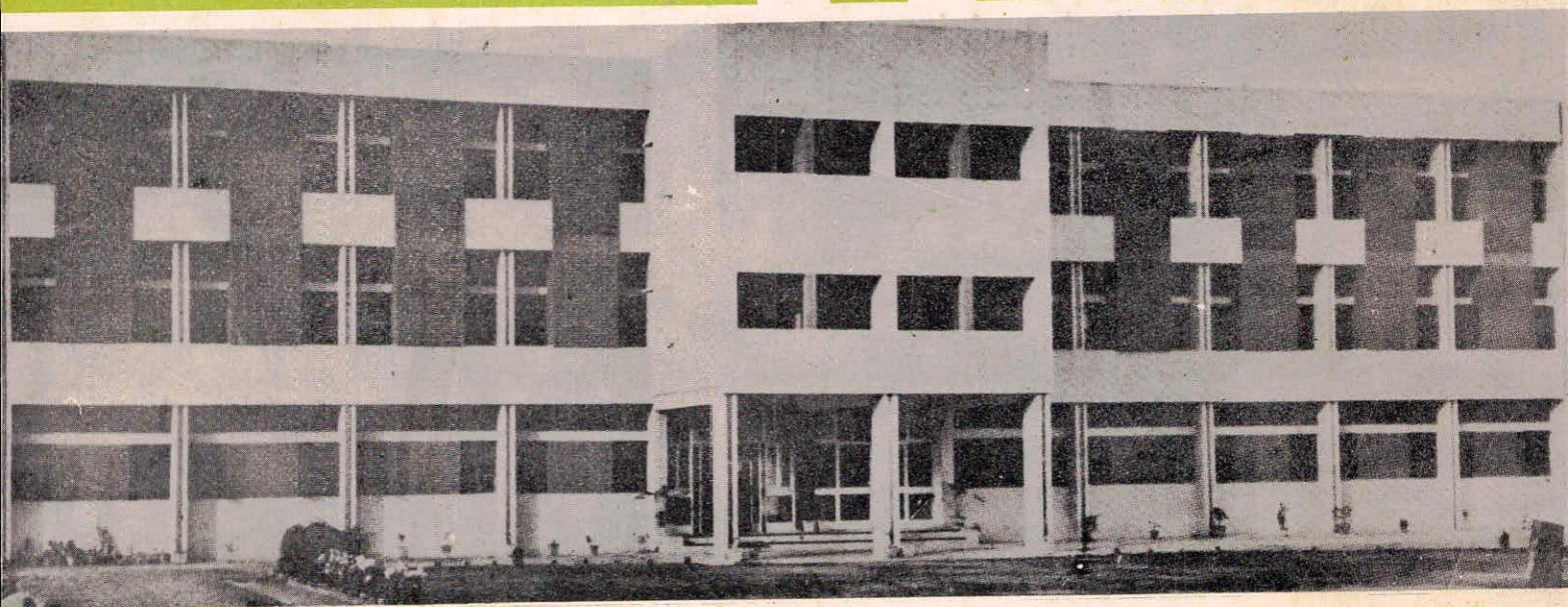
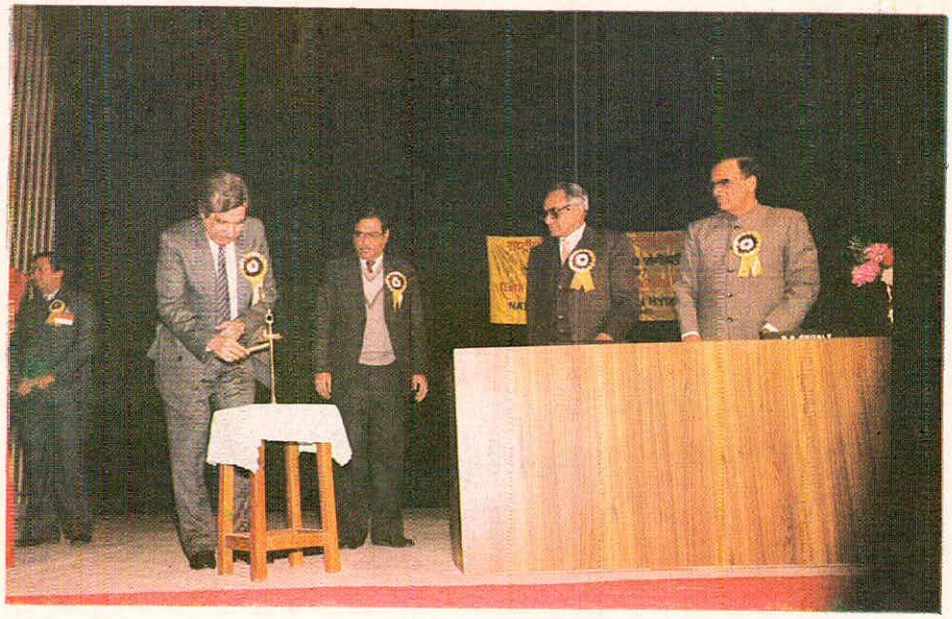
national
institute of hydrology

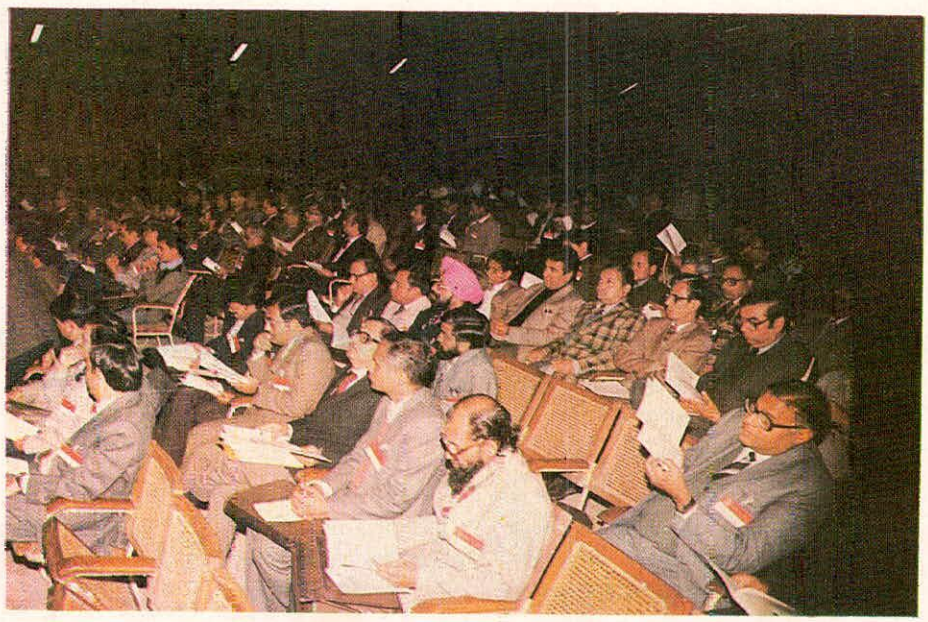
annual report

1987-88





Hon'ble Dr. Alagh, Member (Agriculture), Planning Commission inaugurating First National Symposium on Hydrology organised by Institute (December 16-18, 1987)



View of Inaugural Function of First National Symposium on Hydrology, December 1987

ANNUAL REPORT

1987-88

NATIONAL INSTITUTE OF HYDROLOGY
ROORKEE

PREFACE

During the year under report, studies and research have been conducted covering various aspects of hydrology, as per the approved work programme for the year, under the 14 problem oriented scientific divisions. Significant progress has been made and some of the important studies conducted include (i) Forecasting of monsoon runoff, (ii) Flood frequency analysis, (iii) Hydrological data year book for Hemavathi basin, (iv) Dam break modelling, (v) Kinematic wave routing techniques, (vi) Flood plain zoning, (vii) Glacier melt studies, (viii) Surface and ground water interaction, (ix) System approach to conjunctive use, (x) Drainage in heavy soils, (xi) Hydrological aspects of drought for 1985-86, (xii) Evaporation reduction for drought management, (xiii) User's manual for water and waste water analysis, (xiv) Flood plain mapping of river Mahanadi using remote sensing, and (xv) Data storage and retrieval system.

Based on the studies conducted, the Institute brought out 47 reports in the form of status reports, user's manuals, technical reports and hydrological year book. These reports have been widely circulated to State and Central Government organisations. The Institute has been very active in technology transfer by organising 5 days workshops on specialist topics for hydrological analysis, planning and design. Special emphasis was laid on transfer of computer software and making them operational on available computers in the states. During the year 7 workshops were organised-one in Roorkee, two in Maharashtra, one in Andhra Pradesh, one in Madhya Pradesh, one in Uttar Pradesh and one in Karnataka. The feedback received from these workshops is very encouraging and helped in creating awareness for use of modern techniques amongst field engineers.

The scientists of the Institute are encouraged to participate in seminars and symposium, present papers and participate in discussions. The scientists have participated in a number of seminars and symposium and have contributed to technical literature through publication of 45 papers in national and international journals and proceedings of seminars and symposia. The Institute organised a National Symposium on 'Hydrology' and proposes to organise a Regional Training Course on Urban Hydrology and international seminar on Hydrology of Extremes supported by UNESCO during the next year.

Subsequent upon the approval of the EFC Memo of the Institute, additional staff was recruited to initiate further studies in the Institute. During the year, extension of Jalvigyan Bhawan was completed to house the additional staff and workshops. Construction of field hostel, museum-cum-recreation centre and addition to laboratory block have been taken up. Due to non-availability of land from U.P. Government, the construction of staff colony could not be started.

The work programme of the Institute has been diversified to cover field and laboratory oriented studies besides the computer oriented work. The laboratories of remote sensing applications, water quality, ground water, hydrological investigations and the service instrumentation facilities and workshop were strengthened by adding more equipment. Some equipment have been imported to make the laboratory modern. Comtal Image Processing System for digital analysis of remotely sensed data has been ordered to improve the computer facility. Personal computers have been procured and software are being developed for transfer to the States.

The need for improvement of hydrological practices and activities in different parts of the country has been given due emphasis in the programme of activities of the Institute. Interaction and collaboration with the States forms an essential part of this programme and contacts have been established through visits and correspondence with 14 States. The Institute has emphasised with the States the establishment of hydrological units to enable a very effective interaction with the States. The response from the States is encouraging and some States have already planned their programmes of establishment of hydrological units. Realising the difference in climate, geology, land use, soil and environmental conditions leading to typical hydrological conditions in different regions, the Institute has divided the country into 7 regions and planned to establish seven regional centres. During the Seventh Plan period, 3 regional centres have to be established. The regional centres for Deccan Hard Rock region has been established in Belgaum and has been made operational during the year with skeleton staff. For the North-Eastern Mountainous Region the centre will be established at Guwahati for which the Assam State has agreed to make land available and till the buildings are constructed, an inspection house as temporary accommodation for the centre will be provided by the Assam Irrigation Department. The centre is expected to be operational early next year. The regional centre for North-Western Himalayan Region is proposed to be established during the later half of the next year. Besides conducting hydrological studies for the regions at the regional centres, atleast one representative basin with appropriate instrumentation would also be established in each region. The data collected from these basins over an extended period would be used to develop model parameters applicable to that region.

The Institute is presently involved in consultancy projects referred to the Institute from the Central and State Government Organisations. During the year 4 consultancy projects have been completed for State of Uttar Pradesh. 5 more consultancy projects are in the pipe line; 3 from the States and 2 from Central Government Organisations.

The HILTECH Secretariat which is attached to the Institute and integrated with it has continued to be active during the year. One meeting of HILTECH, 4 meetings of the Panels and 5 meetings of sub-committees were held during the year. A delegation of HILTECH participated in the General Assembly of IUGG and symposia organised by IAHS. On the recommendation of the HILTECH and Indian National Delegation to 24th General Conference of UNESCO, a major regional project for South-Central Asia was approved for being operational during 1988 and India was elected as a member of the inter-governmental council for IHP of UNESCO for a period of 4 years. Three symposia/conferences and one research project were sponsored and funded by HILTECH. One issue of the 'Jalvigyan Sameeksha' was also brought out. The National Hydro-

logy Project-Surface Water was posed to the World Bank by HILTECH and 2 additional National Hydrology Projects for Ground Water and Water Quality have also been prepared for posing to the World Bank.

The ARCCOH Secretariat as a part of the HILTECH Secretariat functioned well during the year and second volume of the directory of hydrologists of ARCCOH Region was compiled and sent for publication. The quarterly ARCCOH Newsletters have been brought out and circulated to the various member countries of the region.

The Institute has, therefore, continued to proceed in the right direction towards the fulfilment of the objectives for which the Institute has been established. The studies and research and other programmes of the Institute have made significant progress and impact.

SATISH CHANDRA
DIRECTOR

CONTENTS

1.0 INTRODUCTION

1.1 General

The National Institute of Hydrology has been in existence since December 1978, having been set up at Roorkee 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), Govt. of India. The Union Minister for Water Resources is the President of the Society; Minister of State for Water Resources is the Vice President of the Society; Secretary to Government of India, Ministry of Water Resources is the Chairman of the Governing Body (GB); and Chairman, Central Water Commission and Ex-Officio Secretary to Government of India is the Chairman of the Technical Advisory Committee.

The Institute is located within the campus of the University of Roorkee on 6.5 acres of land provided by the University of Roorkee on long term lease to the Institute. The main building of the Institute has been in use since December 1982. A laboratory block was constructed in 1985 to house the laboratories. The laboratories of water quality, remote sensing applications, Instrumentation and ground water are operational in this building. The construction of field hostel, extension of laboratory block, and extension of other infrastructural facilities are also planned.

The Institute has taken up the task of solving the hydrological problems of different regions of the country through regional centres. One regional centre at Belgaum was established during the year and is operational to handle the hydrological problems of Deccan hard rock region. It is proposed to establish a regional centre at Guwahati for the North Eastern Region during the first half of 1988-89 and the third regional centre for Western Himalayan region will be established during the later part of the year 1988-89.

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

In the earlier stages of the establishment of the Institute, emphasis was laid on creation of necessary infrastructural facilities like buildings, recruitment of staff, training of manpower and provision of computer facilities. Initially, the Institute concentrated on the studies pertaining to computer oriented studies and research in eight priority areas as defined by Technical Advisory Committee (TAC) and Governing Body (GB) and in training of manpower. During this period, the Institute had procured/developed, implemented and tested a number of computer programmes covering the areas of frequency analysis, rainfall modelling, flood estimation, reservoir operation and ground water 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.

With effect from the year 1984-85, the Institute has embarked on a much larger programme covering field and laboratory oriented studies in addition to computer oriented studies and research, so that it can serve the role of an apex research Institute and body in the field of hydrology in the country. The Institute has taken up studies in the wider areas of hydrology to develop methodologies and systematic procedures and to standardise methods of analysis, planning and design.

Keeping in view the future requirements of the country in the field of hydrology, the work programme for the Seventh Plan period (1985-90) was prepared and approved by TAC and Governing Body. Based on the approved work programme, the infrastructural facilities and manpower requirements were worked out and the EFC Memo of the Institute for the Seventh Plan period was finalized. During the period of preparation of the EFC Memo the Institute conceived the establishment of a Drought Studies Division in view of the acute drought problem faced by the country and Atmospheric Land Surface Process Division to develop modelling methodologies of the integrated system for operation of water resources projects. During the year 1986-87, the EFC Memo with a financial outlay of 4.5 crores was approved under plan. In view of the financial constraints, the building component was suitably modified while maintaining appropriate emphasis on the procurement of equipment and recruitment of manpower so that the studies and research activity of the approved work programme can be carried out reasonably well at the required level.

In view of the various problems which require immediate attention and with the available staff, the work programme is divided into 14 problem oriented divisions and the work has been initiated in most of the divisions with the available staff. These divisions include the frontier areas like remote sensing applications, man's influence on water resources, drought and flood. The 14 divisions are :

(i) Hydrologic Design

(ii) Surface Water Analysis and Modelling

(iii) Flood Studies

(iv) Mountain Hydrology

(v) Ground Water 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 Application of Climate Information

Realising the importance of laboratory oriented studies, the following laboratories were established which are being strengthened as per the requirement of research needs :

(i) Water Quality Laboratory
(ii) Remote Sensing Laboratory
(iii) Ground Water Laboratory
(iv) Hydrological Investigation Laboratory and Instrumentation Service facility and Workshop

The Institute has procured sophisticated and appropriate equipments to strengthen the facilities in these laboratories and computer centre. A number of studies relating to laboratory and computer oriented research have been carried out using these facilities.

The Institute brings out comprehensive reports under various categories based on the studies and research carried out in the Institute, which are circulated to various State and Central Government organisations. Besides the circulation of the technical and scientific work in the form of reports, the Institute organizes workshops both at Roorkee and in the States, for transfer of technology to the personnel of States and Central Government Organisations engaged in water resources development. Through these workshops the Institute transfers the methods of analysis, planning and design and the connected software is made operational on the computers of the organisations concerned.

The hydrological problems of different regions of the country are unique due to differences in climate, geography, geology, land use and cover characteristics, soil drainability, environmental condition and the economic growth of the region to be able to study the complete hydrological problems of different regions, the country has been divided into seven hydrological regions. It is that each of these regions have a regional centre. To start with, these regional centres proposed will have the following main activities :

(a) Review the 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;

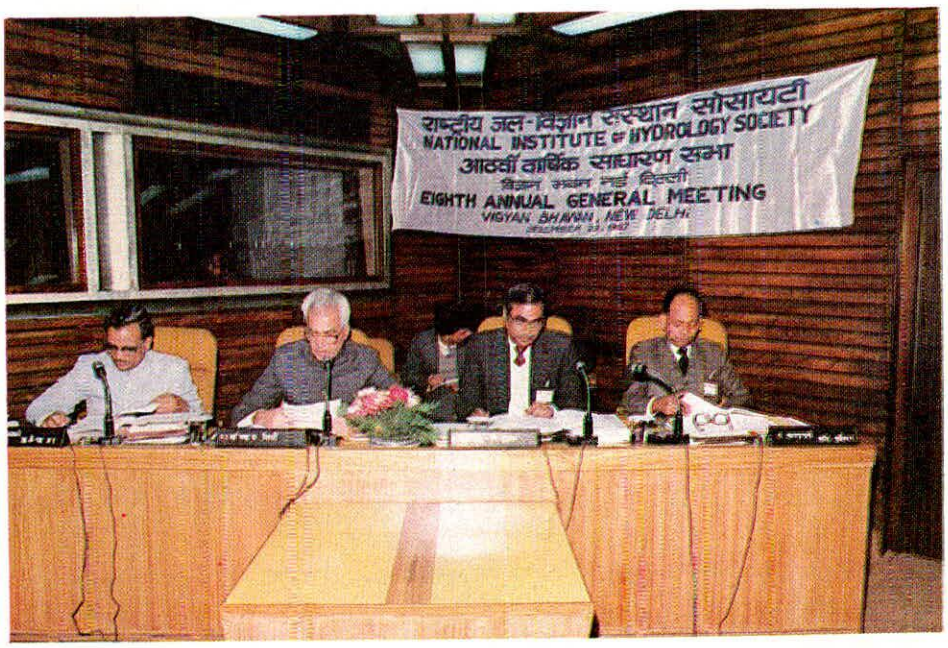
(f) Conduct representative basin studies.

During the Seventh Plan period three of these regional centres would become operational.

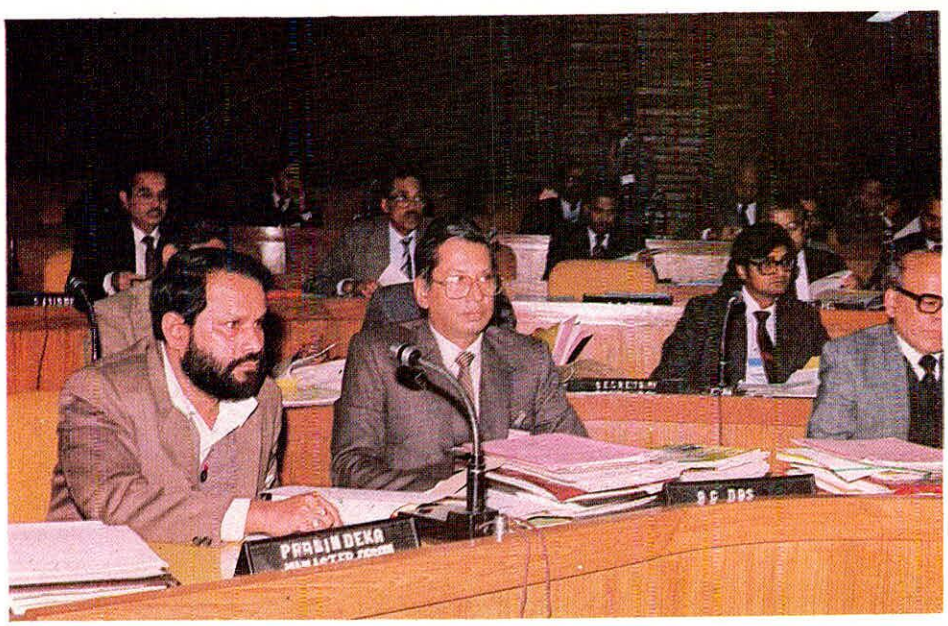
During the year, based on the studies conducted at the Institute, 47 Scientific reports were prepared under various categories – Review Notes, Technical Reports, User's Manuals, Status Reports, and a hydrological year book, and were circulated widely to the States and Central Government Organisations. 45 technical and research papers were contributed to various scientific journals, seminar/symposia by the scientists of the Institute. Seven workshops were also organized under transfer of technology programme which were attended by officers belonging to various States, Central, and Academic organisations.

The scope of the research work undertaken by the Institute is increasing manifold and in order to carry out the programme of work envisaged during the Seventh Plan under EFC Memo, the strength of scientists and other supporting staff has been enhanced during the year under report and infrastructural facilities have been improved by way of increased office space, laboratory space, construction of trainees' hostel and other related buildings. At the time of the establishment of the Institute, the University of Roorkee has provided some residential accommodation funded by the Government of Uttar Pradesh. However, realising the need for additional accommodation during the Seventh Plan, residential accommodation in the form of staff colony in stages will be established.

