FRIEND FLOOD MAPPING

This document sumarises a mapping of the FRIEND activities related to the flood programmes. FRIEND has eight regional groups: Northern Europe, Alpine and Mediterranean-AMHY, Latin America and Caribbean-AMIGO, Southern Africa, West and Central Africa-AOC, Asian Pacific, Hindu Kush Himalayas and the Nile basin group and some of these groups do flood research at the regional level.

The FRIEND project has established close links with WMO's Commission for Hydrology programme on disaster mitigation on floods. This will be a contribution to the joint UNESCO-WMO-IAHS International Flood Initiative (IFI). Mapping FRIEND flood activities will help in identifying the action points within IFI.

Among these, six groups deal with flood issues: Northern Europe, Alpine and Mediterranean-AMHY, Latin America and Caribbean-AMIGO, Asian Pacific, Hindu Kush Himalayas and Nile basin group

A scan through all regional FRIEND flood activities should provide the description of the activities that are being carried out by each regional group in respect of expected outputs and different areas given in the IFI concept paper (annex B).

Based on the inputs from all regional FRIEND groups (Annex C), engaged in each of the expected products (Annex B), an analysis of the interlinkages of various activities is provided, as well as the gap analysis was carried out. The expected outputs of the IFI (Annex B) consist of the short term, medium and long term products. They are related to research, education and training, information networking and technical assistance.

"Methodologies for reliable inundation mapping" is foreseen medium term product related to research (Annex B). HKH-FRIEND contributes on this product through flood risk maps and vulnerability maps. The basic methodology is using GIS and remote sensing data to map flood risk vulnerability. A project on "flood risk and vulnerability mapping using GIS: a case study from Ratu River in Central Nepal" has been recently completed (Annex C).

Three regional FRIEND groups have been contributed on the medium term product "improvement of combined physical and stochastic distributed hydrologic models for more reliable real-time runoff forecasting" NE-FRIEND, AMHY-FRIEND and HKH FRIEND. NE-FRIEND group, through its project "Techniques for extreme rain fall and flood runoff estimate" gave solutions on real-time runoff forecasting using robust methods of real-time forecasting and simulation of flood-runoff and flood inundation taking into account parameters for snow melt and others relating to cold climate conditions. Calibration and validation of flood inundation models depended of boundary conditions including snow data input. Frequency estimate of peak flows and mode standing of runoff generation process was the common methodology for all three FRIEND group in real-time runoff forecasting. It has been noted that AMHY-FRIEND and HKH FRIEND did hydrological modelling using

different time scale and different climatic and morphological features. FRIEND-AMHY group insisted in stochastic modelling of heavy precipitation for runoff forecasting. Apparently, these three working groups underestimated the importance of identification of methods how to deal with uncertainty. Working with an error model should be included in real-time forecasting as well as using subcatchment data for simulations when dealing with large catchments in order to avoid the mentioned gaps, HKH-FRIEND group had started the project "Regional cooperation for flood forecasting and information exchange "where the principal idea is exchange real-time hydrological data from many pilot stations situated in 5 neighbouring countries.

"Risk assessment methodologies, risk management tools and risk communication (for objective and subjective risks)" has been elaborated within NE-FRIEND Asian Pacific-FRIEND and AMIGO-FRIEND flood working groups. Asian Pacific-FRIEND evaluates risk through the relation between land use change including increase of urbanized area and flood risk. Also the impact of urbanization on the hydrological cycle is part of the evaluation methodology. Flood frequency analysis is the common methodology for all 3 groups in flood risk assessment. Frequency estimate of peak flows is the most advanced within NE-FRIEND (Annex C). AMIGO-FRIEND is the most concerned about risk management tools. One of the most sophisticated risk management tool is hydrological and physiographic database which permits vulnerability and risk analysis. Quality control of the available information should be improved in risk assessment by all working groups.

"Probabilistic laws for non-stationary extreme events under changing environment (climate variability and change, land use and population change)", an output related to research (Annex C), is evaluated within FRIEND-AMHY's project "Extreme events". Research objective is to understand hydrological variability and similarly across time and space and to compare the rainfall - runoff dynamics of extreme events in drainage basins with different climatic and morphological features. The research is based on flood events in experimental basins of AMHY countries. The FRIEND/Nile project flood frequency analysis is also dealing with probabilistic laws for non-stationary extreme events, but the basic methodology is comparison flood frequency curves, produced as a result of flood runoff modelling under different environmental conditions (climate, land-use, population change).

A result of interlinkages between the activities of AMHY-FRIEND and FRIEND-Nile projects is enhanced knowledge transfer and exchange of data among different countries. Enhanced methodologies for probabilistic laws for extreme events research are recommended.

AMHY-FRIEND, HKH-FRIEND and FRIEND-Nile play an important role in research on long-term product "tools for warming and forecasting of ungauged basins. The term tools cover: data assimilation, downscaling and remote sensing.

Both, HKH-FRIEND and FRIEND-Nile aim to develop procedures for estimating floods at ungauged basins. HKK-FRIEND intends to develop regional design procedures for such estimation. Forecasting of ungauged basins is elaborated also within FRIEND-AMHY group. Such research is based on distributed rainfall-runoff models for flood estimation is ungauged basins.

Apparently, within research of all 3 group methodology for flood forecasting are developed. But progress on data assimilation and remote sensing is till missing.

HKH-FRIEND contributes on research and the expected output "methodologies for reliable inundation mapping" though flood risk maps and vulnerability maps. Achievements on those researches had been disseminated during a national "Seminar on flood risk and vulnerability mapping of the Ratu River Basin".

The above-mentioned research project of HKH-FRIEND ended by detailed socio-economic survey and institutional set-ups in the watershed.Such complete research allowed HKH-FRIEND to have the main results on short term products "establishment for flood susceptibility indicator based on community vulnerability and resiliency" and "improved methodologies for estimating flood benefits and flood damages for various land uses". This FRIEND group intends in future to carry out flood studies in order to mitigate flood damage. It is recommended to:

-identify community based disaster mitigation activities to reduce loss of life and property

-develop a coping mechanism and implementation of structural and non-structural measures for flood disaster mitigation.

"A case study from Ratu River in Central Nepal can serve as a main lead project to meet medium term product "understanding trade-offs between structural and non-structural flood management measures under different socio-economic conditions".

Asian-Pacific FRIEND group should provide the best contribution on "enhanced understanding forecasting and management of flash floods in urban areas". The main objective of this research group is to define the relation between land use change including increase of urbanized areas and flood risk, and also to evaluate impact of urbanization on hydrological cycle. Research is based on Rainfall-runoff models with parameters related to impermeable areas and flood frequency analyses. It is recommended that FRIEND-Asian Pacific make contribution in future on medium term product:

"Understanding flood anthropology for the description of traditional technologies in flood management".

