Hydrology of the Hindu Kush-Himalayas

Report of the Regional Workshop

Editors
S.R. Chalise
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Organised by
UNESCO and ICIMOD in collaboration with the DHM/HMG/N and the German IHP/OHP Committee

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Inset : Participants at the Inaugural Session

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Foreword

The Hindu Kush-Himalayas are the largest storehouse of fresh water in the lower latitudes. They are also the sources of myriads of large and small rivers and streams, including such mighty rivers as the Indus, the Ganges, and the Brahmaputra which have been the cradles of ancient civilisations.

These large water resources are the lifeline for survival to hundreds of millions of people, both in the mountains and in the plains they nurture. They are also the cause of anguish and loss of life and property when the monsoon unleashes its annual course of destruction.

Whether due to normal variability of climate or due to climate change, it is also seen that, in the upper watersheds of the Hindu Kush-Himalayas, the incidences of extreme climatic events and their destructive hydrological consequences are on the increase.

A proper understanding of the hydrology of the Hindu Kush-Himalayan rivers and streams is, therefore, important whether for harnessing the rich potential of water for power, irrigation, and human consumption or for planning ahead for the mitigation of water-induced disasters.

The International Centre for Integrated Mountain Development has been working closely with the countries of the Hindu Kush-Himalayas, UNESCO, and WMO over several years to develop a regional network for hydrological research.

As a result of these collaborative efforts, a Regional Working Group (RWG) on Mountain Hydrology was constituted in December 1989 with representation from all the countries of the HKH, UNESCO, and ICIMOD.

It is extremely gratifying to all of us who have been engaged in this joint initiative that the RWG, during its last meeting in March 1996, decided to launch a regional programme of hydrological research within the framework of the FRIEND (Flow Regimes from International Experimental and Network Data) Project of the International Hydrological Programme of UNESCO, viz., the HKH-FRIEND. This publication summarises the report of this important workshop, which can be considered to be a major effort to further the cause of hydrological research in the HKH. We very much hope that the information contained in this report will be useful to all those interested in the sustainable use of water resources in the HKH. ICIMOD, from its core programme resources, will be able to start some of the action recommended on a modest scale. Considerable amounts of additional funding, however, are needed to make the programme fully operational and to make a substantial impact on the use of water resources in the Hindu Kush-Himalayas.

On behalf of ICIMOD and also on behalf of the organisers, I would like to take this opportunity to express our gratitude and thanks to our member countries from the HKH, WMO, and the German IHP/OHP Committee for their support and collaboration in launching the HKH-FRIEND and also for the publication of this report. Special thanks are due to DHM Nepal for their continuing support to and collaboration in this initiative.

On behalf of the editors, I would also like to thank all the participants of the Workshop who provided their valuable comments on the draft of this report. Thanks are due to Greta Rana, Senior Editor, Anita Pandey, Assistant Editor, and other members of the Publication Division of ICIMOD for copy editing and to Reeta Rana, Secretary MNR Division, for typing under tremendous pressure to produce a published document within a limited time-frame.

Egbert Pelinck
Director General

September 1996

Editors Acknowledgements

The Editors gratefully acknowledge the contributions of Anita Pandey, Assistant Editor, ICIMOD for her contributions during the workshop and the preliminary stages of report writing. Professor A. Herrmann made a special effort to make a post-workshop contribution, as seen in Annex 5. Narendra Shrestha and Reeta Rana prepared the draft and the computer layout was prepared by Dharma R. Maharjan. Asha Kaji Thaku is responsible for the cover arrangement. Their contributions were an essential ingredient to the production of this document.

Contents

Regional Workshop on Hydrology of the Hindu Kush-Himalayan Region

The Regional Workshop on Hydrology of the Hindu Kush-Himalayan (HKH) Region, jointly organised by UNESCO and ICIMOD, in collaboration with the Department of Hydrology and Meteorology (DHM)of the Ministry of Water Resources of His Majesty's Government of Nepal (HMG/N) and the German International Hydrological Programme (IHP/OHP) Committee, was held from 23-24 March, 1996, at the ICIMOD Conference Hall, Kathmandu. It was attended by 26 participants from seven countries of the HKH region. A list of participants, the agenda, and the programme, as well as a draft proposal for a Flow Regimes from International Experimental and Network Data (FRIEND)-type project in the HKH are given in Annexes 1, 2, and 3 respectively.

Inaugural Session

Mr. Egbert Pelinck, Director General of ICIMOD, highlighted the complexity of the climate and hydrology of the HKH region in his welcome address and emphasised the need to understand these complexities in order to manage water resources and meet the growing needs for human and animal consumption. He added that large variations in rainfall patterns led to extremes in seasonal river flows and pointed out that inaccessibility, an inadequate number of hydrometeorological stations, and the costs incurred in observing and monitoring hydrometeorological parameters had added to the difficulties of developing a long-term, reliable hydro-meteorological database and, consequently, had added to the problem of understanding these complexities of climate and hydrology in the region. He emphasised the need for regional cooperation for the sustainable management of water resources, given the transboundary nature of all the major river systems in the region.

Mr. Pelinck stated that ICIMOD had joined hands with UNESCO under its International Hydrological Programme (IHP) and the DHM-HMG/Nepal in December 1989 to organise a Regional Workshop on Mountain Hydrology which resulted in the establishment of a project on Mountain Hydrology under UNESCO's International Hydrological Programme (IHP) during its IVth phase. The 1989 Regional Workshop also led to the establishment of the Regional Working Group (RWG) on Mountain Hydrology in the Hindu Kush-Himalayas. Apart from the regional participating countries, the Regional Working Group included UNESCO/IHP, ICIMOD, and the World Metereological Office (WMO) and, more recently, had been supported by IDRC and the German IHP/OHP Committee. He said that the agenda of the present meeting included the finalisation of a FRIEND- type project for the HKH. He also welcomed the interest of Dr. Alan Gustard of the Institute of Hydrology, U.K., and the FRIEND Steering Committee and Dr. Wolfgang Grabs, Director/Head of the Global Runoff Data Centre (GRDC), Koblenz, Germany, in supporting and establishing the proposed FRIEND-type project. Mr. Pelinck also expressed gratitude on behalf of ICIMOD to the Ministry of Water Resources of His Majesty's Government of Nepal for their continued support in establishing a regional research programme on mountain hydrology.

Mr. Kiran Shankar Yogacharya, Director-General, Department of Hydrology and Meteorology (DHM), briefly described the background and objectives of the Regional Workshop. He pointed out that realising the need to understand the complex hydrological systems of mountain environments, UNESCO and ICIMOD, together with HMG/N, had organised a Regional Workshop on the Hydrology of Mountainous Areas in 1989. This workshop had recognised the urgent need for systematic study of hydrological processes in order to use and develop natural resources on a regular basis with minimal detrimental effects, and it had recommended the establishment of a Regional Working Group and finalisation of a detailed project on the hydrology of mountainous areas for submission to the Ninth Session of the Intergovernmental Council of the IHP of UNESCO. As per the recommendation of this Workshop, Project: H-5.6 was instituted into IHP-IV of UNESCO.

Mr. Yogacharya also added that the Regional Working Group (RWG) had already met four times, twice in Kathmandu and twice in New Delhi. Under the joint sponsorship of UNESCO, ICIMOD, and the German IHP/OHP National Committee, the fourth meeting of the RWG had been held in New Delhi in 1995 to explore the possibilities of launching a FRIEND-Type project for the HKH region. This meeting was attended by five of the eight HKH countries and representatives of UNESCO and the German IHP/OHP National Committee. An Interim Working Committee had been formed to prepare a preliminary proposal. Mr. Yogacharya, citing one of the ancient epics of the *Mahabharat* in Sanskrit, stated, *Andham balam jalam cha ahuh, pranetavyam vichakshanae,* meaning that water is a blind force that has to be properly guided and channelised by scientists or engineers for optimum human welfare and national/regional development. He added that water not harnessed properly would be lost forever. Delay in the development of water resources would mean loss of its potential wealth.

Mr. L.A. Mandalia, UNESCO Representative, conveying greetings from the Director General of UNESCO, Professor Frederico Mayor, stated that UNESCO was committed to launching a FRIEND-type project in the HKH region. The FRIEND project, with four groups in Europe and South Africa working under the International Hydrological Programme (IHP), was one of the most active and successful UNESCO projects. Pleased with the presence of six of the eight regional member countries (RMCs),including DHM, HMG/N, along with collaborating institutions, viz, ICIMOD, WMO, the German IHP/OHP Committee, and other cooperating agencies such as the Institute of Hydrology, U.K., GRDC, IHP-Slovakia, he recalled the long-term collaboration between UNESCO and ICIMOD and urged the unique gathering to move forward to produce concrete results.

Dr. Z.W. Kundzewicz, WMO Representative, thanking the organisers on behalf of Professor G.O.P. Obasi, Secretary-General of WMO, noted that, in keeping with the WMO mandate, the organisation was keenly interested in the hydrology of mountain regions. Acknowledging the fact that the lack of data on mountain water resources can be due to inaccessibility, the harsh environment, hydrological aberrations, and sometimes problems with neighbouring countries, he emphasised the need to overcome these drawbacks with a denser network of stations using a consistent data collection system. He also added that WMO promotes cooperation on

global and regional levels and mentioned that the GRDC and the World Hydrological Cycle Observing Systems (WHYCOS) had established a global network on the major rivers for monitoring flow and water quality and then transmitting these data through satellite to data centres. In conclusion, he hoped that plans formulated at the workshop would come to fruition.

Professor A. Herrmann, representative of the German IHP/OHP Committee and of the FRIEND Steering Committee, noted that both the Regional Workshop on Hydrology and the International Conference on Ecohydrology were being co-funded by the German IHP/OHP under the auspices of UNESCO. At the outset, on behalf of the National Committee of the Federal Republic of Germany for the International Hydrological Programme (IHP) of UNESCO and the Operational Hydrological Programme (OHP) of WMO and on behalf of the steering committee of the Western and Northern European FRIEND, he expressed gratitude for being given the opportunity to assist in launching a FRIEND-type project for the Hindu Kush-Himalayan region. He also said that Germany could be considered to be one of the most conscientious sponsors of HKH countries, in terms of their long-standing interest in regional hydrology in the HKH on a small catchment scale under the auspices of UNESCO. Work on small catchments had been recommended by the First Consultative Meeting of the Regional Working Group, jointly organised by UNESCO and ICIMOD in Kathmandu in October 1990. He said that direct interactions between delegates and scientists from several high mountain regions of the world, over the next few days, during the Ecohydrology Conference, would also contribute towards the establishment of a competent, institutionalised regional counterpart in the near future for a better understanding of regional hydrology in the HKH region. He added that the German IHP/OHP committee strongly supported both the Workshop and the Conference in the establishment of a FRIEND Group with a systematic organisational structure and action plan. He hoped that many suggestions would come forth during the deliberations and that the work of the IHP would not be limited to a specific region.

