Evaluation Report
Regional Study Course on Climate Change, Hydrological Droughts and Floods
Thimphu, Bhutan 28th November – 3rd December 2010

Hege Hisdal       February 2011
Photos on the cover:

- Study course participants and lecturers at the opening ceremony (upper left)
- Stage gauge at Yebeza hydrological station (upper right)
- Presentation by study course participant (lower left)
- Study course participants at the workshop on modelling impacts of climate change (lower right)
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1. Introduction

As part of the Institutional Cooperation between Bhutan’s Department of Energy (DoE) and the Norwegian Water Resources and Energy Directorate (NVE) for strengthening of the energy sector (Phase III) sponsored by NORAD, improvement of the hydrological analysis capacity at the DoE is included. Improved skills in analysing hydrological data are beneficial to accelerate and improve hydropower development. Training modules were developed, including training at basic and advanced levels within hydrology. Lectures at the basic level within a wide range of hydrological topics were given to employees at DoE visiting NVE in the autumn of 2009 and again in the autumn of 2010.

The regional study course on “Climate Change, Hydrological Droughts and Floods” that was held in Thimphu, Bhutan, 28th November – 3rd December 2010, emphasized to develop the understanding of hydrology focusing on floods, droughts and climate change and its effects on hydrology. The study course gave experience in hydrological analysis and promoted dialogue between hydrologists in the Hindu-Kush-Himalaya region. The latter was obtained through co-operation with UNESCO-IHP and Hindu-Kush-Himalaya IHP-FRIEND.

General information about the study course, including an overview of the lecture material, the study course program, the organizing committee and lecturers can be found in Annex 1, a technical note distributed to all study course participants prior to the study course.

This report summarizes the course objectives and the main outcome of the study course evaluation. A set of annexes is attached (see Table of Contents), including study course reviews (Annex 4) by participants from ICIMOD, Nepal and the G B Pant University of Agriculture and Technology in India.

2. Study Course Objectives

The main objective of the study course was to give the study course participants a comprehensive knowledge about the characteristics of the hydro-hazards flood and drought and how to analyse these extremes. A particular focus was put on climate change and its impacts on hydrology including droughts and floods.

It was also an objective to encourage co-operation and networking between hydrologists in the Hindu-Kush-Himalaya region through the FRIEND HKH programme.

In particular the course aimed at:

- giving the participants the opportunity to advance their knowledge on climate change, floods and droughts;
- giving an overview of analysis methods used to study
  - hydrological data quality,
  - low flows and droughts,
  - floods,
  - effects of climate change on hydrology;
- giving the participants the opportunity to practice analysis of floods and droughts and climate change effects on hydrology;
- promoting networking in the HKH-region.

Means to reach the aims were:

- to distribute parts of the lecture material prior to the study course;
to provide textbooks, journal articles, self-guided tours, data and software to all participants;
- to invite recognized experts in the field as lecturers;
- to introduce a wide range of topics through lectures;
- to invite participants to present their own studies and experiences from their countries;
- to let participants actively take part by carrying out and present a case study dealing with different aspects of floods, droughts and climate change;
- to reserve ample time for discussions, including a plenary closure session;
- to provide sufficient time (ice breaker, coffee/tea breaks, joint dinners, midweek excursion) for developing contacts and build networks;
- to evaluate the content and organization of the study course.

3. Selection of participants

The thirteen study course participants from Bhutan were invited by DoE, and the majority were employees at the Hydro-met Services Division of DoE. The participants from India (1), Nepal (3), Bangladesh (2) and Pakistan (1) were selected by the UNESCO regional office in New Delhi, India. A list of participants is given in Annex 2.

About 30% of the selected participants were female. The participants had different backgrounds from engineering and natural sciences. The educational level ranged from BSc-to PhD-degrees and their employment records ranged from applied hydrology to university positions.

4. Study course program

The study course started on Sunday 28th November, late afternoon, with an introduction to the course objectives and program (Annex 1). Lecturers and participants introduced themselves, and were all invited to an icebreaker event including dinner. The welcome session introduced the participants to the following elements of the one week program (Monday-Friday):
- lectures;
- introduction to self-guided tours and worked examples;
- oral presentation by selected participants;
- midweek excursion;
- two parallel workshops;
- plenary presentations of the outcome of the workshops by participants;
- plenary evaluation;
- closing session.

Lecturers were given by invited experts on climate change, floods, droughts and low flows. Six participants gave oral presentations. A midweek excursion to Punakha and Wangdue included visits at the Dochula pass, the Yebesa hydrological gauging station, Punakha Dzong and Wangdue Flood Warning Station. The main objectives of the excursion was at site observations of the hydrology of Bhutan, network building and to have an interruption in the intensive program of the study course.

In the second part of the week the participants could choose to take part in one of two parallel workshops. The first workshop focused on frequency analysis of drought and flood (statistical modelling) and the second on climate change impacts on hydrology (physically-
based modelling). Both workshops were attended by 10 participants. In the workshop the
participants worked on time series of hydrological data and used tools that were provided on
the CD (included with the textbook) or other software. Detailed programs of the workshops
are given in Annexes 1. In a final plenary session, a few students presented the outcome of
the workshops. Eventually, the evaluation of the study course was presented and discussed.
All participants received study course certificates.

