NEWSLETTER

ClimaRice II

- Reduce uncertainties in future monsoon projections.
- Demonstrate the applicability of selected adaptation measures.
- Enhance adaptive capacity to climate change on rice crop and irrigation water management practices.
- Institutional capacity building.
- Emphasis to develop local ownership through participation of local stakeholders in the design, implementation, and management of adaptation measures.
- Create new societal norms in order to ensure the sustainability and effectiveness of the measures.

Photo by Rognor V. Pedersen/Bioforsk

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International Water Management Institute
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NORWEGIAN EMBASSY

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Stakeholders' message

Message from Dr. Colin John Chartres, Director General, IWMI

Given a growing global population, dietary change, biofuel production and urbanization we can expect growing competition for agricultural water over the next 40 years. India, for example, is forecast to have a 50% gap between water demand and supply by 2030, although this will vary geographically. Climate change, characterized by potentially less reliable, later onset, shorter duration and more intense monsoons, will only exacerbate this situation through increasing droughts and floods. So any project that looks at how agriculture can adapt to climate change and other drivers of water demand is very important. However, the importance does not simply lie in the technical solutions made available for adaptive management responses. What is also vital is that these solutions are promoted to water policy makers, water managers and farmers and explained clearly to all water users. The ClimaRice Project focuses very much on participation of interested parties and, as such, is well placed to help us deliver on-ground change and ultimately more secure food supplies.

Message from Dr. P. Murugesa Boopathi, Vice-Chancellor, TNAU

India is home to more than one sixth of the world's population and primarily an agrarian country where the majority of the population is engaged in agriculture. Land holdings in Indian agriculture are predominantly small and marginal that are heavily influenced by the extreme weather events making them vulnerable to its impacts. On the one hand there is an increasing demand for water in the non-agricultural sector due to increase in population and standard of living, resulting in reduction of water supplies, on the other hand there is greater demand for food to feed the increasing population. Therefore, there is a high demand for managing the available water in efficient ways to meet all these requirements.

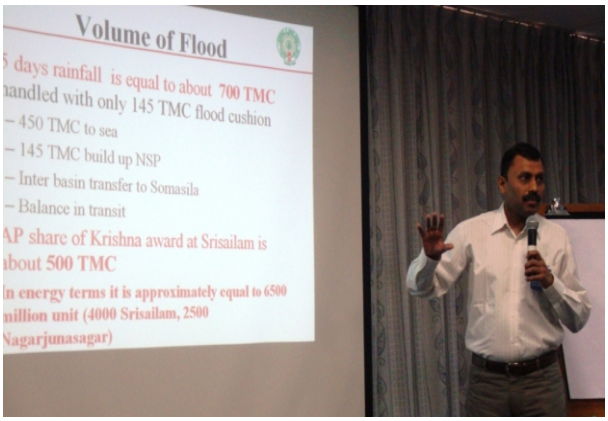
Under this context, ClimaRice is an important project that facilitates in identification and demonstration of integrated adaptation strategies to ensure food security amidst the changing climate. It assists in understanding the vulnerability (exposure, sensitivity and adaptive capacity) of the farming community in the erratic and fragile ecosystem to make them more resilient by enhancing and strengthening the existing adaptive capacity. Very interestingly ClimaRice project results help in integrating climate change aspects in the agricultural policy framework which would empower the farming community in managing the extreme weather events. The adaptation and efficiencies besides minimizing the emission of Green House Gases from paddy eco system. Various technical and policy briefs that are brought out periodically from the project findings need special appreciation. The News Letter of ClimaRice has been nicely compiled by highlighting the project achievements and I congratulate all the project scientists for their collective research efforts to sustain rice production under changing climate.

Message from Mr. Sanjay Gupta, IFS, Additional Project Director and Implementing Officer, AP Disaster Mitigation Society (Former Special Commissioner, CADA), Andhra Pradesh

The government of India has drawn up a Nation Action Plan on Climate Change that would foster actions for better understanding of the likely impact of the climate change, create vulnerability index for local areas and establish adaptation and mitigation measures. The national government has set up eight Missions (covering the themes like Himalayan Ecosystem, Agriculture, Water, Energy Efficiency, Knowledge etc) to address the likely challenges from climate change. In a climate diverse country like India, understanding and action planning at regional level assumes higher significance therefore the respective state governments are also evolving the state level action plans under a broad national framework.

National Water Mission highlights the climate change associated risks on availability and distribution of water that can impact the crop production. Andhra Pradesh is a second biggest producer of rice in India (approx. 14 million tonnes from an average area of 4 million Ha) and significantly contributes to the national food security apart from providing livelihood to millions.