Dr. D.N. Dhungel, Secretary, Ministry of Water Resources, in his inaugural address, highlighted the importance of water resources and noted that previous meetings of the Regional Working Group on Hydrology had paved the way for the launching of a FRIEND-type project in the HKH. He added that transboundary characteristics and the diverse nature of rivers stimulated scientists to open new dimensions in the field of hydrology. This was as true of other regions as it was for the HKH. He gave assurances that His Majesty's Government of Nepal would extend all possible support to the collaborative regional project.

Professor S.R. Chalise, Water Resources' Specialist, ICIMOD, recalled the close collaboration that had taken place between UNESCO, ICIMOD, and the Department of Hydrology and Meteorology of HMG/N since 1989 to develop a FRIEND-type project in the HKH and the excellent support received from the regional member countries and other institutions such as WMO, GRDC, the German IHO/OHP Committee, the Institute of Hydrology, U.K., and the Slovak IHP Committee. He concluded the inaugural session with a vote of thanks.

Session One

Background of the Regional Working Group on Mountain Hydrology

Chairman: Mr. Mohammad Rahim, Director General, Hydrology and Water Management, Ministry of Water and Power, Kabul, Afghanistan.

Professor S.R. Chalise opened Session One with a brief note on the background of the Regional Working Group on Mountain Hydrology and its past efforts to initiate a regional FRIEND-type research project in the HKH. He stated that this was the fifth meeting of the Regional Working Group and that the goal was to establish a FRIEND-type project in this region.

Mr. L.A. Mandalia noted that, in accordance with the recommendations of the Third Consultative Meeting of the Regional Working Group on Mountain Hydrology, the fourth meeting of the RWG had been held on July 1995 in New Delhi. The meeting elicited suggestions on how to organise a FRIEND-type project, its name, workplan, guidelines, and so on. He noted that the support of participating countries was crucial and could be stronger. This should change, considering the benefits the countries would receive. One of the drawbacks, he said, was the constant change of representatives from participating countries. This hindered continuity. He emphasised the need for more permanent committee representatives,from both government and non-government institutions, for the successful launching of a FRIEND-type project. "It might also help," he added, "to treat FRIEND in the HKH as a highly scientific and technical project, rather than an official one."

Dr. A. Gustard, from the Institute of Hydrology, U.K., described the FRIEND project's conceptual background, structure, and facts about its inception in different parts of the world. He explained that the primary objective of FRIEND was to develop a better understanding of hydrological variability and similarity across time and space in order to develop the hydrological sciences and improved practical designs. He also stated that there were four project groups of FRIEND; viz., (1) North European, (2) Alpine and Mediterranean Hydrology (AMHY), (3) South African FRIEND, and (4) West and Central African FRIEND; and that there were future plans to expand FRIEND into the HKH, South East Asia, Latin America, and the Nile region. He mentioned some of the training, fellowship, and exchange programmes within FRIEND. He also outlined the difficulties in implementing FRIEND projects, especially the new ones: (i) determination of common research objectives; (ii) agreement on a work programme and common methods of analysis; (iii) funding; (iv) establishment of a coordination centre, secretariat, and central database facilities; and (v) data security while exchanging national data. Listing the advantages, he said that an international database transcended the constraints of national boundaries; promoted the exchange of project staff, models, analyses, and techniques between countries; and also meant that the specialisation lacking in one country could be provided by another. The paper presented by Dr. A. Gustard on the implementations, achievements, and further plans for the Northern and Western European FRIEND project is given in Annex 4.

Professor A. Herrmann pointed out that hydrological behaviour, particularly at the micro-level, was poorly understood in the HKH region. In outlining the activities of FRIEND in Europe, he said that an HKH-specific project would be aimed at solving regional problems. He emphasised the need to begin research on hydrological processes in places where the infrastructure for hydrometeorological monitoring was already available. Further details of his presentation are given in Annex 5.

Discussions

Dr. S. Shah, from Pakistan, suggested the acronym THHUND-FRIEND for the proposed project.

Dr. B.P. Parida, from IIT, New Delhi, said there was a dearth of data in the region. He suggested establishing a research institute for regional hydrological studies.

Professor M. Hussain, from Bangladesh, suggested that the same acronym recommended at the meeting in Delhi the previous year be used.

Professor M.F. Bari, from Bangladesh, stated that his institution had been working on drought and in small catchments and expressed an interest in cooperating with the proposed project work.

Professor B.A. Chandio, from Pakistan, expressed willingness to cooperate. He asked how the project would be supported. He also queried whether it was only UNESCO or other organisations also who were supporting the project.

Dr. R.P. Singh, from the Indian Institute of Technology (IIT), Kanpur, India, pointed out that there was too much government control in the region. Such regional workshops should not be restricted to a few official delegates only. The message should go to larger scientific communities. He also insisted that universities had greater freedom and flexibility for exchanging data and that funding was the critical issue in undertaking such studies.

Dr. L. Molnār, of the Slovak IHP, pointed out that this was the introductory stage of the project. Appropriate ways, appropriate institutions, and appropriate personnel for carrying out the work had to be identified. The second stage would be devoted to research and operations.

Mr. K.S. Yogacharya formally presented the proposal prepared for launching a FRIEND project for the Hindu Kush-Himalayan Region for discussion and comments. He presented the background, name, objectives of the project proposal, names of the participating countries, funding, the structure of the project administration, and programme activities. He highlighted the priority activities which were: (i) to collect existing datasets and catchment characteristics from participating countries, (ii) to locate existing hydrological/meteorological stations in the region, and (iii) to establish and maintain liaison with research projects/institutions. He stated that the proposal envisaged the establishment of a regional database centre at ICIMOD.

Session Two

Responses by Representatives of the HKH Countries and Collaborating Institutions

Chairman: Professor M. Fazlul Bari, Bangladesh

Mr. S. Mohammad, one of the delegates from Afghanistan, presented a paper on the state of the hydrological network in Afghanistan and asked for cooperation in rehabilitating the destroyed hydrological stations in Afghanistan. He strongly supported the establishment of FRIEND in the HKH and confirmed his country's willingness to participate in the project.

Professor M. Hussain, one of the official delegates from Bangladesh, highlighted the highland-lowland linkages in hydrological behaviour. He pointed out that the proposed work was beneficial and reaffirmed Bangladesh's interest in cooperating and supporting the project.

Professor Wei-Zu Gu from China described research work in the Lhasa area and expressed his willingness to collaborate and exchange experiences on behalf of his institution in his personal capacity.

Dr. R.P. Singh described the modelling, GIS, and database activities of his institution and expressed his willingness to contribute to the programme. He emphasised the need for funding and monitoring the network and the training needs of technical staff.

Dr. B.P. Parida, supported Dr. R.P Singh's views and pointed out that the present proposed project was desirable and beneficial. He emphasised the need for uniformity in methodology, instruments, and monitoring activities. He urged that uniform guidelines be developed for future monitoring and research activities. He also suggested that water quality data be collected.

Mr. U.Y. Myint, one of the official delegates from Myanmar, described the state of hydrometeorological stations in Myanmar and highlighted the problems therein. He agreed with the proposed name for the FRIEND project and confirmed Myanmar's support.

Mr. A.P. Pokhrel, representing Nepal officially, noted that the project proposal was good and expressed Nepal's willingness to participate actively in the proposed project and its programme activities. He stated that the proposed HKH-FRIEND regional data centre was necessary and could be located at ICIMOD. However, he pointed out that the budgetary aspect was lacking from the proposal. He also suggested the incorporation of water quality monitoring in the programme.

Professor B.A. Chandio, official delegate from Pakistan, spoke of the flexibility in exchange of hydrological data in his country. He cited the example of the exchange of hydrological data between India and Pakistan in the context of the flood warnings for the Ravi and Sutlej rivers. He expressed Pakistan's willingness to support the proposed FRIEND-type project for the HKH and also added that a database centre under the pro-

posed project could be located in Pakistan. He further offered to provide logistics' and institutional support.

Dr. Z.W. Kundzewicz, WMO representative, stated that WMO was interested in the assessment of water resources at the regional level and in promoting international cooperation in operational hydrology and would consider it if the HKH-FRIEND requested help.

Dr. W. Grabs, Head, Global Runoff Data Centre (GRDC), Koblenz, Germany, described the activities of GRDC and expressed his interest in supporting and assisting the proposed HKH-FRIEND.

Dr. L. Molnãr, member of the Slovak Committee on Hydrology, Slovakia, expressed his willingness to assist in the training programme.

Professor A. Herrmann said that the German IHP/OHP committee strongly supported the establishment of a FRIEND Group.

Discussions

Dr. S. Shah said that, when data collection was considered, the coastal areas should be kept in mind too.

Dr. B.P. Parida suggested that incentives be given to encourage regional countries to participate in the proposed project. The incentives could be that a FRIEND member country could have access to FRIEND data globally and also assistance in the study of global trends in hydrological processes.

Dr. R.P. Singh again emphasised the fact that academic institutions and scientists could collaborate in the proposed project better than their government counterparts.

Professor A. Herrmann pointed out that FRIEND was an IHP project under the auspices of UNESCO, and that the official channels of UNESCO could be used to disseminate information. Normally, research work in FRIEND Europe was carried out by universities and private agencies.

Dr. A. Gustard mentioned that it had taken more than 10 years to establish the European FRIEND. In Europe and South Africa, FRIEND had used UNESCO whenever it was conducive and useful. There were FRIEND countries that might not necessarily have an IHP committee. He recommended starting on a small scale, as all FRIEND projects had done, using minimal data, funds, and staff. He also stated that FRIEND Europe and South African-FRIEND were ready to provide consultancy support. On the question of the scale/area of the basins, he suggested they should not be rigid about having 500sq.km. as the minimum size. He also stated that there was no such limit in South Africa and suggested that existing research projects could be used to introduce FRIEND in the HKH. He also suggested that a new direction for the science, e.g., water quality and sedimentation, be introduced and emphasis be given to supporting the establishment of new stations rather than just collecting available data. He stressed the fact that training and follow-up activities should be given high priority. He also suggested a measure of flexibility, by starting small and

giving it the shape of a club. He stated that then most countries would want to join in. The name should be easily identifiable. Database security was important and the access to databases should be established by the participating countries and not by third parties. For this, it was better to establish a protocol to restrict the data within the region. He suggested that the project start gradually.

Dr. W. Grabs stated that GRDC worked on a signed mandate and followed resolutions adopted by WMO for exchange of data.

Dr. S. Shah noted that donors were more interested in the environment than in issues of hydrology.

