investigator (s)	Status	Remarks
1.	Sabarmati System Studies	Narmada & WR Dept. Govt.of Gujarat	9 months	Agreement signed in 1989	Dr S K Jain, Sc E	Completed	1. 9 months duration is after supply of all data by the Sponsoring Authority 2. Periodical discussion and scope changed. Trial data supplied by 1994. 3. Draft report sent in August 1995. Comments received on September 1996 and the Final report has been sent in March 1997.
2.	Assessment of Impact of Irrig. Application in a part of IGNP Stage-II Command Area Underlain by Hydrologic Barrier	Command Area Development Authorities, IGNP, Bikaner, Rajasthan	2 yrs	21-7-1993	Dr G C Mishra, Sc F	Completed	1. The study was extended as requested by the Project Authorities as it was required to find result for a different set of field values of hydraulic conductivity. 2. The final report has been submitted to Project Authorities in September 1996.
3.	Subsurface Drainage Investigation in Stage-II of IGNP (RD 838)	Command Area Development Authorities IGNP, Bikaner, Rajasthan	2 yrs	3-1-1995	Dr G C Mishra, Sc F	Completed	1. Duration one year after complete data are provided by the Sponsoring Agency. 2. The final report has been submitted to the Project Authorities in January 1997.

4. Preparation of Zonal Plan UNDP-GEF Project on Optimizing Dev. of Small Hydro-resources Hilly Regions of India	Alternate Hydro Energy Centre, UOR, Roorkee, UP	6 months	July 1995	Shri R D Singh, Sc E	Comp-leted	1. Draft report given in April 1996
5. Dam Break Studies of Pulinchintala Multipurpose Project	Environ-mental Protection Training & Research Institute, Hyderabad	1 yr.	February 1996	Dr A B Palani-appan, Sc E	Comp-leted	1. The final report has been submitted to Project Authorities.
6. Surface Water and Ground Water Interaction along river Ganga from Narora to Kanpur	Investi-gation & Planning Dev. of Water Resources Dept., Govt.of UP	2 yrs	March 1989	Dr G C Mishra, Sc F	On Going	1. An interim report was submitted in March 1994. 2. Some data has been supplied by sponsors only recently in July 1997. Therefore the work is delayed.
7. Hydrological Studies at Jhamarkotra Mines.	Rajasthan State Mines and Minerals Corporation	2 yrs	April 1995	Dr G C Mishra, Sc F	On Going	1. There is a delay because sponsors have requested for some changes in field values of parameters. 2. An interim report has been submitted and the final report is being prepared.
8. Indigenous Development of Data Logger and Sensor Unit for Watershed Hydrology	Min. of Agri-culcure, Govt. of India, New Delhi	1 yr	April 1994	Dr Bhishm Kumar, Sc E	On Going	1. Extended upto March 1996 because of increased scope of work. 2. Draft report submitted in March 1996 3. A presentation was also made in August 1997. 4. The equipment is to be extensively tested.
9. Hydrological Studies of Lake Naini, District Nainital, UP	Dept. of Env., Govt. of U.P. (through Nainital Lake Special Area Development Authority	3 yrs	July 1993	Dr Bhishm Kumar, Sc E	On Going	1. 0.75 lakhs will not be released as Principal Investigator advised to funding agency because of change in scope of work. 2. In July 1996 two interim reports (2 volumes) have been submitted.

						3. Final report is under preparation and expected to be submitted by December 1997.
10. Temporal Distribution of Dokriani Glacier Runoff and its relationship using Meteorological Parameters	DST, New Delhi	3 yrs	April 1995	Dr Pratap Singh, Sc.C	On Going	–
11. Dev. of Instruments for Automation of Irrigation Scheduling and Groundwater Recharge Monitoring using Soil Moisture Measurements	Min. of Agriculture, Govt. of India, New Delhi	2 yrs	April 1994	Dr Vikas Goyal, Sc C	On Going	1. Extension given by Project Authorities upto October 1997. 2. The delay has been because of non-availability of required components/ parts and excessive power requirements of the design instruments; shortages of project staff; and modification in instrument design as suggested by subject specialist. 3. Interim report has been submitted in October 1996.
12. Exploration of Construction of Infiltration Gallery Inside the Bed of River Yamuna at Agra	U.P. Jal Nigam	1 yr. & 3 months	August 1996	Dr G C Mishra, Sc F	On Going	1. An interim report has been submitted in Feb. 1997 and the study in in progress.
13. Hydrology of Myntdu Leska Hydro-Electric Project in Meghalaya	Meghalaya State Electricity Board, Shillong	1 yr	December 1996	Dr B C Patwari, Sc E	On Going	1. Preliminary analysis has been taken up pending the release of first installment
14. Integrated Hydrological study for Sustainable Development and Management of two Hilly Watershed in UP.	DST, New Delhi	5 yrs	31 March Sc C	Dr Vikas Goyal,	On Going	—

Appendix-VII

ORGANISATIONS TO WHOM PUBLICATIONS OF NIH WERE SENT DURING 1996-97

1. Farm Science Centre, APAU, KVK Nandyal, MC Farm (PO), Dist. Kurnool, AP.
2. Andhra Pradesh Ground Water Department, BRK Govt Office Complex, Hyderabad
3. Ground Water Department, Govt of Andhra Pradesh, Hyderabad.
4. Chief Engineer (Irrigation), Investigation Wing, Errum Manzil, Hyderabad
5. Irrigation Dept., Errum Manzil, Hyderabad.
6. Ground Water Dept, Tank Bund Road, Hyderabad
7. Irrigation Dept. Investigation Wing, Errum Manzil, Hyderabad
8. Andhra Pradesh Engineering and Research Laboratory, Himayatsagar, Hyderabad
9. National Geophysical Research Institute, Uppal Road, Hyderabad
10. National Remote Sensing Agency, Balaji Nagar, Hyderabad
11. National Institute of Science and Technology and Development Studies, CSIR Headquarters, New Delhi
12. India Meteorological Department, Mausam Bhavan, New Delhi
13. Indian National Committee on Irrigation and Drainage, Chanakyapuri, New Delhi
14. National Water Development Agency, Community Centre, Saket, New Delhi
15. Indian Institute of Technology, Kauz Khas, New Delhi
16. Central Soils and Materials Research Station, Hauz Khas, New Delhi
17. Tata Energy Research Institute, Lodhi Road, New Delhi
18. Director & Chief Engineer, WALMI, Govt of Gujarat, Anand
19. Central Ground Water Board, Ahmedabad
20. Ground Water Division No.1, GWRDC, Govt. of Gujarat, Ahmedabad
21. Gujarat Engineering Research Institute, Race Course, Vadodara
22. River Gauging Division, WR Circle 1, Irrigation Dept., Ahmedabad
23. Space Applications Centre, Jodhpur Tekkra, Ahmedabad
24. Physical Research Laboratory, Navarangpura, Ahmedabad

25. Snow and Avlanche Study Establishment, Ramgarh, Dist. Punchkula, Haryana
26. Central Soil Salinity Research Institute, Karnal, Haryana
27. Technical Services Division, Karnataka Engineering Research Station, Krishnarajasagara
28. Water Resources & Development Organisation, AR Circle, Bangalore
29. Department of Mines and Geology, Lal Bagh Road, Bangalore
30. Department of Mines and Geology, K.M.Puram, Mysore
31. Hydrology Sub-Division, Irrigation Dept., Trivandrum
32. Director (Designs), Irrigation and Research Board, Govt of Kerala, Thirumallapuram
33. Hydrology Division, Irrigation Department, Govt. of Kerala, Trissur
34. Hydrology Division, Irrigation Department, Govt of Kerala, Trichur
35. Hydrology Division, Irrigation Department, Govt of Kerala, Mankot PO, Muvattupuzha
36. Hydrology Division, Irrigation Department, Govt of Kerala, Kottayam
37. Hydrology Section, Irrigation Dept., Govt of Kerala, Kozhikode
38. Groundwater Surveys and Development Agency, Rajgad District, Maharashtra
39. Central Ground Water Board, Nagpur
40. Central Water Commission, Sakri Road, Dhule
41. Directorate of Water Management Research, Rahuri, Ahmedanagar
42. Indian Institute of Tropical Meteorology, Dr Homi Bhabha Road, Pashan, Pune
43. Indian Institute of Technology, Powai, Mumbai
44. Central Water and Power Research Station, Khadakwasla, Pune
45. National Environmental Engineering Research Institute, Nehru Marg, Nagpur
46. Ground Water Service and Development Agency, Civil Lines, Nagpur
47. ICAR Research Complex for North Eastern Hills Region, Kedar Lodge, Jawai Road, Shillong
48. Ground Water Circle, Department of Water Resources, Govt of MP, Arera Colony, Bhopal
49. Chief Engineer (Investigation), Water Resources Department, Govt of MP, Arera Colony, Bhopal
50. Chief Engineer, BODHI, Narmada Bhavan, Bhopal
51. Narmada Control Authority, Dr Sarju Prasad Marg, Indore
52. Narmada Control Authority, Vijay Nagar, Indore
53. Central Ground Water Board, SE Region, Bhubaneswar
54. Mahanadi & Eastern Ring, Central Water Commission, Sahid Nagar, Bbubaneswar
55. Directorate of Ground Water Survey and Investigation, Govt. of Orissa, Bhubaneswar
56. Water Resources Directorate, Govt. of Punjab, Chandigarh
57. Institute of Development Studies, Bapu Nagar, Jaipur
58. Central Arid Zone Research Institute, Heavy Industrial Area, Jodhpur
59. Department of Civil Engineering, Anna University, Chennai
60. Water Resources Organisation, PWD, Chepauk, Chennai

61. Ground Water Division, PWD, Madurai
62. PWD (Ground Water), Chepauk, Chennai
63. PWD, Govt. of Tamil Nadu, Chennai
64. Gauging Sub Division, PWD, Govt of Tamil Nadu, Tiruchirappalli
65. Indian Institute of Technology, Chennai
66. Indian Association of Hydrologists, Roorkee
67. Indian Water Resources Society, WRDTC, Roorkee
68. Indian Institute of Technology, Kanpur
69. GB Pant Institute of Himalayan Environment and Development, Kosi, Almora
70. Wadia Institute of Himalayan Geology, General Mahadev Singh Road, Dehradun
71. Research Design and Standards Organisation, Manak Nagar, Lucknow
72. Central Soil Water Conservation Research & Training Institute, Kaulagarh Road, Dehradun
73. Forest Research Institute, PO New Forest, Dehradun
74. Indian Science Congress Association, Dr Biresh Guha Street, Calcutta
75. Geological Survey of India, Jawahar Lal Nehru Road, Calcutta
76. Indian Institute of Technology, Kharagpur

Appendix-VIII.A

SCIENTIFIC AND TECHNICAL REPORTS PREPARED DURING 1996-97

1. Development of Software for Flood Estimation for Large Catchments
2. Rainfall-Runoff Modelling Using Various Geomorphological IUH Approaches
3. Single Column Hydrologic Simulation for Various Land Uses and Soil Types Using SHE Model
4. Procedure for Risk Based Hydrologic Design
5. Dam Break Study of Barna Dam
6. Effect of Channel Characteristics on the Nature of Flood Wave Propagation.
7. Hydrological Aspects of Flood Disaster Management
8. Development of Empirical Formulae for Approximate Dam Break Flood Estimation
9. Development of a Conceptual Model for Snow, Glacier and Rainfed Catchment
10. Meltwater Storage Characteristics of Dokriani Glacier
11. Flow Characteristics for Rainfall Series Generated Under Different Climate Statistics
12. Analysis of Severe Storms in Arid and Semi-arid Areas
13. Conceptual Land Surface Model for Air-Soil Interface System : Performance Evaluation
14. Operation Policy for Tawa Dam
15. Automated Mapping of Snow Cover Using IRS 1C Data
16. Catchment Modelling in GIS Environment
17. Software for Reservoir Analysis
18. GIS Based Rainfall-Runoff Modelling for a Small Catchment
19. Estimation of Soil Erosion and Sediment Yield Using GIS
20. Hydrological Aspects of Watershed Development at Micro Level
21. Inter-comparison of Block Level Water Balance with Basin Level Water Balance
22. Feasibility Study of Harvesting Infiltrated Water in Semi-arid Region
23. Assessment of Irrigation Return Flow
24. Groundwater Pumping Network for Cleaning of Brackish Aquifer in Agra Area (Part II)

25. Review of Methods for Analyzing Pump-Test Data
26. Analysis of Flow to a Multi-Aquifer Well : A Numerical Approach
27. Effect of Discontinuous Aquitard on Seepage from a Static Water Body
28 Estimation of Hydrological Soil Parameters in a sub-basin of Narmada Basin
29. A Simulation Model for Salt and Water Movement in Arid Region of Rajasthan
30. Development and Verification of Regional Low Flow Equation for Middle Narmada
31. Prediction of Severity of Drought Using Soil Moisture as an Index
32. Studying the Characteristics of Groundwater Droughts using Kriging Method
33. Water Quality Monitoring Network Design for Narmada River System
34. Transport of Pollutants in Different Soil Media
35. Adsorption of Metal Ions on Sediments
36. Environmental Impact Analysis of a Water Resources Project Using Available Software
37. Metal Poilution Assessment from Aquatic Sediments - A Case Study
38. Groundwater Quality Monitoring and Evaluation in Sagar District, Madhya Pradesh.
39. Groundwater Quality Evaluation in Doon Valley, Dehradun
40. Assessment of Probability Distribution of Dissolved Oxygen Deficit
41. Wind Erosion and Lake Sedimentation in Desert Area
42. Status of Important Lakes in Madhya Pradesh
43. Study of Water Balance of Pichola Lake, (Rajasthan)
44. Infiltration Study in a Sub-basin of Narmada
45 Hydrologic Soil Classification in a Sub-basin of Narmada
46. Guidelines for Hydrological Investigations
47. Testing of Weighing Type Rain Gauge Under Field Conditions During Monsoon Season
48. Testing of Weighing Type Snow Gauge Under Field Conditions During Winter Season
49. Development and Testing of Instrument for Soil Moisture Variations and Ground Water Recharge
50. Instrumentation, Investigations and Modelling of a Small Forested Watershed in Garhwal Himalayas
51. Hydrological Problems in India
52. Recent Technical Literature Relevant for Hydrological Problems of the Country
53. Study of Recharge to Groundwater due to Rainfall and Irrigation in Narmada Catchment between Sher and Umar Rivers.
54. Study of Sedimentation Pattern of Lake Nainital, district Nainital, Kumaun, UP.
55. Preliminary Hydrological Status Report of Lake Bhim Tal
56. Estimating Sediment Yield and Prioritisation of Watershed
57. Flood Plain Mapping in Part of Yamuna Basin

