



RESEARCH PROGRAM ON  
**Climate Change,  
Agriculture and  
Food Security**



**IWMI**

**2013 technical report**

## 1. Activity Reporting

### Activity 560-2013 (Milestone 1.1.1 2013)

**Title:** Socio-economic assessment of the needs and suitability of water storage options and technical feasibility assessment of storage in Nepal; Formulation of storage development guidelines in the context of basin development plan.

**Status: Complete.** Storage development is an effective way to cope with temporal and spatial variability in water resources and as a result – to enhance water and food security. In this study, the technical and socio-economic feasibility of small scale storage systems were tested in the Koshi Basin, Nepal. The impact of Climate change was also assessed in the basin. Results show that there is a great deal of future uncertainty in the region as the RCM outputs do not agree on the magnitude and direction of the impacts. The study also shows that there will be little impact when looking at annual, full basin scales. At sub-basin scale however, under both the A2 and B1 projections, precipitation will increase in the upper Trans-mountain region sub-watersheds in the 2030s and in most of the basin in the 2050s and will decrease in the lower sub-basins in the 2030s. Water yield is found to increase in most of the basin except for the A2 scenario from the 2030s. Seasonal analysis shows that flow volumes will increase during the monsoon and post-monsoon but decrease during the winter and pre-monsoon. As the results from baseline vs. future changes indicate that the impacts of CC are higher at smaller temporal (seasonal) and spatial (sub-basin) scales, if water resources infrastructure are in place such as water storage and distribution systems, which store and transfer water seasonally i.e. from the monsoon into the dry season as well as spatially i.e. from water abundant to deficit areas, then, the problem of water deficit due to any changes in rainfall or flow patterns can be managed and would not be a constraint to water resources development. Therefore, multiple Use Systems for water storage—most notably ponds and tanks—present an effective and economical way to mitigate issues involving water availability. The suitability of such systems depends largely on the characteristics of a community’s demands, such as agricultural and potable water requirements, availability of financial and human capital, and the way the system affects the socio-hydrological fabric of the community such as gender and caste relations. Proper interventions regarding water storage systems must thus be adaptable and uniquely suited to the communities they are instituted in.

#### **Gender component:**

Results from the gender analysis shows that as more men travel overseas for work, women left at home face an increased workload within the house as well as in tasks that would once have been shared with men. Women often cannot hire additional labourers to compensate for the workload of their missing male family members, as remittances are often lower than expected due to high interest rates and exploitation by dalals (middlemen). Women must therefore take the additional workload upon themselves, and have little time or money to invest in the management of new water storage systems. Despite the absence of men, women compared to men continue to possess less knowledge about the usage of the systems and its technical specifications. Women’s roles in the village was perceived as very much defined by men and limited to household work and work in the field, causing much resentment amongst female respondents. Women due to lack of information and education were not confident to come forward and raise their voice against the men.

### Deliverables:

- Guidelines for sustainable development of water storage 'continuum' in the Himalaya region

• An IWMI research report has been submitted, reviewed and the comments are being revised Title: LESSONS FOR UP-SCALING SMALL SCALE AGRICULTURAL WATER STORAGE IN NEPAL. Authorship: Fraser Sugden, Lata Shrestha, Luna Bharati, Pabitra Gurung, Laxmi Maharjan, John Janmaat, James Price, Tashi Sherpa. Accepted with major revisions. It is expected to be printed in early 2014 The following publication has been submitted: Journal: Journal of Development Economics Title: Water Storage Systems and Preference Heterogeneity in Water-Scarce Environments: A Choice Experiment in Nepal's Koshi River Basin Corresponding Author: James Price Co-Authors: John Janmaat, PhD; Fraser Sugden, PhD; Luna Bharati, PhD This report is complete: Alexandra Skodyn, Johannus Janmaat, James Price, Tashi Sherpa, Luna Bharati, Fraser Sugden. 2013. The Economics of Optimal Small-Scale Water Projects: A Case Study in the Koshi Basin Region of Nepal. Project Report. University of British Columbia (UBCO). 41p.

- Stakeholder dissemination workshop.

The final stakeholder dissemination workshop was conducted in partnership with the Department of Irrigation (DOI), Nepal. Around 50 stakeholders from donor agencies (ADB, USAID, WB, IFAD, Embassy of Finland etc.), Government agencies (Department of Irrigation, Water and Energy Commission, Department of soil conservation and watershed management) NGOS and Universities had attended

- A report on water storage development in the context of reducing vulnerability of the country to climate change, focusing primarily on International Koshi Basin.

IWMI Research Report has been written and has undergone review and is being revised. Expected to be printed in early 2014 One project report to ADB has been submitted: Gurung, P.; Bharati, L.; Karki, S. 2013. The assessment and management of water resources under current and future climate conditions in the West Seti sub-basin, Nepal. Consultancy report prepared for the Asian Development Bank (ADB). 71p.

- Analysis of uncertainty associated with climate projections for the Basin and implications for development.

Two journal papers have been accepted and will be published in early 2014 • L. Bharati, P. Gurung, L. Maharjan and Priyantha Jayakody. Current and Future Variability in the Hydrological Regime of the Koshi Basin, Nepal. Accepted with major revisions by Hydrological Sciences Journal • Luna Bharati, Pabitra Gurung, Vladimir Smakhtin and Priyantha Jayakody. The Impact of Climate Change on Water Resources Development in the Koshi Basin, Nepal has been submitted and is being reviewed by the journal of Mountain Research and Development.

### Partners:

UBC; WECS; DoI; ADB; ICIMOD

### Locations:

South Asia (SAs)

## **Activity 561-2013 (Milestone 1.1.2 2013 (1).)**

**Title:** Development and application of approaches and methods for improved efficiency and equity of water allocation in aquaculture-irrigation farming systems of Malawi, Zambia and Mozambique under uncertain climates

**Status: Complete.** As part of collaboration with World Fish and local partners, we adopted a multi-disciplinary approach towards sustainable water resources management for integrated aquaculture-irrigation system. The research targets local storage in small watershed, a farmers' own initiative, as a high potential intervention and examines multiple use of the system by man and women and the impacts on watershed hydrology and agricultural productivity. The research, through actively engaging farmers, NGOs, local line departments, and national universities, carried out intensive field monitoring and survey, hydrological modeling, and stakeholders consultation (through role playing games). A DSS tool called Catchment Water Allocation Tool (CaWAT) was developed to explore various options of land, crop and water management considering effects of climate change. The results and findings were disseminated through farmers's feedback sessions, project annual and closing workshops, and scientific publications.

### **Gender component:**

The activities contribute to increased understanding on women's role in local water resources development and agricultural production systems. The focus of the research on small storage and integrated aquaculture-irrigation system has illustrated that not only women lead the innovations to make maximum use of limited resources, but also these types of clever innovations benefit women considering their mandate for multi-tasking, e.g., homework and farming through integrated production system and water resources development.

### **Deliverables:**

- A suite of diagnostic/ analytical tools for improved water allocation and tradeoff in small-scale irrigation-aquaculture production systems.

We developed a computer DSS tool CaWAT. This software is MS Excel based and allows users to explore various options such as land use, storage, diversions, cropping pattern, and small storage management. The software and the ppt is packed in one zip file.

- Reports/ papers documenting these outputs .

In agreement with partners, the team has stepped in to take up major responsibility of the DSS development. As a result of which the publication has been delayed. However, a list of seven publications have been identified with partners and these are now working in progress. 1. Kam, S.P., Cai, X., Sood, A., Hoanh, C.T., Yen, B.T., Nagoli, J., Chijere, A.(2013). Decision support for water management for integrating aquaculture in small-scale irrigation systems: a case for the Chingale catchment in Malawi. WorldFish, Penang, Malaysia. Project Brief: 2013-40. <http://aas.cgiar.org/publications/decision-support-water-management-integrating-aquaculture-small-scale-irrigation#.UuV6MNL8InI2>. Krywkow, J.; Kam, S. P.; Hoanh, Chu Thai [IWMI]; Chijere, A. D. G.; 2012. Eliciting farming decisions of smallholders in response to water availability conditions in Chingale, southern Malawi. In R. Seppelt; A. A. Voinov; S. Lange; D. Bankamp (Eds.). Managing resources of a limited planet: proceedings of the International Congress on Environmental Modelling and Software (iEMSs), Sixth Biennial Meeting, Leipzig, Germany, 1 - 5 July 2012. Leipzig, Germany: International Environmental Modelling and Software Society (iEMSs). 8p. [http://www.iemss.org/sites/iemss2012/proceedings/E2\\_0787\\_Krywkow\\_et\\_al.pdf](http://www.iemss.org/sites/iemss2012/proceedings/E2_0787_Krywkow_et_al.pdf)

### **Partners:**

WorldFish; Universität Osnabrück; UNIMA; Department of Fisheries, Zambia; Department of Climate Change and Meteorological Services, Malawi; Department of Fisheries, Malawi

#### Locations:

Other

### Activity 562-2013 (Milestone 1.2.1 2013 (2).)

**Title:** Analysis of possible future water re-allocation options to agriculture due to increased water desalination capacity coupled with increased clean energy use - globally. Synthesis of bright spots' examples of successful adaptation to climate change through agricultural water management (AWM).

**Status: Complete.** This study examined historical trends in desalination. The goal of the study was to scientifically look at the viability of meeting future water demand with desalination. The analysis was completed and presented in a conference titled "Water in the Anthropocene: Challenges for Science and Governance. Indicators, Thresholds and Uncertainties of the Global Water System" held at Bonn, Germany on 21-24 May 2013. A peer-reviewed scientific publication has been accepted by Journal of American Water Resources Association to be published in 2014. In the study, cost of desalination was broken up into energy-based and nonenergy based. The learning curves (relationship between cumulative production and market price) for desalination was then developed. Assuming that the photovoltaic (PV) technology will be the dominant form of energy used in the desalination process, the existing PV learning curve and desalination learning curve were combined to explore the viability of large-scale adoption of desalination in the future. The world was divided into 7 regions and it was assumed that water demand from desalinated water will be met only within the 100-km coastal belt. It is shown that, in most of the regions, other than sub-Saharan Africa, Central America and South Asia (where water tariffs are low), the desalination (without considering energy) can become viable by 2040. For PV technology, less than 1 million MW per annum growth is required till 2050 to make it affordable. Globally, desalination with renewable energy can become a viable option to replace domestic and industrial water demand in the 100-km coastal belt by 2050.

#### Gender component:

#### Deliverables:

- Global scenarios and projections of possible water- clean energy nexus implications for agriculture, and a method to develop such projections

Presentation at the conference "Water in the Anthropocene: Challenges for Science and Governance. Indicators, Thresholds and Uncertainties of the Global Water System" at the Bonn, Germany on 21-24 May 2013.

