Assistance to the Institute of Hydraulic Research (IPH) of the Federal University of Rio Grande do Sul in Porto Alegre

Project Findings and Recommendations

Serial No. FMR/SC/OPS/82/2011/UNDP

United Nations Educational, Scientific and Cultural Organization

United Nations Institute of Hydraulic Research (IPH)

United Nations Development Programme

Porto Alegre, 1982
LIST OF CONTENTS

1. BACKGROUND AND OBJECTIVES OF THE PROJECT .................. 1
2. ACTIVITIES AND OUTPUTS ........................................ 4
3. ACHIEVEMENT OF IMMEDIATE OBJECTIVES ....................... 13
   3.1 - Technical Course ........................................... 13
   3.2 - Post-graduate course at Master's Degree level .......... 14
   3.3 - Doctoral Programme ......................................... 18
       3.3.1 - Fundamentals ........................................... 18
       3.3.2 - Research and availability of research facilities  21
   3.4 - Scientific output ........................................... 26
   3.5 - Cooperation in training ..................................... 27
   3.6 - Human resources ............................................. 29
4. UTILIZATION OF PROJECT RESULTS ................................ 32
5. FINDINGS ............................................................ 33
6. CONCLUSIONS AND RECOMMENDATIONS .............................. 35
7. COMMENTS ............................................................ 39

ANNEXES 1 - 31
ANNEXES

1. Work plan - Description of Project activities
2. Schedule for the implementation of the Ph.D programme
3. List of courses taught by the UNESCO Consultants at Ph.D level
4. List of fellowships awarded
5. List of Experts
6. List of Consultants
7. Courses given by UNESCO Experts or Consultants at masters level
8. Number of students accepted and passed in the Regular (annual) Technical Course in Hydrology
9. Topics taught in the Technical Course and lecture hours
10. Training courses given by IPH Staffmembers for other institutions within the cooperation in training
11. Research "lines" developed at IPH
12. List of major items of equipment provided by UNDP
13. List of major items of equipment purchased through subcontracts
15. Workshops and meetings
16. List of seminars held at IPH
17. Technical publications of Report UNDP/UNESCO Project BRA/75/007
18. List of papers published in the IPH journal "Cadernos de Recursos Hídricos"
19. List of publications and lectures at national meetings
20. List of publications in national journals
21. List of publications in international journals and international meetings
22. Technical Course Programme
23. Synopsis of Courses in Water Research and Sanitary Engineering

24. Development of the master's degree course and the UNESCO staff contribution (Graph)

25. Number of theses oriented by IPH and UNESCO professional staff (Graph)

26. Master degree theses concluded

27. Number of MS degrees awarded by IPH and UNESCO professional staff (Graph)


29. List of course subjects for the Doctoral Programme

30. Research activities executed with FINEP financial support

31. List of IPH staff members
1. Background and objectives of the project

UNDP/Unesco assistance to the Institute of Hydraulic Research (IPH) of the Federal University of Rio Grande do Sul began with Project BRA/67/527 - Centre of Applied Hydrology, Porto Alegre, on which preliminary operations started in June 1968. On termination of the project in December 1975, a Terminal Report was prepared (Serial No. FMR/SC/HYD/75/249(UNDP). The main objective of that project was to establish, within the structure of IPH (Instituto de Pesquisas Hidráulicas), a Centre of Applied Hydrology to conduct research in hydrology and to train manpower at both professional and secondary school technician levels.

Since it was a pioneer institution in Brazil in the field of hydrology, there was a great demand for IPH's consultancy services. This created the need to upgrade IPH hydrologists to the M.Sc. level. An evaluation mission carried out shortly before project completion recommended that the training of hydrologists in Brazil be upgraded further to the Ph.D level. The project thus entered into a second phase (project BRA/75/007) which was approved in December 1976 and began operations in January 1977. Originally scheduled to terminate by December 1980, it was extended to the end of December 1981 during a tripartite meeting in February 1981.

The new project's long-range and short-term objectives were as follows:

A. Long-range objectives

Effective management and utilization of water resources is of the greatest importance in the development of the Brazilian
economy. Agricultural production is to be increased through irrigation and drainage; river navigation should be improved, the hydro-electric potential should be even more intensely developed; increasing industrialization and urbanization require considerable quantities of water which should return to its sources with the least possible damage to the environment upon which largely depends the development process.

The policies for water resources management should be based on a solid knowledge of the processes that regulate the movement of surface and groundwater.

The course at the Institute will be open to the participation of other countries, particularly Latin American, from which IPH has been receiving about 20% of its students at Master's level. This project, will thus, have an impact on the whole Latin American region.

The long-range objective of the project is to strengthen the structure of the IPH of the Federal University of Rio Grande do Sul, and through it, to assist the Government on a national basis to improve the capacity of engineers and scientists to solve present and future problems related to the utilization of water resources.

B. Immediate objectives

In the field of teaching and research:

(i) to establish programmes at Ph.D level in water resources sciences for the improvement of high-level Brazilian technology and know-how;
(ii) to train professors of Master courses to enable them to obtain their Ph.D degree;

(iii) to continue supporting IPH Master courses in Applied Hydrology which will in turn provide a pool of candidates for further training at Ph.D level;

(iv) to cooperate in the training of personnel at high-school and post-graduate levels, upon request by Government agencies throughout Brazil;

(v) to carry out research projects in co-operation with national institutions, to intensify and develop resources in Brazil, and to strengthen the infrastructure of the laboratory of the IPH, to disseminate the results of the research projects.

In the field of services rendered:

(vi) to develop and strengthen the structure of the IPH so that it will have the capacity to provide consultant services on a competitive basis. It will carry out water resources projects and surveys for development agencies and similar institutions throughout the country. Large-scale projects in which the national technology will have to be developed and improved, such as those that are being designed for the Amazon region, will have priority;

(vii) to disseminate up-dated knowledge to the administration and management teams of the various Federal and State agencies;

(viii) to provide technical knowledge to executives of other nations and to assist them in project execution where requested;

(ix) to provide courses for foreign students within the financial and human resources possibilities of the IPH.
Although primarily concerned with teaching and research, this project has an immediate investment potential. Some of the applied research projects that are carried out for agencies of the Federal, State, and Municipal Governments will generate investments.

The immediate objectives, in a more detailed form, with related sub-objectives, constitute the work plan, attached here as Annex 1.

2. Activities and outputs

In general, all of the project's activities, related directly to the immediate objectives, given in the work plan attached here as Annex 1 have been performed successfully. However not all of the immediate objectives have been fully achieved, and this will be explained later on in this report under chapter 3.

Here is shown the summary of the effects of activities as far as possible in chronological order:

(i) In order to establish the Ph.D programme in the science of water resources, a detailed study of the possibilities for the implementation of such a course was carried out. Besides the personal enthusiastic involvement of the Chief Technical Adviser, Ceferino Alvarez, in the period between July 1974 and December 1979, there was close cooperation with the Colorado State University (CSU) of the United States of America. An outstanding job was done by Prof. Warren Hall of the CSU and this resulted in the preparation, in November 1978, of a detailed document on the conditions required for implementation of a doctoral programme.

In the beginning of 1979, a comprehensive proposal for the
organization of the doctoral programme was prepared by the project and, after approval by the IPH Board of Directors the proposal was presented to the Rector of the University. In November 1979 a schedule for the implementation of the Ph.D programme (Annex 2) was submitted to the Special Chamber for Post Graduation and Research, chaired by the Pro-Rector for Graduate Studies, Prof. Dr. Gerhard Jacob. The schedule was admitted as a basis for the Ph.D programme implementation, however, the Special Chamber has not officially authorized the programme. The requirements set by the Special Chamber to accredit the Ph.D programme can be summarized as the need to increase the number of professionally high level staff members (professors) and increase the scientific production at an internationally recognized level.

Nevertheless, the implementation of the Ph.D programme was initiated, mainly through courses at Ph.D level taught by UNESCO experts and consultants. The courses taught, which are recognized as being at Ph.D level, are listed in Annex 3.

(ii) The Ph.D programme was also initiated through research executed at IPH by Ph.D candidates as a foundation for their doctoral dissertations.

To give only some examples, one must mention the research done by Carlos Tucci who finished his Ph.D studies at Colorado State University in 1979 or Raul Dorfman who has done his research at IPH after a 18-month fellowship in Israel in 1977 and is now back in Israel, working on his thesis.

Within this project, the amount of man-months of fellowships awarded totalled 251. Long-term fellowships have been awarded
to 8 professors, to follow a Ph.D training programme abroad, to 7 of them in United States of America and to 1 in Israel. From the list given in Annex 4 it can be seen that two of the fellows, Caicedo and De Luca, have consumed almost half of available m/m of fellowships (103 m/m). As a result of fellowships awarded, by the end of 1981 three of the IPH staff members will have the Ph.D degree and in spring 1982 another two (Wrege and Caicedo) will get their Ph.D degrees. It can be said then, that during the course of the project, 5 professors have obtained their Ph.D degrees, with one (Raul Dorfman) having good prospects of finishing his Ph.D studies by the end of 1982. Another financial source has to be found to conclude the latter fellowship study.

(iii) The effort made by the project to increase the scientific level insofar as training and research are concerned at IPH, can be demonstrated by the number of experts and especially the consultants active on the site.

There have been five long-term experts, including the Chief Technical Adviser, listed in Annex 5. Besides this one associate expert was designated for one year by the Government of the Federal Republic of Germany to assist in the project.

67 consultant missions were carried out during the life of the project, as can be seen from Annex 6. Besides the project activities directly related to the establishment of the Ph.D programme, the project was active in organizing workshops for the professional staff of the Master's course.
Informal lectures have been organized and given by the project experts and consultants as well as meetings about the scope and range of classes taught by the IPH professors in the Master's course. The course on the application and operation of microcomputers, taught in May 1981 by Prof. Rolf Deininger, must also be mentioned.

The teaching activities established at IPH for the Masters Degree level were strengthened by the direct involvement of the Project experts or consultants through giving courses at the afore-mentioned level. The courses, presented in Annex 7, were held partly to substitute temporarily absent Brazilian professors, who were studying abroad to complete their training or preparing their Ph.D. thesis, and partly to serve as models for classes given in the next semesters by IPH staff.

(iv) Amongst the immediate related objectives given as paragraph 4 in Annex 1, one of the most important activities was the Technical Course begun in 1970 and successfully continued during the life of the project, i.e., 1977-1981. During that period the Course received 104 students, which gives an average of 21 students a year. During the period 1977-1981 on the average 15 students passed all tests and received their diploma as Hydrotechnicians. The number of diplomas awarded in relation to students accepted varied from year to year between 53% and 91% with an average of 72%. This can be considered as highly effective.

The Technical Course with a duration of one year of classes and six months of practical workshops, was officially accredited by the Ministry of Education and Culture (MEC) in 1977. During
the Technical Course, 15 subjects are taught over a total of 1360 hours. A brief summary of topics lectured is listed in Annex 9.

The Course is managed by a Coordination Committee of two IPH staff members: Prof. Marcos Imério Leão, as coordinator and Prof. Lirian F. Furtado, as pedagogical supervisor.

In accordance with the work plan, several courses have been carried out at different levels, for Governmental agencies, with and without the cooperation of other institutions. The list of courses taught is in Annex 10.

One very important fact is seen in Annex 10, i.e., that most of the training activities were carried out in 1980 and 1981.

This can be attributed to the strengthening of the IPH professional staff and the recognition of their professional ability by Governmental agencies and other institutions.

(v) During the last five years, after several modifications, 8 fields (lines) of research have finally been established, as listed in Annex 11. The creation of these fields of research was possible first of all by increasing the professional level of the IPH staff members.

Two of the Chiefs of fields of research created (C.E.M. Tucci and A. E. Lanna) had obtained their Ph.D as a result of fellowships awarded by this project, at the Colorado State University in the United States of America.

One of the eight fields of research is directed by a former UNESCO consultant (F. Semmelmann).

An adequate infrastructure was developed for carrying out research in seven of the fields of research defined in Annex
ll. The last field of research (field H) is based mainly on mathematical models and, if necessary, facilities developed for other lines of research are also utilized.

Research group A - Surface Hydrology, has established a representative basin at Forqueta River, located 150 km NW of Porto Alegre. In this basin, the research group has a 450 km² sub-basin, of Forquetinha River, which is almost fully equipped. The other sub-basins, Fão, Forqueta, still need to be equipped. The installations of the 11 rainfall-sediment measuring stations which will complete the information on local precipitation must still be finished. An experimental basin of Dilúvio Creek was also established. It covers an area of 70 km² and includes an urban and suburban zone of Porto Alegre. It is used for urban hydrology research. Monitoring is done at 12 raingauging, and 15 streamgauging stations which make it one of the best-equipped basins of its kind in the whole world.

Research group B - Groundwater in Fissured Rocks (Hydrogeology), besides its own laboratory in the IPH building, operated two pilot aquifers, located in the afore-mentioned basin of the Forqueta River - pilot aquifers of Soledade and Arvorezinha. The group also receives support from the analog model laboratory at IPH.

Research group C - Erosion and Sediment Prediction, Sediment-related research, has two laboratories at IPH. The laboratory of sedimentology is 230 m² and the laboratory of river morphology 2700 m². Outside IPH, the group operates research facilities in the afore-mentioned Forqueta River Basin, which, at present, consist of:
- 4 rainfall-sediment measurement stations, which are in operation;
- 13 river-gauging-sediment-gauging stations, to measure suspended load in rivers;
- 1 river-gauging, sediment-gauging station, to measure bed load.

Research group D - Irrigation and Drainage - besides a 240 m² laboratory at IPH, has an experimental area of 5 km², located in the county of Cachoeirinha, near Porto Alegre (about 20 km from IPH). It also has a second experimental area of 40 hectares, at the Experimental Station of the UFRGS School of Agriculture, approximately 60 km from IPH.

The Sanitary engineering group of research (Research E) received a new Water and Wastewater quality laboratory, which takes up 95 m² of the newest IPH building. Besides this laboratory, the research group used various isolated facilities, placed at its disposal in Porto Alegre and neighbouring counties, by Sanitary Engineering companies which are interested in IPH research work; but the group has, as its main operation, an experimental basin to study the self-purification capacity of a water course. In this basin, along the 70 km of the lower course of the Sinos River, near Porto Alegre, 13 river-gauging stations and 15 water quality measurement stations have been installed. A pilot plant for waste water treatment started operating in 1980. At this pilot plant, research on sanitary landfill seepage treatment has also been carried out.

The research group on Aerophotogrammetry and Remote Sensing of Water Resources (Research F) has as an important resource the Cartometronics laboratory (500 m²) and a test area located in the
central part of the Dilúvio Creek basin, in Porto Alegre. A programme for the Landsat Mapping System outputs for application in the development and management of water resources was installed. But further development is necessary.

The research group on Fluid Mechanics and Hydraulics (Research G) will have a large laboratory of about 800 m², to be finished within the next few months. The laboratory will have a hydraulic channel (40 m long) for studies of diffusion in homogeneous and non-homogeneous regime. A pumping station with a flow of 0.4 m³/s and equalization basin already exists.

The purchase of modern equipment through the project has played an outstanding role in increasing the research capacity of the IPH. The list of equipment supplied by UNDP through the project is given in Annex 12. Another part of the equipment was purchased through subcontracts, especially the subcontract with the Colorado State University and the University of Michigan (USA). The list of major items received through the subcontracts is given as Annex 13.

(vi) In the course of the project, IPH had undertaken many consultant activities. Most of them were executed by the IPH staff, some of them with the direct input of the UNESCO experts and consultants. The list of major consultant services undertaken is given as Annex 14. It is worthwhile noting the increase in the number of consultancies in consecutive years, as well as the increase in the importance of subjects worked on.
One other important factor was the regionalization of consultancies carried out and the limitation to the State of Rio Grande do Sul and the State of Santa Catarina. However, during the last period there have also been some activities in the State of Minas Gerais.

(vii) Knowledge was disseminated by teaching the aforementioned courses, but most of all through publications and through organizing or participating in different meetings. In-house and out-of-house meetings and workshops have been organized. Some of them are listed in Annex 15, Seminars organized at IPH are listed in Annex 16. Project BRA/75/007 has also brought out a series of internal publications (Annex 17).

A very important achievement was the beginning of an IPH publications - "Cadernos de Recursos Hídricos". The publication has a nation-wide circulation, and is distributed to most of the Brazilian Universities and to many Governmental Institutions. Up to now 4 issues have been published. The contents of the 4 publications are given as Annex 18. There have also been a quite large number of publications to be presented at various out-of-house meetings, conferences, seminars, and printed in national technical journals. The lists of these publications are given respectively as Annex 19 and Annex 20.

(viii) The dissemination of knowledge to other countries was limited to scientific publications at international conferences and in international technical journals. A list of publications appears in Annex 21. Efforts made to carry out short-term workshops and other
international activities related to knowledge dissemination proved unsuccessful, owing to lack of sufficient financial support.

3. Achievement of immediate objectives

3.1 - Technical Course

The demand for high school level technicians in Water Resources, is growing continually on the Brazilian labor market, and the Technical Course in Hydrology which began in 1970 at IPH creates about 20 Hydrotechnicians a year. In the period 1977 to 1981 the Course received 104 students, coming mainly from Government Agencies, such as SUDAM, SUDENE, CPRM and CODEVASF.

As already mentioned, the course was officially accredited by the Ministry of Education and Culture (MEC) in 1977 and the accreditation notice was published in the Official Bulletin, in Brasília, on December 25, 1977.

Now the Technical Course in Hydrology is working satisfactorily without direct UNESCO professional staff contribution. The topics taught in the Technical Course in Hydrology and the names of the teachers are listed in Annex 22.

The students attending the Technical Course carry out a great deal of practical work both in the laboratory and in the field. The subjects the students learn in the field include topography, hydrometry, hydrology, irrigation and drainage, hydrogeology and sanitary engineering.

The Hydrotechnicians graduated from IPH are highly
sought after and find employment in private and Governmental organizations. Their functions and responsibilities are usually in:

- data collection (monitoring), preliminary screening and data compilation;
- assistance in monitoring stations, installation and operation;
- operation of measuring and analytical equipment;
- determination of various parameters in laboratories.

Because of the aforementioned demand for high-level Hydrotechnicians an increase in the number of students is expected in the years ahead.

3.2 - Post-graduate course at Master's Degree Level

Candidates having a degree in engineering, agronomy or geology and, in special cases, another university-level degree can apply to take a competitive admission examination.

The nominal duration of the master's course is two years, the maximum tolerated duration 5 years.

Requirements for a degree are:

- satisfactory performance in the course subjects mentioned in Annex 23, with a minimum of 30 credits;
- preparation of a thesis on research work or a critical review of reference material. The thesis should satisfy certain standards;
- satisfactory performance in a foreign language.

The course subjects listed in Annex 23 are divided into four groups of specialization. The students can choose between:
a) Hydrology, b) Hydrogeology, c) Sanitary Engineering and d) Agricultural Hydrology. In addition to the compulsory courses for the different groups of specialization, suggestions are made to the student as to which of the optional courses he should choose.