Dr. A. Gustard responding to Dr. Shah, stated that there were some institutions in Europe (e.g., Brussels Small Hydropower) which were interested in small-scale hydropower and low-flow studies. On database collection, he suggested that developing new database directories of institutions and researchers could also be considered.

Dr. L. Molnãr emphasised the need to monitor existing research projects and pointed out that all scales were important.

Dr. A. Gustard pointed out that UNESCO had made significant efforts to support research in hydrology in South America and similar efforts should be made in this region as well.

Mr. L.A. Mandalia stated that UNESCO had already compiled a list of hydrologists in the region. Setting up a database would be the first step.

Professor S.R. Chalise noted that so far the main effort had been to bring all countries of the HKH together to cooperate in research for an improved understanding of very complex hydrological systems. He pointed out that it was difficult for any country to have an answer to all the hydrological problems, whether these involved small hydropower or Glacial Lake Outburst Floods (GLOFs). The generation of sufficient data would require substantial funds. The Regional Working Group had been created with the philosophy of a small-scale project. In this forum, they were reiterating what they had said five years previously. He concluded by saying that the need for the project had been expressed unanimously, and the countries that could contribute should join and proceed and those that could not join would hopefully join later. The whole philosophy of FRIEND was based on exchange. No one belittled the capacity of research in the region but knowledge had to be shared among all the centres. On behalf of ICIMOD, he offered to undertake the job of preparing a hydrological database with regional cooperation and support.

Mr. L.A. Mandalia welcomed this offer and said that they should think of cutting costs. ICIMOD would be a good centre since it already had an established data centre. He suggested that the project be introduced in two or three countries with a secretariat at ICIMOD.

Professor M.F. Bari, who was chairing the discussion, noted that budgetary constraints did exist. He also stated that the countries that had agreed to join HKH-FRIEND were Afghanistan, China (Research Institute Level), India (individual basis), Myanmar, Nepal, and Pakistan.

Session Three

Discussion and Finalisation of Recommendations for the Hindu Kush-Himalayan FRIEND Project

Chairman: Dr. Bashir Ahmad Chandio, Pakistan

Dr. A. Herrmann, representing the German IHP/OHP Committee, proposed a structure for the FRIEND project. According to his suggestion, the Steering Committee should be comprised of representatives from the countries of the region. Three membership categories were suggested: participating countries, collaborating institutions, and observer organisations or other FRIEND projects. The core activity of each FRIEND group should be database generation, and he requested ICIMOD to host a data centre. Presenting the organisational structure, he emphasised the need to move on from the Delhi meeting.

Professor S.R. Chalise, referring to the proposal submitted to the Regional Workshop, suggested that the project proposal needed to be fine-tuned and developed as a fully-fledged project. He suggested that Mr. K.S. Yogacharya continue the task of preparing a complete proposal which could then be submitted to donors. He also emphasised that the project proposal should clearly spell out the responsibilities of all members. He also suggested that WMO become a full member of the steering committee of the proposed FRIEND for the HKH, as it had already been a member of the Regional Working Group since its inception. He also said that UNESCO and ICIMOD could continue to provide a joint secretariat for the Regional Working Group.

Dr. W. Grabs said that they should not be divisive but come to a consensus. The spirit of FRIEND was to have the maximum number of members — countries and institutions. It facilitated comparison of results and arriving at scientific conclusions. He confirmed that GRDC could assist in the collection, selection, and transfer of data to the database centre.

Mr. L.A. Mandalia recounted the long history of collaboration between UNESCO and ICIMOD. He also stated that because of the geopolitical placement of Kathmandu, ICIMOD would be well-suited as the proposed HKH-FRIEND database centre.

Dr. S. Shah said that, in principle, they agreed with the mandate of HKH-FRIEND; what needed to be addressed was the issue of collaboration.

Dr. A. Gustard suggested that the future coordinator of HKH-FRIEND should be a part-timer — a maximum of three to six months a year should be devoted to HKH-FRIEND. He also drew the attention of the members to funding aspects.

Dr. B.A. Chandio, from the Chair, said the house was in consensus about the name HKH-FRIEND.

Mr. L.A. Mandalia stated that UNESCO would try to fund the coordinator and ICIMOD could provide help in kind.

Dr. B.A. Chandio stated that the coordinator should first establish a framework and then get the technical aspects together. He also opined that identification of project activities was up to the coordinator.

Dr. L. Molnãr proposed Mr. Yogacharya as the Interim Coordinator until the next Steering Committee Meeting, and Professor Herrmann seconded the proposal.

Professor M.F. Bari stated that the Coordinator should be a rotational post and that ICIMOD could act as the clearing house.

Mr. K.S. Yogacharya clarified that out of the eight activities in the draft proposal (Annex 3), the first three were priorities. It was decided that the Regional Working Group would launch the HKH-FRIEND Group with representatives from all member countries and institutions. He also explained that, in principle, ICIMOD was well placed to shoulder the work of the Secretariat.

Dr. A. Gustard suggested that HKH-FRIEND should consist of participating countries/institutions/agencies. He also suggested that one person from each of the agencies represented at the workshop could be considered for membership. From each country, there could be one from a university and one from the IHP committee.

Dr. M.F. Bari suggested that with a full and complete house, the Steering Committee should be elected immediately.

The Chair urged him to give the Coordinator some more time.

Concluding Session

Endorsement of Recommendations for Launching the Hindu Kush-Himalayan FRIEND

Chairman: Mr. E. Pelinck, Director General, ICIMOD.

Dr. B.A . Chandio presented a summary report of the previous session.

After detailed discussions and deliberations, the following was agreed upon by the house.

1. **Name of the Project**: HKH-FRIEND

2. **Coordinator**: It was recognised that when the project became fully operational, the job of the Coordinator would be a part-time job ranging from between two to six months. It was also agreed that the post of the Coordinator should rotate among member countries, subject to the required qualifications, experience, and clearance from the country from which he/she came.

For the time being, **Mr. Kiran Shankar Yogacharya** was requested to continue as the Interim Coordinator to finalise the project proposal by incorporating comments and suggestions from the participating countries.

3. **Project Implementation/Identification of Priority Activities**: All activities mentioned on Annex 3, page 3 of the project document should be split into two phases. Monitoring of existing research projects, incorporation of data in a common format, database generation, identification of the needs and rehabilitation of stations, flow frequency analysis, and training of staff in the above-mentioned field should be carried out during Phase I (three years from the start of the project). Analysis of snowmelt runoff, modelling, and assessment of the impact of change in land use should be undertaken later in Phase II. **Dr. A. Gustard** suggested that cataloguing and assessment of existing data might be a tangible programme that could be carried out in the first six months. This suggestion was approved.

4. **Regional Working Group Membership**: **Professor A. Herrmann** made a presentation on the concept of the project and the role of donor agencies and member countries. Incorporating the modifications suggested by the house, he confirmed that eight member countries, ICIMOD, UNESCO, and WMO would continue to constitute the regular membership, whereas other scientific and donor agencies willing to collaborate would be observers on the Regional Working Group.

5. **Project Secretariat**: It was unanimously agreed by all participants that ICIMOD would be requested to provide a Secretariat for the HKH-FRIEND Project. **Professor S.R. Chalise** asked whether the Secretariat at ICIMOD was going to be temporary or long term. **Mr. L.A. Mandalia**, expressing UNESCO's views, suggested that for the time being the Secretariat of HKH-FRIEND and the database centre should be located at ICIMOD and the Secretariat of the Regional Working Group provided jointly by UNESCO and ICIMOD, as had been the practice so far. These suggestions were approved.

6. **Steering Committee**: Concerns were raised that if the nomination of a steering committee was left to the respective governments, competitive and functional organisations and experts might not be selected. **Dr. A. Gustard** suggested that the committee should be comprised of experts and institutions dealing with water but scattered into various departments; NGOs and universities might also be members of the steering committee on merit. He also added that the Steering Committee should be comprised of organisations actively working on the FRIEND project. He said that the onus of appointing members for the steering committee lay with UNESCO and ICIMOD. **Mr. L.A. Mandalia** was of the opinion that individual IHP groups might be stimulated by proper guidance to be flexible in making nominations.

After detailed discussion, this item was left for the time being to be finalised by the UNESCO Regional Office and ICIMOD until the project became operational.

7. **Project Support**: As support to the proposed HKH-FRIEND project, UNESCO committed $2,000. WMO offered to help assist with training. The Institute of Hydrology, U.K., offered to contribute by training GIS personnel, with fellowships, and also by preparing a proposal to be submitted to the European Union (EU). **Dr. W. Grabs** said that since the core programme was database generation, GRDC would like to help with information and training and to set up, collect, disseminate, and analyse data in coopera-

tion with expertise from the Institute of Hydrology, U.K. He also pointed out that GRDC had prepared a catalogue of discharge information available from the HKH region. The information contained therein could be used as the first step in the establishment of a HKH-FRIEND database. **Professor A. Herrmann,** on behalf of the German IHP/OHP Committee, said that this was a good suggestion. He also confirmed that the German IHP/OHP Committee would discuss the possible nature and magnitude of its future technical and financial support to the project at its next meeting. **Dr. L. Molnár,** on behalf of the Slovak Committee on Hydrology, expressed willingness to assist in the training programmes.

Mr. E. Pelinck expressed happiness that the Steering Committee would be comprised of the regional countries as well as UNESCO, ICIMOD, and WMO. He noted that a project activity such as this was of a long-term nature. He also added that, once commitments from donors were received, it would be possible to reach out and provide services. He also hoped that commitment from the member countries would be forthcoming.

Dr. B.A. Chandio, on behalf of his organisation, offered to help with the equipment and, possibly, the training facilities.

Professor M.F. Bari, on behalf of his organisation, offered assistance with the laboratory and computing facilities as well as free exchange of data.

Mr. E. Pelinck thanked the participants for their help and said that, as part of the Regional Collaborative Programme of ICIMOD that had been endorsed by the Board (for the period from 1995-1998), ICIMOD had a sub-programme dedicated to "Improved Understanding of the Conditions of Water Resources and Mountain Climate Changes," under which the following programme activities were being carried out: (i) assessment and identification of appropriate methods and techniques for water harvesting and management of local water resources; (ii) promotion of a better understanding of mountain climate changes and their relationship to the ecology and hydrology of the region; and (iii) reinforcement of the present regional network of research and study in mountain hydrology. He added that ICIMOD would continue to provide the professional assistance of its staff, as in the past, to the proposed project within the above programme activities of ICIMOD. However, he also emphasised that any input beyond that would require additional resources. On behalf of ICIMOD, he was happy to provide a database centre for the proposed HKH-FRIEND project at ICIMOD.

Mr. L.A. Mandalia urged all the members to continue working to promote the project when they returned to their countries. **Mr. S.K. Yogacharya** and **Professor M.F. Bari** gave a vote of thanks on behalf of the participants.