5. Study Course Evaluation

The participants received a comprehensive questionnaire (Annex 3). The replies offered the
opportunity to evaluate the study course.

![Figure 1 Response of participants (y-axis: percentage of participants) how they
perceived the content (focus) of the course and if it matched their expectations.]

The questionnaire was completed by 85%, which is a very high score. All participants
classified the study course as acceptable to excellent (Figure 1). They were very happy to be
invited to learn from recognized experts and to meet with other hydrologists to discuss
climate change issues including impacts on hydrology and water resources management.

5.1. Content and program

All students thought that the structure of the course (allocation of time for lectures, oral and
poster presentations by the participants, workshops) was acceptable (25%), good (56%) or
excellent (19%).

More than half of the students thought that the time spent on lecturers and contributions from
students was acceptable (Table 1). Regarding the self guided tours and worked examples,
the response was mixed as many would have liked either more or less time for this. If
optional, it seems that more rather than less time, should have been spent on lectures, and
some participants commented that the contributions from participants not directly relevant for
the topic of the study course could have been skipped.
Table 1 Response of students (%) on the study course program

<table>
<thead>
<tr>
<th>Question</th>
<th>less time</th>
<th>acceptable</th>
<th>more time</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Should there have been less or more lectures?</td>
<td>12.5</td>
<td>50</td>
<td>37.5</td>
</tr>
<tr>
<td>4. Should we have spent less or more time on self-guided tours and worked examples?</td>
<td>31</td>
<td>25</td>
<td>44</td>
</tr>
<tr>
<td>5. Should we have spent less or more time on contributions from the participants?</td>
<td>25</td>
<td>62.5</td>
<td>12.5</td>
</tr>
</tbody>
</table>

Most participants found the textbook (86%) and distributed lecture material (75%) to be good or excellent. About 50% of the students had been studying the distributed lecture material prior to the study course.

The response on the individual lectures has been distributed to the study course lecturers. Here only the general impression is given based on average scores for all lectures. The content of the lectures was found to be very good. Even if the difficulty level in general was found acceptable, some of the lectures were found to have a high level of difficulty. The focus of the presentations was in general found to be good.

The response related to the workshops is illustrated in Figure 2. More than 50% of the participants would have liked to spend more time on the parallel workshops. There was a mixed response on the organisation of two parallel workshop (students could only attend one workshop). Many students commented that they would have liked to participate in both workshops (frequency analysis and conceptual rainfall-runoff modelling). More than 80% of the participants found the content of the workshops good or excellent. Although 50% of the participants found the difficulty level of the workshops to be understandable, more than 30% found the difficulty level high. A majority (79%) found the idea to have presentations of the workshop results by the participants a good or excellent idea.

Figure 2 Workshop evaluation (y-axis: percentage of participants).
5.2. Organisation

Most students (80%) found the number of participants (n=20) was fine, but 20% thought more participants would be fine. Almost 75% found the study course facilities good or excellent and almost 90% found the accommodation good or excellent. The only question were the response “questionable” was used (more than 30%), was related to stating the study course on a Sunday. However, most participants found it acceptable or good.

The icebreaker session was found good or excellent (85%). More than 90% of the participants found that a mid-week field trip is needed and a vast majority (79%) found the purpose of the field trip of interest.

6. Concluding remarks

- the evaluation showed that the study course provided the participants a unique opportunity to advance their knowledge on climate change, hydrological droughts and floods and to learn more about current analysis techniques in hydrology;
- comments were given that the study course was useful for operational hydrology;
- the vast majority of the students thought that the study course had a good content, program and organization, incl. the logistics;
- the mix of education forms (lectures, self-guided tours, excursion, workshops) was well received;
- the possibility to use your own data sets in the workshops would have been appreciated;
- the high academic standards of the lecturers was highly appreciated;
- the background of the participants was mixed, which is a challenge for the lecturers and for some participants the lectures were a bit fast;
- many participants would have liked to spend more time for the study course, i.e. two weeks;
- presentations by participants need to be related to the topic of the study course;
- comments on the evaluation forms, but also the group process showed that participants appreciated to meet other people working within hydrology and climate change, which contributed to developing their network;
- a substantial number of students missed the opportunity to participate in both workshops, which were run in parallel;
- the accommodation, food and local organization was found excellent;
- for the participants from Bhutan it would have been an advantage to arrange the course outside DoE to avoid being interrupted during the study course;
- the organizers were encouraged to continue to make similar study courses.
Regional Study Course on Hydro-Hazards in a Changing Climate
Thimphu, Bhutan 28th November – 3rd December 2010

Organized by:
UNESCO and Hindu-Kush-Himalaya IHP-FRIEND
Department of Energy - Ministry of Economic Affairs, Bhutan
Norwegian Water Resources and Energy Directorate

Organisers
Hege Hisdal
The Norwegian Water Resources and Energy Directorate

Siegfried Demuth
UNESCO, Paris

Hari Sharma
Department of Energy, Bhutan

Lecturers
Dr. Stein Beldring
The Norwegian Water Resources and Energy Directorate

