Impact of Extreme Climate Events on Rice-Based Farming System : Case Study at Bandung District

Dampak Kejadian Iklim Ekstrim Terhadap Sistim Usahatani Berbasis Padi : Studi Kasus di Kabupaten Bandung

E. SURMAINI[1] AND R. BOER[2]

ABSTRACT

Bandung District is ~~found to be~~ an area that ~~is~~ vulnerable to the El-Niño Southern Oscillation (ENSO) events. Whenever ENSO occurs, this district is always suffering from drought and flood leading to significant crop production lost. The vulnerable areas to flood and drought are Bojongsoang and Ciparay. The objectives of the study are : a) to identify problems related climate risks in rice-based farming system and the adaptation ~~of~~ mechanism to cope with climate extreme; b) to elucidate relationship of ENSO development with rainfall variability and effect of rainfall to flood and drought occurrences; and c) to evaluate economics loss due to climate extreme. Assessment of farming system at the study sites was conducted using Rapid Rural Appraisal (RRA) method. Farmer's annual income were analyzed using frequency analysis of gross margin. The results showed that Sea Surface Temperature (SST) in Tropical Pacific has significantly affected on rainfall in Ciparay sub-District. The raise in SST anomaly is clearly ~~a subject to~~ delay the rainy season, ~~to~~ prolong the dry season period, and ~~to~~ decrease rainfall amount ~~up~~ to below normal, while the decreasing ~~of~~ SST anomaly resulting high intensity of rainfall in the rainy season and lower in the dry season. Whenever ENSO occurs, most farmers is always suffering from drought and flood leading to significant crop failure. Most farmers realized that climate has been changed and recently there is a trend uncertainly of rainfall pattern (proved by 84% of respondents). Nevertheless, they are still using traditional way to determine the beginning of planting season. Results showed that Benefit Cost Ratio (BCR) have smaller value in floods and droughts than normal conditions. Annual ~~net~~ income analysis suggests that many farmers will have negative annual income either at first or second crops ~~fail~~. Based on the interviews with local authorities and farmers, it is ~~needed~~ to increase awareness of decision maker, extension workers and farmers to climate extremes and to improve their capacity to manage climate risks.

Keywords : Rainfall, Vulnerable areas, Flood, Drought, ENSO, BC ratio, Farmer income

ABSTRAK

Kabupaten Bandung merupakan salah satu daerah yang rentan terhadap kejadian ENSO. Pada saat kejadian ENSO, daerah ini selalu mengalami banjir dan kekeringan yang menyebabkan kerugian karena kegagalan panen. Daerah yang paling rentan terhadap banjir dan kekeringan adalah Kecamatan Bojongsoang dan Ciparay. Tujuan dari penelitian ini adalah: a) mengidentifikasi permasalahan yang terkait iklim dalam budidaya berbasis padi dan mekanisme adaptasi untuk mengatasi kejadian iklim ekstrim, b) menjelaskan hubungan antara perkembangan ENSO dengan curah hujan dan pengaruh curah hujan terhadap kejadian banjir dan kekeringan, dan c) mengevaluasi kerugian ekonomi yang disebabkan oleh kejadian iklim ekstrim. Analisis sistim usahatani di lokasi penelitian dilakukan dengan metode RRA. Pendapatan petani dianalisis menggunakan analisis frekuensi pendapatan kotor. Hasil penelitian menunjukkan bahwa suhu permukaan laut (SPT) di Pasifik Tropis mempunyai hubungan yang signifikan terhadap curah hujan di Kecamatan Ciparay. Peningkatan anomali SPT secara konsisten secara signifikan menyebabkan mundurnya awal musim hujan, memperpanjang periode musim kemarau, dan menurunkan jumlah curah hujan sampai dibawah normal. Sebaliknya penurunan anomali SPT menyebabkan meningkatnya intensitas curah hujan pada musim hujan dan memperpendek periode musim kemarau. Pada saat terjadi ENSO, sebagian besar petani selalu mengalami kerugian akibat banjir dan kekeringan karena kegagalan panen. Sebagian petani menyadari bahwa iklim telah berubah dan polanya menjadi tidak teratur (dinyatakan oleh 84% petani responden). Namun petani masih menggunakan cara tradisional dalam menentukan awal musim tanam. Hasil analisis menunjukkan bahwa nilai BC rasio rasio lebih rendah pada kondisi banjir dan kekeringan dibanding pada kondisi normal. Analisis pendapatan menunjukkan bahwa sebagian besar petani mempunyai pendapatan bersih negatif apabila tanaman pertama atau kedua mengalami kegagalan. Berdasarkan wawancara dengan staf dinas pertanian dan petani, diperlukan peningkatan kesadaran pengambil kebijakan di daerah, pelaksana lapang, dan petani terhadap kejadian iklim ekstrim dan meningkatkan kapasitas mereka dalam mengelola risiko iklim