The suggestions are as follows:

- For the specialization in Hydrology
  
  HIDP-10 - Numerical computation
  HIDP-11 - Analytical hydrology
  HIDP-16 - Hydrometry
  HIDP-17 - Optimization of water resources
  HIDP-19 - Erosion and sedimentation
  HIDP-61 - Deterministic hydrology
  HIDP-62 - Statistical hydrology

- For the specialization in Hydrogeology
  
  HIDP-13 - Groundwater
  HIDP-32 - Hydrogeology
  HIDP-43 - Groundwater prospecting
  HIDP-63 - Hydraulics of porous media
  HIDP-60 - Special advanced studies in applied hydrology
  HIDP-11 - Analytical hydrology
  HIDP-12 - Chemistry
  HIDP-15 - Pumping stations
  HIDP-21 - Mathematics for hydrology

- For the specialization in Sanitary Engineering
  
  HIDP-12 - Chemistry
  HIDP-13 - Ground water
  HIDP-20 - Biology
  HIDP-46 - Ground water recovery
HIDP-47 - Water treatment
HIDP-48 - Sewerage systems
HIDP-49 - Treatment of urban and industrial waste waters
HIDP-15 - Pumping stations

- For the specialization in Agricultural Hydrology
  HIDP-18 - Fundamentals of irrigation and drainage
  HIDP-33 - Agrohydrology
  HIDP-44 - Irrigation methods
  HIDP-45 - Agricultural drainage
  HIDP-60 - Special advanced studies in applied hydrology

Comparing Annex 23 with the list of courses suggested for the different groups of specialization one can see that not all are included above. This is because some courses are taught on an irregular basis.

From the beginning up to the present time the Post-Graduate Course in Applied Hydrology has been attended by 225 students of whom 30 (i.e. 13%) are not Brazilian. Of the eight Post-Graduate level courses in Water Resources in Brazil, the one in Porto Alegre can be considered the most important. Since 1969 all these courses have been attended by a total of 535 students, which means that the Porto Alegre course has received 42% of all the students.

On the average, the number of participants entering the master's course during the period of 1969-1981 is around 10 per year and the number of degrees awarded, 8.

A total of 98 Master of Science degrees have been awarded in the following specializations:

  49 in Hydrology
  13 in Hydrogeology
14 in Sanitary Engineering
22 in Agricultural Hydrology.

Very interesting conclusions can be drawn about the UNESCO/UNDP contribution to the development of the teaching capacity of the IPH, from a graphic presentation of master degree dissertations supervised (Annex 24 and 25). As from the beginning of 1974, the professional staff of IPH has been making a growing contribution to the supervision of students preparing theses for the M.Sc. degree. Already in 1975 IPH professional staff were supervising more theses than the UNESCO experts. An exception can be noted in 1980 when an equal number of theses was supervised by the IPH and UNESCO staff. This can be attributed to the very late provision of a UNESCO expert in Sanitary Engineering.

In all specific areas IPH now has adequate human resources, to teach courses at post-graduate level and to supervise M.Sc. theses. Probably the best developed group is that concerned with Hydrology.

The increased capacity of the IPH professional staff to run the established post-graduate course can be seen from an analysis of degree awarded (Annexes 25 and 27). The total number of M.Sc. degrees awarded during the first period (i.e. 1970 - 1976) was 51, as against 47 in the second period (1977 - 1981). During the first period, 73% of all degrees awarded were supervised directly by UNESCO experts, as against 31% during the second period.

Once the IPH staff members now abroad completing their Ph.D theses, return to the Institute, no direct contribution from UNDP/UNESCO will be necessary. In this respect the immediate objectives of the project have been fully achieved.

The high level of the master theses was recognized by the
University Authorities and in a broader sense by the scientific community in all parts of Brazil. Also the evaluation mission* of the project, in November 1980, came to a conclusion that "the level of the masters theses which are largely based on research projects, can be considered on the whole as being of a scientific level which is generally considered a prerequisite for a master's degree in technical science".

In general it can be said that the present M.Sc. programme has attained a sufficiently high scientific level as far as teaching and research are concerned. Also, existing human and physical resources for teaching and research can assure that the masters trained at IPH will meet the requirements of the country for competent engineers in the field of water resources development and conservation.

The maturity of the M.Sc. programme can also be seen from the subjects undertaken for M.Sc. theses during the period 1977-1981, listed as Annex 28.

3.3 - Doctoral programme

3.3.1 - Fundamentals

The satisfactorily developed Master's degree programme at appropriate teaching and research levels is supposed to serve as a basis for further broadening the scope and upgrading the level of education, and establishing a Ph.D programme.

* The evaluation mission on behalf of UNESCO was carried out by Prof. Adrian Volker, Senior Engineer at "Rijkswaterstaat" (State Public Works) in charge of foreign relations, Professor extraordinarius Delft Technical University (The Netherlands).
According to prospects, the award of a doctor's degree would require:
- Satisfactory performance in a number of course subjects as mentioned in Annex 29 with a minimum of 50 credits and a minimum duration of 3 years. Credits given for the master's degree (30) can be part of this amount provided that the subjects involved fit into the programme as a whole;
- Preparation of an original dissertation in the fields of water resources and sanitary engineering which contributes towards the development of technical sciences;
- Satisfactory knowledge of 2 foreign languages, one of which is English.

The implementation of the programme requires:
- the availability of research facilities and research topics which render possible a dissertation contributing towards the development of technical sciences in the international framework;
- the availability of teachers ready and competent to act as promotors;
- the availability of teachers competent to teach the course subjects mentioned in Annex 29.

Research results may be in the field of applied or fundamental research and may be obtained through investigations in laboratories, in representative basins or pilot areas, in pilot installations and through indepth case-studies of practical projects which have required special investigations. Also theoretical desk studies, e.g. application of advanced mathematics or physics to problems in the field of hydrology or hydraulics; can provide good dissertation material.
While the primary objective of this project was to up-grade the training in hydrology and sanitary engineering to reach the Ph.D level, more attention should be given to this subject.

The accreditation of a doctor's degree at the IPH is subject to the approval of the University of Rio Grande do Sul and the Government. The approval of the University is based on the opinion of the "Special Chamber for Post-Graduation and Research" (Quinta Câmara) which is chaired by Professor Edmundo Kanan Marques. As a rule, the advice of the Special Chamber is followed by the University and the Government (Federal Council for Education). In November 1979 a schedule for the implementation of the Ph.D programme was submitted to the Special Chamber for Post-Graduation and Research (Annex 2).

The Special Chamber, in August 1980, appointed an ad-hoc committee consisting of three professors of the UFRGS and one of the Pontifical Catholic University of Rio de Janeiro to assess the post-graduate programme of the IPH and to formulate suggestions for its development. The opinion of this committee, based on a visit on September 5, 1980, can be summarized as follows:

(i) There is an upgrading and increase of scientific production thanks to the contribution made by the teachers who have recently obtained their Ph.D, by UNDP/UNESCO experts and consultants of UNDP and by their respective local counterparts;

(ii) A more extensive analysis of IPH activities possibly reveals excessive dispersion of research activities, when a concentration of efforts on a single line of research might be healthy in creating the structure of a Ph.D programme;

(iii) Teachers are involved in very diversified activities, in areas below post-graduate level, such as teaching in technical
and undergraduate courses, and providing consultancy and extension services. There is also a lack of seniority of potential Ph.D advisers according to accepted international standards;

(iv) There was agreement on the essential characteristics of a good Ph.D programme, i.e. a "critical mass" of human resources and high-level scientific production, and the recognition of efforts made by IPH, going as far as to change procedures to achieve the desired excellence;

(v) The opinion of the Committee is that, in addition to the support which, it is agreed, the University must provide to supplement IPH's efforts, UNDP/UNESCO cooperation is indispensable to implement the Ph.D programme for Water Resources and Sanitary Engineering.

Summing up, the three most important factors crucial for the success of the Ph.D programme at IPH are: (a) development of research at an adequately high level (at an international level according to the Special Chamber of the University); (b) building up of staff with high professional standards (critical mass), and (c) increased scientific production in the form of publications at an internationally recognized level.

To show the distinct progress made during the operation of the project, a critical analysis of the requirements for implementation of the Ph.D programme is presented below.

3.3.2 - Research and availability of research facilities

The research and consulting services are carried out by
different sectors, as regards both the organization of the physical facilities for research, and the main fields of research.

The IPH, after reorganization in the first semester of 1981, includes the following sectors:

1 - Hydrology Sector
2 - Ground water Sector
3 - Sedimentology Sector
4 - Irrigation and Drainage Sector
5 - Sanitary Engineering Sector
6 - Mapping Sector
7 - Hydrodynamics Sector
8 - Applied Hydraulics Sector
9 - River Morphology Sector
10 - Hydrometry Sector
11 - Instrumentation Sector
12 - Computation Sector

The following laboratories are available for research and consulting services:

- Didactic hydraulic laboratory
- Laboratory for maritime hydraulics
- Laboratory for fluvial hydraulics
- Laboratory for fluvial morphology
- Laboratory for agricultural hydrology
- Laboratory for hydrogeology
- Laboratory for environmental sanitary engineering
- Laboratory for sedimentology
- Laboratory for aerial photogrammetry
- Laboratory for aerodynamics
- Laboratory for analog models

Special mention should be made of a number of research facilities in the field such as:

- Representative basins on urban hydrology (Arroio Dilúvio, Porto Alegre)
- Representative basins on land use, forecasting, etc. (Forqueta River)
- Pilot installations for waste water treatment at Porto Alegre
- Pilot river basin on pollution propagation modelling (Sinos River)

As aforementioned, research activities are divided into the following eight fields or "lines" of research:

A - Surface Hydrology (Flood formation in non-permeable areas)
B - Hydrogeology (Aquifers of fissured rocks)
C - Erosion and Sediment prediction
D - Irrigation and Drainage
E - Sanitary Engineering
F - Aerophotogrammetry and Remote Sensing of Water Resources
G - Fluid Mechanics and Hydraulics
H - Planning and Use of Water Resources

Originally there were only five fields of research (the first five mentioned above) with which IPH entered into the third period of research activities financed by FINEP - Financiadora de Estudos e Projetos. The third period of financial support by FINEP covering the years 1976-1980, aimed to consolidate research
activities and the infrastructure to serve as a foundation for the doctoral programme. Under the general heading "The use and conservation of water resources in the State of Rio Grande do Sul" ("Uso e Conservação dos Recursos Hídricos do Estado do Rio Grande do Sul"), two phases can be distinguished.

The scope of the first phase carried out during the period of 1976-1978, was to adapt and develop appropriate techniques for solving the most frequent problems occurring in Brazil. This phase also had as an aim the development of fundamental research in the field of hydraulics, and hydrology. During the first phase, the physical facilities, the laboratories, were constructed and equipped.

The second phase of research supported by FINEP funds aimed at consolidation of the research activities and instrumentation of the pilot areas established during the first phase. The major part of research, through data collection and retrieval, data processing with the application of mathematical models, the application of previously developed methodology, was done during the second phase.

However, during the implementation of the second phase there were serious disturbances caused by receiving FINEP funds later than expected. Officially the second phase of research started on October 1, 1978, but was in full operation only one year later. There was a 10-month delay in liberation of FINEP funds. This can be explicitly seen from the tables of research activities in the period October 1978 - September 1980, given in Annex 30. The tables also give a more detailed description of specific activities.

Owing to the delay in the receipt of FINEP's financial
support, not all objectives of the research programme have been achieved. The instrumentation of the pilot areas established during the first phase could not be finished, because of the extremely long period of time required to obtain the equipment and also because of lack of hard currency for its importation. The equipment purchased by UNDP through the project, although of crucial importance was, however, only a part of what was required.

One extremely important result of the research activities was a visible increase in the scientific level, demonstrated by the preparation of scientific publications, published in both Brazilian and foreign technical journals, especially in the United Kingdom and the United States of America. There was also a marked increase in the attendance of IPH professional staff members at conferences held in Brazil and abroad.

In order to improve the organisation of research the scientific programme and the financial resources have, since the beginning of 1981, been controlled by the new Commission of Post-Graduation. UNESCO experts and consultants were instrumental in broadening the scope and raising the level of research at IPH through their direct involvement during short or long-term contracts with the project. This is reflected in scientific production in the form of internal and external publications. Mention should also be made here of the contribution of scientific staff members of the four institutions which cooperated with the project under sub-contract, namely: (a) Colorado State University - USA, (b) University of Michigan - USA, (c) Institute of Hydrology at Wallingford, United Kingdom, (d) National College of Agricultural Engineering at
Silsoe, United Kingdom.

The physical facilities developed during the last few years were related directly to the different fields of research, and have been described in greater detail in Chapter 2.

3.4 - Scientific output

During the course of the project the results of research have been disseminated in various forms. Internal seminars, conferences, and publications can be mentioned as well as papers presented at external meetings and publications in Brazilian scientific journals. There have been presentations at international conferences in the United States, and Europe, as well as publications in international journals.

The analysis of publications made during the course of the project, lead to two main observations: (a) a distinct increase in number, throughout successive years is evident, and (b) the contribution of UNESCO experts and consultants is evident.

Considering the almost complete lack of scientific journals dealing with water resources, in Brazil, it could be recognized as a milestone that IPH has taken the initiative as a national center of excellence in water resources and started publishing a journal, "Cadernos de Recursos Hídricos". The first number was published in January 1978. Up to now 4 issues have been edited and published. The Journal circulated throughout Brazil with 1000 copies distributed to technical and scientific institutions including Universities.

Beside this, the project itself has brought out 19 Technical Publications, in English or Portuguese, which are being used also
as auxiliary material for teaching and research in the specific subject. Some of them recapitulate the courses given by UNESCO consultants at Ph.D level and thus will be very useful for IPH staff members who later teach courses at the same level.

Complete lists of IPH publications are given in Annexes 17 to 21.

The master's degree dissertations, which are also recognized as publications are listed in Annex 28.

3.5 - Cooperation in training

In accordance with one of the immediate objectives, the project was active in nation-wide cooperation in the training of personnel at high school level, undergraduate and post-graduate levels. First of all the project collaborated with project BRA/72/010 on the Hydrology and Climatology of the Amazon River Basin (PHCA). Students from the Amazon Climatology project attended a technical course offered by IPH. Another course was offered and should have taken place in Belém, in 1979, but, for lack of funds on the part of SUDAM, could not be held. It is hoped to hold the course later.

Another form of training cooperation was to invite participants from other institutions throughout Brazil. In 1978, for example, five courses recognized as Ph.D level which were given by UNESCO experts, were attended by participants from the Department of Water and Energy of São Paulo, Eletrobras, Eletronorte, Eletrosul and Corsan. A complete list of public courses, held mainly by UNESCO consultants and experts, is given in Annex 3.
One important form of cooperation in training was the participation of IPH professors as lecturers at courses taught at other Universities at graduate and post-graduate levels. Courses were taught at the University of São Carlos, Federal University of Mato Grosso do Sul, State University of Maringá and others. A complete list of such courses is given in Annex 10.

The project was also involved in the organization of a successful seminar on teaching and research in water resources, held at the IPH in October 1979 with participants from the Universities of São Carlos, Paraná, Ceará, Rio de Janeiro and Rio Grande do Sul, as well as from project BRA/72/010 - Hydrology and Climatology of the Amazon River Basin.

The IPH teachers also had an impact on the evaluation and accreditation of graduate and post-graduate courses at other Universities. This was the case of Professor Amadeu da Rocha Freitas who participated in an evaluation of the post-graduate course at the University in Rio de Janeiro, and of the graduate course at the Mauá Institute of Technology in São Paulo. Prof. Amadeu also took part in the evaluation of the graduate course in Sanitary Engineering at the Federal University in Bahia, and a post-graduate course at the University of São Paulo.

Professor Victor Haertel assisted in the evaluation of a course on Mapping Engineering at the Federal University of Paraná in Curitiba.

The examples given above are to show the recognition of the high professional level of IPH staff members by the Ministry of Education.
3.6 - Human resources

The teaching staff of IPH is involved in all levels of education in the technical course, graduate and post-graduate courses. The total number of teachers belonging to the structural parts of the IPH, the (a) Department of Hydromechanics and Hydrology - DHH, (b) Department of Hydraulic Structures - DOH and the (c) Center of Applied Hydrology - CHA, is indicated below.

<table>
<thead>
<tr>
<th></th>
<th>Part-time</th>
<th>Full-time</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>DHH Hydromechanics and hydrology</td>
<td>6</td>
<td>16</td>
<td>22</td>
</tr>
<tr>
<td>DOH Hydraulic structures</td>
<td>8</td>
<td>15</td>
<td>23</td>
</tr>
<tr>
<td>CHA</td>
<td>-</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>33</td>
<td>47</td>
</tr>
</tbody>
</table>

Most of the part-time teachers (20 hours) teach in the graduate course and are not involved in research. The full-time teachers work in the graduate and/or in the post-graduate course and spend an average of 18 to 20 hours a week on teaching and directly related activities. The remainder of the time is spent on research and organization.

The staff of IPH at any given moment is rather variable depending on whether fellowships have been granted to staff members by the Government of Brazil or by UNESCO, through the project.

Annex 31 gives the names of the staff members who can be considered competent at present to act either as promotor and leader of the research work or as assistant in these activities with prospects for a further leading role. The staff members marked by an O - sign are mentioned in the prospectus as "professores orientadores".
Annex 31 shows that in the year 1981 there is a small group of senior professors who are certainly capable of acting as promoters but who - precisely due to their seniority - have to spend a good deal of their time on management and organization. In the second group three professors - Tucci, Lanna and De Luca - have only just obtained their Ph.D abroad. After the return of the other trainees from abroad, the staff will have, after 1983, a reasonable potential for promoters but needs some more opportunity, through leadership of research work and teaching at the IPH, to carry out its highly responsible duties with the required self-confidence.

In relation to the specific areas of scientific interest the 33 full-time teachers are associated with the following sectors:

- Hydrology: 7
- Ground Water: 3
- Sedimentology: 2
- Irrigation and Drainage: 4
- Sanitary Engineering: 4
- Mapping (Remote Sensing): 2
- Hydrodynamics: 5
- Applied Hydraulics: 2
- River Morphology: 2
- Computation: 2

Ten of the teachers listed above have or will have a Ph.D or equivalent degree in the near future (beginning 1982). Eighteen teachers have a M.Sc. degree. Five of the staff members are at present abroad working on their Ph.D.

During the period the project was in operation a continuous
contribution by the UNESCO experts and consultants had great impact on the training and research carried out, besides, of course, the physical increase of the IPH staff members. Some of the UNESCO experts who were present on the site for up to 5 years, as can be seen from Annex 5, participated actively in teaching and research and could even be regarded as full-time IPH teachers.

With the conclusion of the project at the end 1981 the IPH may lose some momentum. However, the teaching of the course subjects for the doctoral programme (Annex 29) in 1982 (after the return of the IPH professors from abroad) can be left to the entire responsibility of IPH staff. Nevertheless, the newly trained staff may not all have sufficient maturity to lead research on a high enough level to produce adequate doctoral dissertations. The feeling is that during the next two or three years only a limited number of doctoral dissertations can be supervised by IPH staff members.

The technical support group should be mentioned to give a complete picture of human resources available at IPH. At present there are 32 persons with the following specialization:

Hydrotechnicians 18
Airphoto operators (restitution) 6
Laboratory workers 2
Programmers 2
Librarians 3
Interpreter 1

Besides this there are carpentry and mechanics shops, photographic laboratory, and drawing department which employ 32 persons in all.