SCIENTIFIC AND TECHNICAL REPORTS PREPARED BY REGIONAL CENTRES DURING 1996-97

I. HARD ROCK REGIONAL CENTRE, BELGAUM

1. Modelling of an Indian Estuary Using 2-Dimensional Finite Element Model
2. Measurement of Surface Soil Hydraulic Properties for Malaprabha Command Area
3. Tank Studies in Belgaum District
4. Groundwater Quality Modelling in Nargund-Navalgund Area
5. Groundwater Modelling in Ghataprabha Sub-basin
6. Analyses of Surface and Groundwater Flow Process in Western Ghat of Dakshina Kannada District

II. NORTH-EASTERN REGIONAL CENTRE, GUWAHATI

1. Hydrologic and Soil Classification of Soil of Dudhnai Sub-basin (Meghalaya)- Part II
2. Water Quality Monitoring Studies for Greater Guwahati : Part II - Chemical Analysis
3. Implementation of HEC-II Model at Digaru Discharge Site (Assam)
4. Flood Plain Mapping of Phulbari Area of Goalpara District, Lower Assam.
5. Hydrogeomorphological Studies for Digaru Sub-basins (Assam & Meghalaya)

III. WESTERN-HIMALAYAN REGIONAL CENTRE, JAMMU

1. Soil Physico-Chemical Analysis of Basantar Catchment, J&K
2. Variation of Groundwater Quality Monitoring Studies in Jammu and Kathua Districts, J&K
3. Impact of Industrial Effluent of Groundwater Quality : A Case Study of Balal Nalla, near Jammu
4. Water Quality Monitoring and Evaluation of Mansar Lake

IV. GANGA PLAINS REGIONAL CENTRE, PATNA

1. Study of Mokama Group of Tals - Part I
2. Parameter Characterization for Solute Transport in Ground water
3. Study of Arsenic Pollution in West Bengal
4. Characteristic Study of Rainfall-runoff Pattern for Punpun Basin
5. Application of FESWEMS Model for Flood Computation of a Flood Plain Area

V. DELTAIC REGIONAL CENTRE, KAKINADA

1. Daily Rainfall-Runoff Modelling of Brahmani river upto Rengali Reservoir
2. Analysis of Surface Runoff and Base flow at Ariyanyakipuram Anicut, Tambraparani basin, Tamil Nadu
3. Estimation of Infiltration Rates in Suddagedda Representative Basin, East Godavari District, AP
4. Conjunctive use Studies in Pennar Delta Canal System and Groundwater Balance for Southern Channel Command Area in AP
5. Daily Rainfall-Runoff Modelling of Sagileru River using HYSIM

VI. GANGA PLAINS SOUTH REGIONAL CENTRE, SAGAR

1. Groundwater Quality Monitoring and Evaluation in Sagar District
2. Collection and Processing of Available Hydrological Data
3. Reflectance Study in Sagar Pond
4. Drought Study in Sagar District

Appendix-VIII.b

LIST OF PUBLICATIONS

Based on the studies and research conducted at the Institute, results are being brought out in the form of publications under different categories: Technical Reports (TR), Technical Notes (TN), Review Notes (RN), Case Studies (CS), Applied Research (AR), Documentation of Programmes (DP), Manuals (M), Status Reports (SR), Basic Research (BR), Users Manual (UM) and State-of-Art Reports (SA). These reports are printed in 200-300 copies each and circulated to various State and Central Government organisations including educational and research Institutes. This activity is undertaken as a part of transfer of technology and dissemination of information.

LIST OF PRICED PUBLICATIONS

1.	National Symposium on Hydrology, 15-18 Dec., 1987, NIH Roorkee (India), Proceedings Vol. 1 & Vol. 2, 1987	Rs.	400.00
2.	International Seminar, Hydrology of Extremes: (Floods and Low Flows); 1-3 December, 1988, Roorkee (India) organised by NIH Roorkee, sponsored by UNESCO and INCOH, cosponsored by IAHS, IAHR and IWRS Proceedings 503 pp, 1988	Rs. US $	500.00/ 35.00
3.	Regional Course on Project Hydrology: Course Material NIH, Roorkee (India) 499 pp, 1991	Rs.	400.00
4.	Hydrological Developments in India Since Independence : A Contribution to Hydrclogical Sciences 440 pp, Hard Copy, 1992	Rs. US $	400.00/ 30.00
5.	International Symposium on Hydrology of Mountainous Areas, 28-30 May, 1992 Shimla (India) organised by NIH Roorkee, sponsored by UNESCO and cosponsored by IWRS Proceedings: 635 pp, 1992	Rs. US $	600.00/ 40.00
6.	Workshop on Flood Routing and Flood Forecasting : Course Material NIH, Roorkee (India) 221 pp, 1992	Rs.	250.00
7.	Workshop on Flood Estimation by Unit Hydrograph Techniques: Course Material NIH, Roorkee (India) 262 pp, 1992	Rs.	300.00

8.	Workshop on Reservoir Operation: Course Material NIH, Roorkee (India) 124 pp, 1993	Rs.	200. 00
9.	National Workshop on Advances in Hydrological Instrumentation, 25-26 October, 1994, NIH Roorkee (India) Proceedings.		
10.	National Symposium on Hydrology and Water Resources (in Hindi), 15-16 Dec. 1995, NIH, Roorkee (India) Proceedings 498 pp, 1995	Rs.	250. 00
11.	Software on Unit Hydrograph Applications for Flood Estimation, developed by NIH, Roorkee (India), 1996.	Rs.	1000. 00

BROCHURES

1. Information Brochure of National Institute of Hydrology - 1995
2. Water Conservation - DOs and DON'Ts
3. Water - Nature's Wonder Hydrologic Cycle
4. Influence of Deforestation and Afforestation on various Hydrological Parameters
5. Control Evaporation - Save Water
6. Water Quality Conservation
7. Water Conservation
8. Man's Influence on Hydrologic Cycle
9. Rain Water Harvesting
10. Flood and Its Management
11. Water Yield From Snow and Glaciers
12. Hydrological Influences of Forests
13. Hydrological Influences of Land Use Changes
14. Sediment Yield From Different Land Uses

BROCHURES IN HINDI

1. Suchana Vivranika, Rashtriya Jal Vigyan Sansthan - 95
2. Jal Stuti
3. Jal Sanrakshan ke liey kuchh kam ki batein
4. Jal Sanrakshan - kya karein aur kya nahi karein
5. Vashpan Rokein Jal Bachayan
6. Jal Prakriti ka Aashcharya Jaliya Chakra

7. Jal Vigyan Shabdavali - 1
8. Prakaran Adhyayno ke Saransh
9. Sukha Kya-Kyon-Kaise

PUBLICATIONS

1. Hydrology in Ancient India
2. Hydrological Terminology - I (1992)
3. Drainage Manual (1996)

WATER SCIENCE SERIES

1. Snow and Glaciers and their Contribution to India's Water Resources
2. Evaporation from Water Bodies and Its Control
3. Infiltration and Ground Water Recharge
4. Evapotranspiration
5. The Hydrologic Cycle and Water Balance
6. Forest Influence on Hydrological Parameters

LIST OF REPORTS

(Note: Reports are distributed based on availability)

1	CS	0	Conjunctive use studies in Krishna Delta system (Part-I) - status of data availability
2	CS	0	Water Balance studies in Suddagedda basin (Part-I)- status of net work data availability and Instrumentation
3	CS	2	Modelling of daily runoff for Kasurnala basin using Betson and USGS model
4	CS	3	Study of hydrometeorological aspects of Narmada basin
5	CS	5	Simulation of daily runoff of two sub-basins of river Narmada using Tank model
6	CS	6	Rating curves for gauging sites on Narmada river
7	CS	7	Comparative study of unit hydrograph methods
8	CS	8	Application of Thomas Fiering model for monthly streamflow generation in Chaliyar river basin
9	CS	9	Regional flood frequency analysis
10	CS	11	Design flood estimation for Narmada Sagar project using partial duration series
11	CS	12	Network design of raingauges in Rajasthan state
12	CS	13	Application of Muskingum-Cunge method of flood routing
13	CS	14	Land use mapping of Upper Yamuna catchment using remotely sensed data
14	CS	15	Soil water accounting using SCS hydrologic soil classification
15	CS	16	Dam break analysis for Machhu dam-II
16	CS	17	Dissolved oxygen modelling in rivers

17	CS	19	Application of Bivariate Thomas Fiering model for monthly stream flow generation in Mahanadi river Basin
18	CS	20	Flood plain mapping of river Mahanadi by Remote Sensing application
19	CS	21	Hydrological aspects of drought in 1985-86 (Final Report)
20	CS	23	Geomorphology and drainage pattern in north-eastern Gujarat (Sabarmati Basin)
21	CS	24	Hydrological aspects of droughts in 1986-87 (Fina Report)
22	CS	25	Remote Sensing studies on Ganga River characteristics between Allahabad and Buxar through satellite data
23	CS	26	Sabarmati basin landuse/land cover map
24	CS	28	Application of SHE model to the Ganjal sub basin of river Narmada
25	CS	29	Application of SHE model to Narmada (upto Manot) basin
26	CS	30	Application of SHE model to Hiran sub-basin of river Narmada
27	CS	31	Application of SHE model to Sher sub basin
28	CS	32	Application of the SHE model to the Barna sub basin of river Narmada
29	CS	33	Application of SHE model to Kolar sub basin of river Narmada
30	CS	34	Study of impact of soil and land use changes on hydrologic regime using SHE model
31	CS	37	Hydrological aspects of drought upto 1987-88
32	CS	38	Hydrological Aspects of Drought upto 1987-88 - A case study in Madhya Pradesh
33	CS	39	Hydrological aspects of drought upto 1987-88 - A case study in Rajasthan
34	CS	40	Hydrological aspects of drought upto 1987-88 - A case study in Gujarat
35	CS	41	Hydrological aspects of drought for 1987-88 - Andhra Pradesh
36	CS	42	Hydrological aspects of drought for 1987-88 - a case study in Maharashtra
37	CS	43	Hydrological aspects of drought for 1987-88 - Karnataka
38	CS	44	Drought Impacts on socio-economic aspects - a case study
39	CS	46	Application of SHE model to Hemavati (upto Sakleshpur) basin
40	CS	47	Kolar basin simulation studies using the SHE model
41	CS	48	Application of SHE for irrigation command area studies
42	CS	49	Application of NWS Dam Break Programme Using Data of Gandhi Sagar Dam
43	CS	51	Application of SHE model to Beti Sub basin of River Machhu
44	CS	52	Drought impacts on agriculture - A case study
45	CS	53	Geomorphological characteristics of western ghats Part II Ghataprabha and Malaprabha basin
46	CS	55	Application of HEC-1 to Hemavati (Upto Sakleshpur) Basin
47	CS	58	Hydrological aspects of drought upto 1988-89 - Gujarat
48	CS	59	Hydrological aspects of drought upto 1988-89 - Karnataka
49	CS	61	Hydrological aspects of drought upto 1988-89 - Maharashtra

50	CS	63	Hydrological aspects of drought upto 1988-89 - a case study in Rajasthan
51	CS	72	Landuse Mapping of Tawi Catchment using Satellite Data
52	CS	80	Conservation storage regulation of Machhu II reservoir
53	CS	81	Flood control regulation of Machhu II reservoir
54	CS	82	Regulation of spillway gates of Machhu II reservoir
55	CS	83	Sabarmati System Studies System Description and Data Status
56	CS	84	Quantitative Assessment of Sediment Distribution in the Tungabhadra Reservoir using Satellite Imagery
57	CS	85	Hydrological Land Use Mapping of Malaprabha and Ghataprabha Catchments of Krishna Basin
58	CS	86	Water Availability Study of River Tawi, J&K State
59	CS	87	Water Availability Studies - Ujh River Basin
60	CS	88	Hydrometeorology of Ujh River Sub Basin
61	CS	89	Application of Dam Break programme MIKE 11 Machhu II dam and its comparison with NWS DAMBRK application results
62	CS	90	Application of WAHS model to Hemavati upto Sakleshpur Basin
63	CS	94	Estimation of Hydrological soil properties for Design of Drainage System in Bulandshahr Area
64	CS	99	Flood forecasting system for Machhu II reservoir
65	CS	101	Discharge measurement of river Teesta in Sikkim using tracer dilution method
66	CS	104	Representative Basin studies in the Ganga Plains region of India (Part I)
67	CS	105	Infiltration studies in the Malaprabha and Ghataprabha catchment
68	CS	106	Hydrological Modelling of River Sarda Using Tank Model
69	CS	110	Ground Water Quality modelling study in Upper Palar Zone of Palar River basin in Tamilnadu
70	CS	112	Flooded areas and flood plain characteristics of Punpun river basin using satellite data
71	CS	114	Hydrogeomorphological study of Tawi Catchment, J&K
72	CS	115	Snow cover Mapping for Baira catchment (HP)
73	CS	116	The study of the effect of transformation of land use classification in Dehradun
74	CS	117	Seasonal ground water balance study in Central Godavari delta Andhra Pradesh Part II
75	CS	118	Hydrological aspects of Drought upto 1991 - a case study in Karnataka
76	CS	123	Hydrological aspects of drought upto 1991 - a cas study of Maharashtra
77	CS	124	Changes in land use/land cover over Sarda River Basin, A. P.
78	CS/AR	126	Dam Break Study of MITTI dam
79	CS/AR	127	Groundwater balance study in Puri district of Orissa Part-I (Processing and Analysis of data)
80	CS/AR	128	Geomorphological characteristics of Narmada (upto Manot) basin

