APN CAPaBLE

- Making a Difference –

Scientific Capacity Building & Enhancement for Sustainable Development in Developing Countries

Increasing Adaptive Capacity of Farmers to Extreme Climate Events and Climate Variability through Enhancement of Policy-Science-Community Networking

Final Report for APN CAPaBLE Project:

CBA2008-01CMY-Boer

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Project Title

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Final Report submitted to APN

Overview of project work and outcomes

Non-Technical Summary

The Indonesian APN CAPaBLE project was aimed to encourage as many as end users especially farmers to realize the value of climate information to support their agricultural activities and to reduce the vulnerability of their farming system to climate risk. Through National Training Workshops, the project built and enhanced the capacity of local scientists from five nodes (two scientists from each node, i.e. Asahan-North Sumatra, Bandung-West Java, Pacitan-East Java, Janeponto-South Sulawesi and Kupang-East Nusa Tenggara) in developing and using climate forecasting techniques, assessing climate-related problems and developing climate information application technologies to manage climate risk as well as facilitating them in establishing *Policy-Science-Community Networking*. With National APN CAPaBLE team consisted of recognized national scientists from Bogor Agriculture University, Ministry of Agriculture, National Agency for Meteorology, Climatology and Geophysics and extension specialist from Indramayu District, the node scientists assisted local government staff, extension workers and farmers to build their capacity in using climate information application technologies in managing climate risks. Through action researches, the node's scientists with extension workers and farmers group identified appropriate climate information applications for managing climate risks and revised the existing climate field school modules to suit their problems. The awareness of farmers to economic value of climate information and their adoption to technologies on climate information application through Climate Field School Program (CFS) is expected to increase. During the project period, a number of government representatives and extension workers from the nodes were invited to attend national workshops on climate risk management and to share their lesson learnt and experiences in managing climate risks. In the final year of the project, the National APN CAPaBLE team conducted monitoring activities to evaluate the implementation of CFS program and climate forecast skill in the nodes.

Objectives

The project aimed to:
- establish regional nodes CAPaBLE in Indonesia
- improve analytical skills of local scientists to identify the most important research issues in their region through learning experience of the other nodes
- improve communication skills of local scientist and to enhance scientific leadership capacity
- build technical capacity of local government staff and extension workers in using climate risk technologies and agricultural risk management tools
- increase awareness of farmers to economic value of climate information and adoption of farmers to climate information technologies

Amount received and number years supported

The Grant awarded to this project was:
- US$ 40,000 for Year1, 2006-2007
- US$ 30,000 for Year2, 2007-2008
- US$ 20,000 for Year3, 2008-2009

Work undertaken

In line with the objectives of the project, works undertaken by the projects include (i) Training workshops and seminars, (ii) action researches, (iii) development of climate field school modules on climate information applications, and (iv) monitoring activities. During the project period (2006-2009), the workshops and seminars being conducted by the project itself and in collaboration with other agencies were the following:

1. Capacity Building Workshop at Biotrop Bogor 4-7 July 2006
2. Roundtable Discussion in collaboration with Stanford University-USA (7 November 2006)
3. Training Workshop on the use of Climate Prediction Tools in collaboration with International Research Institute for Climate and Society-Columbia University-USA (February 2007)
4. Training Workshop on the Use of CFS Modules (13-14 and 17 January 2008)
5. International Workshop in collaboration with PERHIMPI, GTZ, UNDP and World Bank (15-16 January 2008)
6. National Training Workshop on Climate Risk Management (CRM) at Biotrop, Bogor in collaboration with PERHIMPI, Asian Disaster Preparedness Centre-ADPC-Bangkok (29 March-1 April 2009)
7. CAPaBLE APN Workshop (back to back with the National Training Workshop on CRM; 1-2 April 2009)

Action research being conducted included the assessment of skill of climate forecast and potential application of climate information in managing climate risk in the nodes. Based on the results of the action researches, the existing Climate Field School modules have been revised and modified. The current modules were equipped with guidance for local scientists or extension workers to modify or to further develop the modules that suits local condition. To evaluate the implementation of the project activities in the nodes, the National APN CAPaBLE Team conducted monitoring activities to each node.

In addition to the above activities, the Principle Investigator of the APN CAPaBLE Project has been invited and delivered speeches in a number of International Forum and Regional Trainings held by other organization to share the experience gained from the Indonesian CAPaBLE APN Project. Some of the events were the following:

1. Regional Training on Development of Strategies on Climate Changes held by JICA in 2007, 2008 and 2009.
2. Side events at COP13 Bali December 2007
3. Training for Journalists organized by Oxfam November 2007 at Bali
4. Side event at SBSTA 28 at Bonn, June 2008
5. A number of national seminars on climate variability and climate change and meetings of National Working Group of Climate Anomaly, National Research Consortium on Climate Variability and Climate Change, and National Commission on Crop Protection

Results

APN CAPaBLE research networks at five nodes, Asahan, Bandung, Pacitan, Jeneponto and Kupang has been established. About 10 local scientists have been trained in using tools and methods for Climate Risk Management. Each node has produced reports on the result of improve analytical skills of local scientists to identify the most important research issues in their region through learning experience of the other nodes

- improve communication skills of local scientist and to enhance scientific leadership capacity
- build technical capacity of local government staff and extension workers in using climate risk technologies and agricultural risk management tools
- increase awareness of farmers to economic value of climate information and adoption of farmers to climate information technologies

Relevance to the APN CAPaBLE Programme and its Objectives

Capacity Building for Sustainable Development (CAPaBLE) project is a program coordinated by Asia Pacific Network (APN). The goal of program is to enhance scientific capacity in developing countries to improve decision-making in focus areas of global change and sustainable development. Indonesian project under the CAPaBLE aimed to encourage as many as end users especially farmers to realize the value of climate information to support their agricultural activities and to reduce the vulnerability of their farming system to climate risk. The project built and enhanced the capacity of local scientist in assessing climate-related problems and developing climate information technologies to address the climate problems. The project also facilitated the establishment of Policy-Science-Community Networking to enhance working relationship between the local scientists and policy makers as well as their capacity in communicating climate information application technologies to extension workers and farmers. These are all very relevant to the APN CAPaBLE Programme and its objectives.

Self evaluation

Most of the project objectives were achieved; however, further supports are still needed to further strengthen the capacity in managing climate risks and institutionalize the use of climate information.

Potential for further work

To further increase capacity of local authorities to manage climate risks, the Principle Investigator has proposed a proposal to the Directorate of Higher Education, Ministry of Education, to assist the nodes to institutionalize the use of climate information. A proposal has also been submitted to World Bank under Development Market Place (DMP) to conduct the feasibility study on climate insurance index that can assist farmers in coping with the climate risks. The project was developed in collaboration with IRI (International Research Institute for Climate and Society University of Colombia and MicroEnsure. The proposal submitted to the higher education has been approved, while the one to the World Bank has passed the first screening and will be further reviewed by the DMP Team. The Principle Investigator is invited to attend the final evaluation process at Washington DC on 10-13 November 2009. It has been designed that the two activities will complement each other. Bandung, Indtramayu, Pacitan and Kupang will be selected for the implementation of the two studies as there nodes have strong ENSO signal and have good forecast skill.