Better understanding of impact of climate change on water availability and rice production is of critical significance for agriculture sustenance in Andhra Pradesh. The farmers would need better information system that would equip them with improved understanding of crop water requirement, likely changes in it and adaptation measures to changing environment. The Farmers Organisations, managing the irrigation system,



Mr. Sanjay Gupta explaining about the impact of climate changes

would need tools to assess the changes in water demand from individual farmers and tools to improve the water use efficiency to address the likely scenarios of increased water demand or reduced water availability.

From my interaction so far, I am confident that ClimaRice and Climawater projects would be able to strengthen the link between the national and international research organisations, relevant state government agencies, farmer net works and would bring in the international expertise and experience to support the ongoing efforts of state government for better understanding of the changes associated with climate change, equip the farmers and government functionaries to adapt and mitigate the impacts of the climate change.

Message from Dr. P. Rama Mohana Rao, IAS, Agricultural Production Commissioner & Principal Secretary to Government of Tamil Nadu.

The threat of climate change and its impact on agriculture appears imminent. There are evidences that crop yields may drop from 20 to 40 per cent due to rise in temperatures in the coming decades. Large extents of land may become fallow that it would no longer be good for agriculture and new diseases and pests would come up. Climate change is expected to enhance the frequency and intensity of extreme weather events with differential spatial and socio economic impacts. Under this context, instead of a wait and watch approach, well-designed policies incorporating the range of possible adaptation options from the research outcomes have to be put in place.

Adaptation is a critical response to climate and complementary to mitigation, because benefits of mitigation actions emerge over decades whereas adaptation measures will help to maintain the efficacy of mitigation. Extremes, variability, and rates of change are all key features in addressing vulnerability and adaptation to climate change. Human and natural systems will some degree adapt autonomously to climate change. But planned adaptation can supplement autonomous adaptation.

Projects such as ClimaRice can make meaningful contributions in terms of developing adaptation measures by involving the stakeholders. It is interesting to note that in ClimaRice - Phase II climate change adaptation techniques related to rice production are validated in close co-operation with farmers and local agencies in two major river basins viz., Cauvery and Krishna of Tamil Nadu and Andhra Pradesh States. I understand that the main

emphasis of the ClimaRice project is to develop local ownership through active participation of stakeholders in the design, implementation, and management of adaptation strategies to ensure the sustainability of rice production. The multi institutional approach would certainly bring desired results and I congratulate the researches for their collective effort in developing various technologies to minimize the impacts of climate change on Indian Agriculture. This newsletter has been well compiled and will serve as guide for stakeholders and fellow researchers to appreciate the project achievements and deliverables.

Agriculture in Guntur District - Risks from extreme weather conditions and adaptation - Mr. K. Pulla Reddy, Joint Director of Agriculture, Guntur District, Andhra Pradesh

Sustainable food grain production in Andhra Pradesh is in ambiguity due to the climate variability that occurred in the recent years. Evidences are vast over the years showing significant changes in climate, which are leading to droughts, floods, heat waves etc. The impact of climate change on these extreme events will certainly impact food security in the sate and in the country. Reducing uncertainties in agriculture due to such climate changes is a big challenge. Guntur district has two major irrigation projects, Nagarjuna Sagar project with an ayacut of 254,583 hectares and Krishna ayacut of 202,032 ha. Both of the projects are under Krishna River.

The Gross irrigated area in Guntur district is 408,237 ha of which 87 % is net irrigated area. The district is mostly influenced with floods in the coastal areas, where rice is the major crop in the district. Cotton, chillies, turmeric are also grown as major commercial crops in the district which has high risk and uncertainty in the production and marketing. Weather based crop insurance was also started in the district on a pilot basis due to the uncertain climatic conditions.

Developing certain management practices and policies is also a complex process that requires mixing issues of technical feasibility, scientific knowledge and context. The consideration of scientific progress represents one of the key

Mr. K. Pulla Reddy, Joint Director of Agriculture releasing farmer enrolment card on 31 August 2010, at Jonnalagadda village, Guntur District, Andhra Pradesh

aspects for the design of new policies and the review of existing ones. The present CliamRice project funded by Norwegian embassy could help the district and the state to bring out the important water management practices and interventions. The experimental trails conducting by IWMI through ClimaRice project would help in validating the adaptation measures with close collaboration of farmers and stakeholders. Achieving this could be possible by encouraging stakeholders' participation, building capacity of farmers, agriculture and water managers to climate change adaptation and increasing their awareness on the uncertainties through the project.

