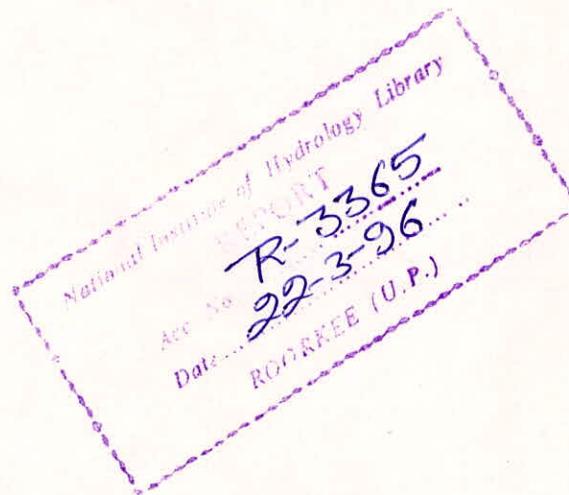


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NATIONAL INSTITUTE OF HYDROLOGY

ANNUAL REPORT 1986-87



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PREFACE

During the year under report, studies and research covering different aspects of hydrology, were conducted as per approved work programme under 14 problem oriented scientific divisions, and significant progress was made. Some of the important studies include (i) statistical analysis of rainfall in Belgaum district, (ii) flow to a dug well in hard rock areas, (iii) aquifer recharge, (iv) flowing artesian well, (v) drought indices (vi) hydrological drought analysis for 1985-86, (vii) water conservation and harvesting for drought management, (viii) reservoir water balance, (ix) soil erosion and water quality modelling, (xi) flood plain mapping and inundation studies, and (xii) development of data storage and retrieval system. Based on the studies conducted the institute brought out 51 reports which included case studies, user's manuals for computer programmes and status reports. The scientists of the institute have also contributed to technical literature through publication of 51 papers in national and international journals, and proceedings of seminars / symposia.

The institute had been very active in technology transfer, particularly to various central and state government organisations through circulation of reports and organisation of 5 days workshops on specialized techniques for hydrologic analysis and design. Special emphasis was laid on transfer of computer programmes after making them operational on available computers in states. During the year, 5 such workshops were organised, which included 2 in Orissa and Karnataka states and 3 at Roorkee. The feedback received from workshops is very encouraging, and gradually awareness regarding modern techniques is growing amongst field engineers. The need for improvement of hydrological practices and activities in different parts of country has been given due emphasis in the programme of activities of the institute. Interaction and close collaboration with states forms an essential part of this programme. Contacts have been established through visits and correspondence with 13 states. The response from states is encouraging. 3 states have referred consultancy projects to the institute and information/data have been provided by other states for drought and other studies.

Realising the differences in climate, geology, land use, soil and environmental conditions leading to typical hydrological conditions in different regions, the institute has planned to establish seven regional centres. Out of these, three regional centres; [i] For Deccan Hard Rock Region, [ii] For North Eastern Mountainous Region and [iii] For North Western Himalayan Region, are to be established during 7th Plan period. Besides conducting hydrologic studies for the region, at least one representative basin with appropriate instrumentation would also be established in each region. The data collected from these basins would be used to develop model parameters for use under similar conditions.

The HILTECH Secretariate which is attached to the institute and integrated with it has carried no. of activities during the year. 7 meetings of panels for various disciplines & meetings of various sub-committees were held during the year. The proposal for National Hydrology Project-surface water for river basins of peninsular India was prepared on behalf of HILTECH, 3 Seminars/Workshops were sponsored/funded by the HILTECH & one research project was sponsored by HILTECH. The first issue of Jal Vigyan Sameeksha, a HILTECH publication was brought out. The ARCCOH secretariate also functioned well during the year and annual bulletin was brought out covering hydrological activities in the region. Directory of Hydrologists in ARCCOH Region was compiled and a preparatory meeting of the participating countries was held to finalise the proposal for South Central Asian Region of Major Regional Project.

The work programme of the institute has been diversified to cover field and laboratory oriented studies, besides computer oriented work. The institute has established laboratories in the areas of remote sensing applications, water quality, groundwater and hydrological investigations, and a workshop cum service and instrumentation facility. The studies and research programme have gained momentum, and the activities are progressing well towards fulfilling the objectives of institute.

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1.0 INTRODUCTION

1.1 General

The National Institute of Hydrology was set up in December 1978 by Government of India as a registered Society under the Societies Registration Act 1860 fully aided by Ministry of Water Resources (formerly Ministry of Irrigation and Power, Department of Irrigation). The Institute is located at Roorkee. The Union Minister of Water Resources is the President of the Society and Secretary to Government of India, Ministry of Water Resources is the Chairman of the Governing Body (GB).

The Institute is located within the campus of University of Roorkee on 6.5 acres of land provided by Univ. of Roorkee on long term lease to the Institute. The main building of the Institute is in use since December, 1982. A Laboratory Block has been constructed during the year and infrastructural facilities are gradually becoming operational.

1.2 Objectives

The National Institute of Hydrology has been established :

- (i) To undertake, aid, promote and coordinate systematic and scientific work in all aspects of hydrology.
- (ii) To cooperate and collaborate with other national and international organisations in the field of hydrology.
- (iii) To establish and maintain a research reference library in pursuance of the objectives of the Society and equip the same with books, reviews, magazines, newspapers 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 above objectives.

1.3 Work Review

During the first five years, the Institute had laid emphasis on creation of necessary infrastructural facilities like buildings, recruitment of staff, training of manpower and provision of computer facilities generally with a view to conduct computer oriented studies in the 8 priority areas of research those were defined by the Governing Body and Technical Advisory Committee (TAC). The Institute has procured/developed, implemented and tested a number of computer

programmes covering the areas of frequency analysis, rainfall-runoff modelling, flood estimation, reservoir operation and groundwater modelling.

The Institute has acquired a sophisticated fourth generation VAX-11/780 computer system with various peripherals including a colour graphic terminal under the UNDP Project. Besides this, a number of computer peripherals, an automatic hydrologic station and some field and laboratory equipment have also been procured under this project. The Institute has established a good library equipped with scientific and technical books and journals in hydrology and related areas. The British Council has also contributed some books and technical literature for the library. The UNDP project has provided training to 17 scientists in diversified areas representing various components of the hydrological system. The former Director of the Institute and a senior scientist also undertook study tours under this project. The Chief Technical Adviser and 4 consultants visited the Institute under the project and helped in the development of its research programme.

The studies and research work carried out during 1979-84 were published during 1984 besides fulfilling the research programme of that year.

Keeping in view the future requirements of the country in the field of hydrology, the work programme for the 7th plan period (1985-90) was prepared and was approved by TAC and GB. The research activities which were earlier computer oriented, have been diversified to cover field and laboratory oriented problems. Establishment of Drought Studies division was proposed considering the acute drought problem faced by the country and importance of drought mitigation in country. This Division was established in February 1986 and studies were initiated. Based on the approved work programme, the infrastructural facilities and man power requirement were worked out and the EFC memo for the Institute for the 7th plan period was finalised,

Based on the approved scientific and technical activities, 64 reports of various categories were prepared and circulated to State and Central organizations during 1985-86. Besides studies and research in various scientific divisions, the technology transfer activities through organization of workshops and seminars and visits to States were also carried out.

During the year under report, the EFC memo was approved, though for a financial outlay lesser than planned. In view of the constraint, the building component was suitably modified while giving emphasis to procurement of equipment and manpower so that the required level can be achieved in the studies and research activities of the approved work programme. Keeping in view the various problems which require immediate attention and with the available staff, the work programme is divided into the following 14 problem oriented divisions and work has been initiated in most of the divisions with the limited available staff.

- (i) Hydrologic Design
- (ii) Surface Water Analysis and Modelling
- (iii) Flood Studies
- (iv) Mountain Hydrology

- (v) Groundwater Assessment
- (vi) Conjunctive Use
- (vii) Drainage
- (viii) Drought Studies
- (ix) Water Resources Systems
- (x) Man's Influence
- (xi) Information System and Data Management
- (xii) Remote Sensing Applications
- (xiii) Hydrological Investigations
- (xiv) Hydrological Applications of Climate Information

The studies are being conducted in the following laboratories with the available facilities while the capabilities are being increased by procuring additional equipment :—

- (i) Water Quality Laboratory
- (ii) Remote Sensing Laboratory
- (iii) Hydrologic Investigation Laboratory
- (iv) Service Instrumentation Laboratory and Workshop
- (v) Ground Water Laboratory

The Institute has also to cater to the hydrological problems of different regions of the country which are unique due to differences in climate, geography, land use and cover characteristics, soil drainability, environmental conditions, state of development etc. In order to carry out systematic studies in representative and experimental basins, it has also been proposed to set up Regional Centres, which will have following activities :—

- (a) Review of existing regional formulae and develop suitable revised formula making use of the available data.
- (b) Prepare year books of typical basins.
- (c) Establish representative basins and experimental catchments, monitor data collection, data compilation, processing and analysis.
- (d) Compile, process and analyse the existing data.
- (e) Interact with State agencies and extend help in conduct of hydrological studies.
- (f) Conduct representative basin studies.

The activities relating to the establishment of three Regional Centres as proposed in the EFC memo have been initiated and it is expected that two Regional Centres would come into being during the next financial year.

In order to carry out the programme of work envisaged under EFC memo proposal, the strength of scientists and other supporting staff has been enhanced and infrastructural facilities improved by way of increased office space, laboratory block, information museum cum-recreation centre and trainees' hostel etc. At the time of establishment of the Institute, the Univ. of Roorkee had provided some residential accommodation funded by UP Government. To house the present staff and proposed staff during the seventh five year plan, residential accommodation in the form of staff colony will be essential and has been approved in stages.

Based on the studies conducted at the institute, fifty one scientific reports were prepared under various categories like review notes, technical reports, case studies, status reports and users manuals and circulated widely to State and Central organizations. Fifty one technical and research papers were contributed to various seminars/symposia/technical and scientific journals by the scientists of the Institute.

Besides the above, five workshops were organised under transfer of technology programme which were attended by officers belonging to various State and Central organisations.

The Institute is, therefore, growing and proceeding in the right direction towards the fulfilment of objectives laid down at the time of establishment of the Institute. The studies and research activities are gaining momentum, and the expertise created in the Institute will contribute significantly to the assessment of water resources and their planning for optimal utilisation.

2.0 ORGANISATION AND MEETINGS

2.1 Society

The National Institute of Hydrology Society is the apex body and meets atleast once in a year. It reviews the progress and performance of the Institute towards the attainment of the objectives and gives such policy directions, as it may deem fit, to the Governing Body. The membership of the Society is given in Appendix—I.

The Seventh Annual General Meeting held on October 23, 1986 at Roorkee reviewed the progress and performance of the Institute during the year 1985-86, and approved the Annual Report and audited accounts for the year 1985-86.

2.2 Governing Body

The Governing Body is the executive body of the Institute to pursue and carry out the activities as per objectives of the Society, and implement the policy direction and guidelines laid down by the Society. The Governing Body exercises all executive and financial powers of the Society. The Governing Body is required to meet atleast once in each quarter of the financial year. The membership of the Governing Body is given in Appendix—II.

As per the requirements, four meetings of the Governing Body are required to be held in a year. These meetings were held on June 30, 1986, September 5, 1986, November 28, 1986 and March 26, 1987. Several decisions concerning the administration of the Institute, creation and recruitment of additional posts of scientists and other staff, creation of infrastructural facilities and staff colony for the employees were taken up. The performance and progress of the Institute during 1986-87 were reviewed at these meetings and suggestions made for furthering the activities of the Institute. During the year revised budget for 1986-87 and budget proposals for 1987-88 were also considered and approved.

2.3 Technical Advisory Committee

The Technical Advisory Committee (TAC) is responsible for the technical scrutiny of the research programme of the Institute for inclusion in the Annual/Five year Plans/External Assistance including proposals for expansion of the Institute and recommend priorities. The Committee is expected to meet at least once in six months. The membership of the Committee is given in Appendix—III.

Three meetings of the Committee were held on May 13, 1986, September 25, 1986 and March 11, 1987. The Technical Programme of the Institute for the year 1986-87 was considered by the Committee including the organisational structure into 14 subject oriented divisions. The

Working Groups for 14 divisions were also constituted. The proposal for establishment of seven Regional Centres based on hydrological and physiographical conditions, the interaction with the State govts and other organisations and activities for transfer of technology were also discussed by the Committee. The proposals for foreign collaboration and creation of Drought Division in view of the recurrent drought situation were also considered. Bharat Singh Award for outstanding contribution in hydrology was also considered.

2.4 Working Groups

As decided by the Technical Advisory Committee at its 15th meeting held on 25th September 1986, 14 working groups for the 14 divisions of the Institute were constituted for reviewing the studies and research programme of the Institute. These working groups have Director of the Institute as Chairman, and members drawn from Central and State government organisations and academic and research institutions.

The working groups would review the work being carried out at the Institute besides, the interaction with different organisations, and advise on further studies to be taken up at the Institute.

The meetings of the Working Groups held during the year are given in Appendix-IV. At these meetings, work programme of the concerned division for the year 1986-87 was considered alongwith the work progress till that date and the suggestions made by the members were noted for appropriate action.

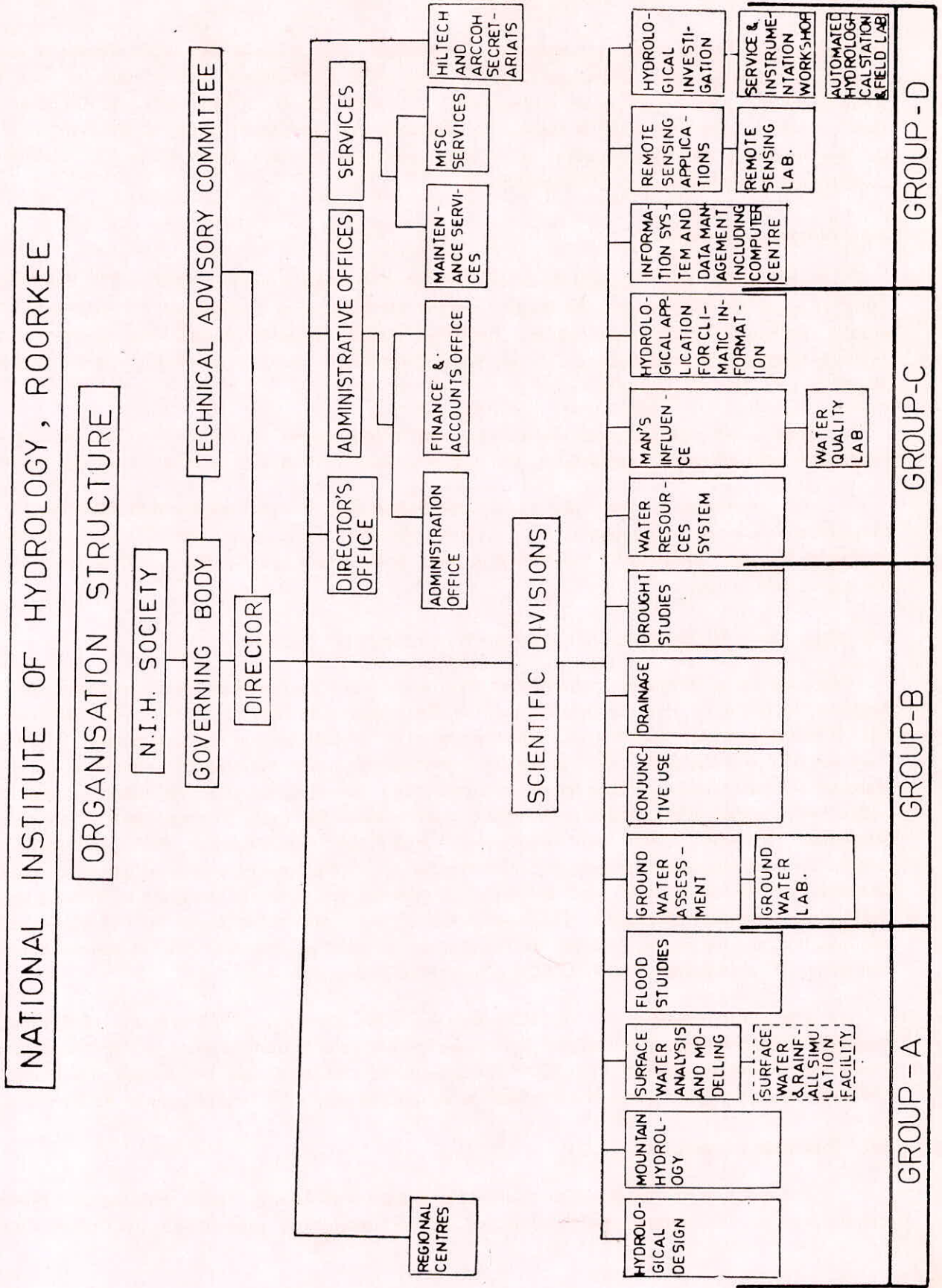
2.5 High Level Technical Committee on Hydrology (HILTECH)

The High Level Technical Committee on Hydrology was constituted by the Government in 1982. National Institute of Hydrology provides the Secretariate to this committee. The functions of HILTECH are to collect state of hydrological research in the country and to disseminate it; identify the areas of hydrology which need immediate attention; encourage national institutions to take up research, sponsor research and promote education and training programmes; foster collaboration with other countries, and coordinate effective participation by India in International Hydrology Programme (IHP) of Unesco and Operational Hydrology Programme of WMO, to disseminate information and improve standards to advise Central and State government agencies, to carry out technical scrutiny of schemes and research programme of National Institute of Hydrology and examine its expansion proposals. The membership of this committee is drawn from various organisations in the country having interest in monitoring, evaluation, analysis and utilisation of water resources. The constitution of HILTECH is presented in Appendix-V.

The Ninth meeting of HILTECH was held on 22nd Jan., 1987 at Delhi. A number of important decisions regarding National Hydrology Project, India's participations in IHP-IV and other important matters were taken. HILTECH has constituted seven panels on various disciplines of hydrology and seven sub-committees to provide support to HILTECH in discharge of its functions.