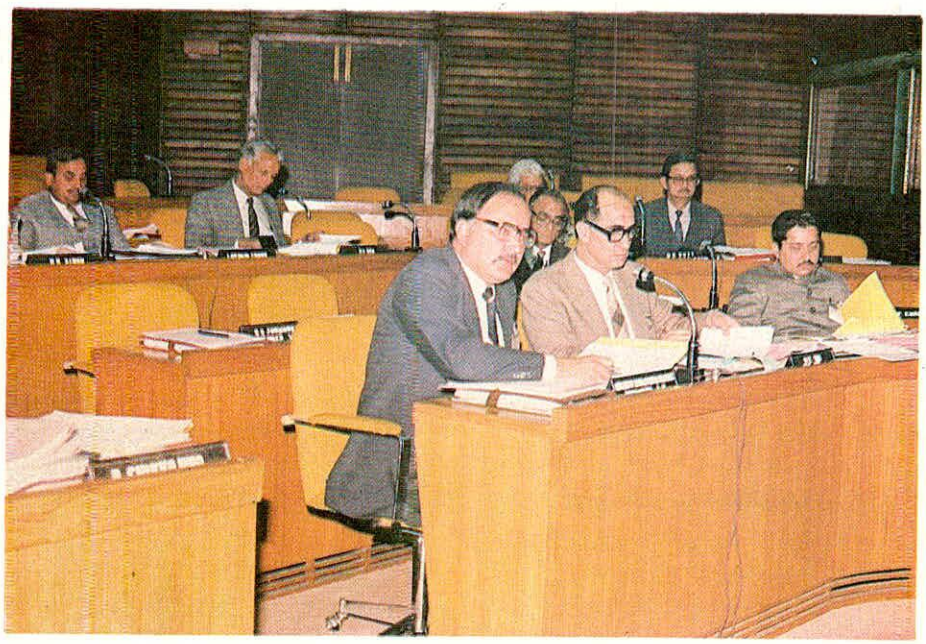
The Institute is, therefore, growing and proceeding in the right direction towards the fulfilment of its objectives laid down at the time of the establishment. The studies and research activities are gaining momentum and expertise is being created at the Institute which will significantly contribute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



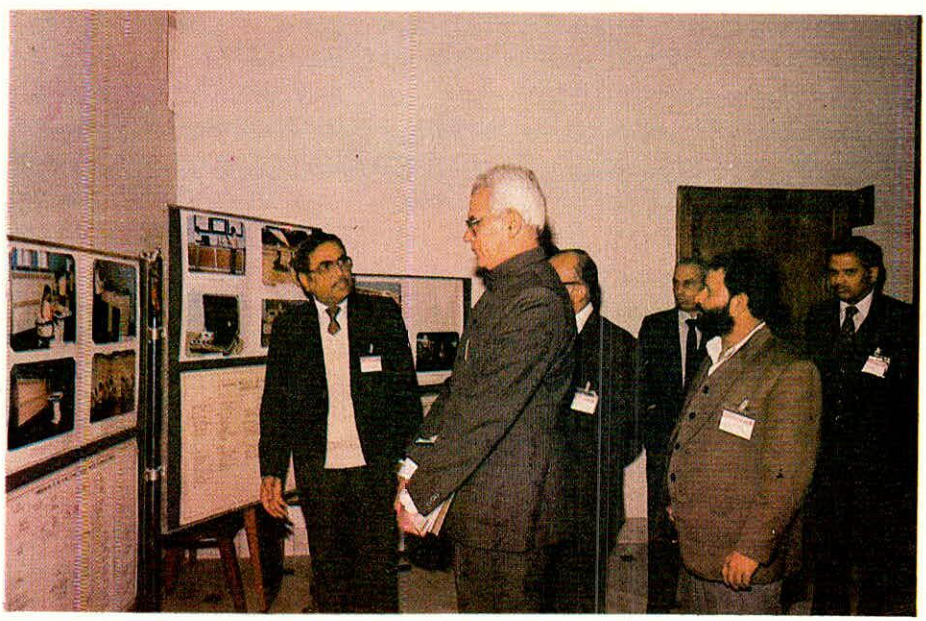
Hon'ble Union Minister Shri R.N. Mirdha and President of Society addressing the Society Members



Hon'ble Minister in-charge (Irrigation), Govt. of Assam and other Members at Society Meeting



Hon ble Ministers in-Charge (Irrigation), Govt. of M.P. & J&K and other Members at Society Meeting



Hon'ble Union Minister, President of Society and Senior Officers visiting Exhibition

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 objective and gives such policy directions, as it may deem fit, to the Governing Body and the Institute. The membership of the Society is given in Appendix-I.

At the Eighth Annual General Meeting held on December 23, 1987 at Delhi, the Society reviewed the work carried out at the Institute during the year 1986-87 and first nine months of 1987-88, approved the Annual Report and audited accounts for the year 1986-87 and approved the budget for the year 1988-89. A special meeting of the Society was also held on Dec. 23, 1987 to consider amendments to Rule Nos. 32, 37 and 69 regarding the membership and frequency of Governing Body Meetings and appointment of auditors.

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 twice in a financial year. The membership of the Governing Body is given in Appendix-II.

As per the requirements, two meetings of the Governing Body were held on August 24, 1987 and March 18, 1987. Several decisions were taken 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 of the Institute. Annual report and audited accounts for 1986-87 were approved before consideration by Society. Other decisions taken included establishment of regional centres, adoption of revised pay scales and programme for celebration of 40th Anniversary of India's Independence. This included institution of "Hydrology Awards" and bringing out a publication on "Achievements in Hydrology Since Independence". The performance and progress of the Institute during 1987-88 were reviewed at these meetings and suggestions made for furthering the activities of the Institute. Revised budget for 1987-88 and budget proposals for 1988-89 were also considered and approved.

2.3 Technical Advisory Committee

The Technical Advisory Committee (TAC) is responsible for the technical scrutiny of the studies and 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 atleast once in six months. The membership of the Committee is given in Appendix-III.

At these meetings the reconstitution of Technical Advisory Committee was considered as it was felt necessary that in view of the establishment of the working Groups, there is a need to have interaction between the Working Groups and the TAC. For this purpose it was proposed that members of the Working Groups be included in the TAC. The Committee considered the long term S & T programme prepared by NIH and made suggestions for improving the same to include all aspects of hydrological activities which are needed in accordance with the National Water Policy. The technical contents relating to the organisation of National Symposium on Hydrology by NIH during December 1987 were approved as also additional members to be included in the Working Groups.

2.4 Working Groups

The Institute has 14 Working Groups relating to 14 divisions of the Institute for reviewing the annual studies and research programme of the Institute and evaluate the technical reports before printing.

During the year the Working Groups reviewed the reports of the studies carried out by the Institute before these were sent for publication. The Working Group also considered the proposed technical work programme of the Institute for the year 1988-89 before consideration by the Technical Advisory Committee. Two meetings each of 14 Working Gronps were held during the year as given in Appendix-IV.

Appendix-IV also presents the status of the meetings of the Governing Body and Technical Advisory Committee held during the year.

2.5 Coordination Committee

The Coordination Committee of the Institute is for coordination with the University of Roorkee. The Commitee is required to ensure effective coordination between University of Roorkee and the National Institute of Hydrology, to recommend assistance to be obtained from the University, to decide the norms of payment of charges to the University on no profit no loss basis for assistance rendered to the Institute and to decide the working arrangement for utilising for mutual benefit of the facilities available in the two organisations. The Coordination Committee is required to meet atleast twice in a financial year.

As per the requirements, two meetings of the Committee were held on July 13, 1987 and Feb. 19, 1988. The Committee, at these meetings, reviewed the progress of construction work being carried out by University for Institute Buildings, telephone connections and residential accommodation for employees of the Institute.

2.6 High Level Technical Committee on Hydrology (HILTECH)

The High Level Technical Committee on Hydrology (HILTECH) was constituted by the

Government in 1982. National Institute of Hydrology provides the Secretariat to this Committee. The functions of HILTECH are to collect state of hydrological research in the country and to disseminate it; to identify the areas of hydrology which need immediate attention; to encourage National Institutions to take up the research in Hydrology which need to be taken up on priority; to promote education and training programmes; to foster collaboration with other countries; and, coordinate effective participation by India in International Hydrological Programme (IHP) of UNESCO and Operational Hydrology Programme of WMO; to disseminate information and improve standards to advise Central and State Government agencies, etc. The membership of this Committee is drawn from various organisations in the country having interest in monitoring, evaluation, analysis and utilization of water resources. The constitution of HILTECH is presented in Appendix-V.

The Ninth meeting of HILTECH was held on 9th July 1987 at Delhi. A number of important decisions regarding National Hydrology Projects on Surface Water, Ground Water, and Water Quality; Major Regional Project for South Central Asia supported by UNESCO; Rules and Procedures of HILTECH working and other important matters were taken. HILTECH constituted 7 panels on various disciplines of hydrology and six sub-committees have provided useful support to HILTECH in discharge of its functions.

2.7 Institute Personnel

The Institute has fourteen scientific divisions and three units of administration, finance and miscellaneous services. The organisational structure of the institute is presented in Fig. 1. During the Sixth Plan the Institute had 121 posts for the Institute and 20 posts of HILTECH (out of which 11 posts were released and for 9 posts ban relaxation is yet to be given by the Ministry), besides this,78 posts of the Seventh Plan were sanctioned by the Governing Body thus making a total of 210 posts. Out of these posts the Institute had, besides the Director, 30 scientists, 60 scientific supporting staff and 63 administrative and other supporting staff at the beginning of the year. Thus having 47 posts vacant at the beginning of the year.

In addition to these vacant posts and keeping in view the work programme of the Institute for the year, 72 additional posts were released by the Ministry for filling up under the Seventh Plan programme. The advertisements for the vacant posts at different levels were issued and selections were made for 88 posts and appointments issued. At the end of the year 71 persons had joined the Institute and 17 persons are yet to join. Out of the remaining 97 posts, 37 are yet to be released for filling up and for 9 posts of HILTECH, ban relaxation has been sought, 37 posts have been advertised and 14 posts have been kept vacant to be filled during 1988-89.

During the year, 6 scientists, 8 supporting technical staff, Chief Administrative Officer, Assistant Engineer, and 4 Administrative and other supporting staff left the Institute and reverted back to parent organisations. At the end of the year there was a net addition of 6 scientists, 24 supporting scientific staff and 21 administrative and other supporting staff making a total of 205 persons in the Institute. The position of staff as on 1.4.1987 and 31.3.1988 is given in Appendix-VI. The status of staff in the Institute for the last three years is presented in Fig. II.

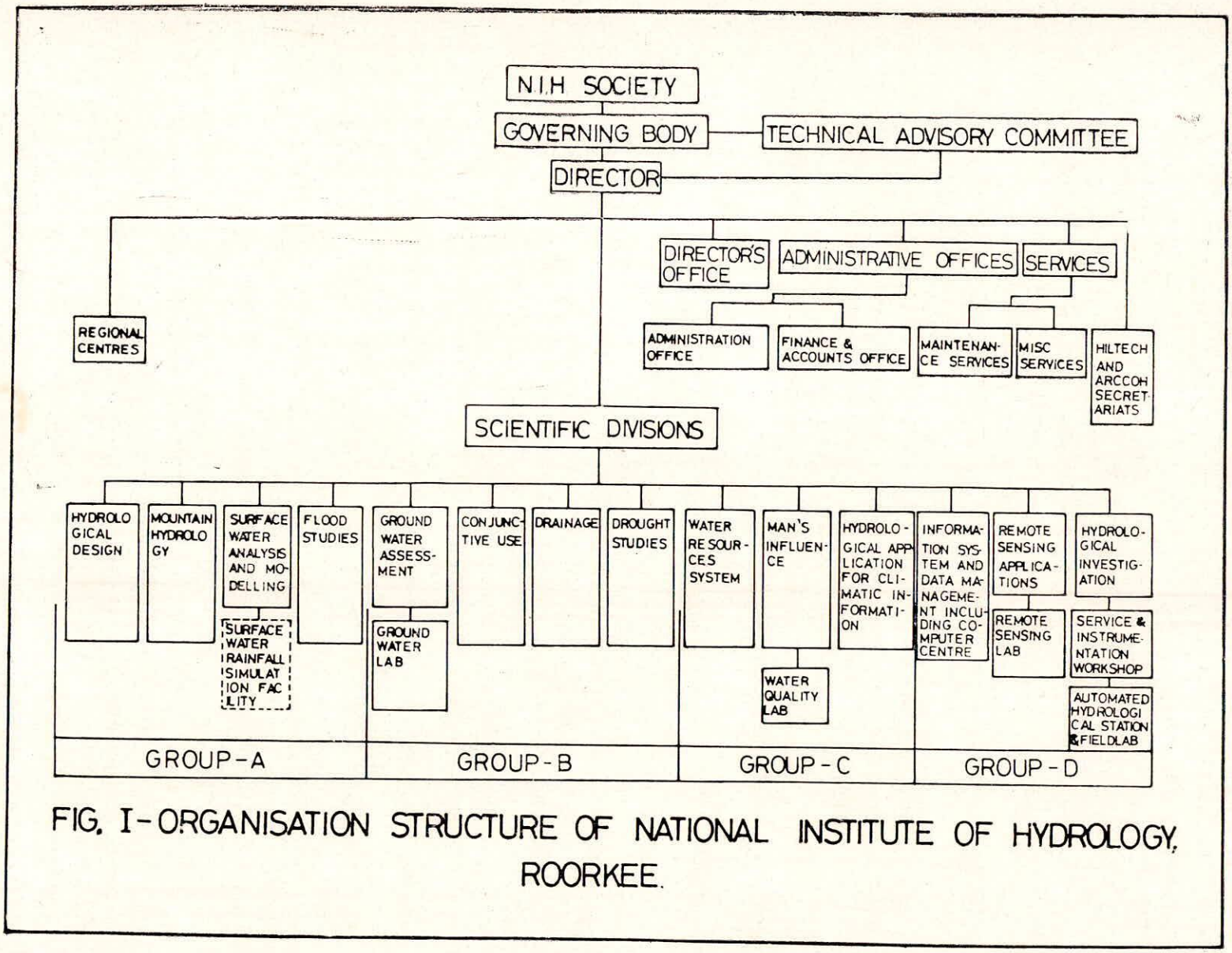


FIG. I - ORGANISATION STRUCTURE OF NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE.

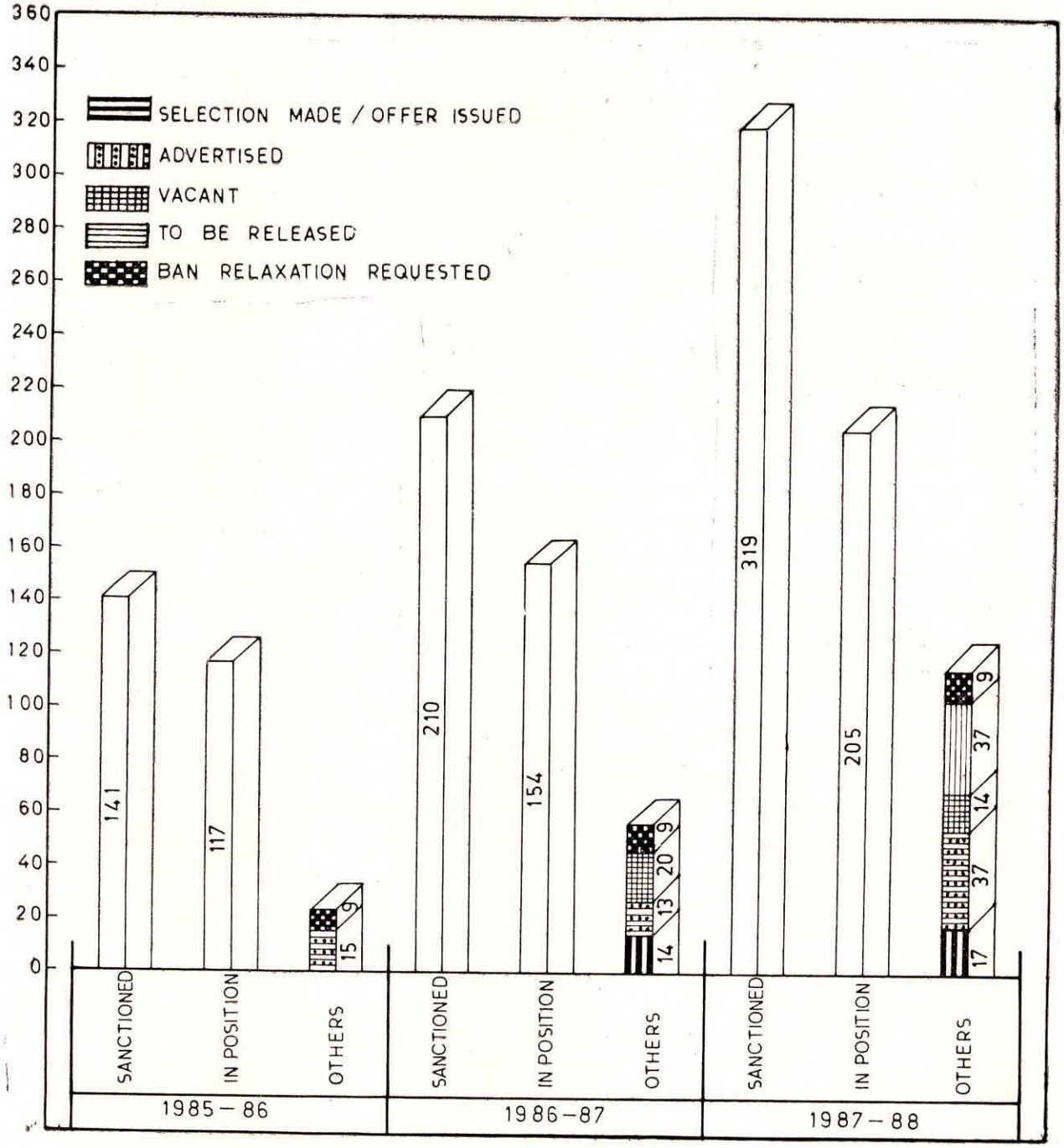


FIG. II - STATUS OF STAFF

3.0 ACTIVITIES DURING 1987-88

3.1 General

The Institute completed the first phase of establishment (1978-85) wherein emphasis was laid on creation of essential infrastructural facilities, recruitment and training of scientists and other manpower, procurement of equipment and establishment of a technical library. These activities were supported by a UNDP project, under which, besides other equipment, the VAX-11/780 computer system with its peripherals and Automated Hydrologic Station were procured. The project also provided for the training of 17 scientists of the Institute abroad in different areas of Hydrology.

During the 7th Five Year Plan (1985-90), the Institute is engaged in consolidation, expansion and diversification of its activities. During 1987-88, while continuing with the computer oriented studies and research on different components of Hydrologic cycle, their interaction as well as their quantitative assessment, the emphasis was also laid on laboratory and field oriented studies. The efforts in that direction were consolidated and intensified. A number of useful studies were conducted on the actual field data which were generated in laboratories or collected from or provided by field agencies. During the year, steps were also taken to create necessary infra-structural facilities by strengthening the existing laboratories and establishment of regional centres.

Some of the areas in which studies have been undertaken during the year cover the areas of Flood Frequency Analysis, Monthly streamflow generation, forecasting of rainfall and runoff, mathematical modelling of moving storms, statistical analysis of rainfall data, flood routing models, ground water assessment studies, analytical solutions for computing reach transmissivity, aquifer recharge studies, hydrological aspects of drought, estimation of evaporation losses, water balance studies of reservoirs, flood inundation and sedimentation studies using remotely sensed data, soil moisture movement studies, water quality modelling etc.

During the year under report, 47 scientific reports were prepared in various categories-technical notes, technical reports, user's manuals, status reports and Hydrology Year Books. The reports by scientists under various divisions prepared were circulated widely. A list of Scientific and Technical reports prepared during the year is given in Appendix-VII. The status of the various reports prepared in different year is given in Figure-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 Figure -IV.

For dissemination of the results of the studies carried out at the Institute and the technology developed, implemented and tested with field data, workshops were organised at Roorkee and at

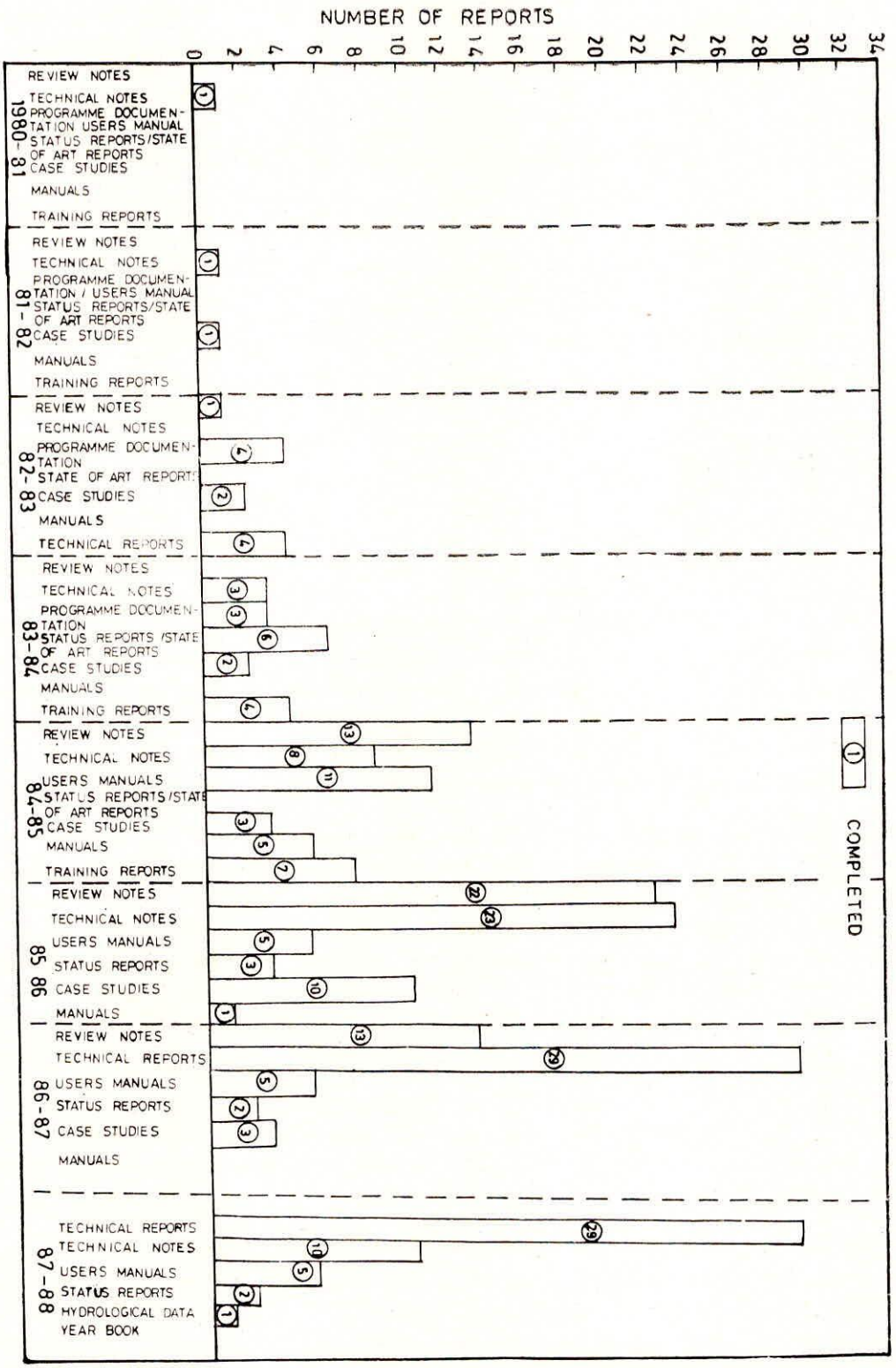


FIG. III - REPORTS PREPARED IN DIFFERENT YEARS

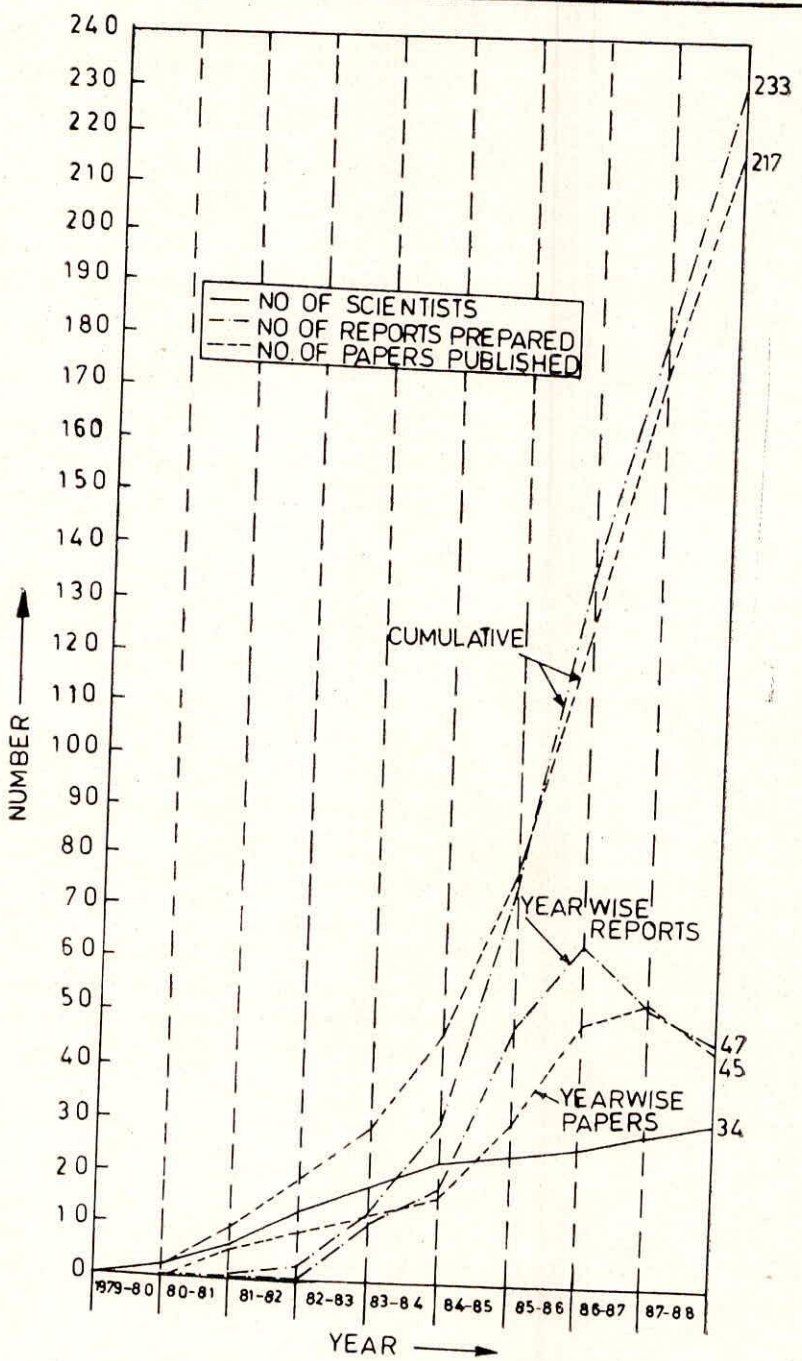


FIG. IV - SCIENTIFIC GROWTH OF N. I. H.