Message from Dr. Udaya Sekhar. N, Project Co-ordinator, Bioforsk, Norway

The involvement of stakeholders in natural resource management, in particular management of water resources is gaining momentum in India. Since 1990s, the increasing requirements for stakeholder engagement are reflected in the National Water Policy and also in the initiatives taken up by the respective states. A good example is the Participatory Irrigation Management (PIM) in many states including Andhra Pradesh, Karnataka and Tamil Nadu. Several arguments can be made for stakeholder participation, including: widening the scientific-stakeholder knowledge base, a broad based decision making and easier implementation of such decisions. However, we need to go a long way before we can claim that we have fulfilled these objectives.

We need to begin linking scientific community, stakeholders and policy makers, in order to address the complex problems related to climate change impacts and adaptation in water and agriculture sectors. In ClimaRice II, the focus is on developing and demonstrating various ways to enhance stakeholder engagement. What we intend from

stakeholder engagement is:

- Joint scenarios development ;
- Incorporating stakeholder knowledge to run models;

- Interpretation of model results
- Integrating scientific and stakeholder knowledge/perspectives to develop adaptation measures
- Testing of participatory methodologies
- Establishing communication between stakeholders, scientists and policy makers
- Jointly planning and organizing capacity building based on identified needs

A number of activities are being organized to engage stakeholders in our projects, including stakeholder workshops, Focus Group Discussions, stakeholder panels, joint scenario development and round-table meetings. The project team interacts continuously with senior policy makers, managers, farmers networks, women self help groups and NGOs in Andhra Pradesh and Tamil Nadu.

Project summary

ClimaRice II is an interdisciplinary pilot project titled "Sustaining rice production in a changing climate" undertaken to reduce the uncertainties by testing and validating the adaptation techniques in close co-operation with farmers and local agencies. This would give local ownership to the technologies and provide options to farmers to adapt to the climate change.

The overall project goal is to reduce uncertainties in future monsoon projections, demonstrate the applicability of selected adaptation techniques and enhance stakeholder adaptive capacity to climate change on rice production and irrigation water management practices through field demonstration, institutional and capacity strengthening in two selected river basins namely the Cauvery and Krishna River Basins. The main objectives of the project are as follows

Objectives of the project

- To reduce uncertainties in climate models' projections, and demonstrate the applicability of selected adaptation measures
- To standardize/and mainstream climate change adaptation measures/ technologies/practices, and activities developed in the ongoing project (ClimaRice) into the regional adaption programs
- To standardize methodologies that could be up scaled to other areas impacted by climate change.
- To actively encourage stakeholder participation and build stakeholder capacity including those of farmers, agricultural and water managers to climate change adaptation and increase their awareness on the uncertainties involved and on the difference between natural climate variability and climate change

As a part of mainstreaming adaptation into regional climate change, study villages were selected under two river basins in India namely, Krishna and Cauvery.

Krishna River Basin

Nagarjuna Sagar Project (NSP) command area under Krishna river basin in Andhra Pradesh was selected as the study area. NSP comprises of a dam across river Krishna with two main canals taking off one to the right and the other to the left covering 5 districts. The Nagarjuna Sagar Right Canal (NSRC) creates irrigation potential in an extent of 4.75 lakh ha in Guntur and Praksam districts, whereas the Nagarjuna Sagar Left Canal (NSLC) create irrigation potential in an area of 4.20 lakh ha in Nalgonda, Khammam and Krishna districts. From the five districts under NSRC and NSLC, Guntur has the highest command area of 2.84 lakh ha covering 39 mandals in the district.

In Krishna basin, it is proposed to make the pilot area into two clusters with two villages under each cluster. Cluster I has the study areas in Rangareddypalem (Narasaraopet mandal) and Jonnalagadda (Guntur rural mandal) villages and Cluster II will focus on Modukuru (chunduru mandal) and Dopplapudi (Ponnur mandal) villages. The villages under the two clusters were selected based on their irrigation sources and the scientific support available from the local research stations. Farmers were identified under selected canal source and experimental trails with various rice farming systems are in practice during the Kharif season 2010.

Cauvery River Basin

Cauvery Delta Zone (CDZ) lies in the eastern part of Tamil Nadu having a total geographic area of 14.47 lakh ha which is equivalent to 11.13 percent of the state area. CDZ encircles the entire revenue taluks of Thanjavur, Thriuvarur, Nagappatinam districts numbering 20, five revenue taluks of Trichy districts, two of Cuddalore and one taluk of Puddukkottai districts. Thus the zone comprises of 28 revenue taluks of the eastern belt of state. All these taluks are benefited by the river Cauvery. The major crops grown under the river are rice,

blackgram, greengram, gingelly and cotton. Ten villages were selected from different districts falling under Cauvery river basin. Primary data was collected from the selected farmers from the village and developed the indicators for the project. Experimental trails on various rice farming systems were also started in the Kharif 2010.