Publications

1. Peer-reviewed Publications:
    a. Moron V, Robertson A and R. Boer. 2008. Spatial coherence of spatial predictability and monsoon onset over Indonesia. Journal of Climate 22: 840-850
    b. Boer, R., K. Rahadiyan, and Perdinan, 2007. The Use of Agriculture System Modelling for Crop Management: Case Study in Pusakanegara. Indonesian Agriculture Meteorological Journal 21:
    c. Boer, R and E. Surmaini. 2009. Economic benefit of SOI phase information for crop management decision in rice-based farming system in West Java Indonesia. Submitted to the Indonesia Journal on Agriculture Science
2. Research/Technical Reports produced by APN CAPaBLE Team from the Nodes:
    a. Bandung: Identification of Climate-Related Problems in Rice-Based Farming System of Bandung District
    b. Pacitan - East Java:Validation of ARIMA, ANFIS, WAVELET models Reliability for Seasonal Forecasting in Pacitan, East Java
    c. Kupang - NTT: Evaluation of ARIMA Model Reliability for Seasonal Forecasting in Kupang, NTT
    d. Asahan - North Sumatra: Evaluation of Probabilistic Models Reliability for Forecasting Monthly Rainfall Characteristics in Asahan, North Sumatra

e. Jeneponto - South Sulawesi:Validation of Forecasting Models Reliability for Seasonal Forecasting in South and West Sulawesi
f. Pacitan - East Java:Potential Use of Crop Simulation Models for Farming Strategy
g. Noelbaki - NTT: Identification of technology needs for anticipating climate extreme events at Noelbaki, Kupang, East Nusa Tenggara
h. Bandung - West Java: Climate Risk Management for Rice-based Farming System in Bandung District
i. Asahan - North Sumatra: Assessment of Climate Risk in Farming System at Sei Balai, Asahan District, North Sumatra

3. Modules for Climate Field Schools
   a. Climate Field School. Book 1-Basic Modules: Understanding climate dynamic, climate variables and its forecasting (*Pemahaman Tentang Dinamika Iklim, Pengamatan Unsur Iklim dan Prakiraannya*)
   b. Climate Field School. Book 2-Basic Modules: Climate information application for climate risk management (*Pemanfaatan Informasi Iklim dalam Pengelolaan Risiko Iklim*

4. Papers presented and published in National or International Workshop or National Media
   a. Boer, R., I. Las, M. A. Rataq, K. Tamkani & E. T. Purwani. 2006. Development of Policy-Science-Community networking for increasing the adoption of climate information for agriculture development: Indonesian Case. In Proceeding International Workshop on Climate Forecast Application for Sustainable Agricultural Production and Risk Reduction Strategies, Jakarta 10 November 2006).
   b. Boer, R. 2007. Is our agriculture sector resilience to climate change? The Jakarta Post 4 December 2007. Can be downloaded from http://www.thejakartapost.com/news/2007/09/20/ri-farmers-told-adapt-climate-change.html
   c. Boer, R. 2009. Climate change adaptation and mitigation of Indonesia food crop sector. Published in Proceeding of National Seminar on Agriculture Land Resources at Bogor, 18 November 2008.
   d. Boer, R. 2009. *Sekolah Lapang Iklim: Antisipasi Resiko Perubahan Iklim. Majalah As Salam, 26 Januari 2009* (Climate field school: Anticipate risk of climate change. Published on line in *As Salam* edition January 26th, 2009. (http://salam.leisa.info/index.php?url=getblob.php&o_id=221298&a_id=211&a_seq=0)
   e. Boer, R. 2009. *Strategy to Anticipate Impact of Climate Change on Food Crop Sub-Sector*. Paper presented in the Natonal Meeting of Crop Protection Agency in Mataram, West Nusa Tenggara, 1 April, 2009.

5. Power Point Presentations in National Seminar or International Symposium
   a. Capacitating farmers to use climate (forecast) application to cope with the adverse impact of climate variability and climate change (presented by Dr. Rizadi Boer in Oxfam Side Event COP13, 12 December 2008 in Bali)
   b. Climate change and disaster risk reduction (paper presented by Dr. Rizaldi Boer in Workshop for Journalist on Disaster Risk Reduction, 9-11 November 2008), Bali)
   c. Enhanced policy integration of adaptation measures (paper presented by Dr. Rizaldi Boer in JICA-net training course on climate change, 5 February 2008 and 2 February 2009)
   d. Influencing the climate change policy in rapidly developing country of Indonesia (paper presented by Dr. Rizaldi Boer in SBSTA 28 joint side event: Inter-American Institute for Global Change Research (IAI) and APN, 3 June 2008 in Bonn Germany)
   e. Enhanced policy integration of adaptation measures (paper presented by Dr. Rizaldi Boer in JICA-net training course on climate change, February 2009)
   f. Climate change coping strategies for crop and agriculture sector (paper presented by Rizaldi Boer in the National Meeting on Crop Protection in Mataram, NTB, dated)

6. Workshops and Proceedings:
    a. Proceeding of the capacity building workshop in Biotrop, 4-7 July 2006
    b. Report of the roundtable discussion on Coping with Climate Variability and Climate Change. In collaboration with Stanford University, 7-10 November 2006
    c. Proceeding of the CPT Training in Kupang, February 2007
    d. Proceeding of 7th Agrometeorology Symposium Conducted by PERHIMPI 15-16 January 2008, Jakarta. Workshop conducted.
    e. Proceeding of Climate Forecast and Its Application in Kupang-East Nusa Tenggara, 29 August 2008
    f. Proceeding of National Climate Training (in collaboration with ADPC and PERHIMPI) in Biotrop, 29 March-1 April 2009
    g. APN CAPaBLE National Workshop in Biotrop, 1-2 April 2009
    h. Monitoring and Evaluation Report on the Implementation of Climate Risk Management in the Nodes

7. CD-ROM containing
    a. EXCEL Programs that can be used to evaluate forecast skill using Relative Operative Characteristics (ROC), to determine monsoon onset, dry spell/wet spell, and seasonal rainfall characteristics from daily rainfall data series (http://www.indonesiaapn-capable.totalh.com/index.php/project-activities/49-dssat/75-model)
    b. Photo Documentations
    c. Workshop Proceedings

8. Website*:* Indonesian APN CAPaBLE website: www.indonesiaapn-capable.totalh.com

Acknowledgments

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TECHNICAL REPORT

Preface

Fluctuation of agriculture production is closely related with rainfall variability. Inter-annual climate variability that leads to recurrences of extreme climate such as floods and droughts often have far reaching impacts on agricultural production. Even technology on climate forecasting has improved quite significant recently, but the capacity to manage climate risks through effective use of climate forecast information is still low. The Indonesian APN CAPaBLE project was aimed to encourage end users especially farmers to realize the value of climate information to support their farming activities and to develop capacity in using reliable climate forecast to manage climate risks and hence reduce the vulnerability of their farming system to extreme climate events. This technical report described the process and approach used in developing and strengthening the capacity of local scientists and local authorities and farmers in managing climate risks.