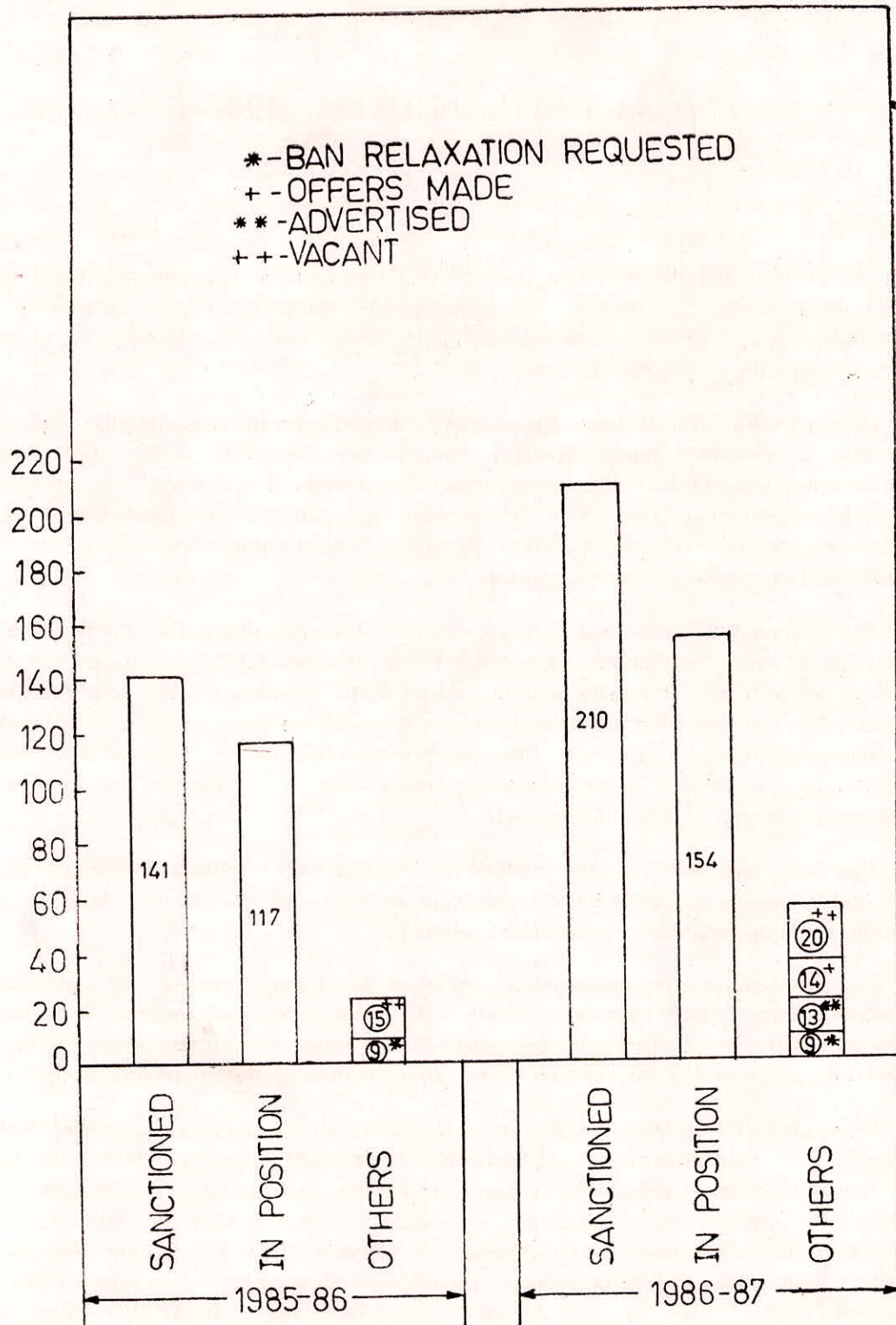
2.6 Institute Personnel

The Institute has 14 scientific divisions and 3 units of Administration, Finance and Miscellaneous services. The organisational structure of the Institute is presented in the Chart-I. Out of



121 posts sanctioned during the 6th Plan period and 11 posts available for HILTECH, the Institute had 27 Scientists, 38 scientific supporting staff, 52 administrative and other supporting staff at the beginning of the year leaving 13 vacant posts.

During the year, 69 posts were approved for filling up under the 7th plan programme. The advertisement for the vacant posts at different levels were issued and selections held. During the year 2 Scientist 'E', 4 Scientist 'C', 5 Scientist 'B', 18 supporting scientific staff, Finance Officer and 22 other supporting staff joined. One Scientist 'C' was promoted as Scientist 'E' and one Scientist 'B' was promoted as Scientist 'C' under the Assessment Promotion Scheme. Other posts under the 7th Plan Programme which have been sanctioned will be filled as soon as approval of the Government is received for filling up of these posts. 11 Scientists and other staff left the Institute for personal reasons or reverted back to their parent organisations leaving 154 personnel in position. The position of staff as on 1.4.86 and 31.3.87 is given in Appendix VI. The status of staff during the year 1985-86 and 1986-87 is presented in Bar Chart-2.



3.0 ACTIVITIES DURING 1986-87

3.1 General

The Institute completed its first phase of establishment and development during 1979-85 which also involved UNDP assistance. The main emphasis during this period had been on creation of some of the essential infrastructural facilities like buildings, recruitment and training of manpower, provision of computer and library facilities.

During 1986-87, the Institute has started its activities for the consolidation, expansion and diversification as proposed during Seventh Plan period (1985-90). While continuing with the computer oriented research and studies in different components of hydrologic cycle, their interaction as well as their quantitative assessment, stress was also laid on laboratory and field oriented studies. Steps have been taken to create necessary infrastructural facilities by strengthening laboratories and establishing Regional Centres.

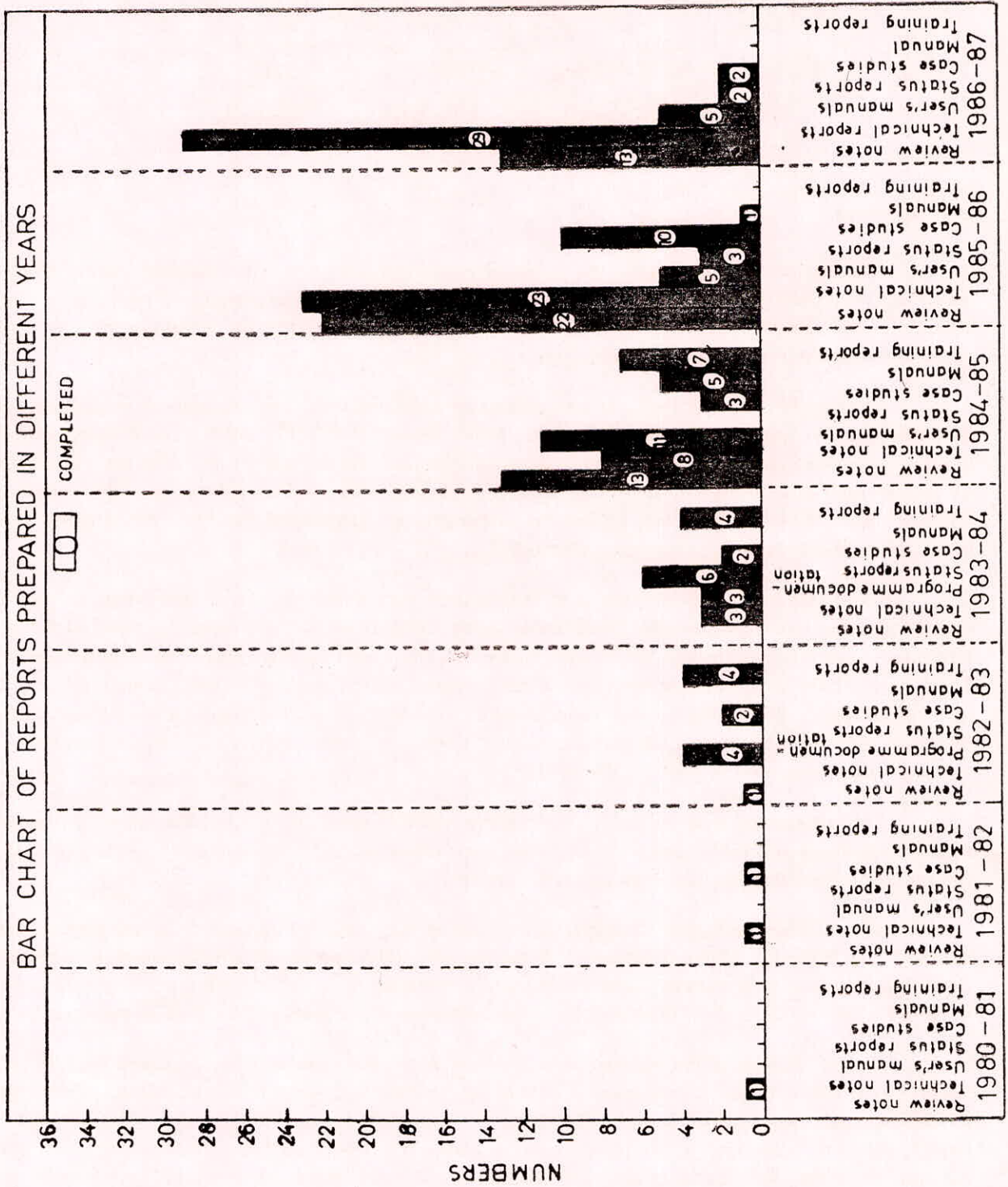
For dissemination of the results of the research studies carried out in the Institute and the technology developed, implemented and tested in the Institute workshops were organised at Roorkee and other States to transfer the technology to various State and Central government organisations. The reports under various categories have been prepared and are being widely circulated. In the year under report, fifty one scientific reports were prepared in various categories like review notes, technical reports, case studies, status reports and users manuals. Yearwise status of number of various reports prepared is given in Chart—III

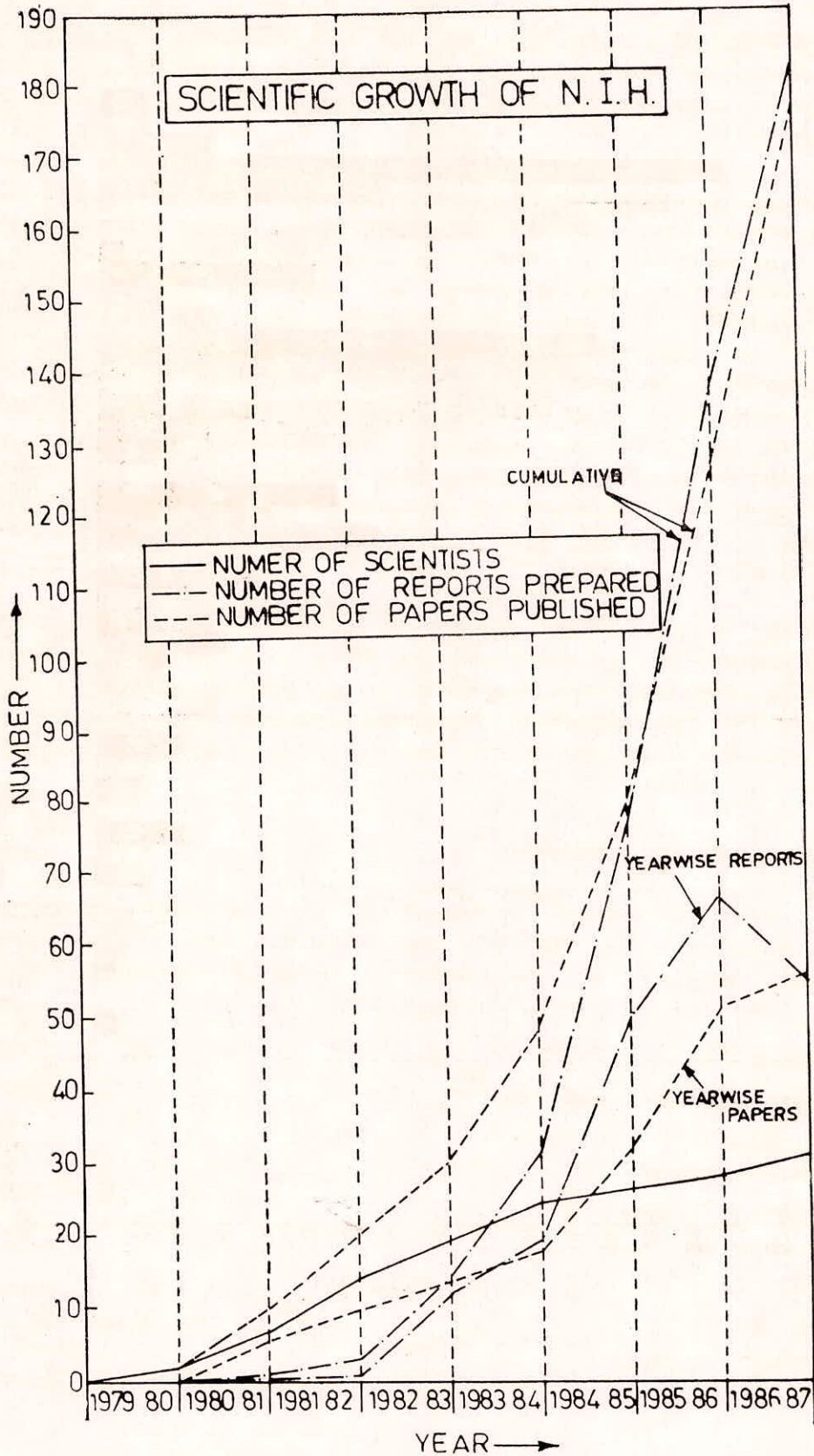
The scientists and scientific staff of the Institute have contributed a number of papers in scientific journals and participated in national and international conferences. Scientific growth of the Institute since its inception is presented in chart-IV.

Towards achieving the envisaged objectives of technology transfer, five workshops were conducted in different States. Number of State and Central government organisations have deputed their engineers and scientists to these workshops. Efforts are on way for setting up Regional Centres for greater interaction and understanding to the problems in the different regions of the country.

During the year under report, the interaction with the States has increased significantly. Visits have been made to number of States by Director and scientists and actions have been initiated for establishment of Regional Centres. In view of serious water shortages created by recent drought scientists of the Institute have visited the drought affected States for first hand assessment of the drought severity and collection of relevant data for drought assessment and developing drought management strategies. The data were collected from drought prone areas in the States of Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra and Rajasthan. Some interim conclusions were also drawn on the basis of limited data. A seminar on 'Drought

CHART — III





Management Strategies' in cooperation with the Water Resources Development Organisation, Karnataka was organised at Bangalore. An All India Seminar on 'Strategies for Drought Proofing and Management' was also organised at Ahmedbad by Institution of Engineers (I) which was sponsored by HILTECH.

Proposals for international collaboration have been initiated for obtaining knowhow and expertise in different problem areas of hydrology. A number of projects for international co-operation are under consideration with the Ministry at various levels. These projects involve scientific collaboration with Netherlands, West Germany, Japan, USSR and USA. The secretariat work of HILTECH and ARCCOH is being handled by the Institute. The HILTECH and ARCCOH secretariat were very active during the year. A number of meetings of main HILTECH and its various sub-committees and panels were held where important decisions were taken. HILTECH also sponsored a research project and a number of seminars and symposia. ARCCOH News letter was brought out regularly. A 'Directory of Hydrologists' in ARCCOH region which included details of 450 experts has also been compiled. Preparatory meeting to finalise the MRP Proposal for South-Central Asia was also organised. The first issue of Jal Vigyan Sameeksha (erstwhile known as Hydrology Review) has been published with specific theme of 'Drought' and the second issue on 'Hydrological Forecasting' is under finalisation.

Construction of two storey laboratory block and extension to the administrative building have been completed. The quarterly Newsletter of the Institute known as, Jal Vigyan Samachar is being published regularly. The staff and scientists of the Institute are being encouraged to use Hindi in regular correspondence and in technical matters as well. Recreation and welfare facilities have been given due importance. NIH Recreation Club organised various cultural and sports activities during the year.

3.2 Studies and Research Activities

The studies and research activities of the Institute encompass different phases and the component process of the hydrological cycle, their interaction and the influence of human activities on the quantity and quality of water resources. The research activities in the institute were undertaken in the following fourteen scientific divisions :

- (i) Hydrologic Design
- (ii) Surface Water Analysis and Modelling
- (iii) Flood studies
- (iv) Mountain Hydrology
- (v) Groundwater Assessment
- (vi) Conjunctive Use
- (vii) Drainage
- (viii) Drought Studies
- (ix) Water Resources Systems
- (x) Man's Influence

- (xi) Information Systems and Data Management
- (xii) Remote Sensing Applications
- (xiii) Hydrological Investigations
- (xiv) Hydrological Applications of Climate Information

The results of studies and research work have been brought in the form of Review Notes, Technical Reports, Case Studies, Status Reports and User's Manuals, and these have been circulated to various State and Central Government organisations. A list of scientific and technical reports prepared during the year under report is given in Appendix-VII.

3.2.1 Hydrologic Design

The research activities in this division were mainly focussed on design flood estimation using flood frequency analysis and unit hydrograph based approaches, hydrological network design, synthetic data generation and water availability studies. A review note and a number of technical reports and case studies have been prepared which include :

(i) Flood frequency analysis

Estimation of a flood corresponding to a specified recurrence interval at a particular point on a river system is the most common problem for the engineers, scientists and others involved in design and construction of water resources projects. In this study, an attempt has been made to develop methodology for transforming the annual peak flood series to follow Gumbel Ev-1 distribution using Box-Cox transformation. The exponent of the Box-Cox transformation has been estimated by trial and error using the method of maximum likelihood (MML) and method of probability weighted moment (MPWM), so as to obtain nearly the same estimates of log likelihood functions by both the methods. This methodology has been tested using 1000 samples of various sample sizes of randomly generated synthetic 'flood' series which follows the Pearson type III distribution. It is seen that the population estimates are satisfactorily reproduced by using the proposed method of frequency analysis.

Probability plots are also used in flood frequency analysis to fit the probability distributions to given flood series, to identify the outliers and to assess goodness of fit. In the present study various plotting position formulae have been compared with the unbiased plotting position (the expected value of reduced variates) on the basis of seven statistical criteria for Gumbel EV-1 distribution. Unbiased plotting positions have been obtained from synthetically generated EV-1 reduced variates for different sample sizes. The results indicate that the plotting positions given by Gringorton formula are more close to the unbiased position (expected value of reduced variates) for all the sample sizes.