81	CS/AR	129	Response of an Indian catchment to expected climatic change due to global warming
82	CS/AR	130	Flood hydrograph simulation in Kolar sub-basin using event based distributed rainfall-runoff model
83	CS/AR	133	Dam break analysis of Machhu Dam-II failure using DMBRRK and SMPDBK models of NWS
84	CS/AR	134	Daily runoff simulation of Hemavati at Sakleshpur using 4x4 tank model
85	CS/AR	135	Design of surface drainage system for Bulandshahr area
86	CS/AR	136	Application of WAHS model to Kolar sub basin
87	CS/AR	137	Evaporation losses from reservoir- study for semi arid region
88	CS/AR	138	Assessment of waterlogged area in IGNP stage-I by remote sensing techniques
89	CS/AR	139	Study of sensitivity of evapotranspiration to expected climatic changes
90	CS/AR	140	Urban watershed modelling - a comparative study (a case study of Nazafgarh drainage basin)
91	CS/AR	141	Integrated regulation of a system of reservoirs for conservation purposes
92	CS/AR	142	Infiltration studies in Baira Nalla sub catchment - H. P.
93	CS/AR	143	Hydrogeomorphological study of Baira Nalla sub-catchment HP
94	CS/AR	144	Application of PC based sutra model
95	CS/AR	146	Representative basin studies in Suddagedda basin network design and installation of equipment
96	CS/AR	148	Fate of trace elements present in industrial effluents discharged into river
97	CS/AR	149	Application of catchment water balance model to the Malaprabha basin, Karnataka
98	CS/AR	150	Hydrological aspects of drought upto 1988-89 - a case study in Madhya Pradesh
99	CS/AR	151	Sedimentation problems in Massanjore reservoir of Mayurakshi river system, West Bengal
100	CS/AR	152	Geomorphological characteristics of Punpun basin of Ganga river system
101	CS/AR	153	Hydrological year book of Mayurakshi basin 1976-77
102	CS/AR	156	Flood protection studies using HEC-2 model on river Tawi near Jammu bridge site
103	CS/AR	157	Water quality studies of Surinsar Lake in Jammu Region
104	CS/AR	158	Application of remote sensing techniques for wate logging study in Tawa command area
105	CS/AR	159	Fluvial geomorphological characteristics of Four sub basins of Upper Narmada
106	CS/AR	161	Precipitation distribution in the Sutlej and Beas Basins
107	CS/AR	162	Seasonal groundwater balance study in Bandar Canal command area, Krishna delta Andhra Pradesh (Part-II)
108	CS/AR	163	Rainfall runoff modelling of Nagavali river upto Narayanapuram
109	CS/AR	164	Seasonal groundwater balance study in Puri district Orissa (Part II)
110	CS/AR	165	Groundwater - Tank interaction in Jabalpur district, Madhya Pradesh
111	CS/AR	166	Simple linear modelling of river flow

112	CS/AR	167	Estimation of hydrological soil properties of Narsinghpur district
113	CS/AR	168	Sensitivity analysis using bats
114	CS/AR	169	Impact assessment studies
115	CS/AR	170	Infiltration study of a sub-basin
116	CS/AR	171	Processing of groundwater data
117	CS/AR	172	Groundwater quality monitoring and evaluation in and around Kakinada, Andhra Pradesh
118	CS/AR	173	Adsorption of metal ions on sediments
119	CS/AR	174	Prediction of water quality parameters using statistical approach in upper Narmada basin
120	CS/AR	175	Water quality modeling of Kali river using QUAL2E
121	CS/AR	176	Representative basin study - Part 2 estimation of groundwater balance of Ghataprabha representative basin (upto Daddi)
122	CS/AR	177	Network design of raingauge stations for Nagaland
123	CS/AR	178	Land capability classification in a part of Narmada basin
124	CS/AR	179	Processing of hydrological data for Manot sub-basin using HYMOS
125	CS/AR	180	Estimation of evaporation from free water surface in semi-arid areas
126	CS/AR	181	Hydrometeorological aspects of Dudhnai basin (Assam/Meghalaya)
127	CS/AR	182	Hydrogeomorphological studies:Dudhnai sub-basin (Assam/Meghalaya)
128	CS/AR	183	Infiltration studies: Dudhnai sub-basin (Assam/Meghalaya)
129	CS/AR	184	Hydrological studies of Lake Naini Part-I
130	CS/AR	185	Preliminary Dam Break analysis of Bargi dam
131	CS/AR	186	Integration of GIS and remote sensing in soil erosion studies
132	CS/AR	187	Status of groundwater quality in Patna town
133	CS/AR	188	HEC-1 Application to Hamidnagar Site
134	CS/AR	189	Sedimentation studies in Massanjore reservoir of Mayurakshi basin
135	CS/AR	190	Establishment of SCS runoff curve number for Batane sub-basin of Punpun basin using IRS-1A LISS II data base
136	CS/AR	191	Delineation of flooded area in Mayurakshi basin using remote sensing and conventional techniques
137	CS/AR	192	Daily rainfall-runoff modelling of Sagileru river using HYSIM
138	CS/AR	193	Sedimentation in thermally stratified lakes of Kumaun region
139	CS/AR	194	Water logging and drainage congestion problem in Mokama Tal area, Bihar, GPRC
140	CS/AR	195	Groundwater quality evaluation in and around Kakinada, Andhra Pradesh for the year 1995
141	CS/AR	196	Ground water quality monitoring and evaluation in district Jammu (J&K)
142	CS/AR	198	Groundwater quality monitoring and evaluation in district Hardwar UP
143	CS/AR	199	Rainfall runoff modelling of Ramganga at Chaukhutia using Rainflo model

144	CS/AR	200	Ground water quality monitoring and evaluation in and around Greater Guwahati (Assam) Part- 1 : Preliminary
145	CS/AR	201	Rainfall runoff modelling of Upper Narmada basins using a geomorphologic technique
146	CS/AR	202	Assessment of waterlogging in Sriram Sagar Command Area
147	CS/AR	204	Soil erosion assessment using remote sensing and GIS technique
148	DP	1	Flood frequency analysis using power transformation
149	DP	2	Rating curve analysis
150	DP	3	Best fit distribution
151	DP	4	Ordering the series and interpolation
152	DP	5	Flood routing (Muskingum cunge procedure)
153	DP	6	Multiple linear regression
154	DP	7	Polynomial regression
155	M-	2	Processing of precipitation data
156	M-	3	Reservoir capacity computation
157	M-	6	Multipurpose operation of a reservoir
158	RN	2	Optimization and programming techniques for reservoir operation
159	RN	3	Hydrogeological parameters in hard rock areas
160	RN	4	Rainfall recharge
161	RN	5	Partial duration series models
162	RN	6	Hydrologic soil classification
163	RN	7	Data collection and transmission system
164	RN	8	Hydrologic flood routing including data requirement
165	RN	9	Study of hydrogeological parameters
166	RN	10	Hydrological parameters in drainage studies
167	RN	11	Overland Flow
168	RN	12	Hydraulic Routing Techniques
169	RN	13	Comparative study of components of watershed models
170	RN	14	Regional flood frequency analysis
171	RN	15	Use of catchment characteristics for Unit Hydrograph derivation
172	RN	16	Estimation of evapotranspiration for variable water table situations
173	RN	17	Regional unit hydrograph
174	RN	18	Time series analysis models
175	RN	19	Comparative study of self-recording raingauges
176	RN	20	Rainfall-runoff relationships
177	RN	21	Effect of floodplain on flood routing
178	RN	22	Effect of channel processes on flood routing

179	RN	23	Irrigation return flow
180	RN	24	Environmental isotopes for hydrological investigations
181	RN	25	Range analysis for storage
182	RN	26	Sedimentation in reservoirs
183	RN	27	Hydrological applications of micro-processors
184	RN	28	Snowline and snowcover mapping by remote sensing techniques
185	RN	29	Land use/vegetal cover mapping using satellite data
186	RN	30	Flash flood studies
187	RN	31	Geophysical investigations for hydrological studies
188	RN	32	Telemetry systems and signal analysers for data transmission
189	RN	33	Atmospheric general circulation models
190	RN	34	Conjunctive use of surface and groundwater
191	RN	35	Flood forecasting models
192	RN	36	Vegetation management for increased water yield
193	RN	37	Hydrological aspects of droughts
194	RN	38	Measurement of snow and estimation of snow cover
195	RN	39	Remote sensing applications for flood inundation studies
196	RN	40	Comprehensive review of drought indices
197	RN	41	Analysis of low flow to investigate drought characteristics and plan water use management
198	RN	42	Procedure for hydrological network design
199	RN	44	Rainfall simulator studies
200	RN	45	Remote sensing application to sedimentation studies
201	RN	46	Snowmelt processes
202	RN	48	Regional approaches for flood estimation in mountainous area
203	RN	49	Overland flow in mountainous areas
204	SA	1	Time series modelling
205	SA	2	Reservoir operation studies
206	SR	0	Hydrology of deltas and east coastal region
207	SR	1	Crop water requirement field, efficiencies and irrigation planning
208	SR	2	Drought estimation and control
209	SR	3	Water quality and sediment modelling in surface waters
210	SR	4	Data systems and library
211	SR	5	Forest influences on hydrological parameters
212	SR	6	Status of hydrological studies in forested catchments
213	SR	7	Sediment yield from different land uses

214	SR	8	Hydrological aspects of drought (an interim report)
215	SR	9	Status of thermal pollution in water bodies
216	SR	10	Identification of formats of collection of data for drought studies
217	SR	11	Evaporation reduction measures from water and land surfaces for drought management
218	SR	12	Water conservation through land treatment measures
219	SR	13	Data processing and hydrological analysis
220	SR	14	A Status Report on Forest Hydrology
221	SR	15	Status report on Urban Hydrology
222	SR	16	Status Report on Snowmelt Modelling Studies
223	SR	17	Global Climate change and its effects on regional and global hydrology
224	SR	18	Status Report on Snow Surveys
225	SR	19	Status Report on Satluj Catchment upto Rampur
226	SR	20	Status report on Catchment Hydrology
227	SR	21	Impact of global change on hydrological and water resources parameters in arid and semi-arid areas
228	SR	22	Methods of Water Conservation and Their effective use in Drought Effected Areas
229	SR	23	Infiltration Measurement techniques/equipment
230	SR	24	Identification of waterlogged and saline soils with the help of remote sensing applications and other modern techniques
231	SR	25	Hydrological data processing and analysis
232	SR	26	Erosion, Sedimentation and Flooding in River Kosi
233	SR	27	Hydrologic Data collection processing and analysis
234	SR	28	Status report on Processing and analysis of Hydrometeorological data
235	SR	30	Catchment Hydrology
236	SR	31	Use of environmental isotopes in hydrology
237	SR	32	Remote Sensing Application in Hydrology
238	SR	33	Ground Water Quality Modelling
239	SR	34	Environmental hydrology with special reference to surface water quality modelling
240	SR	37	Water balance of lakes
241	SR	38	Dispersion of pollutants in streams
242	SR	39	Development of water quality index
243	SR	40	Rainfall runoff modelling in mountainous catchments
244	SR	41	Hyd. data processing & analysis for studies related with water surface profiles, GIS & 2-di. finite element modelling in Esturine
245	SR	42	Environmental Hydrology
246	SR	43	Spillway Gate regulation
247	SR	44	Rainfall measuring equipment

248	SR	45	Major and important lakes of Rajasthan: Status of hydrological research
249	SR	46	Hydrological data book for Indira Gandhi Nahar project Stage-1
250	TN	4	Unsteady flow to a large-diameter well influenced by a river and a no flow boundary
251	TN	5	Water balance and interaction of large depression storage with aquifer in Ghaggar basin
252	TN	6	Estimation of seepage from canal using tracer technique
253	TN	7	Study of depth-area-duration and depth-duration characteristics
254	TN	8	Study of reach transmissivity for stream aquifer interaction
255	TN	9	Unsteady flow to a multiaquifer flowing well
256	TN	10	Artificial recharge of groundwater
257	TN	11	Water requirement of crops
258	TN	12	Methodology for estimation of design storm
259	TN	13	Regional aquifer simulation
260	TN	14	Flow towards well with storage in leaky aquifers
261	TN	15	Seepage from water bodies
262	TN	16	System specific programme inputs for documented programmes
263	TN	17	Drought analysis using soil moisture simulation approach
264	TN	18	Parameterisation of hydrogeological factors in groundwater study
265	TN	19	Duration of test pumping
266	TN	20	Management information system
267	TN	21	Data acquisition system
268	TN	22	Data requirements and data preparation for DAMBRK programme
269	TN	24	Exchange of flow between river and aquifer system
270	TN	25	Guidelines for sample survey for minor irrigation works
271	TN	26	Watershed resources development model
272	TN	27	Seepage from parallel canals
273	TN	28	Study of soil moisture using neutron probe
274	TN	29	Estimation of evapotranspiration under variable soil moisture situation
275	TN	30	Design and performance of large diameter wells in hard rock areas
276	TN	31	Application of resistivity method for moisture estimation in top soil layer
277	TN	32	Evaluation of component of water balance of a river reach
278	TN	33	Hydrologic models for mountainous areas
279	TN	34	Thermal stratification in reservoirs
280	TN	35	Instrumentation and measuring techniques for flow measurements in mountainous area
281	TN	36	Study of glacier melt and physics of glaciers
282	TN	37	Drainage in heavy soils