Current plan of this FRIEND group is to improve design of flood processes based on data collected in Asia Pacific countries.

The expected long term outputs related to "improved medium term flood forecasting incorporating medium and long term weather prediction" are significantly elaborated within AMIGO-FRIEND group.

This research group aims to establish though the Internet a service of probabilistic evaluation of maximum hydrological variables.

Also, group aims to support the work of meteorological and hydrological services in extreme hydrological situations.

The most important task for this group will be to improve knowledge of the hydrological processes linked with heavy rains. Their contribution is significant for the expected outputs of the IFI related to education and training.

The contribution of all FRIEND regional groups to expected outputs of the IFI is sumirazed in the following table:

Regional FRIEND groups	NE FRIEND	FRIEND AMHY	FRIEND AMIGO	Asian Pacific FRIEND	FRIEND Nile	FRIEND HKH
Research	X	X	X	X	X	X
Education and training	X	X	X		X	
Information networking	X	X	X		X	
Technical assistance	X	X		X		
Empowering Communities						

ANNEX A

Northern Europe – FRIEND

Within Northern Europe FRIEND there are five research groups. One group works in the field of flood. The name of the research project is: 'Techniques for extreme rainfall and flood runoff estimation'.
Coordinator: Blazkova Sarka, Czech Republic, blazkova@vuv.cz

Objective:

- robust methods of real-time forecasting
- simulation of flood-runoff and flood inundation
- Frequency estimation of peak flows and design hydrographs
- Understanding of runoff generation process on small and large catchments to be able to predict the results of climate or land use change
- methods how to deal with uncertainty

Scope: All Europe (but most participants are from Northern, Western and Central Europe; cooperation with AMHY group)

Expected outcomes:

- Papers in hydrological journals
- Guidelines on uncertainty estimation in hydrological modeling
- Guidelines on frequency estimation of flood peaks and volumes (hydrographs)

Time schedules: Not as yet defined

Methodologies adopted:

1. Real-time forecasting
   - data based mechanistic models
   - assimilation of data in real time including snow data
   - updating procedures
   - working with an error model

2. Calibration and validation of flood inundation models
   - Choice of model structure
   - Numerical approximations in solution of equations defined in model structure
   - Definition of boundary conditions including data input
   - Choice of effective parameter values.

3. Frequency estimation of peak flows and flood inundation
   - Continuous simulation in hourly time-steps (short simulations of the lengths of the observed series)
   - compute uncertainty based on effective observation error
   - Performing simulations with behavioural parameter sets up to 100,000 years

- Selecting design hydrographs from the behavioural simulations

4. Understanding of runoff generation process
   - Rainfall simulator which produces precipitation events moving across catchments on large catchments
   - Using subcatchment data for constraining simulations when dealing with large catchments
   - Agreement of results of precipitation simulator using Probable Maximum Precipitation
   - Mapping saturated areas during wet and dry events on small catchments

Partners involved:

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Related events:

Bern, Switzerland   March 2002
Nice, France   April 2002
Rotterdam, The Netherlands   March 2003
Nice, France   April 2004
London, UK   July 2004
Tromso, Norway   October 2005
Vienna, Austria   April 2006
Uppsala Sweden   March 2007

Alpine and Mediterranean-AMHY

Within FRIEND-AMHY there are eight research groups. One group works in the field of floods. The name of the research project is: 'Extreme events'.
Coordinator: E.Ferrari, University of Calabria, Cosenza, Italy.

The main AMHY-FRIEND activities in 2006 and 2007 for "Extreme events" topic was the organization of two international workshops on Hydrological extremes, held at the University of Calabria, in Cosenza (Italy), the first one on 2-4 May 2006 and the second one on 6-7 June 2007.

Objective:

- To identify features responsible for heavy rains and rare floods over areas at different spatial scales.
- To understand hydrological variability and similarity across time and space.
- To compare the rainfall-runoff dynamics of extreme events in drainage basins with different climatic and morphological features.
- Education and dissemination program on heavy rainfalls modelling

Scope: Mediterranean countries

Expected outcomes:

- Scientific reports on the most disastrous (recent) hydrological events, analyzed from both hydrological and meteorological points of view, aiming at a better comprehensive explanation of hydrological extreme events in Mediterranean areas.
- Software packages on frequency analysis of hydrological extremes, based on different statistic and stochastic approaches.
- web page on "Extreme events" topics, spreading scientific information on working groups of AMHY-FRIEND, a multi-media data base, selected references about the topic, scientific appointments, software & tools, and links to related activities).
- Setup of a network of experimental basins of AMHY countries for comparison of rainfall-runoff dynamics.
- Annual workshop on Hydrological extremes to better reach objectives of "Extreme events" topic.
- Short courses on statistic and stochastic modeling of extreme floods and rainfalls.

Time schedules:

As ongoing proposals come from the two International Workshop on "Hydrological extremes", attention of researchers involved in "Extreme events" topic in the next years (2007-08) will be focused on:
- the completion of the web page on "Extreme events" topic   end *2007*
- a final report on recent disastrous hydrological events   summer *2008*
- release of software packages on different aspects of frequency analysis of hydrological extremes   summer *2008*
- Setup of a network of experimental basins and rainfall-runoff analysis   end *2008*
- Annual workshop on Hydrological extremes   annual appointments

- Short courses on statistic and stochastic modeling of extreme floods and rainfalls (yet to be implemented)

Methodologies adopted:

- Analysis of meteorological and hydrological conditions causing extreme rainfall and flood events.
- Statistical and stochastic modeling of heavy precipitation at different time scale (monthly, daily, hourly).
- Regional frequency analysis referred to annual maxima of floods and hourly/daily rainfalls.
- Distributed rainfall-runoff models for flood estimation in ungauged basins.
- comparison of the rainfall-runoff dynamics of concurrent rainfall and flood events in experimental basins of AMHY countries

Partners involved:

- University Departments / Scientific Institutions of national coordinators
- National Institutes for Hydrological/Meteorological Researches
- Civil Protection Divisions

Related events:

Lyon (France), SHF conference   28–29 Jan 2004
Koblenz (Germany), International Workshop on Hydrological Extremes   5–8 July 2004
Montpellier (France), HydroSciences, International Seminar on Climatic impacts on the variability of water resources   22-24 Nov 2005
Ohrid (Macedonia), Balwois Conference   23-26 May 2006
Cosenza (Italy), 1st International Workshop on Hydrological Extremes: "Observing and modeling exceptional floods and rainfalls"   3–4 May 2006
Cosenza (Italy), 2nd International Workshop on Hydrological Extremes: "Variability in space and time of extreme rainfalls, floods and droughts"   6–8 June 2007

Latin America and Caribbean-AMIGO

Within FRIEND-AMIGO there are five research groups. One group works in the field of flood. The name of the research project is: 'Floods'.