Concluding the Workshop, **Mr. E. Pelinck** thanked all members for their keen interest and support and said that ICIMOD looked forward to developing this project with the regional member countries of the HKH, and that it could very well develop into a very important programme.

Annex 1
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Annex 2
Programme

Regional Workshop on the
Hydrology of the Hindu Kush-Himalayan Region
Venue: ICIMOD Conference Hall, Jawalakhel

Day 1 - 23 March 1996 (Saturday)

Inaugural Session

8:30	Registration	
9:05	Welcome Address:	Mr. Egbert Pelinck Director General
9:15	Background to the Workshop:	Mr. Kiran Shankar Yogacharya
9:20	Address by:	Mr. L.A. Mandalia, UNESCO Representative
	Address by:	Dr. Z.W. Kundzewicz, WMO Representative
	Address by:	Prof. A. Herrmann, Representative German IHP/OHP Committee
9:30	Inauguration & Inaugural Address by the Chief Guest:	Dr. D.N. Dhungel, Secretary, HMG/N Ministry of Water Resources
9:40	Vote of Thanks:	Professor S.R. Chalise ICIMOD
9:45	*Refreshments*	

Session 1

10:15	Background to the Regional Working Group on Mountain Hydrology	S.R. Chalise
10:30	Report of the July 1995 Preparatory Meeting	L.A. Mandalia
10:45	The FRIEND Project: Conceptual Background	A. Gustard
11:30	Some Prospects of the Proposed FRIEND-HKH	A. Herrmann
11:50	Discussions	
12:05	Proposed FRIEND-type Project for the HKH	K.S. Yogacharya
12:45	Discussions on the Proposed FRIEND-Type Project	
13:00	*Lunch Break*	

Session 2

14:00 Continued:

a) Responses by Representatives of the HKH Countries (Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan)
b) Responses by Representatives of Collaborating Institutions (WMO, German IHP/OHP Committee GRDC, Slovak IHP/OHP Committee)
c) General discussions

15:30 *Tea*

16:00 Discussions and Finalisation of the FRIEND-Type Project Proposal

Day 2 - 24 March 1996 (Sunday)

Session 3

09:00 Discussions and Finalisation of Recommendations for the Implementation of the Hindu Kush-Himalayan FRIEND Project

a) Project Implementation: Identification of Priority Activities
b) Regional Working Group Membership
c) Project Secretariat

10:45 *Tea*

Session 4

11:00 Concluding Session

Chairman: Mr. Egbert Pelinck
Director General

Endorsement of Recommendations for Launching the Hindu Kush-Himalayan FRIEND

Annex 3
Proposal for Launching a FRIEND Project for the Hindu Kush-Himalayan Region

Submitted by
Kiran Shankar Yogacharya
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Proposal for Launching a FRIEND Project for the Hindu Kush-Himalayan Region

Background

The FRIEND (Flow Regimes from International Experimental and Network Data) Project is a contribution to the International Hydrological Programme (IHP) of UNESCO to facilitate research on understanding the hydrological behaviour of river basins located in different regions. FRIEND Projects are active in western, northern, and central Europe; the Mediterranean region; and western and southern Africa. The FRIEND Project is strongly supported by Phases IV and V of the IHP/UNESCO.

A preparatory meeting to launch a FRIEND Project for the Hindu Kush-Himalayan Region was held from 18 to 20 July, 1995, in New Delhi under the sponsorship of UNESCO, the International Centre for Integrated Mountain Development (ICIMOD), and the German IHP/OHP[1] National Committee. Delegates from Afghanistan, Bangladesh, China, Myanmar, and Nepal attended the meeting and agreed unanimously to launch a FRIEND Project for the Hindu Kush-Himalayan Region. The delegates then worked out a preliminary proposal. An interim working committee to finalise the proposal was also constituted by the meeting. The committee is comprised of Mr. Kiran Shankar Yogacharya (Interim Coordinator), Professor M.F. Bari (Interim Member), Mr. Ji Xue Wu (Interim Member subject to the approval of the Chinese Government), Professor S.R. Chalise (ICIMOD), Professor A. Herrmann (German IHP/OHP National Committee and European FRIEND), and Mr. L.A. Mandalia (UNESCO Secretariat).

The meeting also decided that the proposal would be circulated to the member countries for their comments and suggestions by 30 November, 1995. This proposal was formally presented at the Regional Workshop held in Kathmandu from 23 to 24, March, 1996. The workshop approved the principle of the project and authorised Mr. K. Shankar Yogacharya to continue as Interim Coordinator until the project proposal is finalised. The draft proposal presented at the workshop is given below. This proposal will be amended and refined according to the directives and suggestions of the participants at the workshop.

The Hindu Kush-Himalayan Region

The Hindu Kush-Himalayan region is a mountain range, 3,500km in length, stretching from Afghanistan in the west to China and Myanmar in the east. Developmental processes over the past few decades involved intensive use of natural resources and improper planning and management, resulting in rapid degradation of resources. Thus, the region is facing ecological and developmental problems along with widespread and deep-rooted poverty.

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[1] OHP means the Operational Hydrology Programme of the World Meteorological Organisation (WMO)

Natural factors that are causing land degradation in the mountains consist of steep slopes, unstable geology, floods, droughts, high speed winds, heavy precipitation, and so on. Among the several natural resources, water is one of the most important. In mountainous areas such as the Hindu Kush-Himalayan region, there is a great potential for developing and harnessing water resources, especially in the form of hydropower. This region is very rich in water resources. But to plan for development activities, hydrological data and information are needed on a long-term basis. This means that long-term hydrological investigation is essential before actual planning and designing of a water resources' development project takes place. To this effect, every country has some form of activity for collecting hydrological information. But, there is no mechanism among the countries of the region for exchange, even for the limited data and information available.

Rivers and river basins do not follow the national boundaries. Rivers may flow through more than one country. It is more significant to understand the hydrological complexities of such rivers and river basins on a catchment basis. Hence, the importance of regional collaboration in studies to understand the flow regimes of such rivers needs no explanation. It is too difficult to undertake such studies on a larger scale due to several limiting factors. It is, therefore, proposed that some small experimental catchments of the region for study under a FRIEND Project be selected in order to cover different physiographic and climatic zones of the region.

Name of the Project

The suggested name of the project is the 'Hindu Kush Himalayan Flow Regimes from International Experiment and Network Data' with the abbreviation 'HKH FRIEND .

Objectives

The general objective of the HKH FRIEND project is to create a common database in the Hindu Kush-Himalayan region to facilitate research into the hydrological behaviour of representative river basins located in different physiographic and climatic zones. On completion of the project, the common database will be made accessible to all the participating countries, thereby providing a valuable resource for future hydrological studies, particularly when data from two or more HKH countries are required.

The specific objectives of the project are enlisted below.

- To monitor the existing institutional framework and research project within the field of HKH FRIEND
- To locate all the hydrological and meteorological stations which could be incorporated into the HKH FRIEND project framework on a suitable common map
- To bring together existing datasets and catchment characteristics from the participating countries of the region
- To identify areas in which new hydrological and meteorological stations need to be established or existing ones rehabilitated with the aim of covering different physiographic and climatic zones of the region
- To analyse the database in order to develop procedures that will enable

local staff to estimate flood frequency and low flow relationships throughout the region
- To analyse snow/glacier melt contributions
- To use and develop rainfall-runoff models that will form a basis for more detailed design studies and to address problems of the impact of change in land use
- To train local staff in the above-mentioned fields

Participating Countries, Cooperating Organisations, and the Regional Centre

The Hindu Kush-Himalayan Region consists of eight countries, namely, Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan. Out of these countries, five countries who participated in the July 1995 meeting have agreed to launch a FRIEND Project in the region. It is hoped that the remaining countries will also participate in the Project. All these participating countries seem to have similar central agencies to the Department of Hydrology and Meteorology of His Majesty's Government of Nepal (DHM/HMG). These agencies collect, systematise, and publish hydro-meteorological data and information. It is envisaged that these agencies and non-government agencies will cooperate to provide data to the Regional Centre and to facilitate the establishment of new hydrological and meteorological stations or rehabilitation of the existing ones that are appropriate for the project to study.

The most appropriate body for the Regional Database Centre is the International Centre for Integrated Mountain Development (ICIMOD) in Kathmandu, which has representation from the countries of the Hindu Kush-Himalayan region.

Project Administration

The work of the Secretariat has so far been carried out jointly by ICIMOD and ROSTSCA/UNESCO. Hence, it is suggested that the UNESCO Secretariat for this project should be located at ICIMOD to ensure efficient project coordination and administration. The HKH FRIEND Project will be implemented primarily with financial support from UNESCO under the IHP. It is also expected that ICIMOD, Kathmandu, will be able to find some resources (probably in kind) to support the project. There is also a possibility that the other International Funding Agencies involved in FRIEND-type projects, including the German and Slovak IHP/OHP, can provide some form of assistance.

For project administration, a Secretariat for the Regional Database Centre has to be created. It is envisaged that this Centre will be operated within ICIMOD and will be headed by the HKH FRIEND Project Coordinator.

A Project Steering Committee (PSC), with representatives from the cooperating agencies, will be formed to facilitate collection of the existing datasets at the Regional Database Centre, to provide suggestions, and to provide expert manpower on an as and when necessary basis. The PSC

will be responsible for selecting gauging stations/catchments and suggesting establishment/rehabilitation of the stations for inclusion in the HKH FRIEND Project. The PSC will also invite experts engaged in similar FRIEND projects from other regions to its meetings to benefit from their expert advice. A simplified structure for project administration has been proposed as annexed.

The Programme

The HKH FRIEND programme will cover only those basins with catchment areas less than 500sq.km. and should be implemented in the sequence detailed below.

- All the existing hydrological and meteorological stations in the participating countries will be located on a reasonably scaled common map.
- Catchment characteristics of all these stations will be tabulated.
- Selection of basins for inclusion in HKH FRIEND will be made from the existing stations. If these stations are inadequate for the envisaged study, new gauging stations will be established or existing non-functional stations rehabilitated. This will be carried out giving due consideration to coverage of different physiographic and climatic conditions; the network will also include information on snow and glaciers.
- Detailed long-term data of selected existing stations will be collected and analysed. In the mean time, data from newly established/ rehabilitated stations will be collected. Even the short-term data from these stations will be used to complete the analysis. The database will be continuously updated.
- Different existing analytical tools will be used to conduct the analysis; and, based on the analysis, applicable models for the HKH region will be selected and developed.
- By conducting seminars/workshops, the necessary modifications/refinements of analytical techniques and models to be used for estimating hydrological parameters for the rivers of the region will be identified and disseminated to users, particularly in participating countries.

Such a study will require continuous data for at least five years. Considering the paucity of data available in some of the countries of the region, a provision for collecting data from newly established/rehabilitated stations is required. Thus, in the initial phase, the programme should be for a five-year period.