283	TN	38	Positive impacts of water resources on environment projects
284	TN	39	Resistivity and S. P. techniques for study of groundwater pollution
285	TN	40	Metamorphism and remote sensing physics of snow
286	TN	43	Instrumentation for snow measurement
287	TN	45	Estimation of evapotranspiration
288	TN	46	Assessment of groundwater in hard rock areas
289	TN	47	Long term prediction of ground water regime in an internal draining basin
290	TN	48	Mathematical modelling of solute transport in groundwater from a point source of pollution
291	TN	49	Storm drainage estimation in urban areas
292	TN	50	Impact of forest on groundwater
293	TN	53	Movement of pollutants in subsurface environment
294	TN	56	Resistivity techniques for monitoring soil salinity
295	TN	57	Groundwater recharge using tracer techniques
296	TN	58	Soil Moisture Measurement and Movement in Agricultural fields
297	TN	59	Regional GCM for the monsoon area
298	TN	60	Parameterization of infiltration in GCM
299	TN	62	Acquisition of land surface parameters for GCM
300	TN	66	Automatic water quality monitoring
301	TN	70	Long range forecasting onset of drought condition in tropics and sub tropics
302	TN	71	Use of Paleoflood Information in Frequency Analysis
303	TN	72	Review of methodologies and software for flood forecasting
304	TN	73	Review of methodology for low flow forecasting
305	TN	77	Hydrological response of greenhouse effect with emphasis on evaporation and evapotranspiration
306	TN	79	Estimation of evapotranspiration losses from agricultural lands - climatological approach
307	TN	91	Stochastic Modelling of Water Quality Data
308	TN	92	Effect of Urbanisation on Runoff
309	TN	93	Real-time Reservoir Operation - A review
310	TN	95	Geomorphological Instantaneous Unit Hydrograph Studies
311	TN	96	Effect of increase in greenhouse gases on radiation, albedo and evaporation
312	TN	97	Acid Rain and its Implications
313	TN	98	Classification of Lakes and Inventory of Natural Lakes in India
314	TN	99	Behaviour of different types of lakes and their effect and relationship on /with the catchment hydrology
315	TN	100	Hydrological data processing

316	TN	101	Instrumentation for Water Quality
317	TN	102	Digital image processing and pattern recognition
318	TN	103	Infiltration studies in India
319	TN	104	Sedimentation in lakes
320	TN	105	Review of different softwares available for groundwater flow models
321	TN	106	Hydrologic studies for improvement of Khajjiar Lake (HP)
322	TN	107	Representative basin studies: Baira Nalla sub catchment- H. P. Part-I: Preliminary report
323	TN	108	Loktak lake studies - Part I
324	TN	110	Parameterization of hydrological processes-evaporation and evapotranspiration
325	TN	111	Data acquisition systems (DAS) for hydrological measurements
326	TN	113	Thermal regime of lakes
327	TN	114	Hydrological data book for Narmada basin (upto Bargi Dam) 1981-90
328	TR	1	Cause of negative outflow in Muskingum Method
329	TR	2	Suitability of power transformation based Gumbel EV-1 distribution for flood frequency analysis
330	TR	3	Storage in confined aquifer with flowing artesian well
331	TR	4	Statistical analysis of rainfall in Belgaum district, Karnataka
332	TR	5	Ecosystem simulation submodels flora and fauna
333	TR	6	Water quality modelling of rivers
334	TR	7	Use of personal computer for preparation of reports
335	TR	8	Water balance of a reservoir
336	TR	9	Some studies on plotting position formulae for Gumble EV-1 distribution
337	TR	10	Determination of reach transmissivity under various hydrologic boundary conditions
338	TR	11	Study of parameters affecting base flow
339	TR	12	Field measurement of soil moisture movement in ponding condition
340	TR	13	Development of a variable parameter simplified hydraulic flood routing model for rectangular channels
341	TR	14	Estimating Evaporation losses from lakes and reservoirs
342	TR	15	Mathematical modelling of moving storms
343	TR	16	Overland flow modelling
344	TR	17	Simple techniques for forecasting of monsoon rainfall and runoff and application to Mahanadi river at Hirakud
345	TR	19	Recharge from large depression storage
346	TR	20	Identification of Hydroenvironmental indices
347	TR	21	Development of a variable parameter simplified hydraulic flood routing model for trapezoidal channels
348	TR	22	Leaching requirement of agricultural land and study of movement of salts

349	TR	23	Determination of aquifer recharge for varying river stages
350	TR	25	Surface fitting of ground water table by means of least square approach
351	TR	27	Comparison of some variable parameter simplified hydraulic flood routing models
352	TR	28	Study of soil erosion for different land use and vegetal covers using universal soil loss equation
353	TR	29	Estimation of soil moisture variation using resistivity technique
354	TR	30	Study of soil moisture movement during rainfall by Green and Ampt equation and comparison of the study by numerical model
355	TR	31	Estimation of ground water recharge due to rainfall by statistical method
356	TR	33	Establishment of rating curve under shifting control
357	TR	34	Development of dimensionless flood hydrogrphs from Machhu Dam-II failure using Dambrk model
358	TR	35	Analysis of trends and periodicities of rainfall of some districts in east Rajasthan
359	TR	36	Comparative study of different parameter estimation techniques for EV-1 distribution
360	TR	37	Systems approach to optimize conjunctive use of surface and groundwater
361	TR	38	Statistical analysis of low flow in typical river basin to investigation drought characteristics
362	TR	39	Study of spectral reflectance characteristics of various ground features around Roorkee area including Doon valley
363	TR	40	Mapping of salt affected areas of district Aligarh by remote sensing
364	TR	41	Development of dimensionless hydrographs for storm sewers using Kinematic wave routing techniques
365	TR	42	Monthly streamflow simulation for Mahanadi basin using HEC-4 model
366	TR	43	Forecasting of monsoon runoff using data from specific basins
367	TR	44	Application of Kinematic cascade model "Kingen" for flow computation in a hilly catchment
368	TR	45	Distribution of precipitation with elevation
369	TR	48	Type curves for multiaquifer well
370	TR	49	Retention of groundwater recharge beneath a spreading basin
371	TR	50	Groundwater quality variations in Saharanpur district (UP)
372	TR	51	Watershed characteristics of ONG sub basin
373	TR	52	Geoelectrical techniques for study of soil moisture variation
374	TR	53	Hydrological year book Hemavathy subbasin year 1985-86
375	TR	54	Application of HEC-2 programme for water surface profile determination
376	TR	56	Flood plain mapping of river Ganga between Raoli and Narora using multi temporal satellite data
377	TR	57	Remote sensing applications for sedimentation studies in reservoirs
378	TR	58	Hydrological network design for Narmada basin

379	TR	59	Regional flood frequency analysis for Godavari basin sub-zone(3F)
380	TR	63	Geomorphological characteristics of western ghats region Part-I Upper Krishna basin
381	TR	67	Monitoring of groundwater pollution from sewage wastes in Bhadrabad, Hardwar (UP)
382	TR	68	Simulation of daily runoff of two sub basins of river Krishna using Tank model
383	TR	69	Effect of surface water ground water interaction on routing characteristics
384	TR	72	Flood plain zoning for downstream area of Machhu Dam-II
385	TR	75	Study of spring and hydrologic modelling of spring flow
386	TR	79	Effect of tributary junction on routing characteristics
387	TR	80	Application of flood routing procedure incorporating lateral inflow
388	TR	81	Field investigations in Kolar sub basin of river Narmada
389	TR	82	Laboratory analysis of soil samples from Kolar sub basin of river
390	TR	84	Snowmelt modelling in Beas basin
391	TR	86	Interaction of large water bodies with aquifer
392	TR	87	Analysis of flow to a dug well in hard rock area in an unconfined aquifer by Cell theory
393	TR	89	Hydrological studies of Parda Spring in Nainital
394	TR	96	Comparison of some routing techniques
395	TR	97	The effect of Measurement errors on design flood estimation by flood frequency analysis
396	TR	99	Geomorphology of Kolar Sub Basin for Hydrological Studies
397	TR	100	Temperature Lapse Rate Study in Satluj Catchment
398	TR	104	Development of a soil moisture prediction model
399	TR	106	Hydrological Investigations on Chhota Shigri Glacier (H. P.)
400	TR	116	Number of observation wells and their locations for an aquifer test in different geohydrological conditions
401	TR	119	Prediction of Evaporation Losses from Shallow Water Table using a Numerical Model
402	TR	121	Development of Drought Response Plan - Water Availability
403	TR	122	Performance evaluation of Percolation Tanks
404	TR	127	Geomorphological characteristics of western ghats Part III : Hemavati Basin upto Sakleshpur
405	TR	130	Estimation of hydrological soil parameters for Malaprabha and Ghataprabha subbasins
406	TR	131	Hydrological Aspects of the River Tawi
407	TR	132	Rainfall Characteristics in North East India
408	TR	133	Some hydrological Aspects of Brahmaputra River
409	TR	134	Low Flow Forecasting using Statistical Approach

410	TR	137	Guidelines for application of Musking Cunge method of flood routing
411	TR	138	Geomorphology of Sabarmati Basin upto Dharoi
412	TR	139	Application of Macro-scale atmospheric and land surface process hydrologic modelling system
413	TR	140	Current status of Methodology for ground water assessment in the country in different regions
414	TR	141	Mathematical Modelling of Flow from a group of Springs
415	TR	142	Estimation of ground water recharge due to rainfall by modelling of soil moisture movement
416	TR	143	Status of Water Logging, Soil Salinity and Alkalinity in India
417	TR	144	Intercomparison of urban watershed models
418	TR	147	Stochastic Modelling of water quality using Data for River Yamuna
419	TR	148	Effect of Waste Disposals on Quality of Water of River Kali (UP)
420	TR	149	Hydrological year book Malaprabha sub-basin
421	TR	150	Study of Stream-aquifer interaction along river Ganges between Hardwar and Narora using Isotope Techniques
422	TR	151	Hydrological year book Ghataprabha sub-basin
423	TR	155	Development of Data acquisition system (DAS) Instrumentation
424	TR	157	Numerical modelling of GW for Bulandshahar area
425	TR	158	Soil salinisation and reclamation in command areas
426	TR	159	Geographic information system using ILWIS
427	TR	161	Hydrological network for Tawi - J&K
428	TR	163	Infiltration studies in Jammu region
429	TR	164	Sedimentation of reservoir using remote sensing techniques (Tungabhadra)
430	TR	166	Groundwater Balance Study in Central Godavari Delta of Andhra Pradesh(Part-I) Processing and analysis of data
431	TR	173	Geomorphological studies of Bagmati Basin of Kosi river system
432	TR	174	Hydrological data book Punpun Sub basin (1974-90)
433	TR	175	Evaluation and design of raingauge net work in Burhi Gandak Sub- basin
434	TR	177	Streamflow simulation of satluj river using UBC watershed model
435	TR	178	Representative Basin Studies in Malaprabha and Ghataprabha basins
436	TR	179	Application of rainflo model on Malaprabha catchment upsteam of Khanapur
437	TR	180	Evaluation of precipitation gauge density in Punpun catchment of Ganga river system
438	TR/BR	106	Catchment routing using kinematic wave approach
439	TR/BR	107	Effect of orography on precipitation distribution in the Chenab basin
440	TR/BR	108	Effects of errors in annual maximum peak floods on flood frequency estimates
441	TR/BR	109	Development of hydrological drought index based on dynamic groundwater storage

442	TR/BR	110	Semi-pervious stream and aquifer interaction
443	TR/BR	111	Soil moisture simulation by improved numerical method
444	TR/BR	112	Forecasting of low flows for river Narmada at Mortakka
445	TR/BR	113	Excess rainfall and direct surface runoff modelling using geo- morphological characteristics
446	TR/BR	115	Time series analysis of springflow 447 TR/BR 116 Determination of specific yield in the zone of water table fluctuation
448	TR/BR	117	Effect of downstream boundary conditions on the propagation characteristics of the Dam Break Flood
449	TR/BR	117	Regional flood frequency analysis for sub-Himalayan Region
450	TR/BR	118	A runoff model for snow dominated catchment in greater Himalayas
451	TR/BR	119	Groundwater balance before introduction of irrigation in the Canal command area
452	TR/BR	120	Effect of water table depth on recharge due to rainfall
453	TR/BR	121	Assessment of recharge from partially penetrating in fluent stream
454	TR/BR	122	Parameter determination in semipervious stream - aquifer system
455	TR/BR	123	Modelling of spring flow in different geohydrological conditions
456	TR/BR	124	Effect of urbanisation on runoff hydrograph
457	TR/BR	125	Runoff modeling using SCS method
458	TR/BR	126	Development of disaggregation techniques
459	TR/BR	127	Uncertainty analysis of dissolved oxygen model
460	TR/BR	128	Prediction of longitudinal dispersion coefficient for natural stream
461	TR/BR	129	Development of flood control regulation policy
462	TR/BR	130	Identification of aquifer parameters in Narmada basin
463	TR/BR	131	Real-time flow forecasting
464	TR/BR	132	Derivation of GIUH for small catchments of Upper Narmada and Tapi sub-zone (subzone 3C) - Part I
465	TR/BR	133	Regional flood frequency analysis for upper Narmada and Tapi subzone - 3C
466	TR/BR	134	Development of regional flood formula for Mahanadi subzone-(3D)
467	TR/BR	135	Development of a weighing type rain gauge (WRG)
468	TR/BR	136	Development of hydrological drought index based on reservoir level
469	TR/BR	137	Development of model for simulation of flows of non-monsoon season
470	TR/BR	138	Surface water-ground water interaction due to pumping near a recharge boundary
471	TR/BR	139	Flow towards a partially penetrating large-diameter well
472	TR/BR	140	Interaction of multilayer aquifer system with static water body
473	TR/BR	141	Impact of sewage waste disposal on soil strata and ground water quality
474	TR/BR	142	Evaporation from layered soils in the presence of a water table
475	UM	1	Tyson weber ground water flow model
476	UM	2	Frequency analysis

477	UM	3	Multiple linear regression
478	UM	4	Polynomial regression
479	UM	5	Rating curve analysis
480	UM	6	Preparation of working table
481	UM	7	Finite element aquifer flow model
482	UM	8	Unit hydrograph derivation
483	UM	9	Model parameter evaluation using catchment characteristics
484	UM	10	Muskingum cunge routing procedure
485	UM	11	Hydrologic flood routing
486	UM	13	Kalinin-Milyukov method of flood routing
487	UM	14	Application of tank model for daily runoff analysis
488	UM	15	Application of tank model for flood analysis
489	UM	16	Storage yield analysis
490	UM	17	Optimum reservoir operation using dynamic programming
491	UM	18	A flood control operation of a reservoir
492	UM	19	Flood frequency analysis on a microcomputer with basic language
493	UM	20	Mass curve analysis and sequent peak algorithm
494	UM	21	Generation of hydrological graphs using computer graphics
495	UM	22	Graphical representation of information related with floods
496	UM	24	Technique for flood frequency analysis
497	UM	25	Unit hydrograph analysis
498	UM	26	Physico chemical analysis of water and wastewater
499	UM	27	Graphical representation of flow duration curve
500	UM	28	Hydrologic channel routing with graphics
501	UM	29	Reservoir routing with graphical representation
502	UM	30	Data storage and retrieval system on personal computer
503	UM	32	Power transformation technique in basic for flood frequency Analysis
504	UM	36	Processing and analysis of rainfall data
505	UM	39	Event based distributed rainfall runoff model
506	UM	40	Determination of Trace Elements by Atomic Spectrometry
507	UM	41	Biosphere atmosphere transfer scheme
508	UM	42	Comprehensive data requirement for NWS DAMBRK model with selected examples
509	UM	43	The computerization facilities for technical literature
510	UM	44	User's manual for design of drainage system for steady and unsteady state
511	UM	45	Disaggregation techniques user's manual
512	UM	46	A model for simulation of multireservoir system for conservation operation

Appendix-IX

PAPERS PUBLISHED/ACCEPTED FOR PUBLICATION DURING THE YEAR

1. INTERNATIONAL JOURNALS

A. PUBLISHED

Goyal V C, P K Gupta, S M Seth and V N Singh, "Estimation of temporal changes in soil moisture using resistivity method", Hydrological Processes, Vol.10, 1147-1154, 1996.