The administrative and general services sectors employ 49
4. Utilization of project results

Although the long-term and immediate objective of the project can be considered achieved, there are some aspects which were not a full success.

The objective of strengthening the structure of IPH of the Federal University of Rio Grande do Sul, in terms of human resources and physical facilities, was achieved. The IPH is now completely independent of external assistance for teaching hydrology at the level of the technical course and the M.Sc. degree. IPH's physical facilities for research and its scientific output are at a high level and in many cases competitive with research done by the most reputable scientific groups anywhere in the world.

This means that the IPH can reap direct benefit from the results and experience gained in other similar projects, especially in other Latin American countries, and vice-versa, that the teaching and research capacity developed at IPH at a high level can be, if appropriate, directly utilized in other regions of Brazil and/or in other countries.

However, in one respect, namely the establishment of a Ph.D programme at IPH, project planning was excessively optimistic. Within the life of the project it proved impossible to build up professional staff of a sufficiently high level. In this context the ineffective utilization of the 251 m/m of fellowship provided by the project must be mentioned. With the relatively
large number of m/m of fellowships spent, only three fellows obtained their Ph.D degree. Experience thus shows that fellowships for obtaining a Ph.D degree abroad should be awarded only to well advanced staff members. With a project duration of five years a fellowship should not last longer than two years in order to not loose the staff capacity on the site and to be able to gain from the investment made.

Nevertheless it is expected that in the next few years the newly graduated Ph.Ds will gain enough maturity to constitute, with the already existing senior staff members of IPH, the required "critical mass" and be able to implement the doctoral programme planned for the project.

5. Findings

The project made a vital contribution towards consolidating the teaching and research activities of the IPH of the UFRGS.

The Technical Course of Hydrology had already been started in 1970 was run during the period of 1977-1981, without the direct contribution of the project. The Technical Course is well known for its quality and the Hydrotechnicians are greatly sought after in all parts of Brazil.

The education of hydraulic engineers to the master's level with emphasis on "applied hydrology" has been successful and has reached a self-sustaining level as far as foreign aid is concerned. This can be ascribed to the selection of candidates for the master's course and to the fact that the training is based on the two elements of a number of course subjects and a master's thesis.
based on research or on a critical review of reference material. These theses testify to the competence of the teachers and the scientific level of the research. The DNAEE - Departamento Nacional de Água e Energia Elétrica - has expressed its satisfaction with the type and level of education offered at the IPH. The contributions of project BRA/75/007 and its forerunners have played a decisive role in achieving this.

The existing facilities for the master's degree are a prerequisite and a solid foundation for the accreditation of a doctor's degree (Ph.D) provided that a core of competent supervisors is available and that, besides the advanced course subjects, research can be carried out which can be considered of both national and international relevance.

As for the "critical mass" of supervisors for the doctoral dissertation, at present there exists a small nucleus of competent senior professors. After the return of the Ph.D trainees from abroad the staff will have a greater potential for supervision than at present, but some years will be required before the full benefit of that potential can be reaped in the supervision of high-level research and the teaching of advanced subjects.

The present availability of research topics suitable for Ph.D dissertations is largely due to two factors - the research work in representative and experimental basins, in pilot areas, which has been carried out during the last five years and the building up of an adequate infrastructure for this research - both of which are prerequisites for the successful long-term development of a doctoral programme.

Regardless of whether the long-term aim of the University and
the Government with respect to the doctoral programme is to promote exceptional performance by a "happy few" or to produce a much larger body of top-class engineers, the beginning must be a small number of doctoral dissertations (say two or three) over the next three or four years.

6. Conclusions and recommendations

(i) The undoubted success of project BRA/75/007 might have been even greater with the full implementation of the Ph.D programme at IPH, as planned. Development of high-level senior professional staff to run a Ph.D programme and to serve as research supervisors at that level is a very long process, the results of which may be difficult for administrators to plan.

In planning similarly ambitious activities, less optimistic assumptions have to be made. In each specific case a sound realistic appraisal has to be made in the light of local conditions.

(ii) At present the IPH has a structure which is not only capable of carrying out high-level research but also of receiving and disseminating advanced technologies appropriate in solving problems afflicting regions presenting geographical, climatic and social and economic characteristics found in Brazil and throughout most of Latin America.

This structure must be maintained and consolidated since it is the touchstone of the success of the Ph.D programme in the near future and also of larger and wider-reaching programmes,
such as the present Brazilian Plan for Scientific and Technological Development (PBDCT - Plano de Desenvolvimento Científico e Tecnológico), the action programmes proposed by the United Nations Conferences on Water (Mar del Plata, 1977) or on Science and Technology for Development (Vienna, 1979), and other programmes implemented by the International Hydrological Programme or by the International Decade for Drinking Water and Sanitary Engineering. Measures have to be taken to assure continuity of ongoing research and actions which will open channels for exchange and transfer of technology, linking IPH to similar centers at different levels of development and to users of the research results.

(iii) Although eight fields of research in water resources development and conservation have been established at IPH, which reflects the creation of new areas of research during the last few years, a more concentrated effort should be made in three or four fields only, to reach the highest level of excellence in these fields.

Considering the areas in which IPH has specialized and also the guidelines of the III Brazilian Basic Plan for Scientific and Technological Development (PBDCT) or recommendations made by the aforementioned international conferences, the most appropriate fields to implement such a policy are:

* Hydrology, stressing for instance the inventory of water resources, from scarce data and assessing the impact of human activities on the hydrological and sedimentological regimes, using remote sensing techniques in addition to classical methods.
* Environmental engineering, including the development of simple and less expensive techniques for water purification and sewage treatment, in small and medium-sized communities, and/or selected industrial wastewater.

* Irrigation and Drainage, one of the objectives being to improve flood-plain productivity by adequate management of soil and water.

* Hydraulics and Fluid Mechanics, with special emphasis on problems of conservation and of the flow and dispersion of pollutants in large bodies of water and in coastal waters. Concentration on a smaller number of fields of research, as suggested above, seems to be essential for building up a body of mature high-level specialists to carry out internationally recognized research.

(iv) At the end of this project it can be said that IPH appears on the Brazilian and Latin American scene as an institution capable of disseminating appropriate technologies and participating in projects of development and conservation of water resources.

The dissemination of assimilated or created technologies will depend on the links which will be forged for this purpose, at national, regional and international level.

At a national level these links already exist with users and 20 technical and scientific aid agreements have been signed for this purpose, with most of the similar institutions. They should be reinforced even more, to improve the advice and coordination of research programmes being executed at various
research centers, so as to allow especially the testing of new technologies under many different geographical, climatic and social and economic conditions.

(v) At an international level the support which projects sponsored by international organizations can receive from IPH must be mentioned. As an example, links already established between IPH and project BRA/72/010, Hydrology and Climatology of the Amazon River Basin can be mentioned. These links should be maintained, and if a new international or national project on the hydrology and climatology of the Amazon is developed, IPH should not only continue to serve as a resource base for the training of project personnel at intermediate technical level and at post-graduate level, but also provide consulting services in specific areas. In this case, particular reference should be made to IPH experience in the following areas applicable to the needs of the Amazon: (a) software for remote sensing systems (vegetation cover, water resources) (b) mathematical models (rain-drainage/river systems) and (c) sedimentation.

(vi) Finally, at a regional level the IPH itself and the experience gained during the course of this project should have an impact on the development of similar institutions in other Latin American and Portuguese-speaking African countries. Close scientific cooperation should be established with appropriate institutions in other aforementioned countries, in conducting research and teaching activities. The joint and coordinated use of human and physical resources and also of the information available at those institutions
should lead to establishing an adequate research network at the regional level for water resources development and conservation. The IPH could be recognized as a nucleus of high-level scientists which alone, or jointly with other centers of excellence, will create a committee of high-level scientists selected from a network of these centers, who will advise and, through other individuals, promote dissertations at a Ph.D degree level. The possibilities of a regional approach to establish a Ph.D programme in water resources development and conservation should be given serious consideration.

7. Comments

Since the implementation of the Doctoral programme in the field of Water Resources, which was the main goal of the Project, was not achieved by the end of 1980 as planned, nor one year later, during the extension of this project, the fundamental question, why, has to be raised.

As mentioned before, a Doctoral programme is a complex interactive system, the main components of which are individuals dedicated to the creative development, preservation and transmission of knowledge and a ceaseless attempt to understand the behaviour of the Universe in which we live.

From the definition above such individuals, who include both teachers and students, are the crucial point for the success of a Ph.D Programme. Of course, a suitable institution with an adequate infrastructure are also needed to establish and operate such a programme. The institution which includes courses at an
adequate level and the physical structure, including buildings, laboratories, work-shops, apparatus, etc. seems to be a part which can be planned and predicted with more or less success, according to a well prepared schedule. This was the case with Project BRA/75/007.

An important role was definitely played by the previous UNDP/UNESCO supported Project BRA/67/527 in establishing the physical structure during the period 1971 to 1977. The physical conditions were very much further developed during the course of this Project.

Human resources development, the training of individuals dedicated to carrying out creative research, however, is much more difficult to incorporate in administrative planning. One way to increase the number of scientific staff is through awarding fellowships to centers of excellence (at recognized Universities) to study towards a Ph.D. The experience of this Project showed that on the average a 3.5 year period is necessary for a student to obtain his Ph.D. However, in some cases the period was extended to 4.5 years. It seems hard for a newly graduated Ph.D. to serve immediately as an adviser at his mother University (in this case IPH/UFRGS). As a result, during the life of a five-year project it is very difficult if not impossible to count on the creation of high-level staff solely through the project. It appears to be very important to have right at the beginning a reasonable number of staff members with the capacity to serve as advisers. International (UNESCO) support should be directed toward the increase of only a limited number of staff members by granting fellowships and mainly toward the improvement or establishment of Ph.D courses. The most important contribution, however, should be made by local staff who
actively participate in and, if necessary, direct research programmes being carried out by candidates for a Ph.D degree.

At this point one has to answer another question: whether or not a Ph.D programme should be recognized officially in advance, before all of the necessary conditions are met. Conditions are defined mainly as a sufficient number of senior staff members and internationally recognized research and publications at an appropriate level. If a decision to create a Ph.D programme has been taken both by the University authorities and at the Ministerial level, then there should also be official recognition of the programme by the respective authorities, even if only on an experimental basis.

If there is no spontaneous development of a research group through creation of a Ph.D programme, but it is nevertheless planned to accelerate this process (with or without international cooperation), then such a programme should be officially approved even if not all of the prerequisites are fulfilled. Under Project BRA/75/007 there were six long-term experts and 67 UNESCO consultant missions. Several technical courses were taught by them at the highest recognized Ph.D level. The consultants' visits to the project as well as the course mentioned were not fully utilized, simply because of the lack of students admitted to a Doctoral programme. Only with official recognition of the Ph.D programme can students be admitted and adequate research be carried out toward that end. If, to obtain a Ph.D degree abroad at well recognized Universities in the United States of America, it takes about four years, as was the case with the IPH fellows, why should it take less at IPH ?
In other words, it is a long time before results can be achieved when a decision to start a Ph.D programme is taken. The decision to undertake such a Project should be combined with the decision to recognize the Programme.

Another important fact is the concentration of effort. The term "Water Resources" covers so many areas, fields and topics of research that it is not specific enough to show the area of concentration. More attention should be given, at least at the beginning, to two or three specific fields of research. And those subjects should be developed faster and given preferential treatment.

And so, during the last phase of the Project, emphasis was given to the development of long-range research, leading to a high level of excellence in limited fields of interest. This may lead to publications at an internationally recognized level.

Summing up once again, during the course of the project it was found that the following aspects could be helpful in achieving all of the objectives of the Project and above all the implementation of the Ph.D programme:

- The training of high-level staff members, including the completion of Ph.D studies (abroad), always takes a long time, approximately four years, and thus within the life of one project, there is very little chance of taking advantage of the newly trained staff.

- Universally recognized as important aspects of the Doctorate studies are research and the preparation of respective theses. This is a relatively long process which depends mainly on dedication and individual predispositions of the students.
Long-term research programmes should thus be available to constitute a part or a foundation for a thesis.

- The decision to carry out an assisted project involving a Ph.D programme should be necessarily accompanied by the decision by the Government and related authorities to recognize such a programme, even under experimental conditions. No students can be admitted or research conducted towards a Ph.D if there is no official permission to do so.

- In the early stages of a Doctoral programme, one should try to limit the scope and range of research and concentrate on a small number of topics to achieve an internationally recognized level of excellence.
WORK PLAN

Description of Project Activities

Project Activities

1. Related immediate objectives

Establish programme at Ph.D level in the science of water resources for the improvement of high-level Brazilian technology and know-how:
   (i) elaborate and strengthen a programme for the training of Ph.D;
   (ii) initiation of the implementation of Ph.D programme.

2. Related immediate objectives

Train the professors of Master courses to enable them to obtain their Ph.D degree:
   (i) a total of up to 14 professors will follow a Ph.D training programme, partly in Brazil and partly abroad, to obtain the corresponding degree.
   (ii) preparation of Ph.D theses jointly with research projects related to Brazilian water resources problems.

3. Related immediate objectives

Continue supporting IFH Master courses in Applied Hydrology, to permit further training at Ph.D level:
   (i) organization of workshops for the professional staff of the Masters course;
   (ii) substitute temporarily the Brazilian professors studying abroad to complete their training or preparing their Ph.D thesis.

4. Related immediate objectives

Co-operate with the training of personnel at medium and post-graduation levels, upon request by Government agencies all over the national territory:
   (i) train about 25 middle-level technicians per year (sub-professional level) in the regular one-year courses.
   (ii) carry out special training courses of short duration for technicians of Governmental agencies from Brazil and other countries, upon request.
   (iii) assist other Brazilian institutions and training activities at all levels.
   (iv) carry out special courses of short and medium duration (up to 2 months)
5. **Related immediate objectives**

Carry out research projects in co-operation with national institutions to intensify and develop water resources in Brazil, and strengthen the infrastructure of the laboratory of the IPH:

(i) carry out scientific research projects upon request of the Government.
(ii) modernize, equip and enlarge the hydro-sciences laboratories of IPH.

6. **Related immediate objectives**

Develop and strengthen IPH structure to provide consultant activities so that it may be competitive in carrying out water resources projects and surveys for development agencies and similar institutions all over the country; large-scale projects in which the national technology will have to be developed and improved such as those that are being formulated for the Amazon region will have priority:

(i) prepare and carry out applied research and survey projects upon request of Government and private agencies.

7. **Related immediate objectives**

To divulge up-dated knowledge to the administration and management teams of Federal and State Agencies:

(i) carry out special short-term courses to familiarize executives of various agencies with the most up-to-date techniques and methods in the field of the development of water resources.

8. **Related immediate objectives**

To divulge technical knowledge to executives of other nations and assist them in project execution where requested:

(i) prepare and carry out short-term high-level workshops, as well as render services outside Brazil upon request by foreign Governments and Institutions with the assistance of the national and international staff to the extent permitted by IPH resources.
Schedule for the implementation of the Ph.D programme

1. Introduction

The main objectives of the plan of Operations of Project BRA/75/007, signed on December 12, 1976 between the Brazilian Government, UNDP and UNESCO, were the establishment of a Doctoral level programme in Water Resources Science, and the training of the Masters Course students in Applied Hydrology aiming to obtain a Ph.D.

The activities of the present Project BRA/75/007 were started in January 1977, and are to end in December 1980.

The following documents were prepared concerning the implementation of a Ph.D programme

- D.01 "Basic Document to prepare the policy to be followed for the implementation of the Doctorate in Water Resources at IPH" - Prof. Ceferino Alvarez, CTA BRA/75/007 - September 15, 1978.

- D.02 "Document on the analysis of conditions for the implementation of the Ph.D in Water Resources at IPH" - Prof. Warren Hall - Consultant BRA/75/007 - November 1978.

- D.03 "Analysis of the activities carried out during the year of 1978, by the Institute for Hydraulic Research, with the aid of Project UNDP/UNESCO/ BRA/75/007" - November 1978.

The purpose of these documents is to present the programme for the implementation of the Water Resources Doctorate Programme, at IPH.

The general strategy for this implementation can be summed up as follows:

- During the first phase the minimum conditions required to create a Ph.D Programme were studied. Contacts were made with the Pro-Rector of Research and Post-Graduation, Professor Gerhard Jacob, and, especially, advice was received from Colorado State University, as well as the opinion of several consultants who are professors at other Universities (Laval, Michigan, Wallingford, etc).

During the second phase the Ph.D Course Programme was partly defined by the present Coordinating Committee for the Post-Graduate Course in Applied Hydrology, which consists of Professors Amadeu da Rocha Freitas (Coordinator), Ceferino Alvarez, Marc Pierre Bordas, Paulo Ramos and Carlos E.M.Tucci (Members).
This definition was consolidated in the following documents: "Proposal for the Organization of Ph.D Programme in Applied Hydrology" and the "Statutes" which were sent to the Pro-Rectory of Research and Post-Graduation of the UFRGS. During this phase also the scientific publication programme related to ongoing research at IFH was prepared.

- The third phase was to consist of the implementation of the Ph.D Program, proper, and was to culminate in the official recognition by the authorities of UFRGS and, later on, by those at the Federal Council of Education.

Considering the intrinsic nature of the objective, this phase will not end fully within the present Project, and a second complementary phase is deemed necessary, lasting at least 2 years, to strengthen the programme as can be gathered from the Tripartite Review Report, of December 13, 1978.

2. Premises

2.1 General Conditions

Ph.D training implies in the development of original research which will lead to a real contribution to the knowledge on the subject, and verified by a thesis defense, besides the fulfillment of other requirements such as obtention of credits, passing qualifying exams, etc.

Quality control and the study of the convenience of such a course must depend first of all on a decision on the part of the University, independent of external influences, and thus it is implicit that the first responsibility is therefore up to the University.

Post-Graduation, both at a Masters and Ph.D level, has as general objectives:
- to train teachers for university level courses, so as to improve the quality of university teaching.
- to train researchers for scientific work in research nuclei and centers throughout the country.
- to prepare high level professionals, considering the requirements of the labor market.

The implementation of a Ph.D Programme in Water Resources, oriented toward the solution of national problems and at a level of competence compatible with international standards creates possibilities for a center to:
- do training in the field of water resources, emphasizing certain areas of competence at an international level;
- do basic and applied research, emphasizing certain areas of competence at an international level;
- do transference of knowledge;
- do international cooperation in Water Resources;
- do advisory work for national and international, public or private clients;
- be a repository of knowledge in the field of Water Resources.

2.2 Components of Doctoral Programme

It is understood that a Doctoral level programme does not consist mainly of plans, rules, classrooms, laboratories, libraries, computers, etc., although these elements are indispensable for it to work.

A Doctoral programme is a complex interactive system, the main components of which are individuals dedicated to the creative development, preservation and transmission of knowledge and the ceaseless attempt to understand the behaviour of the Universe in which we live.

Such individuals include both teachers and students chosen by means of a severe intellectual selection.

The difference between them is rather a question of experience and maturity, than the fact that one group gives and the other group receives academic titles.

2.3 Characteristics of a research environment

The main characteristics of a research environment into which we can introduce a Doctoral programme can be summed up in a single word: "attitude".