Prof. Dr. Siegfried Demuth
UNESCO, France

Dr. Hege Hisdal
The Norwegian Water Resources and Energy Directorate

Dr. ir. Henny van Lanen
Wageningen University, the Netherlands

Director Gwyn Rees
Centre for Ecology and Hydrology, UK

Dr. Thomas Skaugen
The Norwegian Water Resources and Energy Directorate

Prof. Dr. Lena Tallaksen
University of Oslo, Norway
<table>
<thead>
<tr>
<th>Content:</th>
<th>p</th>
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<tbody>
<tr>
<td>Introduction</td>
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<tr>
<td>Objective</td>
<td>4</td>
</tr>
<tr>
<td>Content, lecture material &amp; outcomes</td>
<td>4</td>
</tr>
<tr>
<td>Detailed program</td>
<td>8</td>
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<tr>
<td>Organizing committee</td>
<td>12</td>
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</table>
Introduction

Droughts and floods are devastating, recurring worldwide phenomena, with spatial and temporal characteristics that may vary significantly from one region to another. Drought can be defined as a sustained and regionally extensive occurrence of below average natural water availability that is reflected in variables such as precipitation, soil moisture, groundwater and streamflow. Hydrological drought is seen as drought in groundwater and streamflow. A general definition of flood is that it is a rise, usually brief, in the water level in a stream to a peak from which the water level recedes at a slower rate. Most people however would associate floods with an overflowing of water from a river onto land that is normally dry.

Drought and flood has a major impact on human well being. They affect the environment and the economy we depend on. Drought may for example cause losses in crop production, lead to lack of drinking water, hinder waterborne transport, reduce hydropower production and cause forest fires. The impacts are serious and they cause loss of life and especially in developing countries aggravation of poverty and mass migration. Impacts are likely to increase with time as societies’ demands for water and environmental services increase. Floods can also result in huge economic losses due to damage to for example infrastructure, property and agricultural land, and indirect losses in or beyond the flooded areas, such as production losses caused by damaged stock or roads, or the interruption of power generation and navigation. Unfortunately, climate change is expected to intensify the hydrological cycle and both floods and droughts are predicted to become more severe and frequent in the future.

A prerequisite for an adequate assessment and management of the impacts of hydrological hazards, and associated policy-making (pro-active and re-active) is through knowledge on the generation and development of floods and drought. This applies to both current and future conditions, the latter related to climate change adaptation.

The Study Course on hydro-hazards in a changing climate entitled ‘Climate Change, Hydrological Drought and Flood’ will provide a unique opportunity for the participants to advance their knowledge about floods, droughts and climate change. They will learn both basic and advanced techniques to analyse floods and droughts and climate change effects on these extremes. The lecturers are recognized experts in the field.
Objectives
The main objective of the study course is to give the study course participants a comprehensive knowledge about the characteristics of the hydro-hazards flood and drought and how to analyse these extremes. A particular focus will be put on climate change and its impacts on droughts and floods.

It is also an objective to encourage co-operation and networking between hydrologists in the Hindu-Kush-Himalaya region through the FRIEND HKH programme.

Content, lecture material & outcomes
The content of the intensive five day study course is outlined below. The first two days of the course will mainly consist of lectures combined with some time for hands-on training using self-guided tours. A mid-week field trip will be organized. On the last two days participants work in two parallel workshops. In the first workshop the participants get hands-on training on flood and drought frequency analysis and in the second workshop the focus is on the assessment of the impact of climate change on flood and drought using physically based hydrological models. Participants work in small groups on real world data. The course is concluded by a plenary presentation and discussion of the outcome of the workshop. The study course participants are also invited to give short presentations about their own or national studies of hydro-hazards, including hydro-hazards a changing climate.

The study course participants will receive textbooks, reports and relevant journal papers. The lecture notes will be stored on memory sticks and distributed to the students at the study course.

The study course will also provide datasets, worked examples and self-guided tours to demonstrate methods to analyse droughts and floods. A CD including software and user guides will be distributed. The software amongst others includes the rainfall-runoff model BILAN and statistical modelling tools to be used at the workshop.

Participants receive a certificate (3ects) after completing the Study Course provided they have actively taken part in the course.
The study course contains three major parts; (i) climate change (ii), low flow and drought, (iii) floods.

(i) Focus Climate Change:
Lectures:
- Introduction Climate Change
- Projected climate change impacts on hydrology
- Climate change effects on floods and droughts
- Modelling the effect of climate change

Lecture material:
- IPCC, 2007: Climate Change 2007: The Physical Science Basis (the complete report can be downloaded at: http://www.ipcc.ch/)
  - Frequently asked questions, pp 94-127 (will be distributed prior to the study course)
  - Regional Climate Projections, Chapter 11.4 Asia, pp 879-887 (will be distributed prior to the study course)
- Sælthun, N.R. (1996) The Nordic HBV model, NVE, Publication No. 7, Oslo, 26 pp (will be distributed prior to the study course)

(ii) and (iii) Focus drought and flood:
Lectures:
- Introduction flood and drought
- Hydrological data for flood and drought analysis
- Hydrological drought characteristics – definition, estimation and recommendation
- Drought generating processes
- Flood generating processes
- Frequency analysis – at site floods and droughts
- Regionalisation procedures and estimation at the ungauged site floods and droughts
Operational applications

Lecture material:

- Tallaksen, L. M & van Lanen, H.A.J. (Eds) (2004) *Hydrological Drought – Processes and Estimation Methods for Streamflow and Groundwater*. Developments in Water Sciences 48. Elsevier Science Publisher, the Netherlands. Chapters 1, 3, 4, 5, 6, 8, 9, 11 (The textbook is included in the study course, and will be distributed in Bhutan)