Events

Project Inauguration

The project kickoff workshop was held on November 23, 2009 at IWMI, South Asia Regional Office, Hyderabad (located at ICRISAT campus). State level officials, international experts and scientists working on climate change related issues have participated in the workshop. The project was inaugurated by Mr. S. K. Joshi, Principal Secretary (Projects), Govt. of Andhra Pradesh and Mrs. Inges, Counselor-development, Royal Norwegian Embassy.

Kick off meeting of the ClimaRice-ii project at IWMI, ICRISAT Campus, Hyderabad

Addressing the gathering, Mr. Joshi said that there was need for strong institutions; adaptive managerial systems and progressive science to help farmers meet the challenges of extreme floods and droughts arising due to climate change. Mr. Sanjay Gupta, Special Commissioner, I&CAD, Govt. of Andhra Pradesh explained about the case of the recent natural disaster due to floods in Andhra Pradesh and highlighted the need for appropriate mitigation strategy.

Dr. Goswami, *Director IITM, Pune*;

Dr. Annamalai, *IPRC Hawaii;*

Mrs. Nils Otto Kitterod, *Bioforsk, Norway* and

Dr. Jannes Stolte, *Bioforsk*

Made technical presentations based on climate modeling.

Book release from ClimaRice I project (2008-10), Feb 2011,New Delhi

The book titled "Sustainable Rice Production on a Warmer Planet" (Edited by Udaya Sekhar Nagothu, Geethalakshmi, V.; Annamalai, H.; Lakshmanan, A) was launched by the Norwegian Minister of Research and Higher Education, Mrs. Tora Aasland at the Delhi Sustainable Development Summit 2011, special event "Water and Climate" workshop on the 2nd February, 2011.

During the inaugural session, Mrs. Tora Aasland, handed over the first copy of the book to Indian Minister of Water Resources, Mr.Salman Khurshid, as a symbolic gesture of Indo-Norwegian co-

operation. She appreciated the work done by the Climarice partners, Bioforsk, TNAU, IWMI and IPRC, Hawaii, and the efforts made to bring out the book. Dr.Rajendra K.Pachauri, Chair of the IPCC (that shared the Nobel Peace Prize) who was present on this occasion, said that the book gives a good and important insight into a research area that is crucial in the Indian context.

Adaptation Programs

Technologies upscaling from ClimaRice I

ClimaRice I project has tested various rice farming systems (SRI, Azolla, Rotational Irrigations, Alternate wetting and drying) in Tamil Nadu. Based on the results obtained from the project some of the key technologies are validated for upscaling in both Krishna and Cauvery River basins in climarice II. For example, Azolla culture was taken up at the villages in Andhra Pradesh (Krishna River basin) which helps in reducing the methane gas emissions and weed population.

Demonstrating Azolla culture on farmer field, Jonnalagadda, Guntur Distirct, Andhra Pradesh

Capacity Building

Farmers training and awareness program on water management by IWMI, Andhra Pradesh

As a part of ClimaRice II project various capacity building and training programs have been organized in Tamil Nadu and Andhra Pradesh. In Andhra Pradesh, farmers training and awareness workshop on climate change and water management activities was conducted in Jonnalagadda village in Guntur district. The village is also adopted by the Regional Agricultural Research Station (RARS) for extensive research and development. In all, 75 farmers attended the one day training workshop on climate change and water management. Scientists from RARS focused on issues ranging from climate change impacts on agriculture and farm level adaptation measures (Direct seeded rice, critical stage irrigation, etc). The RARS staff will be visiting the village on a regular basis to monitor the validation trials on farmers' fields. Scientific and capacity building support/services to farmers are being provided by the staff from RARS and IWMI.

Farmers participation and Dr. Subbarami Reddy explaining about crop pest and disease management activities in Andhra Pradesh

Adaptation technologies of delta farmers in Tanjore, Tamil Nadu

In the ClimaRice II, eight villages have been adopted in the river basin to disseminate various adaptation and mitigation technologies among the delta farmers. In this regard, Mr. L. Vijayanathan, Senior Scientific Advisor, The Royal Norwegian Embassy New Delhi and Dr. Nagothu Udaya Sekhar, Bioforsk, Norway along with ClimaRice Scientists Dr. V. Geethalakshmi and Dr. A. Lakshmanan visited Ammanpetai village of Tanjore district on 27-06-2010 and participated in the capacity building programme to the farmers.

The community nursery programme, seed nurseries of Bio Fertilizers such as blue green algae and Azolla were initiated in this village. Around 60 farmers participated in the capacity building programme and were trained on SRI cultivation, composting process, mass multiplication of Bio Fertilizers like Blue Green algae and Azolla and interpretation of weather parameters for farm decision making. Besides this, Dr.Udayasekhar, Dr.Geethalakshmi and Dr.Lakshmanan also interacted with the scientists from various dissemination centers at ADAC&RI, Trichy on 28-06-2010 and formulated action plan for the ensuing season.