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B. ACCEPTED FOR PUBLICATION

Bhar A K and G C Mishra, "One dimensional springflow model for time variant recharge", Accepted for publication in Hydrological Sciences Journal of IAHS, Vol.42(3), June 1997.

Ghosh N C and E A McBean, "Water quality modelling Kali river, India", Accepted for publication in Intl. Jour. of Soil Water and Air Pollution, The Netherlands.

Jain C K and Daya Ram, "Adsorption of lead and zinc on bed sediments of river Kali", Accepted for publication in Jour. of Water Research, 1996.

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Rao S V N, M V Rao, K S Ramasastri and R N P Singh, "A spatial sediment yield model for Chenab river system in western Himalayas", Accepted for publication in Nordic Hydrology.

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Swamee P K, G C Mishra and Adel A S Salem, "Effectivity of multiple sheet-piles in weir design", Accepted for publication in Jour. of Irrigation & Drainage Engineering, ASCE, Vol.123, No.3, May/June 1997.

2. NATIONAL JOURNALS

A. PUBLISHED

Abbasi S A, K K S Bhatia, A V M Kunhi and R Soni, "Studies on the limnology of Kuttiadi Lake (North Kerala)", Ecol.Env.& Cons. 2 (17-27), 1996

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B. ACCEPTED FOR PUBLICATION

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Goyal V C and P S Das, "Development of an automated weighing rain gauge (WRG)", Accepted for publication in Hydrology Journal.

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Jain C K, M K Sharma and Omkar, "Ground water quality in Jammu district", Accepted for publication in Indian Journal of Environmental Protection.

Jain M K and S M Seth, "Rainfall runoff modelling of a Himalayan catchment using a distributed approach", Accepted for publication in Journal of Institution of Engineers (India), Calcutta.

Kumar Bhishm and U K Singh, "Isotope application to hydrology and water resources", Accepted for publication in Bhagirath Journal (English).

Kumar Bhishm and U K Singh, "Hydrological studies in India using environmental isotopes", Accepted for publication in IWRS Journal.

Kumar Bhishm and U K Singh, "Environmental tritium as a tracer in natural waters - measurement and applications", Accepted for publication in Vayumandal Journal.

Mehrotra R, "Performance vs complexicity in conceptual rainfall-runoff modelling - application to some arid, semi-arid watersheds of Gujarat State", Accepted for publication in Journal of Institution of Engineers (India).

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3. INTERNATIONAL CONFERENCES

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Chandramohan T., "Application of FESWMS-2DH in estuarine modelling", Proc. National Conf. HYDRO-96, IIT Kanpur, Dec.11-13, 1996.

Dwivedi V K and P K Bhunya, "An exploratory study of hydraulics of fish habitat structures in rivers", Proc. National Conf. HYDRO-96, IIT Kanpur, Dec.11-13, 1996.

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Kumar Bhishm, S K Verma and U K Singh, "Comparative study of soil moisture movement and recharge to groundwater using neutron moisture gauge and tritium tagging techniques", Proc. of DAE-BRNS Symposium on Nuclear Techniques in Increasing Crop and Animal Productivity, BARC, Mumbai, Oct. 7-9, 1996.

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Kumar S V Vijay and P V Seethapathi, "Conjunctive use practices and assessment in deltas", National Sem. on Geology, Bhopal, Mar. 1997.

Majumdar P K and S Sen, "Environmental litigation: accepting model results as facts", Proc. of Twelfth National Convention of Environmental Engineers and National Seminar on Pollution Control for Sustainable Development & Human Health, Jabalpur, Oct.12-13, 1996.

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Mehta Rama, "Water resources for future", Proc. of Sem. on Role of Women in Science-Society Interaction, IWSA, Roorkee, Sept. 1996.

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Patwari B C and K K S Bhatia, "Rainfall distribution and associated meteorological situation contributing to worlds highest rainfall in NE India", Souvenir, HP Barua Memorial Lecture, IEI, Assam State Centre, Guwahati, Sept.26, 1996.

Patwari B C, V K Dwivedi and P K Bhunya", "Sorrows of the Brahmaputra: looking from the hills", Souvenir, National Convention for Utilization of Water Resources of Assam, Guwahati, Dec. 6, 1996.

Purandara B K and Venkatesh B, "Crop planning for Malaprabha command", Proc. National Seminar on Hydrogeology of Hard Rock Areas, Dharwad, Feb.3-4, 1997.

Purandara B K, "Reservoir sedimentation and water quality - a case study", Proc. of National Seminar on Environmental Pollution, Dharwad, Dec.12-13, 1996.

Purandara B K, "Clay mineral distribution along the central Kerala coast", Abstracts volume, XIV Convention of Indian Association of Sedimentologists, Banaras, Aug. 1996.

Rai S P and J S Rawat, "Role of geology and landuse on hydrology on mountainous areas : a case study in Kumaun lesser Himalaya", Presented in Brain Storming Session/Sem. on Hydrological Problems and Perspectives in Western Himalayan Region, Western Himalayan Regional Centre of NIH, Jammu, Mar.14, 1997.

Rao S V N, M V Rao, K S Ramasastri and R N P Singh, "Spatial sediment yield model for Chenab basin in western Himalayas", Proc. of HYDRO-96, IIT Kanpur, Dec.11-13, 1996.

Singh Pratap, "Modelling of snow and glacier runoff", Brainstorming Session of Hydrological Research in Western Himalayan Region: Present Status and Future Directions, Western Himalayan Regional Centre of NIH, Jammu, Mar. 14, 1997.

Singh Pratap, K S Ramasastri and Naresh Kumar, "Where do we stand in glacier hydrology today?", National Symposium on Himalayan Glaciers and Snow Cover, Jawahar Lal Nehru University, New Delhi, Mar. 4-5, 1997.

Singh S K and S M Seth, "Deriving basin IUH for multi-storm data", Proc. of Conf. HYDRO-96, Department of Civil Engineering, IIT Kanpur, pp.1-6, Dec.11-13, 1996.

Singh S K, "Explicit expressions for aquifer parameter determination", Proc. of Conf. HYDRO-96, Department of Civil Engineering, IIT Kanpur, pp.75-80, Dec.11-13, 1996.

Tyagi J V, "Flow simulation behaviour of HYSIM in semi-arid climatic zone of India", Presented at National Conf. on India: Water Resources Management in 21st Century, WRDTC, Roorkee, Dec. 27-28, 1996.

Tyagi, J V, "Rainwater management in dry land farming - a review", Presented in National Conf. on Soil and Water Conservation for Sustainable Farming Systems, Nagpur, Feb. 1997

Appendix-X

POSITION OF STAFF AS ON 1.04.1996 AND 31.3.1997

S.No.	Description	Existing on 1.04.1996	Existing on 31.3.1997
GROUP - A			
1.	Director	1	1
2.	Scientist F	2	2
3.	Scientist E	8	7
4.	Scientist C	21	20
5.	Senior Administrative Officer	1	-
6.	Finance Officer	1	-
7.	Scientist B	30	44
8.	Assistant Engineer	-	-
	Sub total	64	74
GROUP - B			
1.	Documentation Officer	1	1
2.	Section Officer	1	2
3.	Principal Research Assistant	1	3
4.	Senior Personal Assistant	1	1
5.	Senior Research Assistant	23	22
6.	Senior Technician Asst. (Library)	1	1
7.	Senior Hindi Translator	1	-
8.	Junior Engineer (Senior Grade)	-	1
9.	Senior Technician	1	-
10.	Superintendent	2	1
11.	Assistant Superintendent	2	2
12.	Stenographer Grade-I	1	1
13	. Stenographer Grade-II	7	7
	Sub total	42	42

S.No.	Description	Existing on 1.04.1996	Existing on 31.3.1997
GROUP - C			
1.	Draftsman Grade-I	-	1
2.	Research Assistant	21	20
3.	Technical Assistant (Library)	-	-
4.	Junior Engineer	2	1
5.	Technician Grade-I	1	1
6.	Draftsman Grade-II	2	1
7.	Technician Grade-II	12	12
8.	Stenographer Grade-III	9	9
9.	Upper Division Clerk	4	5
10.	Draftsman Grade-III	2	2
11.	Junior Research Assistant	7	6
12.	Receptionist	1	1
13.	Technician Grade-III	11	11
14.	Lower Division Clerk	16	14
15.	Driver (Grade-II)	2	2
16.	Driver (Ordinary Grade)	5	6
	Sub total	95	92
GRADE - D			
1.	Mali (Senior Grade)	-	1
2.	Safai Karmachari (Senior Grade)	-	1
3.	Attendant	17	16
4.	Messenger	22	22
5.	Chowkidar	7	7
6.	Mali	4	3
7.	Safai Karmachari	4	3
	Sub total	54	53
	GRAND TOTAL	255	261

Appendix-XI

LIST OF AWARDEES UNDER SCHEME OF CASH AWARDS FOR GROUP B C AND D STAFF FOR THE YEAR 1995-96

SN.	Name and Designation	Tech./Non-tech	Amount Rs.
Group B:			
1.	Shri Mathew Kutty, Jose Senior Research Assistant	Technical	500
2.	Shri S S Kanwar, Documentation Officer	Non-technical	500
Group C:			
1.	Shri S L Srivastava, Research Assistant	Technical	300
2.	Shri Charan Singh Chauhan, Technician Gr. III	Technical	300
3.	Shri Brijesh Kumar, Stenographer Grade III	Non-technical	300
4.	Shri S P Sharma, Upper Division Clerk	Non-technical	300
Group D:			
1.	Shri V P Singh, Attendant	Technical	200
2.	Shri Satya Prakash, Attendant	Technical	200
3.	Shri Amar Singh, Messenger	Non-technical	200
4.	Shri Raghubir Singh, Chowkidar	Non-technical	200

Appendix-XII (A)

VISITS OF CONSULTANTS UNDER UNDP PROJECT

S.No.	Name of consultant and address	Area of Consultancy	Period of Consultancy
1.	Dr Ralph A Wurbs Environmental & WR Engg., Civil Engg. Dept., Texas A&M University, College Station TX 77843 USA	Data Processing	17.6.96 to 17.7.96
2.	Dr Lee H MacDonald Dept.of Earth Resources, Colorado State Univ. Fort Collins, CO 80523, USA	Mountain Hydrology	17.7.96 to 16.8.96
3.	Dr R J Drimmie Dept.of Earth Sciences University of Waterloo, Waterloo, Ontario Canada N2L 3G1	Nuclear Hydrology	1.9.96 to 4.10.96
4.	Dr Bernard Kenney 831 Costigan Court, Saskatoon, Saskatchewan, Canada 57J 3R4	Lake Hydrology	22.10.96 to 22.11.96

Appendix-XII (B)

TRAINING OF SCIENTISTS UNDER UNDP PROJECT

SN.	Name	Area of Training	Country	Period of Training
1.	Shri Omkar, Sc B	Catchment Hydrology	USA	10.10.96 to 9.2.97
1.	Shri A R Senthil Kumar,Sc B	Catchment Hydrology	Germany	22.10.96 to 21.2.97

Appendix-XII (C)

MAJOR EQUIPMENT AND SOFTWARE PROCURED UNDER UNDP PROJECT

1. Electronic Balance
2. Computer Accessories
3. Pygmy Current Meter & Mini Current Meter
4. Electronic Analytical Balance
5. Pocket Altimeter, Clinometer, Bearing Compass, Height Meter, Portable pH meter, Water Level gauge, Soil sample ring kit, Permeameter
6. pF Deteroin Set, Guelph permeameter, Tensiometer
7. Water Sampling Kit
8. Fluoremeter
9. UVP Monitor
10. ARC/INFO package (Software)
11 CR 10 Data Logger
12. Electromagnetic Flow Meter with E-30, Wave Height Meter, Profile Indicator, Silt Measuring Inst., Ultrasonic High Concentration Meter
13. Wave Height Gauge
14. Velocity Meter
15. Automated Weather Stations
16. Total Precipitation Gauge
17. Spares for EC&G ORTEC
18. Spares for AHS
19. Spares for Mastersizer
20. Hydrofind (Software)
21. DS-51 (Software)

Appendix-XIII

PARTICIPATION IN SEMINARS,SYMPOSIA, CONFERENCES AND COURSES

C P Kumar, Sc C attended a short-term course on Computer Based Numerical Algorithm with Engineering Applications held on 27 May - 7 June 1996 at IIT Kharagpur.

S M Seth, Director attended a Conference on Strategies for Ground Water Development held on 21 June 1996 at New Delhi.

Sudhri Kumar, Sc C attended Colloquium on Strategies for Ground Water Development held on 21 June 1996 at CWPRS, Pune.