Software training material:

- A CD included in Tallaksen and van Lanen (2004) contains the following software to be used at workshops during the study course:
  - (ii) & (iii) Excel software to estimate the flow duration curve
  - (ii) NIZOWKA: Program to extract drought events and carry out frequency analysis
  - (i) BILAN: A hydrological model to study CC effects on hydrology
- (iii) R – statistical freeware, will be downloaded and installed on computers prior to the study course and used for flood frequency analysis
- (i) The HBV-model: A PC-version of the conceptual rainfall-runoff model will be installed on computers prior to the study course and used to estimate CC effects on floods and droughts

Additional lectures:

- Hydrology of the Hindu-Kush-Himalaya Region
- Low flow study in Bhutan
- Drought characterisation in mid-climatic regions in India
- Impacts of climate change on water resources in Nepal
- Floods and droughts in Bangladesh
- Satellite based rainfall estimates for rainfall prediction
Regional Study Course on Climate Change, Hydrological Drought and Flood  
Department of Energy, Ministry of Economic Affairs, Thimpu, Bhutan  
Sunday 28th November – Friday 3rd December  
Jointly convened by DoE, UNESCO (including HKH FRIEND) and NVE

Lecturers: SD: Siegfried Demuth (UNESCO), HH: Hege Hisdal (NVE), HvL = Henny van Lanen (Wageningen University, NL), SB=Stein Beldring (NVE), GR = Gwyn Rees (CEH, Wallingford), LT = Lena Tallaksen (University of Oslo),  
TS=Thomas Skaugen (NVE)

In addition the participants are invited to give presentations and there will be presentations from Bhutan

<table>
<thead>
<tr>
<th>Timetable</th>
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<tbody>
<tr>
<td><strong>Sunday 28 Nov.</strong></td>
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<tr>
<td><strong>Lectures</strong></td>
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</table>
| 09:00-10:30 Hydrology of the Hindu-Kush Himalaya region (DoE) 30 | 09:00-10:30 Frequency analysis – at site analysis (Ch. 6 + floods)(LT, TS) 45 + 45 minutes (Example paper Engeland et al.) | Field trip 09:00-18:00 | Presentations 09.00 – 10.00  
Low flow study in Bhutan (Karma Chhopel)  
Satellite based rainfall estimates for flood prediction (Mandira Shrestha) (chair: HH) | Workshops 1, 2  
10.00 – 10.30  
Workshop A  
Drought & flood frequency analysis (LT,HH, TS)  
Workshop B  
Human impacts & climate change (HvL,SB) |
| 10.30 Break | 10.30 Break | **10.30 Break** | **10.30 Break** | **10.30 Break** |

1 Participants choose for Workshop A or B (2 parallel workshops).  
2 A detailed programme for the two parallel workshops is given below.
<table>
<thead>
<tr>
<th>Lectures</th>
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<tr>
<td>11:00 – 12:30</td>
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<tr>
<td>Hydrological floods and drought impact of climate change (Ch. 2 &amp; new material) (HH/SBE) 30</td>
<td>Regionalisation procedures and estimation at the ungauged sites, incl. examples (Ch. 8 + floods) (LT, THS, SD) 90</td>
<td>Regionalisation procedures and estimation at the ungauged sites, incl. examples (Ch. 8 + floods) (LT, THS, SD) 90</td>
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<tr>
<td>Drought generating processes (Ch. 3) (HL) 30</td>
<td>Flood generating processes (New material) (TS) 30</td>
<td>Drought generating processes (Ch. 3) (HL) 30</td>
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<tr>
<td>12:30 – 14:00 Lunchtime</td>
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<thead>
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<td>11:00 – 12:30</td>
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<tr>
<td>Workshop A</td>
<td>Workshop A</td>
<td>Workshop A</td>
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<tr>
<td>Frequency analysis a) drought b) flood</td>
<td>Frequency analysis a) drought b) flood</td>
<td>Frequency analysis a) drought b) flood</td>
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<td>Workshop B</td>
<td>Workshop B</td>
<td>Workshop B</td>
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<tr>
<td>Human impacts &amp; climate change a) BILAN b) HBV</td>
<td>Human impacts &amp; climate change a) BILAN b) HBV</td>
<td>Human impacts &amp; climate change a) BILAN b) HBV</td>
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<tr>
<td>12:30 – 14:00 Lunchtime</td>
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<td>17.00-19.00</td>
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<td>Opening address² (DoE, UNESCO) 30</td>
<td>Opening address² (DoE, UNESCO) 30</td>
<td>Opening address² (DoE, UNESCO) 30</td>
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<tr>
<td>Welcome and introduction to the Study course Course programme (HH) 15</td>
<td>Welcome and introduction to the Study course Course programme (HH) 15</td>
<td>Welcome and introduction to the Study course Course programme (HH) 15</td>
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<tr>
<td>Introduction lectures and participants 30</td>
<td>Introduction lectures and participants 30</td>
<td>Introduction lectures and participants 30</td>
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<tr>
<td>Introduction to CC, Hydrological drought and Floods CC (IPCC summary) (SBE) 10</td>
<td>Introduction to CC, Hydrological drought and Floods CC (IPCC summary) (SBE) 10</td>
<td>Introduction to CC, Hydrological drought and Floods CC (IPCC summary) (SBE) 10</td>
</tr>
<tr>
<td>Hyd. Drought (Ch. 1) (LT) 10</td>
<td>Hyd. Drought (Ch. 1) (LT) 10</td>
<td>Hyd. Drought (Ch. 1) (LT) 10</td>
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<tr>
<td>Floods (New material) (HH) 10</td>
<td>Floods (New material) (HH) 10</td>
<td>Floods (New material) (HH) 10</td>
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<tr>
<td>Domestic information (DoE) 10</td>
<td>Domestic information (DoE) 10</td>
<td>Domestic information (DoE) 10</td>
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<tr>
<td>15.30 Break</td>
<td>15.30 Break</td>
<td>15.30 Break</td>
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² DoE representative, UNESCO representative
³ Estimated duration, e.g. 30 minutes
⁴ Plenary session
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>19.00</td>
<td>Icebreaker reception (DoE)</td>
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</tbody>
</table>
| 16.00 – 17.00 | Presentations Participants, etc.  
Drought characterization in mid-climatic regions in India (Ranjendra Prasad Pandey)  
Impact of Climate Change in Water Resources of Nepal (Gautam Rajamikar)  
(Plenary) (chair: SD) |
| 16.00 – 18.00 | Workshops  
Workshop A  
Drought & flood frequency analysis  
Workshop B  
Human impacts & climate change |
| 16.00 – 18.00 | Closing Session  
General discussion 30 (ALL, HH)  
16.30  
Study course Review and close (SD) |
Thursday and Friday two parallel workshops will be convened: Workshop A: Drought and flood frequency analysis and Workshop B: Human impacts – climate change (BILAN/HBV).