The time required for each of the steps tentatively considered above can be decided at meetings of the Project Steering Committee with the cooperation of experts engaged in similar FRIEND Projects in other regions.

Actions Proposed Prior to the Introduction of the HKH FRIEND Project

To realise the 'HKH FRIEND' project, certain preparatory activities were proposed for implementation between July 1995 and March 1996.

- Collect comments on the proposal from the five countries that have already agreed to participate in the project (by December 1995)

- Secure the consent/comments on the proposal from the three countries of the region that were not represented at the July 1995 preparatory meeting (by the end of December 1995)
- Finalise the proposal by incorporating all the relevant comments (by the end of February 1996)
- Secure approval in principle on the HKH FRIEND Project during the International Conference on Ecohydrology scheduled to be held from 23 to 28 March 1996 in Kathmandu
- Receive nominations for the Project Steering Committee from cooperating agencies from all the countries of the Hindu Kush-Himalayan region (by the end of April 1996)
- Assess the resources and funding for the project
- Continue the formal dialogue with UNESCO and ICIMOD to acquire logistics' and other support to house the Secretariat and Regional Database Centre within ICIMOD
- Appoint a Project Coordinator for the Secretariat

Budget and Detailed Workplan

The total project budget would depend on a number of factors; viz., resource availability, field activities, Regional Database Centre, and the Secretariat. Once the Project Steering Committee is formed, through a series of meetings and/or other types of interaction, a detailed workplan for the project period can be framed and the corresponding budget requirements for the field activities in each of the participating countries estimated.

Apart from this component, there are establishment and running costs for the Secretariat and Regional Database Centre. Since ICIMOD is likely to contribute, the detailed budgetting for this component of the project can be carried out in association with ICIMOD and UNESCO. The salaries and fringe and other benefits for the Project Coordinator and staff of the Secretariat, should be at par with those of ICIMOD staff. Office equipment, stationery, fuel, vehicle, and so on should be similar to those of FRIEND projects in other regions. Also, a lump sum budget will be required to hold the Project Steering Committee meetings.

Initially, a budget estimate and approval will be essential in order to establish and run the Secretariat and Regional Database Centre for one year in the preparatory phase. During this preparatory phase, the first and second steps of the programme, as outlined in this paper, will have to be completed and selection of catchments for inclusion in the project carried out. To do this, the Project Steering Committee meetings of the participating countries should take place more frequently. In addition, the PSC meetings will finalise the detailed workplan and budget for the next five years.

Annex 4
Implementation, Achievements and Further Plans for the Northern European FRIEND Project***

Alan Gustard

Abstract

This paper reviews the development of the Northern and Western European FRIEND (Flow Regimes from International Experimental and Network Data) project since its inception in 1985. The project was established by the International Hydrological Programme of UNESCO in order to improve international cooperation in research in regional hydrology. The paper describes the implementation and organisation of the project which is carried out by a steering committee with support from the project secretariat. Some of the problems associated with developing the project are described in the paper, together with a review of the achievements. A number of opportunities for further research in the areas of hydrological extremes, catchment modelling, and process studies are summarised.

*** *Published in 1995 in the Proceedings of the UNESCO IHP International Symposium on Rivers and People in Southeast Asia and the Pacific - Partnership for the 21st Century, pp 163 - 171. Tokyo: United Nations University.*
Minimal editorial inputs only have been carried out at ICIMOD.

Introduction

The FRIEND - Flow Regimes from International Experimental and Network Data - research programme is an international collaborative study in regional hydrology. It is a recognised contribution to UNESCO's Fourth International Hydrological Programme. The primary objective of the FRIEND project has been to improve the understanding of hydrological variability and similarity across time and space, in order to develop hydrological science and practical design methods. To achieve this, it has been essential to permit hydrological research to cross national boundaries. This has been carried out in two ways. First, by developing international hydrological databases of time series and spatial data, including catchment boundaries, climate, land use, and soil types held in vector or raster form. Second, by establishing project groups that could exchange models and analysis techniques and interpret the results using a common approach to analysing data derived from different hydrological regions. The FRIEND project was initially established in Northern and Western Europe (Figure 1), but groups have now been established in the Mediterranean and Alpine regions of Europe, in Southern Africa, and in West Africa and research programmes are being planned in the Hindu-Kush Himalayan region, in Asia, South America, and the Nile region. This paper reviews the development of the FRIEND project, summarises some of the achievements, and presents a forward look of how the project may develop.

Implementation

The Northern and Western European FRIEND project was initiated by the IHP committees of the U.K., Germany, The Netherlands, and Norway, who seconded full-time scientists for a period of three years to collaborate in an international project group based at the Institute of Hydrology in Wallingford. They were soon joined by hydrologists seconded for shorter periods from a number of European countries, and the project was supported by the provision of hydrological data from all European countries in the project area. The first phase of the project was completed in 1989. At this stage the database contained river flow data from 1,350 gauging stations from 13 countries in northern and western Europe. The second and third phases of the project have extended the geographical area to eastern Europe and increased the database to over 4,000 flow records from 17 countries.

FRIEND research is carried out by five individual project groups with approximately ten participants from different European countries in each group. The five projects established are:

- Database,
- Low Flows,
- Large-scale Variations in River Flow Characteristics,
- Techniques for Extreme Rainfall and Runoff Estimation, and
- Processes of Streamflow Generation in Small Basins.

These projects are overseen by the FRIEND Steering Committee which meets annually and is made up of country representatives, nominated by

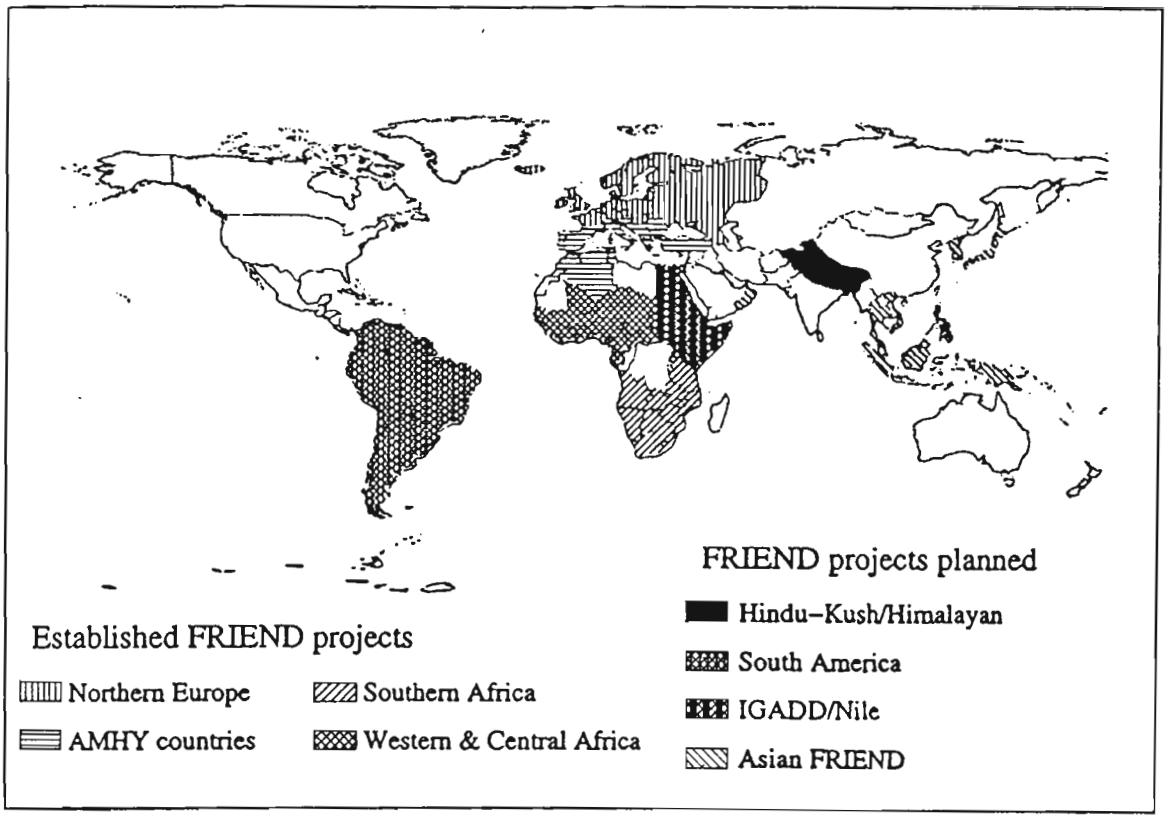

Figure 1: Global Perspective of FRIEND participation

national IHP committees, and representatives from UNESCO, WMO, GRID (the Global Resource Information Database of the United Nations Environment Programme [UNEP]), and the European Environment Agency. The project secretariat is based at the Institute of Hydrology and coordinates the activities of the project groups and provides administrative support to the steering committee.

Results of the FRIEND project have been presented in the proceedings of two conferences. The first was held in Norway in 1989 and was published in IAHS Publication No. 187 (Roald et al. 1989), the second was held in Germany in 1993 and published in IAHS publication No. 221 (Seuna et al.), a three-volume report has also been published (Gustard 1993). Key achievements of the project are summarised in the following passages.

Difficulties in Project Implementation

The establishment of the FRIEND project requires a lead organisation. The lead organisation introduces the project and solicits the support of at

least two other countries in order to develop an international research programme. It is often this first step which is the most difficult stage in the project, because it requires a financial and resource commitment from one country to a project which is dependent for its success on the active participation of other agencies. This is often perceived as a high risk in an environment where funds for hydrological research are limited. The second key difficulty is that of data security. The policy which has been approved by each international FRIEND group is that the common international database can only be used within the FRIEND project. There are understandable concerns that the transfer of part of a national data archive to a coordinating centre leads to a loss of control in terms of who has access to the data. Despite these early concerns, participating countries have contributed extensively to the database and safeguards on data security have been maintained over ten years. A third problem which must be addressed is that of agreeing on a common work programme using or developing common methods or models of analysis. There is also a need for good communications within project groups. This can be difficult if there are linguistic problems, and, if project groups include several members, there is an inevitable administrative overhead of communicating between FRIEND participants, in addition to that of supporting a steering committee. Finally, and inevitably, the resources available for the project will limit project activities, although resources from related ongoing national research programmes can be used to support the project.

Achievements of the FRIEND Project

The European Water Archive

A key achievement of the FRIEND project has been the development of an international hydrological database by collecting flow data from over 4,000 small research basins and national network stations from northern and western Europe. In addition, an inventory of catchment characteristics has been compiled using digital cartographic techniques by overlaying basin boundaries on vector and grid thematic databases. The European Water Archive has been a major focus of the project, initially in data archiving and subsequently in data analysis. Station details, flow statistics and time series' data are now held on an ORACLE database management system, while the vector and grid thematic data are held on an ARC INFO Geographical Information System.