- Related publication

A peer reviewed publication accepted by Journal of American Water Resource Association (JAWRA). The title of the paper is "CAN DESALINATION AND CLEAN ENERGY COMBINED HELP TO ALLEVIATE GLOBAL WATER SCARCITY?"

- A Book on Agricultural Water Management under climate change

A chapter titled "Global Water Requirements of Future Agriculture" is under the final stage of publication - for CABI Book to be printed in 2014

**Partners:**

**Locations:**

Global

### **Activity 563-2013 (Milestone 1.2.1 2013 (2).)**

**Title:** Regional analysis Managed Aquifer Recharge and related interventions in CCAFS Climate Smart Villages as an option to offset climate change impacts and improve water availability and access for poor rural men and women.

**Status: Partially complete.** Inventory of MAR structures was carried out at both study sites. A total of 87 MAR structures were found in 6 project villages within Gujarat. The major aspects noted in this survey were: location, type of structure, catchment area, storage capacity, present management system, use of structure and history. GPS locations of all MAR structures have been recorded. GIS maps with the location of the structures are being prepared. A total of 18 soil samples from the MAR structure in Gujarat have also been collected and tested. Chemical and bacteriological analysis has been undertaken on water samples from six villages in the Gujarat site. Out of 29 water samples tested, 17 were found to be contaminated with pathogenic bacteria, while 10 had relatively high levels of nitrate. The historic data of rainfall, climate, water level and discharge have been collected from the Indian Meteorological Department and the State Water Data Centre for the Gujarat site. Similarly, these data are being obtained for the Rajasthan site. A field day was organized at Badgaon village in Rajasthan in which 110 farmers participated. Field demonstrations of maize crop over 9 ha areas during Kharif 2013 season. In the present Rabi 2013 season, the mustard crop (variety Laxmi) demonstration is being organised over a 16.4 ha area. Weekly monitoring of water levels in Anicuts was implemented during the 2013 monsoon period. This monitoring has continued and it will facilitate an understanding of the extent of groundwater recharge in two study areas to be developed. Water resource and watershed modules have been completed for BJs (Hindi - Bhujal Jaankars, i.e., Groundwater knowledge brokers). Several meetings were held with teachers of schools to establish good rapport. A drawing competition on the theme of water and water sources was held in five schools in Gujarat. 294 students participated in the competition and prizes were distributed to the children with particularly good entries. A postgraduate student did fieldwork on PhotoVoice in the Rajasthan site (four villages and two schools). This work has been quite effective in engaging the local community and gave hands-on experience to BJs, villagers and students (both at high school and university levels) to improve their understanding of the groundwater situation and possible options for improvements. Field data taken on water availability, irrigation practices, water conservation and agricultural production systems in the project areas of Rajasthan and Gujarat during a micro-level survey in February 2013 has been analysed. Based on the results of this survey, a draft of the research paper "Farmers' Practices and Perspectives on Water Management in Semi-arid Areas – A Case Study of Rajasthan and Gujarat, India" has been written. It is ready to be sent to project partners for their suggestions and input and subsequently a final version of the paper

will be prepared for submission to an international journal for publication. Survey results reveal that water availability is the number one issue affecting the sustainability of agricultural production systems and livelihoods of farmers in both regions.

#### **Gender component:**

A total of 110 farmers (including 29 farmwomen), benefited from a field day organized at Badgaon village in project site of Rajasthan on improved agronomic and water management practices for maize cultivation

#### **Deliverables:**

- Quantified managed aquifer recharge (MAR) potential to offset climate change impacts in South and, possibly, South-East Asia, suitability, acceptability, needs and geohydrological feasibility analyses

Two researchers from DSC, three from MPUAT and one from VBKVK have been trained by ACT in the use GIS and preparation of base maps (October, 2013). Data base of relevant parameters (e.g., wells and recharge structures) have been developed future scenario analysis. Dr Peter Dillon presented a paper on behalf of the project team, titled 'Economic, social and environmental benefits of MAR in village scale interventions in rural India – Some insights from Gujarat and Rajasthan', at the International Symposium on Managed Aquifer Recharge (ISMAR 8) in Beijing, China during October 2013. This presentation has now been selected for publication in a special issue of international peer reviewed journal, Water. Dr Maria Varua presented preliminary findings of the fieldwork 'Groundwater and Gender: Understanding the impacts of water availability on wellbeing and livelihood of village communities' at the University of the Philippines (Visayas Campus).

- Documented assessment of various MAR interventions in CCAFS sites

Data taken during micro-level survey on water availability, irrigation practices, water conservation and agricultural production issues in project area of Rajasthan and Gujarat during February 2013 was analysed. A draft of the research paper "Farmers' Practices and Perspectives on Water Management in Semi-arid Areas – A Case Study of Rajasthan and Gujarat, India" based on the above survey work has been written and is ready to be sent to project partners for their comments and input. It will be then submitted to for publication in an international journal by February 2014

#### **Partners:**

MPUAT; CSIRO

#### **Locations:**

South Asia (SAs), Other

### **Activity 564-2013 (Milestone 1.2.1 2013 (2).)**

**Title:** Simulating impacts of possible climate change on irrigation management in selected schemes and in overall Indus basin. Modelling the impacts of climate change on availability of water for agriculture in the Nile and, Possibly - Niger basin

**Status: Incomplete.** This activity was supposed to focus on Indus Basin only. It is probably by mistake that African part, (and correspondingly, the contact person name iss added here. The correct contact persons for this activity are Dr Arif Anwar and Dr Usman Khalid Awan, both at IWMI-Pakistan office. A summary of the status of this activity in Pakistan is as follows. The overall intention is to build an effective decision support system for the

entire Indus Basin (and Indus Basin Irrigation Scheme within it) - based on two models - SWAT (basin hydrology model) and WEAP (water allocation and planning tool), and illustrate the application of this system under different climate scenarios. The activity was supported in 2013, primarily by the funds received from ICIMOD and the government of Netherlands. Both models were setup and calibrated. However, a short length of record available limits the reliability of calibration. A Research Report that described WEAP model application to Indus basin has been produced, but after careful internal review, it was decided that additional work on recalibration of both models, and better link between them is necessary. The team started to work, in the second half of 2013, on revision of both models for a longer period of 15 years - to cater for seasonal variability, which is very important in managing Indus water. We are trying to acquire more input data from relevant agencies in Pakistan, which is a tedious process. The team also works on the new LULCC for entire Indus basin and is trying to include Indian part of the Basin, which was ignored in most studies before. We are trying to achieve more progress in the first half of 2014.

#### **Gender component:**

#### **Deliverables:**

- Models and scenarios for Indus Basin available, alternative water delivery strategies identified, evaluated and summarised in a report / paper that documents these outputs.

The draft Report has been prepared, which contains new aspects for Indus that, despite many previous studies, have not been properly examined before - e.g., water supply and demand gap for different canal command areas under existing and changing climate. The models, however, need to be revised using a longer period of record that caters for seasonal variability

- Model simulations and report comparing the changes in water availability in the Nile and Niger due to +2°C increase in global temperature

This deliverable was erroneously included in this Indus Basin -focused activity.

#### **Partners:**

ICIMOD; Provincial Agriculture Department; PID

#### **Locations:**

East Africa (EA), West Africa (WA)

### **Activity 565-2013 (Milestone 1.3.1 2014 (1).)**

**Title:** Analysis of patterns of vulnerability and adaptive capacity for women, with a focus on agricultural water management in Nepal, North India and Bangladesh. Literature review on the topic and field studies in three communities in watersheds in Nepal considered highly vulnerable to climate change.

**Status: Complete.** The first phase of research in Madhubani (Bihar), Dhanusha and Morang (Nepal) identified how climate stress affects women farmers in Nepal, and identified challenges they face in adapting to change. In particular, it was found that women farmers who are left behind following male out-migration are vulnerable to events such as droughts due to a loss of regular income and support networks, even if they will benefit in the long term. The second phase of the research which also included Bangladesh, investigated a series of case study irrigation projects focused on climate change adaptation to identify ways to improve the benefits for women



farmers and improve the delivery of irrigation interventions. A detailed report has been written for each of the two phases. The first paper in particular, challenges the contention that agrarian stress is primarily linked to climate change, and identifies the intersectionality of climate, economic, cultural and political stresses, which affect agricultural livelihoods. A third important part of the project which encompassed themes from both phases, was a participatory video project organised by Floriane Clement in Dhanusha district. Using participatory video in was based on the observation that farmers, and especially women farmers, have a limited voice in national climate change debates and planning processes. IWMI trained 12 men and women farmers from two villages in Dhanusha District in video-making and editing. The farmers/film-makers formed six groups, who chose two topics each and video-interviewed on their own people from different social groups in their village on the topics selected. Farmers produced in total 12 short films on livelihood adaptation to climatic and societal changes. IWMI partnered with the Nepal Forum of Environmental Journalists (NEFEJ) to develop an expository TV program from the films directed by the farmers. The journalists from NEFEJ showed farmers' films to local or national policy-makers, government officials, development practitioners, and scientist and video-recorded their reaction and comments on the issues raised by the farmers. These comments were added to farmers' films which were then packaged as a 20 min TV episode. The TV episodes were broadcasted every Monday on NTV plus until December 2013. As a final project activity, we organised a workshop with staff from the Department of Irrigation to discuss how to improve the mainstreaming of gender into irrigation projects in Nepal. The results of the workshop have been used to develop a draft gender mainstreaming framework, and this is being further developed this year.

#### Gender component:

The focus of the study was explicitly on gender issues

#### Deliverables:

- A theoretical framework to analyse gender and vulnerability, adaptation, adaptive capacity, and resilience at a macro and local level - developed and tested in the field.

Paper title: Agrarian stress and climate change in the Eastern Gangetic Plains: Gendered vulnerability in a stratified social formation

- A paper describing the results of the study. Analysis of female perceptions on climate change and a role of film-making as a means of women's empowerment in South Asia under changing climate.