The attitude compatible with a Doctoral programme must involve the faculty, the students, the administration of the institution and the agencies in charge of allocating funds.

Obviously this attitude is the resultant of various factors, and it is the critical point, especially as regards the faculty.

Attitude is almost always the decisive factor between programmes of an adequate quality and those of an inferior unacceptable quality.

The foundation for a good research environment is difficult to define, but we suggest the following:
- a marked interest in research, shown by the Administration in the allocation of resources and by the existence of an adequate system to pay the faculty, which will reflect and compensate the individual effort which has effectively been made;
- freedom of scientific enquiry;
- active participation of the faculty, the student body and also of the higher authorities in discussion of problem-areas and in the establishment of the development policy for the Doctoral programmes;
- a research management system which stimulates rather than guides potential productivity;
- a system of incentives and facilities for scientific publication which is
indispensable for the continuous enforcement of the level of excellence of
the activity according to international standards.

3. **Basic Elements for the Implementation of a Doctoral Programme at IPH/UFRGS**

For the implementation of a Doctoral programme in the field of Water Re-
sources the following basic elements must be considered:

1) the critical mass required;
2) research programme;
3) the infrastructure needed to go ahead with research;
4) adequate dissemination of the results of research.

The schedule for the programme implementation includes providing part of
the IPH faculty with the qualifications needed to direct advanced research
(Appendix 2). For this purpose, fifteen teachers are considered in this schedule,
involving the cooperation of UNDP/UNESCO and bilateral cooperation with France;
one teacher has already received his Doctorate in 1978, and another is preparing
the presentation of his thesis for the end of 1979.

To obtain the qualification compatible with the programme, it is necessary,
besides obtaining the title of Doctor, that the IPH teacher participate in advanced
research for a certain period of time, under the orientation of senior scientists,
who have experience in the formulation and work in research and who also,
preferringably, have academic experience at a Doctoral level. For this purpose it is of
essential importance to have the continuity of United Nations support. A sequence
of teachers who are perfectly established and duly committed, with recognized
competence in the more promising areas of IPH, from the point of view of a Doctoral
programme, will provide solid support on which the capacities of the scientific
nucleus of the institution will be able to develop and also will attract students
to research activities. Some of these students may show capacity for becoming
Doctoral candidates.

Since 1977 IPH has been carrying out some research programmes funded by FINEP.
These programmes consider mainly four experimental areas:

- the Forqueta river basin
- the Dilúvio Creek basin
- the Sinos river basin
- Cachoeirinha experimental station

The first results, among others, made it possible to develop the infrastructure
which was required to obtain basic data without which it would not have possible
to develop research and to organize groups of researchers.

Besides these experimental basins, IPH has the necessary equipment and
laboratories to treat data collected in the field.
Consequently, the United Nation scientists will have a national counterpart, consisting of teachers who are directly integrated in the Doctoral programme, and whose priority in their working plan will be the joint execution of the activities related to the Doctoral programme.

The excellence of advanced research carried out by the national and international teams will be proved by means of publications at an international level, and this is one of the aims of the programme. For this purpose it will be necessary to continue with the present efforts which are characterized by the preparation, during the year of 1979, of 29 publications (6 of which at an international level), publishing the journal called "CADERNOS DE RECURSOS HÍDRICOS" and technical publications.

4. Implementation Schedule

The general schedule for the implementation of a Water Resources Doctoral programme is presented in Appendix 1, and gives a summary of the main past and future events and decisions and is a basis for checking the development of activities.

4.1 First and Second Phases

The first two phases correspond to the years of 1977/1978, and ended with satisfactory results.

i) The purpose of the first phase was to create the conditions required to implement the Doctorate Programme.

The efforts centered on
- strengthening the masters course as a sine qua non condition for a Doctorate Programme;
- incrementing the critical mass of IPH teachers to obtain a high scientific qualification;
- expand and improve the infrastructure which is necessary for research;
- within the framework of scientific level cooperation a sub-contract was signed with Colorado State University (CSU) and publications were made and seminars and conferences were given;
- eight lines of research were defined, including the present and future fields of action of IPH. 5 research projects were begun with the financial support of FINEP.

ii) The purpose of the second phase was to define and partially implement the Doctoral Programme.

To fulfill the objectives we considered:
- the definition of the conditions required for the implementation of the Doctorate, resulting from several discussions, and they were
mentioned in three Project publications;
- continuation and control of the implementation of the critical mass.

One of the Project fellows received his Ph.D at Colorado State University;
- five courses which are usually offered at a doctoral level at Colorado State University were taught at IPH;
- we carried on with publications by IPH faculty, and many lecture were held. Caderno de Recursos Hídricos nº 1 was published;
- research begun in the previous year was finished and research programmes for the next two-year period were prepared.

4.2 Third Phase

The third phase is divided into two stages, the first of which corresponds to the period of 1979/1980 and the second of which to 1981/1982.

1st Stage - The schedule details the following topics:
- structuring of the Doctorate Programme
- critical mass
- research
- cooperation at a scientific level
- student body
- dissemination of activities

Among the initiatives to be taken the following must be emphasized:

a) definition by the Coordinating Committee of the Post-Graduate Course in Applied Hydrology of the area(s) of research which is relevant in the field of Water Resources, and classifying it by order of potential of IPH, considering:
- the present state of scientific knowledge, their prospects and their poles of development throughout the world;
- the national and regional interest which may be presented by research subjects, taking into account, on one hand the labor market at the Universities and research institutions, and on the other feasibility of financial support;
- the availability of IPH faculty, their capacity for high level research and their individual disposition to take on the responsibilities inherent to the development of a Ph.D program.

b) having defined the subject(s) by order of potential, start preparing a research programme which is of unquestionable relevance to support the Doctoral Programme, and submit it to the appropriate authorities;

c) begin the Programme activities by engaging qualified students to work in research as a condition to assess them for a future Doctorate, the validity of which will depend on the accreditation to be given by the Federal Council of Education.
2nd Stage

Considering the nature itself of the objectives of implementation of the Doctorate Programme, it is impossible to finish the third phase completely, within the present UNDP/UNESCO Project.

It is necessary to have a second complementary stage, lasting at least 2 (two) years, to strengthen the Programme, so as to insure full scientific production for the future.

For this purpose it will be necessary to have the basic support of the United Nations, through senior scientists with academic experience at the level of the Doctoral Programme, to formulate and direct research involved in the Doctoral Programme, aided by the high level national team (mostly trained during the previous phases of the Project).

The programme for the stay of these scientists should be established in such a way that the previous objective can be carried out.
<table>
<thead>
<tr>
<th><strong>OBJECTIVES</strong></th>
<th><strong>DECISIONS AND DOCUMENTS REQUIRED</strong></th>
<th><strong>STATUS</strong></th>
</tr>
</thead>
</table>
| **1. Strengthening the Masters Course** | - Review of the summary: discussion with teachers in charge of the courses  
  - Statutes: preparation of the new Statutes by the Post-Graduation Committee  
  - Re-accreditation of Course: preparation of papers needed for re-accreditation  
  - Dissemination of the Course: preparation and distribution of posters           | - Approved by CPG and V Chamber  
  - Sent to the V Chamber and approved on May 24, 1977. Opinion No. 092/77  
  - Sent to Pro-Rector (Letter no. 77.312.1.2 on Dec 14/1977)  
  - Increase in the number of candidates                                            |
| **2. Critical Mass**                  | - Preparation of the calendar for teachers to go abroad to prepare for their Doctorate, by the Governing Board BRA/75/007 | - Six (6) teachers left to finish their Ph.D training (Appendix 2)                             |
| **3. Infrastructure**                | - Create laboratories: Agricultural Hydrology; Group Water; Sanitary Engineering and Analog Models.  
  - Implementation of the new Library  
  - Classrooms - Teachers offices  
  - Preparation of graph of IPH organization  
  - New distribution of teachers' offices gathering the groups of researchers together  
  - Definition of the ways by which a computer can be acquired for IPH             | - The Sanitary Engineering Laboratory must conclude installations in its definite location  
  - Although the new building is not yet ready, it is being used  
  - Provisory schedule still experimental  
  - The teachers and researchers of Hydrology and Sanitary Engineering grouped together  
  - The acquisition of the Computer is being done directly by the University       |
<table>
<thead>
<tr>
<th>4. Cooperation at a Scientific level</th>
<th>11 publications were prepared</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Dissemination of updated knowledge</td>
<td>- 02 seminars were held</td>
</tr>
<tr>
<td>- Preparation of the 1977 calendar for consultants by the Project Governing Board, and approval by CPG</td>
<td>- 13 sets of lectures were held</td>
</tr>
<tr>
<td>- Cooperation with Colorado State University</td>
<td>- 7.8 man/months of consultants</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5. Research</th>
<th>8 lines of research and researchers' groups were defined</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Definition of research policy</td>
<td></td>
</tr>
<tr>
<td>- Development of research through the UFRGS/IPH/FINEP agreement</td>
<td></td>
</tr>
</tbody>
</table>
## General Schedule for the Implementation of the Doctoral Programme at IPH

**1978 - 2nd phase:** Partial definition and implementation of the Doctoral Programme

<table>
<thead>
<tr>
<th>OBJECTIVES</th>
<th>DECISIONS AND DOCUMENTS REQUIRED</th>
<th>STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Definition of the conditions required for implementation of the Doctorate</td>
<td>- Previous meetings between IPH/CSU/PROPESP/PROJECT to assess the minimum conditions which should be offered to IPH</td>
<td>- Project Documents: 1-2-3</td>
</tr>
<tr>
<td></td>
<td>- Preparation of Basic Documents on the Doctorate</td>
<td></td>
</tr>
<tr>
<td>2. Critical Mass</td>
<td>- Project Governing Board checks results obtained by the teachers abroad</td>
<td>- 4 fellow obtained his Ph.D: 4 are still abroad, and 1 gave up</td>
</tr>
<tr>
<td>3. Doctoral level Course</td>
<td>- Schedule of Ph.D level courses by the Post-Graduation Committee and holding of same</td>
<td>- 5 courses were offered, and taught by Project consultants</td>
</tr>
<tr>
<td>4. Cooperation at a scientific level</td>
<td>- Dissemination of up-dated knowledge</td>
<td>- Technical publications of Project: 1-2-3 - 8 publications by faculty members were presented - 17 lectures - Cadernos de Recursos Hídricos (Journal), n° 1 - 7,6 man/months - Preparation of the consultant calendar of BRA/75/007 for 1978, by the Governing Board, according to CPG</td>
</tr>
<tr>
<td>5. Research</td>
<td>- Ending of previously started research</td>
<td>- Letter to FINEP 3815/78</td>
</tr>
<tr>
<td></td>
<td>- Preparation of new research programmes for UFRGS/IPH/FINEP - 79/80 agreement</td>
<td></td>
</tr>
</tbody>
</table>
# General Schedule for the Implementation of Doctoral Programme at IPH

## 1979 - 1980: 3rd Phase: Implementation of the Doctorate

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Decisions and Documents Required</th>
<th>Status</th>
</tr>
</thead>
</table>
| 1. Structuring of Doctorate Programme | - Proposal for implementation of doctorate, to be sent to the Pro-Rectory of Research and Post-Graduation  
- Preparation of Structures by PG Committee  
- Sending statutes to PROFESP  
- Calendar of P.G. courses and approval by the Pro-Rectory of Research and Post-Graduation  
- CPG sends on the request for the accreditation of the Doctoral Programme | - Letter 79.90.1.2  
- Minutes of 21 September 1979  
- Letter 79.205.1.2 |
| 2. Critical Mass                  | - Periodic examination of the status of teachers who are abroad by the Governing Board  
- CPG approves the subjects for the Ph.D. theses of Project fellows | - Minutes of Governing Board - May 30, 1977  
- 3 fellows are still abroad  
1 returned to IPH temporarily |
| 3. Research                       | - Follow-up of scientific production  
- Calendar of IPH scientific publications | - 29 publications were prepared by faculty members/1979  
- (OS-IPH 11/79) |
| 4. Cooperation at a scientific level | - Schedule of the consultant of BRA/75/007 for 1979 by the Governing Board, according to CPG  
- Scheduling of consultant calendar of BRA/75/007 for 1980 by Governing Board according to CPG  
- Governing Board considers the general lines for cooperation between IPH and:  
. Colorado State University |
<table>
<thead>
<tr>
<th>5. Advanced level courses</th>
<th>- CPG prepares calendar of courses and sends it to PROPESP</th>
<th>- Letter 79.90.1.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Student body</td>
<td>- Official request to teachers and researchers of IPH to tell of their interest in taking the Ph.D at IPH</td>
<td>- Circular CPG/79 Aug.13, 1979</td>
</tr>
<tr>
<td></td>
<td>- Preparation of enrollment forms by CPG</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Official annual acceptance of 5 students at most by CPG</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- CPG establishes a Committee and an advisor for each student</td>
<td></td>
</tr>
<tr>
<td>7. Dissemination of IPH and Post-Graduate Course Activities</td>
<td>- Preparation of booklet on IPH activities</td>
<td>- being prepared</td>
</tr>
<tr>
<td></td>
<td>- Preparation of a Catalogue on the Course of Post-Graduation in Water Resources</td>
<td>- being prepared</td>
</tr>
</tbody>
</table>
1981-1982 - 3rd phase - 2nd stage: Strengthening of the implementation of the Doctoral Programme

<table>
<thead>
<tr>
<th>OBJECTIVES</th>
<th>DECISIONS AND DOCUMENTS REQUIRED</th>
<th>STATUS</th>
</tr>
</thead>
</table>
| 1. Doctoral Programme | - Consolidation of Doctoral Programme  
- Execution of advanced research programme  
- Offering courses at an advanced level  
- Follow-up of the accreditation process |        |
| 2. Critical Mass | - Carry on the strengthening of the critical mass of IH by means of fellowship grants  
  - Schedule of what is required  
  - Check periodically the results attained  
  - Make it easier for the IH faculty to prepare the Doctorate within the IH's own programme |        |
| 3. Research | - Define the Doctoral Programme research plans within the IH's general research policy  
- Direct and control the research involved in the Doctoral Programme by means of the senior scientists with the help of their Brazilian counterparts  
- Follow up of scientific production |        |
| 4. Cooperation at a scientific level | - Schedule of consultants  
- Cooperation with other institutions to develop research, especially:  
  - Colorado State University  
  - University of Michigan  
  - Wallingford Institute of Hydrology  
  - CNRS (France)  
  - National College of Agricultural Engineering  
- Dissemination of specialized knowledge by publication in journals |        |
and congresses
- Carry on with the technical publications and the journal "Cadernos de Recursos Hídricos"
- Schedule seminars and lectures

5. Student body
- Dissemination of Doctoral programme
- Official acceptance of 5 students at most by CPG
- Definition of students' programs
- Control of students' activities
- Assessment of results obtained
### Strengthening of Critical Mass - Scheduling of trips abroad

made by IPI teachers to obtain the Ph.D

<table>
<thead>
<tr>
<th>NAME</th>
<th>PLACE</th>
<th>Initial Date of Trip</th>
<th>Date Forecast for Obtaining Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neusa Gonçalves da Cruz</td>
<td>Laval</td>
<td>1976</td>
<td>Desisted</td>
</tr>
<tr>
<td>Antonio E.L. Lanna</td>
<td>CSU</td>
<td>1977</td>
<td>1979</td>
</tr>
<tr>
<td>Sôrgio J. de Luca</td>
<td>N.Carolina</td>
<td>1977</td>
<td>1980</td>
</tr>
<tr>
<td>Nelson C. Luna Caicedo</td>
<td>CSU</td>
<td>1977</td>
<td>1981</td>
</tr>
<tr>
<td>José Carlos S. Martins</td>
<td>CSU</td>
<td>1977</td>
<td>Desisted</td>
</tr>
<tr>
<td>Raul Dorfman</td>
<td>Technion</td>
<td>1977</td>
<td>1980</td>
</tr>
<tr>
<td>*Jorge P. Rios</td>
<td>Grenoble</td>
<td>1978</td>
<td>Desisted</td>
</tr>
<tr>
<td>Mário Damé Wrege</td>
<td>CSU</td>
<td>1979</td>
<td>1981</td>
</tr>
<tr>
<td>*Nara Rosauro</td>
<td>Southampton</td>
<td>1979</td>
<td>1982</td>
</tr>
<tr>
<td>Gilberto E. Canali</td>
<td>CSU</td>
<td>1980</td>
<td>1983</td>
</tr>
<tr>
<td>Luiz O. Monteggia</td>
<td>USA</td>
<td>1980</td>
<td>1982</td>
</tr>
<tr>
<td>Victor Haertel</td>
<td>CSU</td>
<td>1980</td>
<td>1982</td>
</tr>
<tr>
<td>*Luiz Emílio Almeida</td>
<td>France</td>
<td>1980</td>
<td>1982</td>
</tr>
<tr>
<td>*Rogério Maestri</td>
<td>France</td>
<td>1981</td>
<td>1983</td>
</tr>
</tbody>
</table>

* Fellowship grant from CNPq (Brazilian Council for Research)

** Forecast made in 1979
### List of courses taught by UNESCO Consultants at Ph.D level

<table>
<thead>
<tr>
<th>NAME OF THE CONSULTANT</th>
<th>SUBJECT</th>
<th>PERIOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEN, Yung-Hai</td>
<td>Hydrology and Hydraulics</td>
<td>10/07/78 - 15/07/78</td>
</tr>
<tr>
<td>McWHORTHER, David</td>
<td>Advanced Study of Ground Water</td>
<td>31/07/78 - 18/08/78</td>
</tr>
<tr>
<td>GRIGG, Neil</td>
<td>Urban Hydrology</td>
<td>10/09/78 - 22/09/78</td>
</tr>
<tr>
<td>HALL, Warren</td>
<td>System Analysis</td>
<td>18/09/78 - 31/10/78</td>
</tr>
<tr>
<td>ROUSE, Hunter</td>
<td>Fluid Mechanics</td>
<td>04/11/78 - 03/12/78</td>
</tr>
<tr>
<td>RAMALHO, Rubem S.</td>
<td>Water Treatment</td>
<td>28/07/79 - 17/08/79</td>
</tr>
<tr>
<td>DEININGER, Rolf</td>
<td>Water Resources Conservation</td>
<td>19/08/79 - 24/08/79</td>
</tr>
<tr>
<td>BONNEVILLE, René</td>
<td>Marine Engineering</td>
<td>06/08/79 - 17/08/79</td>
</tr>
<tr>
<td>NIR, Dov</td>
<td>Agricultural Hydrology</td>
<td>19/11/79 - 30/11/79</td>
</tr>
<tr>
<td>BONNEVILLE, René</td>
<td>Marine Engineering</td>
<td>04/08/80 - 16/08/80</td>
</tr>
<tr>
<td>CLARKE, Robin</td>
<td>Stochastic Hydrology</td>
<td>04/10/80 - 04/11/80</td>
</tr>
<tr>
<td>LESPINARD, Georges</td>
<td>Advanced Fluid Dynamics</td>
<td>15/11/80 - 12/12/80</td>
</tr>
</tbody>
</table>
List of fellowships awarded