Blue green algae seed nursery at Ammanpettai, Tanjore

Field visits

Visit of Minister of Agriculture and Food, Norway to Cauvery basin, Trichy, Tamil Nadu

Mr. Lars Peder Brekk, the Hon'ble Minister of Agriculture and Food, Norway along with a 10 member delegation, and officials from the Royal Norwegian Embassy, New Delhi visited Cauvery basin, Trichy between 16 and 17 of February 2010 to observe ClimaRice project activities. On this occasion The Norwegian minister interacted with farmers, women self-help group members, and officials from the state departments. On February 17, the Norwegian Minister participated in the ClimaRice- Farmers Day function which was conducted at Saraswathi Krishi Vigyan Kendhra (SKVK), Karur. Honorable Minister for Agriculture, Government of Tamil Nadu participated in the function and addressed the audience. The District Collectors of Trichy and Karur also complemented the efforts of ClimaRice research team. The ClimaRice News Letter in Tamil was released by the Honorable Minister for Agriculture, Government of Tamil Nadu. An exhibition was arranged by the ClimaRice team to showcase the results of field and laboratory experiments on climate change adaptation and rice cultivation. Lot of emphasis has been placed on stakeholder involvement in ClimaRice I and ClimaRice II projects. More than 100 participants attended the stakeholder workshop.

In addition, a number of Stakeholder Panel meetings (July 2010, Trichy; March 2010, Hyderabad) were held during the year, where participants received a broad understanding of the Climate change impacts on agriculture, water resources and food security. The highlight of the panel discussions, however is the development of joint scenarios by scientists, managers, farmers, women self-help groups and policy-makers. Panel

meetings are useful methods to strengthen the linkage between science-stakeholder-policy. A lot of enthusiasm was observed at the different meetings, Participants acknowledge the strength of the ClimaRice efforts to involve stakeholders in increasing the level of effectiveness of the project results.

Mr. Lars Peder Brekk, the Hon'ble Minister of Agriculture and Food, Norway interacting with farmers in Trichy District (February 2010) visiting ClimaFarm

A team from Norwegian Embassy, New Delhi-Interacting with project scientists at TNAU Coimbatore

A two member team from the Royal Norwegian Embassy, New Delhi comprising of Mr. Ole Reidar Bergum, First Secretary, and Mr.L.Vijayanathan, Senior Advisor, visited the ClimaRice II project sites in Tamil Nadu and Andhra Pradesh in August 2010. During the visit, the team interacted with project partners (Bioforsk, TNAU, IWMI), farmers, officials from different government agencies and women self help groups in Andhra Pradesh and Tamil Nadu. Scientists from Regional Agricultural Research Station (Lam), Acharya N G Ranga Agricultural University have also explained about the research work and farming practices in the region.

The embassy team observed the Climate Control Chamber facility installed at Agro Climate Research Centre, TNAU, Coimbatore and also visited the wet lands to observe the ClimaRice field trials. The team visited the Azolla commercial nursery maintained by Climafarmers at Udumalpet, Coimabatore and attended the Capacity building programme to rice farmers at Agricultural Research Station, Bhavanisagar. The ClimaRice I reviewers Dr.Khalid and Dr.Rajiv accompanied the team and interacted with the farmers.

Embassy team observing the experiments at Climate Control Chamber, TNAU

News

Training on SWAT, 1-3 December 2010

Soil and Water Assessment Tool (SWAT) is non point source model and physically based rather than incorporating the regression equations to describe input and output relationships. The physical processes associated with water movement, sediment movement, crop growth, nutrient cycling etc. are directly modeled by SWAT using input data.

SWAT model worshop, IIT, Chennai

SWAT allows a number of different physical processes to be simulated in a Watershed. Simulation is useful when different areas of the watershed are dominated by land uses or soils dissimilar enough in properties to impact hydrology. By partitioning the watershed into sub-basins, the user is able to reference different areas of the watershed to one another spatially. Input information for each sub-basin is grouped as climate; hydrologic response units or HRUs, ponds/wetlands; groundwater; and the main channel, or reach, draining the sub-basin. Hydrologic response units are lumped land areas within the sub-basin that are comprised of unique land cover, soil, and management combinations. No matter what type of problem studied with SWAT, water balance is the driving force behind everything that happens in the watershed. To accurately predict the movement of pesticides, sediments or nutrients, the hydrologic cycle as simulated by the model must confirm to what is happening in the watershed.