various state & Central Govt. Organisations. Under the technology transfer programme, during the year, 7 workshops were conducted at Roorkee and in different states. The state and Central Govt. organisations deputed their engineers and scientists to these workshops. The Institute has also to cater to the hydrological problems of different regions of the country. One regional centre for the Deccan Hard Rock area was established at Belgaum, Karnataka and is operational. Efforts are on way for setting up two more regional centres for greater interaction and understanding of the problems of different regions of the country. It is expected that the regional centre for North-Eastern Region at Guwahati will become operational soon, and the Regional Centre for Western Himalayan Region will be established during 1988-89.

The interaction with the states has further increased during the year. The Institute is closely interacting with various state organisations through the visits of Director and senior scientists. State organisations are also represented in the Advisory bodies such as Technical Advisory Committee and Working Groups.

In view of serious water shortages created by recent drought situation during the last four years, scientists of the Institute have been involved in carrying out studies on Hydrological Aspects of Drought. The scientists of the Institute visited the drought affected areas of states of Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra and Rajasthan for obtaining first hand information of the drought severity and for collection of relevant data for the assessment of drought and for development of drought management strategies. A report on the hydrological aspects of drought for 1985-86 was completed during the year. After incorporating the comments of Working Group members, the report will be printed and circulated to various states and central and other organisations. During the year 1988-89 similar reports for 1986-87 and 1987-88 will be prepared and circulated.

Hydrology has grown as an interdisciplinary science after launching of the international hydrology programme by UNESCO. Realising the importance of systematic, basic and applied research in the area of hydrology to solve complex field problems, it was thought appropriate to interact with foreign organisations and agencies abroad through international cooperation. A number of projects for international cooperation are with the Ministry at different stages. These projects involve scientific collaboration with Denmark, The Netherlands, West Germany, Japan, USSR and USA.

During the year a project was taken up for transfer of hydrological computerised modelling system (SHE) developed by three institutes in Europe. This project, is being financially supported by European economic community in agreement with the Govt. of India.

The HILTECH and ARCCOH have functioned very effectively and the Secretariat at the Institute has handled the work and made further progress. A number of meetings of HILTECH, its panels and subcommittees were held during the year which led to the development of programmes for faster growth of hydrological activities in India. National Hydrology projects in surface water (Southern region), ground water and water quality has been prepared after identifying the area of deficiency in the hydrology sector in the country. The surface water project was posed to the World Bank and other projects would also be posed to World Bank, as World Bank

has evinced interest in these projects. Another project for the Indus, Ganga and Brahmaputra basins is also under preparation. Jal Vigyan Sameeksha (Hydrology Review), a publication of HILTECH is being brought out regularly. HILTECH also sponsored research projects and partially supported Seminar/Symposia and also sponsored candidates to international courses abroad. Under the activities of ARCCOH, quarterly "ARCCOH newsletter" is being brought out regularly and circulated to the countries of Asian region. The second volume of the directory of hydrologists in Asian region has also been prepared and will be sent for printing soon. A major regional project for South Central Asia supported by UNESCO would be made operational soon.

The second extension of Jal Vigyan Bhawan (the main building of the Institute) was completed during the year and occupied. The extension of laboratory block, the construction of field hostel and the museum cum recreation centre were taken up during the year.

The quarterly newsletter of the Institute "Jal Vigyan Samachar" is being published regularly. During the year greater emphasis was laid on the use of Hindi in office correspondence and in a limited manner in technical activities also. Recreation and welfare activities have continued with interest 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 problem oriented scientific divisions :

(i) Hydrologic Design
(ii) Surface Water Analysis and Modelling
(iii) Flood Studies
(iv) Mountain Hydrology
(v) Ground Water 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 is given in Appendix-VII.

A brief account of studies and research conducted during the year in each of the above divisions is given below :

3.2.1 Hydrologic Design

The activities of this division are mainly focussed on various elements of the hydrological cycle as a part of total design of hydrology component of the projects including design flood estimation. Besides conventional techniques like unit hydrograph based approaches, the watershed models for different terrain situations are also being studied and developed as a part of the activities of the division. A number of technical reports have been prepared in the above areas. These include :

(i) Forecasting of Monsoon Runoff Using Data from Specific Basins

In this study the monsoon runoff magnitudes have been forecasted using simple correlation technique for 19 reservoirs/river sites located in different agro-climatic regions of the country. 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 relationships have been used after updating the parameters of regression relationships in calibration and forecasting have been computed and presented.

(ii) Monthly Streamflow Generation

The planning and design of water resources projects require synthetic streamflows to predict the characteristics and quantity of stream-flows to derive critical flow sequences of their associated return period. HEC-4 model is a monthly streamflow simulation model developed by Hydrologic Engineering Centre, US Army Corps of Engineers, USA. In this study HEC-4 model has been used to generate synthetic monthly streamflows for four sites of Mahanadi river basin.

The performance of the HEC-4 model in preserving mean, standard deviation, lag one serial correlation coefficient and cross correlation coefficient with respect to univariate and bivariate Thomas Fiering models has been compared and presented in the study.

(iii) Comparison of Different Parameter Estimation Techniques

Design of water resources structures needs estimation of hydrologic and meteorologic event for different return periods. This can be achieved through frequency analysis approach using EV-1 distribution. In this study various techniques for estimation of parameters of EV-1 distribution have been explained and statistically inter-compared using data of different sample sizes generated by Monte Carlo Simulation.

(iv) 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 planning of water resources projects. In this study the details of the eight computer programmes to carryout flood frequency analysis have been presented. These programmes are fitting of (i) Lognormal two parameters (ii) Lognormal three parameters (iii) Extreme Value Type-1 (iv) Pearson Type III (v) Log Pearson Type-III distribution and for (vi) Computation cf standard errors (vii) Best fit distribution using normalization procedures and Chi-square criterion and (viii) Flood frequency analysis using Power transformation method. These programmes are written in FORTRAN language and implemented/developed and tested on VAX-11/780 Computer System.

(v) Unit Hydrograph Analysis

Unit Hydrograph technique is one of the simple and versatile techniques available for the estimation and forecasting of flood. The unit hydrograph for a catchment is generally derived from the available data of rainfall and runoff for different events. This study gives the details of twenty one computer programmes to carry out unit hydrograph analysis. The computer programmes deal with (i) the processing and analysis of precipitation data, (ii) the computation of discharge and rating curve analysis, (iii) the computation of excess rainfall and rating curve analysis, (iv) the unit hydrograph derivation, and (v) the reproduction of direct surface runoff and estimation of flood hydrograph. The programmes have been written in FORTRAN language and developed, implemented and tested on VAX-11/780 computer system. The programmes can be run on personal computers also.

3.2.2 Surface Water Analysis and Modelling

The studies and research programme of this division comprises of network design, water availability studies, hydrometeorological analysis and modelling of streamflows. The studies carried out in this division during the year included statistical analysis of rainfall of some districts in east Rajasthan, determination of water surface profile and preparation of hydrological data year book. The details are given below :

(i) Some of the districts in east Rajasthan which have a semi arid climate and traditionally agricultural area have been experiencing drought conditions since 1984. To study the abnormal behaviour of rainfall in these districts, statistical analysis of monthly and annual rainfall data of raingauge stations located in Alwar, Jhunjhunu, Sawai Madhopur, Bharatpur, Jaipur, Tonk and Kota districts was carried out. The analysis indicated lack of any persistence in the rainfall series of the raingauge stations in these districts. Some rainfall series, however, indicated some linear trend which is significant.

(ii) Determination of Water Surface Profile using HEC 2

The HEC 2 programme developed by hydrologic Engineering Centre, USA can be used to study the effect of obstructions such as bridges, weirs and other structures in the flood plain. The computation of water surface profile in the tributary system if necessary can be made after the computation of the main stream. The data requirement includes flow regime, starting elevation, discharge, loss coefficient, cross sectional geometry and reach length.

The programme has been implemented and tested on VAX-11/780 computer system of the institute. The computations of water surface profile for river Omar, a tributary of Narmada have been carried out using data supplied by RDSO, Lucknow and CWC.

(iii) Hydrological Data Year Book for Hemavathy Basin

Hydrological data collected by various State and Central Govt. agencies are generally not published in a form which can be useful for carrying out hydrologic analysis. The institute has made efforts to provide a typical water year book as an example to meet the requirements of hydrologists. The division has prepared a water year book for Hemavathy sub-basin in Cauvery basin using data and other information made available by the Irrigation Department, Karnataka. The water year book covers information regarding topography, soils, land use pattern, flood prone and drought prone areas, command area, irrigation development, lakes, dams and reservoirs, details of raingauges and river gauges etc. Available cross sections and longitudinal sections of the river have also been included. Certain statistical details based on past data have also been given.

3.2.3 Flood Studies

The studies and research programme of this division include the areas of dam break modelling, flood routing and flood forecasting and flood plain zoning. The brief description of the technical reports prepared during the year are as follows :

(i) Development of Dimensionless Flood Hydrographs from Machhu Dam-II Failure Using DAMBRK Model :

This report presents a methodology for the quick estimation of dam break flood wave and its characteristics such as peak flows, peak stages and their respective timings at the dam site and at specified locations downstream of Machhu Dam-II, using the technique of dimensionless hydrographs of dam break flood wave developed based on different breach area criteria. These dam break flood waves were developed using U.S. National Weather Services DAMBRK model on the data of Machhu dam-II which failed on 11th August 1979 in Gujarat State.

Using these dimensionless hydrographs and relationships one can quickly estimate the peak flow and peak stages at specific sites knowing only the breach area at the time of disaster without the need for using the DAMBRK model. The usefulness of this approach has been demonstrated by developing the dam break flood wave hydrographs for a breach area which was not used for the development of dimensionless hydrographs and other relationships.

(ii) Establishment of General Procedure for Lateral Inflow Estimation Required in Flood Routing :

The study is based on the use of four parameters Muskingum Flood routing method. The method involves the estimation of the coefficients of the conventional Muskingum equation by matrix technique and then the estimation of the four parameters K, X-and-using these coefficients and a trial and error technique by comparing the estimated lateral flow with the observed

lateral flow. The lateral flow to be estimated is obtained in the form as $\alpha I - \beta Q$, where I and Q are the inflow and out flow respectively. The study shows that when Muskingum method of flood routing is able to simulate the observed event closely then the approach is suitable for lateral inflow estimation in the form $\alpha I - \beta Q$. It has also been found from the study that in some of the cases the lateral inflow hydrograph could not be reproduced very well as a linear combination of inflow and outflow as described above.

(iii) Dimensionless hydrographs for flow routing in sewers using Kinematic wave routing Technique :

The study presents a methodology for the estimation of flood wave characteristics in rectangular sewers at a down-stream location of a given inflow site using kinematic wave routing technique. For the development of dimensionless hydrographs and other relationship, it is presumed that the flood wave would be contained within the sewer. Using the kinematic wave routing technique the dimesionless hydrographs are developed for rectangular sewers for different widths varying from 6 to 18 ft., for different sewer slopes varying from 0.001 to 0.009, and for different inflow hydrographs shapes. The relationships have been developed between sewer slopes and time of arrival of the flood peak at downstream location of the given inflow site. These relationships have been established for different shapes of inflow hydrographs with peakflow varying from 100 to 500 ft^3/sec. A dimensionless relationship has been established for a given reach length between sewer slopes and the ratio of time lag of the peak flow for given sewer slope and the time lag of the same peak flow with sewer slope 0.001. The relationship has also been established between peak flow and time lag of the peak for given reach length corresponding to the sewer slope of 0.001.

(iv) Rating Curve Establishment Under Shifting Control :

The study considers the factors responsible for section control and channel control which affect the rating curve. It then considers the factors which affect the section and channel control, and thus the rating curve relationship. The study considers in broad perspective the shifting of the rating curve due to vegetative growth along the bed, change of alluvial bedform, backwater effect, and scour and fill. Various methods available for establishing rating curve relationships under these situations have been described.

(v) Flood Plain Zoning :

This study describes the methods available for flood plain zoning as a non-structural flood management measure. The literature review indicate that the literature available on this subject matter is limited and also with reference to studies carried out in U.S.A. only. The approach of flood plain zoning is more suitable for flood plain situations wherein much development has not taken place and allow such developments which are not susceptible to severe damages. The zoning might be achieved-corresponding to a particular recurrence interval flood say corresponding to a flood of the 100 year return period level. Once the 100 year flood level at a particular location has been achieved to estimate the water surface profile along the reach under consideration and then, using the estimated water surface profile the delineation of the flood plain land is made.

3.2.4 Mountain Hydrology

The studies and research programme of this division encompass the areas of flow measuring techniques, network design, hydrologic modelling, storm studies, orographic effects on hydrological parameters, land use changes, geomorphological studies, overland flow studies and snowmelt and glacial melt studies for mountainous areas. Review notes and technical reports prepared during the year include :

(i) Flow Measuring Techniques

The flow measurement in mountain stream is comparatively difficult due to problems associated with the mountainous areas, inaccessibility and climate conditions. A review of the instrumentation and techniques for flow measurement, applicable to mountainous areas was carried out.

(ii) Hydrologic Models for Mountainous Areas

Several watershed models are available and most of them were developed taking into account the component processes of the runoff formation as the basis of their development. These include the models for snow covered areas, non-snow covered areas and catchments with both types of areas. Some models have capabilities to make use of the remotely sensed data as well.

A technical note on hydrologic models was prepared with emphasis on studying the capabilities of models, the data requirement for them, techniques of evaluating model parameters, their application to mountainous areas and associated difficulties.

(iii) Storm Studies

The precipitation is known to vary largely in space and time due to several factors such as topography, nature of weather system, geography, aerosol content and dropsize distribution in cloud, etc. A report on variation of precipitation with elevation problem of rainfall input to hydrologic models has been prepared.

(iv) Overland Flow Studies

The technical report prepared on hydrologic modelling of overland flow in hilly areas consists of analysis of overland flow by kinematic wave theory, using computer model KINGEN-75. The studies have been conducted for the 250 square miles of catchment area of river Mala-prabha upto Khanapur in Karnataka.

(v) Glacier Studies

A Technical note has been prepared on physics of glacier melt covering the physics of glacier and method of computing glacier melt induced runoff.

During Chhota Shigri Glacier expedition organised by DST, field studies and experiments were conducted to measure stream flow, suspended sediment and stratigraphy of snow cover on glacier. The report was submitted to Department of Sciences and Technology, New Delhi.

3.2.5 Ground Water

The activities of this division include the study of parameters in groundwater balance,

estimation of aquifer parameter, groundwater recharge and aquifer yield and study of springs. The studies carried out by this division during the year include :

(i) Interaction of Large Water Bodies with Aquifer System

Based on the study conducted on lake interaction with the ground water reservoir, a type curve has been developed for the assessment of seepage from lake to groundwater reservoir. The present study is aimed at understanding the behaviour of aquifer system in conjunction with large water body and identifying the important parameters effecting seepage.

(ii) Water Balance studies - Upper Ganga Canal Command Area

A case study has been taken up using the long term data of Upper Ganga Canal Command Area and the groundwater balance for the study area has been completed. The study includes the estimation of recharge and discharge components for the groundwater reservoir like seepage from main & branch canals, distributories, seepage from the water courses, irrigation return flow, draft from wells, direct evaporation from the shallow water table areas, evapotranspiration, inter-basin flow, base flow to the rivers and groundwater storage. The rainfall recharge was estimated after evaluating these components over a period of 12 years commencing from 1972-73 to 1983-84. Based on this study, discretized model studies on monthly basis using finite difference approach is taken up for understanding the aquifer behaviour under different stress conditions.

3.2.6 Conjunctive Use

The studies and research programme of this division include the conjunctive use of surface and groundwater, crop planning, groundwater modelling and aquifer response to pumping and recharge in single and multiaquifer system. The following technical reports have been prepared during the year :

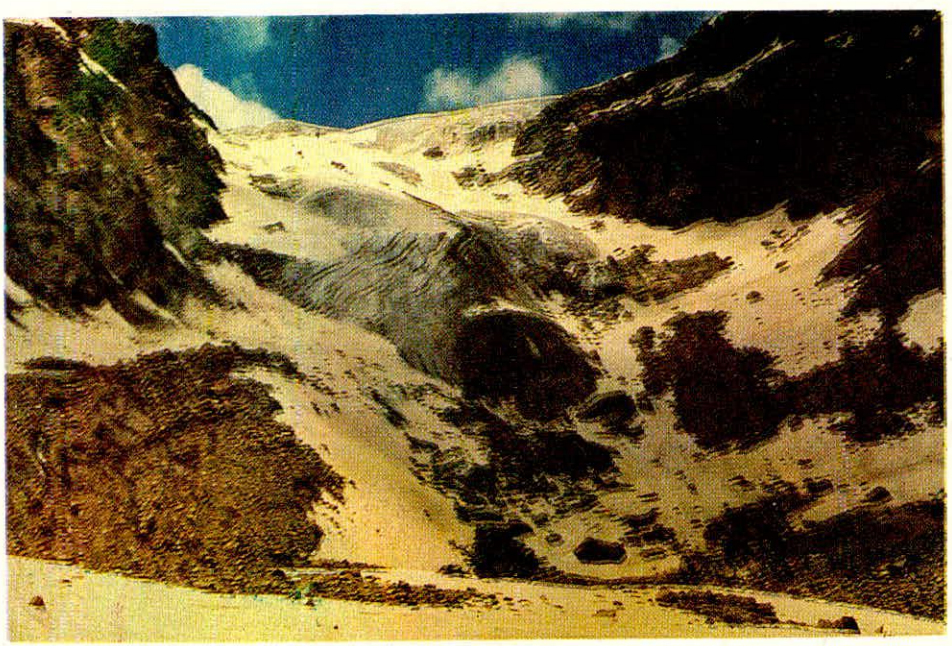
(i) Estimation of Groundwater Recharge due to Rainfall by Statistical Methods

Direct groundwater recharge from rainfall depends on the intensity and duration af rainfall, the evaporation demand, soil moisture defficiency, the sorptivity, depth of unsaturated zone and hydrogelogical conditions etc. Given all these parameters, it is possible to predict the ground water recharge at a site due to rainfall. Rainfall recharge would result in rise of water table. There have been attempts to predict rainfall recharge by statistical methods using only the point rainfall data and point water table fluctuation neglecting the fact that water table fluctuation may be caused by recharge at some other point with varied conditions. In the present report an attempt has been made to check the validity of statistical approach. Using Green and Ampt infiltration equation and sorptivity of a known soil, the recharge due to successive rainfall has been predicted. The consequent water fluctuation have been determined using Hantush solution for water table fluctuation and rainfall values, the rainfall recharge has been estimated statistically and compared with true but synthetic recharge values.