Catchment and Regional Modelling of Low Flows

The low flow investigations have ranged from physically based and conceptual modelling studies to multivariate low flow studies on regional and European scale. The groundwater modelling studies identified the importance of catchment hydrogeology in controlling the detailed spatial variation in low flows. Simple distributed models and single cell models have been used to show that there is no dominant model parameter controlling low flows, and they were also used to assess the impact of groundwater pumping on low flows. The impact of coniferous afforestation was evalu-

ated by using two different rainfall runoff models, both of which demonstrated a decrease in the mean and low flows following afforestation.

The detailed modelling studies of individual catchments were complemented by three regional investigations. In the U.K., a twelve class classification of soils was used to predict the mean of the seven-day annual minima and the flow duration curve at the ungauged site. In southwest Germany, a hydrogeological index was developed from a knowledge of the hydrogeology of different rock types. This was based on 14 classes (compared to 12 in the U.K.) using observed flow data from 58 catchments and enabled a method to be developed for estimating base flow at ungauged sites. In order to develop a consistent procedure on the European scale, a digital European soil map was classified into nine groups and related to the Base Flow Index (BFI), the 95 percentile from the flow duration curve, and the 10- and 180-day mean annual minima.

Large-scale Variations in River Flow Characteristics

The overall objective of this sub-project was to define and map spatial and temporal patterns in river flow regimes in northern and western Europe. Work focussed on the definition of representative flow regimes, the presentation of runoff data on a grid, and the examination of temporal patterns in flow regime class and seasonal runoff volumes. Two different approaches have been adopted in the project to present average annual runoff on a grid framework. The first was based on objective methods for statistical interpolation along a river network, by analogy with the procedures used to interpolate meteorological observations. Several variants of this approach were examined using data from southern Norway. The second approach was based on producing a 'mosaic' map of runoff depth by catchment area and superimposing a regular grid to calculate grid cell averages. This approach was implemented using data from western Europe. A map of average annual runoff for the whole of Europe at a resolution of 0.5 × 0.5 was also produced, using a range of methods.

Floods

Both flood frequency analysis and rainfall/runoff analysis methods of flood estimation were reviewed in the FRIEND project. The index flood method seems basically to be a sound and robust approach, provided homogeneous regions can be established. This method is not very sensitive to change in estimation methods and yields comparable results for climatically similar regions in Norway and Britain. It can be difficult to apply in boundary zones between regions. Both Czech and Norwegian experiences indicate that estimating flood statistics by regression on catchment characteristics alone can lead to large errors. French methodology for flood estimation has for a long time been based on a combination of rainfall and runoff flood frequency analysis. The AGREGEE development of the traditional GRADEX method yields smoother and more plausible growth curves. The choice between possible transition models from the observed flood frequency growth curve to the asymptotically limiting rainfall growth rate is primarily based on considerations of the robustness and stability of the results.

Physical Processes of Streamflow Generation in Small Basins

The project is developing closer links between field workers and physical hydrologists and mathematical modellers. It is very important that contact be encouraged between those whose work is 'data-driven' and those whose approach is rather more conceptual. The development of models (and the correct interpretation of their results) requires a proper understanding of the physical processes operating in the system of interest. Similarly, there is little point in site-specific empirical studies without the development of conceptual (even if not mathematical) models of the processes operating and how they change and interact. It is hoped that the inventory of small research basins, which was published in the FRIEND report, will stimulate a more integrated approach to research basin studies.

Directions for Further Research

Low Flows

There is a need for further research to improve understanding of the interaction between hydrogeology and low flows. It is proposed that groundwater models be applied to a number of catchments with contrasting climate, land use, soil type, and hydrogeology, using observed precipitation, evaporation, streamflow and estimated transmissivity, and storativity. A subsequent sensitivity analysis would enable a better understanding of the dominant processes which influence the low flow regime of rivers in different climate and hydrological regions. Improvements in indexing the influence of storage characteristics (hydrogeology and lakes) on low flows is one of the main areas of research which will lead to improvements in relating low flows to basin properties and enable practical design techniques to be used with greater confidence. Although studies of the impact of land-use change on streamflow response has been a major research area, the further extension of this work to provide design techniques for estimating the impact of afforestation on low flows is a high priority. This work could usefully include the calibration of a simple conceptual model at a large number of sites to provide a readily available and consistent technique for estimating the time series of flows across the study area. The final recommendations for further research relate to the spatial and temporal variability of droughts and are important in the context of identifying changes in low flow regimes. Further work needs to be done on defining indices of drought and describing the temporal variability of these indices and the spatial coherence of droughts, as well as the relationship between droughts and synoptic weather patterns and catchment hydrogeology.

Large-scale Variation

Further research is warranted in a number of areas. First, flow regime classifications need refinement to discriminate better between Atlantic and south European flow regime types. It will be necessary to use daily data or at least some key statistics derived from daily data and to explore further

the use of statistical clustering tools. Second, the theoretical and practical issues posed by the use of objective methods for the interpolation of runoff along a river network need to be further addressed. Third, the method for producing grid maps based on overlaying a grid on a mosaic map of catchment runoff needs to be refined and applied to seasonal and monthly data. It could also be used to present time series of monthly or seasonal data in order to portray the spatial evolution of, for example, a drought. Finally, and most generally, there is a clear need for investigations into the links between atmospheric circulation patterns and hydrological regimes.

Techniques for Extreme Rainfall and Runoff Estimation

The flood studies in the first FRIEND project period focussed primarily on identifying and describing characteristic regional patterns in the flood regimes of northwestern Europe, with the index flood method as the basic analytical approach. The second and third phases have been devoted to the description and comparison of some of the different methods and approaches in development and use in the region. The logical continuation of the work is to systematically test and compare the methods on the regional dataset. Such comparisons will throw more light on the strength and weaknesses of the different methods, and they would be an important step in the difficult process of establishing optimal methodologies for combining information from flood and rainfall series, catchment characteristics, and regional information. There is hardly any doubt that methods that combine all available information hold greater potential for the difficult task of reliable extrapolation of flood frequency curves to the high return periods and for flood estimation at ungauged sites. More research on how to integrate the physics of the rainfall/runoff process in this transition would strengthen the confidence in the model extrapolations and enhance the transferability of the method to other hydrological regimes.

Physical Processes of Streamflow Generation in Small Basins

This project brought together the knowledge (both conceptual and data) from a wide range of basin studies and research workers in countries across western and northern Europe. This has involved compiling an international inventory of small basin studies (FRIEND Vol. III); the important criteria for inclusion being that they provide measurements and understanding of hydrological processes. In addition to standard hydrological records of precipitation and streamflow, there were additional measurements in each basin, such as soil water conditions (contents and fluxes) and water quality parameters (such as chemistry and isotope concentrations), which help to develop an understanding of water pathways and residence times.

One important new initiative is to extend the FRIEND concept to ecohydrology and progress has been made in establishing a European group in this area. The group will use a physical habitat simulation model (PHABSIM) developed by the U.S. Fish and Wildlife Service. Opportunities will be explored for cooperative software development, carrying out sensitivity analysis of changing flow regimes on habitat availability in Eu-

rope, and, by comparison with detailed habitat investigations, evaluating the potential for producing regional relationships between species preference and hydraulic parameters.

Development of Links with Other International Programmes

At the outset of the FRIEND project, it was considered important to maintain close links with related international research programmes. For example, this included the World Meteorological Organisation and the European Union's CORINNE programme which produced digital spatial data and includes flow archives for Europe and the European Research Basin network. More recently, the newly-established European Environmental Agency has been assisted by the network of FRIEND organisations with experience of cooperation in the area of surface water. The establishment of the Global Runoff Data Centre at Koblenz in Germany can also be assisted by close cooperation with FRIEND database development. Opportunities exist for input from regional FRIEND groups into the WMO WHYCOS programme which is aimed at developing real-time data collection programmes. For example, FRIEND could provide both experience and software for the analysis and display of real-time data in the context of historical flood and drought frequencies. The United Nations Environment Programme, through their GRID (Global Resource Information Database) project, has also expressed an interest in following developments in FRIEND data and analysis techniques. There are clear benefits to both the FRIEND project and national and international operational and research projects in developing closer links.

Conclusions

The FRIEND project has demonstrated many of the advantages of international cooperation in hydrological research. First, by using the resources of large project teams, it has been possible to assemble extensive international databases. Second, models, analysis techniques, and particular specialisations from different countries have been applied to this data. Third, regional studies have benefitted from applying analysis techniques to datasets not constrained by national boundaries and from using research basin data which provided most of the data from small basins. Finally, the project has brought together hydrologists with different experiences ranging from hydrogeologists to regional surface water hydrologists.

The understanding of hydrological variability and similarity on a regional basis has improved considerably due to the work of the FRIEND project. The application of regional datasets in hydrological analysis has brought about an improved appreciation of hydrological behaviour and contributes significantly to the characterisation of flows at ungauged sites. Introduced in 1985, the FRIEND project originally involved 13 nations in northern and western Europe. The growth of interest in the FRIEND project has been such that now over forty countries collaborate in the research activities of the four international FRIEND research programmes. FRIEND was recently designated Project 1.1 of IHP-V for adoption by the Intergovernmental Council of UNESCO's IHP in February 1995, and it is antici-

pated that this will encourage further developments in the scientific and geographical extension of the international research programme.

Acknowledgements

The author would like to thank all the participants of the FRIEND research programmes on which this review is based. In addition, I would like to thank all the research institutes, universities, and operational hydrological organisations who provided both research facilities and data for the project. The opinions expressed here are those of the author and not necessarily those of the Institute of Hydrology.

Annex 5
Some Prospects of the Proposed FRIEND HKH

Andreas Herrmann

Background

The Hindu Kush-Himalayan (HKH) region, extending over 2,500km and 3.4 million sq.km. from Afghanistan in the west to Myanmar in the east (Chalise 1993), is an important fresh-water reservoir for the lower altitudes and also the source area of some major rivers of the world and their tributaries, e.g., the Indus, Ganga, and Yarlung-Tsangpo-Brahmaputra. Population pressure in the region, where the present population of more than 120 million is expected to double after 35 years, is already tremendous, thus causing both considerable socioeconomic and environmental problems.

In this context it is really remarkable that the supply of drinking water, for instance, is a most serious problem, not only in the urbanised but also in the extended rural areas of the region, and lack of electricity is a main obstacle to improvement of living conditions. As a matter of fact, only a negligible fraction of the theoretical hydropower potential, which amounts to 83,000 MW in Nepal alone (Gyawali 1989), is actually being used, e.g., 235 MW in Nepal in 1990 (Chalise et al. 1993). The same is true for the river flows from the Himalayas, which altogether are estimated to amount to 8,634km^3 per annum. Such facts indicate the various kinds of serious water problems in the Hindu Kush-Himalayan region and also in the piedmont alluvial plains, which, of course, are of vital significance to the population. As a consequence, one should also recognise that environmental problems, which are often interrelated with quantitative and qualitative water problems, and their solutions are frequently considered to be of secondary importance in the region itself.