Kata kunci : Curah hujan, Daerah rentan, Banjir, Kekeringan, ENSO, BC rasio, Pendapatan petani

INTRODUCTION

Climate variability encompasses inter-annual or decadal fluctuations in precipitation and temperature patterns driven by coupled ocean-atmosphere circulation dynamics. Patterns of climate variability, particularly ENSO dynamics, have been measured for decades; observational data are easily accessible on the internet and have been used widely in food and agriculture impact assessments. The strongest and most direct ENSO agriculture connections are found in countries along the equator bordering the Pacific Ocean.

1. Peneliti pada Balai Penelitian Agroklimat dan Hidrologi, Bogor.
2. Guru Besar Perubahan Iklim Global, Fakultas MIPA, Institut Pertanian Bogor, Bogor

ENSO patterns have strong climate teleconnections throughout the world with related impacts on agricultural systems in countries as diverse as Zimbabwe, Australia, the U.S., Argentina, and Indonesia (Cane *et al*., 1994; Nicholls, 1986; Hansen *et al*., 1998; Podesta *et al*., 1999; Naylor *et al*., 2001). Such dynamics can affect planting dates, crop yields and rotations, farm income, and food prices at local to global scales (Naylor *et al*., 2007).

Rice, the main staple crop for the Indonesia's 220 million citizens, depends importantly on the timing and amount of rainfall throughout the year, and thus the food security implications of climate variability are significant. Most of rice areas are located in Jawa and Bali, which account for roughly 55 percent of the nation's rice production. These areas consistently experiences to ENSO droughts and floods during the warm (El-Niño) and cold (La-Niña) phase of ENSO cycle, with significant consequences for rice production. The strong correlation between ENSO and rainfall in Indonesia has been identified (Kirono and Tapper, 1999; Hendon, 2003; Aldrian and Susanto, 2003; Battisti *et al*; 2006; Surmaini and Susanti, 2009).

Floods and droughts are most common climate hazards in rice-based farming systems in West Java, Indonesia. In this area, farmers planted rice crop twice a year; the first rice crops are done in the wet season (between November and February), which often affected by flood, while the second rice crops are in the dry season (between March and June), where drought is the major constrain. Floods are common between January and March, where its risk increases with monthly rainfall (monthly rainfall increases above 300 mm), while drought typically develops in May. These hazards are frequently associated with ENSO events. In ENSO 'warm event' (*El-Niño*) years, for most cases the dry season starts earlier and the rainfall amount is often substantially reduced (Boer and Subbiah, 2005; Kirono and Partridge, 2002). Under this condition most of second rice crops will suffer from drought (Alimoeso *et al.*, 2002; Meinke and Boer, 2002).