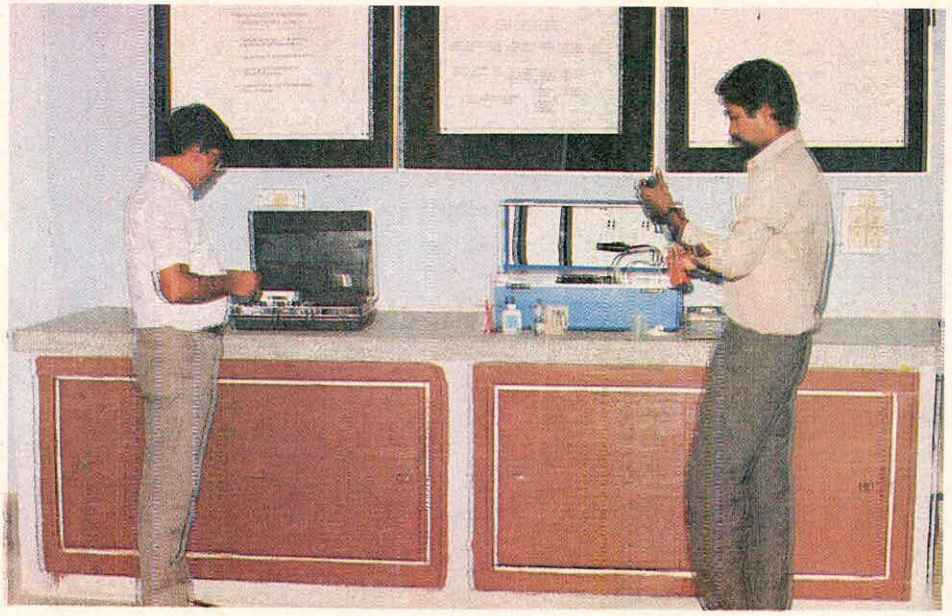
(ii) Type Curves for Multiaquifer Well

Type curves pertaining to aquifer test conducted in multiaquifer well, which is open to two aquifers, have been presented. Using these type curves the storage coefficient and transmissivity

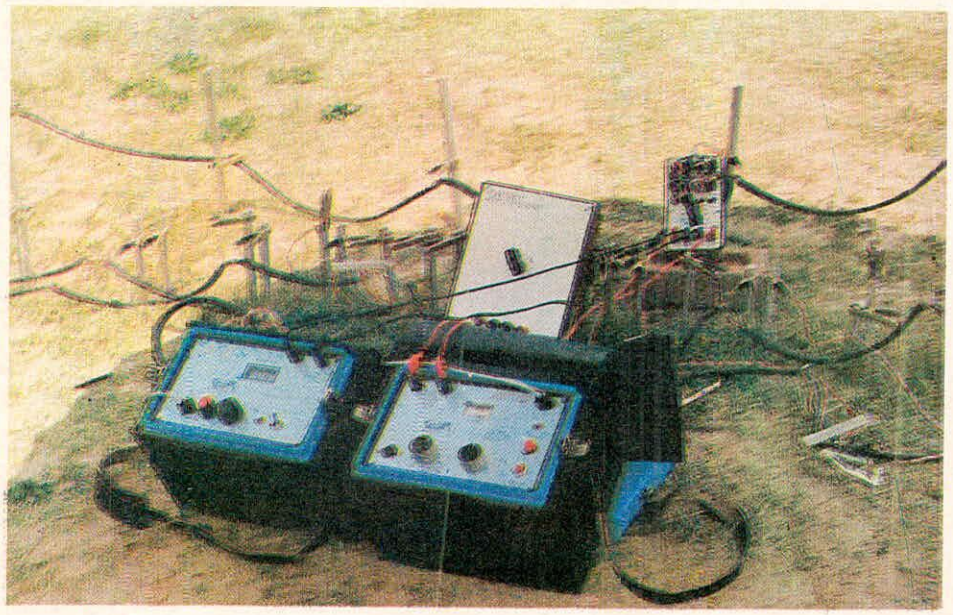
Drought Affected Area



Mountain Hydrology Study Area



Water Quality Analysis Work



Resistivity Meter Studies in Field

of each aquifer can be predicted. In a two aquifer system, an observation well may tap a single aquifer or it may be open to both the aquifers. Some times the multiaquifer pumping well may also be used as an observation well. The type curves presented in the report include all these three cases. Use of the type curves for parameter estimation has been demonstrated using synthetic drawdown data.

(iii) Systems Approach to Optimise Conjunctive Use of Surface and Groundwater

In the study a conjunctive use model for optimum agricultural production in the sub-basin of the Ghataprabha command area in Karnataka state has been formulated. The aim is to develop an optimal crop plan, which is economically feasible and socially acceptable exploiting the irrigation potential both from surface and groundwater.

Ten crops have been identified for production on the basis of soil and climate and the cropping pattern observed in the area. The consumptive use and the net irrigation requirement of each crop have been computed. The groundwater resources and surface water availability over a time period have been estimated. A linear programming model has been used to allocate the optimal areas to different crops subject to the constraint of surface and groundwater availability.

3,2.7 Drainage

The studies and research programme of this division include the areas of drainage of agricultural lands both surface and subsurface, drainage of flood affected areas, and salt balance in root zone in agricultural land. Based on the work carried out, the following reports have been prepared :

(i) Drainage in Heavy Soils

Drainage of Heavy land is largely governed by the fact that the hydraulic conductivity of the subsoil is generally too low to allow percolation of excess rain water to lower depth. Vertisols and associated soils occupy about 72.9 m ha areas in India. Inspite of high potential productivity of these soil and favourable climatic conditions, the soil remain under utilized due to number of problems. Most of the problems arise due to their generally low water intake rate and due to poor internal drainage.

There are several techniques available for draining heavy clay soils. The solutions depends essentially on the ratio of rate of precipitation to the rate of downward flow through the soil system consisting of poorly pervious layer and the presence or absence of a highly pervious subsoil. The various technique of draining heavy soil currently practised in different parts of Maharashtra, Madhya Pradesh such as various surface methods, vertical drainage, pipe drainage have been reviewed. Also the use of various models for estimating field drainage from heavy land in the tropics have been presented. The various methods currently used in different parts of the world for draining heavy land such as artificial backfill, more drainage, subsoiling, chemical methods and surface drainage have also been reported.

(ii) Salt Balance in the Root Zone Under Shallow Water Table

In region where the water table is at shallow depth below ground surface, capillary rise may cause the ground water to reach the root zone or even the soil surface, where it evaporates leaving

the salt behind, irrigated soil also receive considerable quantities of dissolved salts supplied partly by the irrigation water and partly by the inflowing ground water. A certain amount of leaching is therefore needed to counteract the process of salinization i.e. an excess of water is supplied to the soil surface and the salts are washed down out of the root zone.

In the study, salt balance has been carried out in the root zone during application of irrigation water and during the period of non-irrigation. The root zone has been divided into number of layers. Soil moisture movement during application of irrigation water has been predicted using Green and Ampt infiltration equation. During non-irrigation period, water movement has been predicted using potential theory applicable to unsaturated flow. For salt balance each layer has been treated as a reservoir where the salt is thoroughly mixed with the water. A series of reservoir has been considered for prediction of salt at different depths in the root zone.

3.2.8 Drought Studies

The activities of the division progressed well during the year as the scientists and the scientific staff continued their efforts in collection of field data for carrying out studies on hydrological aspects of drought for 6 drought affected states of Andhra Pradesh, Maharashtra, Gujarat, Karnataka, Madhya Pradesh and Rajasthan. A brief description of activities of this division and the reports published by the division during the year are given as below :

(i) Hydrological Aspects of Drought in 1985-86

The division took up work to carry out studies on Hydrological Aspects of Drought in two chosen districts of 6 drought affected states of Andhra Pradesh, Gujarat, Maharashtra, Karnataka, Madhya Pradesh & Rajasthan. The scientific teams visited the various Central and State Government Deptts. in these states for collection of data during March and May months in 1986 and June and Sept, months in 1987. The various types of data collected for study included rainfall, ground water levels, streamflow, soil moisture, drought relief programme reports, revenue records, agricultural statistics etc. Due to non-availability of data at a time frequent visits were required.

The study included detailed rainfall analysis for two districts in each of 6 chosen states. These districts included Ahmadnagar & Solapur in Maharashtra, Jamnagar and Rajkot in Gujarat, Jhabua and Khargone in Madhya Pradesh, Belgaum and Bijapur in Karnataka, Barmer and Banswara in Rajasthan and Cuddapah and Anantpur in Andhra Pradesh. The detailed rainfall analysis included seasonal and monthly rainfall departure analysis using 10-15 years data and probability analysis of annual rainfall using 85 years data, dry spell analysis and excess/deficit analysis of monthly rainfall using Herbst Approach. In general, the rainfall analysis indicated that during water year 1985-86 from rainfall deficiency point of view the condition of drought was severe in the study area as compared to previous 4-5 years. The soil moisture monitoring data could be available only from Jodhpur for which drought analysis using simple soil moisture index Pearl Millet crop was done. Low flow studies were carried out for 9 sites of Krishna Basin (falling in Maharashtra, Karnataka and Andhra Pradesh) for which 20 years flow records were analysed by carrying out comparison of monthly flow hydrograph runoff volumes with the long term values, development of flow duration curves and low flow index volumes, deficit duration and deficit volume analysis with respect of different demand levels. The results indicated that the flow conditions were deficient than previous 4-5 years due to prevailing drought conditions. In case

of analysis of ground water deficit, the groundwater levels as collected from the State/Central Government departments were analysed and a trend in ground water level regime was derived using 10 years data. In general, the studies indicated that in all 6 states for the chosen districts the ground water level showed declining trend which was compared with the trend in rainfall over last 10 years and were found in coherence. However, due to non-availability of ground water abstraction data exact correlation between ground water level and rainfall could not be established. Efforts were made to forecast the monsoon runoff based on simple regression relationship for 7 sites of Krishna Basin. In most of cases, efficiency of forecasting runoff was found quite accurate and the technique is to be extended for application to other sites of the basin. The report has come out with certain recommendations. Efforts are on to extend similar study for drought years 1986-87 and 1987-88 with more coverage of districts.

(ii) Identification of Format for Collection of Data for Drought Studies

In view of the long felt need to identify the type of data to be monitored and collected for drought studies and to develop suitable formats for collection and storage of data for drought studies, a report was prepared giving detailed information of identification of format for collection and storage of data. The various types of meteorological, hydrological, soil crops, water demand, water use and other relevant data required for drought studies are identified in the report. The report is expected to serve as a guideline for the field agencies/users in identification and data requirement for drought studies.

(iii) Statistical analysis low flows in typical river basin to investigate drought characteristics

The stream flow represents the runoff from catchment and reflects the basic effect of rainfall deficiency as well as change in characteristics, land use and vegetation. Therefore, the drought phenomena can be better understood from the hydrology of the river basins for which local singularities are eleminated. The effects of drought on stream flow are reflected through low flow studies which indicate the conditions of hydrological drought. An attempt has been made to study the effects of drought conditions as on stream flow during year 1985-86 in nine sites of Krlshna basin. The low flow data has been analysed using different statistical approach including developing flow duration curves, deficit volumes and deficit duration analysis and developing curves for annual maximum duration and annual maximum deficiency of low flow spells of flow frequency analysis.

(iv) Evaporation reduction measures from water and land surfaces for drought management

The evaporation loss for water surface form a substantial amount of water in hydrologic cycle. Almost one fourth to one half water lost from cropped area is through evaporation from soil surface. One of the supply oriented drought management measures is to conserve water and enhance or augment available water supplies by evaporation reduction measures. The report presents the status of research/work done on various kinds of techniques for controlling evaporation from land and water bodies. The results on use of chemicals for evaporation retardation as done at different places have been presented. Also water conservation due to surface mulches as experimented at different places and its effects on agricultural yields have been included in the report.

3.2.9 Water Resources System

The studies and research activities in this division cover the areas of system studies, realtime multipurpose and multi reservoir operation, basin planning and reservoir capacity computation.

The studies conducted during the year are as follows :

(i) Single purpose reservoir is designed and operated for serving only a single purpose. It may be either for irrigation hydropower generation, municipal and industrial water supply or flood control. While all these purposes except flood control reservoir to be as much full as possible, flood control operation of a reservoir requires the reservoir to be empty so that the incoming flood may be absorbed in it. The report describes storage requirements for different purposes and present the detailed procedure for its calculation.

(ii) Operation of a Single Purpose Reservoir for Hydroelectric Power Generation

A computer programme was developed for the operation of a reservoir for hydroelectric power generation and the User Manual for the use of software thus developed was prepared. Two aspects for operation procedure have been considered (a) considering the monthly distribution factor, monthly power generation can be computed (b) monthly generation should be adopted to determine weekly/daily operation knowing the firm power and inflow sequence.

The consultancy projects offered by Govt. of Gujarat are also in progress.

3.2.10 Man's Influence

The studies and research activities of this division include the areas of water quality, ground water pollution, sedimentation of reservoirs, forest hydrology, environmental impact assessment and thermal stratification. A number of technical reports and status reports have been prepared in the above areas. These include :

(i) User's Manual on Water and Waste Water Analysis

Water and waste water analysis have become increasingly important in water quality monitoring. Analytical techniques adopted for monitoring should be precise and accurate. The methods should take into consideration the limitations in developing country situations. Analytical procedures for measurement of various water quality parameters have been developed and are readily available in manuals of standard procedures.

The present manual is an attempt to collate and synthesize much of this information in a simplified form in order to serve as an aid to practical work. The analytical methods recommended in this report have been selected on the basis of their wide applicability and their general acceptability. The details of each test procedure is described as general principle, chemicals required for tests, the method of calculations and its significance. Under 'sampling', a brief statement describes sampling precautions that may be required and specifies the type of container to be used. Under 'analysis' detailed procedure and method of calculations have been given. For all the methods, the form and units of reporting values for physical and chemical quality parameters and constituents are specified. The proper number of significant figures to be used in reporting analytical measurements are specified to indicate the confidence level that the data may expect.

It is expected that the manual will be of use ful to field agencies who are engaged in water quality analysis work as an extension work.

(ii) Ground Water Quality Variations in a Selected Area

Ground water pollution problem can be understood only by the regular monitoring of the ground water quality. To monitor the groundwater quality of shallow unconfined aquifer of Saharanpur district, about thirty dug wells have been subjected. Samples from these wells are being collected and analysed to see the status of pollution in the district.

The study includes type of pollutants, if any, identification of zones of pollution, if any and cause of pollution. The preliminary study reveals that there is no pollution in shallow aquifers in Saharanpur district, except for one place which shows high values of nitrate-nitrogen through accepted as potable according to ISI standards.

(iii) Thermal Stratification in Lakes

A lake's vertical thermal regime has dual significance to the water quality modeler. Temperature has direct importance as it influences the rates of chemical and bio-chemical reactions. However, it has additional significance as a tracer of mass transport in the water column. Infact, heat balances are a primary tool for estimating mixing rates in the vertical dimension. Temperature lakes are those with surface temperature above 4°C in winter, thermal gradients large, two circulation periods in spring and autumn. Although other lake types can be severely polluted, discussion generally focuses on temperate lakes because many of the world's developed areas are in temperate climate and consequently many lakes in these climates are subjected to pollution.

The thermal regime of temperate lakes is primarily the result of the interplay of two proecsses— (i) heat and momentum transfer across the lake's surface and (ii) the force of gravity acting on density differences within the lake. The study reviews the vertical temperature variation in lakes and the mathematical models available for temperature stratification in lakes have been understood for application. Various models like Water Resources Eugineers, Tennessee Valley Authority, MIT and Cornell have been reviewed.

(iv) Positive Impacts of Water Resources Projects on Environment

In recent years the effects of water resources projects on environment is being propagated in a negative sense in news media, papers etc. which is affecting the water resources development. However, the fact is that the water resources projects are necessary for economic survival of a country. There have been seminars, conferences on these issues in past which have deliberated in depth the issues of environmental effects of water resources projects. However, the positive effects of water resources projects on environment have not been published in a desired manner. With this in view and also as recommended during past conferences, the division has taken up a study to compile the positive impacts of water resources projects, on environment.

The study includes extensive collection of data and literature describing impacts of water resources projects, on environment. A few completed projects, have been chosen for the study. The data indicating positive and adverse impacts of the development have been collected and the impacts of the development has been spelt out. An attempt was earlier made to review the

various hydro-environmental indices and a report was prepared. In present study, few projects have been taken and their positive impacts have been highlighted.

(v) Development of Resources Management Model Combining Water, Flora, Fauna sub-models

Watershed resources play a significant role in the development of any country. The main resources may include water, land, flora and fauna. The watershed lands constitute a major portion of the earth's habitable land surface (excluding well defined agricultural lands and urban areas). In view of increasing pressure of rising population, attention has to be diverted to these watershed lands for additional supply of food, fibre, energy and living space.

The development of watershed resources demands a careful study of inter-relationship among resources products and demands the watershed has to cater for. Unfortunately, the development of watershed resources has been taking place in an unscientific manner with the sole objective of short term gain. While the approach should be based on integrated resources management wherein all resources are given due consideration while planning the developmental strategy. In order to have integratad and balanced development of watershed resources, it may be necessary fo assess the yields of the resource products properly. Once a proper assessment of watershed resources is made, then the effect of any land management policy on yields of the resources can be found out. To understand impact of land management policies on ecosystem in general, a watershed resources development model consisting of sub-models for various resources, can be developed. These sub models may include determination of water yield, sedimentation, growth and yield of vegetation and wild life habitat as a result of the adopted land management policy.

A beginning has been made in this direction by defining various aspects of the proposed watershed resources development model. As stated earlier, this model comprises of various sub-models which include effects of varying land management practices on various aspects of watershed resources. The conceptual formulation of model has been discussed and the data requirement for operating such a model has been defined. Once all sub-models are developed separately, then these all will be combined in one model to have a comprehensive assessment of effects of various land management policies on watershed resources.

3.2.11 Information System

Development and management of Institute's Computer Centre and Library as well as development of general purpose software on VAX-11/780 and personal computers continue to be the major activity of this division. The division is engaged in developing software on personal computers which can be used for typical problems in hydrological analysis. During the current year following software have been developed :

(i) Flow Duration Curves

The flow duration curves which represent the combined effect of flow characteristics of any stream are the simplest available technique for distribution of streamflows. A programme has been developed on personal computer to draw the flow duration curve. Provision has also been made to either tabulate the ordinates of the curve or to draw the curve using a graphical package.

(ii) Reservoir Routing

The purpose of this report is to describe and document, a programme for routing inflow hydrograph through a reservoir using level pool method. This programme has also been developed on a personal computer and results can be obtained in graphical or tabular form.

(iii) Flood Routing through Channels

Flood routing is an important component in most of the hydrological analysis. A large number of methods are available ranging from simple hydrologic models to complex hydraulic models. Muskingum method is one of the commonly used method In the present report a method known as Variable Storage Coefficient (VSC) method has been used which is an improvement of Muskingum method.

The theory of VSC method has been described in the report and a programme has been given for routing the flood waves through channels using this method.

Besides this the development of data storage and retrieval system is progressing satisfactorily. A coding system for river basins of India has been developed which is being finalised in consultation with other organisations. Computerization of ground water data of U.P. Ground Water Investigation Organization was also completed this year. A two week training on use of VAX-11/780 was given to the officers of Central Mine Planning Design and Research Institute, Ranchi by this division.

3.2.12 Remote Sensing Applications

The studies and research activities in this division include preparation of maps for Landuse, flood plain, water bodies, geomorphological, geological, soil, snow covered, drought affected area estimation or river courses; and sedimentation of reservoirs and many other applications to hydrology. During the year, studies have been conducted in the areas of metamorphism and remote sensing physics of snow, remote sensing of reservoir, suspended sediment and flood plain mapping. The brief descriptions of these studies are :

(i) Metamorphism and Remote Sensing Physics of Snow

Snow and ice are significant elements of the world hydrological system, which occur subject to tremendous variations in space. After the snow is deposited the particle shapes are modified by a process known as metamorphism. The dendritic crystals decompose into fragments and the larger fragments grow at the expense of the smaller ones. This process continues until the fragments have been reduced to more or less rounded grains of ice or until a significant temperature gredient develops within the pack. Snow flakes undergo a rapid metamorphism that reduces their surface area and brings them to a more stable thermodynamic state. Remote Sensing techniques offer an excellent synoptic view in various spectral channels of electromagnetic spectrum which serve as a spatial data for snow related studies.

(ii) Remote Sensing of Reservoir Suspended Sediment

The suspended material discharged by river into reservoir transport pollutants and are the natural material that fill channel and reservoirs. Remote sensing of reflected solar radiation can

provide timely and repeated information covering suspended sediment flow pattern in reservoirs. The main objective of this study is to describe available remote sensing techniques, to estimate the estimate loads of reservoir and also to bring out the ground truth survey strategy and sample collection, storage in the field and water, sediment analysis in the laboratory and field measurement. This study brings about the development of remote sensing application in reservoir sedimentation.

(iii) Flood Plain Mapping of River Mahanadi by Remote Sensing Applications :

The impact of floods has been accentuated by ever increasing activities of man in flood-plains of rivers to meet his requirements of food and fibre. The protection works have failed to keep pace with continued development in flood plains. Therefore, the objective of this study is to evolve a method of flood damage reduction through management of regulation uses rather than solely by structural works. Remote Sensing techniques with the advent of satellites have offered a great promise to delineate flood-plain features and inundated areas in a time and cost effective manner.

3.2.13 Hydrological Investigations

This division is engaged in carrying out studies and research in the areas of soil moisture studies using nuclear and geophysical techniques and development of hydrological instrument and devices. This year technical reports have been prepared related to the following areas :

(i) Geoelectrical Techniques for Study of Soil Moisture Variations :

Resistivity and streaming potential (S.P.) measurements were conducted to study the influence of water movements on resistivity and S.P. anomaly-patterns. Repeated measurements over a period of five months revealed an inverse correlation between the soil moisture content and the two types of anomalies.

(ii) Resistivity and S.P. Techniques for study of Ground Water Pollution :

A comprehensive review of applications of resistivity and S.P. technique in ground water pollution studies have been made.

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 Symposium Organised by NIH

3.3.1 Workshops

Towards fulfilling the objective of technology transfer and having a closer interaction with

state water resources organisations, the institute conducted a number of workshops in the following areas :

(i) Reservoir operation at Roorkee
(ii) Design Storm and Design flood at K.R. Sagar, Karnataka
(iii) Flood frequency analysis at Hyderabad, A.P.
(iv) & Processing and analysis of precipitation data at Tawanagar
(v) M P. and Nasik, Maharashtra
(vi)& Flood Estimation by unit Hydrograph method at Nasik, Maharashtra
(vii) and Lucknow, U.P.

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

The details of the workshops organised during the year are given in Appendix-VIII and workshops organised during the last three years are presented in the bar chart form as given in Figure V.

3.3.2 National Symposium on Hydrology

The Institute organised the First National Symposium on 'Hydrology' at Roorkee from Dec. 16-18, 1987 which was sponsored by Indian National Committee on Hydrology (HILTECH). The symposium was inaugurated by Dr. Y.K. Alagh, Member (Agriculture) Planning Commission.

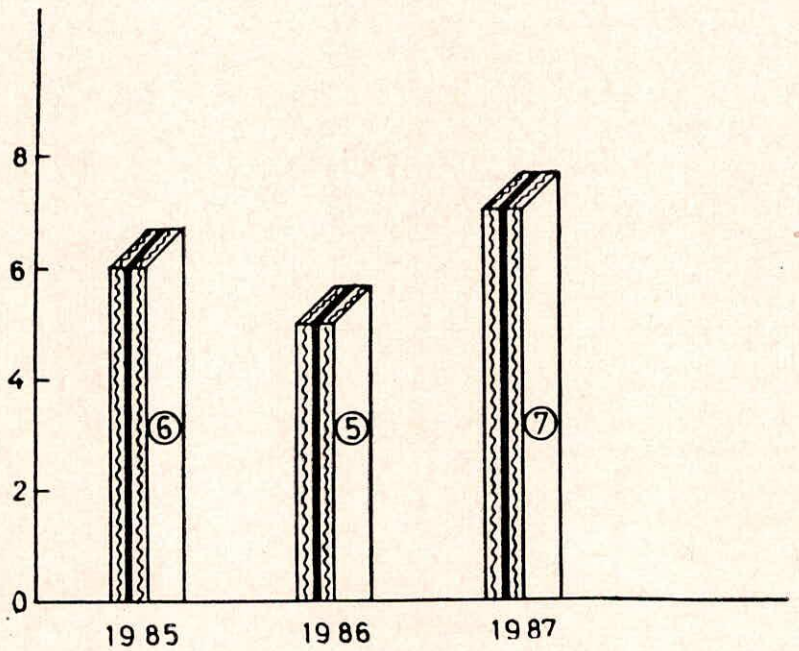


FIG. V : WORKSHOPS ORGANISED IN DIFFERENT YEARS

Sh. M.A. Chitale, Chairman, Central Water Commission delivered key-note address. About 120 delegates from various organisations participated in the three days Symposium and deliberated on eight technical themes. The proceedings of the Symposium contains 64 papers. The symposium came with concrete recommendations on technical themes of the symposium which are being circulated to Central and State Organisations for implementation.