**DETAILED PROGRAMME**

<table>
<thead>
<tr>
<th>Workshop A: Drought &amp; flood frequency analysis (LT, HH, TS)</th>
<th>Workshop B: Human impacts including climate change (HvL, SBE)</th>
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</thead>
<tbody>
<tr>
<td><strong>Thursday</strong></td>
<td><strong>Thursday</strong></td>
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<tr>
<td>10:00-10:30</td>
<td>10:00-10:30</td>
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<tr>
<td>Introduction and objectives of Workshop A a) and b)</td>
<td>Introduction and objectives of Workshop B</td>
</tr>
<tr>
<td>Presentation of the cases</td>
<td>Modelling concept of a) BILAN and b) HBV (two models – same climate input – compare results?)</td>
</tr>
<tr>
<td>10:30-11:00 Break</td>
<td>10:30-11:00 Break</td>
</tr>
<tr>
<td>11:00-12:30</td>
<td>11:00-12:30</td>
</tr>
<tr>
<td>Presentation and demonstration of computer programs</td>
<td>Impact of climate change: approach</td>
</tr>
<tr>
<td>Discussion &amp; Questions</td>
<td>Catchment description</td>
</tr>
<tr>
<td>Data preparation and exploratory data analysis using software from the CD (drought) and R (flood)</td>
<td>Description of input file for BILAN</td>
</tr>
<tr>
<td>12:30-14:00 Lunchtime</td>
<td>Compilation of input file (students; 1 PC per 2 students)</td>
</tr>
<tr>
<td>14:00-15:30</td>
<td>Model calibration - parameter optimization (groups of 2 students)</td>
</tr>
<tr>
<td>Prepare summary of key drought and flood characteristics for the given streamflow stations</td>
<td>15:30-16:00 Lunchtime</td>
</tr>
<tr>
<td>15:30-16:00 Break</td>
<td>15:30-16:00 Break</td>
</tr>
<tr>
<td>Discussion of the results in the whole group</td>
<td>15:30-18:00</td>
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<tr>
<td>15:30-18:00</td>
<td>Climate change scenarios (whole group, lead: HvL, SBE)</td>
</tr>
<tr>
<td>16:00-18:00</td>
<td>Adaptation of input file (groups of 2 students)</td>
</tr>
<tr>
<td><strong>Friday</strong></td>
<td>Start of processing of results scenario study (groups of 2 students)</td>
</tr>
<tr>
<td>09:00-10:30</td>
<td>09:00-10:30</td>
</tr>
<tr>
<td>Finalising of results according to tasks defined in the case</td>
<td>Finalization of processing of results climate change study and interpretation (groups of 2 students)</td>
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<tr>
<td>Preparation for presentation of case</td>
<td>10:30-11:00</td>
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<tr>
<td>10:30-11:00 Break</td>
<td>11:00-12:30</td>
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<tr>
<td>11:00-12:30</td>
<td>Preparation for presentation, compilation powerpoint presentation Human Influence – climate change (students)</td>
</tr>
</tbody>
</table>
Organizing committee

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E-mail: ths@nve.no
<table>
<thead>
<tr>
<th>Name</th>
<th>Organization and Location</th>
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<tr>
<td>Akter Kahn, Nasrin</td>
<td>Bangladesh Water Development Board, Bangladesh</td>
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<td>Basnet, J.B.</td>
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<td>Dema, Tshering</td>
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<td>Prasad, Jyothi</td>
<td>G B Pant University of Agriculture and Technology, India</td>
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<td>Rajkarnikar, Gautam</td>
<td>Water and Energy Commission Secretariat, Nepal</td>
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<td>Department of Agriculture, Bhutan</td>
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<td>DoE, Bhutan</td>
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<td>Zaidi, Syed M. Faisal</td>
<td>Water Management Centre, Pakistan Poverty Alleviation Fund, Pakistan</td>
</tr>
</tbody>
</table>
Regional Study Course on Climate Change, Hydrological Droughts and Floods
Thimphu, Bhutan 28th November – 3rd December 2010

Evaluation Form

Please complete evaluation before 3rd December at 12:00 hour

We appreciate your critical comments very much, and we will try to respond to it in a next course

The textbook on Hydrological Drought is meant as teaching material for MSc. and PhD courses on Hydrological Drought, but can also be used as self-study material. This study course has also included additional lecture material to cover the topics Climate Change and Floods.