(ii) Monthly Stream Flow Generation

A Bivariate Thomas Fiering model has been developed for monthly streamflow generation based on the algorithm given by Clarke. This has been used for 11 years, 37 years and 100 years, simultaneous generation of monthly streamflow at (i) Hirakud and Salebhata (Orissa) and (ii) Hirakud and Kantamal using 11 years concurrent period (1972-82) observed data. The monthly

flows have been generated at Hirakud, Salebhata and Kantamal independently using univariate Thomas Fiering model also. The monthly means, standard deviations and correlation with previous month of observed and generated flows have been compared on the basis of sum of squares of error in mean, sum of squares of error in standard deviation and absolute error in correlation with previous month on annual (June-May) and monsoon (June-October) basis.

The results indicate good performance of the bivariate Thomas Fiering model for the generation of monthly streamflow at two sites simultaneously.

(iii) Forecasting of monsoon rainfall and runoff

In this study the monsoon rainfall and runoff have been forecasted using simple correlation technique. The regression relationships have been developed to correlate monsoon runoff with the total runoff upto the end of June, July, August and September. These regression relationship have been used without updating the parameters and after updating the parameters of regression relationships to forecast the monsoon runoff. The efficiency of the regression relationship in calibration and forecasting has been computed and presented.

3.2.2 Surface Water Analysis and Modelling

The research activities in this division were carried out in the areas of mathematical modelling of moving storm and statistical analysis of meteorological and hydrological data for the study of trends and periodicities. A number of technical reports have been prepared in the above areas. These include :

(i) Mathematical Modelling of Moving Storms

Modelling of moving storms has been attempted by several authors using both dynamical and statistical approaches. Some of these methods are reviewed in the report and the statistical technique of interstation cross correlation has been applied to model the movement of four historical storms in Narmada basin which have caused critical floods in Narmada river.

The results have indicated the usefulness of the statistical model based on cross-correlation in modelling the movement of the tropical storms inspite of the rather poor network of self recording stations in the Narmada basin.

(ii) Statistical Analysis of Rainfall in Belgaum District

Belgaum district in Karnataka has been experiencing drought continuously for the past few years. To study the phenomenon of low rainfall in the district, statistical analysis of monthly and annual rainfall data of raingauge stations located in the district and neighbouring Bijapur and Dharwar observatories has been carried out. Besides studying the cross correlation of rainfall in monsoon months and serial correlation, other techniques like linear regression and polynomial regression have also been applied to identify the presence of any trend.

3.2.3 Flood Studies

The research activities in this division were carried out in the areas of flood routing and flood plain zoning. Technical reports have been prepared in the following areas :

(i) Development of a Variable Parameter Simplified Hydraulic Flood Routing Model

A variable parameter simplified hydraulic method based on the approximation of the St. Venant's equations which describe the one dimensional flow in a channel or river has been developed for routing floods in channels having uniform trapezoidal cross-section and constant bed slope. The parameters θ and K , viz. the weighting parameter and the travel time respectively, have been related to the channel and flow characteristics. It has been found from this study in general, that the method in which both θ and K varying along the multiple routing reaches consideration is able to produce the true solution much closer than the method in which both θ and K varying, but with the consideration of single routing reach, or the method in which only K varying and θ remaining constant, but with the consideration of single routing reach.

(ii) Comparison of Some Variable Parameter Simplified Hydraulic Flood Routing Models

The three point variable parameter Muskingum-Cunge Method envisaged by Ponce and Yevjevich is based on the concept of relating the physical diffusion with the numerical diffusion at every routing time level by averaging the discharges and the wave celerities at both inflow points of the previous time level, and the inflow discharge of the present time level. It has been found that this method is able to reproduce the St. Venant's routing solution for a given inflow hydrograph and for a given channel reach closely than the constant parameters Muskingum-Cunge method. Another variable parameter approach for the Muskingum method flood routing solution based on the concept of linear variation of flow depth along the reach has been developed. In this report both these methods have been compared with the St. Venant's routing solution for a given inflow hydrograph and the given river reach. The results show that the variable parameter Muskingum method developed here performs better than the variable parameter Muskingum-Cunge method developed by Ponce and Yevjevich.

(iii) Causes of Negative Outflow in Muskingum Method

The Muskingum method is a widely used method for routing floods in rivers and channels. The applicability of the method has increased after Cunge related the parameters of the method based on the conventional difference scheme, with the channel and flow characteristics using the principle of diffusion analogy. One of the disturbing fact of the Muskingum method is the formation of negative or reduced outflow in the beginning of the solution. Various remedial measures like skipping the negative or reduced outflow zone, finding lower bound of reach length so that the magnitude of the defect is reduced, accepting this defect considering that it is small enough and short lived etc. have been suggested in the literature. Taking this into consideration, it is attempted to provide a theoretical basis to negative outflows.

3.2.4 Mountain Hydrology

This division is currently engaged in snow and glacial melt studies, estimation of flood flows from mountainous catchments and modelling of stream flow using geomorphological characteristics. Review notes have been prepared on the problems related to measurement of snow and snow cover which stresses the need for basic research on snow cover accretion and depletion and their relation to meteorological and terrain factors.

An exhaustive review of overland flow has also been carried out. The review indicated that the kinematic wave approximation to the hydraulics of overland flow is well suited for rough and steep slopes. Several investigators emphasised that the approximation is valid for almost all cases of overland flow.

3.2.5 Groundwater Assessment

The research activities in this division were carried out in the areas of groundwater recharge and aquifer yield, recharge from a large depression storage, interpolation of ground water table and flow to a dug wells in hard rock areas. A detailed review has been made on ground water recharge including both empirical formulae developed on the basis of water table fluctuations and experimental studies. Different methods of estimating recharge components are outlined and methodologies have been recommended to estimate the various components leading to groundwater recharge to be adopted in northern India with particular reference to alluvial plains. The transient analysis of the ground-water flow around a lake of square cross section and having uniform depth has been performed for a hypothetical setting of the boundaries using a three dimensional finite difference model. Similarity approach has been employed to develop a type curve, which enables the assessment of the rate of recharge from the lake to groundwater reservoir, with the help of observed head change in an observation well situated anywhere within the influence area of the lake and vice-versa. Ideal location for an observation well has also been suggested. Besides this the following reports were also prepared :

(i) Interpolation of Ground Water Level

With the advent of high speed computers, the model studies for the analysis of complex groundwater flow problems, have become a common practice. For carrying out such model studies the spatial and temporal variation of water table levels and aquifer parameters, in a systematic pattern of space coordinate is imperative, as an input to the model and are amenable to numerical differentiation. But, generally the water table elevations and aquifer parameters are measured only at a few points in space, where an observation well is located for this purpose. Thus, the available historical record of water table and aquifer parameters are not distributed in space in any systematic pattern. This report deals with such interpolation of water table at nodal points, using least square technique, to fit a trend surface or regression on space coordinate approximating to the water table level.

(ii) Flow to a Dug Well in Hard Rock Areas

The open dug wells are being used extensively in hard rock areas, for groundwater abstraction. The flow towards dug well in alluvial aquifer depends upon aquifer parameters T and S and well storage and rate of abstraction Q , while in hard rock areas, the flow occurs through the fractures and fissures of the rock, hence, instead of transmissivity, rock porosity will dominate the flow. In the present study, the simulation of flow towards finite diameter dugwell has been attempted. The porosity of the rock has been considered as one of the parameter. The storage in the well has also been taken into account. The results have been presented in the form of type curves.

3.2.6 Conjunctive Use

The research activities in this division were carried out in the areas of reach transmissivity, base flow, aquifer recharge for varying river stages and storage in confined aquifer with flowing artesian well. A number of technical reports have been prepared which include :

(i) Reach Transmissivity

Reach transmissivity for a canal or stream is a site specific constant which depends on canal geometry and aquifer boundary. In the present report, the reach transmissivity for various sub-soil conditions has been reviewed. Analytical solution for reach transmissivity pertaining to a canal embedded in a porous medium underlain by a highly permeable layer, has been obtained using Zhukovskii function and conformal mapping. Results have been presented for various positions of water table above the highly permeable layer.

(ii) Base Flow

Base flow computation plays an important role for assessment of lean flow in a river. During passage of flow in a river the river stage rises which leads to recharging of the aquifer. Besides, the aquifer also gets recharged by rainfall. In the present report the base flow has been computed for generally observed river stage and groundwater table hydrographs. It is assumed that the changes in river stages occur during the monsoon period when the water table rises exponentially. Beyond monsoon the water table decays in an exponential manner and the river stage remains constant more or less. In the present analysis the base flow has been computed for such variations. One dimensional Boussinesq's equation has been solved and Duhamal's approach has been applied to find the aquifer response for varying river stages.

(iii) Aquifer Recharge

In a sedimentary groundwater basin occurrence of multiple aquifer separated by confining layers of low and negligible permeability is quite common. A stream in such basin will penetrate either partially or fully the top aquifer. During the passage of flood the river stage changes rapidly. The rise in river stages above the aquifer water level in the vicinity of the river leads to recharge of groundwater. In the present report, the two aquifers and river interaction problem has been studied analytically. The recharge from the river to the aquifers and exchange of flow between the two aquifers through the aquitard have been quantified for a known fluctuation pattern in river stage. The time parameter has been discretised and interaction problem has been solved assuming each of the aquifer to be a linear system.

(iv) Storage in Confined Aquifer with Flowing Artesian Well

Flowing wells are uncommon occurrence resulting from erratic geological process. The discharge of a flowing well depends on the difference between the elevations of the piezometric head in the aquifer in the vicinity of the flowing well and elevation of the flowing well's threshold. Using discrete kernel approach, an analytical solution has been obtained to determine temporal variation of discharge of a flowing well in a confined aquifer of finite areal extent. The quantities of water that remain in the aquifer storage at any time after the onset of flow, which will be subsequently drained by the flowing well, have been quantified. Type curves have been prepared to enable determination of aquifer parameters.

3.2.7 Drainage

The research activities in the division were carried out mainly in the area of leaching requirement of agricultural land. A technical report has been prepared which gives in detail the solute movement of salts in different layers and its variation with time and depth.

(i) Leaching Requirement of Agricultural Land

One of the major problems associated with irrigated agricultural land is accumulation of salt in the soil which results in low productivity if proper water management practices are not adopted. The concentration of soluble salts in soils increases as the applied water is removed by evaporation and transpiration. To prevent harmful accumulation of salts in soils, an additional amount of water, over and above that required to meet crop evapotranspiration needs, must be passed through the root zone for leaching of salts.

A model has been formulated using Green and Ampt equation for estimation of infiltration volume from different soil layers. The soil system was divided into 4 layers of thickness 50 cm each having some initial salt concentration and soil moisture. When irrigation water having low salt concentration is applied to soil system for leaching, the solute movements from different layers have been determined using salt balance approach. The time required to fill the different layers has been estimated from the initiation of the infiltration. The variation of salt concentration with time and depth has been estimated and presented. Break-through curves have also been presented for different layers.

3.2.8 Drought Studies

The activities of this new division are mainly to work in the areas of hydrological aspects of drought, impact assessment of drought on various sectors and development of drought management strategies. Drought studies in six States of the country were initiated and number of technical reports, status reports and review notes were prepared.

(i) Hydrological Aspects of Drought in 1985-86

Efforts were made to collect the required data from some drought prone areas in the States of Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra and Rajasthan. Some interim conclusions have been drawn based on the limited available data which may not be generalised. The hydrological drought in terms of deficit in rainfall, surface water, soil moisture and ground-water have been studied including their effects on fodder and crop production and drinking water supply. Further data collection and analysis for preparation of final report are under process.

(ii) Drought Indices

A comprehensive review of important meteorological, agricultural and hydrological drought indices was made to assess their applicability and limitations so as to select a particular criteria of drought quantification and help in developing improved drought indices. Most of the indices but for few comprehensive indices appear to be adhoc and work in isolation. They consider rainfall alone or take some account of soil water storage and loss of water from soil storage by evapotranspiration. It is not sufficient to go by the variability

of total rainfall alone but also to analyse and understand spatial and temporal variability in hydro-logic process as well as study demand patterns to analyse drought in a better perspective. An overall water availability index could be a better index of drought. An attempt was also made to develop a simple approach of soil water budgeting model to simulate daily soil moisture in dry lands to study incidence, severity, duration and frequency of drought.

(iii) Low Flows and Hydrological Drought

The studies on hydrological aspects of drought are less attempted as compared to the meteorological and agricultural droughts. The quantification of drought using hydrological variables such as streamflow, reservoir levels/storages, soil moisture and groundwater is a better approach. Two reports were prepared in this direction. One report presents the review of various deterministic, statistical and stochastic approaches used for determining magnitude, frequency and duration of low flows for drought analysis including the approaches of low flow forecasting and their application in planning drought management measures. Another report presents guidelines for analysis of hydrological drought with more attention on low flows including regional analysis of multi year hydrological droughts in order to estimate the parameter of drought severity, magnitude and duration for the ungauged catchments.

(iv) Estimation of Evaporation Losses

Engineers, planners and all concerned with water resources require an estimate of evaporation losses from lakes and reservoirs for the efficient reservoir operation and the water balance studies, specially in arid and semi arid regions and in drought affected areas while designing drought alleviation schemes. A technical report was prepared on estimating evaporation losses from reservoirs. It indicates that the methods of mass transfer and Penman equation can be considered as good alternative to provide relatively better estimates of evaporation losses in the absence of large amount of data required for the energy budget method. The procedure of estimation is presented in the report using field data.

(v) Water Harvesting and Conservation for Drought Management

Renewed interest in water harvesting and conservation has been sparked by ever increasing demands on limited amounts of surface and ground water and recurrent droughts in the country. Water harvesting is one of the ways to increase both the quantity and dependability of water in drought prone areas. Storage is an integral part of any water harvesting system. It may be in soil profile, as in runoff agriculture, or in ponds, tanks or small reservoirs for irrigation, live stock, industrial, or human use. A report was prepared in this direction to bring out the past efforts, recent developments, present status and potential of water harvesting and conservation as regard to drought management including the leading methods of water harvesting. The techniques of water conservation through evaporation reduction were also covered. The work on evaporation reduction measures is also underway and a paper was also prepared towards this end. A technical paper giving the State-of-Art of drought management strategies in India was also prepared.

During the year two seminars on drought management were organised in collaboration with other organisations one at Mysore and another at Ahmedabad. One seminar on Drought

Management Strategies was organised at Mysore in May, 1986 in collaboration with Water Resources Development Organisation, Govt. of Karnataka. Another All India Seminar on Drought Proofing and Management was organised at Ahmedabad in February, 1987 in collaboration with Institution of Engineers (I), Gujarat State Centre and Gujarat Irrigation Department.

3.2.9 Water Resources Systems

The research activities in this division were carried out in the areas of reservoir operation and reservoir capacity computation. Reports have been prepared and two consultancy projects offered by Gujarat Irrigation Department have been taken up.

(i) Reservoir Operation for Hydroelectric Power

The generation of hydroelectric power is a typical purpose for which reservoirs are operated. The related operation problem can be either to determine firm power from a reservoir or to operate the reservoir knowing inflows and firm power. The first type of problem usually comes in the planning stage of reservoir. Assuming the size of the reservoir, the inflow data from the most critical years from the history is used to determine the firm power. The second type of problem comes during the operation of an existing reservoir.

Computer programme has been developed to solve these problems. The same has been described in the manual. The details of programme, its sample input and output have also been appended.

(ii) Mass Curve Analysis

The computation of required storage is one of the important steps of reservoir design. Two computer programmes have been described in this report which make use of mass curve method and sequent peak algorithm for this purpose. As mass curve is basically a graphical technique, computer graphics have been used for the development of programme of mass curve method. Both the programmes are interactive in nature.

(iii) Water Balance of a Reservoir

The water accounting of reservoir is necessary for their proper management. The purpose of water balance of a reservoir is to estimate the various components representing inflows, outflows and changes in storage. Once these are determined, the continuity equation can be used to either test whether the components tend to balance out or to estimate an element of water balance equation should balance themselves theoretically, a residual term is obtained in practice.

3.2.10 Man's Influence

The research activities in this division were carried out in the areas of water quality modelling, soil erosion and sedimentation, forest hydrology, thermal pollution and environmental impact assessment. A number of technical reports and status report have been prepared in the above areas. These include :

(i) Water Quality Modelling in Rivers

Water quality in flowing waters is closely linked to the total water quality in the basin and hence it becomes imperative that water quality assesment and river basin planning are closely related.

The report begins with a general introduction of water quality modelling, the needs of such models and stresses the day by day increase of water resources requirements. A detailed account of various water quality models available to users has also been brought out. The report presents mathematical models for biodegradable wastes, accelerated eutrophication model, terminal model, conservation constituents and upstream use models. The various governing equations have been drawn up. The type of data required for such modelling studies has also been discussed.

(ii) Soil Erosion Studies

Erosion of soil by water poses an increasing threat as needs for food, fiber production and economic necessities of a growing population add, pressures to our nation's land resources. The soil loss prediction techniques have developed over many years as understanding of the erosion process expanded and increasingly more erosion research was conducted.

The Universal Soil Loss Equation was applied to the Chaukhutia catchment of Ramganga River. The methods of determination of different parameters and results of universal soil loss equation for predicting soil loss from the above basin are presented in the report.

(iii) Forest Hydrology

Increased demands for water, timber and recreation combined with the demand for environmental quality necessitates the development of new and better tools to evaluate land management alternatives. The objectives of this study are : (i) to provide a management tool to predict watershed response and to evaluate the change in watershed response due to afforestation or deforestation and (ii) to examine the physical processes taking place in a watershed.

In this study a deterministic, physical model is used to predict mean daily stream flows from a typical Indian watershed with forest cover where rainfall is the major form of precipitation input and the primary source of annual stream flow. Different objective functions were used to examine the model response by determining the optimum number of watershed partitions and by analysis of model sensitivity due to changes in optimum parameter values.

A technical report on development of sub-models flora and fauna for evaluating responses of vegetation and wild life habitats has also been prepared. The report describes effects of various developmental activities on floral and faunal resources of a watershed besides including simulation models for development of these resources.

The Flora model consists of simulation models for predicting the growth, yield and diversity of forest overstories, the production and composition of herbaceous understories and the development and accumulation of organic material on the forest floor. The Fauna model consists of sub-models developed to describe habitat quality for a variety of animal species, the animal

supporting capacity of an area and reproduction, growth and mortality characteristics of selected animal populations.

(iv) Environmental Impact Assessment

A technical report has been prepared which gives in detail the various types of water resources development projects, their impacts on environmental components, and identifies possible hydroenvironmental indices which would characterise the environmental system.