3.4 Regional Centres

Considering the diverse climatic geographical land use and environmental conditions in different regions of the country, Society and Governing Body of the National Institute of Hydrology desired that Regional Centres of the National Institute of Hydrology be set up to cater to the hydrological problems of different regions. The regional centres would work in close cooperation with the irrigation departments of states in the region. The centres besides undertaking studies typical to the region by interacting with states in the region would also take up systematic studies in representative basins, reviews and develop suitable regional flood formulae. To fulfil this objective seven regional centres were proposed :

(i) Deccan Hard Rock Region
(ii) Deltaic Region
(iii) Western Himalayan Region
(iv) Semi Arid Region
(v) North Eastern Region
(vi) Ganga Plains Region, and
(vii) Western and Southern Coastal Region

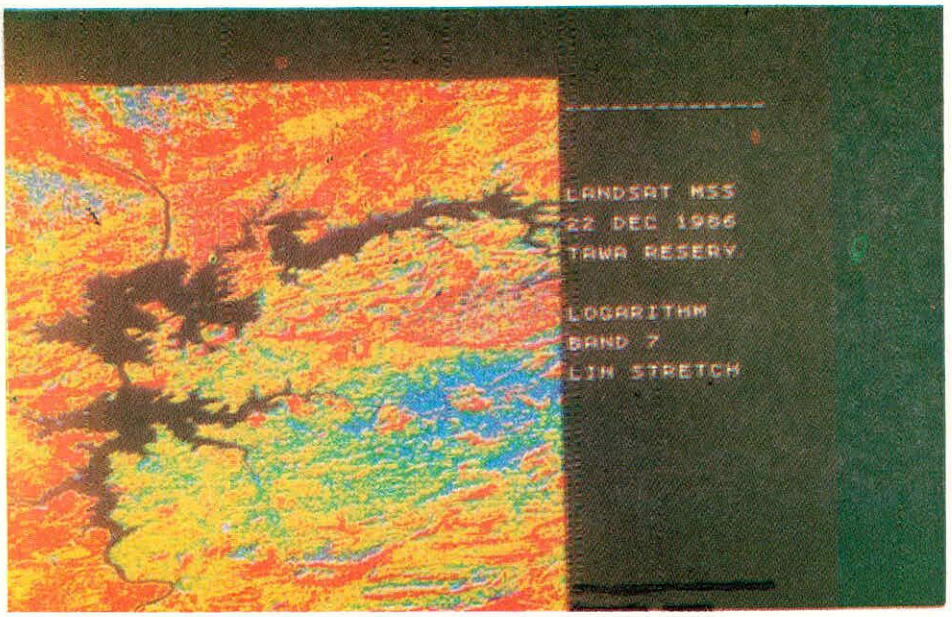
The Ministry of Water Resources had approved the setting up of three regional centres during the 7th plan period (i) Deccan Hard Rock Region, (ii) Western Himalayan Region and (iii) North-eastern region.

The Regional Centre for the Deccan Hard Rock Region started functioning at Belgaum, Karnataka since June, 1987 with skeleton staff. Necessary action for recruitment of other staff has been initiated. Two basins Ghataprabha and Malaprabha have been take up for representative basin studies. Necessary equipment has been procured. Collection of rainfall and streamflow data have been in progress. A few studies on rainfall and streamflow have been completed.

Some progress has been made to establish a regional centre for North Eastern region at Guwahati. The regional centre in Western Himalayan region and North Eastern region will be established during the next financial year.

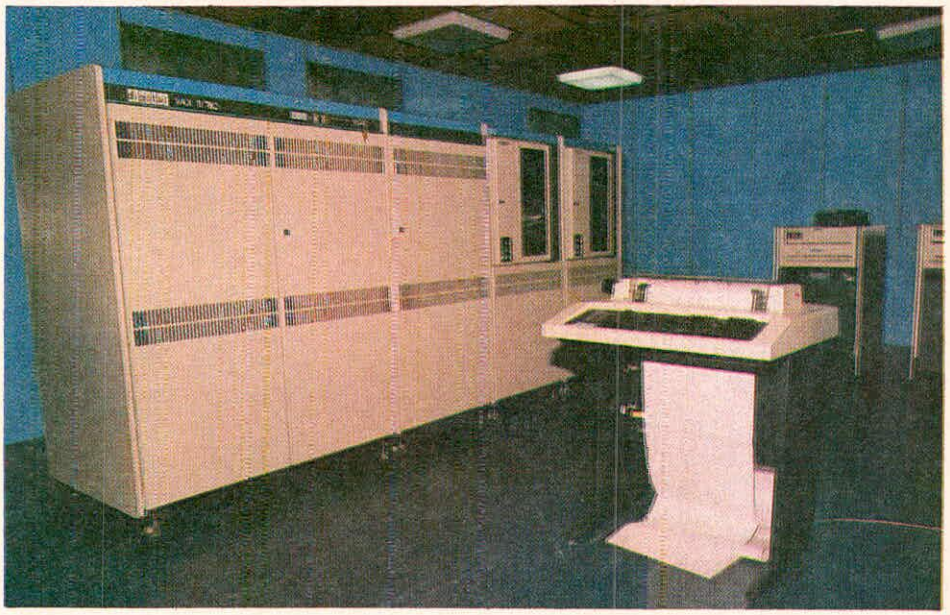
3 5 Interaction with States

There is close interaction with State Water Resources Organisations and Irrigation Departments of a number of States. Special efforts have been made by the Director and senior scientists to visit the states and to have a first hand idea about specific hydrological problems typical to the states and to properly reorient the studies and research workplan of the various divisions in the Institute to suit the needs of the States.

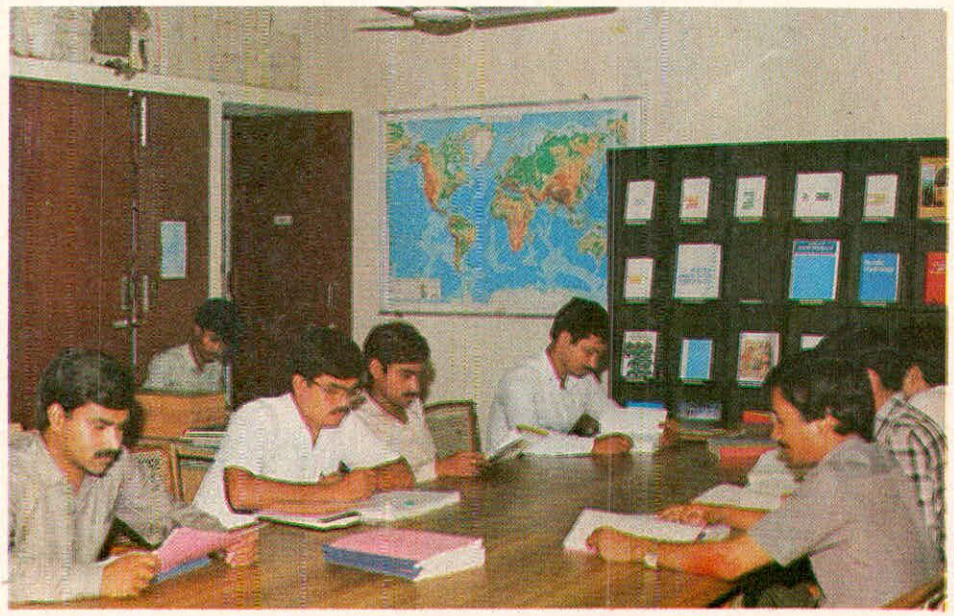


Hydrological Applications of Remotely Sensed Data

Institute's Regional Centre at Belgaum (Karnataka)



CPU of Computer Centre



Scientists and Scientific Staff in the
Reading Room of Institute

Visits have been made by the Director to Gujarat, Rajasthan, Punjab, Himachal Pradesh, Uttar Pradesh, Tamilnadu, West Bengal, Assam, Meghalaya, Orissa, Madhya Pradesh, Jammu & Kashmir, Maharashtra, Andhra Pradesh and Karnataka. These visits have provided possibilities of interaction and to work out the programmes of mutual interest. The studies proposed to be taken up with different states are given in Appendix-X. The status of interaction with states is presented in Figure VI.

3.6 Physical Facilities

3.6.1 Building

The extension of Jal Vigyan Bhawan both on the eastern and western sides of the present building was completed and occupied. The extension of laboratory block, Field Hostel and Museum-cum-Recreation Centre have been taken up and work is in progress. The construction of the extension of Experts Guest House, construction of cycle stand are expected to start soon.

For the construction of staff colony, an area of 21.45 acres of land was requested on long term lease basis from Government of Uttar Pradesh. The case is pending with U.P. Govt. and is being persued.

3.6.2 Infrastructure

The internal bitumen roads have been laid and street lighting of the campus was completed during the year.

The 30 tonne capacity Air-conditioning plan was installed and made operational for providing the necessary environmental conditions for the computer centre of the Institute.

The workshop was shifted to the newly constructed building in the extension of administrative building and made operational.

3.7 Computer Centre

The Institute has a centralised electronic data processing and computing facility in the form of VAX-11/780 computer system procurred under UNDP project which is a fourth generation system based on 32 bit architecture and has a VMS-4.2 version of Operating System. A number of peripherals such as calcomp dual mode plotter, RA81 456 MB Winchester disc drive and 1.5 MB CPU memory have been added during the year to enhance the capability of the system. A comptal image processing consol is expected shortly. Four IBM compatible personal computers (PC/XT), three with coloured monitor and coloured printer and one monochrome have been procured. One of these is connected with the VAX-11/780 computer, and others also have provision for connection to computer.

The scientists and scientific staff are using the computer for studies and research and also for hydrological analysis of field problems. The computer facility was also made available to various Government and Semi-Government organisations like CBRI, SERC & University of Roorkee.

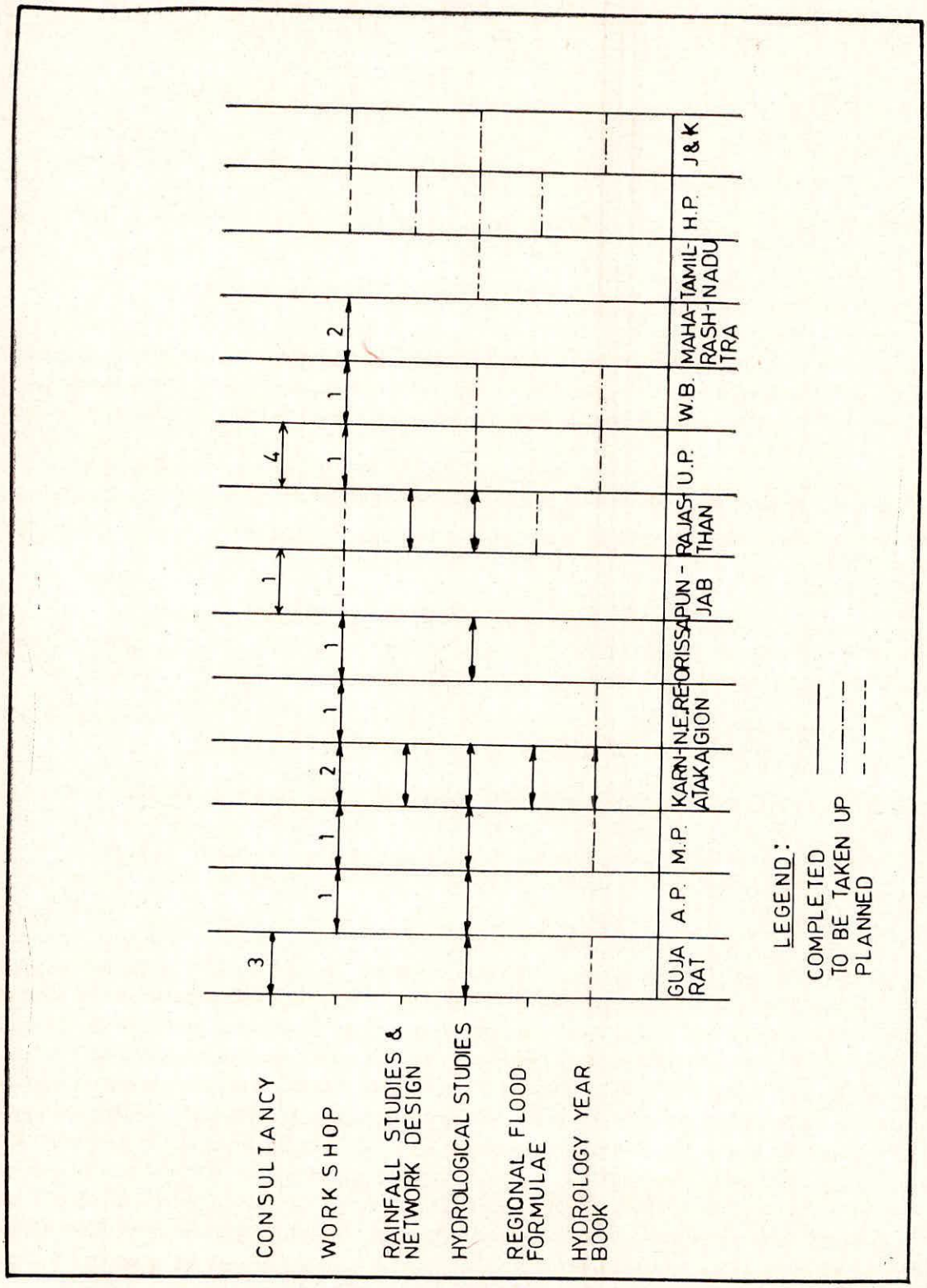


FIG. VI : STATUS OF INTERACTION WITH STATES

3.8 Laboratories

The Institute has established the following laboratories to initiate Laboratory Oriented Studies :

(i) Water Quality Laboratory
(ii) Remote Sensing Applications Laboratory
(iii) Ground Water Laboratory
(iv) Hydrological Investigations Laboratory including Instrumentation Service facility and workshop

(i) Water Quality Laboratory

The laboratory has been set up with the objectives of classification of water resources, collection of base line data, estimating waste essimilation capacity and pollution determination. The water quality laboratory at the Institute is well equipped with facilities for analysing water samples upto 40 paramerers. The laboratory has the capability to analyse physical, chemical and biological parameters. During the year various equipment were used for monitoring of ground water quailty in Saharanpur District. For this purpose 30 representative wells were located and regular analysis of water samples for about 22 parameters was carried out. Analysis of surface water samples from Ganga at Hardwar was also regularly performed.

During the year various equipment like autoclave, autodeioniser, distilled water still were procured. Orders have been placed for sophisticated equipment like flow injection analysis system and COD assembly and these are expected to arrive by April, 1988.

(ii) Remote Sensing Applications Laboratory

The Remote Sensing Application Laboratory has been established to develop capability to prepare outputs by interpretations of imageries as an input to hydrological studies. The laboratory is equipped with large format enlarger, diazo printer, and mirror stereoscopes. Image processing software form SAC (ISRO) has been installed on VAX-11/780 computer system and is being used for digital interpretation and analysis.

Multi-temporal library of Landsat film negative images (1 : 1,000,000) MSS/MT, Landsat (MSS/TM) FCCS (1:250, 000), CCTS, for a number of scenes covering various hydrological regions of India has been set up for various remote sensing studies pertaining to Snow Hydrology, Drought, Flood Plailn Mapping, Land Use/Vegetal Cover, Sedimentation etc. A Spectro Radiometer has also been procured which is compatible to Landsat spectral bands for signature collection The facilities of Light table with coordinate measuring system to calculate the areal distance between two points on a map, toposheet, imagery have have also been created. A photo-lab has has also set up to meet the requirements of visual processing. So far 8X products have been successfully tried upon for the studies. Progress in the direction for 20X enlargement is in the offing. The Stereo Zoam Transferoscope, optical pentograph, colour composite printer/enlarger, and Image Processiog Console COMTAL vision one/20 have been ordered and are expected soon.

(iii) Ground Water Laboratory

The ground water laboratory has been set up with the objectives of carrying out various studies relating to flow through unsaturated soil, ground water recharge, two phase fluid flow, two dimensional seepage and flow of immiscible fluids. The laberatory presently is equipped with ring infiltrometers, variable head and constant head permeameters, electric analogue apparatus, equipmant for determining grain size distribution and Heleshaw model for conducting two dimensional seepage studies.

During the year field infiltration studies were conducted in Indira Gandhi Nahar Pariyojna command area and in the NIH campus. It is planned to equip the laboratory with R.C. Analogue Hybrid System hooked to P.C. and develop tensiometer for determining soil moisture characteristics. Efforts are being made to strengteen the laboratory for advanced studies in various field of ground water.

(iv) Hydrological Instrumentation Laboratory and Instrumentation Service and Workshop

The Instrumentation laboratory has the main objective of demonstraring applications of nuclear, geophysical and instrumentation techniques in proper evaluation and assessment of water resources and also development of hydrological instruments. The laboratory has a Troxler Nucleonic gauge, resistivity meter, synchroscope and general purpose electronic equipment. A resistivity meter procured in the laboratory is being used for carrying out resistivity measurements for estimation of soil moisture in the unsaturated zone. Besides, the laboratory has developed a circuit for interfacing a tipping bucket raingauge with a strip chart recorder, and electronic water level detector.

A Data Acquisition System is also being developed to be used in a telemetry system.

The instrumentation service facilities have been developed for catering to the day to day maintenance of various epuipment in different laboratories of the Institute. A mechanical workshop equipped with required machinery has been in operation. Apart from attending to the maintenance jobs, the workshop has also fabricated instruments for the ground water laboratory and assembled display boards.

3,9 International Cooperation

In keeping with the objectives of the institute and as recommended by the tripartite review committee of the UNDP project, the institute has been pursuing relentlessly project proposals for international collaboration to strengthen the laboratory facilities, undertake field oriented studies and develop expertise in new areas of research such as snow hydrology, Remote Sensing Applications, Data Storage and retrieval system, hydrological investigation using nuclear techniques and rainfail simulator experiments,

During the year 1987-88 two agreements have been reached for scienrific and technical cooperation between Govt. of India and Europian Economic Community and Govt. of India and USSR.

(i) NIH/EEC Collaboratian Project

A project entitled 'Hydrological Computerised Modelling System (SHE)' is operational since October, 1987 for the transfer of SHE Model under an agreement between GOI and European Economic Community to be operated by Danish Hydraulic Institute, Copenhagen, Denmark. The transfer of SHE model include necessary mathematical modelling know-how and computational expertise in order to enhance the practical applications of the modelling system to Indian rivers. The SHE model would be made operational on VAX-11/780 computer system in NIH and scientists of the institute would be trained in the operational model in Europe to enable them to apply the model on water resources projects in India.

(ii) Scientific and Technical Cooperation with USSR

Optimal utilisation of available water resources is necessary such that surface and ground water are used conjunctively. The project 'Optimal conjunctive use of surface and ground water' provides for visits of two NIH experts to institutes in USSR and visit of two Soviet experts to NIH. Under the project technical literature in the area of conjunctive use would also be transferred between Institutes in USSR and NIH.

(iii) Apart from the above, four more projects for bilateral cooperation programme are also being developed and are under consideration of Ministry.

(a) Cooperation with Dutch Government for strengthening National Institute of Hydrology in the areas of remote sensing application, agricultural drainage, hydrological data acquisition system, groundwater modelling and water quality.

(b) Cooperation with German Technical Cooperation (GTZ) for development of National Institute of Hydrology in the areas of snow hydrology, Nuclear and Geophysical Investigations, hydrology of special areas, hydrological instrumentation and environmental hydrology.

(c) Cooperation with Braunschweig Technical University, West Germany in the areas of Representative and experimental Basins and techniques of water availability in reservoirs.

(d) Ccoperation will Louisiana State University and Gujarat Government under USAID for development of a hydrological model using geomorphological parameters.

3.10 Library

The Institute has a well equipped library which was established in 1980. A large number of books, journals, documented computer programmes, technical reports, Indian and foreign standards, atlases and maps related to various research areas of hydrology are available in this library.

As on 31st March, 1988 the library had in its possession 4066 books, 2265 reports, 63 Indian and foreign periodicals, 947 papers, 247 standards, 255 documented computer programmes, 41 microfiches and 1946 maps. The current year's activities of the library include procurement of 578 books, 368 reports, 11 microfiches and 28 maps. 13 new periodicals have been added in

the library during the year and the Institute has obtained organisational membership of four National Professional Organisations.

Aiming at the better use of facilities available, the library extended its services to documentation and referal services. A data base for books, reports and journals available in the library has also been created.

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 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. The secretariat also functions as the secretariat of the Asian Regional Coordination Committee on Hydrology (ARCCOH). Year wise activities of HILTECH are presented in Figure-VII.

3.11.1 Meetings of High Level Technical Committee on Hydrology (HILTECH)

The tenth meeting of HILTECH was held at New Delhi on July 9, 1987 under the Chairmanship of Sh. M.A. Chitale, Chairman, Central Water Commission.

The following main issues were discussed :

(i) Rules and Procedure for HILTECH
(ii) Calender of activities in the area of hydrology
(iii) National Hydrology Projects on Surface Water and Water Quality
(iv) International activities in Hydrology
(v) Designing of on the job training courses in hydrology for hydrology technicians,

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

During the year 1987-88, the third meeting of water Resources System Panel, Hydrometeorology Panel, Surface Water Panel and second meeting of Ground Water Panel were held. During these meetings important decisions regarding preparation of State of art reports, identificatron of thrust areas of research were taken.