To make familiarize with the SWAT model, capacity building program was conducted at IIT Chennai from 1st to 3rd December, 2010. Dr. Balaji, IIT Chennai orgnasized the workshop and an expert from Texas University (Dr.Srinivasan, Member of the SWAT model development group) also took part in the capacity building workshop. Various stakeholders from Department of Irrigation and CAD, Andhra Pradesh and Tamil Nadu, Tamil Nadu Agricultural University, Coimbatore and IWMI, Hyderabad were participated in the workshop.

Database development

Bioforsk is working with IIT Chennai, on ClimaRice database development. The project team had discussions about web design on 8th of August 2010. The database will consists of farm attribute tables, climate information along with georeferenced maps such as basin boundary, state boundaries, district boundaries, mandal boundaries, reservoirs location, sub-basins boundaries and river network and cadastral maps for both Krishna and Cauvery River basins. The project partners will be provided with login and password for updating their data on the website. The project partners could also send the data for updation to Indian Geoinformatics Centre, directly.

The time series data could be queried and the results could be downloaded as excel files, graphs and maps. The displayed maps and graphs could be exported as they are visible, into tif or jpeg format, so that project partners could use them in the reports.

Student dissertations

The ClimaRice II project also provides student fellowships under the dissemination activity. Students from Acharya N G Ranga Agricultural University (ANGRAU) and Tamil Nadu Agricultural University (TNAU) are working on the following topics

- Assessment of Vulnerability Index and Adaptation strategies in rice production due to the climate change under Krishna River basin of Andhra Pradesh- Mr. Praveen, ANGRAU
- Economic analysis of crop insurance schemes and payouts in sustaining rice production due to climate change in the Krishna river basin of Andhra Pradesh- Mr. Ashok, ANGRAU
- Influences of high temperature on pest and disease dynamics of rice Ramya. M, TNAU
- Climatic influence on methane emission from rice field in sodic soils of Cauvery delta zone and designing climate change mitigation technologies Sankar. A, TNAU
- Impact of elevated temperature on rice phenology, physiology and productivity under controlled condition Ramadevi. C, TNAU
- Impacts of climate change on hydrology and rice productivity of Ponnaiyar basin and development of adaptation strategies- Bhuvaneswari. K, TNAU
- Simulation of crop yield over Cauvery delta zone of Tamil Nadu using high resolution future climate change scenario Rajalakshmi. D, TNAU

Research reports / Activities

Vulnerability assessment methods

K. Palanisami and K. R. Kakumanu, IWMI

Vulnerability is a function of three components: exposure, sensitivity, and adaptive capacity. According to some references existing in the vulnerability assessments literature, exposure and sensitivity cannot be considered separately when building a vulnerability index assessment. Because sensitivity factors can only be defined according to a certain exposure, these two factors are not relevant to consider without each other, at least at the individual or household unit level. Therefore, in the index, vulnerability has two major components: Sensitivity (which includes exposure) and Adaptive Capacity.

An important goal of such vulnerability assessment is to create an index of overall vulnerability from a suite of indicators. These could be related to market, population and other socio-economic factors that act simultaneously together with climate change. Hence, it can be well represented by a set of composite indices. Composite indices are used as yardsticks to gauge the vulnerability of each region to climate change. They help to classify the sub-regions based on a set of large multivariate data. The information contained in the large set is transformed into a small set of indices which would provide a convenient method for classification.

Vulnerability due to climate changes can be of various types. The factors responsible for such changes are grouped into five components viz., Demographic, Climatic, Agriculture, Occupational and Geographic. Each one of these components can have several sub-indicators. In the present climaRice project these five components will be considered for vulnerability index for both Krishna and Cauvery river basins. The methodologies proposed by Patnaik and Narayanan (2005) and

Iyengar and Sudarshan (1982) are used for the study. These methods are simple as compared to the agro-ecological zones (AEZ) model developed by the FAO. The methods do not have the restrictive assumption of linearity in relation to indicators, Further they lend themselves for classification of the regions based on probability distribution of the vulnerability index.

In addition, Ricardian model is also used for the assessing the adaptation strategies of the farmers to the climate change. The cross-sectional data will be collected from the pilot areas and analysed to find the adaptation mechanisms to the climate change.

Gender role in climate change

Rebekka Ovstegard, Bioforsk

Gender analysis is an important component of the ClimaRice project in order to better understand the ways in which women and men are differently affected by climate change and how they are adapting. The focus of the study will be on different roles of women and men in order to understand what they do, resources they have, and what their needs and priorities are and how they respond to climate change.

Climate change has specific effects on women and men because of the different roles they play in society and their differentiated access to social, economic and physical resources. The distinct roles and responsibilities of women and men give rise to differences in vulnerability and ability to cope with change. Gender analysis is an important tool to address and highlight these differences between men and women in terms of vulnerability and their needs and priorities in relation to adapting to climate change. Understanding the role of changing role of women in agriculture due to climate change is important to develop future adaptation strategies. Climate adaptation technologies should be accessible, beneficial, and acceptable to both male and female stakeholders.