The details of the video project and the videos themselves are available at the URL below:<http://gendercc-southasia.iwmi.org/videos.aspx>

- Possibly - local/ national workshop

The workshop "CLIMATE CHANGE, AGRARIAN STRESS AND GENDER IN THE EASTERN GANGETIC PLAINS" was held on November 15th at the Summit Hotel in Lalitpur, and was attended by around 60 delegates. Presenters included Fraser Sugden, Sanjiv de Silva, Floriane Clement, Niki Maskey-Amatya, Anil Philip, Vidya Ramesh, Adiba Karim (iDE Bangladesh), Richard Rose (iDE Bangladesh). Panelists included practitioners and experts in the field of AWM and climate change, including: Prachanda Pradhan, Uttam Raj Timilsina, Lalita Sah, Bharat Pokharel, Sushil Mainali

**SUMMARY OF KEY POINTS**

**Vulnerability:** The workshop showed that climatic stress is perceived by farmers as significant, even if they are not familiar with the concept of 'climate change'. There are however a wide range of stresses on agriculture aside from just climate change which are in part driving out-migration of young males across the Eastern Gangetic Plains. These include the poor terms of trade for agriculture, the monetisation of the economy and growing cash demands, and a breakdown of trust and collective action.

Another key point was that vulnerability to these stresses is intricately connected with class relations. For example, it can determine how one is affected by the losses associated with climatic or economic shocks, one's capacity to adapt. It can also shape where one lives, making one more vulnerable to natural disasters. For example, poorer households in Bangladesh often live on land more vulnerable to flooding. Crucially, gendered vulnerability is intricately connected to class, whereby women from poorer households face by far the greatest constraints such as an increased labour burden due to male out-migration, lack of capital or property rights to diversify their livelihoods, particularly if men are not present. Not all gendered patterns of vulnerability however, are directly connected to class. For example, social norms and pressures on women can shape their capacity to adapt to agrarian stress – and this affects women headed households in particular. The videos shown during the workshop in particular show the intense peer pressure from other women to conform to particular gender norms, impeding women from becoming financially independent following the departure of their husbands. It was clear from the workshop that migration and agrarian stress are intricately connected. Migration both is caused by agrarian stress, yet can also worsen existing stress. Although migrants come from all wealth and caste groups, the effects of migration can be linked to one's economic wealth. Income outside is often not as much as potential migrants expect, and those with lower paid jobs have less money to send to the household members left behind. The shift from a regular cash income (from local labour) to sporadic remittances, can leave family members highly vulnerable in the case for example of a drought or failed harvest. There are also extreme pressures on the families of poorer migrants to repay the debts they accrued to go overseas, impeding adaptation for those left behind. Migration also increases demand for dowry. The labour burden for women from poorer communities is also highest following male out-migration as they can not afford to bring in outside labourers to help on the farm. Another challenge is that following male out migration, women have to play a critical role in managing irrigation systems. This affects their sustainability, particularly when gender norms have not evolved to allow equal participation of women in management, while men lose interest in maintaining the systems as their aspirations are outside the community. It was noted that although there has been a shift to non-farm livelihoods and migration due to agrarian stress this is a survival strategy within the existing socio-economic context, and agriculture is also here to stay. Households cannot subsist on either migrant remittances or agriculture alone, and the two supplement each other. People still depend on farming, but the difference is that it is now largely feminized. In effect, the low wage economy of the Eastern Gangetic Plains, and the centres which receives its migrants, is supported by agriculture back in the villages which sustain families, allowing men to be paid below subsistence wages, while ensuring a continued supply of labour. Accepting that migration is here to stay it is important to look at ways in which migrants' lives can be improved, such as safe migration initiatives.

**Adaptation:** The second phase of the workshop was focused on the issue of adaptation to climate change as well as broader patterns of agrarian stress. Women face some of the greatest challenges adapting, as indicated above, particularly those from poorer socio-economic groups or castes. Barriers include: access to citizenship, access to credit and property, access to remittances themselves – which are often cornered by in-laws. Other challenges include a complex bureaucracy to navigate to benefit from government led schemes to facilitate adaptation (such as tube well provision) and the tendency for large (mostly male) farmers to capture the benefits of the schemes which are implemented. At a policy level, what is discussed by government agencies is often not translated into practice, as the example of many of the Bihar state irrigation policies show. A number of lessons were drawn for what may facilitate successful adaptation, particularly for women. These include:

- 1) Need to enhance household level entitlements – in particular, property rights which can for example allow

households to bore a tube well with government support, or set up a business. Access to communal property rights is also important, for example, collectively managed ponds for fisheries in Bihar have been piloted by the Sakhi foundation, with a strong impact on women's empowerment. Cooperation is critical for adaptation.<sup>2)</sup> Women's empowerment activities remain important: this include the importance to continually engage with women directly in educational and training initiatives. Due to male out-migration, there is a need to include women in training relating to sectors which are not traditionally the 'female' domain such as the management of large canal systems.<sup>3)</sup> The systems around technologies are often as important as the technologies themselves. For example, new technologies which facilitate climate change adaptation will not be effective without forward and backward linkages (e.g. an appropriate market, ability to procure spare parts). This is critical for the sustainability of government and non-government initiatives beyond the project cycle.<sup>4)</sup> Mainstreaming gender in irrigation projects is important for climate change adaptation in the context of male out migration. To do so, some initiatives have taken place, such as the effort to include 33% of women in Department of Irrigation project management committees at a village level. However, it can be difficult to implement and ensure active participation. There is a need to give women a sense of ownership over irrigation. 4) Agriculture and irrigation should also be part of the educational curriculum for all. However, low overall education levels for women can result in difficulties mobilizing and training women farmers, although there have been positive case studies, as RSDC's cooperatives in Dhanusha demonstrate, whereby 20% of women have started engaging in saving schemes for the first time.<sup>5)</sup> Women's participation in adaptation and livelihood diversification projects will be improved if they feel it actually makes an impact on their lives. The example of community forestry demonstrates this.<sup>6)</sup> There is a need to link the basic questions of farmers directly to the implementers and high level policy makers. The media can play an important role in this process.

**Partners:**

NEFEJ

**Locations:**

**Activity 566-2013 (Milestone 1.1.2 2013 (1).)**

**Title:** Developing integrated science-stakeholder-policy approach to Adaptation in Water and Agriculture sectors in Andhra Pradesh, and Tamilnadu states of India. Analysis of production risk and farm technology adoption in climate change prone rainfed eco-systems of Karnataka, Andhra Pradesh and Tamilnadu

**Status: Partially complete.** There are two main componets: a) developing stakeholder based approach in piloting and upscaling different adapatation strategies in the Krishna river basin in Andhra Predesh. Five adaptation strategies/practices coupled with 19 capacity building programs, 6 stakeholder workshops and 2 exposure visits were completed in 2013. Number of farmers covered for piloting these interventions was 100 ( Rabi 2013 season: 33 and kharif 2013 season:67).b) analysing the different adaptation strategies in dryland regions of Andhra Pradesh, Karnataka and Rajasthan states using the base line survey conducted in 2013. As such 1200 households were covered and .about 20 adaptation practices in each region were documented. In total about 68 adaptation practices for the three study regions were studied interms of their additional income over no adaptation practives (control). Household vulnerability mapping and risk in the adoption of the various

adaptation practices were analyzed and risk premium associated with each adaptation practices were worked out. The draft reports are being finalized.

#### **Gender component:**

Gender role and livelihood pattern with different adaptation practices will be analysed

#### **Deliverables:**

- A tool box of measures, up scaling methodologies and policy inputs to the state adaptation strategies

List of adaptation practices are compiled for reporting to the Govt departments for upscaling purposes. Two newsletters (one on climate change policy manual and another on different adaptation strategies) were prepared and circulated. A book chapter on cost of adaptation has been included in the book "Climate change and Agriculture in India: Studies from selected river basins". (eds). K.Palanisami, C.R.Ranganathan, N. Udaya Sekhar and K.Krishna Reddy. Routledge, New Delhi, 2014.

- Advanced econometric tools to quantify vulnerability, production risk and farm technology adoption.

Two econometric tools have been applied to the base line survey data. They are: a) Household vulnerability mapping tool ( three stage Feasible generalized leased squares (FGLS) model) b) risk quantification tools (moment based model). These tools are ready for use in related data analysis.

- Primary survey of 250 households in each state

The baseline survey covered three regions: Andhra Pradesh, Karnataka and Rajasthan, Totally, 1200 households were surveyed including additional hh survey in Andhra Pradesh and Rajasthan. After cleaning the data, 1019 households were kept for analysis.

- Policy workshops with stakeholders.

Policy workshop ( 2 days duration ) was completed in June 2013 involving the line department officials in Krishna Basin. The workshop focused on sharing the experiences about different climate change related adaptation strategies. Policy makers and government officials (14); scientists ( 9); farmers ( 35) attended it. Major issues were : what is the actual cost of these adaptation strategies, why not many farmers adopting them? what follow ups are needed to upscale the adaptation?. Major outputs include: a paper on cost of adaptation strategy

#### **Partners:**

ANGRAU; TNAU; WALAMTARI

#### **Locations:**

South Asia (SAs)

### **Activity 567-2013 (Milestone 1.3.2 2013.) Commissioned**

**Title:** Agricultural sector adaptation planning in Sri Lanka.

**Status: Complete.** The IWMI staff member on the National Expert Committee on Climate Change Adaptation continued to work in an advisory role to the Climate Change Secretariat of the Ministry of Environment. A training workshop was conducted in December 2013 to officials of national water sector agencies on vulnerability assessments in the water sector, on request by the Ministry of Environment. The training was aimed at assisting water sector agencies in preparing Sri Lanka's Third National Communication to the UNFCCC. The report preparation will commence in early 2014. A National level workshop on adaptation to climate

change and especially on the role of water storage as an adaptation option was held on October 9, 2013. The proposed IWMI project on developing sustainable storage scenarios for the country under current and future climates was also presented to stakeholders including government agencies, NGOs and academic institutes, at this workshop.

#### **Gender component:**

#### **Deliverables:**

- Analysis of impacts of climate change on the agricultural sector: Collation of available data on impacts of climate change on the ag sector; new model runs providing plausible future scenarios of what might happen. (GCM projections coupled with available mechanistic rice models).

Studies on the impacts of climate change on the agricultural sector have been compiled under IWMI RR 135 - earlier. Advise and input provided to the Ministry of Environment on preparation of National Adaptation Action Plan throughout the year. A training workshop conducted in December 2013 to officials of national water sector agencies on vulnerability assessments in the water sector on request by the Ministry of Environment. The training was aimed at assisting water sector agencies in preparation of Sri Lanka's third national communication to the UNFCCC, which will commence in 2014.

- National level workshop, involving a wide range of stakeholders and the public sector, aimed to identify a range of promising adaptation options

National level workshop on adaptation to climate change and especially on the role of water storage as an adaptation option was held on October 9, 2013. The proposed IWMI project on developing sustainable storage scenarios for the country under current and future climates was also presented to stakeholders including government agencies, NGOs and academic institutes. The project is expected to be carried out with the wider participation of all stakeholders.