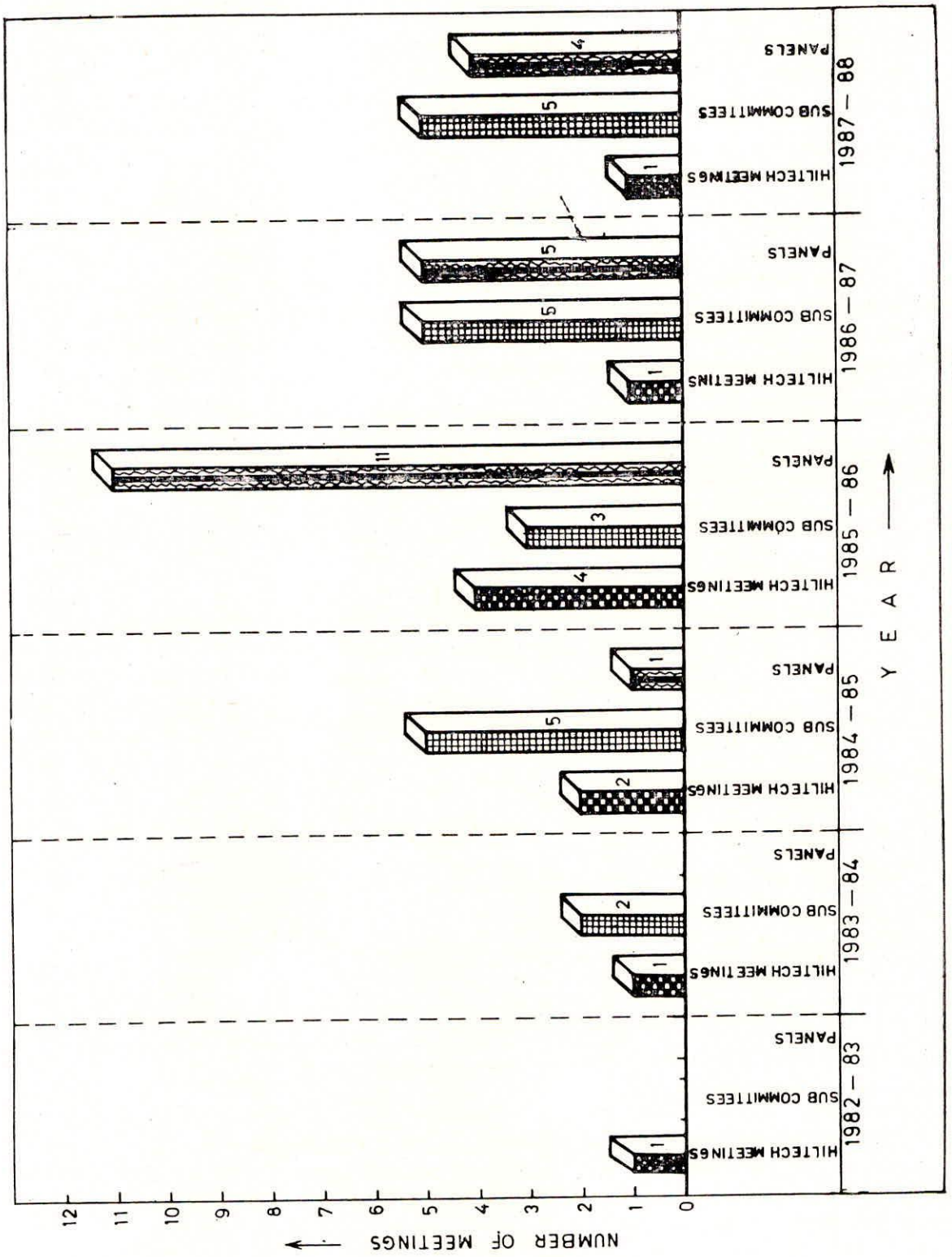


FIG. VII : YEARWISE ACTIVITIES OF HILTECH

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) Interaction Between Research Organisations, Universities and agencies
(v) Man Power Requirement in Hydrology
(vi) P.G. Level Courses

During the period under report, two meetings of Steering Committee, one meeting of Editorial Advisory Board of Jal Vigyan Sameeksha and two meetings of other Sub-Committees were held,

3.11.4 Indian Delegation to Various International Meetings

(i) The HILTECH Secretariat circulated information regarding XIX General Assembly of International Union of Geodesy and Geophysics (IUGG) which was held in Vancouver, Canada from August 9-22, 1987 during which one of the seven associations of IUGG i.e. International Association of Hydrology Science (IAHS) held various symposium on hydrology. The HILTECH sent a delegation of Indian experts for participation in the General Assembly of IUGG and symposia organised by IAHS.

(ii) The HILTECH Secretariat prepared the comments on various agenda items proposed for discussion at the 24th General Conference of UNESCO which was held in Paris during Oct. - Nov., 1987, The comments were forwarded to the Indian delegation sent from Ministry of Human Resources, New Delhi. A resolution was also prepared to include financing the second component of Major Regional Project (MRP) for South-Central Asia Region for consideration at the General Conference. MRP for South-Central Asia was approved at this meeting and US $ 20,000 were allocated for the year 1988. Also the HILTECH Secretariat recommended for contesting for one seat in Inter-governmental Council Election which was held during 24th General Conference of UNESCO. India was elected as one of the 30 members of Inter-governmental Council (IGC) of IHP of UNESCO and its term will expire until 26th General Conference in UNESCO sometime in 1991.

3.11.5 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.

3.11.6 During the period, the HILTECH Secretariat also provided partial financial support for organisation of activities in hydrology and water resources in the country :

(i) 6th Annual Convention of Association of Hydrologists of India (AHI) and seminar on 'Hydrology' with colloquium on 'Urban Water Supply', 28th to 30th August, 1987 Madras organised by AHI (Waltair).

(ii) Afro Asian Conference on 'Integrated Water Management in Urban Areas', Dec. 3 to 6, 1987, Bombay organised by Indian Water Works Association (IWWA).

(iii) First National Symposium on 'Hydrology'. Dec. 16-18, 1987 Roorkee, organised by National Institute of Hydrology, Roorkee.

A statement of various Seminars/Symposium & research projects funded during the year by HILTECH is given in Appendix-IX.

3.11.7 Publication of Jal Vigyan Sameeksha

The second half yearly issue of Jal Vigyan Sameeksha for 1986 with 'Hydrological Forecasting' as the focus theme, has been published and circulated to various concerned organisations and HILTECH members. The next issue of Jal Vigyan Sameeksha with focus theme of 'Ground Water Management' is under publication.

3.11.8 Activities at ARCCOH Secretariat

The ARCCOH Secratariat functioned quite actively and various activities initiated by ARCCOH were constituted during the year. A brief description of various activities carried out are as below :

(i) Directory of Hydrologists

The Secretariat has compiled a 'Directory of Hydrologists' in ARCCOH region in pursuance of the decisions taken at various meetings of ARCCOH. The first volume of 'Directory of Hydrologists' has been circulated to various member countries of ARCCOH which contains particulars of about 450 hydrologists from various countries. Second volume of directory with particulars of 450 additional hydrologists also been compiled and is under printing and would be circulated soon.

(i i) Annual Bulletin of ARCCOH

As decided during 3rd meeting of ARCCOH Steering Committee, an annual bulletin of ARCCOH for the year 1985 was brought out by the Secretariat which contained reports on hydroiogical activities during 1985 of ten countries of ARCCOH region. Besides, hydrological activities coordinated by the two regional offices of UNESCO in Asia namely, ROSTSCA, New Delhi and ROSTSCA, Jakarta have also been included in the annual bulletin. The bulletin has been circulated to various member countries of ARCCOH. Actions to compile annual bulletins for 1986 and 1987 are under progress.

(iii) ARCCOH Newsletter

One of the objectives of the ARCOOH is to bring out a quarterly newsletter giving information about various hydrological activities and other activities related with IHP of UNESCO for diffusion in the region. During the year, 4 issues of Newsletter were brought out and circulated to various member countries in the region. The Newsletter contained information regarding various meetings organised in connection with IHP of UNESCO in different countries, membership of various Working Groups of IHP-III Projects description of various short and long term training courses in hydrology organised in the region and elsewhere, hydrological activities of various

IHP National Committees in the region, information regarding various international events on hydrology and water resources in the world, description of publications brought out by various National Committees in the region on Hydrology and Water Resources, changes in the composition of National Committees and their addresses, missions of UNESCO exprts in various countries in the region for developing hydrological activities and various other kinds of information regarding IHP of UNESCO.

(iv) Major Regional Project (MRP)—South-Central Asia Component

In order to finalise the activity details of second component of major Regional Project (MRP) for a group of South-Central Asian countries, a preparatory meeting was organised during Jan. 1986 at Roorkee. During the year actions on various decisions taken at this meeting were continued and the project proposal was finalised and circulated to various countries of ARCCOH. The proposal was considered at the 24th General Conference of UNESCO held during Oct./Nov., 1987 and an allocation of U.S.$ 20,000 has been made for activities during 1988. Further actions are under progress.

(v) Hydrogeological Map of Asian Region

As decided during earlier meetings of ARCCOH a mission has been launched by the ARCCOH Secretariat to compile a hydrogeological map of the Asian Region using a common legend. In this connection, experts have been identified to undergo missions in various countries to accelerate the processes of compiling National Hydrogeological Maps and inturn the map of Asian Region. The experts have already undertaken missions in this connection to Nepal and Sri Lanka. Actions to send experts in other countries are under process and it is expected that the map will be compiled soon.

3.12 Consultancy

The Institute has been carrying out the research studies sponsored by various States/Central Government organisations. The following consultancy projects have been completed during the year.

1. Computerization of Ground Water data of U.P.
2. Software development for Ground Water balance.
3. Studies for Assessment of dewatering efforts in the construction of UGC canal in the zone of high water table.
4. Design flood studies for Kishau Dam Project.

In view of the severe drought situation in the country, the availability of drinking water has become a problem for most of the areas. The Technology Mission on drinking water supply under Dept. of Rural Development, Ministry of Agriculture, New Delhi requested the Institute to take up the study relating to the water availability in 8 problem districts belonging to 7 States as a pilot study.

Also, in view of the fact that the water availability studies have to be carried out basinwise. The technology Misson desired that Institute may conduct study for conjunctive use water planning for Sabarmati basin in Gujarat & Rajasthan States to develop a forecasting model linking with monsoon rainfall for which the data collection is in progress.

The water logging situation is very acute in the Indira Gandhi Nahar Pariyojna Command Area-Stage-I. The Government of Rajasthan referred the problem to the Institute for conducting the studies in command area and for suggesting measures for its control.

The Government of Gujarat requested the Institute to conduct system studies and to prepare real time operation manuals and forecasting system for Sabarmati and Machhu reservoir system.

The following five projects are in progress :—

1. Water Accounting studies in 8 problem districts belonging to 7 States.
2. Developing a forecasting model linking with monsoon rainfall for Sabarmati basin.
3. Studies of causes of water logging and its control in Indira Gandhi Nahar Pariyojna Command Area-Stage-I.
4. Reservoir operation studies for Machhu System.
5. Reservoir Operation studies for Sabarmati System.

Various consultancy projects which have been completed and are under progress are given in Appendix-XI.

3.13. Participation in Seminars and Symposia

The scientists and scientific staff of NIH participated in various Seminars and Symposia during the year under report as given in the Appendix-XII.

3.14 Visitors

Prof. Y.K. Alagh, Member (Agriculture), Planning Commission visited the Institute on 16th Dec., 1987. He inaugurated the National Symposium on 'Hydrology' organised by the Institute and delivered his inaugural address. Sh. M.A. Chitale, Chairman, Central Water Commission visited the Institute and delivered key note address at the Symposium. Sh. K.K. Framji, Secretary-General ICID and Sh. C.C. Patel, Former Secretary, Mtnistry of Irrigation, Government of India visited the Institute on 18th Dec., 1987 and delivered presidential and valedictory addresses respectively for the symposium. Prof. Bharat Singh, Former Vice-Chancellor and Professor Emeritus, University of Roorkee, and Sh. M.G. Padhye, Former Secretary, Ministry of Irrigation, Government of India also visited the Institute.

World Bank team consisting of eminent Scientists and Engineers visited the Institute in connnction with draft National Hydrology Project. 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 scientists and scientific staff of the Institute.

3.15 Recreation and Welfare Activities

Recreation Club organisad various activities for the recreation and benefit of fhe staff and their family members. Varlous cultural functions a picnic, several cricket matches with local organisations and annual sports were organised.

3.16 Newsletter

The Institute's Newsletter "Jal Vigyan Samachar" is published quarterly. During the year, four issues of "Jal Vigyan Samachar" were published in April, July, October, 1987 and January, 1988.

Besides furnishing the plan, programme and progress of the Institute the Newsletter report on tho studies and the research that are being carried out in the Institute. Short abstracts of the technical reports with illustration are published. Information of general interest to the hydrologic community are also covered. Reports from various Central/State Govetnments Institutions are identified and coverage of hydrologic news from the State and Central Organisations are being gradually widened. This has been found to be very effective forum for interaction with the hydrologic community at large.

The Newsletter is widely circulated to various Central/State Governments and academic organisations. The feed back information from the readers are reviewed to update the contents and format of the Newsletter.

3.17 Use of Hindi

In accordance with the Official Language Policy of the Government, efforts were made by the Institute during the year towards implementation of various provisions of the Official Language Act, 1983 and the rules framed thereunder. The Hindi Salahkar Samiti of this Institute was reconstituted as Rajbhasha Karyanvayan Samiti (Official Language Implementation Committee) which had its first meeting on 23rd November, 1987. In accordance with its decisions, name plates of the Laboratories were made bilingual, 237 books in Hindi were purchased for the library. Bilingual signboards of the Institute have been set up on the Delhi Roorkee highway.

A Hindi week was celebrated from 30th November to 4th December, 1987, during which it was emphasised upon the personnel of the Institute to use Hindi in official use as much as possible. Hindi essay Competition for the Scientific Staff and a Hindi noting-drafting competition for non-scientific staff were held during the week. A progressive consciousness towards Hindi is evident in the Institute.

All letters received in Hindi during the year 1987-88 were replied in Hindi and 218 letters & telegrams were sent in Hindi. Annual report of the Institute is being published bilingualy in Hindi and English.

4.0 FINANCE & ACCOUNTS

During the year under review the Government of India, Ministry of water Resources provided an amount of Rs. 80 lakhs as grant-in-aid and Rs. 60 lakhs was released to the Institute under Plan and Non-Plan heads. The actual expenditure of the Institute during the year after taking into account the amount carried forward from the previous year was Rs. 64,69,418.12 under Plan head and Rs. 65 32,113.34 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 1988 duly certified by the Auditors is given in Appendix XIII. It will be seen from the auditors report that additions worth of Rs. 53.48 lakhs were made to the fixed assets of the Institute during the year.

Auditors observations are given below :

1. Working Results

During the year under audit, the net revenue expenditure incurred by the Institute works out of Rs. 74,64,913.36 as against Rs. 51,73,465.84 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. 39,25,494.41 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	(+)	53,48,297.99
2. Increase in work-in-progress	(+)	5,592.35
3. Decrease in Advance	(—)	16,44,111.66
4. Increase in Deposits	(+)	19,000.00
5. Increase in Prepaid	(+)	3,72,892.11
Less : Increase in liabilities :		
Decrease in Deposits	(—)	8,147.30
Increase in liabilities	(+)	1,84,323.68
		(—) 1,76,176.38
		39,25,494.41

3. Building work-in-progress-Rs. 67,74,996.63 :

Upto the year under audit, a sum of Rs. 67,74,996.63 has been given to University of Roorkee, Roorkee for various construction works as per details given in Schedule-'B' forming parts of annual accounts.

3.1 Advance for Various Construction Works, Rs. 50,67,734.24 :

(a) A sum of Rs. 4,68,697.00 has been paid to University of Roorkee, Roorkee on the basis of estimates submitted by UOR, Roorkee and a sum of Rs. 15,05,738.00 has been adjusted/refunded. 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.

(b) A sum of Rs. 10 lakhs has been given to UOR, Roorkee on 26.03.87 for construction of Museum-cum-information centre representing 90% payment of the above work and the same were has not been completed by UOR, Roorkee till finalisation of accounts i.e. 27.07,88.

(c) The sanction of the government was granted for Rs. 11.04 lakhs for construction of Laboratory Block while the same has been completed at the cost of Rs. 12.67 lakhs and no approval/sanction of the Government for escalation was not shown to us for our verification.

3.2 Steel & Cement with UOR, Roorkee-Rs. 17,07,262.29 :

(a) Cement & 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.

(d) The details of the cost of empty cement bags were not available for our verification.

4. Advances Rs. 3,14,264.00 :

4.1 Advances to U.P.S.E.B. :

A sum of Rs. 95,154.60 has been given as advance to Uttar Pradesh Electricity Board for temporary connections of line to the Administrative Building and L.T. Site preparation and the amount is being adjusted in 1988-89 in monthly electricity bills.

4.2 Other Advances Rs. 13,101.00 :

A sum of Rs. 13,101.00 is outstanding against various parties for supply of equipments/ services and some of the advances have been adjusted in 1988-89.

4.3 Staff Advances-2,06,008.40 :

A sum of Rs. 2,06,008.40 is outstanding with various employees of the Institute.

5. Library :

5 1 It is observed in some cases, that books have not been returned since last so many years while the same should be returned after a certain period.

5.2 Physical verification of books have not been done during the year under audit.

6. Purchase :

The Institute is having a own purchase procedure but the same has not been fully followed in few cases.

7 Accounts :

It is suggested that Institute should have Accounts Manual to define clear accounting system and procedures.

As per past practice, the Balance Sheet and Income and Expenditure accounts has been prepared on accrual basis of accounting were as the utilisation Certificate has been prepared on the basis of actual receipts and payments. 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.

The pointwise replies to these observations are as follows :

3.1 (a) The construction work is taken up by University of Roorkee as a deposit work and advances are given to the University to the extent of 90% of the estimated cost after deducting the cost of Cement and Steel which is provided to the University by the Institute. The University provides the financial accounts and completion certificate. Any balance payment required on account of the construction concerned is paid by the Institute to the University.

(b) The tenders for the Museum-cum-recreation centre were called by the University and the work awarded to a contractor. Since the contractor did not take up the construction work and the contract was rescinded and fresh tenders were floated. As a result, the work could not be completed in the year under consirderation.

(c) The Institute had asked the University for the construction of a connecting corridor between lab block and the Administrative building. The University of Roorkee did not submit the

accounts of connecting corridor separately and added this in the cost of Laboratory block. The increase in the cost of construction of laboratory block is on account of this additional construction.

3.2 The cement and steel were procured by the Institute and maintained by the University of Roorkee as the Institute does not have a store of its own and facilities of storage of steel and cement.

The University maintains the accounts of steel and cement and provides the balances of steel and cement available with them to the Institute. The status of cement and steel is checked by the Institute every time when the completion certificate of any work is received. The Institute has recently started a quarterly reconciliation of the steel and cement available with the University. The University maintains the account of empty cement bags also and adjust in the bill to the Institute.

4. The advances to U.P. State Electricity Board have been adjusted Other advances for the supply of equipment and services has also been adjusted since the audit. The advances to various employees of the Institute are being recovered regularly as per the normal procedure.

5. The physical verification has normally been done between the month of April and June every year. In view of audit observations, these physical verification are carried out during the year 1988-89 during January to March so that the report of verifications are available to the auditors.

6. The Institute has been following the purchase procedure of its own. Since the cases in which auditor has indicated the purchase procedure not been followed fully have been scrutinised and concerned divisions have been advised to follow the procedure rigorously.

7. The manual of Accounts suggested by auditors is being prepared. The figures in the balance sheet and utilisation certificate have since been reconciled.

The observations of the auditor alongwith the replies/clarifications as given were presented in the 33rd Governing Body meeting of the Institute held on 9th August 1988. The Governing Body approved the auditors reported taking into account these replies/clarifications.

5.0 ACKNOWLEDGEMENT

The different activities of the Institute have progressed well under the blessings of the President and Vice-president of the Society and direction and guidance from Chairman 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 is 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

APPENDIX I

NATIONAL INSTITUTE OF HYDROLOGY SOCIETY

PRESIDENT : Union Minister for Water Resources
Government of India
Shram Shakti Bhawan
New Delhi - 110 001

VICE PRESIDENT : Minister of State for Water Resources
Government of India
Shram Shakti Bhawan
New Delhi - 110 001

MEMBERS

Member
Planning Commission
Yojna Bhawan
Sansad Marg
New Delhi-110 001

Minister-in-Charge of Irrigation
Government of Himachal Pradesh
Shimla

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 of Irrigation
Government of Bihar
Patna

Minister-in-Charge of Irrigation
Government of Assam
Guwahati

Minister-in-Charge of Irrigation
Government of Karnataka
Bangalore

Secretary to Govt. of India
Ministry of Environment & Forest
Bikaner House
New Delhi

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

Secretary to Govt. of India
Ministry of Water Resources
Shram Shakti Bhawan
New Delhi - 110 001

Secretary to Govt. of India
Ministry of Science & Technology
Department of Science & Technology
Technology Bhawan, New Mehrauli Road
New Delhi - 110 016

Secretary to Govt. of India
Ministry of Agriculture & Cooperation
Krishi Bhawan
New Delhi – 110 001

Secretary to Govt. of India
Ministry of Energy
Shram Shakti Bhawan
Rafi Marg
New Delhi - 110 001

Secretary to Govt. of India
Department of Expenditure
Ministry of Finance
New Delhi - 110 001
(or his nominee)

Secretary to Govt. of India
Ministry of Urban Development
Nirman Bhawan
New Delhi - 110 002

Secretary to Govt. of India
Planning Commission
Yojna Bhawan
Sansad Marg
New Delhi - 110 001

Chairman
Central Electricity Authority
Sewa Bhawan, R.K. Puram
New Delhi - 110 066

Chairman
Central Water Commission
Sewa Bhawan. R.K. Puram
New Delhi - 110 066

Member (Water Planning)
Central Water Commission
Sewa Bhawan, R.K. Puram
New Delhi - 110 066

Member (River Management)
Central Water Commission
Sewa Bhawan, RK Puram
New Delhi – 110 066

Chairman
Central Ground Water Board
236, Krishi Bhawan
New Delhi – 110 001

Chairman
Brahmputra Board
Silpukhuri
Guwahati - 781 003

Director General
National Water Development Agency
Office-cum-Shopping Complex
Community Centre
Near Anupam Cinema
Saket, New Delhi - 110 017

Chairman
Narmada Control Authority
213, Palika Bhawan
Sector XIII, RK Puram
New Delhi - 110 066

Chairman
Ganga Flood Control Commision
Sinchai Bhawan (3rd Floor)
Patna - 800 015

President
Indian Association of Hydrologists &
Secretary, Irrigation Department
Gandhinagar - 382 010 (Gujarat)

Shri KK Framji
Secretary-General
International Commission on Irrigation &
Drainage,
48, Nayaya Marg, Chankayapuri
New Delhi - 110 021

Shri MG Padhye
Secretary (Retd.)
Irrigation Department
6, Kalashree Apartments
6th Lane, Prabhat Road
Pune - 411 004 (Maharashtra)

Dr. B.S. Mathur
Professor & Head
Department of Hydrology
University of Roorkee
Roorkee - 247 667 (U.P.)

Dr. R. Sakthivadivel
Director
Centre for Water Resources
College of Engineering
Anna University
Madras-600 025 (T.N.)

Prof. Subhash Chander
Department of Civil Engineering
Indian Institute of Technology
Hauz Khas
New Delhi - 110 016

Director General (Meteorology)
Indian Meteorological Department
Mausam Bhawan
Lodi Road, New Delhi - 110 003

Director General
Geological Survey of India
Chowringee Road
Calcutta

Additional Secretary
Government of India
Ministry of Water Resources
Sharm Shakti Bhawan
New Delhi - 110 001

Chairman
Central Board for Prevention &
Control of Water Pollution
Skylark, 6th Floor
60. Nehru Place
New Delhi - 119 019

Joint Secretary (Admn.)
Ministry of Water Resonrces
Shram Shakti Bhawan
New Delhi - 110 001

Commissiener (Projects)
Ministry of Water Resources
Shram Shakti Bhawan
New Delhi - 110 001

Commissioner (Indus & Floods)
Ministry of Water Resources
CGO Complex, 9th Floor
Block No. 11, Lodi Estate
New Delhi - 110 003

Commissioner (JRC)
Ministry of Water Resources
CGO Complex
Block No. 11, Lodi Estate
New Delhi - 110 003

A representative of the HILTECH
Roorkee

Member Secretary

Director
National Institute of Hydrology
Roorkee - 247 667 (U.P.)