Objective:

- To establish through the internet a service of probabilistic evaluation of maximum hydrological variables
- To support the work of meteorological and hydrological services in extreme hydrological situations
- To improve the knowledge of the hydrological processes linked with heavy rains
- To develop the appropriate method for analysis of extreme hydrological phenomena
- To create a hydrological and physiographic database which permits:
- Regional and singular analysis of the maximum extreme values of precipitation
- Vulnerability and risk analysis
- Digital maps of precipitation and flow index
- Quality control of the available information.
- To contribute to the environmental education of politicians, decision –makers and the population in general.

Scope: Latin America and Caribbean

Expected outcomes:

An internet-based service of probabilistic evaluation of maximum hydrological variables.

Time schedules: Not as yet defined

Methodologies adopted:

To be defined, not visible from the document.

Partners involved:

Related events:

No events related to flood.

Hindu Kush Himalayas-HKH

Within FRIEND-HKH there are six research groups. One group works in the field of flood. The name of the research project is: 'Floods.
Coordinator: Thapa, Khadga B., Nepal

Objective:

- To carry out flood studies in order to mitigate flood damage
- To develop regional design procedures for estimating floods at gauged and non-gauged sites in the HKH region
- To develop rainfall-runoff models for the region which will contribute to flood forecasting activities
- To investigate impact of land-use change upon downstream river flow regimes.

Scope: Bangladesh, Bhutan, China, Nepal and Pakistan

Expected outcomes:

- Flood risk maps
- Vulnerability maps
- Guidelines on flood disaster mitigation
- Publications on the institutional set-ups in the watershed
- Rainfall-runoff models for flood forecasting
- Water resource schemes.

Time schedules: Not as yet defined

Methodologies adopted:

- Using GIS and remote sensing data to map flood risk vulnerability
- Hydraulic model based on detailed topographic
- Hydrologic Engineering Center's River Analysis System (NEC-RAC) model
- A detailed socio-economic survey
- Exchange of real-time hydrological data from pilot stations
- Interpolation of missing data
- Seminars on flood disaster mitigation
- Structural and non structural measures for flood disaster mitigation
- High level meetings and national consultations

Partners involved: please complete

Related events:

Nepal, regional seminar	January 2004
Janakpur, Nepal, local stakeholders cons	Nov. 2005

Nile-FRIEND

The FRIEND/Nile project is one of the major UNESCO projects to strengthen and enhance the research cooperation between Nile basin countries for a better understanding of hydrological regimes of Nile basin. The FRIEND/Nile Project is a Fund In Trust Project funded by the Government of Flanders for a duration of 4 years starting November 2001, and aims also at enhancing the capacity building and networking for Nile countries.). Four research themes are supported by the project, namely: Flood Frequency Analysis (FFA); Rainfall-Runoff Modeling (RMM); Droughts and Low Flow Analysis; and Sediment Transport and Watershed Management (STWM)
The main coordinator is: Mr. Motaleb, M. A. Water resources research institute, Egypt, Motaleb@wrrisnet.com

Flood Frequency Analysis Component (FFAC)

The Flood Frequency Analysis Component is one of the four research components of the FRIEND UNESCO-FLANDERS Science FUND IN TRUST PROJECT. This component was coordinated by the Water Resources Research Institute of the National Water Research Center of Egypt and assisted by the theme researchers from the participating Nile Basin countries and the resource persons from Belgium.

The major objectives of the FFA component

Can be summarized as follows:

- Obtaining relationships between flood peaks and their corresponding return periods on both single and regional
- Develop design procedures for flood estimation at the gauged and ungauged catchments on regional basis
- Produce the regional flood frequency curves, and define the hydrological regions

This will serve to improve designs of hydraulic structures along or across streams; planning flood plain adjacent to a stream; designing storage works for irrigation, water supply, and flood control.

Scope: Sudan, Tanzania, Kenya, Ethiopia

Expected outcomes:

- Flood Frequency Curves for single sites
- Regional Flood Frequency Curves for a homogenous region
- Using GIS techniques for estimating the geometric characteristics
- Application at ungauged basins

Findings and Lessons Learned

- Enhanced knowledge transfer and exchange among Flemish and Nile countries experts

- Trust, confidence, mutual trust and understandings have been developed among the research team of the FFA component which enables the exchange of data among the different countries. This is an important issue in the cooperation in the field of Flood Frequency Analysis
- Enhanced methodologies and promoted relevant flood analysis practical research; Introduce new ideas for the application of the GIS procedures in the RFFA is recommended

Proposed Future studies in the regionalization analysis

Extraction of catchment characteristics:
- Based on DEM: percentage in different slope classes
- Based on land cover map (Africover data): percentage of urban, percentage of agricultural land and percentage of forest
- Based on soil type map: percentage of sand, percentage of loam and percentage of clay.

Implementing slope, land use and soil type characteristics:
- Update analysis of MAF vs. catchment characteristics
- Mean annual rainfall (MAR) should also be re-defined and used in the context of the duration in which the flood peaks are observed
- Comparison between peak over threshold and annual maxima methods (for some selected stations)
- Estimation of the flow duration frequency (QDF)-relationships (with different time scales)
- More advanced homogeneity tests and uncertainty analysis on regional curves

Time schedules: Not as yet defined

Methodologies adopted:

Harmonized methodology and procedures of at-site and Regional Flood Frequency Analysis (RFFA) have been applied by all theme researchers of the participating countries. The analysis consisted of data Processing and models applications. The data acquisition for the FFA has been carried out by each theme researcher of the participating countries which are: Egypt; Sudan; Tanzania; Ethiopia and Kenya. Three models have been used to carry out the technical research activities. The first approach was the Flood package developed by Institute of Hydrology, UK. The second approach was the Flood Frequency Analysis developed by Cairo University, Egypt. The Third approach was the Extreme value analysis (Q–Q) Plot developed by the Flemish Counterpart.

Constraints Faced Research Activities:

Topographic; land use; soil type and digital elevation maps with a proper resolution are not available. These maps are helpful to obtain the chatchment characteristics which are the main parameters in the RFFA.

Partners involved:

The project is executed by UNESCO Cairo Office and implemented by namely:
The Water Resources Research Institute of Egypt,
UNESCO-Chair in Water Resources of Sudan,
University of Dar Es Salaam of Tanzania,
University of Nairobi of Kenya, and
The Ministry of Water Resources of Ethiopia.

Related events:

- The first workshop for Flood Frequency Analysis was organized in Cairo, Egypt on 11-16 November 2001. A detailed work plan and budget were prepared for this component.