1. How do you perceive the content (focus) of the course? Did it match your expectations?
   Not at all, questionable, acceptable, good, excellent

   [Underline your answer, for example acceptable]
2. How did you find the structure of the course (allocation of time for lectures, oral presentations by the participants, workshops)?

Questionable, acceptable, good, excellent


3. Should there have been more lectures?

Less lectures, acceptable, more lectures


4. Should we have spent less or more time on self-guided tours and worked examples?

Less times, acceptable, more time


5. Should we have spent less or more time on contributions from the participants?

Less time, acceptable, more time


6. Is the textbook on hydrological drought and CD suitable as course material?
   Very poor, poor, acceptable, good, excellent

7. Were the distributed additional publications suitable as course material?
   Very poor, poor, acceptable, good, excellent

8. Did you prepare for the course by studying the distributed publications before coming to Thimphu?
   I did NOT, I did study
9. Evaluation of the different presentations

<table>
<thead>
<tr>
<th>Lecture material</th>
<th>Is the content relevant for you?</th>
<th>How did you find the level of difficulty of the presentation?</th>
<th>What is your option about the focus of the presentation?</th>
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<tbody>
<tr>
<td>Introduction to CC (IPCC Summary)</td>
<td>Stein Beldring</td>
<td></td>
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<tr>
<td>Introduction droughts (Textbook chapter 1) Lena Tallaksen</td>
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<tr>
<td>Introduction to floods</td>
<td>Hege Hisdal</td>
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<td>Projected climate change – impacts on hydrology (IPCC Report)</td>
<td>Stein Beldring</td>
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<td>Hydrological droughts – impacts of climate change (Textbook chapter 2)</td>
<td>Hege Hisdal</td>
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<td>Floods - impacts of climate change (IPCC Report)</td>
<td>Stein Beldring</td>
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<tr>
<td>Drought generating processes (Textbook chapter 3) Henny van Lanen</td>
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<tr>
<td>Flood generating processes</td>
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<td>Hydrological data (Textbook chapter 4)</td>
<td>Gwyn Rees</td>
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<td>Hydrological drought characteristics (Textbook chapter 5)</td>
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<td>Frequency analysis droughts – at site (Textbook chapter 6, Example paper Engeland et al.)</td>
<td>Lena Tallaksen</td>
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<tr>
<td>Frequency analysis – floods – at site (Example paper Engeland et al.)</td>
<td>Thomas Skaugen</td>
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<tr>
<td>Regional frequency analysis – drought (Textbook chapter 6)</td>
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<td>Regional frequency analysis – flood</td>
<td>Thomas Skaugen</td>
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<td>Regionalisation procedures (Textbook chapter 8)</td>
<td>Siegfried Demuth</td>
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<tr>
<td>Human influences BILAN (Textbook chapter 9)</td>
<td>Henny van Lanen</td>
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<tr>
<td>Human influences HBV (Publication about HBV model)</td>
<td>Stein Beldring</td>
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<tr>
<td>Operational applications (Textbook chapter 11)</td>
<td>Gwyn Rees</td>
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</tbody>
</table>
10. Did you participate in parallel workshop A drought, A floods, B BILAN or B HBV?

11. Should the workshop have been shorter or longer?
   Shorter, acceptable, longer

12. What is your opinion about the parallel workshops A and B (i.e. not possible to participate in both)?
   No parallel workshops, parallel workshops OK

13. Was the content of the workshop relevant?
   Not at all, questionable, acceptable, good, excellent

14. How was the level of difficulty?
   Very high, high, acceptable, understandable, easy to understand

15. Did you enjoy giving an own “workshop” presentation
   Not at all, questionable, acceptable, good, excellent

If you have any specific comments on the workshop where you participated, please provide:
16. How do you view the number of participants?
   Fine, too many, more would be fine

17. How did you find the facilities
   Questionable, acceptable, good, excellent

18. How did you find the accommodation?
   Questionable, acceptable, good, excellent

19. Is it OK to start on Sunday afternoon
   Questionable, acceptable, good, excellent

20. How did you find the icebreaker session the first day?
   Questionable, acceptable, good, excellent
FIELD TRIP

21. Is a mid-week field trip needed?
   Questionable, acceptable, good, excellent

22. Did you find the purpose of the field trip of interest?
   Questionable, acceptable, good, excellent

We would be please if you could contribute with your general impression in one or two lines:

________________________________________________________________________________________________________________________________________

________________________________________________________________________________________________________________________________________

________________________________________________________________________________________________________________________________________