During the current year, a preliminary analysis has been carried out on Gender issues. This will be followed by a detailed study in 2011 in selected areas in Andhra Pradesh and Tamil Nadu (Focus group discussions and a questionnaire survey). The expected outputs will provide more detailed information on gender differences to improve knowledge about men and women's vulnerabilities to climate change and clarify the special needs of men and women, all with a view to developing appropriate responses to the impact of climate change. The project team has interacted with Women Self Help groups in the two states (Tamil Nadu and Andhra Pradesh), and has organized training and awareness workshops to improve their awareness and capacity on issues related to climate change and adaptation technologies.

Plant pest & disease forecasting for early warning in crop protection

Trond Rafoss, Senior Scientist, Planthelse, Bioforsk.

Climate factors play a major role in determining the impact of several pests and diseases on rice crop yields. Based on this rationale, the ClimaRice II project identified a potential for further use of the existing TNAU weather data (http://www.tawn.tnau.ac.in/ - as input to a computerised system for plant pest and disease forecasting). Initially, the focus will be on paddy blast disease, caused by the fungal pathogen *Magnaporthe grisea*, and insect pest paddy leaf mite *Oligonychus oryzae*. The assumption is that farmers access to pest and disease warnings, either directly by mobile internet/SMS, or through advisory service officers, enables improved

targeting of crop protection measures which both can give increased crop yield and quality, as well as reduced pesticide use/or timely use and less production costs to farmers. The benefits for the public of a working system are reduced risks from pesticides in food and environment. Moreover, such a system is also implicitly addressing the climate change impacts on the pest and disease situation in rice. Currently, the scientific literature is reviewed for availability of forecasting models and climate response information for the selected pests. The next steps of development in the project will be to implement selected models to operate against all weather stations of TNAU and put the dissemination service online.

Automatic Weather Station, Tamil Nadu

The Tamil Nadu Agricultural University (TNAU) has under the National Agricultural Development Programme (NADP) established a network of 224 Automatic Weather Stations (AWS) throughout Tamil Nadu state. The primary use of the data from the AWS until now has been as input to a weather forecasting model and the resulted outputs are being disseminated to farmers and to the public on the web page (http://www.tawn.tnau.ac.in/).

Algal carbon sequestration in rice soil eco system

A.Lakshmanan and V.Geethalakshmi, TNAU

The CO_2 level in the atmosphere, which has been stabilized for 100, 000 years has been rising after the industrial revolution, to a present level of 360 ppm. Geological predictions are that it may reach to a level of 480 ppm by 2050. While agriculture stands to be greatly affected by projected climate change, it has also been a major source of greenhouse gases to the atmosphere and contributes to climate change. Modifying current management of agricultural systems could therefore greatly help to mitigate global anthropogenic emissions. Possible mitigation approaches in agriculture concentrate on either (or both) of two key components: (1) Sequestration of atmospheric C in agricultural soils, resulting in increased soil organic carbon (SOC) pools; and (2) Reduction of greenhouse gas emissions to the atmosphere from agricultural operations. Various solutions have been proposed to mitigate the greenhouse effect of CO_2 emissions. One of the options currently being explored is the use of Cyanobacteria (Blue Green Algae) as CO_2 sinks.


Blue green algal mat in paddy rhizosphere, Tamil Nadu

Recently, it has been reported that growing Cyanobacteria in rice fields results in sequestering carbon. Cyanobacteria are attractive candidates in this respect as they are fast growing and easier to manipulate in paddy fields and open ponds. They possess an essential biophysical mechanism (Carbon Concentrating Mechanism, CCM), which concentrates CO_2 at the site of photosynthetic

Groundwater Assessment in the Musi and Upper Bhima Sub-Basins

Paul Pavelic, Kiran Jella, Sreedhar Acharya, Murali K. Gumma, Sylvain Massuel and Uday Patankar, IWMI

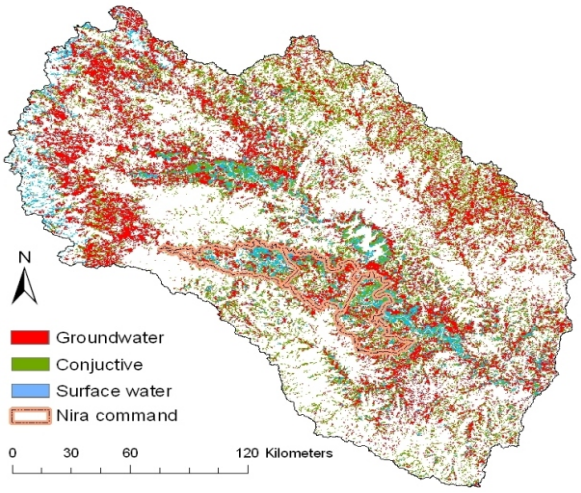
Hardrock aquifers in the Krishna Basin provide a vital water resource for all sectors, and particularly for irrigated agriculture. In order that these aquifers continue to sustain rural livelihoods it is crucial to improve our understanding of the availability and limitations of the groundwater resources and the agricultural production they support.