- The second Flood Frequency Analysis Workshop was held in Cairo, Egypt, on 1-3 April 2003. The main aims of the meeting was to review the progress in implementing the activities of the component and prepare the second year Work plan, list of planned activities and their expected dates. Moreover, deliverables of each FFA theme researcher were identified. Also, a group of free FFA software were compiled on a CD and distributed to the FFA theme researchers. The workshop was covered by the media.

- The third workshop took place in Sharm El-Shiekh, Egypt on 29th of November to 2nd of December 2003. The research teams of the Flood Frequency Analysis (FFA) component in Egypt, Sudan, Kenya, Tanzania, and the Flemish counterparts have participated in this workshop and presented their technical reports on regional analysis for the different regions of the Nile Basin. A number of working group sessions were carried out where FFA experience has been exchanged among the FFA researchers. Problems with data shortage and inconsistencies in the approach presented by the different countries were identified and discussed. Procedures for harmonizing the methodology of the regionalization analysis has been outlined and approved. The third year work plan and activities was also identified.

- The fourth workshop was held in Borg El Arab, Egypt on 22-24 June 2004. The progress in implementing the FFA research activities was reviewed and adopted on a regional Flood Frequency Analysis, in addition to prepare a detailed list of activities for each FFA theme researcher. Proposed new methodologies for the regionalization analysis were discussed. Moreover, encountered problems for conducting Regional Flood Frequency Analysis (RFFA) in the different countries were reviewed and identified.

- The fifth workshop took place in Nairobi, Kenya in the period 26th to 29th of November. The implemented regional frequency analysis in the participating countries was presented, reviewed and discussed. GIS visualization of the results for the whole Nile basin was introduced. The USGS-DEM raw data of the whole area of the Nile Basin with resolution of 90m×90m was distributed to all FFA themes researchers. GIS manipulation of the DEM data was guided by the Flemish counterpart to extract more physiographic parameters for the enhancement of the regionalization analysis. Some statistical homogenous regions within the Nile basin were defined. The workshop participants identified the framework and time schedule of the FFA technical papers to be presented in the Final FRIEND/Nile International Conference as an output of the FFA Component during the first phase of the FRIEND/Nile project. It was agreed that a total of five FFA papers will be prepared for the November 2005 conference Future research activities were defined for each of the research theme researcher.

- Finally, the sixth workshop was held in Khartoum, Sudan in the period 25-30 July 2005. The implemented research activities of the FFA component in Kenya, Tanzania, Sudan, Ethiopia and Egypt were presented and discussed. Improvement in the preparation of the technical papers to be presented in the Final FRIEND/Nile International Conference was recognized in all countries. The participants discussed and reviewed thoroughly all papers. The Flemish counterparts presented their comments on each technical paper. Intensive working group sessions were conducted to finalize the papers and to adopt the reviewers' comments. The papers were totally finalized and reviewed during the workshop. The workshop participants identified the framework and time schedule of finalizing the rest of the FRIEND/Nile papers. Also, the outlines of the annual progress report for the fourth year of the FFA component were discussed and reviewed by the research team of the FFA component. Moreover, the outlines of the conference agenda and schedule of activities were discussed and reviewed.

Asian Pacific-FRIEND

Within Asian Pacific-FRIEND there are four research groups. One group works in the field of flood. The name of research project is: 'Hydrological problems from urbanization'

Objective:

- To define the relation between land use change including increase of urbanized area and flood risk
- To evaluate impact of urbanization on the hydrological cycle.

Scope: Malaysia, China, Japan

Expected outcomes:

There was agreement that a plan be developed and illustrative examples from each country on Design Flood Determination as discussed at the workshop in Kuala Lumpur in June 2005. In the following Sections such a plan has been developed and Actions from individual coutries listed. It is necessary that interested researchers and government agencies be identified for each country.

Action: Each Participating Country to supply names of researchers and organisations before August 31st, 2007 to Trevor Daniell (trevord@civeng.adelaide.edu.au) .

Following the Workshop on IFDs a steering panel of three members should be established to progress the actions listed.

Action: Establishment of a steering panel of three members by 30th September 2007

- Publications on flood forecasting problems due to rapid urbanization
- Urban storm water manual incorporating both water quality and water quantity management strategies.

At the workshop the Philippines, Australia, Rep. of Korea and Malaysia participated in this group to address the following points:

- Developing a process for design flood analysis including flood frequency analysis and development of flood hydrographs through runoff models
- Regional processes that were applicable to design flood estimation (eg Flood frequency analysis)
- Quality control of data
- Software and techniques that could be exchanged

Time schedules: Not as yet defined

Methodologies adopted:

Extensive use will be made of the data in the Catalogue of Rivers. If further data is required then individual countries will be approached for that data.

Flood Frequency methods employed

Sets of data from the Catalogue of Rivers need to be further extended using the latest Catalogue of Rivers and perhaps GRDC Data.

Each country is to give the preferred distriburtions that are used in their country and the reasons for their adoption. If differen regions/prefectures use different methods then these should be supplied.
Software that can be made available for performing flood frequency analyses should also be listed as per section 4.

This data is really required as soon as possible.
A draft Paper by Kuczera and Franks on the latest thinking in Australia has been was supplied. If other countries have publications similar to this could they be supplied for disemination.

Action: Each Participating Country to supply.

Flood Flow Determinations by Runoff Routing Methods

The transfer of Design Rainfalls into Design Flows is paramount to the design flood Process outlined in the Tables above. What techniques are used in individual countries and is there a preferred technique.that is applied across all provincial governments. Are there guidelines on the use of different rainfall runoff routing methods for countirs in the region. Relevant publications outlining the methods can be sent to Trevor Daniell (Australia) either as pdfs or word documents or in paper form and he will pdf them and send them to participants of the workshoop.