- Adaptation strategy for the sector produced outlining what needs to be done, by who, when and how best achieved.

The National Adaptation Strategy is being prepared by the Ministry of Environment. IWMI as a member of the National Expert Committee on Climate Change Adaptation continues to provide input, guidance and capacity building to agencies and officials involved in the process.

#### **Partners:**

MOE; Department of Irrigation

#### **Locations:**

### **Activity 568-2013 (Milestone 2.1.1 2013.)**

**Title:** Analysing risks from catastrophic floods in Asia, and current trends in catastrophic flooding due to changing climate - with impacts on production, livelihoods and food security - at sub-national scale in selected countries in South Asia and East Africa.

**Status: Partially complete.** This project has several phases of activities including successful completion of mapping flood inundation extent for South Asia and associated flood-related risk to identify flood hotspots for mitigation measures.

## Gender component:

### Deliverables:

- Documented analysis of flood risks and recent flood-related trends in impact on production, livelihoods, and food security in Asia.

Flood mapping extent for Asia and flood risk analysis completed but research publication summarizing the results is in the stage of preparation; expected to be printed in 2014. A presentation was made at the International conference: Amarnath, Giriraj; Pavelic, Paul; Smakhtin, Vladimir. 2013. Analysis of trends in extreme flood events and mitigation strategies in South East Asia. [Abstract only]. In German Aerospace Center (DLR); Germany. Federal Ministry of Education and Research (BMBF). Mekong Environmental Symposium, Ho Chi Minh City, Vietnam, 5-7 March 2013. Abstract volume, Topic 06 - Hazards and disaster risk reduction in the Mekong Basin. Wessling, Germany: German Aerospace Center (DLR); Bonn, Germany: Federal Ministry of Education and Research (BMBF). pp.46.

- Online repository and dissemination of this flood information to users.

Flood Data online repository available in IWMI Water Data Portal Data also been shared to Ministry of Disaster Management (Bangladesh) for wider flood management planning. Presentation in World Irrigation Forum (October, 2013) on "Applications of remote sensing and modeling in flood risk analysis and Irrigation Water Management" [http://www.slideshare.net/IWMI\\_Media/applications-of-remote-sensing-and-modelling-in-flood-risk-analysis-and-irrigation-water-management](http://www.slideshare.net/IWMI_Media/applications-of-remote-sensing-and-modelling-in-flood-risk-analysis-and-irrigation-water-management)

- Analysis of flooding implications for irrigation and crops at large in selected countries of Africa.

One success here in 2013 was that funding that has been received from Nigerian Government for a larger Agricultural Water Management study in the country. Part of this study will be looking at the impacts of floods on crops in Nigeria and on flood risks - from 2014 onwards

### Partners:

MODMR; UN-SPIDER; ICAR

### Locations:

South Asia (SAs)

## Activity 569-2013 (Milestone 2.1.3 2013 (2).)

**Title:** Implementation of cell-phone based Pilot information services (condition of crops, soil, water) to selected farming communities in Egypt, Ethiopia and Sudan.

**Status: Partially complete.** The work under this activity is largely the one under IFAD-funded Project that will finish in mid-2014. The mobile and internet-based service on irrigation, crop growth and weather parameters for the project farmers has been established in all three countries. The assessment of the service has been completed in Ethiopia and is under progress in Egypt and Sudan.

### Gender component:

The project takes care of both the men and women farmers and the farm functionaries.

**Deliverables:**

- Cell-phone and web-based information systems on climate water and crop monitoring at field scale are tested in pilot areas in at least two countries.

The cellphone and web-based information system on climate and water and crop monitoring was tested with pilot farmers (about 60 in each case) in Ethiopia (Chufa Arat) village, Sudan (Gash river catchment area) and in Egypt (Naubariya area). In Sudan region, the additional information on the occurrence of floods was provided. Four capacity building programs were organised at the project sites: two in Sudan and one each in Ethiopia and Egypt. Training Manuals on Flood Forecasting have been published and widely shared and are available through IWMI virtual library. URL is given below. The project plans to organise an end of the Project Meeting and a policy dialogue on this theme with all the partners during mid-2014.

**Partners:**

Water Watch; Basfood; MOIWR; SWERI; HEDBEZ

**Locations:**

Other, East Africa (EA)

## 2. Succinct summary of activities and deliverables by Output level

### Output: 1.1.1

#### Summary:

Storage development is an effective way to cope with temporal and spatial variability in water resources and as a result – to enhance water and food security. Technical and socio-economic feasibility of small scale storage systems were tested in the Koshi Basin, Nepal. The impact of Climate change was also assessed in the basin. Results show that there is a great deal of future uncertainty in the region as the RCM outputs do not agree on the magnitude and direction of the impacts. The study also shows that there will be little impact when looking at annual, full basin scales. At sub-basin scale however, under both the A2 and B1 projections, precipitation will increase in the upper Trans-mountain region sub-watersheds in the 2030s and in most of the basin in the 2050s and will decrease in the lower sub-basins in the 2030s. Water yield is found to increase in most of the basin except for the A2 scenario from the 2030s. Seasonal analysis shows that flow volumes will increase during the monsoon and post-monsoon but decrease during the winter and pre-monsoon. As the results from baseline vs. future changes indicate that the impacts of CC are higher at smaller temporal (seasonal) and spatial (sub-basin) scales, if water resources infrastructure are in place such as water storage and distribution systems, which store and transfer water seasonally i.e. from the monsoon into the dry season as well as spatially i.e. from water abundant to deficit areas, then, the problem of water deficit due to any changes in rainfall or flow patterns can be managed and would not be a constraint to water resources development. Therefore, multiple Use Systems for water storage—most notably ponds and tanks—present an effective and economical way to mitigate issues involving water availability. The suitability of such systems depends largely on the characteristics of a community's demands, such as agricultural and potable water requirements, availability of financial and human capital, and the way the system affects the socio-hydrological fabric of the community such as gender and caste relations. Proper interventions regarding water storage systems must thus be adaptable and uniquely suited to the communities they are instituted in.

It is also shown that as more men travel overseas for work, women left at home face an increased workload within the house as well as in tasks that would once have been shared with men. Women often cannot hire additional labourers to compensate for the workload of their missing male family members, as remittances are often lower than expected due to high interest rates and exploitation by dalals (middlemen). Women must therefore take the additional workload upon themselves, and have little time or money to invest in the management of new water storage systems. Despite the absence of men, women compared to men continue to possess less knowledge about the usage of the systems and its technical specifications. Women's roles in the village was perceived as very much defined by men and limited to household work and work in the field, causing much resentment amongst female respondents. Women due to lack of information and education were not confident to come forward and raise their voice against the men.

Several publications ranging from journal articles to Project Reports have been produced, as described in Activities section. Stakeholder dissemination workshop has been held

### Output: 1.1.2

#### Summary:



A multi-disciplinary approach towards sustainable water resources management for integrated aquaculture-irrigation system was tested in Malawi. The research targeted local storage in small watershed, a farmers' own initiative, as a high potential intervention and examines multiple use of the system by man and women and the impacts on watershed hydrology and agricultural productivity. The research, through actively engaging farmers, NGOs, local line departments, and national universities, carried out intensive field monitoring and survey, hydrological modeling, and stakeholders consultation (through role playing games). A DSS tool called Catchment Water Allocation Tool (CaWAT) was developed to explore various options of land, crop and water management considering effects of climate change. The results and findings were disseminated through farmers's feedback sessions, project annual and closing workshops, and scientific publications.

The activities contribute to increased understanding on women's role in local water resources development and agricultural production systems. The focus of the research on small storage and integrated aquaculture-irrigation system has illustrated that not only women lead the innovations to make maximum use of limited resources, but also these types of clever innovations benefit women considering their mandate for multi-tasking, e.g., homework and farming through integrated production system and water resources development.

relevant activities in India included two directions. First was- developing stakeholder based approach in piloting and upscaling different adaptation strategies in the Krishna river basin in Andhra Pradesh State. Five adaptation strategies/practices coupled with 19 capacity building programs, 6 stakeholder workshops and 2 exposure visits were completed in 2013. Number of farmers covered for piloting these interventions was 100 ( Rabi 2013 season: 33 and kharif 2013 season:67).

Second direction in India was - analyzing different adaptation strategies in dryland regions of Andhra Pradesh, Karnataka and Rajasthan states. 1200 households were covered and about 20 adaptation practices in each region were documented. In total about 68 adaptation practices for the three study regions were studied.. Household vulnerability mapping and risk in the adoption of the various adaptation practices were analyzed and risk premium associated with each adaptation practice were worked out.

## **Output: 1.2.1**

### **Summary:**

Historical trends in desalination and prospects for future water supply combined with the use of solar energy globally were examined. The analysis was completed and presented in a conference titled "Water in the Anthropocene: Challenges for Science and Governance. Indicators, Thresholds and Uncertainties of the Global Water System" held at Bonn, Germany on 21-24 May 2013. A peer-reviewed scientific publication has been accepted by Journal of American Water Resources Association to be published in 2014. In the study, cost of desalination was broken up into energy-based and nonenergy based. The learning curves (relationship between cumulative production and market price) for desalination was then developed. Assuming that the photovoltaic (PV) technology will be the dominant form of energy used in the desalination process, the existing PV learning curve and desalination learning curve were combined to explore the viability of large-scale adoption of desalination in the future. The world was divided into 7 regions and it was assumed that water demand from desalinated water will be met only within the 100-km coastal belt. It is shown that, in most of the regions, other

than sub-Saharan Africa, Central America and South Asia (where water tariffs are low), the desalination (without considering energy) can become viable by 2040. For PV technology, less than 1 million MW per annum growth is required till 2050 to make it affordable. It was shown that globally, desalination with renewable energy can become a viable option to replace domestic and industrial water demand in the 100-km coastal belt by 2050.

In another study, a survey of managed aquifer recharge (MAR) structures was carried out in two study sites in India. A total of 87 MAR structures were found in 6 project villages within Gujarat. The major aspects noted in this survey were: location, type of structure, catchment area, storage capacity, present management system, use of structure and history. GPS locations of all MAR structures have been recorded.

A total of 18 soil samples from the MAR structure in Gujarat have also been collected and tested. Chemical and bacteriological analysis has been undertaken on water samples from six villages in the Gujarat site. Out of 29 water samples tested, 17 were found to be contaminated with pathogenic bacteria, while 10 had relatively high levels of nitrate.

A field day was organized at Badgaon village in Rajasthan in which 110 farmers participated.

Field demonstrations of maize crop over 9 ha areas during Kharif 2013 season. In the present Rabi 2013 season, the mustard crop (variety Laxmi) demonstration is being organized over a 16.4 ha area.