Table of Contents

1. Introduction

Climate plays a key role in the socio-economic activities of many sectors in Indonesia, particularly in agriculture sector. Fluctuation of agriculture production is closely related with rainfall variability. Inter-annual climate variability that leads to recurrences of climate extremes such as floods and droughts often have far reaching impacts on agricultural production. Climate monitoring and timely early warning of climatic extremes, with respect to onset, severity, cessation, duration, time evolution, geographical extent, and impact on associated agricultural production systems such as water resources, transportation, energy, among many other socio-economic sectors and formulation of appropriate strategies, can be used to improve agricultural production.

Based on historical impact data, it was shown that the total damage and loss due to the extreme climate events, particularly floods and drought, tended to increase from time to time (Boer and Subbiah, 2005). In Indonesia these extreme events often associated with the ENSO occurrence. From 43 drought events in Indonesia only 6 events were not associated with El-Nino (Boer and Subbiah, 2005). On the other hand, skill to forecast such extreme events has been developed quite well. Under ENSO condition, the reliability of the climate forecast is high (Giannini et al. 2007). However this reliable forecast information has not been use effectively as indicated by the consistent significant increase in agriculture production loss whenever these extreme events occurred.

To increase the effective use of climate forecast information, an effective climate information system should be developed and the application of climate information should be institutionalized. Process for institutionalizing the application of climate information applications will be a long process as it will involve various institutions and different groups of communities. Good understanding and knowledge as well as networking between scientific communities, policy makers and intermediaries will help to accelerate the process. To develop such networking, knowledge and understanding of scientific community, policy makers and government officials either at local and national level to the climate information system should be improved.

The project goal is to increase understanding and to develop capacity of local scientists on climate information application and their working relationship with policy makers in assisting farmers to address climate-related problems. While, the objectives of the project are:

- To establishment of regional nodes CAPaBLE in Indonesia
- To improve analytical skills of local scientists to identify the most important research issues in their region through learning experience of the other nodes
- To improve communication skills of local scientist and to enhance scientific leadership capacity
- To build technical capacity of local government staff and extension workers in using climate risk technologies and agricultural risk management tools
- To increase awareness of farmers to economic value of climate information and adoption of farmers to climate information technologies

2. Methodology

Explain how you carried out the project, which should follow logically from the aims. Depending on the kind of data, this section may contain subsections on experimental details, materials used, data collection/sources, analytical or statistical techniques employed, study field areas, etc. Provide sufficient detail for a technical/scientific audience to appreciate what you did. Include flowcharts, maps or tables if they aid clarity or brevity.

2.1. Study Sites

The sites selected for the project were Asahan-North Sumatra, Bandung-West Java, Pacitan-East Java, Janeponto-South Sulawesi and Bandung-West Java (Figure 1). The selection of the sites based on consultation with Agriculture Research and Development Agency and National Agency for Meteorology, Climatology and Geophysics (BMKG) considering the level of vulnerability of the region to the extreme climate events.

Figure 1. Sites of Indonesian CAPaBLE APN

2.2. Study Approach

To achieve the above objectives, activities conducted under the project followed a number of steps. The initial step was to identify potential candidates to be invited to joint the Indonesian APN CAPaBLE Team from each selected site. Identification and selection of the candidates was done through discussion with Head of Agency for Agriculture Research and Development (AARD), Head of Centre for Research and Development of National Agency for Meteorology, Climatology and Geophysics (BMKG) and Head of Directorate of Plant Protection-Ministry of Agriculture (Ditlin). The potential candidates were mostly come from Agency for Assessment and Application Agriculture Technologies (BP2TP), local universities and regional BMG.

The second step was to implement training workshop for the Indonesian CAPaBLE APN team (the selected scientists from each site) on the use of tools, methods and approach on climate risks management. After the training, the team conducted participatory rapid assessment to identify climate related problems in their sites and implement action research to address the problem. The action researches were designed to produce a number of climate information applications for managing the climate risks. In collaboration with local extension workers and agriculture staff, the climate information applications were disseminated to farmers through various means particularly through Farmers Field School. The APN CAPaBLE Team along with the extension workers and local agriculture staff developed climate field school modules through workshops with the assistance of Indonesian APN CAPaBLE Researchers.

Directorate of Crop Protection of Ministry of Agriculture (Ditlin), as a responsible agency at national level in developing crop protection programs, provided support programs for the local agriculture offices in capacitating farmers in managing climate risks through CFS, while the regional BMGs worked with the BMG HQ to evaluate the climate forecast skill and to improve the reliability of forecasts for the sites. Finally, the APN CAPaBLE Team shared lesson learnt gained during the implementation of the project through workshops. Schematically, the process of the project implementation is given in Figure 2.

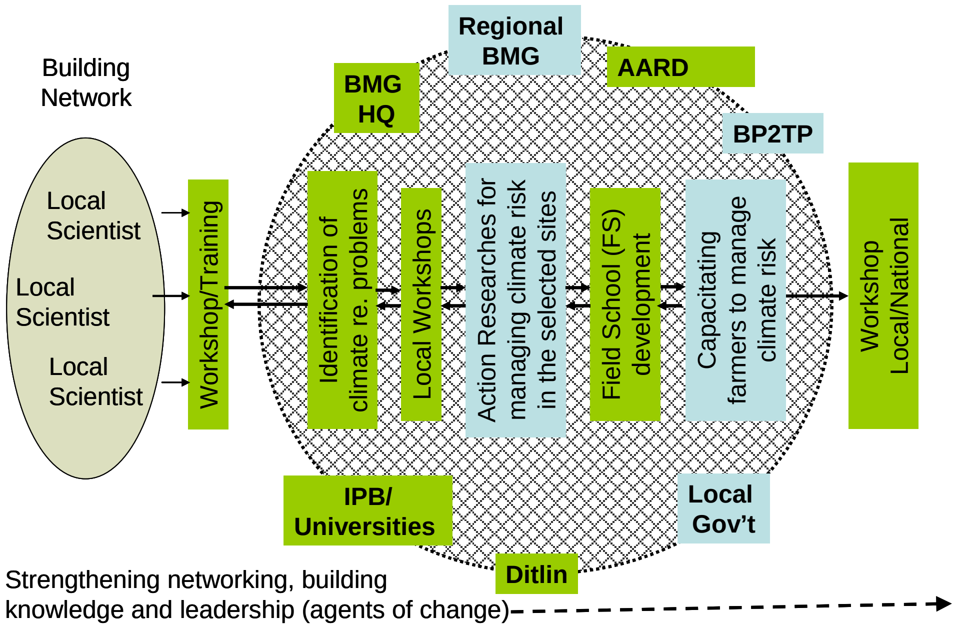

Figure 2. Process of the implementation of the APN CAPaBLE project in Indonesia

2.3. Development of Climate Forecast Information Application

Development of climate forecast information application was based on the result of the participatory rapid assessment. The analysis on the potential use of climate forecast information was done using modelling approach (Meinke et al., 2001, 2003, 2005; Hansen et al. 2006). This analysis was designed to assess various cropping management strategies in managing climate risks. This analysis will provide basis for extension workers/farmers how they should tailor their cropping management strategies to climate forecast.