Action: Each Participating Country to supply

Rainfall- runoff models with parameters related to impermeable areas
Flood frequency analysis

Partners involved: Members of the IHP Regional Steering Committee of SE Asia and the Pacific

Related events:

IFD Workshop in Kuala Lumpur, Malaysia   6–7 June 2005
RSC Meeting in Philippines   Nov 2007

ANNEX B

**EXPECTED OUTPUTS OF THE IFI
RESEARCH AGENDA**

Research agenda outputs	
Short term products	1. Risk assessment methodologies, risk management tools and risk communication (for objective and subjective risks)
	2. Enhanced understanding, forecasting and management of flash floods in urban areas and arid zones as well as those resulting from dam break and dike break
	3. Improved methodologies for estimating flood benefits and flood damages for various land uses (agriculture, urban, peri-urban, industrial)
	4. Establishment for flood susceptibility indicators based on community vulnerability and resiliency
	5. Comparative assessment of institutional models for flood management
Medium term products	1. Methodologies for reliable inundation mapping
	2. Probabilistic laws for non-stationary extreme events under changing environment (climate variability and change, land use and population change)
	3. Understanding trade-offs between structural and non-structural flood management measures under different socio-economic conditions
	4. Improvement of combined physical and stochastic distributed hydrologic models for more reliable real-time runoff forecasting
	5. Improved methodologies for estimating flood benefits and flood damages for various land uses (agriculture, urban, peri-urban, industrial)
	6. Tools for group based multi-objective decision making with multiple stakeholders
	7. Comparative analysis of socio-economic incentives and instruments in flood management
	8. Understanding flood anthropology for the description of traditional technologies (nature for nature) in flood management
	9. Improved communication strategies for effective flood warning and forecasting
	10. Enhanced understanding of psycho-social impacts of flooding on individual and family responses
	11. Strategies for effective flood mitigation investment scheduling
Long term products	1. Improved medium term flood forecasting incorporating medium and long term weather prediction
	2. Understanding trade-offs between structural and non-structural flood management measures under different socio-economic conditions
	3. Tools (data assimilation, downscaling, remote sensing) for warning and forecasting of ungauged basins
	4. Tools for hydro-meteorology triggered land-slide prediction
	5. Improved management of floods caused by ice jams
	6. Procedures for ecologically sound flood management
	7. New design criteria for non stationary flood computation
	8. Strategies for effective flood mitigation investment scheduling

EXPECTED PRODUCTS OF THE IFI
EDUCATION AND TRAINING AGENDA

	Training and education agenda products
Short term products	1. Synthesized flood preparedness guidelines on flood emergency for communities (country specific)
	2. Training courses and manuals for community leaders, decision makers, technical persons on various aspect of flooding, such as preparedness planning, flood fighting and flood recovery
	3. Post evaluation conferences/lessons learned of case studies highlighting best practices on all aspects of flood issues
	4. International network of flood related institutions to cooperate on producing training materials for various users groups
Medium term products	1. Production of teaching material for training courses for various levels
	2. Training courses and manuals for community leaders, decision makers, technical persons on various aspect of flooding, such as preparedness planning, flood fighting and flood recovery
	3. Post evaluation conferences/lessons learned of case studies highlighting best practices on all aspects of flood issues
	4. International network of flood related institutions to cooperate on producing training materials for various users groups
	5. Popularized publications, books, videos and public education programs dealing with different aspects of flood preparedness, flood fighting and flood recovery in different cultural and socio-economic settings
Long term products	1. Introducing the concept of living with floods in schools programs through text books and teaching materials
	2. Curricula for undergraduate disciplinary programs and integrated curricula for interdisciplinary graduate programs promoting interdisciplinary thinking
	3. Enhanced public awareness through various international events on various aspects of flood management (campaign, media, web)

EXPECTED PRODUCTS OF THE IFI
INFORMATION NETWORKING AGENDA

Information network agenda product	
Short term products	1. Global hydrological database on extreme flood events
	2. Database for description of the various aspects of flood (physical, economic and social)
	3. Open access multi-lingual CDS/ISIS-based international bibliographical database on flood literature and reports (published and informal)
	4. Open access and reviewed depositary of proven methodologies and tools for flood prediction, analyses and management
	5. Network between IFI and relief and humanitarian agencies
Medium term products	1. Database of data-type relevant to the various aspects flood management
	2. Compilation of available DEM data and other spatial datasets (land use) in the appropriate resolution for flood management
	3. Open access international depository of flood related legal instruments, policies and comparative studies
	4. Cooperative network between IFI and insurance industry
	5. Network between IFI and relief and humanitarian agencies
Long term products	1. Global hydrological database on extreme flood events
	2. Compilation of available DEM data and other spatial datasets (land use) in the appropriate resolution for flood management
	3. Cooperative network between IFI and insurance industry

EXPECTED PRODUCTS OF IFI
TECHNICAL ASSISTANCE

Technical assistance products	
Short term products	1. Help design cooperative agreements for flood related activities in transboundary watersheds
	2. Flood emergency management manuals and procedures
	3. Flood Relief and recovery manuals and procedures
Medium term products	1. Facilitation of jointly coordinated flood fighting in transboundary watershed
	2. Design and construction of appropriate methodologies for flood mitigation measures at local scale
	3. Assessment of individual and community flood vulnerability exposure
	4. Provide assistance to the governments in designing national strategies for flood reduction
Long term products	1. Provide assistance to the governments in designing national strategies for flood reduction

ANNEX C

Northern Europe – FRIEND

Within Northern Europe FRIEND there are five research groups. One group works in the field of flood. The name of the research project is: 'Techniques for extreme rainfall and flood runoff estimation'.
Coordinator: Blazkova Sarka, Czech Republic, blazkova@vuv.cz

Objective:

- robust methods of real-time forecasting
- simulation of flood-runoff and flood inundation
- Frequency estimation of peak flows and design hydrographs
- Understanding of runoff generation process on small and large catchments to be able to predict the results of climate or land use change
- methods how to deal with uncertainty

Scope: All Europe (but most participants are from Northern, Western and Central Europe; cooperation with AMHY group)

Expected outcomes:

Papers in hydrological journals

Guidelines on uncertainty estimation in hydrological modelling – for guidelines there would have to be funding

Guidelines on frequency estimation of flood peaks and volumes (hydrographs) – for guidelines there would have to be funding

Time schedules: Not as yet defined

Methodologies adopted:

Real-time forecasting
- data based mechanistic models
- assimilation of data in real time including snow data
- updating procedures
- working with an error model

Calibration and validation of flood inundation models
- Choice of model structure
- Numerical approximations in solution of equations defined in model structure
- Definition of boundary conditions including data input
- Choice of effective parameter values.

Frequency estimation of peak flows and flood inundation

- Continuous simulation in hourly time-steps (short simulations of the lengths of the observed series)
- compute uncertainty based on effective observation error
- Performing simulations with behavioural parameter sets up to 100,000 years
- Selecting design hydrographs from the behavioural simulations

Understanding of runoff generation process
- Rainfall simulator which produces precipitation events moving across catchments on large catchments
- Using subcatchment data for constraining simulations when dealing with large catchments
- Agreement of results of precipitation simulator using Probable Maximum Precipitation
- Mapping saturated areas during wet and dry events on small catchments

Partners involved:

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Related events:

Bern, Switzerland	March 2002
Nice, France	April 2002
Rotterdam, The Netherlands	March 2003
Nice, France	April 2004
London, UK	July 2004
Tromso, Norway	October 2005
Vienna, Austria	April 2006
Uppsala Sweden	March 2007

Asian Pacific-FRIEND

Plan for Design Flood Determination APFRIEND Phase II

Background

There was agreement that a plan be developed and illustrative examples from each country on Design Flood Determination as discussed at the workshop in Kuala Lumpur in June 2005. In the following Sections such a plan has been developed and Actions from individual coutries listed. It is necessary that interested researchers and government agencies be identified for each country.