With regard to hydrology, which is the main topic here, the HKH shares several common problems with rapidly developing mountainous regions, and these have been summarised comprehensively by Shankar (1991). They include:

- lack of a reasonably accurate assessment of water resources; mainly because there are no consistent and dense hydrological and climatological networks in extended remote areas and difficult terrain—these problems are frequently combined with a need for more experienced authorities and well-trained staff;
- deficits in knowledge of relevant hydrological processes;
- considerable human impacts which are, in this context, mainly due to factors of poverty and rapid population growth;
- frequent hydrological disasters which can hardly be controlled, e.g., cloudbursts and flashfloods, glacial lake outburst floods, rock and landslides, debris flows, and soil erosion;
- considerable bedload transportation, outburst, and deposition;
- degradation of water quality; and
- need for knowledge and information (transfer) and expertise along with tackling the specific problems caused by technology transfer from the

plains to the mountains without considering different boundary conditions (not specific for developing countries alone).

As emphasised by Chalise (1993), the controversial discussion of highland-lowland relationships, as far as the impacts of degraded uplands on lowland flood generation are concerned, shows the need for proper hydrological investigation and data acquisition across the HKH; including assessment of relevant processes and downstream impacts. Reduction of uncertainty with respect to adequate management of water-induced hazards and water resources and their sustainable development remain major tasks for the HKH region.

However, despite a general lack of basic hydrological, climatological, and long-term data series compared to most developed countries, one should realise that the data situation is not too bad at all in the HKH region. Nevertheless, lack of long-term data and a reliable database for the hydrological core regions of windward slopes and glaciated and snow-covered high altitudes makes it difficult to reliably assess the impacts of climatic warming on hydrology, water resources, and the related development of complex mountainous environmental systems.

As a consequence, the following would encourage the HKH countries to commence regional cooperation in the field of regional hydrology immediately by using the FRIEND idea as a basis for developing their own strategies.

Some Aspects of a Basic Framework for a Regional FRIEND HKH

A regional FRIEND (Flow Regimes from International Experimental and Network Data) project could help to intensify regional cooperation and facilitate systematic collection and documentation of hydrological and catchment data. This optimistic prognosis is mainly founded on existing scientific and practical know-how, data availability, and the administrative and experimental infrastructure and experience in the region itself compared to other regional FRIEND programmes such as the Northern and Western European (NWE) FRIEND core project, the Alpine and Mediterranean Hydrology (AMHY) project, and the recently established Western (WA) and Southern African (SA) FRIEND projects.

The HKH region can be proud of its Working Group (WG) on Hydrology which met for the first time in December 1989 in Kathmandu. After five meetings and extended and careful preparations, it is time now to launch a FRIEND-type programme within the framework of the Regional Working Group (RWG). A favourable condition is the offer made earlier by the International Centre for Integrated Mountain Development (ICIMOD) in Kathmandu, Nepal, to host the project's secretariat and database centre. Considering the close regional cooperation between ICIMOD and UNESCO under its IHP programme (Chalise 1993), this is encouraging.

There are several hydrological (and climatological) agencies in the HKH member countries (Shankar 1991), although gauging networks are as yet insufficient. Apart from Bhutan, however, the regional countries have a number of competent authorities.

Climatological and hydrometric networks are extremely sparse in mountainous areas. On the other hand, information (see Alford 1992) on relevant hydrological aspects of the HKH region is available. The data on sediment transport, quantity, and quality are quite substantive, at least for certain stations and regions. Alford's study is largely confined to macro- and meso-scales, thus leaving out the micro-scale on which study is necessary in order to understand environmental systems, including hydrological sub-systems.

A special case in this context is Afghanistan which, since the early eighties, has been affected by continuous abandonment and even destruction of the climatological and hydrometric networks that were established from the fifties to the early seventies. Today, even Kabul airport does not have functional meteorological equipment, and most of the 150 hydrometric stations are in a deplorable state. Therefore, hydrological and meteorological services in this country will have to be reintroduced: basic measuring and data processing and documentation equipment, staff education and training, and expertise on water resources' assessment and local water supply systems are essential. For complete rehabilitation of hydrological and meteorological services, a tremendous international effort is necessary. A FRIEND Project in the HKH could make a substantial contribution to the amelioration of this situation.

There are some very promising and encouraging examples, for instance, the undertaking of HMG/Nepal's Department of Hydrology and Meteorology in cooperation with the German Agency for Technical Cooperation (GTZ) to set up a special Snow and Glacier Hydrology Unit (SGHU) in 1987 (Grabs and Pokhrel 1993). Today, the SGHU has staff, modern data acquisition and processing systems' equipment, and six small, glaciated high-mountain pilot basins of 148-725sq.km. located above 2,600-4,375masl. Similar basins are already available in most other HKH countries (Chalise 1993), or could at least be launched by following specific criteria which do not necessarily need to follow the regulations of the other regional FRIEND projects.

Finally, apart from the national hydrological and climatological services, the numerous state research and university institutes in the HKH region are willing to contribute their rich resources in know-how, staff, and scientists and contribute to the establishment of a regional FRIEND project within the given RWG. It seems that there is a surprisingly large number of small-scale hydrological research and monitoring activities within the region. One of the important initial activities to be undertaken by a regional FRIEND group is, therefore, a region-wide enquiry to assess the information and databases available. The following European experience is meant to give an example of the possibilities of small-scale hydrological research and monitoring activities.

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Small Basins' Inventory: The Case of ERB-ICARE

A European Network of Experimental and Representative Basins (ERB) was recommended by the European Council and established in 1986. The main objectives of the ERB network are to (i) increase relationships between members, research teams, and basin managers through exchange of information, visits, and meetings; and (ii) to facilitate joint operations of common interest between members. Information is disseminated through the ERB Newsletter Bi-annual, and the ERB Conference (together with the General Assembly) takes place every two years.

The ERB Steering Committee (SC) meets once a year. It consists of national correspondents nominated by the national UNESCO-IHP committees and is chaired by the ERB coordinator.[2] The following 13 countries are members of ERB: Belgium, The Czech Republic, France, Germany, Italy, The Netherlands, Poland, Romania, Russia, Slovakia, Spain, Switzerland, and The United Kingdom. ERB has cooperated with other international programmes such as FRIEND of the UNESCO-IHP. Several ERB SC members are also members of the NWE or AMHY FRIEND SC.

The network's core tool is the research basin inventory ICARE (Inventory of Catchments for Research in Europe) which is located in France.[3] ICARE is a relational database which is continuously being updated. It consists of these entities: ERB codes (nos. of attributes: 1-7), objectives (8-26), administration (21-29), station (30-34), data (35-40), equipment (41-46), hydrology (47-55), geomorphology/morphometry (56-60), geo-biochemistry (67-74), and updating (75-76). Accordingly, ICARE gives information on anything of interest on management and administration; research objectives; basin physiography—including geology and soils, instrumentation, and water quantity and quality; data availability; maps; and publications.

The responsibility of proposing which basin should be included in ICARE remains with the member country. Access to ICARE is open to scientists from member countries, provided that the information is for scientific use only, and information is free of charge. In future, an interactive (telemetric) database systems' access is planned.

One major prospect for similar regional databases is easy documentation of all or selected information stored about research activities on a small basin scale. Examples for multipurpose use are (i) planning of multilateral cooperation in education, research, monitoring and expense, regionalisation tasks, (ii) assessment of research potentials, (iii) staff and equipment, (iv) orientation for potential donors, and so on. Therefore, the German National IHP/OHP Committee has recently decided to update the German basin inventory which was established under its auspices. It is available in hard copy only (IHP/OHP 1983). East German research basins are not included.

Option for Operational Hydrological Reference Basins

With respect to the need for more practical hydrological networks for small basins, the following suggestions are made by Spreafico (1994), to be applied in the initial stages of the FRIEND HKH project. Table 1 gives a rough idea of the two different subtypes of Small Hydrological Basins (SHB):

viz., Hydrological Research Basins (HRB) and Operational Hydrological Reference Basins (OHRB), with the specific tasks, aims, and requirements.

Table 1: Criteria for different small hydrological basins

Operational Hydrological Reference Basins (OHRB)		Small Hydrological Basins (SHB)		Hydrological Research Basins (HRB)
Long term	←	Operation period	→	Short term
A few with a high degree of accuracy	←	Number of observation parameters	→	A large number of detailed investigations
As little staff as possible	←	Requirements of time, costs, and staff	→	Depending on the aim of the research
Operational hydrological service	←	Operating body	→	Research institute

Source: Spreafico 1994

In the case of the HKH region, with its rather restricted number of small hydrological study basins, compared to the situation in Switzerland to which the study by Spreafico (1994) mainly refers, a similar focus could be used to propagate combined operational (including monitoring) and scientific purposes in order to increase the benefits from costly observations, investigations, and maintenance. Since the responsibility for running such basins would be first of all in the hands of operational services, continuity of important hydrological data series would be guaranteed as well as permanent access to the basins for researchers. In the meantime, it has been agreed that at international, national, and medium-term levels, a strategy, which aims at bringing research and practice closer to each other, is desirable, especially for the International Hydrological Programme (IHP) of UNESCO and the Operational Hydrology Programme (OHP) of WMO.

As a result, to take such considerations into account, a newly-established regional FRIEND project is strongly recommended, particularly as profit from small multipurpose basins is out of proportion. This is also due to the fact that basic observations of hydrological variables, including sediment transport, which is explicitly mentioned by Spreafico (1994) as a routine task of operational authorities, and assessment of basic physiographic basin parameters; considering variability as a common task of both scientific and operational basin approaches; are essential.

Propagating a Regional FRIEND in the Hindu Kush-Himalayas (HKH)

In view of the main results of the Fourth Consultative Meeting/Workshop of the RWG in New Delhi in July 1995, which are summarised in Figure 1, one believes that a regional FRIEND in the HKH will fulfill several basic requirements for solving some of the regional problems mentioned in the beginning. This expectation is above all due to the fact that the country representatives have really focussed on major regional deficiencies and problems in making the regional project proposal which has just now been accepted during the March 1996 Workshop (cf. Figure 1, Annex 4).

Database project (1) as a core task, small research basins' establishment practices, (2) definition and assessment of hydrological regions, (3) application of existing and development of new rainfall runoff models if necessary, (4) a snow and glacier hydrological project component, and (5) which can profit from of the experiences of SGHU at the Department of Hydrology and Meteorology (DHM) in Kathmandu and from many other similar and famous institutions in the region which specialise in this important hydrological field. Finally, the training component (6) is considered to be most important to meet the need for experienced and qualified field and indoor staff.