Rakesh Kumar, Sc C; V K Dwivedi, Sc C; S K Jain, Sc C; M K Goel, Sc C; M K Jain, Sc B; B Venkatesh, Sc B; A R Senthil Kumar, Sc B; A K Keshari, Sc B; P K Garg, SRA; P K Agarwal, SRA; T Thomas, SRA; N K Bhatnagar, SRA; Rajesh Agarwal, RA attended workshop on River Basin Analysis and Modelling held on 24 June - 5 July 1996 at NIH Roorkee.

K S Ramasastri, Sc F; P K Majumdar, Sc C; J V Tyagi, Sc C attended a workshop on World Bank Procurement Policy for Hydrology Project held on 4-5 July 1996 at CWPRS, Pune.

S V N Rao, Sc E attended workshop on Watershed Hydrology held on 5-7 July 1996 at Hard Rock Regional Centre of NIH, Belgaum.

B Chakravorty,Sc C; R Jha,Sc C and A K Lohani, Sc C attended Sem. on Planning and Evaluation of Flood Control System held on 19 July 1996 at CWRS, Bihar College Engineering, Patna.

Rama Devi Mehta, Sc B and M K Jose, SRA attended Training Course on Computer Course for Data Base Managers held on 30 Jul.-9 Aug.1996 (under Hydrology Project) NIH, Roorkee.

P K Bhunya, Sc B attended workshop on Runoff Analysis in Mountainous Watersheds held on 5-10 August 1996 at Hard Rock Regional Centre of NIH, Belgaum.

N C Ghosh, Sc E; B Chakravorty, Sc C; R Jha, Sc C; A K Lohani, Sc C; R K Jaiswal,SRA attended workshop on Environment and Water Management held on 12 August 1996 at Dept. of Environment, A N College, Patna.

Naresh Kumar, SRA; P K Agarwal, SRA and M K Sharma, SRA attended Training Course on Software for Surface Water Data Management held on 19-39 August 1996 under Hydrology Project at NIH, Roorkee.

B C Patwari, Sc E (as faculty) attended Training Course on Rainfed Agriculture held on 20-30 August 1996 at NERIWLM, Tezpur.

S M Saheb, SRA; T Thomas, SRA; T Vijay, SRA and U V N Rao, SRA attended workshop on Computer Applications in Groundwater Hydrology held on 27-31 August 1996 at JNTU, Kakinada.

Rama Devi Mehta, Sc B attended 7th All India Meeting of Women in Sciences held on 5-7 September 1996, Roorkee.

S M Seth, Director attended 3rd join UNESCO/IAHS George Kovacs Colleguim held from 19-21 September 1996 and 12th Session of Intergovernmental Council of IHP of UNESCO held on 23-28 September 1996 at Paris, France as a designated representative of Government of India.

B C Patwari, Sc E attended HP Barua Memorial Lecture held on 26 September 1996 at Institution of Engineers (India), Guwahati.

K S Ramasastri, Sc F attended a two day International Conference on Effects of Land Use Changes on Himalayan River Environment held on 30 September - 1 October 1996 at New Delhi.

Hemant Chowdhary, Sc C & Chandramohan, Sc C attended workshop on Establishment of a Data Centre held on 7-8 October 1996 under Hydrology Project at IMD, Pune.

U K Singh, RA attended and presented a paper in the National Symposium on Nuclear Techniques in Increasing Crop and Animal Productivity held on 7-9 October 1996 at BARC, Mumbai.

S K Jain, Sc E and Deepa Chalisgaonkar, Sc C attended ACCESS96 - Advanced Computer Conference for the Education and Scientific Societies held on 8 October 1996 (organised by CDAC of Pune) at New Delhi.

B K Purandara, SRA and Manohar Arora, SRA attended the Training Course on Software for Groundwater Data Management held on 7-18 October, 1996 under Hydrology Project at NIH, Roorkee.

P K Majumdar, Sc C attended 12th National Convention of Environmental Engineers alongwith National seminar on Pollution Control for Sustainable Development and Human Health held on 12-13 October 1996 at Institution of Engineers (India), Jabalpur

S M Seth, Director chaired Ist Technical Session in the Workshop on Remote Sensing for Environmental Management held on 2 November 1996 at Jamia Milia Islamia, New Delhi.

S V Vijayakumar, Sc C attended workshop on Monitoring and Modelling of Coastal Marine Problems held on 18-29 November 1996 at IIT New Delhi.

S M Seth Director attended Seminar-cum-workshop on Water Resources of National Capital Region Problems and Alternatives held on 22 November 1996 at INTACH, New Delhi.

B C Patwari, Sc E attended National Convention on Utilisation of Water Resources in Assam held on 6 December 1996 at Guwahati

Omkar, Sc B attended the weekly Seminar Series on Watershed Management held on 10 Oct.-20 December 1996 (while receiving training under UNDP Project) at University of Idaho, USA.

N C Ghosh, Sc E; S K Singh, Sc C; S R Kumar, Sc B attended National Conference on HYDRO-96 held on 11-13 December 1996 at IIT Kanpur.

S M Seth, Director inaugurated and delivered Key Note Address at National Seminar on New Strategies of Water Resources Management held on 20-22 December 1996 at Jodhpur

S M Seth, Director presided over the Brain Storming Session on Hydrological Problems of Ganga Plains held on 2-4 January 1997 at Patna.

N C Ghosh, Sc E; B Chakravorty, Sc C; R Jha, Sc C; A K Lohani, Sc C and R K Jaiswal, SRA attended Sem. on Hydrological Problems and Perspectives of Lower Gangetic Plains held on 3 January 1997 at Ganga Plains North Regional Centre of NIH, Patna.

N C Ghosh, Sc E; B Chakravorty, Sc C; R Jha, Sc C and A K Lohani, Sc C attended Sem. on Environment and Ecological Problems in Water Resources Management in Flood Prone Alluvial Plains held on 13 January, 1997 at CWRS, Bihar College of Engineer, Patna.

P K Majumdar, Sc C attended workshop on Standards for Groundwater Monitoring Processing and Data Dissemination held on 20-30 January, 1997 at IISC, Bangalore.

V Sreenivasulu, Sc B attended workshop on Hydrological Modelling held on 20-30 January 1997 at NIH, Roorkee

B C Patwari, Sc E(as faculty) and P K Sarkar,RA attended Winter Course on Advances in Water Pollution Control held on 20 January - 2 February 1997 at AEC, Guwahati.

K S Ramasastri, Sc F attended the 77th workshop on Implementation of Reservation Directives for SC/ ST/OBCs in Services held on 27-31 January 1997 at Third World Development Centre, Mysore.

P K Majumdar, Sc C attended National Seminar on Hydrogeology of Hard Rock Areas held on 3 February 1997 at Karnataka University, Dharwad.

S M Seth, Director and K S Ramasastri, Sc F attended International Conference on Civil Engineering for Sustainable Development held on 13-15 February 1997 at University of Roorkee, Roorkee.

N C Ghosh, Sc E and A K Lohani, Sc C attended National Seminar on Environment & Development held on 14 February 1997 at Department of Environment, A N College, Patna

S M Seth, Director attended workshop on Application of Remote Sensing Technology in the Water Resources Sector held on 20 Feb. 1997 at CSMRS, New Delhi

Pratap Singh, Sc C and Naresh Kumar, SRA attended National Symposium on Himalayan Glaciers and Snow Cover held on 4-5 March 1997 at Jawahar Lal Nehru University, New Delhi

S M Seth, Director; S K Jain, Sc E; Pratap Singh, Sc C; D K Agrawal, Sc C; Omkar, Sc B; S P Rai, Sc B; and V Sreenivasulu, Sc B attended the Brain Storming Session on Hydrological Problems and Perspectives in Western Himalayan Region held on 14 March 1997 (organised by Western Himalayan Regional Centre of NIH) at RRL. Jammu.

M K Jain, Sc C attended Users Meet on Remote Sensing Satellite Data Products and Applications with Special Emphasis on IRS-1C Products held on 19 March 1997 at Indian Institute of Remote Sensing, Dehradun.

V S Jayakanthan, Sc B attended Workshop on Dam Break held on March 97 at NIH Roorkee

Appendix-XIV

LIST OF WORKSHOPS/TRAINING COURSES ETC ORGANISED DURING 1996-97

SN	Topic	Time Schedule	Place	Number of Participants
1.	Application of Remote Sensing and GIS in Hydrology	17-21 Jun. 1996	Roorkee	11
2.	River Basin Modelling and Analysis	25 Jun. 1996-5 Jul. 1996	Roorkee	17
3.*	Computer Course for Data Base Managers	29 Jul. 1996-9 Aug. 1996	Roorkee	20
4.	Hydrological Modelling of Mountainous Watersheds	5-9 Aug. 1996	Belgaum	15
5.*	Software for Surface Water Data Management	19-30 Aug. 1996	Roorkee	18
6.	Design Flood Estimation	2-7 Sept. 1996	Nasik	29
7.*	Software for Ground Water Data Management	7-18 Oct. 1996	Roorkee	20
8.	Hydrology of Watersheds	16 Oct. 1996	Belgaum	30

SN	Topic	Time Schedule	Place	Number of Participants
9.*	Computer Applications in Groundwater Hydrology	27-31 Aug. 1996	Kakinada	25
10.*	Reservoir Operation	9-20 Dec. 1996	Roorkee	10
11.*	Hydrological Modelling	20-31 Jan.1997	Roorkee	18
12.	Brainstorming Session on Hydrological Problems & Perspectives in Western Himalayan Region	14 March 1997	Jammu	62
13.	Brainstorming Session on Hydrological Problems of Hard Rock Region	15 March 1997	Belgaum	30
14.	Brainstorming Session on "Hydrological Problems and Perspectives of Lower Gangetic Plains"	3 Jan. 1997	Patna	58
15.*	Dam Break Flood Studies	24 Feb.- 6 March 1997	Roorkee	8

* Training Course under Hydrology Project

Appendix-XV

AUDITED STATEMENT OF ACCOUNTS

P.N. BAHRI & CO.,
CHARTERED ACCOUNTANTS
DEHRA DUN - NAGPUR

Fax No. : 0135-654991
Gram : AUDITORS
Phones : 654604, 656493

10, CONVENT ROAD
DEHRA DUN-248001

AUDITOR'S REPORT

We have audited the Balance Sheet of NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE as at 31st March, 1997 and also the annexed Income & Expenditure Account and the Receipts and Payments Account for the year ended on the date and report that:-

1. We have checked the accounts of the society from the books and vouchers produced and the information and explanations given to us, in which are incorporated the returns from Regional Centres not visited by us.

2. We have obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purpose of our audit.

3. The Balance Sheet, the Income & Expenditure Account and the Receipts & Payments Account dealt with by the report are in agreement with the books of account.

In our opinion and to the best of our information and according to the explanations given to us, the statements together with Schedules A to G attached and read with Schedule `H' of Notes on accounts give a true and fair view:

i) In the case of the Balance Sheet of the state of affairs of the society as at March 31st 1997.

ii) In the case of the Income & Expenditure Account of the SURPLUS for the year ended on that date.

iii) In the case of the Receipts & Payments Account of the cash transactions for the year ended on that date.

For **M/S P.N. BAHRI & CO.,**
CHARTERED ACCOUNTANTS,

Seal

Sd/-

(DINESH GUPTA)
Partner.

10-Convent Road, Dehra Dun
Dated: October 25 1997

P.N. BAHRI & CO.,
CHARTERED ACCOUNTANTS
DEHRA DUN - NAGPUR

Fax No. : 0135-654991
Gram : AUDITORS
Phones : 654604, 656493

10, CONVENT ROAD
DEHRA DUN-248001

UTILISATION CERTIFICATE

Certified that the National Institute of Hydrology, Roorkee has utilised the Grant-in-aid as detailed hereunder during the financial year 1996-97 and the same has been verified with reference to accounting records maintained by the Institute and has been found to be correct :

Particulars	PLAN	NON PLAN	TOTAL
Opening Balance (as on 01.04.1996)	14,994.00	51,539.50	66,533.50
Grant in aid received from Ministry of Water Resources, N. Delhi.	2,45,00,000.00	1,78,00,000.00	4,23,00,000.00
Total	2,45,14,994.00	1,78,51,539.50	4,23,66,533.50
Less Payment	2,44,79,517.29	1,78,16,786.70	4,22,96,303.99
Closing balance as on 31.03.1997	35,476.71	34,752.80	70,229.51

Sd/-

(C.P. KUMAR)
Finance Officer

Sd/-

(S.M. Seth)
Director

PLACE : ROORKEE

DATED : 25 October, 1997

Sd/-

For M/s P.N. Bahri & Co.
Chartered Accountant

Seal

Sd/-

10, CONVENT ROAD, DEHRADUN
Dated : 25 October, 1997

(DINESH GUPTA)
(Partner)

NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE (U.P.)
BALANCE SHEET AS AT 31ST MARCH, 1997

PREVIOUS YEAR (Rs.)	FUND AND LIABILITIES	CURRENT YEAR (Rs.)		PREVIOUS YEAR (Rs.)	ASSETS	CURRENT YEAR (Rs.)
	UNSPENT BALANCE				FIXED ASSETS (AT COST)	
78,764.50	OPENING BALANCE	66,533.50		10,99,02,129.80	(AS PER SCHEDULE 'A')	11,71,51,398.71
5,10,00,000.00	Add: (a) GIA FROM GOI, MOWR, N.Delhi	4,23,00,000.00				
	Less: (a) AMOUNT TRANSFERRED TO CURRENT ASSETS FUNDS	1,05,55,759.89			BUILDING WORKS IN PROGRESS	
(-) 1,01,45,992.68	(b) AMOUNT TRANSFERRED TO FIXED ASSETS FUNDS	72,49,268.91		47,83,000.00	(AS PER SCHEDULE 'B')	47,83,000.00
(-) 1,81,26,406.79	(c) AMOUNT TRANSFERRED TO INCOME & EXPENDITURE	2,44,91,275.19			DEPOSITS	
(-) 2,26,68,955.53	(d) PREVIOUS YEAR ADJUST.					
(-) 70,876.00				1,02,310.00	(AS PER SCHEDULE 'C')	1,28,220.00
66,533.50	CLOSING BALANCE	70,229.51	70,229.51			
	FIXED ASSETS CAPITAL FUND				LOAN AND ADVANCES	
9,65,58,723.01	OPENING BALANCE	11,46,85,129.80		4,11,60,048.17	(AS PER SCHEDULE 'D')	5,25,36,465.06
(+) 1,81,26,406.79	Add: TRANSFERRED FROM GIA	72,49,268.91				
11,46,85,129.80	SUB TOTAL	12,19,34,398.71	12,19,34,398.71		PRE PAID EXPENSES	
				11,25,530.00	(AS PER SCHEDULE 'F')	4,29,138.00
	CURRENT LIABILITIES					
	LIABILITIES FOR EXPENSES					
5,01,912.00	(AS PER SCHEDULE 'E')	6,52,087.00				
	DEPOSITS			66,533.50	BANK BALANCES WITH STATE BANK OF INDIA	70,229.51
(+) 3,000.00	(AS PER SCHEDULE 'G')	3,000.00				
5,04,912.00	SUB TOTAL	6,55,087.00	6,55,087.00			

		CURRENT ASSETS FUNDS					
	3,17,36,983.49	OPENING BALANCE	4,18,82,976.17				
		Add : TRANSFERRED FROM CURRENT					
(+)	1,01,45,992.68	ASSETS FUNDS	1,05,55,759.89				
	4,18,82,976.17	SUB TOTAL	5,24,38,736.06	5,24,38,736.06			
	15,71,39,551.47	TOTAL		17,50,98,451.28	15,71,39,551.47	TOTAL	17,50,98,451.28

Note: Schedules 'A' to 'H' form integral part of this Balance sheet.