Action: Each Participating Country to supply names of researchers and organisations before August 31st, 2007 to Trevor Daniell (trevord@civeng.adelaide.edu.au) .

Following the Workshop on IFDs a steering panel of three members should be established to progress the actions listed.

Action: Establishment of a steering panel of three members by 30th September 2007

Design flood

At the workshop the Philippines, Australia, Rep. of Korea and Malaysia participated in this group to address the following points:

1. Developing a process for design flood analysis including flood frequency analysis and development of flood hydrographs through runoff models;
2. Regional processes that were applicable to design flood estimation (eg Flood frequency analysis);
3. Quality control of data; and
4. Software and techniques that could be exchanged.

Concerning points 1 and 2 the following table was prepared

Type of catchment	Location	Small catch. $<100 \text{ km}^2$	Medium catch. $> 100 \div <500$	Large catch. $> 500 \text{ km}^2$
Gauged	Rural	Probabilistic Rm. If data available then flood Frequency analysis	Rm-R/R If data available then flood Frequency analysis	Full R/R model If data available then flood Frequency analysis
	Urban	Probabilistic Rm If data available then flood Frequency analysis	Rm-R/R	Full R/R model
Ungauged	Rural	Regionalised/empirical Method If data available then flood Frequency analysis	Rainfall/Runoff with regional Rainfall design and Index Flood Method	Rainfall/Runoff with regional Rainfall design and Index Flood Method

	Urban	Regional Rainfall and rational method If data available then flood Frequency analysis	Rainfall/Runoff with regional Rainfall design	Rainfall/Runoff with regional Rainfall design

Legend Rm Runoff modelling, -R/R Rainfall Runoff Modelling

Processes for flood design estimation and quality control

Type	Data	Series of data to be used	Improving fit of peak data	Choice of Probability distribution
Gauged	- Observed WL (peak levels, historic information) - observed flows Watch out for land use changes, stationarity of records	Selection of annual series or partial series or POT (selection to ensure of independent events)	- Historical information, - Outlier data (censoring low flow data) Non homogenity/mixed distribution (eg IPO + IPO-)	- GEV - Log Normal, - LP III, - Generalised Pareto - Exponential, - P III Etc.

Regionalisation

Flow Index method – choice between Mean Q and Median Q $Q_t/Q_{\text{mean median}} = \psi_t$
Regression Method - regionalise parameters of probability distribution a function of drainage area, annual mean rainfall, slope, length of channel and other parameters.

Plan of activities for design flood determination

Extensive use will be made of the data in the Catalogue of Rivers. If further data is required then individual countries will be approached for that data.

Flood Frequency methods employed

Sets of data from the Catalogue of Rivers need to be further extended using the latest Catalogue of Rivers and perhaps GRDC Data.

Each country is to give the preferred distriburtions that are used in their country and the reasons for their adoption. If differen regions/prefectures use different methods then these should be supplied.
Software that can be made available for performing flood frequency analyses should also be listed as per section 4.

This data is really required as soon as possible.
A draft Paper by Kuczera and Franks on the latest thinking in Australia has been was supplied. If other countries have publications similar to this could they be supplied for disemination.

Action: Each Participating Country to supply.

Flood Flow Determinations by Runoff Routing Methods

The transfer of Design Rainfalls into Design Flows is paramount to the design flood Process outlined in the Tables above. What techniques are used in individual countries and is there a preferred technique.that is applied across all provincial governments. Are there guidelines on the use of different rainfall runoff routing methods for countirs in the region. Relevant publications outlining the methods can be sent to Trevor Daniell (Australia) either as pdfs or word documents or in paper form and he will pdf them and send them to participants of the workshoop.

Action: Each Participating Country to supply

Software availability

All countries to list software availabie including websites for design flood analysis in their countries. If the software has to be requested from a government department then please state. Some software will be part of data archiving packages such as Tideda, Hydsra etc.
If countries have software that is available please indicate how it might be accessed.

Action: Each Participating Country to supply

Review of actions to be undertaken

The work of APFRIEND phase 1 will be built upon by preparing a review of the methods outlined in the Tables in Section 2. Information is needed in each of the areas of flood determination. As an example of Regional Methods employed an Australian example has was attached for participating countries to note. If there are many techniques for a particular country then just give relevant publications and if possible pdf the publication or paper.

The panel will need initially to undertake the following tasks:
* collation of the material received for each of the areas;
* examination of the data available in the Catalogue of Rivers;
* assembling data for further processing; and
* collation of appropriate software.

Action: Each Participating Country and Researcher to Supply

Partners involved: Members of the IHP Regional Steering Committee of SE Asia and the Pacific

Related events:

IFD Workshop in Kuala Lumpur, Malaysia   6–7 June 2005
RSC Meeting in Philippines   Nov 2007

The FRIEND/Nile Project:

Flow Regimes from International Experimental
And Network Data (FRIEND) of the Nile Basin

Background

The FRIEND/Nile project is one of the major UNESCO projects to strengthen and enhance the research cooperation between Nile basin countries for a better understanding of hydrological regimes of Nile basin. The FRIEND/Nile Project is a Fund In Trust Project funded by the Government of Flanders for a duration of 4 years starting November 2001, and aims also at enhancing the capacity building and networking for Nile countries.). Four research themes are supported by the project, namely: Flood Frequency Analysis (FFA); Rainfall-Runoff Modeling (RMM); Droughts and Low Flow Analysis; and Sediment Transport and Watershed Management (STWM

Partners involved:

The project is executed by UNESCO Cairo Office and implemented by namely:
The Water Resources Research Institute of Egypt,
UNESCO-Chair in Water Resources of Sudan,
University of Dar Es Salaam of Tanzania,
University of Nairobi of Kenya,
The Ministry of Water Resources of Ethiopia

Flood Frequency Analysis Component (FFAC)

The Flood Frequency Analysis Component is one of the four research components of the FRIEND UNESCO-FLANDERS Science FUND IN TRUST PROJECT. This component was coordinated by the Water Resources Research Institute of the National Water Research Center of Egypt and assisted by the theme researchers from the participating Nile Basin countries and the resource persons from Belgium.

The major objectives of the FFA component

Can be summarized as follows:

- Obtaining relationships between flood peaks and their corresponding return periods on both single and regional;
- Develop design procedures for flood estimation at the gauged and ungauged catchments on regional basis;
- Produce the regional flood frequency curves, and define the hydrological regions.