Thank you for completing the evaluation form!
ICIMOD News Dec. 10/Jan. 11 Issue 39:
http://www.icimod.org/enews/index.php

27 November – 3 December 2010: Climate change, droughts, and floods in the HKH region, Thimpu, Bhutan

As one of the activities of HKH-FRIEND a regional course on climate change, droughts, and floods in the HKH region was organised in Thimpu, Bhutan from 27 Nov – 3 Dec 2010. The course was hosted by the Hydromet Services Division, Department of Energy of the Royal Govt of Bhutan and organised by Norwegian Water Resources and Energy Directorate and UNESCO, with 16 participants from Bangladesh, Bhutan, India and Nepal and resource persons from the University of Oslo, Norwegian Water Resources and Energy Directorate, Wageningen University, Centre for Ecology and Hydrology UK, and UNESCO. The main aim was to provide comprehensive knowledge about the characteristics of hazards flood and drought hazards and how to analyse these extremes, with a particular focus on climate change impacts.

The course included lectures, hand on exercises, field trips, and presentations from participants. It covered a broad thematic area which included climate change, droughts, and floods. A text book was introduced on climate change, low flow, and droughts. Participants prepared individual projects based on their area of interest in small group exercises. The lowflow group familiarised themselves with software and the various lowflow distributions and choice of distributions. The flood group was introduced to the “R” software and the various extreme flow modules it contains and two modelling groups using BILAN and HBV software with AR4 SRES scenarios to assess the impacts of climate change.

The participants found the training very useful for both research and operational purposes and suggested that in future such training should be of longer duration, particularly the introduction to software and hands on exercises.

Mandira Shrestha
Regional Study Course on Climate Change, Hydrological Droughts and Floods
28th November - 3rd December 2010, Thimpu, Bhutan

Sponsored by UNESCO

Dr. (Mrs.) JYOTHI PRASAD
Associate Professor
Department of Civil Engineering
College of Technology
G B Pant University of Agriculture and Technology
PANTNAGAR-263145, Uttarakhand State, INDIA
**Objectives:**
The main objective of the study course was to give a comprehensive knowledge about the characteristics of the hydro-hazards like floods and droughts and how to analyse these extremes. A particular focus was put on climate change and its impacts on droughts and floods. An other objective was also to encourage co-operation and networking between hydrologists in the Hindu-Kush-Himalaya region through the FRIEND HKH programme.

**Participants:**
Total 21 participants representing 05 countries in different parts of the region namely India, Pakistan, Nepal, Bangladesh and Bhutan took part in this course. This course was organized by the UNESCO and Hindu-Kush-Himalaya IHP-FRIEND, Department of Energy – Ministry of Economic Affairs, Bhutan, Norwegian Water Resources and Energy Directorate. The Organizers of this programme was Dr (Ms.) Hege Hisdal (The Norwegian Water Resources and Energy Directorate [NVE]), Prof Dr Siegfried Demuth (UNESCO, Paris) and Mr Hari Sharma, Department of Energy, Bhutan.

**Course Contents:**
The contents of the intensive five days study course are outlined as below. The first two days of the course consist of lectures combined with hands-on training using selfguided tours, along with a mid-week field trip to Do Chula Punkha, Punkha Dong, Yeseba gauging station and Flood warning station at Wangdue Phodrang. During the last two days participants worked in two parallel workshops. In the first workshop, the participants got hands-on training on flood and drought frequency analysis and in the second workshop the focus was on the assessment of the impact of climate change on flood and drought using physically based hydrological models. Participants worked in small groups on real world data. The course was concluded by a plenary presentation and discussion of the outcome of the workshop. The study course participants were also invited to give short presentations about their own or national studies of hydro-hazards in a changing climate.

**Course in Brief:**
On the first day, 28th Nov, 2010, the participants were welcomed by Er Karma Chhaphel, Director General, DOE, Bhutan. Prof Siegfried Demuth, UNESCO explained about the thrust areas in which UNESCO looking for, Dr Hege Hisdal NVE gave brief introduction of the study course. Mr Dasho Sonam Tshering, Hon’ble Secretary, Ministry of Energy addressed about the Water resources and challenges in Bhutan and the effects of climate change. Followed with this, introduction to Climate change by Dr Stein Beldring, NVE, Hydrological drought by Prof Dr (Ms.) Lena Tallaksen from University of Oslo, new material on floods by Dr Hege Hisdal and the opening programme was concluded with welcome dinner at Hotel Namgay Heritage hotel.

On 29th Nov 2010, the course lecture was started by Ms. Mandira Shrestha of ICIMOD on “Hydrology of the Hindhu-Kush Himalaya region”, followed by the lecture Dr Stein Beldring on Projected climate change – impact on hydrology. In his lecture he covered the IPCC report on emission criteria, how to obtain the hydrological projections and hydrological impacts of climate change in the NORDIC countries and in Asia.

After the tea break, lecture session was continued by Dr Hege Hisdal on Hydrological floods and drought impact of climate change. She explained about the climate variability or climate change, strong interrelationship between climate and water resources systems, how change in one of the systems will induce a change in the other magnitude and frequency of droughts will
increase the uncertainty in water resources planning, which is often based on assumptions of stationary conditions and covered IPCC reports on assessed & compared studies on impact of climate change on water resources – Analyze observed data for trends and changes– Scenario calculations using physically based models. She also emphasized that research is needed to increase the confidence regarding the effects of climate change on drought. Drought threat may increase in the future, but in a global perspective the raising water demand outweigh the effect of climate change.