(v) Thermal Pollution in Water Bodies

Thermal pollution of water bodies is a very important and crucial phenomena. The purpose of this report is to highlight the thermal pollution status, its effect on various physical, chemical and biological environments and to study the theory behind the phenomena.

Various effects of heated discharges on water quality have been brought out which include stratification of impounded water, effect of differing density, effect on various water quality parameter (like DO, iron, manganese, temperature etc.), waste assimilative capacity etc. The beneficial effects of thermal discharges like greenhouses, aquaculture, agriculture etc. have also been brought out. The report also brings out the need for research in the area.

3.2.11 Information System and Data Management

Management of Institute's Computer and Library as well as development of generalized software has been the major activity of this Division. In order to make their use more extensive and meaningful, actions in the following areas have been undertaken :

- (i) Development and introduction of graphic features into generalised application programmes which have been brought out through two user manuals titled 'Graphical Representation of information related with Floods' and 'Generation of Hydrological Graphs using Computer Graphs'.
- (ii) Use of personal computer for preparation of reports.
- (iii) Development of data storage and retrieval system for systematic storage and retrieval of hydro-meteorological data.
- (iv) Inclusion of new journals/literatures, books etc. for current awareness as well as for advance research in hydrology.

Besides, a five day workshop on 'Data Storage and Retrieval System' has also been undertaken by this Division for transfer of technology to field officers.

3.2.12 Remote Sensing Applications

The research activities in this division were carried out in the areas of flood inundation, remote sensing application to sedimentation and flood plain mapping. Review notes and technical reports have been prepared:

(i) Flood Inundation Studies

Flood inundation is one of the basic data need to understand, combat and to take ameliorative and preventive measures with respect to flood. There are established ground based survey methods for delineation of flooded area. But these are time consuming as well as often hazardous to undertake. Remote sensing methods especially after the advent of satellite era have opened new vista in acquiring flood inundation data because of synoptic repetitive coverage of the satellite. These admirably suit to monitor and study the dynamic nature of flood over space and time.

Though the use of microwave band is much sought for by the user community, it is worthwhile to mention that microwave reflections or emissions from earth materials bear no direct relationship to their counterparts in the visible and thermal portion of the spectrum. It has been recommended that flood studies capability could be enhanced considerably if a future satellite carries microwave sensor along with multispectral sensors.

(ii) Sedimentation Studies

Monitoring of sediment load in water bodies is an integrated part of any water resources management programme. After the advent of satellite age, remote sensing technique with its unique synoptic and repetitive coverages could admirably supplement the conventional ground based data collection endeavour. Remote sensing techniques to study sediments and turbid water are essentially based on complex energy water interaction physics. Presently the status of sedimentation studies by remote sensing is experimental and to be used as supplemental data base. Though the remote signal from turbid water is more reflective than clear water, but the signal represent only the near surface conditions. Also the problems of calibration of the signal with respect to sediment size and concentration are often formidable.

It is expected that the status will improve appreciably in near future and the remotely sensed water quality data will serve as a good data base for both surveillance and modelling of water quality.

(iii) Flood Plain Mapping

This report describes procedures and results of flood-plain delineation in Mahanadi river basin using Landsat data. The area of study extends from downstream of Hirakud dam to the point river meets Bay of Bengal. Flood plain boundary and other features such as streams, river levees, abandoned channels, sediment deposits etc. were delineated and depicted on a 1 : 250,000 scale base map. Digital analysis employing ratioing technique was also attempted to demarcate continuous flood-plain boundary.

3.2.13 Hydrological Investigation

This division is engaged in carrying out advanced research in the areas of soil moisture studies usins nuclear and geophysical studies. Technical reports have been prepared related to the above arees.

(i) Soil Moisture Movement Studies Using Nuclear Techniques

Soil moisture movement studies provide potential information in the field of agriculture and hydrology. In this study, investigations on the movement of soil moisture in the unsaturated zone under ponding condition using depth moisture neutron gauge are presented.

Studies carried out clearly show the capabilities of neutron moisture probe, for accurate measurements of soil moisture changes under ponding conditions in the unsaturated zone. The variation of soil moisture is analysed for the ponding to provide basic understanding of the processes occurring within it. Various graphs are presented to understand the variation of soil moisture in the soil profile and the contribution of the ponded water to the unsaturated and saturated zone.

(ii) Soil Moisture Variation Using Resistivity Technique

Relation between bulk resistivity and amount of pore water as well as its properties has been known in form of empirical formulae. The electrical properties of soils in unsaturated zone above water table are dependent on a number of parameters. Important among these are porosity, degree of saturation, grain size and shape, and conductivity of water/electrolyte saturating the soil. The study aims at using the surface resistivity measurements in determination of soil moisture status and its temporal variation.

The study shows that effect is appreciably large for low soil moisture contents and for higher porosities. It is, therefore, possible to use field resistivity measurements to monitor soil water variation for irrigation scheduling etc.

3.2.14 Hydrological Applications of Climate Information

The activities of this new division are to study the application of results from atmospheric general circulation models to the land surface process models for forecasting of flows into reservoirs. A review of the available general circulation models is carried out in this note with a view to identify such models which have the necessary space-time structure and requisite output so that they could be coupled with suitable hydrological models. A number of regional and general circulation models made operational in India with various constraints and forcing introduced into them are reviewed in particular.

3.3 Workshops and Seminars Organised by NIH

Towards fulfilling the objective of technology transfer and having interaction with states and central government organisations dealing with water resources, the Institute organised a series of workshops at Roorkee and in some States on the following important areas :

- (i) Flood Frequency Analysis
- (ii) Unit Hydrograph Techniques
- (iii) Flood Routing and Flood Forecasting
- (iv) Design Storm and Design Flood
- (v) Data Storage and Retrieval System

These workshops provided to the practicing engineers and scientists of various organisations, an opportunity to learn the techniques and methods of analysis which have been implemented and developed at the Institute.

The HILTECH organised a series of seminars in various parts of India on the following important areas :

- (i) Third regional training seminar on Ice and Snow Hydrology
- (ii) Seminar on Drought Management Strategies
- (iii) International seminar on Water Management in arid and semi arid zones
- (iv) All India seminar on strategies for drought proofing and management.

The details of workshops and HILTECH sponsored seminars organised are given in Appendix VIII.

3.4 Regional Centres

The Society and Governing Body of the National Institute of Hydrology has desired that Regional Centres of the National Institute of Hydrology should be set up to take care of the problems of different regions, so that the Institute can actively interact with the States in the region and develop an understanding of the problems of the region. Keeping this in view seven regional centres were proposed in the following regions :

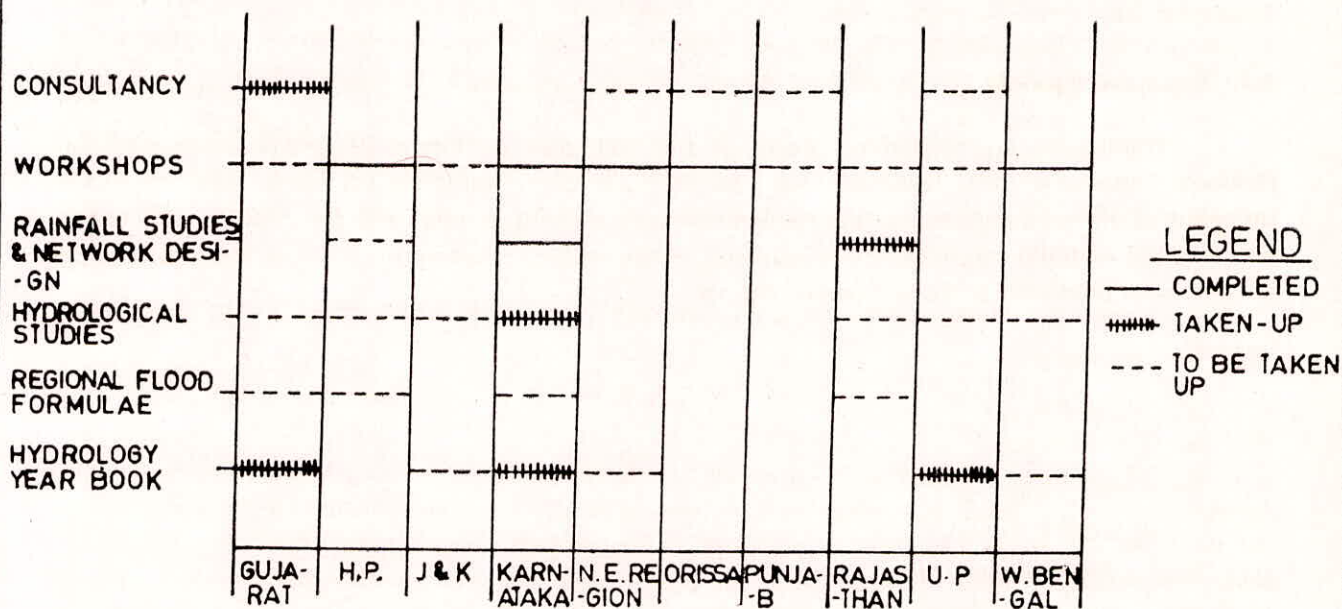
- (i) Deccan region
- (ii) Deltaic region
- (iii) Himalayan region
- (iv) Semi arid region
- (v) North Eastern region
- (vi) Ganga Plains region, and
- (vii) Western and Southern coastal region

To start with it is planned to have three regional centres for the Deccan hard rock areas, north eastern region and western Himalayan region during the 7th plan period. It is also proposed to undertake representative basin study at these regional centres. The action to establish the regional centres is in the process.

3.5 Interaction with States

The Institute has initiated efforts for interaction and collaboration with State Governments and Organisations during the year. Visits have been made to the States of Gujarat, Assam, Punjab, Himachal Pradesh, Jammu and Kashmir, Karnataka, Orissa, Rajasthan, Uttar Pradesh and West Bengal. The interaction with the States and studies proposed to be taken up are given in Appendix IX. The progress and proposed interaction in the form of a bar chart is presented in chart-V.

STATUS OF INTERACTION WITH STATES



3.6 Physical Facilities

3.6.1 Buildings

The extension of Jal Vigyan Bhawan both on the eastern and western side of the present building by 4 bays on three floors was taken up for providing office accommodation to the staff being recruited under Seventh Plan. The lab block which is to house various laboratories like Instrumentation, Water Quality, Groundwater and Remote Sensing was completed. The extension of laboratory block to provide necessary facilities for housing sophisticated equipment is expected to start soon. The Ministry cleared the proposals for the construction of Museum-cum-Recreation Centre and Field Hostel. The construction work is expected to start soon.

3.6.2 Infrastructure

A 30 tonne A.C. Plant is being procured for the computer centre and the present package unit which could not cope up with the load requirement of the Computer Centre is planned to be used for air conditioning the laboratories where sophisticated equipment are kept.

Telephones for the officers and general purpose telephones were provided by the University of Roorkee from the grant paid by the Institute. A separate board has been provided in the University Telephone Exchange and a cable with a capacity of 50 lines was laid to cater to the needs of the Institute.

The internal bitumin roads are being laid and the work is expected to be completed shortly.

3.7 Computer Centre

The Institute provides a centralized electronic data processing and computing facility through its VAX-11/780 System which is a Fourth generation system based on 32-bit architecture and has VMS 3.2 Version of Operating System. The current year's activity includes the procurement of a CALCOMP 19480 Digitizer to augment the existing peripherals such as magnetic disk drives, tape drives (1600/800), card reader, line printer, coloured graphic terminal, photographic hard copying facility and 12 video terminals. Actions have also been taken to procure several items like one RA 81 Winchester Disk Drive, one Dual mode plotter and 1.5 MB of CPU Memory. Also efforts have been to upgrade the personal computer available at the Institute through procurement of PRO 380 upgrade kit.

The available facilities are being extensively used not only for the scientific and research purpose but also for other office administration and library uses for tackling jobs involving large volume of information processing. The system has also been made available to other education and research institutes like C.B.R.I., S.E.R.C. and various departments of the University of Roorkee for use in some advance research activities.

3.8 Laboratories

The institute has established following laboratories to initiate laboratory oriented studies :

- (i) Water Quality Laboratory
- (ii) Remote Sensing Applications Laboratory
- (iii) Hydrological Investigations Laboratory
- (iv) Service Instrumentation Laboratory and Workshop
- (v) Groundwater Laboratory.

(i) WATER QUALITY LABORATORY

Water Quality Laboratory has been set up with the objectives of classification of water resources, collection of base line data, estimating waste assimilation capacity, and pollution determination.

The main attraction of the laboratory is an Environmental Laboratory DREL/5 System, a water testing kit, which combines all the instrumentation, reagents and apparatus into one convenient package to perform 30 of the most used determinations in water quality management. In general, all physical, chemical and biological parameters can be estimated in the laboratory.

(ii) REMOTE SENSING APPLICATIONS LABORATORY

The Remote Sensing Laboratory has been established to develop capability to prepare various types of thematic maps which are used as input to various hydrological studies. Image processing software has been installed in Institute's VAX-11/780 computer systems. This is being used for interpretation of remotely sensed data contained in computer compatible tapes (CCT).

A land use map of upper Yamuna Basin has been prepared using interpretation technique. Flood plain mapping of Mahanadi basin downstream of Hirakud dam to its confluence with Bay of Bengal using satellite imagery is in progress.

(iii) HYDROLOGICAL INVESTIGATIONS LABORATORY

This lab has the main objective of demonstrating applications of nuclear and geophysical techniques in proper evaluation and assessment of water resources. The main equipment in the lab included a neutron probe and a resistivity meter. With the help of neutron probe, soil moisture modelling studies are done. The resistivity meter is being used for carrying out resistivity surveys for assessment of water resources.

(iv) SERVICE INSTRUMENTATION LABORATORY AND WORKSHOP

The Service Instrumentation Laboratory and Workshop is developing a microprocessor based data acquisition system for hydrological studies. It would also cater to the day-to-day needs of various equipment in different laboratories of the Institute, and a workshop for development and fabrication of instruments.

(v) GROUND WATER LABORATORY

Ground Water Laboratory has main objectives to conduct experiments related to ground water flows, determination of parameters like permeability, specific yield, soil moisture, rock permeability etc. Analog/hybrid models for studying ground water problems have also been planned. The main equipment procured in the laboratory include constant head permeameters, electrical analogy apparatus, Hele Shaw apparatus, split spoon sampler, sand pouring cylinder etc.

A field station to measure the parameters of meteorological and hydrological data using the conventional equipment has already been installed in the campus. To enhance the capabilities of this station, an Automatic Hydrologic Station (AHS) with data acquisition system for obtaining the real time data and processing the same through a microprocessor is planned and the equipment ordered under UNDP grants have been received. Further a lysimeter to measure soil moisture, soil temperature, percolation loss in the irrigated fields and estimate evapotranspiration losses is procured.

3.9 International Cooperation

In keeping with the objectives and as also suggested by the Tripartite Review Committee of the UNDP project of the Institute, the Institute has been actively pursuing avenues of international cooperation for getting the latest know how in various aspects of hydrology. The following projects for international cooperation are under consideration of the Ministry at various levels :

- (i) Cooperation with EEC and DHI
- (ii) Cooperation with Louisiana State University and Gujarat Government
- (iii) Cooperation with Dutch Government
- (iv) Cooperation with GTZ of West Germany for a comprehensive development project for the Institute
- (v) Cooperation with Japan Government for exchange of personnel
- (vi) Cooperation with Japan Government for establishment of rainfall runoff facilities and associated programmes
- (vii) Cooperation with Braunschweig University, FRG
- (viii) Cooperation with USSR for exchange of personnel and organization of seminars.

3.10 Library

The Institute has a well equipped library since 1980. A large number of books, journals, documented computer programs related to various research areas of hydrology are available in this library. As on 31st March, 1987 the library is in possession of 3387 books, 1896 reports, 45 journals, 931 papers, 247 standards, 30 microfiche and 1918 maps. The current year's activity of the library include procurement of 220 books, 330 reports, 20 standards and 250 maps. The most

highlighting feature is the addition of "Current Contents" Journal which will facilitate and bring in the current awareness of the advance work/research carried out at International level to the scientists of this Institute. Aiming at better use of facilities available at the library, the cataloguing is being computerised.

3.11 High Level Technical Committee on Hydrology (HILTECH)

The High Level Technical Committee on Hydrology was constituted vide Ministry of Water Resources, Government of India Resolution dated August 18, 1982. This committee came into existence with the transfer of the responsibilities of Indian National Committee for International Hydrological Programme from CSIR to Ministry of Water Resources. The Secretariat of this Committee stands attached to National Institute of Hydrology and is known as HILTECH Division of the Institute. Year wise activities of HILTECH are presented in Chart VI. The secretariat also functions as the secretariat of the Asian Regional Coordination Committee on Hydrology (ARCCOH)

3.11.1 Meeting of High Level Technical Committee on Hydrology

The ninth meeting of HILTECH was held at New Delhi on 22nd Jan. 1987 under the Chairmanship of Shri M.A. Chitale, Chairman, Central Water Commission. The following issues were discussed.