Models for climate forecasting were developed using different techniques, mainly statistical techniques (Wilks, 2006), such as ARIMA, wavelet, ANFIS, principle component regression and other linear regression. Evaluation of the climate forecast skill was done using various approaches described in Mason and Graham (1999) and Jolliffe and Stephenson (2003).

Evaluation of the networking among climate producers, agriculture technologies producers and users (agriculture office and farmers) was done through interview in the five nodes. The evaluation was based on interaction among agencies and implementing climate field school program.

3. Results & Discussion

3.1. Climate Related Problems in the Study Areas

In the five sites, the common types of climate hazards are flood and drought. At Kupang-NTT, strong wind is also quite common (around January-February). Flood normally occurs during peak of wet seasons (around January-March), while drought occurred during dry season (April-October). However, crop planting early in the wet season may also expose to drought due to the occurrence of false rain, isolated rainfall events around the expected onset date do not signal the sustained onset of the monsoon. Such false starts occurring in September or October depending on the regions prompt farmers to start planting. In the eastern part of Indonesia, such as Kupang, multiple false starts can cause multiple failures, with farmers sometimes planting up to four times in a season. Based on survey conducted in a number of villages in the five districts, type of climate hazards affecting their cropping system is shown in Table 2.

Table 2. Type of climate related problems in the five sites

Village	District/Province	Main crop	False Rain	Flood	Drought
Sei Balai[1]	Asahan	Rice and vegetable	No	Yes	Yes
Sumber Sari and Tagal Luar[2]	Bandung, West Java	Irrigated Rice and maize	Yes	Yes	Yes
Pringkuku and Sugi Waras[3]	Pacitan, East Java	Maize and Soybean	Yes	No	Yes
Kuluka[4]	Janeponto	Rainfed rice and maize	Yes	No	Yes
Noelbaki[5]	Kupang	Irrigated Rice and Maize	Yes	Yes	Yes

Source: [1]Halolo and Ramidja (2006); [2]Surmaini and Boer (2006); [3]Wahab et al. (2006); [4]Mole and Damanik (2006); [5]Kendang and Geru (2006).

The rainfall pattern of Sei Balai is different from the other four sites. Rainfall pattern at Sei Balai is belong to equatorial rainfall characterized by two monthly rainfall peaks, in March and in October, while those of the four sites are long to monsoon rainfall (‘*Monsoon*’) with a monthly rainfall peak in December. The monsoon rainfall can be further divided into two groups (Types A and B) which are prevalent in southern Indonesia. Type A and B indicate a clear distinction between a dry and a wet season throughout the year, but type A shows a longer dry period (eastern part of Indonesia, Nusa Tenggara islands) and is overall drier compared to the Type B (Java, South Sumatra, and South Sulawesi). The region with the Type A rainfall experiences severe drought more frequently. In general, rainfall variation is larger in the dry season (April to September) compared to the wet season (October to March). In connection with the cropping pattern, the common climate related problems for crop is shown in Figure 3.

Based on monthly rainfall data, in most of the sites flood normally occurs in wet season months when its rainfall is much above normal. Above normal rainfall in wet season occurred quite often during La-Nina years. However, in some site such as Kupang, floods also occurred quite often in the wet season month where the monthly rainfall is normal or below normal. In this district, the rainfall is very erratic. Monthly rainfall in particular year may be constituted from a few rain days. This means that intensity of rainfall in particular days in particular wet season month can be very extreme even cumulatively the rainfall for the corresponding month is not above normal. This suggests that in the other two villages the monthly rainfall forecast can be used to assess flood risk for that particular month.

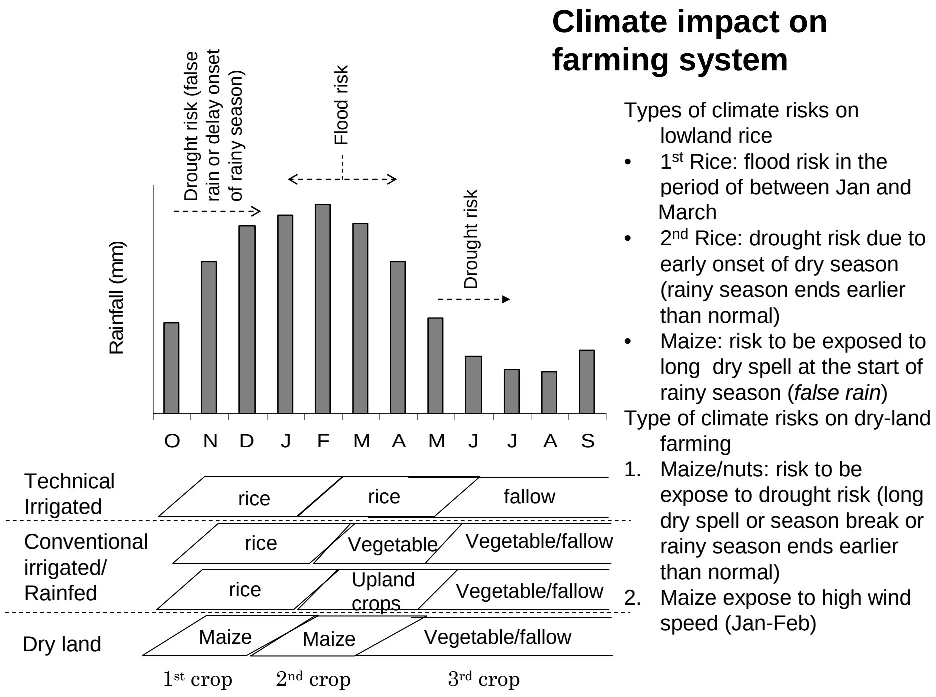

Figure 3. General climate impact on cropping system in areas with Monsoonal Type

Drought normally affects second crops when rainy season ends earlier or rainfall in the dry season fall far below normal. Too late planting for the second rice crop due to much delay of the onset of wet season can also cause drought. These conditions commonly occur in El-Nino years. Too late planting for second rice will not cause drought problem when rainfall in the season is much above normal which is commonly occur in La-Nina years. A study at Indramayu district of West Java province show clear connection between ENSO events and rainfall characteristic and its association with drought occurrence (Figure 4).