<table>
<thead>
<tr>
<th>NAME</th>
<th>PLACE</th>
<th>SUBJECT</th>
<th>PERIOD</th>
<th>m/m</th>
<th>Ph.D Received</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carlos E.M. Tucci</td>
<td>USA - Colorado State University (CSU)</td>
<td>Water Hydrology</td>
<td>July 77- Nov 78</td>
<td>18</td>
<td>yes</td>
</tr>
<tr>
<td>Antonio E.L. Lanna</td>
<td>USA - Colorado State University (CSU)</td>
<td>Water Resources</td>
<td>Aug 77-Mar 80</td>
<td>32</td>
<td>yes</td>
</tr>
<tr>
<td>José C.S. Martins</td>
<td>USA - Colorado State University (CSU)</td>
<td>Water Resources</td>
<td>Aug 77-Dec 78</td>
<td>17</td>
<td>desisted</td>
</tr>
<tr>
<td>Nelson O.L. Calcedo</td>
<td>USA - Colorado State University (CSU)</td>
<td>Water Resources</td>
<td>Aug 77-Dec 81</td>
<td>53</td>
<td>yes</td>
</tr>
<tr>
<td>Sérgio J. de Luca</td>
<td>USA - North Carolina State University</td>
<td>Water Resources</td>
<td>Aug 77-Sept 81</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Raul Dorfman</td>
<td>Technion - Institute of Technology - Israel</td>
<td>Agricultural Hydrology</td>
<td>Oct 77-Mar 79</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Mário D. Wrege</td>
<td>USA - Colorado State University (CSU)</td>
<td>Groundwater</td>
<td>May 79-Apr 82</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Gilberto Canali</td>
<td>USA - Colorado State University (CSU)</td>
<td>Hydrology</td>
<td>Jan 81-Dec 81</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Luiz O. Monteggia</td>
<td>USA - Houston University</td>
<td>Environmental Engineering</td>
<td>Feb 82-Apr 82</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

TOTAL .......... 248
ANNEX 5

<table>
<thead>
<tr>
<th>NAME</th>
<th>COUNTRY OF ORIGIN</th>
<th>FIELD</th>
<th>DURATION OF CONTRACT</th>
<th>m/m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceferino Alvarez*</td>
<td>Spain</td>
<td>Chief Technical Adviser</td>
<td>Jan/77</td>
<td>Dec/79</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Applied Hydrology and Systems Analysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Michel Roze</td>
<td>France</td>
<td>Photogrammetry</td>
<td>Jan/77</td>
<td>Jun/77</td>
</tr>
<tr>
<td>John C. Taylor</td>
<td>England</td>
<td>Agricultural Hydrology</td>
<td>Sept/77</td>
<td>Sept/80</td>
</tr>
<tr>
<td>Jan Suschka</td>
<td>Poland</td>
<td>Water Resources Conservation</td>
<td>Dec/79</td>
<td>Dec/81</td>
</tr>
<tr>
<td>Herbert Neuland**</td>
<td>Germany</td>
<td>Ground, Water Hydrology</td>
<td>May/79</td>
<td>Apr/80</td>
</tr>
</tbody>
</table>

Total... 128.4

* Ceferino Alvarez was also the CTA of the former project BRA/75/007 and began his mission in July 1974.

** Associate Expert
### List of Consultants

<table>
<thead>
<tr>
<th>NAME</th>
<th>COUNTRY OF ORIGIN</th>
<th>FIELD</th>
<th>DURATION OF CONTRACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neil Grigg</td>
<td>USA</td>
<td>Ph.D Programme</td>
<td>May/77</td>
</tr>
<tr>
<td>Daryl Simons</td>
<td>USA</td>
<td>Ph.D Programme</td>
<td>May/77</td>
</tr>
<tr>
<td>Fernando Anguita</td>
<td>Spain</td>
<td>Analog Model</td>
<td>Jun/77</td>
</tr>
<tr>
<td>Michael Abbott</td>
<td>England</td>
<td>Hydraulics</td>
<td>Jul/77</td>
</tr>
<tr>
<td>Rolf Deininger</td>
<td>USA</td>
<td>Water Resources Optimiz.</td>
<td>Aug/77</td>
</tr>
<tr>
<td>Robin Clarke</td>
<td>England</td>
<td>Deterministic Hydrology</td>
<td>Oct/77</td>
</tr>
<tr>
<td>Rolf Deininger</td>
<td>USA</td>
<td>Water Res. Conservation</td>
<td>Nov/77</td>
</tr>
<tr>
<td>Michel G. Roze</td>
<td>France</td>
<td>Photogrammetry</td>
<td>Nov/77</td>
</tr>
<tr>
<td>Manuel Varela</td>
<td>Spain</td>
<td>Ground Water</td>
<td>Nov/77</td>
</tr>
<tr>
<td>Jose Llamas</td>
<td>Canada</td>
<td>Stochastic Hydrology</td>
<td>Dec/77</td>
</tr>
<tr>
<td>Warren Hall</td>
<td>USA</td>
<td>Water Res. Management</td>
<td>Oct/77</td>
</tr>
<tr>
<td>David McWhorter</td>
<td>USA</td>
<td>Ground Water</td>
<td>Nov/77</td>
</tr>
<tr>
<td>William Spanns</td>
<td>England</td>
<td>Mathematical Model</td>
<td>Mar/78</td>
</tr>
<tr>
<td>Rolf Deininger</td>
<td>USA</td>
<td>Water Res. Conservation</td>
<td>Apr/78</td>
</tr>
<tr>
<td>Peter Meier</td>
<td>USA</td>
<td>Water Res. Conservation</td>
<td>Apr/78</td>
</tr>
<tr>
<td>Warren Hall</td>
<td>USA</td>
<td>Ph.D Programme</td>
<td>May/78</td>
</tr>
<tr>
<td>Yung-Hai Chen</td>
<td>USA</td>
<td>Mathematical Model in Rivers</td>
<td>Jul/78</td>
</tr>
<tr>
<td>David McWhorter</td>
<td>USA</td>
<td>Hydrogeology</td>
<td>Jul/78</td>
</tr>
<tr>
<td>Rolf Deininger</td>
<td>USA</td>
<td>Water Res. Conservation</td>
<td>Jul/78</td>
</tr>
<tr>
<td>Peter Meier</td>
<td>USA</td>
<td>Water Res. Conservation</td>
<td>Jul/78</td>
</tr>
<tr>
<td>Carlos E.M.Tucci</td>
<td>USA</td>
<td>Mathematical Models</td>
<td>Jul/78</td>
</tr>
<tr>
<td>Antonio E.L.Lanna</td>
<td>USA</td>
<td>Systems Analysis/Water Resources Optimization</td>
<td>Aug/78</td>
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<tr>
<td>Warren Hall</td>
<td>USA</td>
<td>System Analysis/Ph.D</td>
<td>Sept/78</td>
</tr>
<tr>
<td>Rene Bonnefille</td>
<td>France</td>
<td>Hydrodynamics of Pollution</td>
<td>Sept/78</td>
</tr>
<tr>
<td>Ruh-Ming Li</td>
<td>USA</td>
<td>Mathematical Models in Rivers</td>
<td>Sept/78</td>
</tr>
<tr>
<td>Neil Grigg</td>
<td>USA</td>
<td>Urban Hydrology</td>
<td>Sept/78</td>
</tr>
<tr>
<td>Daryl Simons</td>
<td>USA</td>
<td>Ph.D Programme</td>
<td>Sept/78</td>
</tr>
<tr>
<td>Eduardo P.Jordão</td>
<td>Brazil</td>
<td>Water Treatment</td>
<td>Oct/78</td>
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<tr>
<td>Hunter Rouse</td>
<td>USA</td>
<td>Hydraulics</td>
<td>Nov/78</td>
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<tr>
<td>Ian Calder</td>
<td>England</td>
<td>Evapotranspiration</td>
<td>Nov/78</td>
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<tr>
<td>William Jones</td>
<td>USA</td>
<td>Sanitary Engineering</td>
<td>Nov/78</td>
</tr>
<tr>
<td>Mike Lowing</td>
<td>England</td>
<td>Urban Hydrology</td>
<td>Nov/78</td>
</tr>
<tr>
<td>Jim Shuttleworth</td>
<td>England</td>
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<td>Nov/78</td>
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<td>Manuel Varela</td>
<td>Spain</td>
<td>Ground Water</td>
<td>Nov/78</td>
</tr>
<tr>
<td>David Hendricks</td>
<td>USA</td>
<td>Water Treatment</td>
<td>Apr/79</td>
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<tr>
<td>James McCulloch</td>
<td>England</td>
<td>Hydrology</td>
<td>May/79</td>
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<tr>
<td>Waldemir da Cruz</td>
<td>Brazil</td>
<td>Hydrogeology</td>
<td>Jun/79</td>
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<tr>
<td>Herman Klein</td>
<td>Germany</td>
<td>Photogrammetry</td>
<td>Jul/79</td>
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<tr>
<td>Rubens S.Ramalho</td>
<td>Canada</td>
<td>Water Treatment</td>
<td>Jul/79</td>
</tr>
<tr>
<td>Rolf Deininger</td>
<td>USA</td>
<td>Water Res. Conservation</td>
<td>Aug/79</td>
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<tr>
<td>Rene Bonnefille</td>
<td>France</td>
<td>Marine Engineering</td>
<td>Aug/79</td>
</tr>
<tr>
<td>Murray McPherson</td>
<td>USA</td>
<td>Urban Hydrology</td>
<td>Oct/79</td>
</tr>
<tr>
<td>Yung-Hai Chen</td>
<td>USA</td>
<td>Mathematical Hydraulics</td>
<td>Nov/79</td>
</tr>
<tr>
<td>Dov Nir</td>
<td>Israel</td>
<td>Agricultural Hydrology</td>
<td>Nov/79</td>
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<tr>
<td>N. Quang Trac</td>
<td>Portugal</td>
<td>Ground Water</td>
<td>Nov/79</td>
</tr>
<tr>
<td>NAME</td>
<td>COUNTRY OF ORIGIN</td>
<td>FIELD</td>
<td>DURATION OF CONTRACT FROM</td>
</tr>
<tr>
<td>--------------------</td>
<td>-------------------</td>
<td>--------------------------------------------</td>
<td>---------------------------</td>
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<tr>
<td>Lee Miller</td>
<td>USA</td>
<td>Photogrammetry and Remote Sensing</td>
<td>Jan/80</td>
</tr>
<tr>
<td>Ceferino Alvarez</td>
<td>Spain</td>
<td>Hydrology and Geral revision research</td>
<td>Apr/80</td>
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<td>Rolf Deininger</td>
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<td>Water Res.Conservation</td>
<td>May/80</td>
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<td>Lee Miller</td>
<td>USA</td>
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<td>Roger Templeman</td>
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<td>France</td>
<td>Marine Engineering Subcontract National College of Agricultural Engineering</td>
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<td>Brian May</td>
<td>England</td>
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<td>Aug/80</td>
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<td>Manuel Varela</td>
<td>Spain</td>
<td>Advanced Fluid Dynamics Project Evaluation mission</td>
<td>Nov/80</td>
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<tr>
<td>Robin Clarke</td>
<td>England</td>
<td>Agricultural Hydrology Course on minicomputers</td>
<td>Jan/81</td>
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<tr>
<td>Milagros S.Simons</td>
<td>USA</td>
<td>Course on Agricultural Hydrology</td>
<td>May/81</td>
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<tr>
<td>Georges Lespinard</td>
<td>France</td>
<td>Research on Activated Carbon</td>
<td>Aug/81</td>
</tr>
<tr>
<td>Adrian Volker</td>
<td>Holland</td>
<td>Water Quality Analyses Ground Water</td>
<td>Sept/81</td>
</tr>
<tr>
<td>John Taylor</td>
<td>England</td>
<td>Agricultural Hydrology</td>
<td>Nov/81</td>
</tr>
<tr>
<td>Rolf Deininger</td>
<td>USA</td>
<td>Course on Agricultural Hydrology</td>
<td>Dec/81</td>
</tr>
<tr>
<td>Martínez Beltran</td>
<td>Spain</td>
<td>Water Quality</td>
<td>Dec/81</td>
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Courses given by UNESCO Experts or Consultants at Master level

<table>
<thead>
<tr>
<th>Course No.</th>
<th>DISCIPLINE</th>
<th>NAME</th>
<th>PERIOD</th>
<th>OBSERVATION</th>
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<tbody>
<tr>
<td>HIDP-63</td>
<td>Porous Media Hydraulics</td>
<td>Ceferino Alvarez</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Water Res.Optimization</td>
<td>Rolf Deininger</td>
<td>Aug-Sept77</td>
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<td>HIDP-69</td>
<td>Deterministic Hydrology</td>
<td>Robin T.Clarke</td>
<td>Oct-Dec77</td>
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<td></td>
<td>Water Res. Optimization</td>
<td>Rolf Deininger</td>
<td>Nov/77</td>
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<td></td>
<td>Photogrammetry</td>
<td>Michel G.Roze</td>
<td>Nov-Dec77</td>
<td></td>
</tr>
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<td></td>
<td>Water Res.Conservation</td>
<td>Peter Meier</td>
<td>Apr-May78</td>
<td></td>
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<tr>
<td></td>
<td>Water Treatment</td>
<td>Rubem Ramalho</td>
<td>Jul-Aug79</td>
<td></td>
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<td></td>
<td>Water Res.Conservation</td>
<td>Rolf Deininger</td>
<td>Aug/79</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Urban Hydrology</td>
<td>Murray McPherson</td>
<td>Oct-Nov79</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agricultural Hydrology</td>
<td>Dov Nir</td>
<td>Nov/79</td>
<td></td>
</tr>
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<td></td>
<td>Photogrammetry</td>
<td>Lee Miller</td>
<td>Jan-Feb80</td>
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<td></td>
<td>Waste Water Treatment</td>
<td>Jan Suschka</td>
<td>Sept-Dec80</td>
<td>part of the course</td>
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<td></td>
<td>Sanitary Engineering</td>
<td>Milagros Simons</td>
<td>Nov/80</td>
<td></td>
</tr>
<tr>
<td>HIDP-33</td>
<td>Agrohydrology</td>
<td>John Taylor</td>
<td>Sept/79</td>
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</table>
Number of students accepted and passed in the regular (annual) Technical Course in Hydrology

<table>
<thead>
<tr>
<th>YEAR</th>
<th>STUDENTS ACCEPTED</th>
<th>STUDENTS PASSED</th>
<th>%</th>
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<tbody>
<tr>
<td>1977</td>
<td>17</td>
<td>9</td>
<td>53%</td>
</tr>
<tr>
<td>1978</td>
<td>23</td>
<td>16</td>
<td>70%</td>
</tr>
<tr>
<td>1979</td>
<td>23</td>
<td>21</td>
<td>91%</td>
</tr>
<tr>
<td>1980</td>
<td>21</td>
<td>14</td>
<td>67%</td>
</tr>
<tr>
<td>1981</td>
<td>20</td>
<td></td>
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<tr>
<td>TOTAL</td>
<td>104</td>
<td>60</td>
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</tr>
<tr>
<td>Average</td>
<td>21</td>
<td>15</td>
<td>72%</td>
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</table>
Topics taught at the Technical Course and lecture hours

<table>
<thead>
<tr>
<th>DISCIPLINE</th>
<th>HOURS</th>
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<tbody>
<tr>
<td>Topography</td>
<td>160</td>
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<tr>
<td>Design</td>
<td>100</td>
</tr>
<tr>
<td>Hydraulics</td>
<td>100</td>
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<tr>
<td>Statistics</td>
<td>80</td>
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<tr>
<td>Hydrology</td>
<td>240</td>
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<tr>
<td>Water Supply and Sanitary Engineering</td>
<td>120</td>
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<tr>
<td>Sedimentology</td>
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<tr>
<td>Hydrogeology</td>
<td>120</td>
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<tr>
<td>Construction and Hydraulic Machines</td>
<td>80</td>
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<tr>
<td>Irrigation and Drainage</td>
<td>80</td>
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<tr>
<td>Moral and Civic Education</td>
<td>40</td>
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<tr>
<td>Physical Education</td>
<td>40</td>
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<tr>
<td>Health and Safety</td>
<td>40</td>
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<tr>
<td>Photography</td>
<td>20</td>
</tr>
<tr>
<td>Amateur Boat Pilot</td>
<td>20</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1360</strong></td>
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</table>
Training courses given by IPH Staff-members for other institutions within the cooperation in training

1. Specialization course for the Brazilian Association of Sanitary Engineering

   SUBJECT: Environmental Engineering
   PERIOD: April - December 1977
   LECTURE HOURS: 400 hours
   LECTURER: Prof. Amadeu da R. Freitas; Prof. R. Ungaretti; Prof. C.A. Santos
   NUMBER OF PARTICIPANTS: 7 students
   OBSERVATION: Specialization

2. Hydrology and Computational Hydraulics Course for CETESB - Centro Técnico de Hidráulica - Departamento de Hidráulica (São Paulo)

   SUBJECT: Hydrology and Computational Hydraulics
   PERIOD: September 1979
   LECTURE HOURS: 40 hours
   LECTURER: Prof. C.E.M. Tucci
   NUMBER OF PARTICIPANTS: 12 students
   OBSERVATION: Course to provide additional training

3. Course for Centro Técnico de Hidráulica - CETESB - Departamento de Hidráulica (São Paulo)

   SUBJECT: Hydrology and Computational Hydraulics
   PERIOD: January 1980
   LECTURE HOURS: 60 hours
   LECTURER: Prof. C.E.M. Tucci
   NUMBER OF PARTICIPANTS: 12 students
   OBSERVATION: Course to provide additional training

4. Course for the Federal University of Mato Grosso do Sul

   SUBJECT: Hydrology
   PERIOD: May - June 1980
   LECTURE HOURS: 60 hours
   LECTURER: Prof. J. Sánchez
   NUMBER OF PARTICIPANTS: 50 students
   OBSERVATION: Graduation level

5. Course for the Engineering Department of the Federal University of Rio Grande do Sul

   SUBJECT: Alternative Sources of Energy
   PERIOD: August - September 1980
   LECTURE HOURS: 30 hours
   LECTURER: Prof. B. Resende; Prof. J.L. Souza; Prof. Bristotti
   NUMBER OF PARTICIPANTS: 35 students
   OBSERVATION: Course to provide additional training
6. Course for ELETROBRAS (Centrais Elétricas Brasileiras S/A)

   SUBJECT: Engineering Hydrology - CEHID II
   PERIOD: 02 September - 09 October 1980
   LECTURE HOURS: 177 hours
   LECTURER: Coordination Prof. B.Resende (participation + 17 professors)
   NUMBER OF PARTICIPANTS: 15 students
   OBSERVATION: Technical level course

7. Course for the Engineering Department of the Federal University of Rio Grande do Sul

   SUBJECT: Alternative Sources of Energy
   PERIOD: March 1981
   LECTURE HOURS: 30 hours
   LECTURER: Prof. Bristotti, Prof. B.Resende, Prof. J.L.Souza
   OBSERVATION: Course to provide additional training

8. Extension course in Irrigation and Drainage for IRGA (Instituto Riograndense do Arroz)

   SUBJECT: Course of Extension in Irrigation and Drainage
   PERIOD: 30-31 July 1981
   LECTURE HOURS: 60 hours
   LECTURER: Prof. F.Cauduro, Prof. L.Beltrame, Prof. P. Ramos
   NUMBER OF PARTICIPANTS: 23 students
   OBSERVATION: Extension level