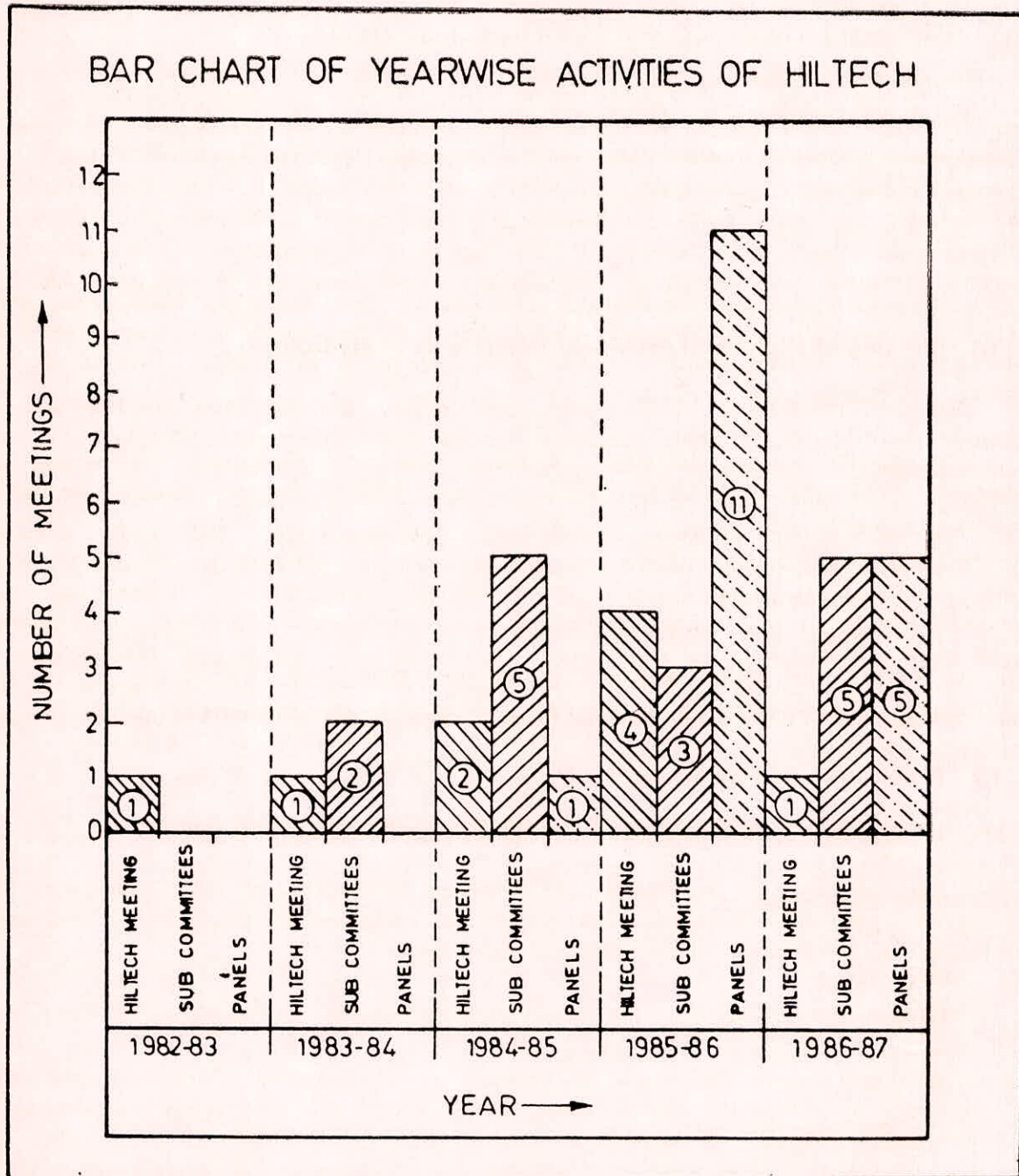
- (i) National Hydrology Project : The National Hydrology project (NHP) surface water was discussed by the members and it was decided to formulate the NHP for Ground Water and Water Quality separately.
- (ii) Rules of procedure for HILTECH
- (iii) Preliminary report on the planning of IHP-IV Programme (1990-95).
- (iv) Remuneration for writing State-of-Art Reports as recommended by different panels.

3.11.2 Panels and their Meetings

HILTECH has constituted seven panels on various disciplines of Hydrology. They are :

- (i) Education and Training
- (ii) Surface Water
- (iii) Ground Water
- (iv) Hydrometeorology
- (v) Water Quality, Erosion and Sedimentation
- (vi) Snow and Ice
- (vii) Water Resources System

The second meeting of Surface Water panel, Hydrometeorology panel, Water Quality, Erosion and Sedimentation panel, Snow and Ice panel and Water Resources System panel were held during the year 1986-87.



3.11 3 Sub-Committees and their Meetings

HILTECH has constituted seven sub-committees. They are :

- (i) Steering committee
- (ii) Editorial Advisory Board of Jal Vigyan Sameeksha
- (iii) Country Plan on Hydrology
- (iv) Technicians Training
- (v) Interaction Between Research Organisations, Universities and User Agencies
- (vi) Man Power Requirement in Hydrology
- (vii) P.G. Level Courses

The second meeting of sub-committee on Country Plan was held at Delhi on September 2, 1986. The Fourth meeting of Editorial Advisory Board of Jal Vigyan Sameeksha was held at Roorkee on March 4, 1987 under the Chairmanship of Dr. Satish Chandra, Director, National Institute of Hydrology, Roorkee.

The 4th, 5th and 6th meetings of Technician Training were held at Roorkee and Delhi respectively. The report of Technician training in India was finalised by the sub-committee for consideration of HILTECH.

The Indian delegation represented by Dr. Satish Chandra, Director, National Institute of Hydrology; Shri J.F. Mistry, Secretary (Irrigation), Govt. of Gujarat and Shri N.K. Sarma, Member (Water Planning), Central Water Commission participated in 'Hydrology and Scientific Bases of Water Resources Management', during 16-21 March, 1987 held in Geneva, Switzerland. The conference deliberated upon future activities of the UNESCO and the WMO in the area of Hydrology and Water Resources.

3.11.4 Support to Research Projects/Courses/Seminars/Workshops etc.

Research project on 'Development of Generalised Software on HP-1000 Computer for Unit Hydrograph Based Forecast Model and its Application' sponsored by HILTECH is in progress at Civil Engineering Department, Indian Institute of Technology, Delhi.

Besides these, HILTECH sponsored and funded the following seminars/workshops :

- (i) International seminar on 'Water Management in Arid and Semi-arid Zones' organised by Haryana Agricultural University, Hissar, during 27-29 November, 1986, co-sponsored by UNESCO.
- (ii) Workshop on 'Flood Estimation in Himalayan Region' organised by U.P. Irrigation Design Organisation, Roorkee on September 25th and 26th 1986 at Roorkee.

- (iii) All India Seminar on 'Strategies for Drought Proofing and Management', organised by the Institution of Engineers (India), Gujarat State Centre, Ahmedabad, 6th-7th Feb. 1987.

3.11.5 Publication of Jal Vigyan Sameeksha

The first issue of Jal Vigyan Sameeksha (June 1986) on the main theme of 'Drought' has been brought out and circulated to various national and international organisations dealing with hydrology and water resources. The second issue of Jal Vigyan Sameeksha on the specific theme of 'Hydrological Forecasting' is under finalisation.

3.11.6 Activities at ARCCOH Secretariat

The ARCCOH Secretariat functioned quite actively during the year. ARCCOH Newsletter was brought out regularly on quarterly basis. The Newsletter is sent to all member countries of ARCCOH and various organisations in India. The Secretariat also compiled a 'Directory of Hydrologists' in ARCCOH region which has included about 450 experts of hydrology from various ARCCOH countries.

The implementation of first component of Major Regional Project (MRP) developed for a group of South East Asian countries, namely Indonesia, Malaysia, Thailand and the Philippines, is in progress. Preparations are on to develop pilot projects on the use of mathematical modelling in salt water intrusion management in the areas of Jakarta and Bangkok. A preparatory meeting to finalise the proposal of 2nd component of Major Regional Project (MRP) for participating countries of South-Central Asia, namely, Nepal, Bangladesh, Bhutan, Burma, India and Pakistan was held on 20-22 Jan. 1987 at Roorkee. A delegate from Nepal and an observer from Iran participated in this meeting.

A workshop on 'Erosion and Sediment Transport Processes' was held at Dhaka, Bangladesh during 20-23 Dec. 1986. It was organised by the Department of Water Resources Engineering and the Institute of Flood Control and Drainage, Bangladesh University of Engineering and Technology, Dhaka in cooperation with Bangladesh Water Development Board, and was sponsored by the Regional Office of UNESCO at New Delhi and International Centre of Integrated Mountain Development (ICIMOD), Nepal. Delegates from Bhutan, India, Pakistan, Sri Lanka and Bangladesh participated in the workshop. Twenty papers covering various aspects of erosion and sedimentation were presented for discussion. The workshop came out with five recommendations for future work.

A Regional Workshop on Ground Water Modelling, was organised by the Water Resources Development Training Centre, (WRDTC) University of Roorkee, Roorkee from December 12-17, 1986. The workshop was co-sponsored by UNESCO.

3.12 Consultancy

The Institute has been carrying out research studies sponsored by the various State and Central Govt. Organisations. Three consultancy projects have been completed so far and 10 projects are under consideration at various levels as given in Appendix X.

3.13 Participation in Conferences and Symposia and Publication by Scientific Staff

The scientists and scientific staff of NIH participated in various seminars, symposia, workshops and courses and presented papers during the year under report.

A number of papers were also published by the scientists in professional journals. The list of papers published is given in Appendix XI.

3.14 Visitors

Hon'ble Sh. B. Shankaranand, President of NIH Society and Union Minister of Water Resources visited the Institute on 23rd Oct., 1986. He inaugurated the newly constructed Lab Block and also laid Foundation Stone for the Recreation Centre and Museum. He also presided over the 7th Annual General Meeting of NIH Society and the Special General Meeting of the Society. The Hon'ble Ministers of Irrigation of Govt. of Madhya Pradesh, Assam, Himachal Pradesh and Uttar Pradesh also visited the Institute on 23rd Oct., 1986 and attended the Society Meetings. The other distinguished visitors included Sh. M.A. Chitale, Chairman, CWC, Sh. B.B. Vohra, Chairman, Board of Energy, Govt. of India, Mr. W.H. Gilbrich, UNESCO, Paris, Mr. D. Kraatz and two eminent scientists from USSR. Besides them a number of eminent and distinguished visitors from within the country and abroad visited the Institute and some of them delivered lectures to the scientific staff of this Institute.

3.15 Recreation and Welfare Activities

During the year various activities were undertaken by the club for recreation of its members. Friendly cricket matches were organised with local organisations.

3.16 Newsletter

The publication of the quarterly Newsletter of the Institute started in 1984. During the year under report four issues of the Newsletter were published in April, July, October, 1986 and January 1987. Newsletter has been named as "Jal Vigyan Samachar".

Plan and progress of various research and technical activities of the Institute are brought out in the Newsletter. The Newsletter is circulated all over India and the feed back information reviewed to update the contents and format of the Newsletter. Attempts are being made to cover various news from the States and to bring out the Hindi version of the Newsletter.

3.17 Hindi Use

In keeping with the Official Language Policy of the Government sustained efforts were made by the Institute during the year towards the implementation of various provisions of the Official Language Act 1983 and the rules framed thereafter. Meetings of the re-constituted Hindi Salahkar

Samiti of the Institute were held wherein decisions were taken to increase the use of Hindi in day to day working of the Institute. All correspondence with Group D staff of the Institute is being carried out in Hindi,

A written contest in Hindi on 'India's Independence Struggle' was held on the eve of Independence Day in the Institute. 13 officials participated in the contest. A portion of the Newsletter of NIH is being brought out in Hindi,

All letters received in Hindi were replied in Hindi. During the year 105 letters were received in Hindi and 110 communications were sent in Hindi. Annual Report of NIH is also published bilingual in Hindi and English.

4.0 FINANCE AND ACCOUNTS

During the year under review the Government of India, Ministry of Water Resources (Formerly Department of Irrigation, Ministry of Irrigation and Power) provided an amount of Rs. 75 lakhs as grant-in-aid and Rs. 45.00 lakhs was released to the Institute under Plan Head. The actual expenditure of the Institute during the year after taking into account the amount carried forward from the previous year was Rs. 78,25,613.05 under Plan Head and Rs. 43,17,385.40 under Non-Plan Head. The accounts of the Institute for the year have been audited by M/s. Satyendra and Co., Chartered Accountant, Roorkee and a copy of audited statement of account consisting of receipt and payment accounts, income and expenditure account and the balance sheet as on 31st March, 1987 duly certified by the auditors is given at Appendix XII. It will be seen from the auditors report that additions worth of Rs. 25.03 lakhs were made to the fixed assets of the Institute during the year.

The replies to the auditors observations have been submitted separately to the Governing Body of the Institute.

5.0 ACKNOWLEDGEMENTS

The different activities of the Institute have progressed well under the blessings of the President of the Society and direction and guidance from Chairmen of the Governing Body and Technical Advisory Committee and members of the Society, Governing Body and TAC. Support and help from UNDP, UNESCO, Department of Economic Affairs and from officers of Ministry of Water Resources, Central Water Commission, India Meteorological Department, University of Roorkee and several other Central and State government organisations is gratefully acknowledged. Whatever has been achieved by the Institute since its establishment, in particular during the year under report, would not have been possible without their help and guidance. The Institute also acknowledges the help and cooperation received from members of Working Groups, scientists and engineers from many academic and research organisations.

APPENDICES

APPENDICES

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NATIONAL INSTITUTE OF HYDROLOGY SOCIETY

PRESIDENT : Union Minister for Water Resources
Government of India,
Shram Shakti Bhawan,
NEW DELHI-110001

MEMBERS

Member
Planning Commission
Yojna Bhawan,
Parliament Street,
NEW DELHI-110001

Minister-in-charge of
Irrigation,
Government of Himachal Pradesh,
SIMLA

Minister-in-charge of
Irrigation,
Government of Jammu & Kashmir,
SRINAGAR (J & K)

Minister-in-charge of
Irrigation,
Government of Uttar Pradesh
LUCKNOW

Minister-in-charge
Irrigation,
Government of Bihar,
PATNA

Minister-in-charge of
Irrigation,
Government of Assam
GUWAHATI

Minister-in-charge of Irrigation
Government of Karnataka
BANGALORE

Minister-in-charge of Irrigation
Government of West Bengal,
Writer's Building,
Dalhouse Square,
CALCUTTA

Minister-in-charge of Irrigation
Government of Kerala,
TRIVANDRUM

Minister-in-charge of Irrigation
Government of Madhya Pradesh,
BHOPAL

Minister-in-charge of Irrigation
Government of Rajasthan,
JAIPUR

Vice Chancellor,
University of Roorkee
ROORKEE-247 667

Secretary to Govt. of India
Ministry of Water Resources
Shram Shakti Bhawan
Rafi Marg,
NEW DELHI-110001

Secretary to Govt. of India
Ministry of Science & Technology,
Department of Science & Technology,
Technology Bhawan,
New Mehrauli Road.
NEW DELHI-110029

Secretary to Govt. of India
Ministry of Environment
& Forest,
Bikaner House,
NEW DELHI

Secretary to Govt. of India
Ministry of Agriculture & Cooperation,
Krishi Bhawan,
NEW DELHI-110001

Secretary to Govt. of India
Ministry of Energy,
Shram Shakti Bhawan,
Rafi Marg,
NEW DELHI-110001

Secretary to Govt. of India
Department of Expenditure,
Ministry of Finance
NEW DELHI-110001
(or his nominee)

Secretary to Govt. of India
Ministry of Urban Development,
Nirman Bhawan,
NEW DELHI-110002

Secretary to Govt. of India
Planning Commission
Yojna Bhawan,
NEW DELHI-110001

Chairman,
Central Electricity Authority,
Sewa Bhawan, R.K. Puram,
NEW DELHI-110066

Chairman,
Central Water Commission
Sewa Bhawan, R.K. Puram,
NEW DELHI-110066

Member (Water Planning)
Central Water Commission,
Sewa Bhawan, R.K. Puram
NEW DELHI-1100066

Member (River Management)
Central Water Commission
Sewa Bhawan, R.K. Puram,
NEW DELHI-110066

Chairman,
Central Ground Water Board
Shram Shakti Bhawan,
Rafi Marg,
NEW DELHI-110001

Chairman,
Brahmaputra Board,
Silpukhuri
GUWAHATI-781003

Director General
National Water Development Agency,
Office-cum Shopping Complex,
Community Centre,
Near Anupam Cinema Saket,
NEW DELHI-110017

Chairman,
Narmada Control Authority,
213, Palika Bhawan,
Sector-XIII, R.K. Puram,
NEW DELHI-110066

Chairman,
Ganga Flood Control
Commission,
Sinchai Bhawan,
3rd Floor,
PATNA-800015

President,
Indian Association of Hydrologist,
F-9/1, Vasant Vihar,
NEW DELHI

Shri K.K. Framji,
Secretary General,
International Commission
on Irrigation & Drainage,
48, Nayaya Marg,
Chanakyapuri,
NEW DELHI-110021

Shri M.G. Padhye,
Secretary (Retd.)
Ministry of Irrigation,
7, Vishwa,
1264/3, Shivaji Nagar,
PUNE-411004

Dr. B.S. Mathur
Professor & Co-ordinator
School of Hydrology,
University of Roorkee
ROORKEE-247 667

Dr. R. Shakthivadivel
Director,
Centre for Water Resources,
College of Engineering,
Anna University,
MADRAS-600025

Prof. Subhash Chander
Civil Engineering Deptt.
Indian Institute of Technology,
Hauz Khas,
NEW DELHI-110016

Director General (Meteorology)
India Meteorological Department,
Lodi Road,
NEW DELHI.

Director General
Geological Survey of India,
Chowringee Road,
CALCUTTA

Joint Secretary (Admn)
Ministry of Water Resources
Shram Shakti Bhawan,
NEW DELHI-110001

Commissioner (River Basin)
Ministry of Water Resources
Shram Shakti Bhawan,
NEW DELHI-110001

Commissioner (Indu Basin)
Ministry of Water Resources
Shram Shakti Bhawan,
NEW DELHI-110001

Member
Joint River Commission,
Ministry of Water Resources
Shram Shakti Bhawan,
NEW DELHI-110001

A representative of the HILTECH,
ROORKEE

Additional Secretary
Government of India
Ministry of Water Resources,
Shram Shakti Bhawan,
NEW DELHI-110001

Chairman
Central Board of Prevention &
Control of Water Pollution,
NEW DELHI

Director
National Institute of Hydrology
ROORKEE
Member-Secretary

GOVERNING BODY

CHAIRMAN	Secretary to Government of India Ministry of Water Resources Shram Shakti Bhawan, NEW DELHI-110001
VICE CHAIRMAN	Vice Chancellor University of Roorkee, ROORKEE
MEMBER SECRETARY	Director, National Institute of Hydrology, ROORKEE

MEMBERS

Secretary Government of India, Department of Power (or his nominee)	Secretary Government of India, Planning Commission, (or his nominee)
Secretary Government of India Ministry of Agriculture & Cooperation, (or his nominee)	Secretary Government of India Ministry of Science & Technology (or his nominee)
Secretary Government of India, Ministry of Urban Development (or his nominee)	Chairman Central Water Commission, (or his nominee)
Secretary Government of India, Department of Expenditure, Ministry of Finance, (or his nominee)	Chairman Central Electricity Authority, (or his nominee)
Chairman, Central Ground Water Board	Additional Secretary Government of India, Ministry of Water Resources,
Commissioner (Projects) Ministry of Water Resources	Director General, (Meteorology) India Meteorological Department
Joint Secretary (Admn) Ministry of Water Resources	

TECHNICAL ADVISORY COMMITTEE

CHAIRMAN

Chairman,
Central Water Commission
NEW DELHI

CONVENER

Director,
National Institute of Hydrology,
ROORKEE

MEMBERS

Member (Water Planning)
Central Water Commission
NEW DELHI

Member (River Management)
Central Water Commission
NEW DELHI

A Representative of
Central Electricity Authority
NEW DELHI

Chairman
Central Ground Water Board
NEW DELHI

A Representative of India
Meteorological Department
NEW DELHI

Director
Central Water & Power
Research Station,
PUNE

A Representative of
Deptt. of Science & Technology
Government of India
NEW DELHI.