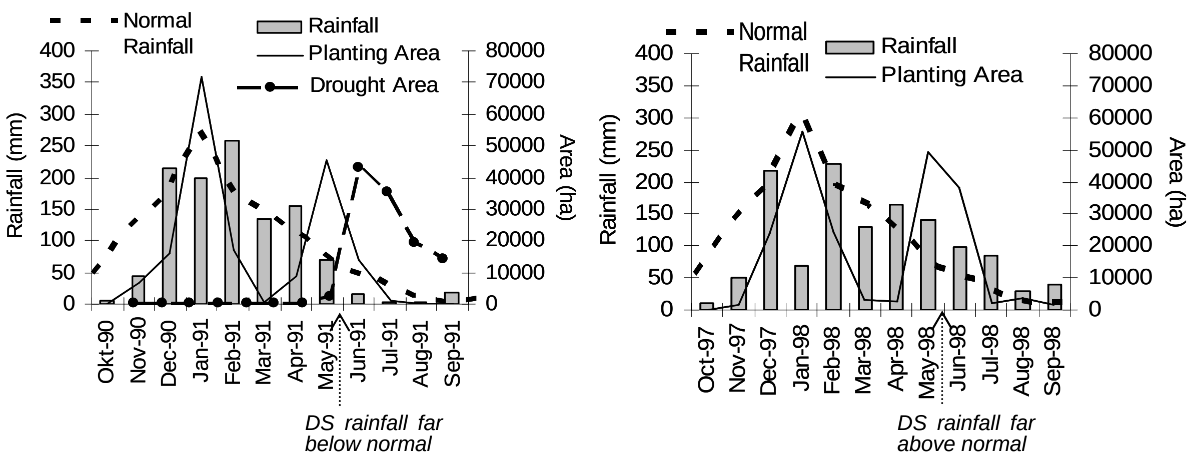

Figure 4. Relationship between rainfall characteristics and drought occurrence in El-Nino (1990/91) and La-Nina (1997/98) years at Indramayu District of West Java Province (Boer, 2002)

Thus, there are three basic scenarios can be identified that lead to different crop loss levels due to ENSO. The following scenarios best describe impact (see Figure 4):

- El Nino initiates delays in the onset of the rains, but false rain occurs which trigger farmers to start planting their crops.

- El Nino causes below normal dry season rainfall and this will expose the dry season crop to high drought risks as happened in 1990/91.
- El Nino initiates delays in the onset of the rains such as happened in 1997. This causes delays in planting up to 2-3 months. This will cause an increasing drought risk for the second crop as it will be planted late in dry season. The impact will be more severe if the El-Nino continues as dry season rainfall normally falls below normal. However, if it is followed by La Nina, the second crop will not suffer from drought despite delays in planting as this phenomena will increase dry season rainfall above normal as happened in 1998,

3.2. Evaluation of Climate Forecast Skill

BMKG[1] provided rainfall forecast regularly. The forecast information includes onset of season and characteristics of monthly/seasonal rainfall (below normal, normal or above normal). The regional BMKGs under coordination of BMG Head Quarter are developing rainfall forecast model using statistical-based models such as ANFIS (Artificial Neural Network), wavelet, GCM statistical downscaling. The statistical based-model used for operational forecasting is ARIMA (*Autoregressive Integrated Moving Average*) model along with dynamic based model. Based on the validation results, ARIMA have been found to be superior to other two models (Damanik, 2008; Setyadipratikto e al. 2008; Geru, 2008; Haloho, 2008). It was also found that the skill of forecast is higher in dry season than in wet season. Giannini et al (2007) also found that high predictability during the dry and transition seasons, which coincide with ENSO growth, is expected from the coherent large-scale response to ENSO's initial perturbation. International Research Institute for Climate and Society (IRI) has provided training for the APN CAPaBLE Team on the use of other model called 'cpt' (*climate prediction tool*), i.e. Statistical Downscaling Model using Principle Component Regression. The APN CAPaBLE team has tested the model. However the performance of the model was not very good.

For prediction the season onset, the BMKG used linear regression model where the sea surface temperature has been used as predictor (Setyadipratikto et al. 2008). They found the season onset at Pringkuku-Pacitan can be predicted from sea surface temperature in Indonesian ocean well (5˚ – 15˚ S and 125˚ – 135˚E) with one month lead time (r = 0.69). IRI and IPB also evaluated the use of sea surface temperature as predictor for the season onset in all Indonesia Region (Moron et al., 2009). It was found that simple linear regression model can be used to forecast large-scale onset based on July Sea Surface Temperatures (SST) over Central and Western Equatorial Pacific (Figure 5). The use of the SSTs for forecasting monsoon onset provides good skill particularly in most part of Indonesian Region (correlation more than 0.5) with exception in North part of Sumatra and Kalimantan islands as indicated by Figure 6.

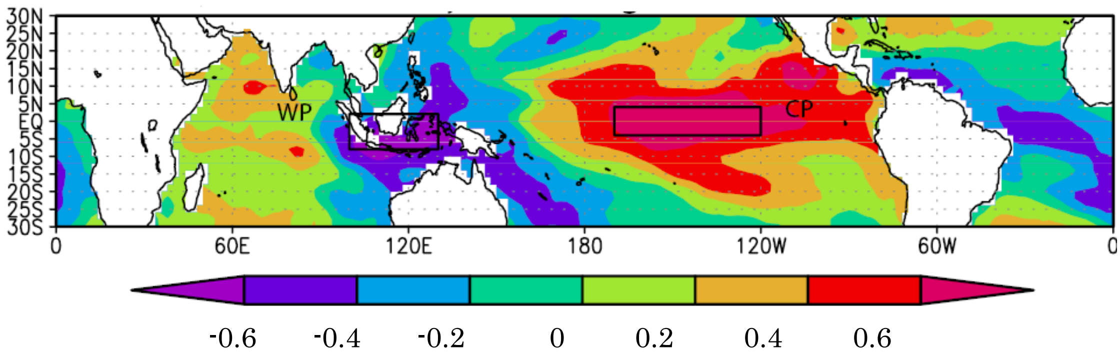

Figure 5. Correlation map between large-scale monsoon onset (EOF1 of the onset date) and SST index. Contour interval is 0.3 and black boxes indicate the SST index regions (Moron et al. 2009).

[1] Formerly, the BMKG is called BMG. The name of BMG agency was changed to BMGK in 2009.