9. Course for the Hydraulics Department of the Federal University of Mato Grosso do Sul

   SUBJECT: Ground Water Hydrology
   PERIOD: 4 August - 2 September 1981
   LECTURE HOURS: 30 hours
   LECTURERS: Prof. M.I.Leão, Prof. W. Alcântara
   NUMBER OF PARTICIPANTS: 50 students
   OBSERVATION: Graduation level

10. Course for the Hydraulics Department of the State University of Maringá (Paraná)

    SUBJECT: Ground Water Hydrology
    PERIOD: 11-21 August 1981
    LECTURE HOURS: 150 hours
    LECTURERS: Prof. J.C.S.Martins, Prof. F.Semmelmann, Prof. V. Haertel
    NUMBER OF PARTICIPANTS: 35 students
    OBSERVATION: Graduation level

11. Course for ELETROBRAS (Centrais Elétricas Brasileiras S/A)

    SUBJECT: Engineering Hydrology CEHID-II
    PERIOD: 21 September - 16 October 1981
    LECTURE HOURS: 128 hours
    LECTURERS: Prof. A.E.L.Lanna, Prof. R.Ungaretti
    NUMBER OF PARTICIPANTS: 25 students
    OBSERVATION: Technical level course
12. Course for the Hydraulics Department of the Federal University of Mato Grosso do Sul

SUBJECT: Course in Hydraulics
PERIOD: Nov 1981
LECTURE HOURS: 60 hours
LECTURER: Prof. F. Semmelmann
NUMBER OF PARTICIPANTS: 
OBSERVATION: Graduation level

13. Course of Hydrology and Engineering of Water Resources - CNPq

SUBJECT: Course of Hydrology and Engineering of Water Resources
PERIOD: November 1981
LECTURE HOURS: 100/150 hours
LECTURERS: Prof. R. Ungaretti, Prof. A. E. L. Lanna
NUMBER OF PARTICIPANTS: 30 students
OBSERVATION: Extension level

14. Practical workshops on Hydraulics for students of the Course of Engineering of the Course of Agronomy at the following Universities
- Passo Fundo (RS)
- Rio Grande (RS)
- Pelotas (RS)
- Caxias do Sul (RS)

(duration 1 week, each year, ministered by IPH professors)
Research "lines" developed at IPH

A - **Surface Hydrology** - Chief: Prof. Carlos E.M.Tucci
   - forecast and damping of river floods
   - hydrology model in less permeable areas, including urban areas
   - regional analysis of hydrological variables

B - **Hydrogeology** - Chief: Prof. José Carlos S.Martins
   - hydrogeology of fissured rocks
   - studies of coastal aquifers

C - **Erosion and Sediment Prediction** - Chief: Prof. Franz Semmelmann
   - characterization of the phenomena of production and transport of sediments in hydrographic basins
   - pluvio-sedimentology models

D - **Irrigation and Drainage** - Chief: Prof. Flávio Cauduro
   - studies of hydroclimatological parameters
   - systems of irrigation and drainage

E - **Sanitary Engineering** - Chief: Prof. Anadeu da R. Freitas
   - water purification
   - treatment of sewage and industrial wastewaters
   - mathematical models of water quality

F - **Aerophotogrammetry and Remote Sensing of Water Resources**
   Chief: Prof. Victor Haertel

G - **Fluids Mechanics and Hydraulic** - Chief: Prof. Rubem Ungaretti
   - physical models (in reduced scale)
   - analog models
   - mathematical models
   - hydrodynamics of pollution

H - **Planning and Use of Water Resources** - Chief: Prof. Antonio E. Lanna
   - economic dimensioning and development of the water resources capacity
   - optimization of operation of water management systems
List of major items of equipment provided by UNDP

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Year of Supply</th>
<th>Price (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1 Video tape machine and Packard circulators</td>
<td>1977</td>
<td>4027.86</td>
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<tr>
<td>2.</td>
<td>1 Lecture reproducter 500 B</td>
<td>1977</td>
<td>3795.51</td>
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<td>3.</td>
<td>1 Chevrolet Caravan 1977 Serial No. SNI5EB127995</td>
<td>1977</td>
<td>4220.80</td>
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<tr>
<td>4.</td>
<td>1 Compass</td>
<td>1978</td>
<td>1041.38</td>
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<tr>
<td>5.</td>
<td>2 7234 Transducer 200 KHz DE719 &amp; DE119 Series for thru hull or pipe mount</td>
<td>1978</td>
<td>800.00</td>
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<tr>
<td>6.</td>
<td>1 Dissolved oxygen meter MDL 57</td>
<td>1979</td>
<td>513.30</td>
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<td>7.</td>
<td>1 Conductivity/Salinity Meter</td>
<td>1979</td>
<td>306.00</td>
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<td>8.</td>
<td>1 Automatic Weather Station w/ Microdata M200 Ledger</td>
<td>1980</td>
<td>10968.18</td>
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<tr>
<td>9.</td>
<td>1 M200TR Translator in Instrument Case</td>
<td>1980</td>
<td>3472.73</td>
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<td>10.</td>
<td>1 M200 TR/IEEE 488-1975 Interface</td>
<td>1980</td>
<td>977.27</td>
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<td>11.</td>
<td>1 Nashua 1220S Photocopy Machine 220V/50C</td>
<td>1979</td>
<td>4725.00</td>
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<td>12.</td>
<td>1 Texas electronic calculator Instruments TI59 No. 2320175</td>
<td>1980</td>
<td>418.77</td>
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<td>13.</td>
<td>1 Berceau Imprimant PC100 No. 9180577</td>
<td>1980</td>
<td>367.41</td>
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<td>14.</td>
<td>1 Programmable printing Calculator No. 97A</td>
<td>1979</td>
<td>790.00</td>
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<td>15.</td>
<td>1 Programmable printing Calculator No. 67A</td>
<td>1979</td>
<td>475.00</td>
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<tr>
<td>16.</td>
<td>4 Nixon Streamflow probe-Model 404</td>
<td>1981</td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>Voltmeter with Micro processor Solartron Model 7055</td>
<td>1981</td>
<td></td>
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<tr>
<td>18.</td>
<td>Pressure transducer PDL/0,1 bar with accessories</td>
<td>1981</td>
<td></td>
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List of major items of equipment purchased through subcontracts

<table>
<thead>
<tr>
<th>No.</th>
<th>ITEM</th>
<th>YEAR OF SUPPLY</th>
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<td>1</td>
<td>Surber Sampler</td>
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<td>Ponar Grab Sampler</td>
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<td>pH-Oxygen Conductivity Meter</td>
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<td>Receptor SONY KV1921</td>
<td>1978</td>
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<td>5</td>
<td>Modulo 2600 RF for SONY, Tape Recorder</td>
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<td>6</td>
<td>37 videocassettes for the Course on Hydrology and Water Quality Model</td>
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<td>7</td>
<td>6 virgin videocassettes</td>
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<td>Filter Funnel Manifold</td>
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<td>9</td>
<td>Peristaltic Pump</td>
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<td>10</td>
<td>Warburg Apparatus</td>
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<td>Laboratory Turbidimeter Model 2100A</td>
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<td>12</td>
<td>2 Hach BOD Apparatus Model 2173</td>
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<td>13</td>
<td>2 Calculators HP-41C with accessories</td>
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<td>14</td>
<td>2 Houston Model 4950 dual channel strip chart recorders</td>
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<td>15</td>
<td>Universal Counter/timer Hewlett Packard Models 5308A and 5308B</td>
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<td>16</td>
<td>6 Bourns Potentiometer Model 3501S</td>
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<td>17</td>
<td>14 Channel mounting Case-Power supply Model 1-080</td>
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<td>18</td>
<td>Bridge Signal Condition w/local shunt calibration card Model 1-183</td>
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<td>19</td>
<td>Pressure transducer - Model 8506-2 ENDEVCO</td>
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<td>20</td>
<td>3 Apple II, computer with monitors and accessories</td>
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## List of main consultancies executed by IPH in the period 1977-1981

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<th>№</th>
<th>TITLE</th>
<th>DESCRIPTION</th>
<th>CLIENT</th>
<th>STARTED/ENDED</th>
<th>Cost in thousand of cruzeiros</th>
<th>IMPLEMENTED</th>
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<td>75.009</td>
<td>Hydraulic behaviour of Jacuí River Delta</td>
<td>Hydraulic studies of Jacuí River delta and upstream section of Guaíba river</td>
<td>DMAE</td>
<td>Dec75/Dec78</td>
<td>3.700.</td>
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<td>75.012</td>
<td>Orthophotos of Porto Alegre county</td>
<td>Aerophotographic restitution of Porto Alegre county</td>
<td>PMPA</td>
<td>Dec75/Dec77</td>
<td>2.275.</td>
<td>RS</td>
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<tr>
<td>76.002</td>
<td>Jacuí II Hydroelectric development</td>
<td>Scale model study of Jacuí II Hydroelectric development</td>
<td>CEEE</td>
<td>Oct76/Jan78</td>
<td>640.</td>
<td>RS</td>
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<td>76.006</td>
<td>Water Resources Conservation</td>
<td>Applied research on use and conservation of water resources in the State of Rio Grande do Sul</td>
<td>.FINEP</td>
<td>Jun76/Oct78</td>
<td>8.000.</td>
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<td>76.007</td>
<td>Scale model study of Sinos River in São Leopoldo</td>
<td>Flood protection for the town of São Leopoldo (study of second alternative)</td>
<td>DNOS</td>
<td>Mar75/Jul77</td>
<td>384.</td>
<td>RS</td>
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<td>76.008</td>
<td>3rd Petrochemical Complex, Rio Grande do Sul</td>
<td>Location and preliminary size estimate of water intake for 3rd Petrochemical Complex</td>
<td>COPESUL</td>
<td>Nov76/Jul77</td>
<td>357.</td>
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<td>76.009</td>
<td>Aerotriangulation of Jaguarão irrigation project</td>
<td>Analytical aerotriangulation for planimetric support in a block of 190 models</td>
<td>SUDESUL</td>
<td>Dec76/Mar77</td>
<td>76.</td>
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<td>76.011</td>
<td>New São João Navegantes water intake</td>
<td>Bathimetric studies to implement new water intake in São João Navegantes</td>
<td>DMAE</td>
<td>Dec76/Oct77</td>
<td>49.</td>
<td>RS</td>
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<td>77.001</td>
<td>Sombrio II Project</td>
<td>Soil, Climatology and hydrology studies at Sombrio</td>
<td>SUDESUL</td>
<td>Feb77/Nov78</td>
<td>1.646.</td>
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<tr>
<td>77.003</td>
<td>Hydrological study of Dilúvio Creek</td>
<td>Hydrological studies to guide urbanization in the Dilúvio Creek basin, in Porto Alegre</td>
<td>PMPA</td>
<td>Oct76/Mar79</td>
<td>2.467.</td>
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<tr>
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<td>77.004</td>
<td>Coal Mining Impact</td>
<td>Study of impact of coal mining on water resources in Santa Catarina coal region</td>
<td>FAIMA</td>
<td>Jun77/April78</td>
<td>600.510</td>
<td>SC</td>
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<td>77.005</td>
<td>Aerophotorestitution of Osório County</td>
<td>Air survey of a 50 km² area in the county of Osório</td>
<td>CEDRO</td>
<td>Nov77/Mar78</td>
<td>150.</td>
<td>RS</td>
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<td>77.007</td>
<td>Aerophotorestitution for the Rio Grande do Sul Carbochemical Complex</td>
<td>Aerophotorestitution of air photos of the area where a Carbochemical Complex is to be implemented in Rio Grande do Sul</td>
<td>PETROFAC</td>
<td>Sept77/Oct77</td>
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<td>RS</td>
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<td>78.001</td>
<td>Hydrological studies for Pond development</td>
<td>Hydrological studies for the development of a pond, in plot nº 28 of the Rio Grande do Sul Petrochemical Complex</td>
<td>PETROFLEX</td>
<td>Apr78/Jun78</td>
<td>69.</td>
<td>RS</td>
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<td>78.002</td>
<td>Uruguay River Sediment</td>
<td>Potential sediment retention in Upper Uruguay River reservoir</td>
<td>ELETROSUL</td>
<td>May78/Sept78</td>
<td>719.</td>
<td>SC</td>
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<td>78.003</td>
<td>Water quality of the Upper Uruguay river</td>
<td>Assessment of characteristics presented by water of Pelotas and Uruguay rivers, upstream from Peperi-Guacu river and its tributaries, at possible dam locations</td>
<td>ELETROSUL</td>
<td>May78/Oct78</td>
<td>668.</td>
<td>SC</td>
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<tr>
<td>78.004</td>
<td>Aerophotorestitution of Sombrio region</td>
<td>Photogrammetric restitution of a 150 km², area located in the Sombrio Swamp region, Santa Catarina</td>
<td>SUDESUL</td>
<td>Nov77</td>
<td>575.</td>
<td>SC</td>
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<td>78.007</td>
<td>Hydrology of Sombrio Swamp, SC</td>
<td>Continuation of hydrometeorological data collection in the sub-project area, Sombrio, SC</td>
<td>SUDESUL</td>
<td>Sept78/Feb80</td>
<td>1.534</td>
<td>SC</td>
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<td>78.008</td>
<td>Agricultural development of Ibituci River Banks, RS</td>
<td>Preliminary studies on agricultural and pastoral development on Ibituci River banks, RGS</td>
<td>SUDESUL</td>
<td>Nov78/Jun79</td>
<td>585.</td>
<td>RS</td>
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<td>79.001</td>
<td>Bathmetry of Lake Patos</td>
<td>Bathmetry of Patos Lake in Tapes County, RS</td>
<td>GEOMETRIC</td>
<td>Mar79/Apr79</td>
<td>93.7</td>
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<td>Orthophotorestitution of Santa Maria County</td>
<td>Restitution of airphotos of surface of Santa Maria County</td>
<td>PEMS</td>
<td>Feb</td>
<td>Feb79/Mar81</td>
<td>1.608</td>
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<td>79.009</td>
<td>Orthophotorestitution of Caxias do Sul, RS</td>
<td>Restitution of airphotos of surface of Caxias do Sul, RS</td>
<td>CAXIAS</td>
<td>Jun</td>
<td>Jun78/Feb79</td>
<td>2.765</td>
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<td>Hydrological Yearbook 1979</td>
<td>Rio Grande do Sul hydrological yearbook</td>
<td>IEPEC</td>
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<td>Apr80/May81</td>
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<td>79.012</td>
<td>Flood formation in Joinville</td>
<td>Services to identify the role played by the various causes of flooding in the city of Joinville, SC</td>
<td>JUDESUL</td>
<td>1st</td>
<td>1st sem.79</td>
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<td>79.013</td>
<td>Storm water pollution at 3rd Complex</td>
<td>Hydraulic study of dam spillway structures to retain, temporarily possibly contaminated storm water</td>
<td>CUFETPAF</td>
<td>Dec</td>
<td>Dec79/ongoing</td>
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<td>80.001</td>
<td>Flood protection for city of Joinville</td>
<td>Study for the partial protection of city Project Joinville III, SC</td>
<td>JUDESUL</td>
<td>Dec</td>
<td>Dec79/ongoing</td>
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<td>Sombrio Swamp Hydrology</td>
<td>Collection of hydrometeorological data in the region of the hydrographic basin of Mampituba river, Santa Catarina, 2nd phase</td>
<td>JUDESUL</td>
<td>Apr</td>
<td>Apr80/Dec80</td>
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<td>80.005</td>
<td>Mãe Luzia</td>
<td>Studies on water quality and main polluting activities in the upper basin of the Luzia river, SC</td>
<td>FATMA</td>
<td>Jul</td>
<td>Jul80/Oct81</td>
<td>1.510</td>
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<td>80.008</td>
<td>Jequitinhonha</td>
<td>Regionalization study of CETEC hydrological variables</td>
<td>CETEC</td>
<td>Oct</td>
<td>Oct80/ongoing</td>
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<td>81.004</td>
<td>Jacuí river Delta</td>
<td>Execution of preliminary project for navigation channel on eastern branch of the Jacuí river delta, from Caras curve until the raising bridge over Getúlio Vargas Crossing, RS</td>
<td>COPESUL</td>
<td>Jun</td>
<td>Jun81/Mar82</td>
<td>13.400</td>
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<td>81.005</td>
<td>Mina União</td>
<td>Treatment of effluents from the site of União Mine, Pre-washer and Metropolitan cokery, SC</td>
<td>FATMA</td>
<td>Jul</td>
<td>Jul81/Apr82</td>
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<td>Start Date</td>
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<td>Dona Francisca</td>
<td>Scale model study of Dona Francisca Hydropower Plant, on the Jacuí river</td>
<td>CHIL</td>
<td>Nov81/ongoing</td>
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<td>Machadinho</td>
<td>Scale model study of Machadinho Hydropower Plant on the Uruguay river</td>
<td>ELECTROUL</td>
<td>Nov81/ongoing</td>
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Workshops and meetings

1977

1) Daryl Simons - River Mechanics Model
2) Neil Grigg - Planning of Urban Water Systems
3) Michael Abbott - Computational Hydraulics: a brief pathology
   - Modelling in River Hydraulics
4) Rolf Deininger - Water and air quality indicators
5) Warren Hall - Practical use of systems analysis in planning
   - and managing water resources
   - Problems of integrated planning in hydrographic
   - basins
   - Multiple purpose optimization: compensation of
   - substitute value
6) David McWhorter - Use of ground water in agriculture
   - Flow in fissured rocks
7) Luiz Ferreira - Cavitation problems in Hydraulic structures
   - Cavitation in spillways in dissipation basins
   - and locks
8) Amadeu da R. Freitas - Water pollution

1978

1) Willem Spanns - Basic aspects of water movement in rivers
   - Numerical resolutions in hydraulics problems
2) Ceferino Alvarez; Marcos I. Leão - Environmental impact of coal mining on water
   - resources in the Santa Catarina coal basin
3) Rolf Deininger - Water quality and coal mining
4) Peter Meier - Biological aspects due to coal mining
5) John Taylor - Erosion due to water
6) Flávio Caudo - Irrigation and drainage
7) Neil Grigg - Problems of urban hydrology effects and solutions
8) René Bonnefille - Methods to choose urban and industrial district
   - sites at sea-side, and near lagoons and estuaries,
   - considering environmental protection
9) Mike Lowing - Problems and methods of urban hydrological data
   - collection and processing in England
   - Quantitative prediction of effects of urbanization
   - on flood characteristics
   - Rainfall-runoff models for small urban areas
   - Comparison of rational methods and TRRL, to new
   - methods, presently under development
10) Jim Shuttleworth - Recent progress in description and prediction of natural evaporation
- Evaporation measurement methods
- Introduction to automatic weather stations, to be used in hydrometeorological research

11) Ian Calder - Neutron probe theory for research on soil humidity and evapotranspiration
- Measurements and models to estimate evaporation in forests

1979

1) Robin Clarke - Development and result of hydrological research in English experimental basins

2) David Hendricks - Water quality models

3) Victor Haertel - Orthophotogrammetry (Army 1st Division of Surveyors)

4) Lawson Beltrame; John Taylor - Effects of drainage and sub-soiling on soybean production (Experimental Rice Station in Cachoeirinha, RS)

5) John Taylor - Physical properties of soil and their use in agriculture (National Wheat Research Center, Passo Fundo, RS)

6) John Taylor; Flávio Cauduro - Optimization of use of irrigation and drainage technologies


1980

1) Carlos Tucci - Cinematic wave model

2) John Taylor - Automatic weather station

3) Antonio E.L. Lanna - Optimum operation of hydrothermal generation systems for electric power - Application in South Brazil

4) Daniel Silva - Streamflow regionalization by means of least squares method

5) Carlos E.M. Tucci - Water quality non-steady flow model for a river network - Application to Jacuí Delta

6) Julio Sánchez - Urban hydrology: Dilúvio Creek

7) Raul Dorfman - Coordinated colonization system applied to an irrigation project in the Northeast

8) Liana Moretti - Simulation of Sinos River level of pollution

9) Lawson Beltrame - Probability of drought events in Rio Grande do Sul, from the agricultural viewpoint

10) Luiz O. Monteggia - Sewage treatment plant project for the New Campus of the Federal University of Rio Grande do Sul
11) Frank Farquharson - A new flood estimation method in RGS
12) Amadeu da R. Freitas - Viruses in water supply and relative effectiveness of usual water and sewage treatment processes in their removal
13) Lawson Beltrame - Potential streamflow estimate, based on soil data
14) Manuel Varela - Groundwater flow models in water resources management
15) Jan Suschka - Municipal sewage treatment using biological filters
16) Lawson Beltrame - Technique and use of neutron probe to measure soil humidity
17) Israel Barcelos - Hydrogeochemical study of groundwater in RGS
18) Vera Lucia de Cés - Comparative study of common water disinfection methods
19) Gilberto Canali - Sediment yield in small basins
20) Raul Dorfman - Agrihydrological method
21) Amadeu da R. Freitas - Pre-chlorination should be avoided in water treatment
22) José C.S. Martins - Groundwater quality in the Porqueta River representative basin.
24) Francisco Bidone - Correlation of hardness in water supply to cardiovascular disease
25) Marcos I. Leão - Use of vertical Hele-Shaw model in studying coastal aquifers
26) Milagros Simmons - Some aspects of research in the Great Lakes

1981

1) David Ford - Activated Carbon (theory and practice)
List of seminars held at IPH

1977

- Seminar on Analog Models
  18-22 July

- Economic Process of Sanitary Sewage Treatment
  8-12 August . (68 participants)

1979

- 1st Brazilian Meeting on Research and Post-Graduate Teaching in Water Resources
  9-11 October - (15 participants - Technical management and General Secretariat: Prof. Raul Dorfman)

- Seminar on Use of Water Resources in Agriculture (PAPERGS/IPH)
  8-10 August - (51 participants - Coordinator: Prof. Flávio Cauduro)
Technical Publications of the Project UNDP/UNESCO/BRA/75/007


No 2 - "Os modelos analógicos nos estudos de águas subterrâneas" - Fernando Anguita, October, 1978.