Weekly monitoring of water levels in Anicuts was implemented during the 2013 monsoon period. This monitoring has continued and it will facilitate an understanding of the extent of groundwater recharge in two study areas.

Water resource and watershed modules have been completed for BJs (Hindi - Bhujal Jaankars, i.e., Groundwater knowledge brokers).

Several meetings were held with teachers of schools to establish good rapport. A drawing competition on the theme of water and water sources was held in five schools in Gujarat. 294 students participated in the competition and prizes were distributed to the children with particularly good entries.

The work in Rajasthan was effective in engaging local community and gave hands-on experience to BJs, villagers and students (both at high school and university levels) to improve their understanding of the groundwater situation and possible options for improvements.

Field data taken on water availability, irrigation practices, water conservation and agricultural production systems in the project areas of Rajasthan and Gujarat during a micro-level survey in February 2013 has been analysed. Based on the results of this survey, a draft of the research paper "Farmers' Practices and Perspectives on Water Management in Semi-arid Areas – A Case Study of Rajasthan and Gujarat, India" has been written. It is

ready to be sent to project partners for their suggestions and input and subsequently a final version of the paper will be prepared for submission to an international journal for publication. Survey results reveal that water availability is the number one issue affecting the sustainability of agricultural production systems and livelihoods of farmers in both regions.

Research in Indus Basin intends to build an effective decision support system for the entire Basin (and Indus Basin Irrigation Scheme within it) - based on two models - SWAT (basin hydrology model) and WEAP (water allocation and planning tool), and illustrate the application of this system under different climate scenarios. Both models were setup and calibrated, but additional work on recalibration of both models, and better link between them is necessary. The team started to work, in the second half of 2013, on revision of both models for a longer period of 15 years - to cater for seasonal variability, which is very important in managing Indus water. We are trying to acquire more input data from relevant agencies in Pakistan, which is a tedious process. The team also works on the new LULCC for entire Indus basin and is trying to include Indian part of the Basin, which was ignored in most studies before.

### **Output: 1.3.1**

#### **Summary:**

This was an explicit gender-focused research. Research in Madhubani (Bihar), Dhanusha and Morang (Nepal) identified how climate stress affects women farmers, and identified challenges they face in adapting to change. In particular, it was found that women farmers who are left behind following male out-migration are vulnerable to events such as droughts due to a loss of regular income and support networks, even if they will benefit in the long term.

The second phase of research, which also included Bangladesh, investigated a series of case study irrigation projects focused on climate change adaptation to identify ways to improve the benefits for women farmers and improve the delivery of irrigation interventions. A detailed report has been written for each of the two phases. The first paper in particular, challenges the contention that agrarian stress is primarily linked to climate change, and identifies the intersectionality of climate, economic, cultural and political stresses, which affect agricultural livelihoods.

A third important part of the project which encompassed themes from both phases, was a participatory video project Dhanusha district of Nepal (reported also as a Case study). It was observed that farmers, and especially women farmers, have a limited voice in national climate change debates and planning processes. IWMI trained 12 men and women farmers from two villages in Dhanusha District in video-making and editing. The farmers/film-makers formed six groups, who chose two topics each and video-interviewed on their own people from different social groups in their village on the topics selected. Farmers produced in total 12 short films on livelihood adaptation to climatic and societal changes. IWMI partnered with the Nepal Forum of Environmental Journalists (NEFEJ) to develop an expository TV program from the films directed by the farmers. The journalists from NEFEJ showed farmers' films to local or national policy-makers, government officials, development

practitioners, and scientist and video-recorded their reaction and comments on the issues raised by the farmers. These comments were added to farmers' films which were then packaged as a 20 min TV episode. The TV episodes were broadcasted every Monday on NTV plus until December 2013.

As a final project activity, we organised a workshop with staff from the Department of Irrigation to discuss how to improve the mainstreaming of gender into irrigation projects in Nepal. The results of the workshop have been used to develop a draft gender mainstreaming framework, and this will be further developed in 2014.

### **Output: 1.3.2**

#### **Summary:**

The IWMI staff member on the National Expert Committee on Climate Change Adaptation continued to work in an advisory role to the Climate Change Secretariat of the Ministry of Environment. A training workshop was conducted in December 2013 to officials of national water sector agencies on vulnerability assessments in the water sector, on request by the Ministry of Environment. The training was aimed at assisting water sector agencies in preparing Sri Lanka's Third National Communication to the UNFCCC. The report preparation will commence in early 2014. A National level workshop on adaptation to climate change and especially on the role of water storage as an adaptation option was held in October 2013. The proposed IWMI project on developing sustainable storage scenarios for the country under current and future climates was also presented to stakeholders including government agencies, NGOs and academic institutes, at this workshop.

### **Output: 2.1.1**

#### **Summary:**

Flood mapping extent for Asia and flood risk analysis completed. Research publication summarizing the results is in the stage of preparation; expected to be printed in 2014. All spatial outputs for South Asia are available at online IWMI Water Data Portal. Data also been shared to Ministry of Disaster Management (Bangladesh) for wider flood management planning.

Several presentations on flood risk mapping in Asia were made, including World Irrigation Forum (October, 2013) on "Applications of remote sensing and modeling in flood risk analysis and Irrigation Water Management" [http://www.slideshare.net/IWMI\\_Media/applications-of-remote-sensing-and-modelling-in-flood-risk-analysis-and-irrigation-water-management](http://www.slideshare.net/IWMI_Media/applications-of-remote-sensing-and-modelling-in-flood-risk-analysis-and-irrigation-water-management)

The work spreads between WLE and CCAFS and is supported from both CCAFS regional funds and CCAFS center funds. It is also extending into South East Asia and captured the attention of the Insurance Industry, which who we are currently exploring the possibilities of collaborative work, and putting it into insurance practice in SA and SEA.

On top of what is reported here, IWMI recently initiated similar, but more detailed studies in Sri Lanka. IWMI and MAFF (Japan) working on a research project to mitigate impacts of flood on agriculture in Sri Lanka in providing effective flood protection measures and improving policy for sustainable agriculture. The intention is to estimate losses as it is essential for facilitating good decision making at the district, province and national

levels and to appraise aid agencies for necessary assistance.

**Output: 2.1.3**

**Summary:**

The work under this activity is largely the one under IFAD-funded Project that will finish in mid-2014. The mobile and internet-based service on irrigation, crop growth and weather parameters for the project farmers has been established in all three countries -Ethiopia, Egypt and Sudan

The cellphone and web-based information system on climate and water and crop monitoring was tested with pilot farmers (about 60 in each case) in Ethiopia (Chufa Arat) village, Sudan (Gash river catchment area) and in Egypt (Naubariya area). In Sudan region, the additional information on the occurrence of floods was provided.

Four capacity building programs were organized at the project sites: two in Sudan and one each in Ethiopia and Egypt. Training Manuals on Flood Forecasting have been published and widely shared and are available through IWMI virtual library.

### 3. Publications

#### Publication #1

**Type:** Conference proceedings

**CCAFS Themes:** Theme 2

**Citation:** Amarnath, Giriraj [IWMI]; Simons, G.; Sharma, Bharat [IWMI]; Mohammed, Y. [NARS]; Gismalla, Y. [NARS]; Smakhtin, Vladimir [IWMI] 2013. Smart-ICT for weather and water information and advice to smallholders in Africa. In UNESCO-IHE Institute for Water Education. Conference on New Nile Perspectives Scientific Advances in the eastern Nile Basin, Khartoum, Sudan 6-8 May 2013. Advance copy of extended abstracts. Delft, Netherlands: UNESCO-IHE Institute for Water Education. pp.117-125

#### Publication #2

**Type:** Journal papers

**CCAFS Themes:** Theme 2

**Citation:** Amarnath, G. (2013), An algorithm for rapid flood inundation mapping from optical data using a reflectance differencing technique. Journal of Flood Risk Management. doi: 10.1111/jfr3.12045

#### Publication #3

**Type:** Journal papers

**CCAFS Themes:** Theme 2

**Citation:** Uddin K., Gurung D.R., Giriraj A., Shrestha B. (2013). Application of Remote Sensing and GIS for Flood Hazard Management: A Case Study from Sindh Province, Pakistan. American Journal of Geographic Information System 2(1): 1-5

#### Publication #4

**Type:** Conference proceedings

**CCAFS Themes:** Theme 2

**Citation:** Amarnath, Giriraj; Pavelic, Paul; Smakhtin, Vladimir. 2013. Analysis of trends in extreme flood events and mitigation strategies in South East Asia. [Abstract only]. In German Aerospace Center (DLR); Germany. Federal Ministry of Education and Research (BMBF). Mekong Environmental Symposium, Ho Chi Minh City, Vietnam, 5-7 March 2013. Abstract volume, Topic 06 - Hazards and disaster risk reduction in the Mekong Basin. Wessling, Germany: German Aerospace Center (DLR); Bonn, Germany: Federal Ministry of Education and Research (BMBF). pp.46.

## Publication #5

**Type:** Conference proceedings

**CCAFS Themes:** Theme 2

**Citation:** Amarnath, Giriraj. 2013. Cascading Ganges: floods and their impact in the eastern Gangetic Plains. In Sharma, Bharat R.; Prathapar, Sanmugam A. Moving from water problems to water solutions: research needs assessment for the eastern Gangetic Plains. Proceedings of the International Workshop held at the National Agricultural Science Complex (NASC), Indian Council of Agricultural Research (ICAR), New Delhi, India, 7-8 May 2013. Colombo, Sri Lanka: International Water Management Institute (IWMI). CGIAR Research Program on Water, Land and Ecosystems (WLE). pp.59-68.

## Publication #6

**Type:** Other

**CCAFS Themes:** Theme 1

**Citation:** Savoskul, Oxana S.; Smakhtin, Vladimir. 2013. Glacier systems and seasonal snow cover in six major Asian river basins: water storage properties under changing climate. Colombo, Sri Lanka: International Water Management Institute (IWMI). 61p. (IWMI Research Report 149) doi: <http://dx.doi.org/10.5337/2013.203>

## Publication #7

**Type:** Other

**CCAFS Themes:** Theme 1

**Citation:** Savoskul, Oxana S.; Smakhtin, Vladimir. 2013. Glacier systems and seasonal snow cover in six major Asian river basins: hydrological role under changing climate. Colombo, Sri Lanka: International Water Management Institute (IWMI). 45p. (IWMI Research Report 150).

doi: <http://dx.doi.org/10.5337/2013.204>

## Publication #8

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Lacombe G, Smakhtin V, Hoanh CT. 2013. Wetting tendency in the Central Mekong Basin consistent with climate-change-induced atmospheric disturbances already observed in East Asia.