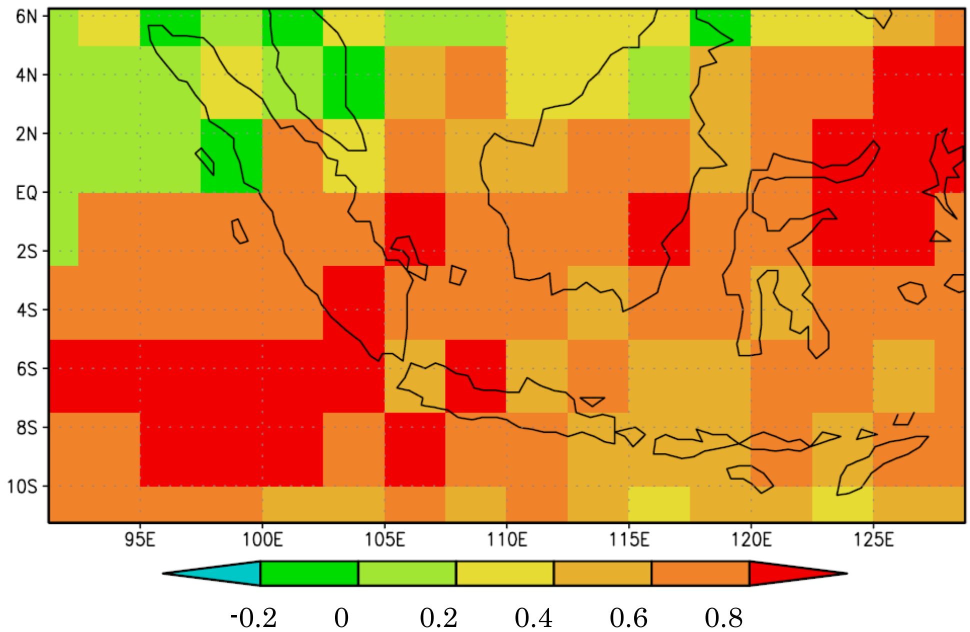

Figure 6. Correlations of the onset dates with the principal component time series (EOF1; Moron et al. 2009).

The APN CAPaBLE project has developed Excel program for facilitating local team to determine season onset and other rainfall characteristics and developing season onset forecast model using sea surface temperature and to evaluate the forecast skill using the Relative Operating Characteristics ((http://www.indonesiaapn-capable.totalh.com/index.php/project-activities/49-dssat/75-model).

3.3. Potential Use of Climate Forecast Information for Managing Climate Risk

The skill of forecast is reasonable high for monsoon onset and dry season rainfall. This information is very useful for setting up cropping management strategies for particular season. The onset forecast can be used to determine the suitable time for planting crops. With this information, farmers can avoid the problem of false rain. For irrigated rice farmers in Java and NTT, information on onset timing is also important for developing strategies to avoid exposure of the second rice crop to higher drought risk at dry season planting (April-July), particularly for farmers located at the tail-end of the irrigation system (Boer and Subbiah, 2005; Naylor et al., 2007). As shown in Figure 3 (see case for 1990/91), the decrease of dry season rainfall of 1991 much below normal has also caused serious drought problem for the rice crops. Thus if dry season rainfall is forecasted to be below normal, farmers may use it to change their crop from rice to non-rice which require less water. Potential applications of climate information in crop management for Bandung were reported Bandung is reported by Surmaini *et al.* (2008), Asahan by Harahap et al. (2008), Pacitan by Wahab et al. (2008) and Kupang by Kendang et al. (2009).

The economic benefit of using climate information has been evaluated in Bandung (Boer and Surmaini, 2009). It was suggested that if farmers use consistently the April or May SOI information for making decision in selecting second crop (see Figure 2) planted in May or June, they will get higher cumulative income compare to farmers who do not used the information. The results of the study suggested that farmers who switch their crop to soybean or maize for May planting if April SOI Phase is 1 or 3 (indicates El Nino Years) will get a higher income compared to farmers that keep planting rice (Figure 7). Cumulatively, over 24 years, the net income difference between farmers that use April SOI Phase information in deciding a crop type for May planting and those that do not is about 25 million IDR at Ciparay and 35 million IDR at Bojongsoang if they chose soybean as the second crops, and about 2 and 5 million IDR respectively if they chose maize. Farmers who choose not to plant a second crop will accrue a lower income than those that plant the crops.

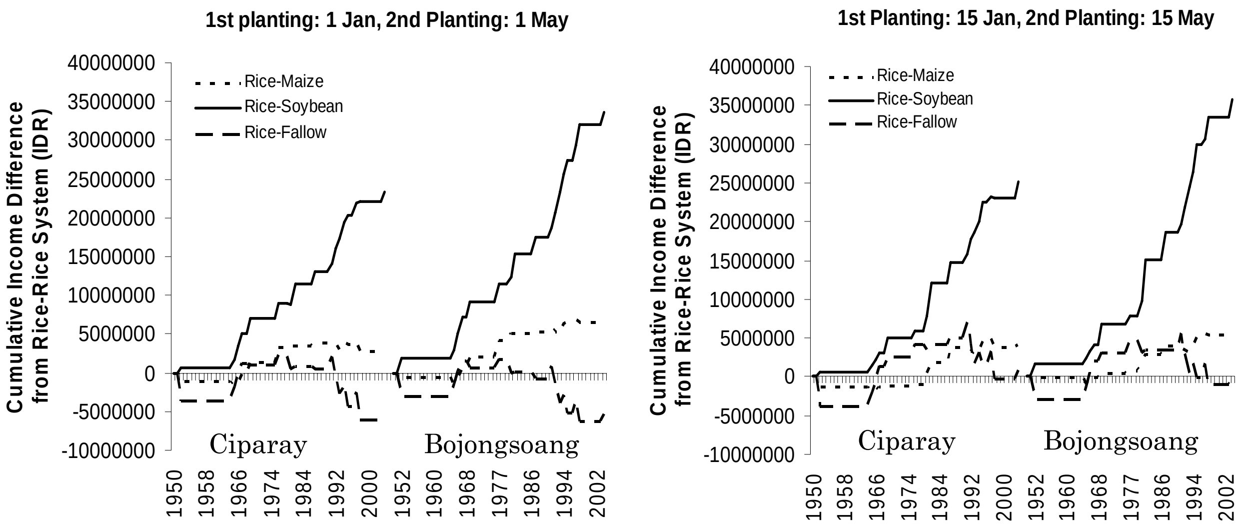

Figure 7. Economic benefit of using one month lead time Southern Oscillation Index (SOI) information at Bandung District (Boer and Surmaini, 2009)

Since sea surface temperature in the Pacific and Indian Ocean have significant correlation with rainfall variability in many part of Indonesia, many studies attempted to develop models for predicting crop production from anomaly sea surface temperature. For example, Falcon et al (2004) found that the rice production anomaly in Indonesia can be well predicted from August sea surface temperature anomaly (AugSSA) over the Pacific Ocean. The equation is the following:

$$\text{Paddy production} = 35{,}311 - 1{,}318\ \text{AugSSTA} + 1{,}675\ t - 45.0\ t^2;\ \text{Adj}\ R^2 = 0.94$$

Where t is time measured in years, where 1 = 1983/84.