No 4 - "Utilização da sonda de neutrons" - Ian Calder, January, 1979.


No 6 - "Procedimento de campo para o uso da Estação Meteorológica Automática de Wallingford, e interpretação dos valores computados a partir dos seus registros" - Robin T. Clarke, June, 1979.

No 7 - "Análise e interpretação dos testes de bombeamento nos poços G 646 S09, G 659 S010 e 665 S011 do aquífero basáltico da área de Soledade (RS)" - Herbert Neuland e Rogério Dewes, August, 1979.

No 8 - "Aferição de campo de um amostrador de descarga sólida fluvial em suspensão" - Franz Semmelmann e Paulo Umezawa, August, 1979.


No 14 - "Utilização do Computador na análise de dados de testes de bombeamento - Método de Jacob" - Rogério Dewes e Alejandro Borche, August, 1980.

No 15 - "Drip (Trickle) irrigation" - Dov Nir, September, 1980.

No 16 - "Translation of Automatic Weather Station data in Brazil" - Roger Templeman, April, 1981.


No 19 - "Filtros Biológicos" - Jan Suschka, 1981.
List of papers published in the IPH Journal
"Cadernos de Recursos Hídricos"

No 1 - January, 1978 - "Bibliografia das pesquisas desenvolvidas no IPH"

No 2 - May, 1979 - (i) Avaliação da eficácia de projetos de drenagem (Neil Grigg)
                        (ii) Estudo hidrológico da urbanização da bacia do arroio Dilúvio no município de Porto Alegre (Ceferino Alvarez, Julio Sanchez)
                        (iii) Bibliografia das pesquisas desenvolvidas no IPH durante o ano de 1978

No 3 - July, 1980 - (i) Simulação de DBO e OD em regime de escoamento não-permanente (Carlos E.M. Tucci)
                        (ii) Fundamentos para pesquisa geohidrológicas mediante a aplicação de métodos multivariados (Herbert Neuland)
                        (iii) Bibliografia das pesquisas desenvolvidas no IPH durante o ano de 1979/69

No 4 -
                        (i) Utilização de reservatórios para geração de energia elétrica e amortecimento de cheias - Metodologia de Estudo (Bruno S. Resende)
                        (ii) Ensino e pesquisa de Recursos Hídricos a nível de Pós-Graduação no Brasil (Carlos E.M. Tucci, Ceferino Alvarez)
                        (iii) Recentes descobertas sobre a relação coeficiente de oxidação (K0) versus temperatura - Resultados preliminares (Allen Chão, Efran Galaraga, Sérgio João de Luca)
                        (iv) Bibliografia das pesquisas desenvolvidas no IPH durante o ano de 1980
                        (v) Resumo e abstract de teses
ANNEX 19

List of publications and lectures at national meetings


D'AMICO, Jose Juan - Proposição de um modelo de síntese plúvio-hidrométrica para os rios de planícies Seminário de Hidrologia e Recursos Hídricos, Rio de Janeiro, 1977.


BORDAS, Marc - Política e programas de pesquisas do IPH/UFRGS Seminário de Hidrologia e Recursos Hídricos, Rio de Janeiro, 1977.


BELTRAME, Lawson F. de S.; CAUDURO, F. - Perdas de nutrientes (N-K-Ca-Mg) por lixiviação em sistemas de drenagem subterrânea IV Congresso de Irrigação e Drenagem, Salvador (BA) 11-14 September, 1978.


CLARKE, Robie; SILVEIRA, Ruy - Instalação e uso de uma estação meteorológica automática em Porto Alegre e análise dos dados registrados pelos aparelhos IIIº Simpósio Brasileiro de Hidrologia, Brasília (DF), 19-23 August, 1979.


SIMÕES LOPEZ, Mário; SANCHEZ, Julio - Propagação de descargas pelo método da analogia de difusão IIIº Simpósio Brasileiro de Hidrologia, Brasília (DF), 19-23 August, 1979.

ALVAREZ, Ceferino; SANCHEZ, Julio - Tentativa de identificar os efeitos da urbanização na hidrologia do Arroio Dilúvio IIIº Simpósio Brasileiro de Hidrologia, Brasília (DF), 19-23 August, 1979.


TAYLOR, John; MATIOS, Carlos; BELTRAME, Lawson - Efeitos da drenagem na época de preparo do solo no número de dias disponíveis para implantação de culturas de verão IIº Encontro Nacional de Pesquisa sobre Conservação dos Solos, Recife, 28 July - 01 August, 1980.


LEÃO, Marcos A.; MARTINS, José Carlos S.; PACHECO, Cláudio P.S. - Análise de qualidade das águas subterrâneas em rochas basálticas. IV Simpósio Brasileiro de Hidrologia e Recursos Hídricos, Fortaleza (CE), November, 1981.


SILVEIRES, Lopes, Mário; SANCHEZ, Julio - Utilização de reservatórios para enchentes urbanas. IV Simpósio Brasileiro de Hidrologia, Fortaleza (CE), 15-19 September, 1981.


List of publications in national journals


CLARKE, Robin; TUCCI, Carlos E.M. - Os efeitos de algumas suposições implícitas no cálculo da média e da variância de escoamento médio anual usando as séries mais longas de precipitação Revista da Associação Brasileira de Hidrologia e Recursos Hídricos - ABHR, 1977


BELTRAME, Lawson; GONDIM, Luiz; TAYLOR, John - Influência da desestruturação e compactação na permeabilidade do solo Revista Ciência do Solo, July 1980.

MONDADORI, Helena; TAYLOR, John - Compactação na unidade de solo Vacaça I Revista "Lavoura Arrozoeira" N° 320, Marc/April, 1980.

TAYLOR, John, BELTRAME, Lawson - Por que, quando e como utilizar a subsolagem? Revista "Lavoura Arrozoeira" N° 321, May/June, 1980.


TAYLOR, John; MATTOS, Carlos C.; BELTRAME, Lawson - Efeitos da crenagem na época de preparo do solo no número de dias disponíveis para implantação


HERVE, Egydio; DORFMAN, Raul; BELTRAME, Lawson - A irrigação no IPH. Revista Lavoura Arrozeira, Nº 328, May-June, 1981.


List of publications in international journals and international meetings


ALVAREZ, Ceferino - The binomial "knowledge-knowledge transfer" in water resources. The second International Conference on Transfer of Water Resources Knowledge, Colorado State University, Fort Collins, USA, 1977.


CANALI, Gilberto; BORDAS, Marc - The influence of soil use and topography on the hydrological and sedimentological behaviour of basins in the basaltic region of South Brazil. International Symposium on the influence of man on the hydrological regime with special reference to representative and experimental basins, Helsinki, Finlandia, June 1980.

BORDAS, Marc; CANALI, Gilberto; SHIMON, Meiko - Monitoring pilot basins for studying the effect of soil cultivation in the steeply-sloping basaltic areas of South Brazil. International Symposium on the influence of man on the hydrological regime with special reference to representative and experimental basins, Helsinki, Finland, June 1980.


NEULAND, Herbert - Simulaciones de las variables y análisis de costos empleando un modelo para predecir deslizamientos en diferentes pisos altitudinales y unidades litológicas. VI CPMSIC, Lima Peru, December 1979.


Technical Course Programme
Federal University of Rio Grande do Sul
Institute for Hydraulic Research
Technical Course of Hydrology

Disciplines and topics

1) Water Supply and Sanitary Engineering (120 hours) - Prof. Liana Moretti
Topics: Water pollution; Water quality; Water collection; Water supply (intake, distribution, urban network design); Sanitary sewer system; Storm sewer system; Buildings; Water surveys for pollution control.

2) Sedimentology (120 hours) - Prof. Franz Semmelmann
Topics: Engineering works requiring sediment grain size surveys; Source of solid load and the various materials which are transported; River transport of mineral solids; Special instruments; Physical analysis of minerals; Use of airphotos for hydrotechnical work; Characteristics of single airphotos.

3) Hydraulics (100 hours) - Prof. Rubem Ungaretti
Topics: Increasing units systems; Hydrostatics; Hydromodynamics; Spillways, nozzles and orifices, Venturimeters and diaphragm; Calculation of pressure conduits; Calculation of canals.

4) Technical and Cartographic Drawing (100 hours) - Profs. J.Barbosa; M.Remião
Topics: Drawing utensils and instruments; Scale; Standard paper sizes; Geometrical constructions; Lines, letters and numbers; Drawing of views and solids; Heights, cross hatching, profile; Cartographic projections; Representation of the surface of the earth; Projection system; Conventions; Cartographic drawing; Countours.

5) Hydrogeology (120 hours) - Prof. Marcos Leão
Topics: The Earth; Minerals; Rocks; Weathering; Erosion; Surface deposits; Stratigraphy; Lithosphere deformations; Geological maps; Aerophotogeology; Groundwater; Infiltration; Porosity; Types of soil water; Porous rocks Vertical distribution of groundwater; Aquifers; Variations of piezometric surface; Basic notions of fluid mechanics; Darcy's Law; Isotropy and anisotropy; Permeability; Methods to solve constant flows; Well hydraulics; Hydraulic load measurements; Piezometric maps; Well technology; Pumping tests; Groundwater quality.

6) Hydrology (240 hours) - Profs. Lawson Beltrame and Juan D'Amico
Topics: Importance of hydrology; Hydrological cycle; Hydrographic basin; Measurements of meteorological phenomena; Rainfall charts; Evaporation and transpiration; Infiltration and lifting; Wind; Evaporation; Humidity; Temperature; Study of physical characteristics of Hydrographic basin; Precipitation (formation, types, distribution); Intensive rainfall; Notions of evaporation; River gaging (velocity measurements, Surface measurement - Location of vertical in a section - Streamflow computation.
7) **Statistics** (80 hours) - Prof. Neusa da Cruz  
**Topics:** Review of mathematical background; Mathematics applied to statistics; Basic principles of statistics; Probability; Normal distribution; Practical application.

8) **Photography** (20 hours) Prof. Walace Lehnemann  
**Topics:** Overview of the subjects; Concepts, objectives and limits; The process of photography; Spectrum of applications, Photography; Lighting; The subject; The camera; The film; Processing; Practical aspects; The laboratory.

9) **Construction and Hydraulic Machines** (80 hours) - Prof. Rubem Ungaretti  
**Topics:** Hydraulic machines; Turbines; Pumps; Hydraulic Structures; Dams; Spillways; Locks and Intakes; Channels; Penstocks.

10) **Topography** (160 hours) - Prof. Paulo Dias de Castro Ramos  
**Topics:** I Unit - Planimetry: Topography, Marking out alignments, Measurements of alignments, Direction and Azimuths, Apparatus employed in planimetry, Survey methods, Analytical calculation of surfaces, Checking and rectifying theodolites, Solution to various problems, Determination of true meridian using the theodolite; II Unit - Altimetry: Geometrical and trigonometrical levelling; Concepts, Instruments, Simple and compound levelling, Errors, Filling in standard sheet of numbers, Calculation of heights, Error distribution, Drawing of longitudinal profile; III Unit - Stadimetry: Concept, Use, Instruments, Measurements, Plane calculation, Errors and their compensation, Contours, Drawing of site; IV Unit. - Topohydrography: True North - determination by means of soil observation method; Triangulation - rivers, lakes and islands; Cross section; Hydrographic survey: Methods and Instruments.

11) **Irrigation and Drainage** (80 hours) - Prof. Paulo Dias de C. Ramos  
**Topics:** Irrigation; Physical characteristics of soil; Soil and water; Water consumption by plants; Evapotranspiration; Methods for controlling humidity in irrigated soils; Irrigation methods; Equipment used; Drainage; Drain action in soil; Shape and position of equilibrium line of water table; Direction of drains; Slope of drains; Depth of drains; Spacing of drains; Sizing of drains.

12) **Moral Education and Civics** (80 hours) - Prof. Lirian Purtado  
**Topics:** Doctrinal introduction; Full development and National security; The Constitution; National Politics; Psychosocial field; Permanent values and transient values; Problem of education - Qualitative and quantitative.

13) **Health and Safety** (40 hours)  
**Topics:** General principles of nursing and first aid; Direct care of the patient; Signs and symptoms of fractures; First aid immobilization; Emergency nursing care of injuries; Emergency care of hemorrhages; Emergency care of burns; Emergency care of asphyxia, drowning, syncope, poisoning.
14) **Amateur Boat Pilot** (20 hours) - Prof. Coronel Adão

   **Topics:** Ship nomenclature; Nautical terms; Rules to avoid crashing; Sound signals; Day signals; Rules of steering and navigation; Buoys; Fire-fighting; First aid; Boat manoeuvering practice.

15) **Physical Education** (40 hours)
Synopsis of Courses in Water Resources and Sanitary Engineering

HIDP-01 General Hydrology (4 credits)
Hydrometeorology; characteristics of the river basin; study of rainfall, evaporation, infiltration and surface runoff, groundwater hydrology; hydrometeorological stations; instruction to analytical hydrology; water balance of a river basin, climatology, climate, factors, climatological classification.

HIDP-02 Hydromechanics (3 credits)
Velocity and acceleration in fluids; pressure variation in an accelerated current; effects of gravity on fluid movements; one-dimensional method of analysis; Effects of viscosity on fluid movement; surface resistance; form resistance; laboratory methods.

HIDP-03 Statistical Hydrology (3 credits)
Random nature of hydrological processes; elementary theory of probability; statistical classification of hydrological events; theoretical frequency distributions applied to hydrology; adjustment of theoretical distributions to hydrological sample series; time lag and its relationship to project life and risk; theory of extreme values; statistical study of high flows and low flows; regression and correlation; regional analysis of hydrological data; statistical influence; analysis of variance and co-variance in hydrology.

HIDP-04 Water Resources Development Planning (4 credits)
Economic principles; macroeconomics and microeconomics; economic assessment of water resources development projects; water resources systems planning by objectives: flood control, drainage, hydroelectric developments, water supply, environmental engineering and navigation; multiple purpose projects.

HIDP-05 Mathematics for Applied Hydrology (2 credits)
Differential calculus of several variable functions; vectorial differential calculus; integral calculus of several variable functions; vectorial integral calculus; matrices and determinants; common differential equations.

HIDP-10 Numerical Computations for Applied Hydrology (2 credits)
Interpolation and approximation; numerical integration; equation solution; equation systems solution; approach to the solution of ordinary differential equations and partial derivatives; applications of numerical calculus to the solution of hydrology problems.

HIDP-11 Analytical Hydrology (3 credits)
The hydrological system: Components and interactions; characteristics of the flood hydrograph; hydrograph formation; pre-determination and hydrograph forecast; empirical formulae; rational methods, hydrometeorological and of the unit hydrograph; Seddon's law, and Bache's method, discharge routing in river basins and reservoir, flow regulation by reservoirs.

HIDP-12 Chemistry for Sanitary Engineering (2 credits)
Review of important concepts of chemistry; usual parameters in assessing physical and chemical characteristics of water. Criteria and standards of water used for supply, recreation, irrigation, and fauna and flora preservation. Variations of these parameters considering climatology, geology and pollution. Probable values depending on velocity and depth of water in rivers, lakes and estuaries; Sampling techniques; use of field and laboratory equipment.
HIDP-13  Ground water  (3 credits)
Ground water in the hydrological cycle; porosity; porous formation;
free and confined aquifers; physico-chemical study and quality of ground
water; basic notions on ground water flow; determination of permeability;
infiltration; ground water-surface water relationship; technical aspects;
legal and environmental aspects, ground water planning.

HIDP-14  Hydraulic Structures  (2 credits)
Hydraulic sizing in a constant regimen for channels and hydraulic struc-
tures; dissipation basins; surface spillways; locks; siphons and water
intakes; percolation in channels and in earth dams.

HIDP-15  Pumping Stations  (1 credit)
Sizing of pumping pipes: hydraulic machines; classification; hydraulic
pumps; type, behaviour, selection, installation and maintenance; serial
and parallel pump associations; similarity relationships; electric motors;
pumping stations; elements for a project; system protection; other eleva-
tion systems.

HIDP-16  Hydrometry  (2 credits)
River gauging: hydrometric stations; water level observation; discharge
measurement: instruments, methods: direct, surface-velocity, surface-slope,
chemical and radio-isotope use, water level-discharge relationship: calibra-
tion rainfall; variation control, extrapolation, analysis and homogeneiza-
tion of river gauging data; Sediment measurement stations; monitoring
methods, computation of bed load and suspended load. Hydrometric data
collection network; Field practice.