The earlier study by IWMI team focuses upon two of the sub-basins of the Krishna Basin: the Upper Bhima sub-basin situated on basaltic (Deccan Trap) terrain primarily within the state of Maharashtra, and the Musi sub-basin situated on granitic terrain in Andhra Pradesh.

Numerical groundwater modeling has been carried out for both sub-basins to quantify the magnitude and relative significance of the various components of the groundwater balance and to better understand their interactions. The models were calibrated and validated using observation well data over a 10-15 year period. In the case of the Musi it was found that natural and anthropogenic recharge from rainfall accounts for 17% of the total annual rainfall (1176 Mm^3) while the annual groundwater withdrawal yield over the period is close to 1220 Mm^3 for the total basin. A small deficit for the long term groundwater balance supports the observed depletion trend of the water table of 0.18 metres per year (in the last few years following the calibration and validation period this trend has been reversed). In the case of the Upper Bhima the utilization is less than the annual replenishment rate, and as a result no net long term decline in groundwater was observed. In drier years however, some reversible decline has been observed.

Additionally in the Bhima, we combined hydrogeological data with moderate spatial resolution/high temporal resolution satellite image data to assess the effects of differing degrees of groundwater scarcity over an eleven year period. This analysis shows no evidence of systematic declines in total groundwater availability across the basin, although considerable stress is observed for individual low rainfall years, combined with a declining trend in unit well productivity. Groundwater, particularly when conjunctive use is also taken into account, is of equal or higher importance to that of surface water in meeting crop water demands and sustaining food production across the basin, particularly in dry years where surface water availability is greatly constrained. This serves to better understand the way in which irrigated agriculture respond to changes in water availability and highlights the way in which groundwater offers an adaptive mechanism to climate variability. Continued groundwater development at the current rate cannot go on indefinitely without incurring higher pumping costs and reduced well yields and areas under irrigation.

Current work focuses on assessing the role that future climate change will have on groundwater availability and demand, taking into account the role that enhanced groundwater recharge (watershed development) may have as a supply-based mitigation strategy.



Distribution of irrigation water sources across the Upper Bhima basin during the low rainfall year, 2002-03

Upcoming events

Aquacrop Workshop; February 14-18, 2011, Hyderabad

The Food and Agriculture Organization (FAO) of the United Nations will organize a one week workshop/training course on the Aquacrop model, together with Bioforsk, IWMI and other ClimaRice II partners in February 2011. About 20 participants including managers from the Irrigation and CAD Department, Govt. of Andhra Pradesh, the Water Resourcces Organization, Government of Tamil Nadu and scientists will take part in the workshop. AquaCrop is a crop water productivity model developed by the Land and Water Division of FAO. It simulates yield response to water of herbaceous crops, and is particularly suited to address conditions where water is a key limiting factor in crop production. AquaCrop attempts to balance accuracy, simplicity, and robustness. It uses a relatively small number of explicit and mostly-intuitive parameters and input variables requiring simple methods for their determination.

Annual review meeting and all partners meet February 19-22, 2011 in Coimbatore, Tamil Nadu

The all partners annual meeting and the annual review of ClimaRice I and ClimaRice II projects will take place in Coimbatore from February 19-22. This will also be the closing workshop for ClimaRice I project that was started in January 2008.

Stakeholder workshop, February 21, 2011 at Trichy, Tamil Nadu

A large stakeholder workshop will be organized in Trichy to share results with the stakeholders (Policy makers, managers, farmers, women self help groups (SHGs), NGOs etc). On this occasion, feedback from the stakeholders will be taken on respective tasks and future course of action.

Awareness and Capacity Building workshop

A number of capacity building activities will be taken up in 2011, as per the needs identified by stakeholders. In the first quarter of 2011, an awareness course for farmers and managers, on climate change and related concepts will be organized in Andhra Pradesh and Tamil Nadu.

Guide book on Climate change and water management: Questions & Answers

A farmer guide book on climate change and water management questions & answers will be released both in English, Telugu and Tamil languages by IWMI during April 2011.

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The research, including its line of action and results, is independent of the financial contributor(s).

Bioforsk NORWEGIAN EMBASSY IWMI International Water Management Institute irrc INTERNATIONAL PACIFIC RESEARCH CENTER