Dr. Subhash Chander
Professor,
Civil Engineering Deptt,
Indian Institute of Technology
NEW DELHI

Dr. A.S. Chawla
Professor,
W.R.D.T.C.
University of Roorkee
ROORKEE

Shri J.F. Mistry,
Secretary (Irrigation)
Govt. of Gujarat,
GANDHINAGAR

Chief Engineer
(WR & Jt. Secretary)
Govt. of Maharashtra
BOMBAY

APPENDIX IV

Meetings of bodies, committees & Working groups

Title	Date of Meeting
Governing Body	
1. 27th G.B. Meeting	30.6.86
2. 28th G.B. Meeting	5.9.86
3. 29th G.B. Meeting	28.11.86
4. 30th G.B. Meeting	26.3.87
Technical Advisory Committee	
1. 14th TAC Meeting	13.5.86
2. 15th TAC Meeting	25.9.86
Working Group	
1. Water Resources Systems	19.2.87
2. Groundwater Assessment	19.2.87
3. Remote Sensing	25.3.87

MEMBERS OF HIGH LEVEL TECHNICAL COMMITTEE ON HYDROLOGY

CHAIRMAN

Chairman,
Central Water Commission
Seva Bhawan: R.K- Puram,
NEW DELHI-110066

MEMBERS

1. Director,
National Institute of Hydrology
ROORKEE
2. Chairman,
Central Ground Water Board,
Krishi Bhawan, Room No. 236-A,
NEW DELHI-110001
3. Director General,
Indian Council of Agricultural
Research,
Krishi Bhawan,
NEW DELHI-110001
4. Director General
C.S.I.R., Rafi Marg,
NEW DELHI-110001
5. Director General
Geological Survey of India,
27, Jawaharlal Nehru Marg,
CALCUTTA-700016
6. Director General of Meteorology
I.M.D.
Lodi Road,
NEW DELHI-110003
7. Chairman,
Central Board for Prevention &
Control of Water Pollution,
5th & 6th Floor, Skylark,
60, Nehru Place,
Post Box No. 4364,
NEW DELHI-110011
8. Chairman,
Central Electricity Authority,
Seva Bhawan, R,K- Puram,
NEW DELHI-110066
9. President,
Forest Research Institute,
& College. P.O. New Forest,
DEHRADUN-248006
10. Director,
National Remote Sensing Agency
Balanagar
HYDERABAD-500037
11. Advisor, CPH EEO,
Ministry of Works & Housing.
Nirman Bhawan.
NEW DELHI-110011

- | | |
|--|--|
| <p>12. Chairman,
Narmada Control Authority,
118, Palika Bhawan,
Sector-XIII, R.K. Puram,
NEW DELHI-110066</p> <p>13. Engineer-in-Chief,
Irrigation Department (U.P.)
1, Canal Colony,
LUCKNOW-226001</p> <p>14. Chief Engineer
(Water Resources) &
Joint Secretary,
Department of Irrigation
Govt. of Maharashtra
Mantralaya,
BOMBAY-400032</p> <p>15. Chairman,
Brahmputra Board
Silpukhuri
GUWAHATI-781003</p> | <p>16. Dr. Subhash Chander
Department of Civil Engineering,
Indian Institute of Technology,
Hauz Khas,
NEW DELHI-110016</p> <p>17. Shri K.K. Framji,
Secretary General, I.C.I.D.,
48, Nayaya Marg, Chankayapuri,
NEW DELHI-110021</p> <p>18. Chief Engineer
P.W.D., Ground Water,
Chepauk,
MADRAS-600005</p> <p>19. Director,
State Water Investigation Directorate,
Sech Bhavan, III Floor
Bidhan Nagar,
CALCUTTA-700064</p> <p>20. Director,
Snow & Avalanche Study Establishment,
Defence Research & Development
Organisation
MANALI (H.P.)</p> |
|--|--|

MEMBER—Senior Scientist

SECRETARY—HILTECH Division
National Institute of Hydrology
ROORKEE

APPENDIX—VI

POSITION OF STAFF OF NIH AS ON 1.4.86 and 31.3.87

Sl. No.	Description	Existing as on		Remarks
		1.4.86	31.3.87	
1.	Director	1	1	
2.	Scientist 'F'	2	2	
3.	Scientist 'E'	1	4	
4.	Chief Administrative Officer	1	1	
5.	Scientist 'C'	8	10	
6.	Finance Officer	—	1	
7.	Scientist 'B'	15	14	
8.	Assistant Engineer	1	1	
9.	Section Officer	—	—	
10.	Senior Personal Assistant	1	1	
11.	Senior Research Assistant	15	16	
12.	Senior Research Assistant (Programming)	—	—	
13.	Research Supervisor	—	1	
14.	Senior Technical Assistant (Lib.)	—	—	
15.	Superintendent	—	1	
16.	Personal Assistant	3	5	
17.	Research Asstt/Tech. Asstt.	5	11	
18.	Senior Computer Operator	—	—	
19.	Hindi Translator	—	1	
20.	Junior Engineer (Civil)	—	—	
21.	Junior Engineer (Elect.)	—	—	
22.	Foreman (E & M)	—	—	
23.	Senior Technician	—	—	
24.	Technical Asstt. (Photography)	—	1	
25.	Work Supervisor	1	1	
26.	Technician (Grade I)	—	—	
27.	Senior Draftsman	—	—	
28.	Technician (Grade II)	—	4	
29.	Draftsman	1	1	
30.	Senior Laboratory Asstt.	—	1	
31.	Computer Operator	1	1	
32.	Mechanic (Grade I)	5	2	
33.	Stenographer (including Hindi Steno)	4	6	
34.	Upper Division Clerk	4	5	

Sl. No.	Description	Existing as on		Remarks
		1.4.86	31.3.87	
35.	Receptionist	1	1	
36.	Laboratory Assistant	1	1	
37.	Mechanic (Grade II)	—	3	
38.	Lineman	1	1	
39.	Tracers	2	2	
40.	Horticulture Assistant	1	1	
41.	Observers	—	—	
42.	Lower Division Clerk	9	12	
43.	L.D.C. (Telex)	1	1	
44.	Driver	3	3	
45.	Laboratory Attendant	5	5	
46.	Library Attendant	2	2	
47.	Laboratory Attendant (Sub-Station)	—	3	
48.	Laboratory Attendant (Tube-Well)	1	1	
49.	Photocopier Operator	1	1	
50.	Amonia Print Operator	1	1	
51.	Duplicating Machine Operator	—	—	
52.	Messenger	15	15	
53.	Mail	1	2	
54.	Safai Karamchari	1	2	
55.	Daftar	—	—	
Total		115	154	

APPENDIX VII

SCIENTIFIC AND TECHNICAL REPORTS PREPARED DURING 1986—87

REVIEW NOTE :

1. Hydrological Aspects of Droughts	RN 37
2. Measurement of Snow and Estimation of Snow Cover	RN 38
3. Remote Sensing Application for Flood Inundation	RN 39
4. Comprehensive Review of Commonly used Meteorological, Agricultural and Hydrological Drought Indices	RN 40
5. Analysis of Low Flows to Investigate Drought Characteristics and Plan Water Use Management	RN 41
6. Procedure for Hydrological Network Design	RN 42
7. Design of Hydrological Network in Mountainous Region	RN 43
8. Rainfall Simulator Studies	RN 44
9. Remote Sensing Applications to Sedimentation Studies	RN 45
10. Snowmelt Process	RN 46
11. Critical Review of Rainwater Harvesting Techniques in Drought Prone Areas	RN 47
12. Regional Flood Formulae for Mountainous Region	RN 48
13. Overland Flow in Mountainous Areas	RN 49

TECHNICAL REPORT

1. Causes of Negative Outflow in Muskingam Method of Flood Routing	TR 1
2. Determination of Suitability of Transformation for Flood Frequency Analysis	TR 2
3. Storage in Confined Aquifer with Flowing Artisan Well/Pumping Well	TR 3
4. Analysis of Rainfall Data of Belgaum District	TR 4
5. Development of Sub Models Fauna and Flora for Evaluating Responses of Vegetation and Wildlife Habitat	TR 5
6. Water Quality Modelling of Rivers	TR 6
7. Use of Personal Computer for Preparation of Reports	TR 7
8. Reservoir Water Balance	TR 8
9. Some Studies on Plotting Position Formulae of Gumbel EV-1 Distribution	TR 9
10. Determination of Reach Transmissivity under various Hydrologic Boundary Conditions	TR 10
11. Study of Parameters Affecting Base Flow	TR 112
12. Field Measurement of Soil Moisture Movement in Ponding Condition	TR 1
13. Variable Parameter Hydrologic Flood Routing	TR 13
14. Estimating Evaporation Losses from Lakes and Reservoirs using Available Information Indices	TR 14

15. Mathematical Modelling of Moving Storms and their Hydrological Implications	TR 15
16. Modelling of Overland Flow	TR 16
17. Simple Techniques of Forecasting of Monsoon Rainfall and Runoff and Application to Mahanadi River	TR 17
18. Assessment of Recharge from Various Sources to an Aquifer and Assessment of Aquifer Yield	TR 18
19. Recharge from Large Depression Storage	TR 19
20. Identification of Hydro-environmental Indices	TR 20
21. Development of Physically based Hydrologic Flood Routing Method for Different Prismatic Sections.	
22. Teaching Requirement of Agricultural Land and Study of Movement of Salts	TR 22
23. Determination of Aquifer Recharge for River Stages	TR 23
24. Modelling Studies for Forest Influences on Hydrological Parameters	TR 24
25. Surface Fitting of Groundwater Table	TR 25
26. Analysis of Flow to a Dug Well in Hard Rock Areas in an Unconfined Aquifer by Cell Theory	TR 26
27. Comparison of some Physically Based Hydrologic Flood Routing Methods	TR 27
28. Study of Soil Erosion for Different Land uses and Vegetal covers using Soil Loss Equation	TR 28
29. Measurement of Soil Moisture Variation using Resistivity Techniques	TR 29

CASE STUDY :

1. Bivariate Thomas Fiering Model	CS 19
2. Flood Plain Mapping by Remote Sensing Application	CS 20
3. Study of Hydrological Aspects for 1985-86 Drought	CS 21

STATUS REPORT :

1. Hydrological Aspects of Drought	SR 8
2. Thermal Pollution in Water Bodies	SR 9

USERS MANUAL :

1. Frequency Analysis on Micro-Computer	UM 19
2. Mass Curve Analysis and Sequent Peak	UM 20
3. Generation of Hydrological Graphs using Computer Graphics	UM 21
4. Graphical Representation of Information Related with Floods	UM 22
5. Single Purpose Reservoir Operation for Hydroelectric Power	UM 23

WORKSHOPS/SEMINARS ORGANISED IN 1986-87
WORKSHOPS

TOPIC	PLACE	PERIOD	No. OF PARTICIPANTS
1. Flood Frequency Analysis	Bhubaneshwar	Aug. 25—30, 1986	43
2. Flood Routing and Flood Forecasting	Roorkee	Nov. 10—14, 1986	17
3. Unit Hydrograph	Mysore	Nov. 24—29, 1986	26
4. Design Storm and Design Flood	Roorkee	Jan. 5—9, 1987	15
5. Data Storage and Retrieval System	Roorkee	March 9—13 1987	26

HILTECH SPONSORED SEMINARS

1. Third Regional Training Course on Ice & Snow Hydrology	Manali	March 14 to April 1, 1986
2. Seminar on Drought Management Strategies	Mysore	May 15—16, 1986
3. International Seminar on Water Management in arid and Semi-arid zones	Hissar	Nov. 27—29, 1986
4. All India Seminar on Strategies for Drought Proofing and Management	Ahmedabad	Feb. 6—7, 1987

**INTERACTION WITH STATES AND STUDIES TAKEN UP AND
PROPOSED IN THE STATES**

A. GUJARAT

1. Preparation of typical Hydrological Year Book for Machchu I basin
2. Proposal for establishment of Regional Centre
3. Regional Flood Formulae
4. Representative basin studies for Machchu I basin
5. Mathematical Model Studies.

B. KARNATAKA

1. Preparation of Hydrological Year Book for Malaprabha Basin
2. Hydrological and water resources study for Malaprabha and Ghataprabha Rivers
3. Study of Rainfall trends in Belgaum District
4. Drought Studies
5. Development of Modified Regional Formulae
6. Water Balance Study of Reservoirs
7. Hydrological Study for Conjunctive Use Planning of Ghataprabha and Malaprabha Basins.

C. NORTH EASTERN REGION

1. Proposal for Establishment of Regional Centre and Representative Basin being formulated jointly with State organisations
2. Hydrological studies of Barak Basin.

D. ORISSA

1. Criteria for design flood with calculated risk guidelines and manual
2. Help in finalising computer configuration

E. PUNJAB

1. Flash Flood studies in Bist Doab region
2. Problem of Water logging and salinity in South Western Punjab
3. Workshop on (a) Unit Hydrograph Derivation and Flood Frequency Analysis (b) Storage, Processing and Analysis of Hydrologic Data.

F. HIMACHAL PRADESH

1. Representative basin study
2. Drying of springs
3. Choking of Khuls and changing river courses
4. Hydrological studies of glaciers
5. Instrumentation in high altitudes and network improvement and telemetry.
6. Organisation of workshops
7. Establishment of a regional centre
8. Problems of erosion and flooding
9. Drought problems in hilly regions
10. Water availability studies.

G. RAJASTHAN

1. Design of Network of Raingauges and stages and Discharge measuring sites
2. Design flood for flashing streams
3. Regional Flood frequency Studies
4. Initiation of lake studies
5. Drough studies in Barmer
6. Organisation of workshops

H. UTTAR PRADESH

1. Seasonal Ground Water Balance and Monthly mathematical modelling of UGC Command Area.
2. Water logging problem of Sarju Nahar Pariyojna
3. Organisation of a workshop on Unit Hydrograph Techniques.
4. Preparation of typical year book of a River basin in U.P.
5. Establishment of a representative basin (Pinder river) and Instrumenting it for hydrological response.
3. Operation study for Yamuna System upto Tajewala for Hydropower.

I. WEST BENGAL

1. Preparation of Hydrological Year Book for Kalighai Basin
2. Hpdrological studies of Tidal Basin (Saptamukhi river and Tolleys Nala)
3. Analysis of Sedimentation data and Empirical Approach to Flood Forecasting for small reservoirs.
4. Effect of Deforestation and Afforestation on Runoff and Sediment Yield.
5. Ground Water Balance Study and Modelling for Daru Keshwar Basin.
6. Workshop on Ground Water and Modelling at Calcutta

J. JAMMU & KASHMIR

1. Studies for orographic effect on precipitation, design flood studies in mountainous areas, snow melt forecasting and glacier melt runoff.
3. Preparation of Status report on effect of deforestation on Snow fall/snow melt
3. Typical study of snow-cover/glaciated area

K. MAHARASHTRA

1. Regional flood frequency analysis.
2. Study of Hydrologic Drought Indices.
3. Impact of droughts on groundwater.
4. Performance study of percolation tanks in drought prone areas
5. Workshops on unit hydrograph, flood frequency analysis, data storage & retrieval system etc.
6. Stable isotope study to investigate river interaction for river Ganga-Hardwar and Narora (with BARC, Bombay).

APPENDIX X


CONSULTANCY PROJECTS UNDER PROGRESS AND UNDER CONSIDERATION

- | | |
|--|---|
| 1. Hydrological Studies of Barak Basin | Brahmaputra Board |
| 2. Flash Flood Studies of Punjab | Punjab Irrigation Dept. |
| 3. Preparation of a Reservoir Operation Manual for Dharoi Reservoir | Gujarat Irrigation Dept. |
| 4. Preparation of a Reservoir Operation Manual for Machchu reservoir | Gujarat Irrigation Dept. |
| 5. Hydrological Studies of lower Indra Project | Orissa Irrigation Dept. |
| 6. Hydrological Studies of Kishau Dam | U.P. Irrigation Dept. |
| 7. Waterlogging Problem of Sarju Nahar Pariyojna | U.P. Irrigation Dept. |
| 8. Design of well point system for dewatering Solani Aquaduct, Upper Ganga Canal Modernisation | U.P. Irrigation Dept. |
| 9. Development of Storage and Retrieval System of Groundwater Data | U.P. Groundwater Investigation Organisation |
| 10. Software Development for Groundwater balance. | U.P. Groundwater Investigation Organisation |

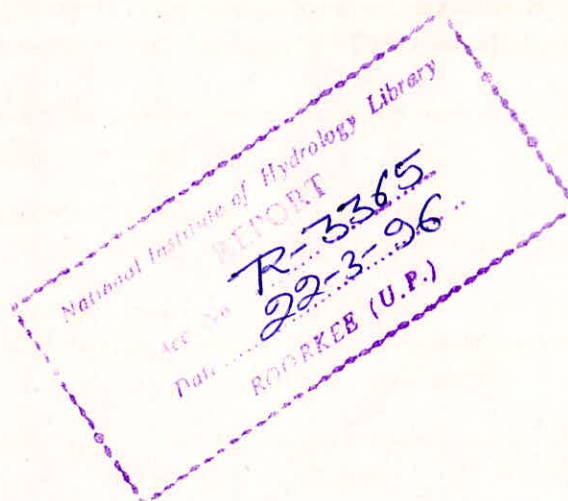
PAPERS PUBLISHED DURING THE YEAR 1986-87

1. Bhar, A. K. : 'Remotely Sensed Measurement of Soil Moisture', Hydrology Journal of IAH, Vol. IX, No. 2 & 3, June, 1986.
2. Bhar, A. K. : 'Flood inundation mapping using remotely sensed data—An Overview'. Proc. of 'Flood Estimation & Control' Seminar, Institution of Engineers (I), Roorkee, December 1986.
3. Bhargava, D. N., G. C. Mishra and Satish Chandra : 'Evaluation of Water Table due to Seepage from Two Parallel Canals' International Symposium on Ground-water Monitoring and Management, Dresden, GDR, March, 1987.
4. Bhargava, D. N., G. C. Mishra and Satish Chandra : 'Mathematical Model for Seepage Study for Parallel Canal', High Technology in Water Resources and Power Engineering, CBIP, New Delhi.
5. Bhatia, K. K. S. and A. K. Sikka, : 'Various Procedures for Environmental Impact Assessment', Proc. of the Seminar on 'Environmental Considerations in Planning of Water Resources Projects' held at Roorkee, April, 1986.
6. Bhatia, K. K. S. and E. A. McBean: 'Regression Modelling of Phosphorous Species from Diffuse Sources', Journal of the Institution of Engineers (I), Environmental Division, Oct. 1986-Feb. 1987, Pages 12-17, Vol. 67.
7. Bhatia, K. K. S. and E. A. McBean : 'Steady State Modelling of Dissolved Oxygen in River Speed (Canada)' Hydrology Journal of IAH, Vol. IX, No. 4, Oct.-Dec. 1986.
8. Chand, R. : 'Soil Moisture Studies using Newton Probe', 53rd Research and Development Session of the C. B. I. P., Bhubaneshwar, May 8-10, 1986.
9. Ffolliott, P., M. Fogel and A.K. Sikka : 'Impacts of Upstream Vegetative Management on Water Yield Improvements', Proc. of the Seminar on Environmental Considerations in Planning of Water Resources Projects' held at Roorkee, April 1986.
10. Goel, N. K., S. M. Seth and Satish Chandra ; 'Design Flood Estimation for Narmada Sugar Project using partial Duration Series—A Case Study', International Symposium on 'Flood Frequency and Risk Analysis' at Louisiana State University, Baton Rouge, USA, 14-17 May, 1986.
11. Goyal, V. C. : 'Use of Resistivity Technique in Soil Moisture Studies—A Preliminary Evaluation' (coauthored with H. Sinvhal and A. Sinvhal). Hydrology Journal of the Indian Association of Hydrologists, Vol. IX, No. 4, Oct.-Dec. 1986.