By taking the experience of the other regional FRIEND projects into account, one can expect substantial progress in problem and project definition and handling from the beginning, once the project is established, provided that well-elaborated terms of reference and a workplan exist. Furthermore, according to Bullock et al. (1996) the potential benefits of participation in a regional FRIEND will encourage research groups to join it.

Creation of international time series' databases comprised of new consistent, regional spatial databases; data exchange facilities across administrative and international borders; basic software exchange and upgrading in national services and authorities, research centres, and university institutes; knowledge and technology transfer for theoretical considerations, i.e., mathematical modelling; experimental measuring and network design practices; exchange of hydrological models; comparison of statistical methods for predicting hydrological extremes (floods, low flows); short-duration training courses; scientific exchange visits of short to long duration; scientific meetings; and workshops and regional conferences are among the benefits to be realised.

A regional FRIEND HKH project will give the existing regional cooperation a new quality. Therefore, it is strongly recommended that the proposed project draft outlined in Figure 2 be followed, developed, and fulfilled through substantial working results. In this case, the worldwide growing FRIEND family will feel proud of its new member.

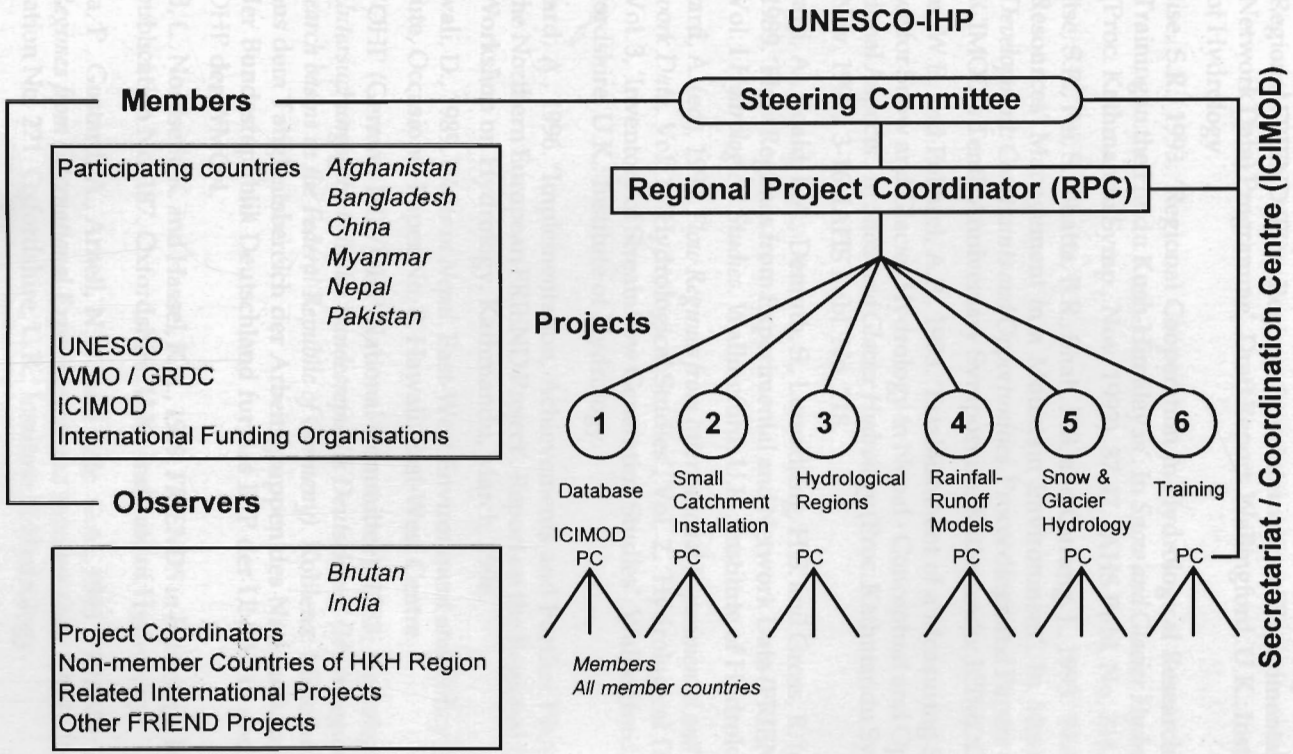

Figure 2: Organisational structure of the future FRIEND HKH project as developed during the 4th RWG, HKH Consultative Meeting, New Delhi, July 1995, taking into consideration the outcome of the March 1996 launching of the project at the RWG, HKH Workshop in Kathmandu

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Acronyms

FRIEND	- Flow Regimes from International Experimental and Network Data
GRDC	- Global Runoff Data Centre
IHP/OHP	- International Hydrological Programme
DHM	- Department of Hydrology and Meteorology
WMO	- World Meteorological Organisation
WHYCOS	- World Hydrological Cycle Observing Systems
ROSTCA	- Regional Office of Science and Technology for South and Central Asia
AMHY	- Alpine and Mediterranean Hydrology
GRID	- Global Resources' Information Database
AGREGEE	- Adaptation du modèle du Gradex à toutes crues Rares et Extrême par Généralisation de ses Estimateurs Elémentaires
GRADEX	- "Gradient exponentiel," flood frequency extrapolation method
IAHS	- International Association of Hydrological Sciences
ERB	- Experimental and Representative Basins.
ICARDA	- International Centre for Agricultural Research in Dryland Areas
THHUND - FRIEND	- Trans Himalayan Hindu Kush United Network for Hydrological Data.

ICIMOD

Founded out of widespread recognition of degradation of mountain environments and the increasing poverty of mountain communities, ICIMOD is concerned with the search for more effective development responses to promote the sustained well being of mountain people.

The Centre was established in 1983 and commenced professional activities in 1984. Though international in its concerns, ICIMOD focusses on the specific, complex, and practical problems of the Hindu Kush-Himalayan Region which covers all or part of eight Sovereign States.

ICIMOD serves as a multidisciplinary documentation centre on integrated mountain development; a focal point for the mobilisation, conduct, and coordination of applied and problem-solving research activities; a focal point for training on integrated mountain development, with special emphasis on the assessment of training needs and the development of relevant training materials based directly on field case studies; and a consultative centre providing expert services on mountain development and resource management.

ICIMOD WORKSHOPS

ICIMOD Workshops are attended by experts from the countries of the Region, in addition to concerned professionals and representatives of international agencies. A large number of professional papers and research studies are presented and discussed in detail.

Workshop Reports are intended to represent the discussions and conclusions reached at the Workshop and do not necessarily reflect the views of ICIMOD or other participating institutions. Copies of the reports, as well as a Catalogue of all of ICIMOD's Publications, are available upon request from:

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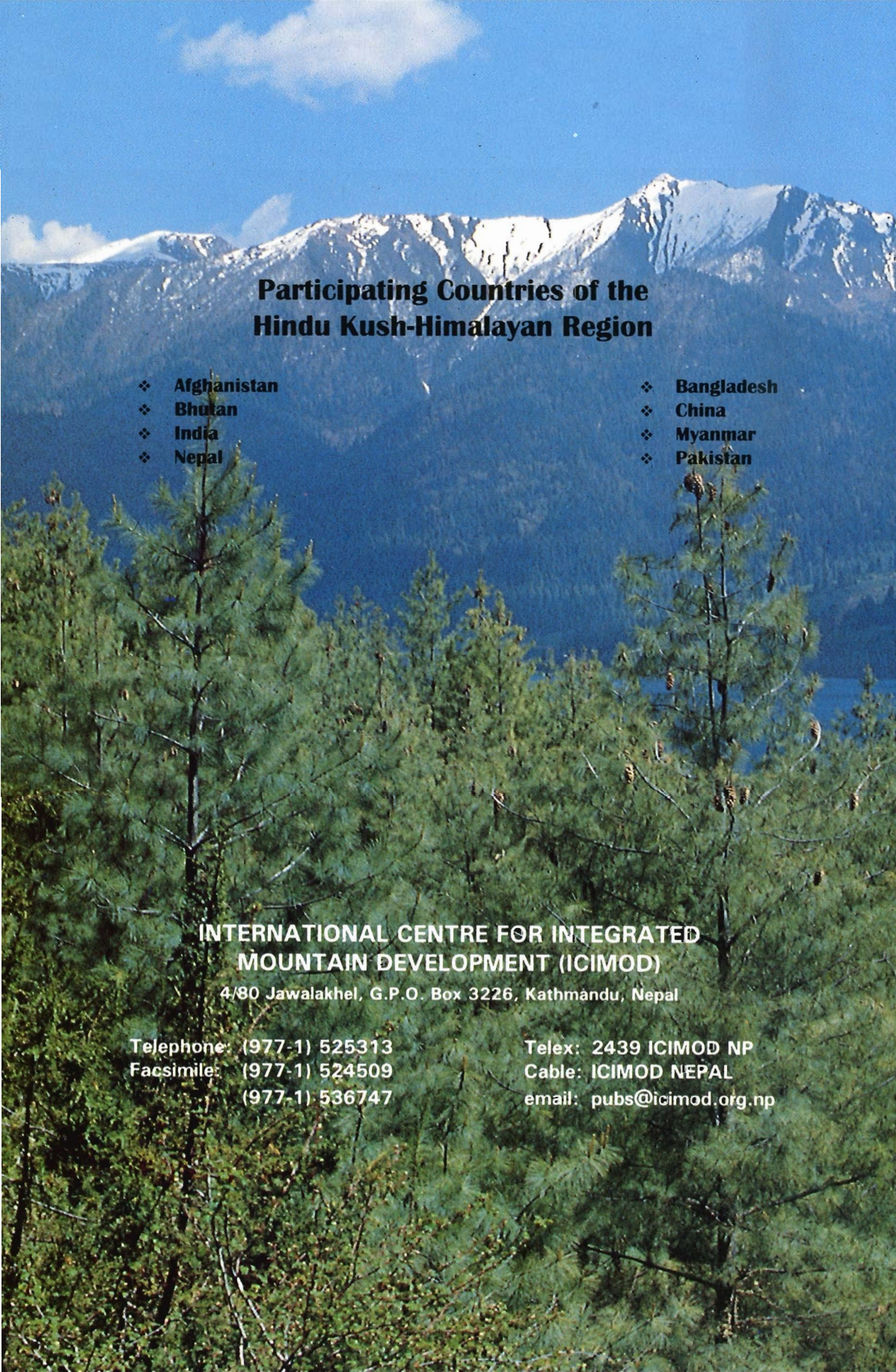

Participating Countries of the Hindu Kush-Himalayan Region

- Afghanistan
- Bhutan
- India
- Nepal
- Bangladesh
- China
- Myanmar
- Pakistan

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