Theoretical and Applied Climatology. 111(1-2): 251-263. doi: 10.1007/s00704-012-0654-6

## Publication #9

**Type:** Conference proceedings

**CCAFS Themes:** Theme 1

**Citation:** Lacombe, Guillaume; Smakhtin, Vladimir; Hoanh, Chu Thai. 2013. Possible link between global warming and rainfall trends in the Mekong Basin. [Abstract only]. In German Aerospace Center (DLR); Germany. Federal Ministry of Education and Research (BMBF). Mekong Environmental Symposium, Ho Chi Minh City, Vietnam, 5-7 March 2013. Abstract volume, Topic, 05 - Mekong Basin hydrology and hydrography. Wessling, Germany: German Aerospace Center (DLR); Bonn, Germany: Federal Ministry of Education and Research (BMBF) pp.63.

## Publication #10

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Vermulen, S. J.; Challinor, A., J.; Thornton, P. K.; Campbell, B. M.; Eriyagama, N.; Vervoort, J. M.; Kinyangi, J.; Jarvis, A.; Laderach, P.; Ramirez-Villegas, J.; Nicklin, K. J.; Hawkins, E.; Smith, D., R. 2013. Addressing Uncertainty in Adaptation Planning for Agriculture. Proceedings of the National Academy of Sciences (PNAS) ([www.pnas.org/cgi/doi/10.1073/pnas.1219441110](http://www.pnas.org/cgi/doi/10.1073/pnas.1219441110))

## Publication #11

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Forkuor, G., Pavelic, P., Asare, E. and Obuobie, E. (2013) Modelling potential areas of groundwater development for agriculture in northern Ghana using GIS/RS. Hydrological Sciences Journal, DOI:10.1080/02626667.2012.754101

## Publication #12

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Pavelic, P., Villholth, K.G. and Verma, S. (2013). Identifying the barriers and pathways forward for expanding the use of groundwater for irrigation in Sub-Saharan Africa. Water International 38(4): 363-368, DOI:10.1080/02508060.2013.821643

## Publication #13

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Surinaidu, L., Bacon, C.G.D. and Pavelic, P. (2013). Agricultural groundwater management in the Upper Bhima Basin: Current status and future scenarios. Hydrol. Earth Syst. Sci., 17:507–517, doi:10.5194/hess-17-507-2013.



### Publication #14

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Xenarios, S. and Pavelic, P. (2013). Assessing and forecasting groundwater development costs in Sub-Saharan Africa. *Water SA*, 39(4):529-537. [doi: <http://dx.doi.org/10.4314/wsa.v39i4.12>].

### Publication #15

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Anayah, F.M., Kaluarachchi, J.J., Pavelic, P. and Smakhtin, V. (2013). Predicting groundwater recharge in Ghana by estimating evapotranspiration. *Water International*, 38(4): 408-432, DOI: 10.1080/02508060.2013.821642

### Publication #16

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Kumar, S., Pavelic, P., George, B., Venugopal, K. and Nawarathna, B. (2013) Integrated Modeling Framework to Evaluate Conjunctive Use Options in a Canal Irrigated Area. *J. Irrig. Drain Eng.*, 139(9):766–774.

### Publication #17

**Type:** Book chapters

**CCAFS Themes:** Theme 1

**Citation:** Owusu, V., Asante, A.V. and Pavelic, P. (2013). Assessing the factors influencing groundwater irrigation technology adoption in Ghana. In: *Irrigation Management, Technologies and Environmental Impact*. Editor: M. Hossain Ali, Chapter 7, pp. 181-192, Nova Science Publishers, Hauppauge, USA

### Publication #18

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Pavelic, P., Villholth, K.G., Shu, Y., Rebelo, L-M. and Smakhtin, V. (2013). Smallholder groundwater irrigation in Sub-Saharan Africa: country-level estimates of development potential. *Water International*, 38(4): 392-407, DOI: 10.1080/02508060.2013.819601

### Publication #19

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Shah, T., Verma, S. and Pavelic, P. (2013). Understanding smallholder irrigation in Sub-Saharan Africa: results of a sample survey from nine countries, *Water International*, 38(6):809-826, DOI: 10.1080/02508060.2013.843843

### Publication #20

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Torou, B.M., Favreau, G., Barbier, B., Pavelic, P., Illou, M. and Sidibé, F. (2013). Constraints and opportunities for groundwater irrigation arising from hydrologic shifts in the Iullemeden Basin, south-western Niger. *Water International*, 38(4): 465-479, DOI: 10.1080/02508060.2013.817042

### Publication #21

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Pavelic, P., Giordano, M., Keraita, B., Ramesh, V. and Rao, T. [Eds.]. (2012) Groundwater availability and use in Sub-Saharan Africa: a review of 15 countries. Colombo, Sri Lanka: International Water Management Institute (IWMI), 274p. [doi: 10.5337/2012.213]

### Publication #22

**Type:** Journal papers

**CCAFS Themes:** Theme 1, Theme 4.2

**Citation:** Sood, Aditya; Muthuwatta, Lal; McCartney, Matthew. 2013. A SWAT evaluation of the effect of climate change on the hydrology of the Volta River Basin. *Water International*, 38(3):297-311.

### Publication #23

**Type:** Working papers

**CCAFS Themes:** Theme 1

**Citation:** Hoanh, Chu Thai. 2013. ACIAR Project on Climate Change Affecting Land Use in the Mekong Delta:

Adaptation of Rice-based Cropping Systems (CLUES). Technical report no. 1. Canberra, Australia: Australian Centre for International Agricultural Research (ACIAR). 16p.

## Publication #24

**Type:** Working papers

**CCAFS Themes:** Theme 1

**Citation:** Hoanh, Chu Thai. 2013. ACIAR Project on Climate Change Affecting Land Use in the Mekong Delta: Adaptation of Rice-based Cropping Systems (CLUES). Technical report no. 2. Canberra, Australia: Australian Centre for International Agricultural Research (ACIAR). 25p.

## Publication #25

**Type:** Conference proceedings

**CCAFS Themes:** Theme 1

**Citation:** Ngo, P.; van Ngoc, N.; Quang, T. T.; Duc, D. T.; Phuc, T. T.; Hoanh, Chu Thai; Xuan, H. N.; Huy, K. N. 2013. Impact of sea level rise on submergence, salinity and agricultural production in a coastal province of the Mekong River Delta, Vietnam [Abstract only]. In German Aerospace Center (DLR); Germany. Federal Ministry of Education and Research (BMBF). Mekong Environmental Symposium, Ho Chi Minh City, Vietnam, 5-7 March 2013. Abstract volume, Topic 09 - Mekong Delta: climate change related challenges. Wessling, Germany: German Aerospace Center (DLR); Bonn, Germany: Federal Ministry of Education and Research (BMBF). 1p.

## Publication #26

**Type:** Other

**CCAFS Themes:** Theme 2

**Citation:** Amarnath, Giriraj; Sharma, Bharat. 2013. Manual of the Training on Application of Remote Sensing and GIS in Flood Inundation Mapping for Spate Irrigation Assessment in Sudan, jointly organized by IWMI, the Hydraulic Research Institute (HRS), Sudan, and the International Fund for Agricultural Development (IFAD), held at Wad Medani, Sudan, 15-17 January 2013. Colombo, Sri Lanka: International Water Management Institute (IWMI). 96p

## Publication #27

**Type:** Other

**CCAFS Themes:** Theme 2

**Citation:** Amarnath, Giriraj; Rajah, Ameer. 2013. Manual of the Training on Flood Inundation Mapping and Modeling: Case Study of Bangladesh, held at the Bangladesh Space Research and Remote Sensing Organization, Dhaka, Bangladesh, 12 - 16 May 2013. Colombo, Sri Lanka: International Water Management Institute (IWMI).

119p.

## Publication #28

**Type:** Other

**CCAFS Themes:** Theme 2

**Citation:** Amarnath, Giriraj; Alahacoon, Niranga; Sharma, Bharat; Smakhtin, Vladimir. 2013. Manual of the Training on Development of Flood Forecasting System for Gash Basin using Hydrological Model System, held at the Hydraulic Research Station (HRS), Kassala, Sudan, 27-29 August 2013. Colombo, Sri Lanka: International Water Management Institute (IWMI). 83p

## Publication #29

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Boelee, Eline; Yohannes, M.; Poda, J.-N.; McCartney, Matthew; Hagos, Fitsum; Cecchi, P.; Kibret, S.; Laamrani, H. 2013. Options for water storage and rainwater harvesting to improve health and resilience against climate change in Africa. *Regional Environmental Change*, 13(3):509-519.

## Publication #30

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Eguavo, I.; McCartney, Matthew. 2013. Water storage: a contribution to climate change adaptation in Africa. *Rural* 21, 47(1):38-41.

## Publication #31

**Type:** Book chapters

**CCAFS Themes:** Theme 1

**Citation:** Ferede, T.; Ayenew, A. B.; Hanjra, Munir A. 2013. Agroecology matters: impacts of climate change on agriculture and its implications for food security in Ethiopia. In Hanjra, Munir A. (Ed.). *Global food security: emerging issues and economic implications*. New York, NY, USA: Nova Science Publishers. pp.71-111. (Global Agriculture Developments)

### Publication #32

**Type:** Journal papers

**CCAFS Themes:** Theme 1, Theme 3

**Citation:** Lloyd, C. R.; Rebelo, Lisa-Maria; Finlayson, C. M. 2013. Providing low-budget estimations of carbon sequestration and greenhouse gas emissions in agricultural wetlands. *Environmental Research Letters*, 8(1):1-13.

### Publication #33

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Mainuddin, M.; Kirby, M.; Hoanh, Chu Thai. 2013. Impact of climate change on rainfed rice and options for adaptation in the lower Mekong Basin. *Natural Hazards*, 66(2):905-938.

### Publication #34

**Type:** Other

**CCAFS Themes:** Theme 1

**Citation:** McCartney, Matthew; Rebelo, Lisa-Maria; Xenarios, Stefanos; Smakhtin, Vladimir. 2013. Agricultural water storage in an era of climate change: assessing need and effectiveness in Africa. Colombo, Sri Lanka: International Water Management Institute (IWMI). 37p. (IWMI Research Report 152)

doi: <http://dx.doi.org/10.5337/2013.207>

### Publication #35

**Type:** Other

**CCAFS Themes:** Theme 1

**Citation:** McCornick, Peter; Smakhtin, Vladimir; Bharati, Luna; Johnston, Robyn; McCartney, Matthew; Sugden, Fraser; Clement, Floriane; McIntyre, Beverly. 2013. Tackling change: future-proofing water, agriculture, and food security in an era of climate uncertainty. Colombo, Sri Lanka: International Water Management Institute (IWMI). 36p.