Sd/-

(C.P. KUMAR)
FINANCE OFFICER

Sd/-

(S.M. SETH)
DIRECTOR

PLACE : ROORKEE

DATED : 25 Oct., 1997

As per our separate report of even date.
FOR M/S P.N. BAHRI & CO.
CHARTERED ACCOUNTANT

Seal

Sd/-

10, CONVENT ROAD, DEHRADUN
Dated : 25 Oct., 1997

(DINESH GUPTA)
(PARTNER)

NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE (U.P.)
INCOME AND EXPENDITURE ACCOUNTS FOR THE YEAR ENDING 31ST MARCH, 1997

PREVIOUS YEARS (Rs.)	EXPENDITURE	CURRENT YEAR (Rs.) PLAN	NON-PLAN	TOTAL	PREVIOUS YEAR(Rs.)	INCOME	CURRENT YEAR (Rs.) PLAN	NON-PLAN	TOTAL
1,54,58,892.50	SALARIES,WAGES AND ALLOWANCES	8,13,290.00	1,63,34,476.00	1,71,47,766.00	54,648.10	INTEREST ON SAVINGS/DEPOSITS	-	1,72,343.00	1,72,343.00
7,75,207.40	TRAVELLING AND CONVEYANCE	6,03,729.10	2,02,647.00	8,06,376.10					
4,66,941.25	ELECT./WATER & GEN.RUN,COST	4,01,700.47	1,07,113.00	5,08,813.47	5,52,914.00	MISCELLANEOUS RECEIPTS	-	3,69,116.00	3,69,116.00
5,66,484.35	PRINTING AND STATIONERY	2,96,215.19	46,174.00	3,42,389.19					
9,14,052.55	POSTAGE,TELEPHONE & TELEX	9,35,309.80	54,045.70	9,89,355.50	16,955.00	INTEREST ON ADVANCE	-	26,223.00	26,223.00
1,62,352.00	SEMINAR/WORKSHOP/ TRG.COURSES	2,39,351.00	-	2,39,351.00					
20,925.00	ADVERTISEMENT	91,631.00	38,018.00	1,29,649.00					
4,26,047.00	PRINTING OF TECHNICAL BOOKS	1,41,147.00	34,327.00	1,75,474.00					
6,09,164.43	MISCELLANEOUS	3,60,245.37	1,25,748.00	4,85,993.37					
3,70,480.80	REPAIR & MAINT OF VEHICLE	2,05,657.66	2,52,474.00	4,58,131.66					
18,51,370.42	REPAIR & MAINT. (OTHERS)	21,60,690.10	73,988.00	22,34,678.10	2,26,68,955.53	TRANSFERRED FROM GIA ACCOUNT TO MEET EXPENDI-TURE FOR THE YEAR	71,46,221.49	1,73,45,053.70	2,44,91,275.19

70,499.00	INTEREST TO CPF	7,365.00	11,431.00	18,796.00					
4,92,444.00	EMPLOYER'S CONTRI-BUTION OF CPF	9,584.00	5,15,110.00	5,24,694.00					
6,74,558.80	RUNNING COST OF LAB./COMPUTER	7,28,020.80	1,09,079.00	8,37,099.80					
3,84,930.00	RENT,RATES AND TAXES	1,52,285.00	8,105.00	1,60,390.00					
49,123.13	LOSS ON SALE OF ASSETS	-	-	-					
2,32,93,472.63	TOTAL	71,46,221.49	1,79,12,735.70	2,50,58,957.19	2,32,93,472.63	TOTAL	71,46,221.49	1,79,12,735.70	2,50,58,957.19

Sd/-

(C.P. KUMAR)
FINANCE OFFICER

Sd/-

(S.M. SETH)
DIRECTOR

PLACE : ROORKEE

DATED : 25 Oct., 1997

As per our separate report of even date.
FOR M/S P.N. BAHRI & CO.
CHARTERED ACCOUNTANT

Seal

Sd/-

10, CONVENT ROAD, DEHRADUN
Dated : 25 Oct., 1997

(DINESH GUPTA)
(PARTNER)

NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE (U.P.)
RECEIPTS AND PAYMENTS ACCOUNTS FOR THE YEAR ENDING ON 31ST MARCH, 1997

PREVIOUS YEARS (Rs.)	Receipts	CURRENT YEAR (Rs.) PLAN	NON-PLAN	TOTAL	PREVIOUS YEAR(Rs.)	Payment	CURRENT YEAR (Rs.) PLAN	NON-PLAN	TOTAL
78,764.50	OPENING BALANCE	14,994.00	51,539.50	66,533.50	1,50,72,551.00	SALARIES,WAGES AND ALLOWANCES	5,47,357.00	1,64,83,449.00	1,70,30,806.00
					5,47,694.00	TRAVELLING AND CONVEYANCE	3,14,731.00	2,64,721.00	5,79,452.00
					4,24,777.00	ELECTRICITY & WATER CHARGES	2,97,892.00	91,541.00	3,89,433.00
					3,37,024.00	PRINTING AND STATIONERY	37,619.00	43,917.00	81,536.00
					7,22,030.00	POSTAGE TELE-PHONE & TELEX	5,65,770.00	28,194.70	5,93,964.70
5,10,00,000.00	GIA RECEIVED FROM GOI/MOWR/ND	2,45,00,000.00	1,78,00,000.00	4,23,00,000.00	20,925.00	ADVERTISEMENT	91,631.00	38,018.00	1,29,649.00
					4,26,047.00	PRINTING OF TECHNICAL BOOKS	1,41,147.00	34,327.00	1,75,474.00
					26,81,799.10	REGIONAL CENTRES	30,87,601.00	44,372.00	31,31,973.00
					3,74,918.00	MISCELLANEOUS	1,55,651.00	69,294.00	2,24,945.00
					1,60,523.00	REPAIR & MAIN-TENANCE OF VEHICLE	-	1,75,652.00	1,75,652.00
54,648.10	INTEREST FROM BANKS	-	1,72,343.00	1,72,343.00	12,78,141.00	REPAIR & MAIN-TENANCE - OTHERS	8,16,847.00	64,120.00	8,80,967.00
					5,62,943.00	INTEREST OF CPF/ CPF-CONTRIBUTION	16,949.00	5,26,541.00	5,43,490.00
					7,88,620.00	FURNITURE AND FIXTURE	5,15,890.00	-	5,15,890.00
					5,58,630.00	OFFICE EQUIPMENT	98,066.00	-	98,066.00
5,85,700.00	MISCELLANEOUS RECEIPTS	-	3,65,454.00	3,65,454.00	9,76,280.00	LIBRARY BOOKS/ JOURNALS	9,32,810.00	250.00	9,33,060.00
-	UOR RECEIPTS	64,85,446.71	-	64,85,446.71	20,05,725.00	MACHINERY/LAB. EQUIPMENT/ COMPUTER	20,04,998.00	-	20,04,998.00
					36,195.00	RENT, RATES AND TAXES	35,582.00	15,881.00	51,463.00

16,955.00	INTEREST ON ADVANCES	-	24,113.00	24,113.00		-			
					1,41,557.00	BUILDING AND BULK SERVICES	2,42,159.00	-	2,42,159.00
					3,69,543.00	RUNNING COST OF LAB./COMPUTER	3,56,184.00	1,09,079.00	4,65,263.00
		-	-	-	1,86,79,232.00	ADVANCES TO FIRMS	66,60,191.00	1,17,216.00	67,77,407.00
					9,17,798.00	DEPT.ADV./ADV. TO DIV.HEADS	6,92,889.00	1,27,164.00	8,20,053.00
2,74,658.00	RECOVERIES OF ADV. TO EMPLOYEES	-	3,42,411.00	3,42,411.00	6,29,815.00	ADVANCES TO EMPLOYEES	-	4,88,665.00	4,88,665.00
					42,00,000.00	ADVANCES TO UOR - ROORKEE (UP)	-	-	-
	REMITTANCE	-	1,294.00	1,294.00	31,425.00	SEMINAR AND CONFERENCES	10,000.00	-	10,000.00
					-	ADVANCE TO R.P.N.N	1,33,43,000.00	-	1,33,43,000.00
					66,533.50	CLOSING BALANCES:	35,476.71	34,752.80	70,229.51
5,20,10,725.60	TOTAL	3,10,00,440.71	1,87,57,154.50	4,97,57,595.21	5,20,10,725.60	TOTAL	3,10,00,440.71	1,87,57,154.50	4,97,57,595.21

Sd/-

(C.P. KUMAR)
FINANCE OFFICER

Sd/-

(S.M. SETH)
DIRECTOR

PLACE : ROORKEE

DATED :

As per our separate report of even date.
FOR M/S P.N. BAHRI & CO.
CHARTERED ACCOUNTANT

Seal

Sd/-

10, CONVENT ROAD, DEHRADUN
Dated:

(DINESH GUPTA)
(PARTNER)

Schedule - A

NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE
Fixed Assessts as on 31st March 1997

Sl. No.	Particulars	Cost as on 01.04.96	Additions during the year	Sale/Adjust-ment during the year	Total Balance as on 31.03.97
1.	Building	4,69,70,383.47	3,93,823.00	-	4,73,64,206.47
2.	Land for colony	12,34,222.50	-	-	12,34,222.50
3.	Furniture & Fixtures	60,62,039.57	10,37,955.00	-	70,99,994.57
4.	Office equipmnent	71,66,213.68	3,52,028.00	-	75,18,241.68
5.	Computer Mach.	1,84,15,688.80	53,500.00	-	1,84,69,188.80
6.	Vehicle	18,73,162.37	6,94,460.88	-	25,67,623.25
7.	Library Books	60,57,830.32	12,21,239.75	-	72,79,070.07
8.	Machinery & Equipment	2,19,16,661.09	23,37,136.28	-	2,42,53,797.37
9.	Generator Set	2,05,928.00	11,59,126.00	-	13,65,054.00
	Total	10,99,02,129.80	72,49,268.91	-	11,71,51,398.71
	Previous Year 31.03.1996	7,34,87,723.79	3,64,96,315.92	(-)81,909.13	10,99,02,129.80

Schedule - B

NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE
Building Works in Progress as on 31st March, 1997

Sl.No.	Particulars	Amount as on 01.04.1996	Additions during the year	Adjustment during the year	Amount as on 31st March 1997
1.	UOR, Roorkee	47,83,000.00	-	-	47,83,000.00

Schedule - C

NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE
Deposits as on 31.03.1997 (Made by NIH with outside parties)

Sl.No.	Particulars	Amount (Rs.)		
		Plan	Non Plan	Total
1.	Security deposits for Gas Cylinders	1,900.00	350.00	2,250.00
2.	Deposits to UPSEB for sub station	-	8,480.00	8,480.00
3.	Security deposits for Telex	-	10,000.00	10,000.00
4.	Deposits with SAIL Gaziabad for steel	15,000.00	-	15,000.00
5.	SDO (Telegraph) for telephones	-	13,800.00	13,800.00
6.	Security deposits for telephone at RC Belgaum	8,000.00	-	8,000.00
7.	Distt. G.M. Telecom for telephone connection at Guwahati	8,000.00	-	8,000.00
8.	M/s Deepti Gas Agency Guwahati	500.00	530.00	1,030.00
9.	Accounts Officer (Tel)	6,000.00	-	6,000.00
10.	A.O. (Tel) Patna	16,950.00	-	16,950.00
11.	A.O. (Tel) Kakinada	11,710.00	-	11,710.00
12.	SDO (Tel.) Sagar	12,000.00	-	12,000.00
13.	R.C. Jammu	15,000.00	-	15,000.00
	Total	95,060.00	33,160.00	1,28,220.00
	Previous Year 31.3.1996	69,150.00	33,160.00	1,02,310.00

Schedule - D

NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE
Current Assessts, Loans and Advances as on 31.03.1997