Boer et al. (2004) has also developed model for predicting yield of potato at Pengalengan, Bandung using SOI and Indian Dipole Mode (IDM) prior to planting season (July-August). They found that yield of the potato at Pangalengan, Wet Java planted in the period of September-December could be predicted from June-August SOI, and IDM, population density (P in plants per m^2), and nitrogen application (N in t/ha). About 84% of potato yield variability could be explained by the equation. The form of the relationship is as follows:

$$\begin{aligned}\ln(Y) = {} & 2.14 + 13.7\ N - 2.20(P{*}N) - 0.000822\ (PT{*}IDM_{JA}) \\ & + 0.000890\ (PT{*}SOI_{JA}{*}IDM_{JA}) - 0.279\ (IDM_{JA}{*}SOI_{JA}) \\ & + 0.0000002(PT^2{*}SOI_{JA})\end{aligned}$$

Spatial analysis on the relationship between crop production and sea surface temperature anomalies has revealed strong correlation between the two variables. The analysis was done by correlating (i) Aug-Sep sea surface temperature of particular year and crop production data of the following year and (ii) between May-Jul sea surface temperature of particular year and crop production data of the same year (Figure 8). It was found that the correlation was stronger at Nino regions (Figure 9). For rice crop, the correlation is negative meaning that the higher the sea surface temperature the lower the production is while for maize the correlation is positive. This probably because the occurrence of El Nino may not affect significantly the wet season planting area of maize crop as the water requirement of maize is much lower than rice. In addition, the occurrence of El Nino may increase the amount of radiation received during the wet season.

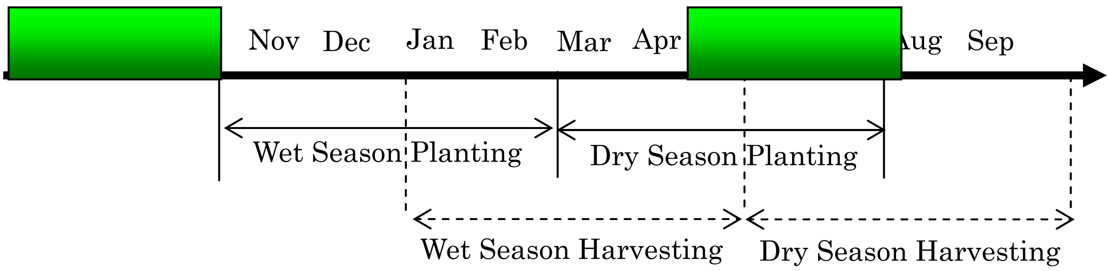

Figure 8. Planting and harvesting seasons for the main food crops in production centre regions of Indonesia

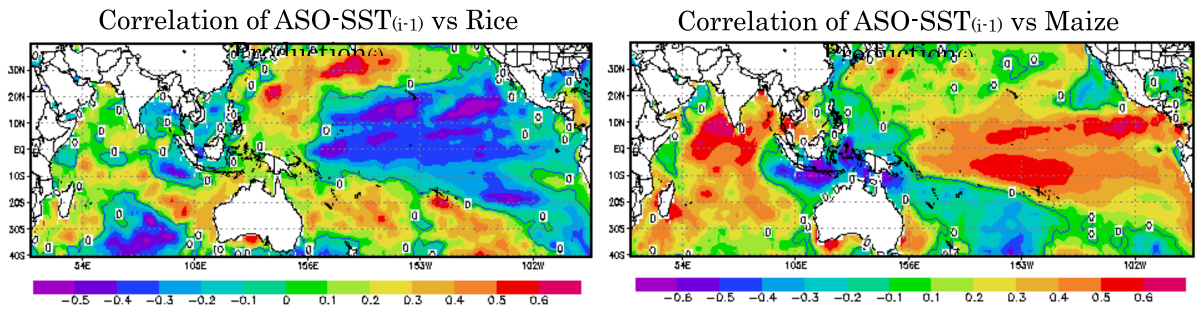

Figure 9. Correlation between ASO sea surface temperature and annual crop production for rice (National) and maize (Central Java only; Boer 2008)

In the second analysis, it was found that the correlations were negative for both crops with sea surface temperature of the Pacific Ocean and were positive with sea surface temperature of Indian Ocean near Indonesia (Figure 10). This may support the Yamagata et al. (2001) and Kumar *et al.* (1999) finding that the effect of Indian Dipole More (IDM) may counteract the effect of El Nino when they occur together.

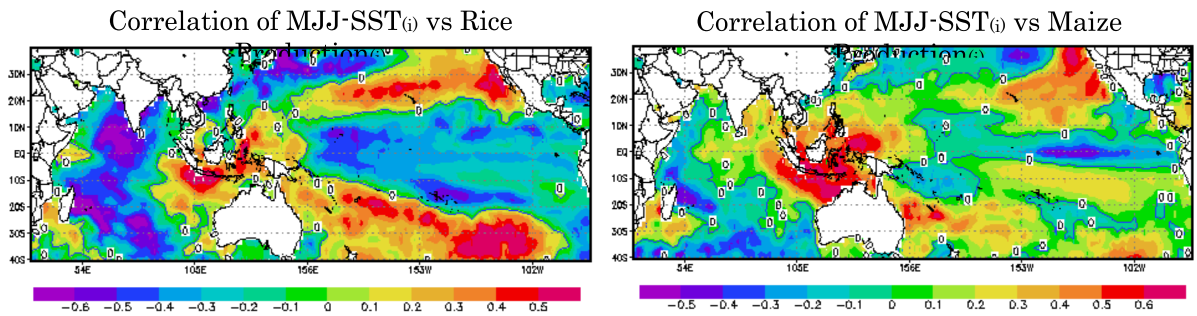

Figure 10. Correlation between May-July sea surface temperature and annual crop production for rice (National) and maize (Central Java only; Boer 2008)

The above findings strongly suggested that the use of climate (forecast) information may be able to minimize the risk of climate on crop production, particularly in regions where their rainfall variability are strongly influence by sea surface temperature anomalies in the Pacific and Indian Ocean.

3.4. Climate Field School Modules

To allow the extension workers using the result of the study for capacitating farmers in managing climate risk through Climate Field School program, two climate field school modules have been developed. The two modules are:

1. Module 1: Understanding climate dynamic, climate variables and their forecasting. This module describes basic concept of climatology, dynamic of Indonesian climate, particularly about ENSO impact of Indonesian rainfall variability and extreme climate events and forecast terminology used by the BMG (Boer *et al.* 2009a).
2. Module 2: The use of climate information for managing climate risk. This module describes about how to identify climate related problems and their influence on cropping management activities so that the climate risk can be managed effectively (Boer et al. 2009b).