### Publication #36

**Type:** Policy briefs

**CCAFS Themes:** Theme 1

**Citation:** Nagothu, U. S.; Xenarios, S.; Rafoss, T.; Geethalakshmi, V.; Lakshmanan, A.; Annamalai, H.; Kuppanan, Palanisami; Kakumanu, Krishna Reddy; Balaji, N. 2013. Sustaining rice production in a changing climate: testing climate uncertainties and validating selected adaptation measures. Policy manual, Climarice II Project. Aas,

Norway: Norwegian Institute for Agricultural and Environmental Research (Bioforsk); Honolulu, Hawaii: International Pacific Research Center (IPRC); Hyderabad, India: International Water Management Institute (IWMI); Chennai, India: Indian Institute of Technology; Coimbatore, India: Tamil Nadu Agricultural University (TNAU) 12p.

### Publication #37

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Qadir, Manzoor; Noble, Andrew; Chartres, Colin. 2013. Adapting to climate change by improving water productivity of soils in dry areas. *Land Degradation and Development*, 24(1):12-21.

doi: <http://dx.doi.org/10.1002/ldr.1091>

### Publication #38

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Qureshi, M. E.; Hanjra, Munir A.; Ward, J. 2013. Impact of water scarcity in Australia on global food security in an era of climate change. *Food Policy*, 38:136-145.

doi: <http://dx.doi.org/10.1016/j.foodpol.2012.11.003>

### Publication #39

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Sapkota, Pratibha; Bharati, Luna; Gurung, Pabitra; Kaushal, N.; Smakhtin, Vladimir. 2013. Environmentally sustainable management of water demands under changing climate conditions in the Upper Ganges Basin, India. *Hydrological Processes*, 27(15):2197-2208.

doi: <http://dx.doi.org/10.1002/hyp.9852>

### Publication #40

**Type:** Book chapters

**CCAFS Themes:** Theme 1, Theme 3

**Citation:** Shah, Tushaar. 2013. Climate change and groundwater: India's opportunities for mitigation and adaptation. In Prakash, A.; Singh, S.; Goodrich, C. G; Janakarajan, S. (Eds.). *Water resources policies in South Asia*. New Delhi, India: Routledge. pp.213-243.

## Publication #41

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Sharma, Bharat. 2013. Impact of climate change on water resources and potential adaptations for Indian agriculture. *Annals of Agricultural Research*, 34(1):1-14.

## Publication #42

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Sharma, Bharat R.; de Condappa, D. 2013. Opportunities for harnessing the increased contribution of glacier and snowmelt flows in the Ganges basin. *Water Policy*, 15(S1):9-25.

doi: <http://dx.doi.org/10.2166/wp.2013.008>

## Publication #43

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Sood, Aditya; Muthuwatta, Lal; McCartney, Matthew. 2013. A SWAT evaluation of the effect of climate change on the hydrology of the Volta River Basin. *Water International*, 38(3):297-311.

doi: <http://dx.doi.org/10.1080/02508060.2013.792404>

## Publication #44

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Tang, B.-H.; Shrestha, B.; Li, Z.-L.; Liu, G.; Ouyang, H.; Gurung, D. R.; Amarnath, Giriraj; Aung, K. S. 2013. Determination of snow cover from MODIS data for the Tibetan Plateau Region. *International Journal of Applied Earth Observation and Geoinformation*, 21:356-365.

doi: <http://dx.doi.org/10.1016/j.jag.2012.07.014>

## 4. Communications

### Media campaigns:

#### Media Releases:

Warsaw, Poland – November 15th 2013 – Climate change will have a “profound” impact on water resources that could have serious knock-on effects for agriculture, according to a new report published today

#### Blogs:

<http://wle.cgiar.org/blogs/2013/10/03/new-storage-strategies-could-manage-floods-and-droughts/>

<http://wle.cgiar.org/blogs/2013/11/25/hydrologist-reality-check-impact-rests-on-social-inclusion/>

<http://wle.cgiar.org/blogs/2013/11/20/adapting-the-financial-climate-for-landscapes/>

<http://wle.cgiar.org/blogs/2013/11/15/tackling-climate-change-adaptation-by-consulting-women/>

#### Websites:

<http://www.iwmi.cgiar.org/2013/05/linking-climate-change-and-water-resources-in-the-upper-blue-nile-2/>

<http://www.iwmi.cgiar.org/2013/06/how-to-prevent-the-volta-countries-from-drying-up/>

<http://www.iwmi.cgiar.org/2013/06/sri-lankan-water-history-informs-global-climate-change-study/>

<http://www.iwmi.cgiar.org/2013/08/mountain-meltdown/>

<http://www.iwmi.cgiar.org/2013/11/smarter-water-use-for-an-uncertain-climate/>

### Social media campaigns:

it is not clear what this is and how is it different from media campaigns.

### Newsletters:

IWMI Monthly Update - November (Dec 2013)

<http://archive.benchmarkemail.com/International-Water-Manegement-Institute--IWMI-/newsletter/IWMI-Monthly-Update---November>

IWMI Monthly Update - September 2013 (Oct 2013)

<http://archive.benchmarkemail.com/International-Water-Manegement-Institute--IWMI-/newsletter/IWMI-Monthly-Update---September-2013>

IWMI goes Mobile - September 05 2013 (Sep 2013)

<http://archive.benchmarkemail.com/International-Water-Manegement-Institute--IWMI-/newsletter/IWMI-goes-Mobile---September-05-2013>

IWMI Monthly Update - August 2013 (Aug 2013)

<http://archive.benchmarkemail.com/International-Water-Manegement-Institute--IWMI-/newsletter/IWMI-Monthly-Update---August-2013>



### Events:

It is not entirely clear what events are meant here. But during the course of 2013 there has been participation in many international conferences and workshops. Many are referred to in individual activities

### Videos and other multimedia:

Voices from women and men farmers in Nepal (2)- Migration - men's views

<http://www.youtube.com/watch?v=ZwvKkUxPm5M&list=UUuAk4FuXASxEV7e4vdpr4w>

Voices from women and men farmers in Nepal (3)- Dowry - women's views

<http://www.youtube.com/watch?v=8erYkkic9ss>

Voices from women and men farmers in Nepal (4)- Farming - men's views

<http://www.youtube.com/watch?v=P3K3AeWCryE>

Voices from women and men farmers in Nepal (5)- Girl's future - women's views

[http://www.youtube.com/watch?v=JY\\_mdTOxoTY](http://www.youtube.com/watch?v=JY_mdTOxoTY)

Voices from women and men farmers in Nepal (6)- Cooperation - men's views

[http://www.youtube.com/watch?v=2RclY\\_5sm7w](http://www.youtube.com/watch?v=2RclY_5sm7w)

### Other communications and outreach:

Media Releases:

Warsaw, Poland – November 15th 2013 – Climate change will have a “profound” impact on water resources that could have serious knock-on effects for agriculture, according to a new report published today.

“5 villages adopted under Climate Smart Village project" Tribune News Service. India. May 5, 2013

Study Highlights Damages of Climate Change on Volta River- Voice of America, 22nd July, 2013

Study Highlights Damages of Climate Change on Volta River- All Africa, 22nd July , 2013

Water security and climate change challenges in developing countries - Climate Action 2013-14 magazine, pp 145-148

The war for precious water - LMD, 22nd Oct, 2013

<http://lmd.lk/2013/09/01/natural-resources/>

West Africa must take actions to tackle water loss - SciDevNet, 20th Aug, 2013

<http://www.scidev.net/sub-saharan-africa/climate-change/news/west-africa-must-take-action-to-tackle-water-loss.html>

Could Sri Lanka gets irrigation boost from ancient reservoirs- IRIN Asia, 05th Sep 2013

<http://www.irinnews.org/report/98503>

Warming climate could hit West Africa river levels- RTCC, 26th Jul 2013

<http://www.rtcc.org/2013/07/26/warming-climate-could-hit-west-africa-river-levels/>

Worrying climate outlook for West Africa's Volta basin - IRIN Africa, 23rd July, 2013

<http://www.irinnews.org/report/98457/worrying-climate-outlook-for-west-africa-s-volta-basin>

West Africa: Latest Volta river basin needs new water strategy: Study- Preventionweb 22nd July, 2013

<http://www.preventionweb.net/english/professional/news/v.php?id=34086>

Changing water management practices in West Africa- circle of blue, 22nd July 2013

<http://www.circleofblue.org/waternews/2013/the-stream/the-stream-july-22-changing-water-management-practices-in-west-africa/>

Modern farming practice of rainwater storage in ancient tanks: Best adoption strategy - The Island, 15th June 2013

[http://www.island.lk/index.php?page\\_cat=article-details&page=article-details&code\\_title=](http://www.island.lk/index.php?page_cat=article-details&page=article-details&code_title=)

Climate change could deprive Volta basin of water needed to boost energy and food production - EurekaAlert 18th July 2013

[http://www.eurekaalert.org/pub\\_releases/2013-07/bc-ccc071813.php](http://www.eurekaalert.org/pub_releases/2013-07/bc-ccc071813.php)

Sri Lankan water history informs global climate change study- Daily FT 14th June 2013

<http://www.ft.lk/2013/06/14/sri-lankan-water-history-informs-global-climate-change-study/>

## 5. Case studies

### Case Study #1

**Title:** Flood Inundation Mapping Case Study in Bangladesh

**Author:** Giriraj A., Rajah A.,

**Type:** Capacity enhancement

#### **Project description:**

Bangladesh is among the most natural disaster prone (flood prone) countries in the world. It has suffered 170 large-scale floods between 1970 and 1998. The frequency of flooding episodes is growing, with catastrophic 'once in a generation' floods occurring more regularly (Chowdhury, 1988, 1989). This includes eight major floods between 1974 and 2004, many of which are considered by hydrologists to be a size expected only once in every 20 years. During the 2007 monsoon, Bangladesh experienced severe floods with serious consequences for the national economy and the livelihoods of millions of people. Our objective is to enhance the capacity of partners to apply use of wide-range of satellite datasets including MODIS and ALOS to spatially quantify flood extent and identify areas of recurrent flooding and develop research approach that could be used during the rapid emergency response mapping.