GOVERNING BODY

CHAIRMAN : Secretary to Government of India
Ministry of Water Resources
Shram Shakti Bhawan
New Delhi - 110 001

VICE CHAIRMAN : Vice Chancellor
University of Roorkee
Roorkee

MEMBER SECRETARY : Director
National Institute of Hydrology
Roorkee

MEMBERS

Secretary to Government of India
Department of Power
New Delhi
(or his nominee)

Secretary to Government of India
Ministry of Agriculture and Cooperation
New Delhi
(or his nominee)

Secretary to Government of India
Ministry of Urban Development
New Delhi
(or his nominee)

Secretary to Government of India
Department ef Expenditure
Ministry of Finance
New Delhi
(or his nominee)

Secretary to Government of India
Planning Commission
New Delhi
(or his nominee)

Secretary to Government of India
Ministry of Science & Technology
New Delhi
(or his nominee)

Chairman
Central Water Commission
New Delhi
(or his nominee)

Chairman
Central Electricity Authority
New Delhi
(or his nominee)

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

Director General (Meteorology)
India Meteorological Department
New Delhi

Chairman
Central Ground Water Board
New Delhi

Commissioner (Projects)
Ministry of Water Resources
New Delhi

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

One representative of Irrigation Department
Uttar Pradesh

APPENDIX — II

TECHNICAL ADVISORY COMMITTEE

CHAIRMAN : Chairman
Central Water Commission
New Delhi

Convenor : 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
Khadakwasla
Pune

A representative of Department
of Science & Techology
Government of India
New Delhi

Dr. Subhash Chander
Professor in Civil Engineering
Indian Institute of Technology
New Delhi

Dr. A.S. Chawla
Professor
Water Resources Development &
Training Centre
University of Roorkee
Roorkee

Shri J.F. Mistry
Secretary (Irrigation)
Government of Gujarat
Gandhinagar, Gujarat

Chief Engineer (WR) & Joint Secretary to
Government of Maharashtra
Irrigation Department
Bombay

APPENDIX—IV

MEETINGS OF BODIES, COMMITTEES & WORKING GROUPS

Title	Date of Meeting	
Governing Body		
1. 31st Governing Body meeting	24.8.1987	
2. 32nd Governing Body meeting	18.3.1988	
Technical Advisory Committee		
1. 17th Technical Advisory Committee meeting	15.7.1987	
2. 18th Technical Advisory Committee meeting	16.12.1987	
Working Groups	**First Meeting**	**Second Meeting**
1. Flood Studies Division	24.7.1987	15.2.1988
2. Drought Management Division	28.7.1987	18.2.1988
3. Surface Water Analysis & Modelling Division	27.7.1987	15.2.1988
4. Hydrologic Design Division	24.7.1987	29.2.1988
5. Mountain Hydrology Division	27.7.1987	24.2.1988
6. Ground Water Assessment	19.2.1987	4.4.1988
7. Conjunctive Use Division	23.7.1987	4.4.1988
8. Drainage Division	29.7.1987	17.2.1988
9. Water Resources System	19.2.1987	29.2.1988
10. Man's Influence Division	30.7.1987	24.2.1988
11. Remote Sensing Applications	25.3.1987	18.2.1988
12. Information System & Computer Centre	22.7.1987	25.2.1988
13. Hydrologic Investigations	20.7.1987	25.2.1988

APPENDIX—V

MEMBERS OF HIGH LEVEL TECHNICAL COMMITEE ON HYDROLOGY

CHAIRMAN : Chairman
Central Water Commission
Sewa Bhawan, RK Puram
New Delhi-110 066

MEMBERS

1. Director
National Institute of Hydrology
Roorkee

2. Chairman
Central Ground Water Board
236, Krishi Bhawan
New Delhi-110 001

3. Director General
Indian Council of Agricultural
Research
Krishi Bhawan
New Delhi-110 001

4. Director General
Council of Scientific and
Industrial Research
Rafi Marg
New Delhi-110 001

5. Director General
Geological Survey of India
27, Jawahar Nehru Marg
Calcutta-700 016

6. Director General (Meteorology)
India Meteorological Department
Lodi Road
New Delhi-110 003

7. Chairman
Central Board for Prevention &
Control of Water Pollution
6th Floor, Skylark
60, Nehru Place
New Delhi-110 019

8. Chairman
Central Electricity Authority
Sewa Bhawan, R.K. Puram
New Delhi-110 066

9. President
Forest Research Institute & College
P.O. New Forest
Dehradun-248 006

10. Director
National Remote Sensing Agency
Balanagar
Hyderabad-500 037

11. Advisor (CPH EEO)
Ministry of Works & Housing
Nirman Bhawan
New Delhi-110 011

12. Chairman
Narmada Control Authority
118, Palika Bhawan
Sector XIII, RK Puram
New Delhi-110 066

13. Engineer-in-Chief
Irrigation Department, U.P.
1, Canal Colony
Lucknow-226 001

14. Chief Engineer (WR) & Joint Secretary
Department of Irrigation
Mantralaya
Bombay-400 032

15. Chairman
Brahmaputra Board
Silpukhuri
Guwahti-781 003

16. Dr. Subhash Chander
Professor in Civil Engineering
Indian Institute of Technology
Hauz Khas
New Delhi-110 016

17. Shri K K Framji
Secretary General
I.C.I.D.
48, Nayaya Marg
Chanakyapuri
New Delhi-110 021

18. Chief Engineer (Ground Water)
Public Works Department
Chepauk
Madras-600 005 (T.N.)

20. Director
State Water Investigation Dte
Sech Bhawan, 3rd Floor
Bidhan Nagar
Calcutta-700 064

20. Director
Snow & Avalanche Study Establishment
Defence Research & Deveiopment Orgn.
C/o 56 A P O

Member Secretary

Senior Scientist
HILTECH Division
National Institute of Hydrology
Roorkee-247667

APPENDIX—VI

POSITION OF STAFF OF NIH AS ON 01.4.1987 AND 31.3.1988

Sl. No.	Description	Existing as on 01.4.1987	Existing as on 31.3.1988	Remarks
1.	Director	1	1	
2.	Scientist 'F'	2	3	
3.	Scientist 'E'	4	3	
4.	Chief Administrative Officer	1	—	
5.	Scientist 'C'	10	12	
6.	Finance Officer	1	1	
7.	Scientist 'B'	14	18	
8.	Assistant Engineer	1	—	
9.	Section Officer	—	—	
10.	Senior Personal Assistant	1	1	
11.	Senior Research Assistant	16	16	
12.	Senior Research Assistant (Programming)	—	1	
13.	Research Supervisor	1	1	
14.	Senior Technical Assistant (Lib)	1	1	
15.	Superintendent	1	1	
16.	Personal Assistant	5	6	
17.	Research Assistant/Tech. Asstt.	11	23	
18.	Senior Computer Operator	—	—	
19.	Hindi Translator	1	1	
20.	Junior Engineer (Civil)	—	1	
21.	Junior Engineer (Elect.)	—	1	
22.	Foreman (E & M)	—	—	
23.	Senior Technician	—	—	
24.	Technical Assistant (Photography)	1	1	
25.	Work Supervisor	1	1	
26.	Technician (Grade I)	—	—	
27.	Senior Draftsman	—	—	
28.	Technician (Grade II)	4	7	
29.	Draftsman	1	1	
30.	Senior Laboratory Assistant	1	1	
31.	Computer Operator	1	2	
32.	Mechanic (Grade I)	2	3	
33.	Stenographer (including Hindi)	6	9	
34.	Upper Division Clerk	5	6	

35.	Receptionist	1	1
36.	Laboratory Assistant	1	3
37.	Mechanic (Grade II)	3	2
38.	Lineman	1	1
39.	Tracers	2	3
40.	Horticulture Assistant	1	1
41.	Observers	—	—
42.	Lower Division Clerk	12	13
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	4
48.	Laboratory Attendant (Tube well)	1	1
49.	Photocopier Operator	1	1
50.	Amonia Print Operator	1	1
51.	Duplicating Machine Operator	—	—
52.	Messenger	13	19
53.	Chowkidar	2	6
54.	Mali	2	3
55.	Safai Karamchari	2	3
56.	Daftari	—	—
	Total :	154	205

APPENDIX — VII

SCIENTIFIC AND TECHNICAL REPORTS PREPARED DURING 1987-88

TECHNICAL NOTES

1.	Evaluation of component of water balance of a river reach	TN 32
2.	Hydrological modelling studies for mountainous areas	TN 33
3.	Temperature stratification in lakes	TN 34
4.	Instrumentation and measuring techniques for flow measurements in mountainous areas	TN 35
5.	Study of glacier melt and physics of glaciers	TN 36
6.	Drainage in heavy soils	TN 37
7.	Positive impacts of water resources projects on environment	TN 38
8.	Resistivity and S.P. Technique for study of ground water pollution around NIH campus	TN 39
9.	Remote sensing physics of snow	TN 40
10.	Development of resources management model combining water flora and fauna sub models.	TN 41

TECHNICAL REPORTS

1.	Study of soil moisture movement during rainfall by Green and Ampt equation and comparison of the study by numerical model	TR 30
2.	Estimation of groundwater recharge due to rainfall by statistical methods	TR 31
3.	Storage determination for a single purpose reservoir	TR 32
4.	Rating Curve establishment under shifting control	TR 33
5.	Development of dimensionless hydrographs of flood from borached dam using DAMBRK Model	TR 34
6.	Analysis of trends and periodicities of rainfall of some districts in Rajasthan	TR 35
7.	Comparative study of different parameter estimation techniques for various probability distributions	TR 36
8.	Systems approach to optimize conjunctive use of surface and ground water	TR 37
9.	Statistical analysis of low flows in typical river basin to investigate drought characteristins	TR 38
10.	Flood plain and inundation mapping — A case study of Mahanadi basin	TR 39

11.	Visual remote sensing studies for watershed characterisation and mapping	TR 40
12.	Stream flow routing using kinematic wave routing option of HEC-1	TR 41
13.	Monthly streamflow simulation for Mahanadi basin using HEC-4 model	TR 42
14.	Forecasting of monsoon runoff using data from specific basins	TR 43
15.	Hydrological modelling of overland flow in hilly areas	TR 44
16.	Variation of precipitation with elevation problem of rainfall input to hydrologic models	TR 45
17.	Interaction of large water bodies with aquifers.	TR 46
18.	Estimation of aquifer parameters using test pumping data of partially penetrating wells	TR 47
19.	Type curves for multiaquifer wells	TR 48
20.	Artificial recharge assessment	TR 49
21.	Groundwater quality variation in a selected area	TR 50
22.	Land use and vegetal cover study using multitemporal variations	TR 51
23.	Geo-electrical techniques for study of soil moisture variations	TR 52
24.	Hydrological year book of Hemavati basin	TR 53
25.	Application of HEC-II programme for water profile determination studies	TB 54
26.	Salt balance in root zone under shallow water table conditions	TR 55
27.	Snow line and snow cover mapping using multidate imageries	TR 56
28.	Remote sensing applications for sedimentation studies in reservoirs	TR 57
29.	Hydrological water year book of Mahanadi basin	TR 58

STATUS REPORTS

1.	Identification of format for collection of data for drought studies	SR 10
2.	Evaporation reduction measures from water and land surface for drought management	SR 11

USER'S MANUALS

1.	Water and waste water analysis	UM 24
2.	Graphical representation of flow duration curves	UM 25
3.	Hydrologic channel routing with graphics	UM 26
4.	Flood routing through reservoirs (with graphics)	UM 27
5.	Processing and analysis of rainfall data	UM 36

HYDROLOCICAL DATA YEAR BOOK

1.	Hemavati basin	HYB 1

APPENDIX — VIII

WORKSHOPS AND SYMPOSIA ORGANISED IN 1987-88

WORKSHOPS

Sl. No.	Topic	Place	Period	No. of participants
1.	Reservoir operation	Roorkee	April 6-10, 1987	18
2.	Design Storm and Design Flood	Krishna-rajasagara, Karnataka	Aug. 10-14. 1987	43
3.	Flood Frequency Analysis	Hyderabad (A.P.)	Oct. 5-9, 1987	27
4.	Processing and Analysis of Precipitation Data	Tawanagar (M.P.)	Oct. 5-9, 1987	30
5.	Flood Estimation by Unit Hydrograph Technique	Nasik (Maharashtra)	Oct. 26-30, 1987	36
6.	Flood Estimation by Unit Hydrograph Technique	Lucknow (U.P.)	Feb. 8-12, 1988	30
7.	Processing and Analysis of Precipitation Data	Nasik	Feb. 22-26, 1988	31

SYMPOSIA

1.	National Symposium on 'Hydrology'	Roorkee	Dec. 16-18, 1987	

APPENDIX — IX

SEMINARS / SYMPOSIA AND PROJECTS FUNDED BY HILTECH

Sl. No.	Title	Place	Period
1.	VIth annual convention of Association of Hydrologists of India and Seminar on Hydrology with colloquium on Urban water supply by AHI, Waltair	Madras	Aug. 28-30, 1987
2.	Afro-Asian conference on integrated water management in urban areas organised by Indian Water Works Association	Bombay	Dec. 3-6, 1987
3.	National Symposium on 'Hydrology' organised by National Institute of Hydrology, Roorkee	Roorkee	Dec. 16-18, 1987
4.	All India Seminar on 'Ground Water Development by GWIO, Lucknow	Lucknow	Apr. 7-8, 1988
5.	Research Project on 'Development of Generalised software of HP-1000 computer system for unit hydrograph based forecast model and its application'	IIT, Delhi	Continuing since 1986

APPENDIX — X

INTERACTION WITH STATES AND STUDIES CONDUCTED, TAKEN UP AND PROPOSED IN THE STATES

A. ANDHRA PRADESH

**1. Workshop on Flood Frequency Analysis
2. Workshop on Flood Routing and Flood Forecasting
3. Problems of Rayalaseema Region of Andhra Pradesh
*4. Water Accounting Studies for Kurnool District
5. Flood Plain Zoning in Badameru basin in Krishna River
**6. Study on hydrological aspects of droughts.

B. GUJARAT

1. Preparation of typical hydrological year book for Sabarmati basin
**2. Dam break studies for Machchu Dam II failure
3. Development of Regional Flood Formulae
*4. Reservoir operation manual for Machchu reservoir
5. Mathematical model studies using geomorphological parameters
*6. Reservoir operation manual for Dharoi reservoir
*7. Conjunctive use model studies for Sabarmati basin
*8. Water accounting studies for Jamnagar and Kutch districts
9. Study of positive effects of WR project - Ukai and Deo Dam
10. Flood plain zoning for Ukai river d/s of Ukai dam
**11. Study of hydrological aspects of droughts
**12. Design flood studies for Sardar Sarovar dam

C. HIMACHAL PRADESH

1. Establishment of Regional Centre
2. Representative basin stu dy
*3. Drying of springs
4. Choking of Khuls and changing river courses
5. Hydrological studies of glaciers
6. Instrumentation in high altitude and network improvement and telemetry
7. Organisation of workshops
8. Problems of erosion and flooding
9. Drought problems of hilly regions
10. Water availability studies

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*Under progress
**Completed

D. JAMMU AND KASHMIR

*1. Studies for orographic effect on precipitation, design flood studies in mountainous areas, snowmelt forecasting and glacier melt runoff.
2. Preparation of status report on effect of deforestation on snow fall/snow melt.
*3. Typical study of snow cover/glaciated area including glacial melt/snow melt forecasting.
4. Design flood studies for mountainous areas in view of orography and presence of snow and glaciers
5. Water availability studies
*6. Improvement of hydrological network
*7. Organisatian of workshops on :
   — Flood routing and flood forecasting, and
   — Flood Estimation using Unit Hydrograph techniques.
8. Forecasting of seasonal rainfall and runoff
9. Remote sensing applications for snow covered and glaciated areas
*10. Effect of afforestation and deforestation on stream flow

E. KARNATAKA

**1. Preparation of hydrological year book for Hemavati basin
**2. Established a regional centre at Belgaum for hard rock area
**3. Study of rainfall trends in Belgaum district
**4. Studies on hydrological aspects of drought
5. Development of modified regional formulae
*6. Reservoir water balance
*7. Hydrological study for conjunctive use planning of Ghataprabha and Malaprabha basins
*8. Water accounting study of Gulbarga District
*9. Sedimentation of Tungabhadra reservoir using remotely sensed data
10. Representative basin studies in Ghataprabha basin

F. MAHARASHTRA

1. Regional flood frequency analysis
*2. Study of hydrologic drought indices
3. Impact of droughts on ground water
*4. Performance of percolation tanks in drought prone areas
**5. Workshop on 'Processing and Analysis of Precipitation Data ; Design Flood using Unit Hpdrograph Technique, and Flood Frequency Analysis'.
6. Stable isotope study to investigate river interaction for River Ganga - Hardwar and Narora (with BARC, Bombay)
**7. Study of hydrological aspects of droughts

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*Under progress

**Completed

G. MADHYA PRADESH

*1. Application of SHE Model to Narmada basin
**2. Design flood studies for Narmada Sagar Project
**3. Workshop on 'Processing and Analysis of Precipitation Data'
4. Workshop on 'Flood Estimation by Unit Hydrograph Technique'
5. Workshop on 'Design Flood; Flood Routing, and Processing and Analysis of Discharge Data'
6. Reservoir water balance study
7. Study of positive effects of WR projects
8. Flood plain zoning in selected reach
9. Regional flood frequency studies for Hasdeo basin and Narmada Basin and development of modified regional formulae
10. Reservoir operation manual for Tawa reservoir
11. Hydrological network design for Narmada basin
**12. Study of hydrological aspects of drought
13. Water accounting studies for Shahdol District

H. NORTH EASTERN REGION / ASSAM

**1. Organisation of Workshop on 'Flood Frequency Studies'
*2. Establishment of Regional Centre at Guwahati
3. Representative basin studies on Brahmaputra basin
4. Development of modified regional formulae
5. Preparation of a typical hydrology year book
6. Study of problem of flash flood
7. Study of water quality problem in rivers and ground water

I. ORISSA

1. Criteria for design flood with calculated risk guidelines and manual
**2. Transfer of dam break model
**3. Water availability studies at three sites on Mahanadi
4. Monthly flow forecasting in Mahanadi at Hirakud
5. Problem of river congestion in delta area
**6. Organisation of workshop on 'Flood Frequency Analysis'
*7. Water accounting studies for Kalindi District

J. PUNJAB

*1. Flash flood studies in Bist Doab Region
2. Workshop on
   (a) Unit Hydrograph Technique,
   (b) Flood Frequency Analysis and
   (c) Processing and Analysis of Precipitation Data

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*Under progress
**Completed

K. RAJASTHAN

**1. Design of network of raing auges and stages and discharge measuring sites
2. Design flood for flashy streams
*3. Regional flood frequency studies
4. Lake studies
*5. Water accounting studies in Barmer and Ajmer
6. Organisation of workshops
7. Drainage of waterlogged area in command of Indira Gandhi Nahar Pariyojna
**8. Study of hydrological aspects of droughts

L. TAMIL NADU

*1. Water accounting studies in Ramanathpuram District
2. Flood plain zoning in Vellar river

M. UTTAR PRADESH

*1. Seasonal ground water balance and monthly mathematical modelling of UGC Command area
**2. Organisation of a workshop on 'Unit Hydrograph Technique'
3. Preparation of typical year book of a river basin in U.P.
4. Establishment of a representative basin (Pinder river) and instrumenting it for hydrological response
**5. Design flood studies for Kishau Dam
**6. Development of data storage system for GWIO
**7. Software development for water balance as per NABARD norms for GWIO
**8. Development of well points system for dewatering of foundations for Solani Aqueduct.

N. WEST BENGAL

*1. Preparation of hydrological year book for Kalighai basin
*2. Hydrological 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
**7. Workshop on 'Flood Frequency Analysis'
*8. Workshop on 'Unit Hydrograph Techniques'

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*Under progress

**Completed

APPENDIX — XI

CONSULTANCY PROJECTS COMPLETED AND UNDER PROGRESS

1.	Flash Flood Studies of Punjab	Punjab Irrigation Department
2.	Preparation of a Reservoir Operation Manual for Dharoi reservoir	Gujarat Irrigation Department
3.	Preparation of a reservoir operation Manual for Machhu reservoir	Gujarat Irrigation Department
*4.	Hydrological studies of Kishau Dam	U.P. Irrigation Department
*5.	Design of well point system for dewatering Solani Aquaduct, Upper Ganga Canal Modernisation	U.P. Irrigation Department
*6.	Development of Storage and Retrieval System of Ground Water Data	U.P. Ground Watar Investigation Organisation
*7.	Software development for Ground Water Plans	U.P. Ground Water Investigation Organisation
8.	Water availability studies in 8 districts belonging to States	Rural Development Department Government of India
9.	Development of forecasting model linking with monsoon rainfall for Sabarmati basin	Rural Development Department, Government of India

Completed during 1987-88

APPENDIX — XII

PAPERS PUBLISHED DURING THE YEAR 1987-88

1. Bhargava, D.N., G.C. Mishra and Satish Chandra, 'Evolution of water table due to seepage from two parallel canals', International Symposium on 'Ground Water Monitoring and Management', March 23-28, Dresden, GDR.

2. Mishra, G.C. and Satish Chandra, 'Unsteady flow to a multiaquifer artesian well', International Symposium on 'Ground Water Monitoring and Management', March 23-28, 1987, Dresden, GDR.

3. Bhatia, K.K.S. and V.K. Lohani, 'Hydro environmental indices — A tool for environmental impact assessment proceedings', National Seminar on 'Impact of Environmental Protection on Future Development' held at Nainital, April 6-8, 1987.

4. Lohani, V.K. and K.K.S. Bhatia, 'Watershed resources development for environmental impact analysis', Proc. of the National Seminar on 'Impact of Environmental Protection on Future Development' held at Nainital, April 6-8, 1987.

5. Singh, R.D., 'Derivation of average unit hydrograph using smooth least square technique', Jour. of the Institution of Engineers (India), Vol. 67, May 1987.

6. Singh, R., B. Soni and A.K. Changkakoti, 'Optimal utilization of irrigation water in Garufalls catchment in Assam, India', Paper presented in the XIX General Assembly of International Association of Hydrological Science at IUGG, Vancouver, Canada, 9-22 Aug. 1987.

7. Perumal, M. and S.M. Seth, 'Discussion on negative outflows from Muskingum method', by A.T. Hjelmfelt, Jour. of Hydraulic Engineering, Proc. ASCE, Vol. 119, No. 8.

8. Palaniappan, A.B., 'Mathematical modelling of alluvial river', Jour. of CBIP, Oct. 1987.

9. Ramasastri, K.S., 'Procedures for quality control of precipitation data in an operational system', Jour. of CBIP, Vol. 44, No. 3, 1987.

10. Satish Chandra and A.K. Sikka, 'Drought analysis and management' in Proc. First National Water Convention. Vol. V, Delhi, Nov. 12-14, 1987.