3.5. Monitoring and Evaluation

The result of monitoring and evaluation indicates that all nodes have implemented climate field school and well adopted and positively responded by farmers. The local governments responded well except in Janeponto. At Janeponto, other related programs from Ministry of Agriculture such as Field School for Integrated Pest Management also do not run well.

The common views from the local government and agriculture office from the district related to factors that affect the effectiveness of the climate risk management programs were:

1. Number of extension workers who have good knowledge on climate risk management is still limited or almost none. Some of extension workers have taken Training of Trainers (ToT) program once but it is far from enough. It is suggested that more trainings on CFS are required and references or practical books on climate risk management should be developed more which may also them to be able to modify, develop or improve climate field school modules.
2. Low skill and non-timely forecast. At present, skill of climate forecast in Asahan (North-Sumatra) and Janeponto (South Sulawesi) is quite low. In addition, the forecast received by agriculture office is also quite late particularly at Asahan-North Sumatra. However, the heads of BMG office at the nodes stated that they already received support from BMG Head Quarter to improve the skill by introducing them with a number of forecasting techniques and rainfall stations network. To accelerate the dissemination of forecast information, BMG at North Sumatara and South Sulawesi plans to use short message system via telephone.
3. Limited funding support provided by local government to continue CFS program.
4. The institutional process on the use of climate information for managing climate risk has not been well developed. Further support to institutionalize the use of climate information in climate risk management is still required.

The summary of the monitoring and evaluation can be found in http://www.indonesia-apncapable.com/download/2008-2009/publication/Monitoring_dan_Evaluasi_SLI-1.xls

4. Conclusions

Objectives of this study have been achieved mostly. Five regional research nodes involving about 10 local scientists as APN CAPaBLE have been established. The analytical skills of the team have improved as well as their capacity in using some agricultural risk management tools. They also actively communicate and develop collaboration with local government in developing further strategies for managing climate risk, particularly in three nodes (Asahan, Pacitan and Kupang). However, further support is still needed especially in assisting the team in institutionalizing the use climate information in climate risk management. Further support to continue the research activities has been obtained from Directorate of Higher Education.

5. Future Directions

The result of this study can be good background and a strong case for weather based insurance development in Indonesia. Key arguments are

- The onset of the rainy season can be used to indicate possible crop losses due to drought of the second rice crop. If the onset is delayed probability is significant that second crop fail. The delays are determined by the El Nino. The onset of the rainy season can be predicted with high skill and some indications on weather based indicators. This allows for the development of ENSO adjusted insurance packages.
- Extreme wet years can be predicted with high skills. This allows for setting of clear thresholds beyond which crop failure.

For extreme dry and wet years, reliable predictions are possible. This allows for the development of weather based index micro-insurance packages which protect poor and impoverished households from the negative impact of extreme weather and allow them to better and more effective cope with disasters. This is urgent as during El Nino years, response capacity both within the Indonesian government as well within the international community is stressed. It is worth noting that for 2002/03 when impacts were significant, many lacked protection of livelihoods, thus a relative moderate El Nino pushed over more people into poverty.

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Appendices

- Proceeding of the capacity building workshop in Biotrop, 4-7 July 2006
- Report of the roundtable discussion with Stanford University, 7-10 November 2006
- Proceeding of the CPT Training in Kupang, February 2007
- Proceeding of 7th Agrometeorology Symposium Conducted by PERHIMPI 15-16 January 2008, Jakarta. Workshop conducted.
- Proceeding of Climate Forecast and Its Application in Kupang-East Nusa Tenggara, 29 August 2008
- Proceeding of National Climate Training (in collaboration with ADPC and PERHIMPI) in Biotrop, 29 March-1 April 2009
- APN CAPaBLE National Workshop in Biotrop, 1-2 April 2009

Funding sources outside the APN

A list of agencies, institutions, organisations (governmental, inter-governmental and/or non-governmental), that provided any in-kind support or co-funding for the project and the amount (s) awarded.

No	Name of Agencies/Institutions	In-kind and/or Co-Funding (Estimated Value in USD)
1	Centre for Climate Risk and Opportunity Management (CCROM), Bogor Agriculture University	2,500
2	Laboratory of Climatology, Department of Geophysics and Meteorology, Bogor Agriculture University	10,000
3	Directorate of Crop Protection, Ministry of Agriculture (Ditlin)	2,000
4	Agriculture Institute for Research and Development, Ministry of Agriculture	5,000
5	Government of Indramayu	500
6	Local Governments of Pacitan, Asahan, Kupang, Janeponto and Bandung	3,000
7	Agency for Agriculture Technology Assessment and Application (BPTP) of Malang, Maros, Medan, NTT	2,000
8	National Agency for Meteorology, Climatology, and Geophysics (BMKG-Jakarta)	2,000
	Regional Agency for Meteorology, Climatology, and Geophysics (BMKG): Malang (East Java), Medan (North Sumatra), Kupang (NTT) and Ujung Pandang (South Sulawesi)	2,000
9	International Research Institute for Climate and Society (IRI), Columbia University	15,000
10	Stanford University, USA	1,000
11	Asian Disaster Preparedness Centre (ADPC)	2,000
12	CARE International	1.500
	TOTAL	48,500

Glossary of Terms

AARD	Agency for Agriculture Research and Development
ADPC	Asian Disaster Preparedness Centre
ANFIS	Adaptive Neuro-Fuzzy Inference System
APN	Asia-Pacific Network for Global Change Research
ARIMA	Autoregressive Integrated Moving Average
BMKG/ BMG	National Agency for Meteorology, Climatology and Geophysics
BP2TP	Agency for Assessment and Application Agriculture Technologies
BPTP	Agency for Agriculture Technology Assessment and Application
CAPaBLE	Capacity Building for Sustainable Development
CCROM SEAP	Centre for Climate Risk and Opportunity Management in South East Asia and Pacific
CFS	Climate Field School

COP	Conference On the Parties
CPT	Climate Prediction Tool
CRM	Climate Risk Management
Ditlin	Plant Protection-Ministry of Agriculture
DMP	Development Market Place
ENSO	El Niño-Southern Oscillation
EOF	Empirical Orthogonal Function
GCM	Global climate model
GTZ	Gesellschaft für Technische Zusammenarbeit
IAI	Inter-American Institute for Global Change Research
IDR	currency code for the Indonesian rupiah
IPB	Bogor Agricultural University
IRI	International Research Institute for Climate and Society
JICA	Japan International Cooperation Agency
NTB	Nusa Tenggara Barat
NTT	Nusa Tenggara Timur
PEMDA	Local Government
PERHIMPI	Perhimpunan Meteorologi Pertanian Indonesia
ROC	Relative Operative Characteristics
SBSTA	A Subsidiary Body for Scientific and Technological Advice
SOI	Southern Oscillation Index
SST	Sea Surface Temperatures
UNDP	United Nations Development Programme
WAVELET	wave-like oscillation with an amplitude that starts out at zero, increases, and then decreases back to zero