**Dr. ir. Henny Van Lanen** from Wageningen University, The Netherlands covered the topic on Drought generating processes and concluded with the remark that lack of precipitation causes hydrological droughts; potential evapotranspiration has smaller effect, lower precipitation reduces both actual evapotranspiration and groundwater recharge. He explained that aquifer characteristics strongly determine groundwater discharge and consequently drought development.

**Dr Thomas Skaugen** from NVE, Oslo taught the topic on Flood generating processes and emphasized on Flood proofing. Any combination of structural and non-structural additions, changes or adjustments to structures which reduce or eliminate flood damage real estate or improved real property, water and sanitary facilities, structures and their contents. After the lunch break, there was a lecture on Hydrological drought, impact of climate change, Atmospheric circulation and drought, observed changes, Projections using physically based models were covered and with the final remark that the choice of event definition or index will depend on:
- The purpose of the study
- The hydrological regime under study
- The data availability

The Lecture on Hydrological drought characteristics was by **Dr Hege Hisdal** and covered Drought terminology, Low flow characteristics, Deficit characteristics, Interrelationship between indices, Groundwater drought characteristics and Complex indices.

Later **Mr Gautam Rajkumar**, Nepal gave a presentation on Impact of Climate Change in Water Resources of Nepal.

On 30th Nov, 2010 lecture on “Frequency analysis – at site analysis” was delivered by **Prof Dr Lena M. Tallakse**. In that, she covered the topics like introduction to frequency analysis, basic probability concepts, data for extreme value analysis, probability distributions, estimation methods and she concluded with the comments that

- Frequency analysis is a flexible method that can be performed on a range of data
- Estimation of design events are based on the tail of the distributions and there are large uncertainties in its estimation;
- Regional methods can reduce the uncertainties in at-site estimation by introducing more data, but care should be taken regarding inter site dependence;
- Distribution functions should be chosen based on knowledge of the phenomenon studied and the theoretical base of extreme value analysis

“**Flood Management aspects in India**” with special reference to Tehri Hydropower Project in Uttarakhand, India with the latest video clip of all the spillway gates in operation during the recent heavy floods (Sept.2010) was presented by **Dr (Ms.) Jyothi Prasad**, GBPUA&T, India.
“At site extreme value analysis- floods” topic was discussed by Dr Thomas Skaugen. Regionalisation procedures and estimation at the ungauged sites, was delivered by Dr Hege Hisdal and Prof Dr S Demuth, “Human influences” lecture was delivered by Dr Henny van Lanen and he taught on the land use pattern, climate change, abstractions, surface water control (water transfer), urbanization and Detection and Attribution: approaches and concluded with the following statements;

- Human activities can initiate water scarcity and enhance natural droughts
- Catchment characteristics control if some man induced changes (e.g. climate) have a positive or a negative impact
- Hard to separate human impact on droughts from natural causes using time series of hydrological data.
- Insufficient data on human impacts are available, especially at the continental scale
- Integrated Water Management required to adequately cope with droughts and floods

“Operational Applications” was delivered by Director Gwyn Rees, Centre for Ecology and Hydrology, UK which included Types of applications of Low flow & flood measures with applications to: Small-scale hydro, Flood estimation and State of the environment.

The end of the session presentation were from a participant of Bangladesh by Er Kausher, on “Water Management, Hydrology, floods and climate change impact- the Bangladesh perspective” and Ms Biljana Radiojevic UNESCO, Paris representative on “Can we detect the Impact of Climate change on Flood Regimes”

The field trip was arranged on 1st Dec, 2010 to scenic places like Do Chula Punkha, Punkha Dong, Yesebagauge station and Flood warning station at Wangdue Phodrang to understand the site conditions and instruments used in gauging site.

Two Parallel workshops i.e. Workshop A on drought frequency analysis, Frequency analysis of floods and Workshop B on BILAN and HBV model were held on 2nd and 3rd December 2010. I participated in HBV Model analysis workshop and this model helped me to understand the following. The HBV- model is a conceptual precipitation-runoff model, which is used to simulate the runoff process in a catchment based on data for precipitation, air temperature and potential evapotranspiration. To accomplish this, model computes water balance for the main storage types in the catchment, and to show how these storages change dynamically in response to the varying meteorological inputs. The model was developed by Dr Sten Bergstrom at the Swedish Meteorological and Hydrological Institute in the early 1970's. The HBV model is to some extent a linear model, lumped model, conceptual model, deterministic model. The standard version of the HBV model uses the four main storage components: Snow, Soil moisture, Upper zone and Lower zone. HBV model once properly calibrated, can have many different types of applications like Runoff forecasting, Flood forecasting, to generate runoff time-series from meteorological data (precipitation and air temperature), to fill in missing runoff observations, to determine the effects of changes in the catchment, to study the effects of climate change and as a tool in quality control of runoff data.

After understanding the software, each group used the software to solve the given problem and analyzed the output. The result analysis and conclusions were presented on 3rd Dec 2010. Departure was on 6th Dec, 2010 from PARO Airport (Bhutan) to Delhi by Drukair Royal Bhutan airlines and reached the Pantnagar University.