11. Satish Chandra and A.K. Sikka, 'Water conservation from urban areas' in Proc. Afro-Asian Conference on Integrated Water Management in Urban Areas at Bombay, Dec. 3-6, 1987.

12. Choubey, V.K., 'Land use map of Indore-Bhopal region from Landsat MSS data', Proc. of National Symposium on 'Hydrology', Roorkee, Dec. 16-18, 1987.

13. Jain, S.K., 'On regulation regime function of a reservoir', Proc. National Symposium on 'Hydrology', Roorkee, Dec. 16-18, 1987.

14. Satish Chandra and M. Perumal, 'Present practices and future strategies for flood plain management', Proc. of the National Water Convention organised by CWC and CBIP at New Delhi, Nov. 12-14, 1987.

15. Seth, S.M., 'Surface water assessment', Proc. First National Water Convention, Delhi 12-14, Nov. 1987.

16. Bhatia, K.K.S., 'Dissolved oxygen modelling for Hindon river', Proc. National Symposium on 'Hydrology', Roorkee, Dec. 16-18, 1987.

17. Chalisgaonkar, D., S.K. Jain and B.P. Parida, 'Ground water data storage and retrieval system Proc. of the National Symposium on 'Hydrology', Roorkee, Dec. 16-18, 1987.

18. Kumar, Anil, 'Hydrological land use/vegetal cover mapping and change detection through Landsat MSS imagery — A case study of Saharanpur District', Proc. of National Symposium on 'Hydrology', Roorkee, Dec. 16-18, 1987.

19. Lohani. V.K., 'Assessment of forest influence on ground water regime', Proc. of the National Symposium on 'Hydrology', Roorkee, Dec. 16-18, 1987.

20. Mishra, G.C., 'Determination of aquifer recharge for varying river stages', Proc. of the National Symposium on 'Hydrology', Roorkee, Dec. 16-18, 1987.

21. Ramasastri, K.S., 'Estimation of evaporation from free water surfaces', Proc. of the National Symposium on 'Hydrology', Roorkee, Dec. 16-18, 1987.

22. Santoshi, M.K., 'Development of dimensionless flood hydrographs from Machhu Dam II failure using DAMBRK Model', Proc. of the National Symposium on 'Hydrology', Roorkee, Dec. 16-18, 1987.

23. Singh. R.D., 'Flood estimation in India using regional frequency analysis', Proc. of the National Symposium on 'Hydrology', Roorkee, Dec. 16-18, 1987.

24. Singh, R D., 'Stream flow analysis for hydrological drought of Krishna basin', Proc. of the National Symposium on 'Hydrology', Roorkee, Dec. 16-18, 1987.

25. Seth, S.M. and Satish Chandra, 'Training of hydrological observers and technicians —Action Plan', Proc. of the National Symposium on 'Hydrology', Roorkee, Dec. 16-18, 1987.

26. Seth, S.M. and R.D. Singh, 'Flood estimation in India using regional frequency analysis', Proc. of the National Symposium on 'Hydrology', Roorkee, Dec. 16-18, 1987.

27. Mohan, M., S.C. Verma, R. Singh and S.M. Seth, 'Generation of multi-station daily rainfall data for yield studies in Beas catchment', Proc. of the National Symposium on 'Hydrology', Roorkee, Dec. 16-18, 1987.

28. Verma, P.K., 'Streamflow analysis for hydrological drought of Krishna basin', Proc. of the National Symposium on 'Hydrology', Roorkee, Dec. 16-18, 1987.

29. Chachadi, A.G. and G.C. Mishra, 'Duration of pumping test', Hydrology Jour. of IAH, 1987.

30. Palaniappan, A.B., 'Analysis of pollution and hydrodynamics of a tidal river', International Symposium on 'New Technology in Model Testing in Hydraulic Research', Sept. 1987.

31. Palaniappan, A.B., 'Numerical experiments on Thiessen weights of rain gauges', Jour, of CBIP, Jan. 1988.

32. Ramasastri, K.S., 'Space time characteristics of short duration rainfall over a semi-urban catchment', Accepted for presentation at 54 R & D Session of CBIP to be held at Ranchi, April, 1987.

33. Chandra, Satish and M. Perumal, 'Dam break analysis for Machhu Dam-II' Paper sent for publication in the 54th R & D Session of CBIP to be held at Ranchi, April 1987.

34. Ramasastri, K.S., 'Hydrometeorological characteristics of flood producing storms in the mountainous areas of India', Accepted for presentation at the International Workshop on 'Hydrology of Mountainous Areas', Bratistav, Czechoslovakia, June 1988.

35. Chachadi, A.G. and G.C. Mishra, 'Relation between transmissivity and specific capacity of larger diameter wells', All India Seminar on Ground Water Development, Lucknow 1988.

36, Jain, S.K., B. Soni and P.V. Seethapathi, 'Optimization technique in water resources management', sent for publication in the Jour. of Inst. of Engr., April, Engg. Division.

37. Kumar, Anil and A.K. Nigam, 'Application of remote sensing methods in land use/vegetal cover mapping', Jour. of Inst. of Engrs. (India), Civil Engg. Div. (To be presented in Annual Paper meeting).

38. Perumal, M., 'An approximate physically based flood routing method', Paper accepted for publication in the Irrigation and Power Journal of Oct. 1988 issue,

39. Mishra, G.C. and Satish Chandra. 'Reach transmissivity for a canal embedded in a porous medium underlain by a highly permeable layer', 54th Annual R & D Session of CBIP, April 1988.

40. Mishra, G.C. and S.M. Seth, 'Recharge from a river of large width to a shallow water table aquifer', Ground water 1988.

41. Singh, R.D., 'Determination of aquifer parameters using Rosen Brock Optimization technique' Accepted for presenting in the forth coming paper meeting of the Institution of Engineers.

42. Goel, N.K. and S.M. Seth, 'Studies on Plotting Position Formulae for Gumbel Distribution', in Journal of Institution of Engineers, Civil Engg. Div.

43. Goel, N.K. and S.M. Seth, 'Comments on Evaluating Flood Retarding Structures' by W.F. Rogers and V.P. Singh published in Advances in Water Resources, 1986, Vol. 9, No. 4, p. 236.

44. Palaniappan, A.B. and S.M. Seth, 'Flood Routing with Flood Plain-A Review' in 'Hydrology' Journal of Indian Association of Hydrologists.

45. Seth S.M. and, 'Application of a Regional Monthly Rainfall Runoff Model Using Data for Mahanadi Basin' for 54th R & D Session of CBIP. April 1988.

APPENDIX — XIII

314, Ram Nagar
ROORKEE - 247 667
Dial : 2829

SATYENDRA & Co
Chartered Accountants

AUDITOR'S REPORT

We have audited the attached Balance Sheet and the Income and Expenditure Account of the the National Institute of Hydrology, Roorkee as on 31st March, 1988 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, subject to the following observations :

1. The physical verification of Fixed Assets and other Assets as on 31.03.88 or in phase has not been conducted. It is suggested that balances as per fixed assets register should be tallied with financial books every year.

2. 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 setgregated into plan and non-plan.

3. **UNCONFIRMED BALANCES**

   The parties balances are subject to confirmation.

4. **RECEIPT FROM COMPUTER HIRE CHARGES**

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

5. **BUILDING ACCOUNTS Rs. 27,06,697.00**

   The most of the amount has been adjusted on the basis of simple completion and utilisation certificate of the University of Roorkee, Roorkee and quantity of cement and steel and their rate could not be verified by us.

   A. In case of the Balance Sheet, the state of affairs of the Institute as on 31st March, 1988 and

   B. In case of Income and Expenditure Account of the surplus for the year ended on that date.

for SATYENDRA & Co.
Chartered Accountants

Place : Roorkee
Dated : 27.07.88

UTILISATION CERTIFICATE

Certified that the National Institute of Hydrology, Roorkee has utilised the Grant-in-aid as detailed hereunder during the year 1987-88 and the same has been verified with reference to accounting records maintained by the Institute and has been found to be correct.

	PARTICULARS		AMOUNT
1.	Opening cash and bank balances as on 1.4.87		3,45,868.11
2.	Add : Opening Bank Margin Money Account against irrevocable letter of credit.	(+)	7,94,000.0
3.	Add : Grant-in-aid from Ministry of Water Resources, New Delhi		
	Plan — 80,00,000.00		
	Non-Plan — 60,00,000.00	(+)	1,40,000.00
	Add : Other Receipts (Gross)	(+)	16,11,123.67
		Total	1,67,50,991.78
	Less : Payments	(—)	1,30,01,531.44
		Total	37,49,460.34

Closing Cash and Bank balances as on 31.3.1988 including a sum of Rs. 18,97,856.00 bank margin money against irrevocable letter of credit.

(R.C. CHOPRA)
Finance Officer

(SATISH CHANDRA)
Director

for SATYENDRA & Co.

Chartered Accountants

Place : Roorkee

Dated : July 27, 1988

NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE

BALANCE SHEET AS AT 31ST MARCH 1988

AS AT 31.3.87	LIABILITIES	Amount (Rs.)		AS AT 31.3.87	ASSETS	AMOUNT (Rs.)
	Grant - in - aid from Govt. of India, Ministry of Water Resources, New Delhi			7845646.61	Fixed assets (At Cost) As per Schedule 'A'	13193944.60
936281.56	Opening Balance	967063.11			Building Works-in-progress	
	Received from Govt. of India Ministry of Water Resources			6769404.28	As per Schedule 'B'	6774996.63
12000000.00	New Delhi	14000000.00			Current Assets, Loan & Advances	
12936281.56		14967063.11				
	Less :			1958375.66	Advances to U.O.R. and others As per Schedule 'D'	314264.00
6795752.61	(a) Cost of acquisition of fixed and other assets transferred to assets fund account	3925494.41		222248.89	Prepaid Expenses As per Schedule 'G'	595141.00
	(b) Transferred to Income & Expenditure a/c to meet the excess of the expenditure over Income for the year :			74330.00	Deposits As per Schedule 'C'	93330.00
5173465.84		7464913.36	3576655.34		Cash and Bank Balances	
967063.11				3563.45	Cash in hand	69087.20
	ASSETS FUND ACCOUNT			6450.00	Imprest with the Divisional Heads	6700.00
9921106.91	Opening Balance	16716859.52		335854.66	Balance in S.B. a/c with SBI,UOR, Roorkee	1775817.14
	Add. Transferred from					
6795752.61	Grant-in-aid	3925494.41	20642353.93			
16716859.52					Margin Money with S.B.I., UOR, Roorkee	
	CURRENT LIABILITIES			794000.00	(against irrevocable Letter of Credit)	1897856.00
12888.78	Deposits (as per schedule 'F')	4741.48				
	Liabilities for expenses					
313062.14	as per schedule 'E'	497385.82	502127.30			
325950.92						
18009873.55	TOTAL		24721136.57	18009873.55	TOTAL	24721136.57

PLACE : ROORKEE
DATED : 27.7.88

As per our report of even date annexed
For Satyendra & Co.,
Chartered Accountants

Sd/-
(R.C. CHOPRA)
Finance Officer

Sd/-
(SATISH CHANDRA)
Director

Sd/-
(S.K. GUPTA)

SATYENDRA & Co. CHARTERED ACCOUNTANTS, 314, Ram Nagar, ROORKEE - 246 667 DIAL : 2829

NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE

NCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31ST MARCH, 1988

PREVIOUS YEAR (Rs.)	EXPENDITURE	CURRENT YEAR	PREVIOUS YEAR (Rs.)	INCOME	CURRENT YEAR
29,96,027.02	Salaries, Wages and Allowances	47,59,236.20	44,773.18	Hire Charges of Computer	28,193.98
3,53,198.90	Travelling & Conveyance	3,73,085.30	65,415.61	Interest on Savings/Deposits	1,17,753.00
70,344.20	News Paper & Periodicals	70,975.70	23,698.00	Miscellaneous Receipts	30,370.25
1,09,693.45	Electricity and Water Charges	1,68,345.60	369.40	Interest on Advances	1,278.00
2,82,574.70	Printing and Stationery	3,69,032.90	831.25	Income on Providing Medical Services	2,796.25
81,455.65	Postage, Telephone & Telex	1,05,363.20	—	Other receipts	3,24,418.50
1,33,625,00	Advertisements	1,17,536.00	51,73,465.84	Transferred from G.I.A. a/c to meet the Expenditure for the year of N.I.H.	74,64,913.36
3,27,910.52	Printing of Technical Books	1,11,194.00			
2,050.00	Grant-in-Aid/Subsidies	27,340.00			
25,624.30	Hospitality Expenses	14,977.60			
84,240.73	Miscellaneous Expenses	2,52,943.34			
30,466.80	T.A. to candidates	82,394.00			
1,55,090.08	Seminar and Conferences	68,778.00			
4,95,558.89	Repair and Maintenance (others)	7,40,494.85			
1,13,278.83	Repair and Maintenance of Vehicles	1,57,079.15			
47,414.21	Interest on C.P.F.	90,070.00			
—	Running cost of laboratory/computer	4,60,877.50			
53,08,553.28	TOTAL	79,69,723.34	53,08.553.28		79,69,723.34

PLACE : ROORKEE

DATED : 27.7.88

Sd/-
(R C CHOPRA)
FINANCE OFFICER

Sd/-
(SATISH CHANDRA)
DIRECTOR

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

SATYENDRA & Co. CHARTERED ACCOUNTANTS, 314, Ram Nagar, ROORKEE – 247 667 DIAL : 2829

NATIONAL INSTITUTE OF HYDROLOGY, ROORKEE

RECEIPT AND PAYMENT ACCOUNT FOR THE YEAR ENDING 31ST MARCH, 1988

PREVIOUS YEAR (Rs.)	RECEIPTS	CURRENT YEAR	PREVIOUS YEAR (Rs.)	PAYMENTS	CURRENT YEAR
	CASH AND BANK BALANCE		28,90,440.92	Salaries, Wages & Allowances	45,90,207.70
3,264,15	Cash-in-hand	3,563.45	3,17,411.00	Travelling & Conveyance	3,82,451.55
4,85,602.41	Bank Balance	3,35,854.66	72,915.40	Journals and Periodicals	1,09,945.00
5,700.00	Imprest with Divisional Heads	6,450.00	1,14,326.70	Electric and Water Expenses	1,51,696.30
6,14,520.00	Bank Margin Money (against Irrevocable Letter of Credit)	7,94,000.00	2,72,302.06	Printing and Stationery	3,61,914.95
			84,940.15	Postage, Telephone and Telex	94,301.70
	GRANT-IN-AID RECEIVED		1,11,215.00	Advertisements	1,39,946.00
1,20,00,000.00	From Govt. of India, Ministry of Water Resources, New Delhi	1,40,00,000.00	3,09,556.52	Printing of Technical Books	1,29,548.00
			2,050.00	Grants-in-aid Subsidy	27,340.00
—	Other receipts	3,24,418.50	18,223.25	Hospitality	8,323.00
44,514.66	Computer Hire charges	28,193.98	64,537.37	Miscellaneous Expenditure	1,82,909.45
5,000.00	Deposit for computer services	—	1,646.00	T.A. to candidates	15,360.00
65,415.61	Interest from Bank	1,17,753.00	81,786.23	Seminar and conferences	67,642.00
23,698.00	Miscellaneous Receipts	30,205.95	—	Running cost of laboratory/computer	11,617.80
369.40	Interest on Advances	1,278.00	—	Urban Hydrology	10,000.00
2,34,318.85	Recoveries from Employees 1. CPF	3,84,524.00	6,02,140.64	Maintenance (other then Vehicle)	10,24,424.50
2,01,805.01	2. others	3,28,726.30	1,01,821.07	Repair and maintenance of Vehicle	1,37,696.00
	RECOVERIES OF ADVANCES :		47,414.21	Interest on C.P.F.	90,070.00
40,516.00	Employees	52,329.00	3,91,431.61	Furniture and Fixtures	1,19,831.00
50,449.74	Departmental	1,50,463.50	1,98,942.23	Office Equipments	1,04,648.00
2,51,055.28	Firms	1,81,458.44	1,00,686.79	Library Books	1,09,646.00
22,439.00	University of Roorkee	10,581.00	13,98,197.05	Machinery and equipments	13,55,876.00
5,445.00	Contractor for Cement	—	98,313.86	Purchase of Vehicle	—
	SECURITY DEPOSITS		1,64,872.14	Buildings	1,29,399.00
1,000.00	Recovered back	—	13,84,962.58	Advance to other Firms/Deposits	19,59,864.02
6,608.00	Deducted from contractors	1,192.00			

SATYENDRA & Co. CHARTERED ACCOUNTANTS, 314, Ram Nagar. ROORKEE – 247 667 DIAL : 2829

			34,23,420.00	Advance to U.O.R.	3,34,447.00
			2,35,348.05	Advance to employees	6,42,700.00
			4,32,952.17	Other remittances (Recovered and paid)	7,09,726.47
				CASH, BANK BALANCES	
			3,563.45	Cash in hand	69,087.20
			6,450.00	Imprest with Divisional Heads	6,700.00
			3,35,854.66	Bank Balances	17,75,817.14
			7,94,000.00	Bank Margin Money (against irrevocable Letter of Credit)	18,97,856.00
1,40,61,721.11	TOTAL	1,67,50,991.78	1,40,61,721.11	TOTAL	1,67,50,991.78

PLACE : ROORKEE

DATED : 27.7.88

Sd/-
(R.C. CHOPRA)
Finance Officer

Sd/-
(SATISH CHANDRA)
Director

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

SCHEDULE — 'A'

SCHEDULE OF FIXED ASSETS AS ON 31st MARCH 1988

Sl. No.	Particulars	Cost as on 1.4.87	Addition during the year	Total Balance as on 31.3.88	Total Balance as on 31.3.87
1.	Buildings	29,72,447.05	27,06,697.00	56,79,144.05	29,72,447.05
2.	Furniture & Fixtures	7,37,517.58	1,47,601.00	8,85,118.58	7,37,517.58
3.	Office Equipments	7,40,458.06	1,81,039.00	9,21,497.06	7,40,458.06
4.	Computer Machinery	2,58,345.40	4,56,654.00	7,14,990.40	2,58,345.40
5.	Vehicles	3,17,308.06	3,428.00	3,20,736.06	3,17,308.06
6.	Library Books	6,23,370.40	1,42,129.25	7,65,499.65	6,23,270.00
7.	Machinery & Equipments	19,90,272.06	17,10,749.74	37,01,021.80	19,90,272.06
8.	Generator Set	2,05,928.00	—	2,05,928.00	2,05,928.00
	TOTAL	78,45,646.61	53,48,297.99	1,31,93,944.60	78,45,646.61
	Previous year (as on 31.3.87)	53,43,077.42	25,02,569.19	78,45,646.61	53,43,077.42

SCHEDULE — 'B'

BUILDING WORKS IN PROGRESS as on 31.3.88

Sl. No.	Particulars	Amount as on 1.4.1987	Payments during the year 1987-88	Recovered Back/ adjusted during 1987-88	Amount as on 31.3.88	Amount as on 31.3.87
1.	Advance for various construction works granted to U.O.R.	61,04,775.34	4,68,697.00	15,05,738.00	50,67,734.34	61,04,775.34
2.	Steel and Cement with U.O.R.	4,33,913.53	18,88,008.76	6,14,988.00	17,07,262.29	4,33,913.53
3.	Material at site with U.O.R.	2,30,715.41	—	2,30,715.41	—	2,30,71577
	Total	67,69,404.28	23,56,706.76	23,51,441.41	67,74,996.63	67,69,404.28

SCHEDULE — 'C'

SCHEDULE OF DEPOSITS AS ON 31.3,1988

Sl. No.	Particulars	Amount as on 31.3.88
1.	Fixed Deposit with S.B.I. for Excise Security	55,500.00
2.	Deposits for Gas Cylinder	4,350.00
3.	Deposits with UPSEB for Sub-station	8,480.00
4.	Security Deposit of Telex	10,000.00
5.	Deposits with SAIL Ghaziabad for Steel	15,000.00
	TOTAL	93,330.00
	Previous year (31.3.87)	74,330.00

SCHEDULE—'D'

SCHEDULE OF ADVANCES AS ON 31.3.1988

Sl. No.	Particulars		Amount
1.	**Advance to UPSEB—ROORKEE**		
	(a) For Sub-station	851.60	
	(b) Temporary connection	11,388.00	
	(c) L.T. Site Preparation	82,915.00	95,154.60
2.	M/s. Birla Jute and Industries Ltd., Satna		5,523.00
3.	Member Secretary, CBIP, New Delhi		1,750.00
4.	National Atlas and Thematic Maps Organisation Calcutta		698.00
5.	M/s. A. Paul Industries, Zind		738.00
6.	M/s. Lawrence & Mayo (India) Ltd., New Delhi		740.00
7.	M/s. Deepali Gas Service, Roorkee		1,797.00
8.	MRIO, Survey of India, Dehradun		706.00
9.	M/s. Allied Publishers Subscription Agency, New Delhi		1,149.00
10.	**Advances to Staff**		
	(a) Cycle Advance	4,968.00	
	(b) Scooter Advance	1,40,260.00	
	(c) Fan advance	2,240.00	
	(d) Festival Advance	17,000.00	
	(e) L.T.C. Advance	3,620.00	
	(f) T.A. Advance	24,752.40	
	(g) Department Advance	2,000.00	
	(h) Advance of Pay	1,168.00	
	(i) Advance for "Urban Hydrology Course"	10,000.00	2,06,008.40
		TOTAL	3,14,264.00
		Previous year (31.3.1987)	19,58,375.66

SCHEDULE — 'E'

SCHEDULE OF OUTSTANDING EXPENSES AS ON 31.3.1988

Sl. No.	Particulars	Amount as on 31.3.1988
1.	Salaries	3,70,403.00
2.	Arrears of Dearness Allowance	45,104.00
3.	T.A. to Candidates	192.00
4.	Office Equipment	2,985.00
5.	Overtime Allowance	2,762.00
6.	Computer Machinery	60,098.00
7.	Stationery & Printing	2,176.00
8.	Running Cost of Laboratory	280.00
9.	Maintenance of Vehicle	1,457.00
10.	Library Books	145.00
11.	Journals	267.00
12.	Telephone	6,043.00
13.	Employee's Recoveries from salaries	1,473.00
14.	Audit fee	4,000.00
	TOTAL	4,97,385 82
	Previous Year (31.3.1987)	3,13,062.14

SCHEDULE — 'F'

SCHEDULE OP SECURITY DEPOSITS MADE WITH NIH AS ON 31.3.1988

Sl. No.	Particulars	Amount
1,	Deposits for computer service (Sh. P.S. Moharir)	4,741.48
	TOTAL	4,741.48
	Previous Year (31.3.1987)	12.888.78

SCHEDULE — 'G'

SCHEDULE OF PREPAID EXPENSES AS ON 31.3.1988

Sl. No.	Particulars	Amount
1.	C.M.C. Ltd. for Maintenance of Computer	5,16,000.00
2.	Maintenance of office Equipment	19,625.00
3,	Journals	56,759.00
4.	Rent, Rates & Taxes	2,757.00
	TOTAL	5,95,141.00
	Previous Year (31.3.1987)	2,22,248.89