#### **Introduction / objectives:**

- To develop time-series flood inundation extent using MODIS satellite data-
- To develop semi-automated approach and tools to rapid delineate flood extent during major disasters-
- To provide capacity building for partners in Bangladesh to apply the tools and techniques in flood management

#### **Project results:**

- Delivered Bangladesh Flood Risk Atlas to the Ministry of Disaster Management-
- Enhanced capacity of partners in providing necessary tools and data-
- 21 participants from 17 institutions participating in the training-
- Preparation of research paper

#### **Partners:**

Ministry of Disaster Management UNDP-CDMP (Bangladesh) UN-SPIDER

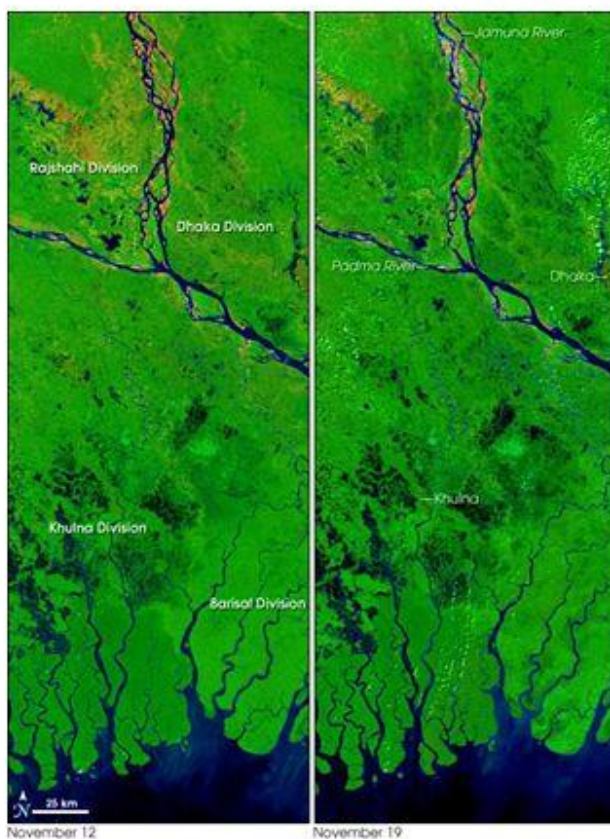
#### **Links/sources for further information:**

[http://www.un-spider.org/sites/default/files/UN-SPIDER-TrainingActivity\\_Report-Bangladesh.pdf](http://www.un-spider.org/sites/default/files/UN-SPIDER-TrainingActivity_Report-Bangladesh.pdf)

# Training Manual on



## Flood Inundation Mapping and Modeling: Case study of Bangladesh



12 – 16 May, 2013

Bangladesh Space Research and Remote Sensing Organization  
Dhaka, Bangladesh

International Water Management Institute (IWMI)

## Case Study #2

**Title:** Farmers voices -Participatory video initiative in Nepal

**Author:** Floriane Clement

**Type:** Social differentiation and gender,Successful communications,Capacity enhancement

### Project description:

The participatory video project was organized in Dhanusha district of Nepal. It was based on the observation that farmers, and especially women farmers, have a limited voice in national climate change debates and planning processes. IWMI trained 12 men and women farmers from two villages in Dhanusha District in video-making and editing. The farmers/film-makers formed 6 groups, who chose 2 topics each and video-interviewed on their own people from different social groups in their village on the topics selected. 12 short films were produced by farmers on adaptation to climate change. The journalists from NEFEJ showed farmers' films to local or national policy-makers, government officials, development practitioners, and scientists and video-recorded their reaction and comments on the issues raised by the farmers. These comments were added to farmers' films which were then packaged as a 20 min TV episode. The TV episodes were broadcasted every Monday on NTV plus until December 2013.

### Introduction / objectives:

-To enhance farmers understanding of climate change and implications that it may have on their livelihoods and future-To communicate the views of the farmers on climate change to a broader audience in Nepal

### Project results:

Farmers produced in total 12 short films on livelihood adaptation to climatic and societal changes.The project built capacity to deal with videos that farmers did not have.IWMI together with Nepal Forum of Environmental Journalists (NEFEJ) developed an expository TV program from the films - directed by the farmers.

### Partners:

Nepal Forum of Environmental Journalists (NEFEJ)

### Links/sources for further information:

The details of the video project and the videos themselves are available at:<http://gendercc-southasia.iwmi.org/videos.aspx>

## Case Study #3

**Title:** Development of flood forecasting system for Gash basin using hydrological modeling system

**Author:** Giriraj A., Alahacoon N., Sharma B.S. and Vladimir S.

**Type:** Successful communications, Capacity enhancement, Food security

### Project description:

An innovative approach of using Hydrological Model tools (HEC-HMS) and satellite data sets covering the upper catchments of the Gash, from where no on the ground data is available, and the downstream portion of the river system. This project, which is supported by the International Fund for Agricultural Development and the CGIAR Research Program of WLE and CCAFS has focused on determining the characteristic of the flood inundation in the lower reaches of the river, combined with satellite rainfall estimates (SRE) along with HEC tools to produce flood early warning system. These tools will allow farmers to access near real-time flood related information via SMS.

### Introduction / objectives:

Development of a medium range flood forecast model for the Gash basin using HEC-GeoHMS and HEC-HMS modeling environment. Incorporate satellite rainfall estimates (SRE) that includes NOAA RFE and NASA TRMM (3B42 and 3B42RT) data in rainfall-runoff model. Test applicability of using near real-time TRMM data in flood forecasting system

### Project results:

Successfully developed tools and approach in providing flood forecasting system for the 2013 flood season. Flood hydrograph were provided to partners on operational basis using FieldLook portal and SMS directly to farmers in early warning and decision making process. Additionally MODIS-based flood extent were used to quantify flood water in irrigation block by Gash Spate Authorities to assess crop productivity as well as the benefits of using satellite information aided with hydrological models to improve livelihoods of farmers and enhance food security. Two national training on flood forecasting and flood mapping were provided with detail case study for implementing partners as well as academic institutes for applying tools for the next flood season. Wide media communications in newspaper, TV channel and promoting the findings in major international conferences.

### Partners:

Hydraulic Research Centre, Ministry of Water Resources Gash River Training Unit, Kassala Agriculture Department, Kassala - Ministry of Agriculture Kassala University and other academic centres

### Links/sources for further information:

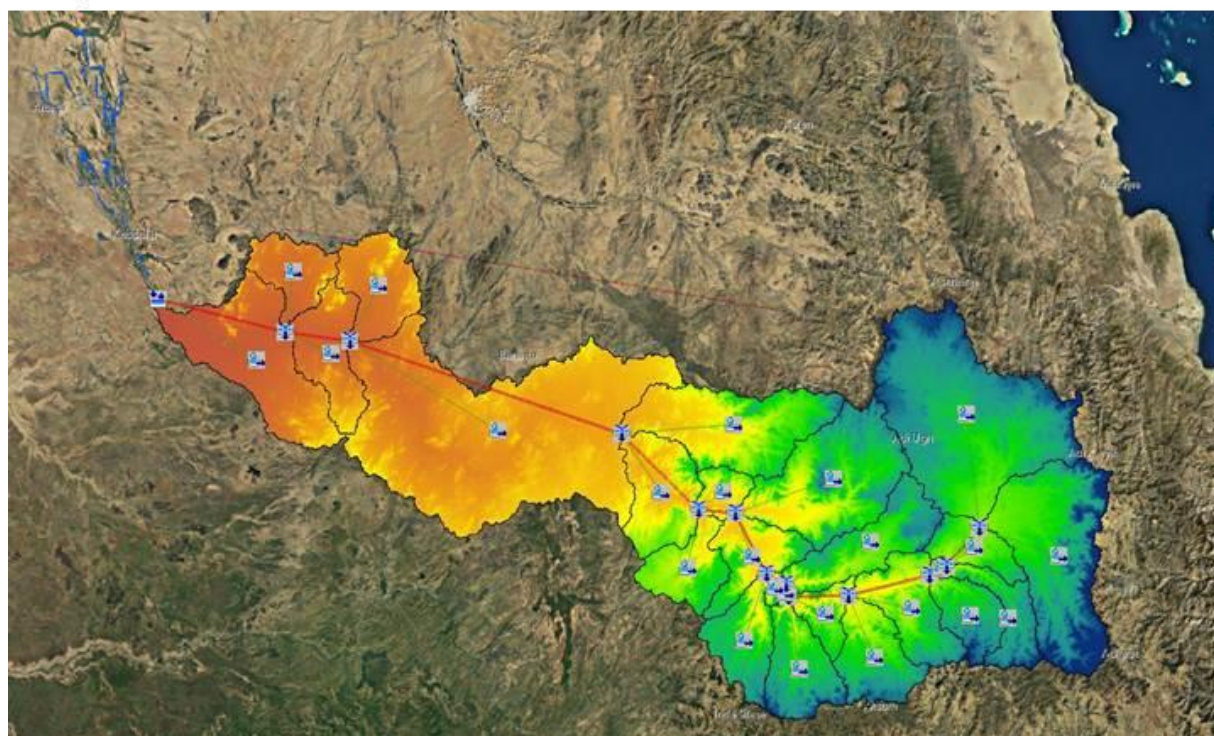
<http://fieldlook.com.sd/>

# Training Manual on

## DEVELOPMENT OF FLOOD FORECASTING SYSTEM FOR GASH BASIN USING HYDROLOGICAL MODELING SYSTEM

27 – 29 August, 2013

Hydraulic Research Station, Kassala, Sudan



International Water Management Institute (IWMI)



## 6. Outcome indicators

### Outcome indicator #1

#### Outcome indicator:

One to five flagship technical and/or institutional approaches identified and developed with farmers, key development and funding agencies (national and international), civil society organizations and private sector in three regions, which would directly enhance the adaptive capacity of the farming systems to the climate change conditions

#### Achievements:

1. IWMI research over the previous years is influencing Sri Lankan Climate Change Adaptation Policies 2. IWMI research on vulnerability of mountain watersheds to climate change in Nepal resulted in a new ADB funded project, whereby ADB will be implementing water interventions in 2 selected vulnerable watersheds, and IWMI will be monitoring the impacts over the next 5 years.

#### Evidence:

1. Participation of IWMI staff in National advisory panels on climate change adaptation in Sri Lanka 2. An ADB-funded project at IWMI that started in 2013

### Outcome indicator #2

#### Outcome indicator:

One to five flagship risk management interventions evaluated and demonstrated by farmers and agencies at benchmark locations in three regions

#### Achievements:

Mobile services for farmers are established in 3 countries in Africa - Ethiopia, Sudan and Egypt. Services provide information on the conditions of farm fields, irrigation needs and anticipated flooding- through wide-spread mobile phones - in terms of simple and succinct messages, but based on the high-tech remote sensing information

#### Evidence:

Services in 3 countries up and running