Sl.No.	Particulars	Amount (Rs.)		
		Plan	Non Plan	Total
1.	Advances to Firms	78,75,774.00	98,910.00	79,74,684.00
2.	Advances to employees			
	a) Cycle Advance	-	6,108.00	
	b) Festival Advances	-	30,360.00	
	c) Fan Advance	-	-	
	d) Scooter/car Advances	-	2,02,848.00	
	e) LTC Advances	-	64,837.00	
	f) TA Advances	1,31,540.00	33,900.00	
	g) Departmental Adv.	33,327.00	200.00	
	h) Pay Advances	-	7,150.00	
	i) Adv. to Div. Head	2,000.00	-	
	j) House Building Adv.	-	14,80,819.00	
	k) Medical Advances	1,000.00	1,000.00	
	l) Other Advances	-	2,500.00	
	Sub Total (2)	1,67,867.00	18,29,722.00	19,97,589.00
3.	Advances for construction			
	a) UOR, Roorkee	1,08,62,885.65		
	b) Ex.Engr.Const.Div. CPWD, New Delhi	12,50,000.00		
	c) Supdt. of works, PWD, DVC, Hardwar	2,07,000.00		
	d) Ex.Engr.Elect.Div. Roorkee	35,12,154.00		
	e) WALMI, Patna	59,21,604.00		
	f) RPNN, Kakinada	85,00,000.00		
	g) RPNN Headquarters	1,18,43,000.00		
	Sub-Total (3)	4,20,96,643.65		4,20,96,643.65
4.	Amount transferred to RCs.			
	a) Belgaum	1,18,363.65	4,174.80	
	b) Guwahati	1,26,534.13	5,225.72	
	c) Jammu	58,612.00	8.077.36	
	d) Patna	6,241.12	5,376.60	
	e) Kakinada	1,07,650.30	9,229.98	
	f) Sagar	18,062.75	-	
	Sub Total (4)	4,35,463.95	32,084.46	4,67,548.41
	Total (1 to 4)	5,05,75,748.60	19,60,716.46	5,25,36,465.06
	Previous Year (31.03.1996)	3,95,17,150.71	16,42,897.46	4,11,60,048.17

Schedule - E

NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE

Outstanding expenses as on 31.03.1997

Sl.No.	Particulars	Amount (Rs.)		
		Plan	Non Plan	Total
I.	Establishment			
	Pay Arrear	-	6,854.00	6,854.00
	D.A.Arrear	-	1,14,685.00	1,14,685.00
	OTA	-	500.00	500.00
	RTF	-	11,630.00	11,630.00
	Medical Expenses	-	50,362.00	50,362.00
	Wages	4,762.00	11,549.00	16,311.00
	Honorarium	-	3,663.00	3,663.00
II.	O.E.			
	Electricity	-	15,572.00	15,572.00
	Payment for Professional charges	-	24,536.00	24,536.00
	Telephone	1,14,842.00	8,695.00	1,23,537.00
	Running Cost of Lab.	876.00	-	876.00
III.	Capital			
	Furniture & fixture	28,350.00	-	28,350.00
	Bldg. works	1,51,664.00	-	1,51,664.00
	Office Equipment	55,194.00	-	55,194.00
	Lab. Equipment	17,334.00	-	17,334.00
	D.G. Set	12,267.00	-	12,267.00
IV.	Maintenance			
	- of Furniture & fixture	16,600.00	-	16,600.00
	- of Building	858.00	-	858.00
V.	Recoveries from salary NIH/GSLI/FP & House rent/Elect.	-	1,294.00	1,294.00
	Total	4,02,747.00	2,49,340.00	6,52,087.00
	Previous year (31.03.1996)	98,913.00	4,02,999.00	5,01,912.00

Schedule - F

NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE

Prepaid expenses as on 31.03.1997

Sl.No.	Particulars	Amount (Rs.)		
		Plan	Non Plan	Total
1.	Running cost of lab.	7,875.00	-	7,875.00
2.	Journals	4,11,759.00	-	4,11,759.00
3.	Maintenance of office equipments	4,900.00	-	4,900.00
4.	RC, Patna	3,667.00	-	3,667.00
5.	RC, Jammu	937.00	-	937.00
	Total	4,29,138.00	-	4,29,138.00
	Previous year (31.03.1996)	11,25,202.00	328.00	11,25,530.00

Schedule - G

NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE

Deposits as on 31.03.1997 (made by outside parties with NIH)

Sl.No.	Particulars	Amount (Rs.)		
		Plan	Non Plan	Total
1.	For Canteen	-	3,000.00	3,000.00
	Total	-	3,000.00	3,000.00
	Previous year (31.03.1996)	-	3,000.00	3,000.00

ASSET FUND ACCOUNT

				Amounts (Rs.)
Sc A	Increase in fixed assets			72,49,268.91
Sc B	Decrease in Works in Progress			
Sc C	Increase in Deposits			25,910.00
Sc D	Increase in Advances			1,13,76,416.89
Sc F	Decrease in Prepaid		(-)	6,96,392.00
	Sub Total			1,79,55,203.80
Less:				
Sc G	Increase in Deposits			
Sc E	Increase in Liability	1,50,175.00		
	Sub Total	1,50,175.00	(-)	1,50,175.00
	Total (i.e. amount transferred to asset fund A/c)			1,78,05,028.80
(a)	Transfer to Current Assets Fund			1,05,55,759.89
(b)	Transfer to Fixed Assets Fund			72,49,268.91

P.N. BAHRI & CO.,
CHARTERED ACCOUNTANTS
DEHRA DUN - NAGPUR

Fax No. : 0135-654991
Gram : AUDITORS
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10, CONVENT ROAD
DEHRA DUN-248001

SCHEDULE 'H'

NATIONAL INSTITUTE OF HYDROLOGY - ROORKEE
ACCOUNTING POLICIES AND NOTES ON ACCOUNTS AS ON 31ST MARCH 1997

A. SIGNIFICANT ACCOUNTING POLICIES :

1) **Accounting Conventions :** The accompanying financial statements have been prepared in accordance with the mandatory accounting standards issued by the Institute of Chartered Accountants of India under the historical cost convention, with revenue recognised on receipt basis and expenses accounted for on accrual basis.

   The cost reflected in these statements are not adjusted to reflect the impact of the changing value in purchasing power of money.

2) **Project Accounts :** Independent Project Accounts against funds provided by independent bodies are maintained separately and are therefore not incorporated in the above statements.

3) **Regional Centres :** Accounts for regional centres are incorporated in the main accounts on the basis of returns received at Head Quarter, and balances if any, are shown under advances.

4) **Fixed Assets :**

   i) Fixed Assets are carried at cost of acquisition or construction and includes freight, duties, taxes and incidental expenses related to such acquisition. None of the fixed assets have been revalued during the year.

   ii) Land at Kakinada and at Patna are in possession of the Institute but are pending legal transfer from the State Governments. Superstructure has been built by the Institute out of its funds.

   iii) The society is maintaining proper records to show full particulars including quantitative details and situation of its fixed assets after adjusting the overall cost of acquisition/ construction.

   iv) Fixed Assets acquired under independent project accounts are maintained separately and are not incorporated in the above statements and separate recordes are maintained for the same.

5) **Depreciation :** Depreciation has not been provided on fixed assets as per past practice.

6) **Inventories :** Stock of Institute's research publications and technical books and consumable stores are not valued in accounts as per past practice and the total expenditure is treated as utilisation of funds.

Cont..

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Work in Progress : Building work in progress as per Schedule `B' represents civil works completed by the executing bodies but not taken over by the Institute.

8) **Revenue Recognition :** Revenue grant has been taken in Income & Expenditure Account whereas Capital Grant has been taken directly to Fixed Assets Capital Fund in Balance Sheet.

B. NOTES :

9) **Fixed Assets Capital Fund :**

i) Fixed Assets Capital Fund represents the cost of fixed assets as on 31st March 1997 including adjustment of Rs. 2,30,71,000 for Building Work in Progress completed and taken over during the year from University of Roorkee and balance of Building Work in Progress on 31st March 1997 at Rs. 47,83,000.

ii) Estimated amount of contracts remaining to be executed for works in progress pending completion Rs. 185 lakhs, for which provision has been made in Budget estimate for the financial year 1997-98.

iii) Current Assets, Loans and Advances as on 31st March 1997 are pending confirmation from parties.

iv) Outstanding expenses of Rs. 6,52,087 includes Rs. 1,14,685 for D.A. Arrears since paid and 17,334 for maintenance of Lab. Equipment.

C. GENERAL : The society is registered under Societies Registration Act 1860 vide Certificate No. 4738/78-79 Renewal no. 858/1995 File No.I-50232 valid upto 16.12.1999.

For **M/S P.N. BAHRI & CO.,**
CHARTERED ACCOUNTS,

Seal

Sd/-

10-Convent Road, Dehra Dun
Dated: October 25, 1997

(DINESH GUPTA)
Partner.

NATIONAL INSTITUTE OF HYDROLOGY
MAJOR LABORATORY FACILITIES AT ROORKEE

CAPABILITIES

COMPUTER CENTRE

- Analysis of hydrological data
- Data storage & retrieval system
- Development of mathematical models
- Development of softwares
- Implementation & application of softwares developed elsewhere
- Management information system

GROUND WATER

- Infiltration rate measurement
- In-situ soil density measurement
- Soil density measurements
- Soil sample collection

HYDROLOGICAL INSTRUMENTATION

- Collection, transmission and processing of hydromet data
- Design & development of various hydromet instruments and data acquisition system for field measurement

HYDROLOGICAL INVESTIGATION

- Flow/discharge measurement
- Infiltration rate measurement
- Measurement of water level in wells
- Water sampling from rivers, lakes etc.

NUCLEAR HYDROLOGY

- C-14/H-3 dating of ground water
- Discharge of rivers
- Ground water velocity measurements
- Leakage/seepage detection from dam/ reservoir
- Environmental tritium enrichment
- Recharge to ground water
- Soil moisture measurement
- Sedimentation in water bodies

REMOTE SENSING APPLICATIONS

- Groundwater zonation mapping, flood plain mapping, land use, salinity, sedimentation, snow cover mapping, soil erosion, visual and digital image processing for water quality, water logging etc.

SOIL WATER

- Determination of soil moisture characteristic curves (0.1 to 15 bar)
- Determination of soil suction (0 to 0.85 bar)
- In-situ soil moisture measurement
- In-situ soil salinity measurement
- Permeability measurement
- Sampling in soft & hard soil
- Sedimentation/wet mechanical analysis of soil

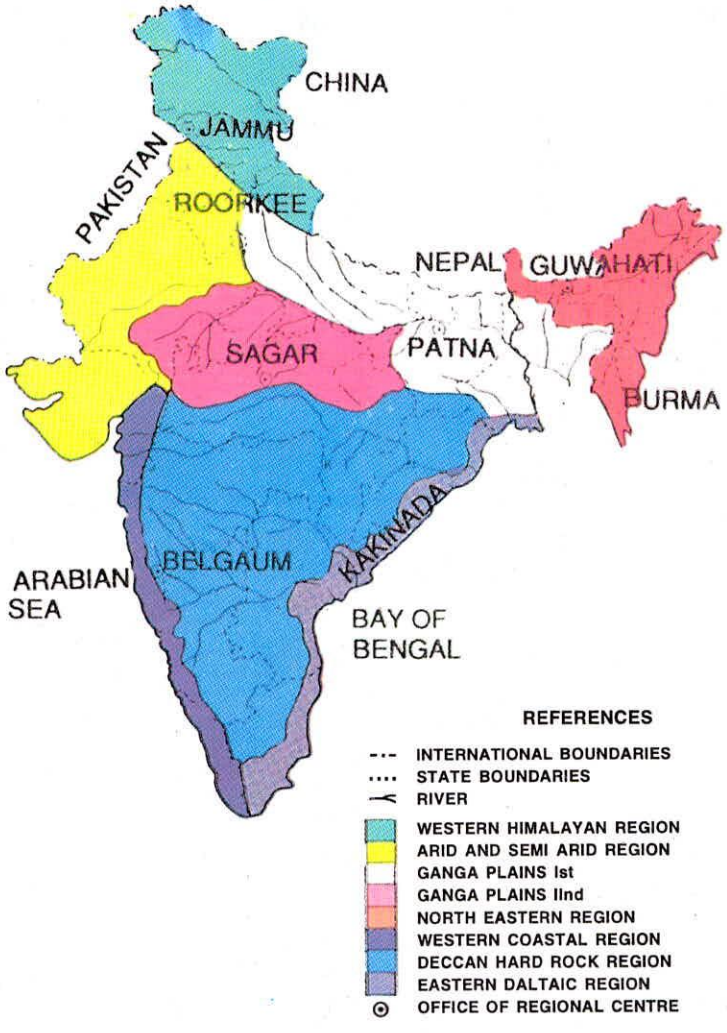
WATER QUALITY

- Analysis of organic carbon, inorganic carbon, total carbon
- Analysis of pesticides & other organic compounds
- Bacteriological analysis
- Digeistion of BOD & COD samples
- Field measurement of pH, conductivity, anions and trace elements

In addition, Regional Centres of NIH at different locations are well equipped to carry out computer, laboratory and field oriented studies relating to

- Hydrological modelling & analysis
- Digital image processing and GIS
- Ground water exploration
- Hydro-meteorology
- Remote sensing applications
- Soil moisture measurements
- Soil sampling & analysis
- Water quality

REGIONAL CENTRES OF NATIONAL INSTITUTE OF HYDROLOGY



NIH REGIONAL CENTRES

Hard Rock Regional Centre
National Institute of Hydrology
Plot No. 11, 1st Main, 2nd Cross,
Hanuman Nagar, Race Course
Belgaum - 590 001 (Karnataka)
Phone : 0831-451514
Fax : 0831-426222

North-Eastern Regional Centre
National Institute of Hydrology
Jalvihar, Chitra Lekha Lane
Usha Nagar, Dispur - 781 006
Guwahati, Assam
Phone : 0361-563153
Fax : 0361-563691

Western Himalayan Regional Centre
National Institute of Hydrology
Irrigation & Flood Control Complex
Belicharana, Satwari
Jammu Cantt - 180 003 (J. & K.)
Phone : 0191-432619
Fax : 0191-450117

Ganga Plains North Regional Centre
National Institute of Hydrology
WALMI Complex, Khagaul
P.O. Phulwari Sharif
Patna - 801 505 (Bihar)
Phone : 0612-452219, 452227
Fax : 0612-452227, 225192

Deltaic Regional Centre
National Institute of Hydrology
Siddartha Nagar, Vakalpudi Road
Kakinada - 533 003
(Andhra Pradesh)
Phone : 0884-72254, 62254
Fax : 0884-63272

Ganga Plains South Regional Centre
National Institute of Hydrology
278, Manorama Colony
Sagar - 470 000 (M.P.)
Phone : 07582-21943

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