This will serve to improve designs of hydraulic structures along or across streams; planning flood plain adjacent to a stream; designing storage works for irrigation, water supply, and flood control.

The output the of the FFAC research activities:

- Flood Frequency Curves for single sites

- Regional Flood Frequency Curves for a homogenous region
- Using GIS techniques for estimating the geometric characteristics
- Application at ungauged basins

Methodology:

Harmonized methodology and procedures of at-site and Regional Flood Frequency Analysis (RFFA) have been applied by all theme researchers of the participating countries. The analysis consisted of data Processing and models applications. The data acquisition for the FFA has been carried out by each theme researcher of the participating countries which are: Egypt; Sudan; Tanzania; Ethiopia and Kenya. Three models have been used to carry out the technical research activities. The first approach was the Flood package developed by Institute of Hydrology, UK. The second approach was the Flood Frequency Analysis developed by Cairo University, Egypt. The Third approach was the Extreme value analysis (Q–Q) Plot developed by the Flemish Counterpart.

Constraints Faced Research Activities:

Topographic; land use; soil type and digital elevation maps with a proper resolution are not available. These maps are helpful to obtain the chatchment characteristics which are the main parameters in the RFFA.

Findings and Lessons Learned

- Enhanced knowledge transfer and exchange among Flemish and Nile countries experts
- Trust, confidence, mutual trust and understandings have been developed among the research team of the FFA component which enables the exchange of data among the different countries. This is an important issue in the cooperation in the field of Flood Frequency Analysis
- Enhanced methodologies and promoted relevant flood analysis practical research; Introduce new ideas for the application of the GIS procedures in the RFFA is recommended

Proposed Future studies in the regionalization analysis

- Extraction of catchment characteristics:
- Based on DEM: percentage in different slope classes
- Based on land cover map (Africover data): percentage of urban, percentage of agricultural land and percentage of forest
- Based on soil type map: percentage of sand, percentage of loam and percentage of clay
- Implementing slope, land use and soil type characteristics
- Update analysis of MAF vs. catchment characteristics
- Mean annual rainfall (MAR) should also be re-defined and used in the context of the duration in which the flood peaks are observed
- Comparison between peak over threshold and annual maxima methods (for some selected stations)
- Estimation of the flow duration frequency (QDF)-relationships (with different time scales)

- More advanced homogeneity tests and uncertainty analysis on regional curves

Related Events and FFA Workshops:

- The first workshop for Flood Frequency Analysis was organized in Cairo, Egypt on 11-16 November 2001. A detailed work plan and budget were prepared for this component.

- The second Flood Frequency Analysis Workshop was held in Cairo, Egypt, on 1-3 April 2003. The main aims of the meeting was to review the progress in implementing the activities of the component and prepare the second year Work plan, list of planned activities and their expected dates. Moreover, deliverables of each FFA theme researcher were identified. Also, a group of free FFA software were compiled on a CD and distributed to the FFA theme researchers. The workshop was covered by the media.

- The third workshop took place in Sharm El-Shiekh, Egypt on 29th of November to 2nd of December 2003. The research teams of the Flood Frequency Analysis (FFA) component in Egypt, Sudan, Kenya, Tanzania, and the Flemish counterparts have participated in this workshop and presented their technical reports on regional analysis for the different regions of the Nile Basin. A number of working group sessions were carried out where FFA experience has been exchanged among the FFA researchers. Problems with data shortage and inconsistencies in the approach presented by the different countries were identified and discussed. Procedures for harmonizing the methodology of the regionalization analysis has been outlined and approved. The third year work plan and activities was also identified.

- The fourth workshop was held in Borg El Arab, Egypt on 22-24 June 2004. The progress in implementing the FFA research activities was reviewed and adopted on a regional Flood Frequency Analysis, in addition to prepare a detailed list of activities for each FFA theme researcher. Proposed new methodologies for the regionalization analysis were discussed. Moreover, encountered problems for conducting Regional Flood Frequency Analysis (RFFA) in the different countries were reviewed and identified.

- The fifth workshop took place in Nairobi, Kenya in the period 26th to 29th of November. The implemented regional frequency analysis in the participating countries was presented, reviewed and discussed. GIS visualization of the results for the whole Nile basin was introduced. The USGS-DEM raw data of the whole area of the Nile Basin with resolution of 90m×90m was distributed to all FFA themes researchers. GIS manipulation of the DEM data was guided by the Flemish counterpart to extract more physiographic parameters for the enhancement of the regionalization analysis. Some statistical homogenous regions within the Nile basin were defined. The workshop participants identified the framework and time schedule of the FFA technical papers to be presented in the Final FRIEND/Nile International Conference as an output of the FFA Component during the first phase of the FRIEND/Nile project. It was agreed that a total of five FFA papers will be prepared for the November 2005 conference Future research activities were defined for each of the research theme researcher.

- Finally, the sixth workshop was held in Khartoum, Sudan in the period 25-30 July 2005. The implemented research activities of the FFA component in Kenya, Tanzania, Sudan, Ethiopia and Egypt were presented and discussed. Improvement in the preparation of the technical papers to be presented in the Final FRIEND/Nile International Conference was recognized in all countries. The participants discussed and reviewed thoroughly all papers.

The Flemish counterparts presented their comments on each technical paper. Intensive working group sessions were conducted to finalize the papers and to adopt the reviewers' comments. The papers were totally finalized and reviewed during the workshop. The workshop participants identified the framework and time schedule of finalizing the rest of the FRIEND/Nile papers. Also, the outlines of the annual progress report for the fourth year of the FFA component were discussed and reviewed by the research team of the FFA component. Moreover, the outlines of the conference agenda and schedule of activities were discussed and reviewed.

Alpine and Mediterranean-AMHY

Within FRIEND-AMHY there are eight (as reported in general web page of AMHY-FRIEND group: http://armspark.msem.univ-montp2.fr/amhy/. For more recent possible change, you should ask to Eric Servat) research groups. One group works in the field of floods. The name of the research project is: 'Extreme events'.
Coordinator: E.Ferrari, University of Calabria, Cosenza, Italy.

The main AMHY-FRIEND activities in 2006 and 2007 for "Extreme events" topic was the organization of two international workshops on Hydrological extremes, held at the University of Calabria, in Cosenza (Italy), the first one on 2-4 May 2006 and the second one on 6-7 June 2007.