12. Harikrishna, J. : 'Reactive Measures during Drought' Proc. Seminar on Drought Management Strategies, 15-16 May, 1986. Mysore.
13. Jain, S. K., V. K. Lohani and G. C. Mishra : 'Water Resources Planning with Environmental Considerations' Proc. of the Seminar on 'Environmental Considerations in Planning of Water Resources Projects' held at Roorkee, April, 1986.
14. Jain, A. K. and R. D. Singh : 'Derivation of Optimum Unit Hydrograph using Linear Programming Approach', 53rd R & D Session of CBIP, Bhubaneshwar, May 8-10, 1986.
15. Jain, S. K. and A. K. Sikka : 'Management of Surface Storages for Drought Mitigation', Seminar on 'Drought Management Strategies May 15-16, 1986 Mysore.
16. Jain, S. K. and P.V. Seethapathi : 'Benefit cost Analysis in Water Resources Planning', Journal of Indian Association of Hydrologists.
17. Kumar Anil : 'Evaluation of Soil Properties in Saharanpur District using Remotely Sensed Data' International Symposium on Geomorphology and Environmental Management, University of Allahabad from Jan. 17-20, 1987.
18. Lohani, V.K. and Satish Chandra : 'Resources Management Model', Proc. of the seminar on 'Environmental Considerations in Planning of Water Resources Projects' held at Roorkee, April 1986.
19. Lohani, V.K. and A.K. Sikka : 'Evaporation Control-A Drought Control Measure', Proceedings of the seminar on 'Drought Management Strategies', Mysore, May 15-16, 1986.
20. Lohani, V.K. : 'Dynamic Programming Approach for Water Allocation in a Command Area' paper presented at Second National Convention of Agricultural Engineers on Land Management and Drainage, Hissar, Feb. - March, 1987.
21. Mishra, G.C. and A.G. Chachadi : 'Type Curve for Determining Geohydrological Parameters of Multiple Aquifer System', Proc. 53rd Research and Development Session of the C.B.I. & P., Bhubaneshwar, May 8-10, 1986.
22. Mishra, G.C. and A.G. Chachadi : 'Performance of Large Diameter well for Non-Linear Abstraction' 53rd R & D Session of the CBIP, Bhubaneshwar, May 8-10, 1986.
23. Mishra, G.C. and Satish Chandra : 'Unsteady Flow to a Multiaquifer Artesian Well', International Symposium on Ground water Monitoring and Management, Dresden, GDR, March 1987.
24. Mishra, G.C. and A.G. Chachadi : 'Type Curves for Multiaquifer System', Workshop on Groundwater Modelling, WRDTC, Roorkee, December 12-17, 1986.
25. Mishra, G.C. : 'Curve for Multiaquifer System', in the regional Workshop on Ground water Modelling Dec. 12-17, 1986 at WRDTC, Roorkee.

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26. Perumal, M. and S.M. Seth : 'Comparative Study of Muskingam and Lag and Route Method' 53rd Research and Development of the C.B.I. & P., Bhubaneshwar, May 8-10, 1986.
 27. Perumal, M., R.D. Singh and S.M. Seth : 'Flood Frequency Analysis using Box Cox Transformation Based Gumbel EV-I Distribution', International Symposium on Flood Frequency and Risk Analysis, at Louisiana State University, Baton Rouge, USA, May 14-17, 1986.
 28. Perumal, M. and Satish Chandra : 'Probability concept in Flood Damage Assessment', at the workshop held at CBIP, New Delhi, 28-30 Oct. 1986.
 29. Ramasastry, K.S. and S.M. Seth : 'Sensitivity of Estimated Flood to Change in Parameters of HEC-I Model', 53rd Research and Development Session of the CBIP, & P., Bhubaneshwar, May 8-10, 1986.
 30. Ramasastry, K.S. : 'Estimation of mean Areal Precipitation in Mountainous Catchment—A Case Study, Hyd. Journal, IAH No. 1-IX, No. 2 and 3, June 1986.
 31. Ramasastry, K.S. and S.M. Seth : 'Estimation of Design Flood for Narmada Sagar and Sardar Sarovar', Seminar on Flood Estimation and Control at IInd Annual Convention of Civil Engineers, Roorkee, December, 1986.
 32. Satish Chandra and Mishra, G.C. : 'Flowing Wells', presented at 53rd Research and Development Session of the CBIP & P, Bhubaneshwar, May 8-10, 1986.
 33. Seethapathi. P.V. ; 'Finite Element Analysis of Large Diameter well in Leaking Aquifer', 53rd Research and Development Session of the CBIP & P, Bhubaneshwar, May 8-10, 1986.
 34. Seethapathi, P.V. & S.K. Singh : 'Guidelines for Assessment of Draft from Ground water', 5th Ground water Congress at Hyderabad, during Feb. 1987.
 35. Seth, S. M. : 'Flood Volume Frequency Analysis' National Convention of Institution of Engineers, Roorkee, December 1986.
 36. Seth, S. M. : 'Use of Micro-Computer in Hydrology', High Technology in Water Resources and Power Engineering, CBIP Diamond Jubilee, New Delhi, Jan. 1987.
 37. Seth, S. M. and Rakesh Kumar, : 'Rivers of India : Ancient Names', Journal Bhagirath', Oct. 1986.
 38. Seth, S. M. and M. Perumal, : 'Negative Outflows from Muskingum Flood Routing', Journal of Hydraulic Engineering Proc. ASCE, Aug., 1987.
 39. Seth, S. M. : 'Role of Micro-computers in Hydrology, Proc. of Symposium on High Technology in Water Resources and Power Engineering at Diamond Jubilee Celebrations of CBIP at New Delhi from Jan. 28-30 1987.
 40. Sikka, A. K. : 'Drought Studies using Budyko-Sellers Water Balance Model', Hydrology Journal of IAH, Vol. IX, No. 2 & 3rd, June 1986.

41. Sikka, A.K. & Satish Chandra : 'Drought Alleviation and Management : State of Art' Proc. Seminar on Drought Management Strategies, Mysore, 15-16 May, 1986.
42. Sikka, A. K. and K. S. Ramasastri : 'Automatic Hydrologic Station-Capabilities for Research', Symposium on 'High Technology in Water Resources and Power Engg., Delhi, 28-30 Jan., 1987
43. Sikka A. K. : 'Estimation of Evapotranspiration using Bowen Ratio Method', in the Journal of Central Board of Irrigation and Power, June, 1986.
44. Sikka, A. K. and B. Soni : 'Estimation of Rainfall Deficit and Surplus Probabilities for Water Management and Crop Planning' Paper Presented at second National Convention of Agricultural Engineers on land Management and Drainage, Hissar, Feb-March, 1987.
45. Singh, R. D. : 'Estimation of Parameters of Discrete Cascade Model Using Quasi Newton Minimisation Procedure,' Hydrology Journal of IAH, Vol. IX, No. 2 and 3, June 1986.
46. Singh, R.D. and M. Perumal and S.M. Seth : 'Nash Integer Cascade Model for Runoff Computation', 53rd Research and Development Session of the CBI & P, Bhubaneshwar May 8-10, 1986.
47. Singh, R.D. : 'Procedure to Derive Average Unit Hydrograph for Flood Estimation' Seminar on Flood Estimation and Control at 11nd Annual Convention of Civil Engineers, Roorkee, December, 1986.
48. Soni, B. : 'Some Guidelines for Prediction of Interception Losses', Hydrology Journal of IAH, Vol. IX, No. 2 & 3, June 1986.
49. Soni, B. : 'Green and Ampt Infiltration Parameters' Irrigation and Power Journal of CBIP, July 1986.
50. Yoganarshiman, G,N. S.K. Jain and S.M. Seth : 'An Experiment with Kringing Interpolation', Proceedings of the Workshops on 'Flood Estimation in Himalayan Region', at Roorkee, 25-26 Sept., 1986.



APPENDIX XII

314, Ram Nagar
ROORKEE-247 667
Phone : 2829

SATYENDRA & Co,
Chartered Accountants

AUDIT REPORT

Ref. No.....

The Members of Governing Body of
National Institute of Hydrology,
ROORKEE

We have audited the attached Balance Sheet and the Income and Expenditure Account of the National Institute of Hydrology, Roorkee as on 31st March, 1987 and report that 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 and that in our opinion and to the best of our information and according to the explanations given to us the accounts give a true and fair view :

1. In case of the Balance Sheet, the state of affairs of the Institute as on 31st March 1987, and
2. In case of Income and expenditure account of the surplus for the year ended on that date.

PLACE : ROORKEE
DATED : JUNE 24, 1987

for SATYENDRA & CO.,
CHARTERED ACCOUNTANTS,
Sd/-
(S. K. GUPTA)

314, Ram Nagar
ROORKEE-247 667
Phone : 2829

SATYENDRA & CO,
Chartered Accountants

UTILISATION CERTIFICATE

Ref. No.....

Certified that the National Institute of Hydrology, Roorkee has utilised the Grant-in-aid as detailed hereunder during the year 1986-87, and the same has been verified with reference to accounting records maintained by the Institute and has been found to be correct.

PARTICULARS	AMOUNT	
	Rs.	P.
(1) Opening cash & bank balances as on 1.4.86 including previous year adjustment amount Rs. 23,238.11	4,94,566.56	
(2) Add : Opening Bank Margin Money account against irrevocable letter of credit.	(+) 6,14,520.00	
(3) Add : Grant-in-aid from Ministry of Water Resources, New Delhi.		
Plan — 75,00,000.00		
Non-Plan — 45,00,000.00	(+) 1,20,00,000.00	
Add : Other Receipts (Gross)	(+) 9,52,634.55	
	<u>1,40,61,721.11</u>	
Less : Payments	(-) 1,29,21,853.00	
	<u>Rs. 11,39,868.11</u>	
	Total	

Closing Cash & Bank balances as on 31.03.1987 including a sum of Rs. 7,94,000.00 bank margin money against irrevocable letter of credit.

(R. C. CHOPRA)
FINANCE OFFICER

(SATISH CHANDRA)
DIRECTOR

PLACE : ROORKEE
DATED : JUNE 24, 1987

for SATYENDRA & CO.
CHARTERED ACCOUNTANTS

314, Ram Nagar
ROORKEE - 247 667
Phone : 2829
Ref. No.....

SATYENDRA & CO.
Chartered Accountants

JUNE 24, 1987

The Chairman,
Governing Body,
National Institute of Hydrology,
University of Roorkee Campus,
ROORKEE

**Sub : Audit of Accounts of National Institute of Hydrology,
Roorkee for the year ended 31st March 1987**

Dear Sir,

We have completed the audit of the accounts of National Institute of Hydrology, Roorkee for the year ended 31st March 1987 and are enclosing herewith five copies of the Balance Sheet as on 31st March 1987 and Income and Expenditure Account and Receipts and Payments Accounts for the year ended on that date. We have taken up the audit with the request to Governing Body that remuneration should be enhanced reasonably as the activities have been increased five times when last audit remuneration was fixed, and there has been phenomenal increase in audit cost during the last four years. One Copy of the accounts are to be returned to us for our record after the same has been approved by the Governing Body.

Our observations on the accounts are detailed below :

1. WORKING RESULTS

During the year under audit, the net revenue expenditure incurred by the Institute works out to Rs. 51,73,465.84 as against Rs. 36,39,299.16 in the previous year. The net revenue expenditure has been shown as deduction in the Balance Sheet from the Grants-in-aids received from Government of India, Ministry of Water Resources, New Delhi.

2. ASSETS FUND ACCOUNT :

A sum of Rs. 67,95,752.61 has been transferred to assets fund account from Grant-in-aid being cost of acquisition of fixed and other assets during the year under audit. The details are under :

PARTICULARS	AMOUNT	
	Rs.	P.
1) Increase in Fixed Assets	(+) 25,02,569.19	
2) Increase in Work in Progress	(+) 35,85,412.64	
3) Increase in Advances	(+) 6,49,387.26	
4) Decrease in Deposits	(-) 1,000.00	
5) Increase in Prepaid Expenses	(+) 2,10,778.48	
		69,47,147.48
Less increase in liabilities	(-) 1,51,394.87	
Total	Rs. 67,95,752.61	

3. FIXED ASSETS :

The physical verification of Fixed Assets and other Assets as on 31.03.1987 or in phase has not been conducted. However physical verification as on 31.03.1986 has been conducted during the year and no quantitative and locational detail has been prepared. It is suggested that balances as per fixed assets register should be tallied with financial books every year.

4. BUILDING WORK-IN-PROGRESS-Rs. 67,69,404.28 :

During the year under audit, a sum of Rs. 36, 73,477.64 has been given to University of Roorkee, Roorkee for various construction works as per details given in Schedule—'B' forming parts of annual accounts.

4.1 ADVANCE FOR VARIOUS CONSTRUCTION WORKS—Rs. 61,04,775.34 :

A sum of Rs. 34,23,420.00 has been paid to University of Roorkee, Roorkee on the basis of estimates submitted by UOR, Roorkee and a sum of Rs. 65,845.51 has been adjusted/refunded by UOR, Roorkee out of Rs. 27,47,200.85 which was given in earlier years. No bill/running bill has been submitted by UOR, Roorkee and advances are adjusted on the basis of completion report. No measurement books have been produced before us for our verification.

4.2 STEEL & CEMENT WITH UOR, ROORKEE—Rs. 4,33,913.53:

- (a) Cement and steel is directly received by UOR, Roorkee on behalf of the Institute. No stock register/balance confirmation was shown to us for our verification. Freight on steel and cement is being paid by UOR, Roorkee while the same should have been accounted for in the books of Institute.
- (b) Moreover cement and steel is issued by UOR, Roorkee to the Institute but no stock registers have been maintained and issue price is calculated by UOR, Roorkee while the same should have been based on the Institute's Calculation.
- (c) There is a practice that theoretical quantity of steel and cement is deducted from the contractor's bills while actual used quantity of steel and cement should be deducted instead of theoretical quantity.

4.3 MATERIAL AT SITE WITH UOR, ROORKEE—Rs. 2,30,715.41 :

No detail of material and confirmation certificate of material have been produced before us for our verification.

5. ADVANCE TO OTHERS-Rs. 19,58,375.66 :

A sum of Rs. 19,58,375.66 is outstanding as on 31st March 1987. It is observed that individual account of the parties has not been opened in the Ledger. We suggest that individual account of the parties should be opened in the ledger or sub-ledger should be maintained. Present accounting system as adopted by the Institute, does not depict the clear and correct balances of the parties however a Kutch Register has been maintained. The details of the aforesaid outstanding advances given in Schedule—'D' forming part of accounts. The detailed observation are as under :

5.1 ADVANCE TO U.P. S. E. B.-Rs. 5,89,757.00 :

- (a) This includes a sum of Rs. 4,95,454.00 given as advance to Uttar Pradesh State Electricity Board for erecting a sub-station of 250 KW. We have been explained that work has been completed and amount could not be adjusted in the absence of final bills.
- (b) A sum of Rs. 11,388.00 has been given as advance to Uttar Pradesh State Electricity Board for temporary connections of line to the Administrative Building. Amount could not be adjusted in the absence of final bills.
- (c) A sum of Rs. 82,915.00 has been given to Uttar Pradesh State Electricity Board for L. T. Site preparation. Amount could not be adjusted in the absence of final bills.

However institute has taken up the matter with Uttar Pradesh State Electricity Board, but bills have not been submitted.

5.2 ADVANCE FOR CEMENT-Rs. 6,60,642.76 :

A sum of Rs. 6,60,642.76 is outstanding as on 31st March 1987 against the various companies and few advances are outstanding since last year. We have been informed that cement has been received for Rs. 4,87,470.28 and amount could not be adjusted in the absence of bills and balance amount was refunded by the Companies. We suggest that necessary step should be taken for adjustment of Rs. 4,87,470.28.

5.3 ADVANCE FOR STEEL-Rs. 1,58,000.00 :

A sum of Rs. 1,58,000.00 has been given to Steel Authority of India Limited on 5.3.87 for steel.

5.4 ADVANCE TO A.C. EQUIPMENT-Rs. 2,78,915.00 :

A sum of Rs. 2,78,915.00 has been given to M/s Suvidha Engineers (P) Ltd. on 28.03.1987.

5.5. ADVANCE FOR LYSIMETER — Rs. 1,35,000.00

A sum of Rs. 1,35,000.00 has been given to UOR, Roorkee for installation of lysimeter on 03.02.1987.