HIDP-17  Optimization in Water Resources  (2 credits)
System optimization conditions; classic optimization methods; differential
calculus and graphic optimization, linear programming; simplex method and
revised simplex, duality, parametric programming; network problems,
application to non-linear problems. Mixed programming using integers;
research techniques; dynamic programming; simulation; applications to
water resources and hydrology problems.

HIDP-18  Fundamentals of Irrigation and Drainage  (3 credits)
Soil properties; soil-water relationship; statics and dynamics of water
in soil, potential of water in soil, soil-water-atmosphere relation-
ship; evapotranspiration. Soil-water-plant relationships; irrigation dose.
Soil survey and classification; pedologic and irrigation classification.
Field and laboratory practice.

HIDP-19  Erosion and Sedimentation  (2 credits)
Significance of production and retention of sediments in development and
conservation of water resources; sediment characteristics and properties
qualitative and quantitative assessment of sediment production in river
basins; treatment of sedimentological information; protection against
erosion in river basins; reservoir and channel sedimentation. Laboratory
practice.

HIDP-20  Biology for Sanitary Engineering  (2 credits)
Review of general concepts of biology and taxonomy, especially relating
to living creatures which are of greater interest to this sector. Limnology;
Interactions between living aquatic organisms in their environment.
Characterization of rivers, lakes and estuaries. Benthos, plankton and
nektan. Changes due to pollution. Primary and secondary productivity.
Bioindicators of water quality. Interaction between physical, chemical and
biological parameters. Water related diseases. Water and wastewater micro-
biology. Field and laboratory techniques.
HIDP-21 Mathematics for Hydrology (3 credits)
Complex number, Fourier series, Laplace transformations.

HIDP-31 Fluvial Mechanics (2 credits)
Behaviour of river systems, basic concepts, significant flows, river bed flow, basic phenomena; erosion, roughness transportation, sediment at rest; deformation of river system; from the transversal and longitudinal profile, changes in roughness and configuration in a horizontal view synthesis, elements to study behaviour of a river system.

HIDP-32 Hydrogeology (2 credits)
Hydrogeotechnical characteristics of materials; piezometric surfaces; piezometric variations, groundwater reservoir: reserves and resources; well technology; types of wells and pumps; groundwater intakes; wells, galleries and drains; coastal aquifers; regional and local hydrogeology. Field practice.

HIDP-33 Agrohydrology (2 credits)
Plant-soil-water: effects of water excess in soil and in crops; crop reaction to various levels of soil humidity; vegetal behaviour related to: germination, aerial part, root system, grain formation and straw. Irrigation water quality; analysis of elements, interpretation and classification; Irrigation of main crops. Influence of irrigation methods used, and irrigation water management. Ecological effects of irrigation and drainage. Field work.

HIDP-41 River Engineering (2 credits)
Flood control-computation of water line profiles in rivers; administrative steps; flood plain zoning; protection structures: reservoirs, river bed straightening. Improvement and control of river basin. River improvements: dredging, panels, river bed regulation, discharge regulation, channeling; Localized erosion in river works.

HIDP-42 Hydropower development (2 credits)
Brazilian hydropower potential; regional distribution; importance; hydropower, power market; consumption regulation reservoir; size of a development; establishment considering watercourse and market characteristics; sizing of penstocks, sizing of equilibrium tank, turbines: types, functioning and preliminary selection.

HIDP-43 Ground Water prospection (2 credits)
Geohydrological methods, geophysical methods; pumping tests; preparation and execution, constant and non-constant flow; limited aquifers, variable flow pumping; superimposed and interference in pumping. Results. Field work.

HIDP-44 Irrigation methods (4 credits)
Land grading for irrigation; gravitation methods, flood irrigation, furrow irrigation, strip irrigation and irrigation by surface runoff, underground methods, sub-irrigation, special methods, drip and spray irrigation. Field practice.

HIDP-45 Agricultural Drainage (4 credits)
HIDP-46 Water Supply (2 credits)
Permanent Technical Report; studies of all hydrological, urban, social, economic, financial, sanitary and infra-structure conditions which precede the preparation of the Final Design. Water intake, feed and reserve. Grid and branch distribution network designs.

HIDP-47 Water Treatment (2 credits)

HIDP-48 Sewerage Systems (2 credits)

HIDP-49 Sewage and Industrial Waste Waters Treatment (3 credits)

HIDP-50 Tidal Hydraulics (2 credits)

HIDP-60 Special Advanced Studies in Applied Hydrology (variable credits)

HIDP-61 Deterministic Hydrology (2 credits)
Deterministic approach to hydrological processes; convolution models; convolution equation; conceptual and empirical models; discharge routing: dynamic and continuity equation, hydrological and hydraulic treatment; cinematic wave model, and diffusion analogy; use of rainfall-water gauging mathematical models: organization, examples of use.

HIDP-62 Stochastic Hydrology (2 credits)
Stochastic approach to hydrological processes; structural analysis of hydrological series; methods for analysis of correlograph and periodograph; detection of periodicity in parameters of hydrological series, tests of non-periodicity and parameter constance, analysis of dependence of stochastic components; generation of synthetic sequence of hydrological variables, range analysis, application to the problem of storage.

HIDP-63 Hydraulics of Porous Media (3 credits)
Validity of Darcy's law; permeability; theory of flow in porous media; solutions of differential equation of flow, direct method, indirect method of function and numerical theory; models: Hoke-Shaw, electric and mathematical; laboratory practice.
HIDP-64 System Analysis in Water Resources

HIDP-65 Urban Hydrology (2 credits)

HIDP-66 Application of Remote Sensing and Photogrammetry to Water Science (2 credits)
Sensing system. Planning and execution of missions. Applications to hydraulic engineering problems.

HIDP-67 Computational Hydrology and Hydraulics (4 credits)
Review of the solution of systems of equations and series; transient flow in channels and rivers; simplified numerical solutions for a river or river network; mass transport in rivers and estuaries; numerical solution of the transport equation, simulation of water quality parameters; simulation of sediment transport for a river or network of rivers.

HIDP-69 Mechanics of Viscous Fluids (3 credits)

HIDP-70 Advanced Ground Water Flow (2 credits)

HIDP-71 Advanced Fluvial Mechanics (2 credits)
Advanced study of basic phenomena of river mechanics, as well as of behaviour and deformity of river system at the level of the basin. Sediment transport in lined or unlined channels. Calculation of these types of channels.

HIDP-72 Advanced Optimization Techniques (2 credits)
Linear programming: Decomposition of large scale system, theory of duality, parametric programming, numerical and mixed programming, quadratic and convex programming. Dynamic programming, continuous, multidimensional and geometric. Gradient methods: conjugated directions, Lagrange multipliers, Fibonacci type methods, preprogrammed algorithms for general investigation.

HIDP-73 Sanitary Engineering Projects (variable credits)
Complete design of water supply systems, sanitary and storm sewer systems and mathematical models to control river, lake, estuary and dam quality. Includes all stages from the Preliminary Technical Report until the detailed one, and specifications for building with respective budget and economic feasibility.

HIDP-74 Transport Phenomena in Fluids (3 credits)
Classic laws of transport for various types of substances. Transport vectors; advection; convection and turbulent diffusion. Applications to transfers of mass, movement, heat, solid matter (sedimentology), dissolved substances and living matter (biology, ecology).
Fig. 1 - Development of the masters degree course and the UNESCO staff contribution.
Fig. 2 - Number of theses oriented by IPH and UNESCO professional staff
Masters degree theses concluded

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Fig. 3 - Number of MS. degrees awarded by IPH and UNESCO professional staff.
Masters of Science degree theses concluded in the period of 1977-1981

1977
Paulo Renato Ferreira Franz
Balanco hídrico da bacia de Serra Azul-MG, visando ao desenvolvimento agropecuário em cerrados
Orientador: Prof. Ruy da Silveira

Ruy Carlos Maranhão Biscaia
Influência da intensidade de movimentação do solo no processo erosivo com uso de simulador de chuva em latossolo vermelho escuro dos campos gerais, no Paraná
Orientador: Prof. Flávio A. Cauduro

Darci Antonio Althoff
Levantamentos detalhados de solos, climatologia e hidrologia para diagnosticar e apresentar soluções em áreas problemas de drenagem
Orientador: Prof. Flávio A. Cauduro

Zeferino Pedro Sachet
Consumo diário de duas cultivares de arroz (oriza sativa, L) em três tratamentos de irrigação
Orientador: Prof. Flávio A. Cauduro

Raul Dorfman
Critério de avaliação de alguns métodos de cálculo de evapotranspiração potencial
Orientador: Prof. Flávio A. Cauduro

1978
Carlos Alberto Irion
A importância econômica e sanitária do processo de coagulação-floculação, em tratamento de água
Orientador: Prof. Amadeu da R. Freitas

José Eloir Denardin
Efeitos do comprimento de rampas nas perdas por erosão e determinação dos fatores erodibilidade do solo e comprimento de rampa de um latossolo vermelho escuro alúvio
Orientador: Prof. Paulo Dias de Castro Ramos

Bruno Seibert Rezende
Metodologia de estudo da compatibilidade de utilização conjunta de um reservatório para geração de energia elétrica e amortecimento de cheias
Orientador: Prof. Ceferino Alvarez

Lawson Francisco Beltrame
Perda de nutrientes por lixiviação em sistemas de drenagem subterrânea
Orientador: Prof. Flávio A. Cauduro

Paulo Sérgio Magalhães
Estudo e classificação das águas de irrigação da região de Sombrio-SC
Orientador: Prof. Paulo Dias de Castro Ramos

Pedro Luiz de Freitas
Ensaios de drenagem em planosolos do Rio Grande do Sul
Orientador: Paulo Dias de Castro Ramos
Jacobo Manoel Gayoso Pereira da Silva
Viabilidade de disposição de esgoto in-natura por infiltração na faixa costeira do Estado do Rio Grande do Sul
Orientador: Prof. Amadeu da R. Freitas

Raul Alfonso Caicedo Noboa
Gerâção sintética de descargas médias anuais para operação de reservatórios em sequência
Orientador: Prof. Bruno Rezende

Enrico Moreno Côccoaro
Estudo hidrológico de um aproveitamento hídrico usando séries sintéticas e simulação
Orientador: Prof. Ceferino Alvarez

Horácio Pinheiro Monteiro
Simulação por modelo matemático do escoamento subterrâneo em regime permanente na região do Arroio do Sapo
Orientador: Prof. Maria Wreege

Sérgio Barbosa de Almeida
Contribuição ao estudo do fator de resistência na interface de escoamentos estratificados
Orientador: Prof. Marc Bordas

1979

Paulo Rogério Couto Rocha
Determinação da demanda de água de irrigação para a cultura do arroz e potência requerida para bombeamento em solo da Depressão Central
Orientador: Prof. Flavio A. Caudeiro

José Medeiros de Noronha Pessoa
Métodos de neutralização de águas ácidas provenientes da Bacia Carbonífera de Santa Catarina
Orientador: Prof. Ceferino Alvarez

Marcos Caetano de Barros
Verificação do grau de proteção do plano de controle de enchentes do Governo Federal - Bacia do Capibaribe - Pernambuco
Orientador: Prof. Ceferino Alvarez

Guilherme Emílio Sinão
Estudo dos métodos tensiometéricos e da resistência da determinação da unidade do solo
Orientador: Prof. Paulo Dias de C. Ramos

Edmundo Barboda C. Pires
Metodologia para correlacionar dados fluviométricos, cotas ou descargas
Orientador: Prof. Carlos Eduardo M. Tucci

Paulo Katsuki Umezawa
Previsão de depluvio (Wash-load) em rio de áreas elevadas
Orientador: Prof. Franz Semmelmann

José Carlos Saraiva Martins
Pesquisa sobre o aquífero basáltico da região sudoeste do Rio Grande do Sul
Orientador: Prof. Ceferino Alvarez

Walmor Alcântara
Técnicas analógicas elétricas em hidrologia subterrânea - Modelos R-C
Orientador: Prof. Ceferino Alvarez
Nara Maria R. Castro  
Modelo hidrodinâmico para rios e redes de canais naturais  
Orientador: Prof. Carlos Eduardo M. Tucci

Artur Santos Dias de Oliveira  
Floculadores hidráulicos de fluxo helicoidal em tratamento de água  
Orientador: Prof. Amadeu da R. Freitas

1980

Luiz Olinto Montegia  
Estudo técnico científico das águas residuárias do novo Campus da UFRGS  
Orientador: Prof. Amadeu da Rocha Freitas

Arno Nicolau Heck  
Nitrificação - desnitrificação na aeração estendida intermitente  
Orientador: Prof. Amadeu da R. Freitas

Michel Koolhaas  
Avaliação da evapotranspiração regional com dados de radio-sonda  
Orientador: Prof. John C. Taylor

Ari de Oliveira Marques Filho  
Regionalização de modelo de escoamento superficial para dados não homogêneos  
Orientador: Prof. Mario Simões Lopes

Rogério Dewes  
Características hidrodinâmicas dos aquíferos basálticos do Estado do Rio Grande do Sul  
Orientador: Prof. Ceferino Alvarez

José Ricardo Druck Sanberg  
Estudo hidrogeológico nas províncias geomorfológicas do Estado do Rio Grande do Sul  
Orientador: Prof. Ceferino Alvarez

Marcos Imério Leão  
O uso do modelo Hele-Shaw vertical para estudo de aquíferos costeiros  
Orientador: Prof. Ceferino Alvarez

Carlos Mattos  
Uso de dados climatológicos na estimativa do número de dias úteis para implantação de culturas de vaso  
Orientador: Prof. John C. Taylor

Luiz Emílio Almeida  
Contribuição à previsão da capacidade de transporte por arraste em canal a fundo fixo  
Orientador: Prof. Marc P. Bordas

Luiz Gondim  
Influência da compactação do solo na condutividade hidráulica dos planosolos da Unidade de Mapeamento Vacacal  
Orientador: Prof. John C. Taylor

Lianna Beatriz Moretti  
Análise da auto depuração em curso de água: aplicação ao Rio dos Sinos  
Orientador: Prof. Carlos Eduardo M. Tucci

José C. Bohnenberger  
A problemática dos costumes gaúchos face à preservação dos recursos hídricos  
Orientador: Prof. Amadeu da R. Freitas
José Antonio Albuquerque
Dimensionamento automático de redes de abastecimento de água
Orientador: Prof. Amadeu da R. Freitas

Maria Lucia Antunes
Sensibilidade e otimização dos parâmetros de um modelo pluviometrique
Orientador: Prof. Carlos Eduardo M. Tucci

1981

Gilberto Ernesto Canali
Produção de sedimentos em pequenas bacias hidrográficas rurais, efeitos das características das chuvas, da declividade das vertentes e do uso do solo
Orientador: Prof. Marc P. Bordas

Adroaldo Dias Robaina
Relação funcional entre condutividade hidráulica e umidade volumétrica no solo da Unidade de Mapeamento Pelotas-RS
Orientador: Prof. John C. Taylor

Israel de Abreu
Estudo hidrogeoquímico das águas subterrâneas do Estado do Rio Grande do Sul
Orientador: Prof. Amadeu da Rocha Freitas

Edson Salvador Ferreira
Verificação experimental da teoria da idade do lodo no processo de lodos ativados por aeração prolongada
Orientador: Prof. Jan Suschka
### List of course subjects for the Doctoral Programme

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<thead>
<tr>
<th>HIDP</th>
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F = facultative
Research activities executed with FINEP financial support

Table 1

Schedule of activities executed
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<td>232. Analysis/Interpretation</td>
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Research C: Protection against sediment

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Research D: Improvement of productivity in rice-growing flood plains

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<td>Studies of Water Resources Planning in Agriculture</td>
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### Table 5
Research E: Water quality of rivers which feed the Guáiba

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<td>E24. Sewage infiltration in sand dunes</td>
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**Notes:**
- Could not be carried out.
### Table 5

Research F: Aerophotogrammetry applied to urban hydrology

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<td>A32. Pre-signalization</td>
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<td>A33. Photogrammetric flight (1/5000)</td>
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<td>A38. Analysis of results</td>
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<td>A39. Preparation of computer programs and their implementation on the UFRGS B 6700</td>
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<td>A310. Program tests, using partial data in existence, in areas which are not of Dilúvio Creek</td>
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<td>A311. Report</td>
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List of IPH staff members

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<td>1. Marc Pierre Bordas</td>
<td>Director of IPH</td>
<td>Ph.D in River Morphology</td>
</tr>
<tr>
<td>2. Rubem Ungaretti</td>
<td>Vice-Director of IPH</td>
<td>Specialist in Hydromecanics</td>
</tr>
<tr>
<td>3. Antonio E.L. Lanna</td>
<td>Chief of the Post-Graduation Commission</td>
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Hydrology Sector

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<td>4. Ruy L da Silveira</td>
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<tr>
<td>5. Carlos E.M. Tucci</td>
<td>Associate professor</td>
<td>Ph.D in Hydrology</td>
</tr>
<tr>
<td>6. Antonio E.L. Lanna</td>
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<tr>
<td>7. Neusa da Cruz</td>
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</tr>
<tr>
<td>9. Nelson L. Calóedo</td>
<td>Assistant professor</td>
<td>M.Sc. in Hydrology</td>
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Groundwater Sector

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<tr>
<th>NAME</th>
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<tr>
<td>10. José Carlos S. Martins</td>
<td>Assistant professor</td>
<td>M.Sc. Hydrogeology</td>
</tr>
<tr>
<td>11. Marcos I. Leão</td>
<td>Assistant professor</td>
<td>Geologist</td>
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<tr>
<td>12. Mário D. Wrege</td>
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Sedimentology Sector

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<tr>
<td>13. Franz Semmelmann</td>
<td>Chief of the sector</td>
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Irrigation and Drainage Sector

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<tr>
<td>14. Flávio A. Cauduro</td>
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<td>M.Sc. Soil Engineering</td>
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<tr>
<td>15. Paulo D. Ramos</td>
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<tr>
<td>16. Lawson F. Beltrame</td>
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<tr>
<td>17. Raul Dorfman</td>
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Sanitary Engineering Sector

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<tr>
<td>18. Anadeu da R. Freitas</td>
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<td>Specialist in Sanitary Engineering</td>
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<tr>
<td>19. Luiz O. Monteggia</td>
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<td>20. Liana B. Moretti</td>
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<tr>
<td>21. Erny Stein</td>
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<td>22. Sérgio J. de Luca</td>
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<td>22. Victor Haertel</td>
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<td>23. Marley R. Gonçalves</td>
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<td>24. Rubem L. Ungaretti</td>
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<td>25. Eurico T. Neves</td>
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<td>26. Bruno S. de Rezende</td>
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<td>27. Mário S. Lopes</td>
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<td>28. Luiz Emílio Almeida</td>
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<td>29. Rorário Maestri</td>
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<tr>
<td>30. Dara Prata</td>
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<td>31. Nuno Midrigan</td>
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<td>32. Jose Juan D'Amico</td>
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<td>M.Sc. Hydrometry</td>
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<td>33. José S. da Silva</td>
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<td>34. Walmar Alcântara</td>
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<td>M.Sc. Hydraulics</td>
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<tr>
<td>35. Alejandro C. Borche</td>
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<td>M.Sc. in Applied Mathematics</td>
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<tr>
<td>36. Assistant professor</td>
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0^a - staff members acting as advisers for dissertations at masters degree level.