Objective:

- To identify features responsible for heavy rains and rare floods over areas at different spatial scales.
- To understand hydrological variability and similarity across time and space.
- To compare the rainfall-runoff dynamics of extreme events in drainage basins with different climatic and morphological features.
- Education and dissemination program on heavy rainfalls modeling

Scope: Mediterranean countries

Expected outcomes:

- Scientific reports on the most disastrous (recent) hydrological events, analyzed from both hydrological and meteorological points of view, aiming at a better comprehensive explanation of hydrological extreme events in Mediterranean areas.
- Software packages on frequency analysis of hydrological extremes, based on different statistic and stochastic approaches.
- web page on "Extreme events" topics, spreading scientific information on working groups of AMHY-FRIEND, a multi-media data base, selected references about the topic, scientific appointments, software & tools, and links to related activities).
- Setup of a network of experimental basins of AMHY countries for comparison of rainfall-runoff dynamics.
- Annual workshop on Hydrological extremes to better reach objectives of "Extreme events" topic.
- Short courses on statistic and stochastic modeling of extreme floods and rainfalls.

N.B. Scientific reports on space distribution of maximum floods across Europe (previously reported as expected outcomes) have been partially obtained mainly as printed contribution of deceased prof. Stanescu.

Time schedules:

As ongoing proposals come from the two International Workshop on "Hydrological extremes", attention of researchers involved in "Extreme events" topic in the next years (2007-08) will be focused on:

- the completion of the web page on "Extreme events" topic   end 2007

- a final report on recent disastrous hydrological events   summer 2008
- release of software packages on different aspects of frequency analysis of hydrological extremes   summer 2008
- Setup of a network of experimental basins and rainfall-runoff analysis   end 2008
- Annual workshop on Hydrological extremes   annual appointments
- Short courses on statistic and stochastic modeling of extreme floods and rainfalls (yet to be implemented)

Methodologies adopted:

- Analysis of meteorological and hydrological conditions causing extreme rainfall and flood events.
- Statistical and stochastic modeling of heavy precipitation at different time scale (monthly, daily, hourly).
- Regional frequency analysis referred to annual maxima of floods and hourly/daily rainfalls.
- Distributed rainfall-runoff models for flood estimation in ungauged basins.
- comparison of the rainfall-runoff dynamics of concurrent rainfall and flood events in experimental basins of AMHY countries

Partners involved:

- University Departments / Scientific Institutions of national coordinators
- National Institutes for Hydrological/Meteorological Researches
- Civil Protection Divisions

Related events:

Lyon (France), SHF conference   28–29 Jan 2004
Koblenz (Germany), International Workshop on Hydrological Extremes   5–8 July 2004
Montpellier (France), HydroSciences, International Seminar on Climatic and anthropogenic impacts on the variability of water resources   22-24 Nov 2005
Ohrid (Macedonia), Balwois Conference   23-26 May 2006
Cosenza (Italy), 1st International Workshop on Hydrological Extremes: "Observing and modeling exceptional floods and rainfalls"   3–4 May 2006
Cosenza (Italy), 2nd International Workshop on Hydrological Extremes: "Variability in space and time of extreme rainfalls, floods and droughts"   6–8 June 2007

Hindu Kush Himalayas-HKH

Within HKH FRIEND there are six research groups. One group works in the field of flood. The coordinator of the Floods group is Prof Khadga Bahadur Thapa from Nepal. During the design of the HKH FRIEND the objectives, scope and expected outcomes were prepared which are provided below:

Objective:

- To carry out flood studies in order to mitigate flood damage
- To develop regional design procedures for estimating floods at gauged and non-gauged sites in the HKH region
- To develop rainfall-runoff models for the region which will contribute to flood forecasting activities
- To investigate impact of land-use change upon downstream river flow regimes.

Scope: Bangladesh, Bhutan, China, Nepal and Pakistan

Expected outcomes:

- Flood risk maps
- Vulnerability maps
- Guidelines on flood disaster mitigation
- Publications on the institutional set-ups in the watershed
- Rainfall-runoff models for flood forecasting
- Water resource schemes.

Time schedules: No fixed schedules were laid out

Activities:

A project on "Flood Risk and Vulnerability Mapping using GIS: A Case Study from Ratu River in Central Nepal" has been recently completed by the group. The study used GIS and remote sensing data to map flood risk vulnerability and sought to identify community-based disaster mitigation activities to reduce loss of life and property. Findings were disseminated during a national 'Seminar on Flood Risk and Vulnerability Mapping of the Ratu River Basin' in January 2004 to 45 participants from national, district and local levels. The seminar was also used to discuss project components for the second phase of the project including, flood disaster mitigation, development of coping mechanism, implementation of structural and non-structural measures for flood disaster mitigation and institutional set-ups in the watershed.

The second phase of the study used detailed topographic information and prepared an accurate hydraulic model, using Hydrologic Engineering Center's River Analysis System (HEC-RAS) for a selected site in Jaleshwor, proposed by the stakeholders. The model predicted accurate water levels and defined inundation areas and identified escape routes during floods of various recurrence intervals. Detailed socio-economic survey was also conducted to check the results obtained from the model with the actual ground information. A UNESCO, HKH FRIEND, ICIMOD joint publication "Preparing for Flood Disaster: Mapping and Assessing

Hazard in the Ratu Watershed, Nepal (2007)" has been published summarizing the methodologies and results of the study.

A significant development with regard to regional floods was also initiated as a contribution to the Floods theme of HKH FRIEND. The project 'Regional Cooperation for Flood Forecasting and Information Exchange in the HKH' began in 2001. The project has achieved full cooperation from five participating countries Bangladesh, Bhutan, China, Nepal and Pakistan, with India as an observing member. Four years of deliberations have resulted in a series of high level meetings and national consultations which have laid the foundation for regional cooperation, strengthened existing bilateral arrangements and enriched institutional linkages. The project has conducted a Demonstration and Testing Phase, during which the five fully participating countries exchanged near real-time hydrological data from twelve pilot stations. After a successful Demonstration and Testing Phase, the partners have recommended that the project should proceed to a second phase and increase the station network to make meaningful interpretations of the real-time data and increase the lead-time so that more lives and property can be saved from floods. The project seeks to improve the technical capacities, infrastructure and know how of the partners.

Methodologies adopted:

- Using GIS and remote sensing data to map flood risk vulnerability
- Hydraulic model based on detailed topographic
- Hydrologic Engineering Center's River Analysis System (NEC-RAC) model
- A detailed socio-economic survey
- Exchange of real-time hydrological data from pilot stations
- Interpolation of missing data
- Seminars on flood disaster mitigation
- Structural and non structural measures for flood disaster mitigation
- High level meetings and national consultations

Partners involved:

Tribhuvan University, Kathmandu Nepal
Institute of Engineering (IOE), Kathmandu, Nepal

Related events:

Nepal, National seminar   January 2004
Janakpur, Nepal, local stakeholders cons   Nov. 2005