5.6 OTHER ADVANCES - Rs. 88,373.70

A sum of Rs. 88,373.00 is outstanding against various parties for supply of equipments/ services and most of the advances have been adjusted in 1987-88.

5.7 STAFF ADVANCES-Rs. 47,687.00 :

A sum of Rs. 47,687.00 is outstanding with various employees of the Institute.

6. The Institute is maintaining two cash books i. e. (a) Plan, (b) Non-plan, while single saving bank account has been maintained with State Bank of India and balance have been segregated into plan and non-plan.

7. SEMINARS :

The Institute has co-sponsored various seminars and contributed own share but audited accounts or vouchers have not been produced before us for our verification e. g.

A M O U N T		P A R T I C U L A R S
Rs.	P.	
50,000.00		Drought Management Strategies, Mysore.
10,000.00		Flood Estimation in Himalyan Region, Roorkee.

8. UNCONFIRMED BALANCES :

The parties balances are subject to confirmation.

9. RECEIPT FROM COMPUTER HIRE CHARGES :

The hire charges on account of Computer has been accounted for on cash basis.

10. NON-PROVISION OF SALARY — Rs. 1,79,104.00 :

A sum of Rs. 1,79,104.00 on account of revision of salary has not been provided in the books.

11. ACCOUNTS

We have suggested in our last two audit reports that accounts should be maintained on Double Entry System. During the year under audit, Double Entry System has been started to some extent and Journal and various sub-ledgers have not been introduced. Accounting system followed by the institute needs to be reviewed and improved.

As per past practice, the Balance Sheet and Income and Expenditure accounts has been prepared on accrual basis of accounting whereas the utilisation Certificate has been prepared on the basis of actual receipts and payment. In view of this the unspent balance of Grant-in aid from Govt. of India as shown in the Balance Sheet differs with the figures shown in utilisation Certificate.

Before we conclude our report, we would like to place on record the cooperation extended to us by the office bearers during the course of our audit.

Yours faithfully,
for SATENDRA & CO.,

PLACE : ROORKEE
DATED : JUNE 24, 1987

CHARTERED ACCOUNTANTS

AS AT 31.3.1986	LIABILITIES	AMOUNT (Rs.)	AS AT 31.3.1986	ASSETS	AMOUNT (Rs.)
	Grant-in-aid from Govt. of India, Ministry of Water Resources, New Delhi	927256.55	5343077.42	Fixed Assets (At Cost)	7845646.51
434822.4	Opening Balance		3183991.64	As per Schedule 'A'	
81437.18	Add, Opening balance of HILTECH	9025.31		Building Works-in-Progress	6769404.28
516259.92			1308988.40	As per Schedule 'B'	
	Add. Grant-in-aid received from Govt. of India Ministry of Water Resources New Delhi.	12000000.00		Current Assets, Loan & Advances	1958375.66
68000000.00		12936281.56	11470.50	Loans & Advances	
7316259.92	Less :			As per Schedule 'D'	
	a) Cost of acquisition of fixed and other assets transferred to assets fund a/c :	6795752.61	75330.00	Prepaid Expenses	222248.89
2740679.20				As per Schedule 'C'	
	b) Transferred to Income & Expenditure A/c to meet the excess of the expenditure over Income for the year	5173465.84	3264.15	Deposits	74330.00
3639299.16				As per Schedule 'C'	
936281.56		967063.11	5700.00	Cash and Bank Balances	3563.45
	Assets Fund Account			Cash in hand	6450.00
7180427.71	Opening Balance	9802649.21	485602.41	Imprest with the Divisional Heads	335854.66
	Add. Opening Balance of HILTECH	118457.70	614520.00	Bank Balances	
2622221.50				Bank Margin Money	794000.00
118457.70	Add. Transferred from GIA	6795752.61	11031944.52	(Against Irrevocable Letter of Credit)	
9921106.91		16716859.52		TOTAL	18009873.55
	Current Liabilities				
	Deposits (As per Schedule 'F')	12888.78			
	Liabilities for expenses (As per Schedule 'E')	313062.14			
174556.05		325950.92			
11031944.52	TOTAL	18009873.55			

As per our report of even date annexed

For Satyendra & Co.,
Chartered Accountants
(S.K. GUPTA)

(SATISH CHANDRA)
DIRECTOR

PLACE : ROORKEE (R.C. CHOPRA)
DATED : 24.6.87 FINANCE OFFICER

Phone : 2829

NATIONAL INSTITUTE OF HYROLOGY, ROORKEE
INCOME & EXPENDITURE ACCOUNT FOR THE YEAR
ENDING 31ST MARCH 1987

SATYENDRA & CO.
Chartered Accountants
314, Ram Nagar, ROORKEE

PREVIOUS YEAR (Rs.)	EXPENDITURE	CURRENT YEAR (Rs.)	PREVIOUS YEAR (Rs.)	INCOME	CURRENT YEAR (Rs.)
20,09,033.43	Salaries, Wages and Allowances	29,96,027.02	45,006.62	Hire charges of Computer	44,773.18
1,05,574.50	Travelling & Conveyance	3,53,198.90	88,959.85	Interest on Savings/Deposits	65,415.61
42,283.00	News Paper & Periodicals	70,344.20	4,559.15	Miscellaneous Receipts	23,698.00
66,706.90	Electricity and Water Charges	1,09,693.45	—	Interest on Advances	369.40
1,68,530.19	Printing and Stationery	2,82,574.70	—	Charges for providing Medical facilities to staff	831.25
39,456.25	Postage, Telephone & Telex	81,455.65	36,39,299.16	Transferred from Grant-in-aid to meet the Expenditure for the year	51,73,465.84
85,248.30	Advertisements	1,33,625.00			
2,39,696.91	Printing of Technical Books	3,27,910.52			
4,302.00	Grant-in-aid/subsidies	2,050.00			
15,440.08	Hospitality Expenses	25,624.30			
57,193.64	Miscellaneous Expenses	84,240.73			
7,587.00	T.A. to Candidates	30,466.80			
7,078.00	Seminar and Conferences	1,55,090.08			
73,099.29	Repair & Maintenance of Vehicles	1,13,278.83			
4,60,210.07	Repair & Maintenance (others)	4,95,558.89			
42,585.00	Interest on C.P.F.	47,414.21			
2,675.00	Local cost of UNDP Project	—			
86,650.75	Staff Welfare	—			
10,520.00	Consultancy	—			
2,53,954.47	Expenditure on HILTECH	—			
<u>37,77,824.78</u>	TOTAL	<u>53,08,553.28</u>	<u>37,77,824.78</u>	TOTAL	<u>53,08,553.28</u>

PLACE : ROORKEE
DATE : 24.6.87

[R.C. CHOPRA]
FINANCE OFFICER

(SATISH CHANDRA)
DIRECTOR

As per our report of even date annexed
Far Satyendra & Co.,
Chartered Accountants
(S.K. GUPTA)

Phone : 2829

SATYENDRA & CO.
Chartered Accountants
314, Ram Nagar, ROORKEE

NATIONAL INSTITUTE OF HYROLOGY, ROORKEE
RECEIPT AND PAYMENT ACCOUNT FOR THE YEAR
ENDING 31ST MARCH 1987

PREVIOUS YEAR (Rs.)	RECEIPTS	CURRENT YEAR (Rs.)	PREVIOUS YEAR (Rs.)	PAYMENTS	CURRENT YEAR (Rs.)
26,983.64	Cash & Bank Balance	3,264.15	19,68,010.35	Salaries Wages & Allowances	28,90,440.92
6,07,532.30	Cash-in-hand	4,85,602.41	1,05,574.50	Travelling & Conveyance	3,17,411.00
3,700.00	Bank Balance	5,700.00	42,283.00	Journals & Periodicals	72,915.40
—	Imprest with Divisional Heads	6,14,520.00	59,422.15	Electricity & Water Expenses	1,14,326.70
—	Bank Margin Money		1,68,530.19	Printing & Stationery	2,72,302.06
—	(Against Irrevocable Letter of Credit)		32,905.15	Postage, Telephone & Telex	84,940.15
68,00,000.00	Grant-In-Aid Received		85,248.30	Advertisements	1,11,215.00
43,506.62	From Govt. of India, Ministry of Water Resources, New Delhi	1,20,00,000.00	2,39,696.91	Printing of Technical Books	3,09,556.52
1,500.00	Computer Hire Charges	44,514.66	4,302.00	Grants-in-aid & Subsidy	2,050.00
88,959.85	Deposit for Computer Services	5,000.00	12,610.08	Hospitality	18,223.25
4,559.15	Interest from Bank	65,415.61	56,808.64	Miscellaneous Expenditure	64,537.37
20,459.00	Miscellaneous Receipts	23,698.00	7,587.00	T.A. to candidates	1,646.00
—	Interest on Advances	369.40	7,078.00	Seminar & Conferences	81,786.23
—	Recoveries from Employees :		4,60,210.07	Repair & Maintenance (other than Vehicle)	6,02,140.64
—	1. C.P.F.	2,34,318.85	71,422.34	Repair & Maintenance of Vehicle	1,01,821.07
—	2. Others	2,00,973.76	42,585.00	Interest on C.P.F.	47,414.21
—	3. On account of providing Medical facilities	831.25	57,029.97	Furniture & Fixtures	3,91,431.61
—			1,56,555.29	Office Equipment	1,98,942.23
—			79,723.87	Library Books	1,00,686.79
—			1,94,396.45	Machinery & Equipment	13,98,197.05
—			87,751.20	Purchase of Vehicle	98,313.86
—			71,871.57	Building	1,64,872.14
—			5,37,171.40	Advance to other firms	13,84,962.58
—			12,30,102.00	Advance to U.O R., Roorkee	34,23,420.00
—			86,845.00	Advance to Employees	2,35,384.05

Contd. 2

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PREVIOUS YEAR (Rs.)	RECEIPT	CURRENT YEAR (Rs.)	PREVIOUS YEAR (Rs.)	PAYMENTS	CURRENT YEAR (Rs.)
58,493.75	Recoveries of Advances :		53.00	Other Remittances (Recovered & Paid)	4,32,952.17
	Employees	40,516.00	86,650.75	Staff Welfare	—
	Departmental	50,449.74	10,520.00	Consultancy	—
	Firms	2,51,055.28	2,675.00	Local cost of UNDP	—
	U.O.R., Roorkee	22,439.00	2,05,928.00	Diesel Engine	—
	Contractor for Cement	5,445.00	11,470.50	Prepaid Expenses	—
	Security Deposits :		3,63,590.07	HILTECH (HYDCOM Unit)	—
	Received back	1,000.00		Cash Bank Balances	
	Deducted from contractors	6,608.00	3,264.15	Cash in hand	3,563.45
			5,700.00	Imprest with Divisional Head	6,450.00
			4,85,602.41	Bank Balances	3,35,354.66
			6,14,520.00	Bank Margin Money	
				(Against Irrevocable Letter of Credit)	7,94,000.00
<u>76,55,694.31</u>	TOTAL	<u>1,40,61,721.11</u>	<u>76,55,694.31</u>	TOTAL	<u>1,40,61,721.11</u>

PLACE : ROORKEE
DATE : 24.6.87

[R.C. CHOPRA]
FINANCE OFFICER

(SATISH CHANDRA)
DIRECTOR

As per our report of even date annexed
For Satyendra & Co.,
Chartered Accountants
(S.K. GUPTA)

SCHEDULE 'A'

NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE
SCHEDULE OF FIXED ASSETS AS ON 31ST MARCH, 1987

Sl. No.	Particulars	Cost as on 1.4.86	Additions during the year	Total balance as on 31.3.87	Total balance as on 31.3.86
1.	Buildings	27,27,743.01	2,44,704.04	29,72,447.05	27,27,743.01
2.	Furniture & Fixtures	3,46,085.97	3,91,431.61	7,37,517.58	3,46,085.97
3.	Office Equipments	5,35,473.93	2,04,984.13	7,40,458.06	5,35,473.93
4.	Computer Machinery	2,58,345.40	—	2,58,345.40	2,58,345.40
5.	Vehicles	2,16,043.20	1,01,264.86	3,17,308.06	2,16,043.20
6.	Library Books	5,12,148.76	1,11,221.64	6,23,370.40	5,12,148.76
7.	Machines & Equipment	5,41,309.15	14,48,962.91	19,90,272.06	5,41,309.15
8.	Generater Set	2,05,928.00	—	2,05,928.00	2,05,928.00
	Total	53,43,077.42	25,02,569.19	78,45,646.61	53,43,077.42
	Previous Year	39,87,750.37	13,55,327.05	53,43,077.42	39,87,750.37

(31.3.86)

SCHEDULE 'B'

NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE
BUILDING WORKS IN PROGRESS AS ON 31.3.87

Sl. No.	Particulars	Amount as on 1.4.86	Payments during the year 1986-87	Recovered back/adjusted during 1986-87	Amount as on 31.3.87	Amount as on 31.3.86
1.	Advances for various construction works granted to U.O.R., Roorkee	27,47,200.85	34,23,420.00	65,845.51	61,04,775.34	27,47,200.85
2.	Steel & Cement with U.O.R., Roorkee	2,06,075.38	2,50,057.64	22,219.49	4,33,913.53	2,06,075.38
3.	Material at site with U.O.R., Roorkee	2,30,715.41	—	—	2,30,715.41	2,30,715.41
	Total	31,83,991.64	36,73,477.64	88,065.00	67,69,404.28	31,83,991.64

SCHEDULE 'C'

NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE
SCHEDULE OF DEPOSITS AS ON 31.3.1987

Sl. No.	Particulars	Amount as on 31.3.1987
1.	Fixed deposit with S.B.I. for Excise Security	55,500.00
2.	Deposit for Gas Cylinder	350.00
3.	Deposit with UPSEB for Sub-station	8,480.00
4.	Security Deposit of Telex	10,000.00
Total		74,330.00
Previous Year (31.3.36)		75,330.00

NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE
SCHEDULE OF ADVANCES AS ON 31.3.1987

Sl. No.	Particulars	Amount
1.	Advances to UPSEB	
	(a) For Sub-station	4,95,454.00
	(b) Temporary Connection	11,388.00
	(c) L.T. site preparation	82,915.00
		5,89,757.00
2.	Advance for Cement	
	(a) A.C.C. Ltd., Kanpur	28,350.00
	(b) Birla Jute and Industries Ltd., Satna	1,92,243.48
	(c) C.C.I., Rajban	92,366.90
	(d) — do —	1,74,509.90
	(e) — do —	1,73,172.48
		6,60,642.76
3.	Steel Authority of India Ltd., Ghaziabad	1,58,000.00
4.	M/s. Suvidha Engineers (P) Ltd., New Delhi	2,78,915.00
5.	University of Roorkee, Roorkee for Lysimeter	1,35,000.00
6.	Other Advances	
	(a) I.S.I., New Delhi	1,190.00
	(b) I.M.D., Pune	4,500.00
	(c) International Machines Tool Co., Bombay	3,613.00
	(d) Director, RRSA, Hyderabad	1,575.00
	(e) Methodex Systems Pvt. Ltd., New Delhi	456.00
	(f) VINCO Services New Delhi	14,355.00
	(g) M/s Bansidher Chiranji Lal (Electricals), N. Delhi	4,698.00
	(h) U.P. Govt. Workshop, Roorkee	1,661.58
	(i) Benz Instruments, New Delhi	2,701.32
	(j) Perfect Computers Forms Pvt. Ltd., New Delhi	3,255.50
	(k) International Scientific Corpn., New Delhi	2,387.00
	(l) U.P. Engines & Machines, Muzaffarnagar	1,428.00
	(m) Hydraulic & Equipments, New Delhi	372.00
	(n) Sh V.C. Gupta, Asstt, Director C.W.C., New Delhi	5,000.00
	(o) Remote Sensing Instruments, Hyderabad	28,171.30
	(p) Thomas Cook (India) Ltd., New Delhi	547.20
	(q) DEC, USA (\$963)	12,463.00
		88,373.90

7. Advances to Staff

(a) Cycle Advance	3,414.00	
(b) Scooter advance	12,963.00	
(c) Fan advance	80.00	
(d) Festival advance	12,260.00	
(e) L.T.C. Advance	360.00	
(f) T.A. advance	15,770.00	
(g) Departmental advance	740.00	
(h) Advance of pay	2,100.00	47,687.00

Total		19,58,375.66
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Previous year (31.3.86)		13,08,988.40
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SCHEDULE 'E'

NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE
SCHEDULE OF OUTSTANDING EXPENSES AS ON 31.3.87

Sl. No.	Particulars	Amount as on 31.3.87
1.	Electricity Charges	7,988.00
2.	Telephone	3,120.00
3.	Salaries (Non-Plan)	1,04,462.80
	(Plan)	29,845.30
4.	Wages	1,240.00
5.	Audit Fees	2,500.00
6.	Telegram Charges	1,706.00
7.	Maintenance of Car	1,311.00
8.	O.T.A. (Non-Plan)	1,254.60
	(Plan)	279.00
9.	Arrears of D.A. (Non-Plan)	12,941.00
	(Plan)	1,106.00
10.	Employee recoveries Pay Advance	2,994.44
11.	Stationery & Printing (Non-Plan)	1,550.00
12.	Publication (Non-Plan)	18,354.00
13.	Advertisement (Plan)	22,410.00
	Total	3,13,062.14
	Previous Year (31.3.86)	1,74,556.05

SCHEDULE 'F'

NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE
 SCHEDULE OF SECURITY DEPOSITS MADE WITH NIH AS ON
 31.3.87

Sl. No.	Particulars	Amount
1.	Deposit for Computer Services (Shri P.S. Mohrir)	4,741.48
2.	Security Deposit recovered from bills of contractors :	
	(a) Sh. Vikram Singh	1,539.30
	(b) Sh. Akhtar Husain	1,777.30
	(c) M/s. National Mechanical Works, New Delhi	4,830.70
	Total	12,888.78
	Previous Year (31.3.86)	Nil

NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE
SCHEDULE OF PREPAID EXPENSES AS ON 31.3.87

Sl. No.	Particulars	Amount
1.	C.M.C. Ltd , for maintenance of Computer	1,97,419.35
2.	Rent, Rates & Taxes	2,182.84
3.	Telephone, Telex etc.	7,045.00
4.	Journals & Periodicals	15,601.70
	Total	2,22,248.89
	Previous Year (31.3.86)	11,470.00