Bandung District is one of central paddy rice production in West Java province, that was found to be a vulnerable area to the ENSO events. For instance, Bojongsoang an area belongs to Bandung District has been identified to be very vulnerable to floods, where a village of Tegalluar situated in this areas found to be the most vulnerable area. On the other hand, Ciparay sub-District is very vulnerable to drought. One of vulnerable villages to drought in this sub-District is Sumbersari (Boer, 2002). Adaptation capacity of farmer to ENSO event is still low. Farmers always do farming system based on assumption of normal rainfall. Whenever the ENSO events occur, the districts are always seriously affected and followed by a significant reduction in crop production. They could not able to anticipate flood and drought occurrence better. Consequently, farmers suffer with their loss of crop production and income.

The objectives of the study are a) to identify problems related climate risks in rice-base farming system and the adaptation mechanism to cope with climate extreme, b) to elucidate relationship of ENSO development and rainfall variability and effect of rainfall to flood and drought occurrences and c) to evaluate economics loss due to climate extreme.

MATERIALS AND METHODS

Data collection

In Bandung district, Bojongsoang sub-district is the most vulnerable area to flood. On the other hand, Ciparay sub-district is very vulnerable to drought. Interviews with farmers to gather various information related to the impact of extreme climate events on farming system was carried out in Tegalluar village (Ciparay) and Sumbersari village (Bojongsoang). Tegalluar village located on the right side of Citarum River and Sumbersari on the left side.

Data and information of farming system is collected by twice visits to the sites. During the first visit, rainfall, flood and drought data were collected, while qualitative data collected by interviewed key person to get valuable information such as farmer characteristics, land holding, farming system, cropping pattern, flood and drought occurrence, available technologies for extreme climate events, use of climate forecast in agriculture management, and institutional system of the local community were collected from the interview with local authorities (Staff of Local Agriculture Office or Dinas Pertanian) and extension workers. Based on first interview, questionnaire is arranged to get detail information about land holding, farming system costs, prices, farmer income from on farm and off farm activities, farmer respond to climate extreme events, and adaptation mechanism to cope with climate extreme event.

During the second visit, Rapid Rural Appraisal was held to get information from 144 farmers have been identified on first visit. Selection of respondent carried out by stratified cluster sampling through several steps. First step is two stage cluster sampling. Sample population was divided based on two sub-district and a village was selected within each sub-district. Sub-district and village were selected based on the vulnerability to flood and drought within the last couple of years. The second step is to stratify sampling by clustering farmers respondent in to homogen group based on criteria such as types of farmers (land owners, tenant and share-cropper), size of land holding, age, and major cultivated crops. RRA was conducted through in debt interview, observation, participatory observation, and Focus Group Discussion (FGD).

Data analysis

Relationship between ENSO and onset wet season were analyzed using South Oscillation Index (SOI) phase. SOI Phase 1 and 3 are for *El-Niño*, phase 2 and 4 are for *La-Niña*, and phase 5 is for Normal. The beginning of rainy season was determined when monthly rainfall amount is more than 150 mm. Probability of onset rainy season that much or higher will occur in a given year analyze using probability of exceedence :

$$p = \frac{m}{n+1}$$

where :

p = Probability of exceedence

m = Onset of rainy season ranked from lowest to highest

n = Number of data points

Relationship between ENSO development and drought occurrences were explained using descriptive analysis in ENSO years of 1986/1987, 1991/1992, 1997/1998, and 2002/2003. The impact rainfall variability and effect of rainfall to flood and of extreme rainfall events on rice damaged area due to flood and drought are described using data of 1989-2009.

Appropriate farming system determined by farmer BCR and net income base on common crop pattern used by farmers. Farmer's annual income were analyzed using frequency analysis of annual net income. There are three scenarios used It is assumed that there are no fail of crops, all 1st crop fails when flood occurs in rainy season, and all 2nd crops fails when drought occurs in dry season. Net income was calculated using the equation below :

$$\Pi_i = \sum_{j=1}^{m} x_j \pi_{ij} - C - T_i,$$

$$\pi_{ij} = Y_{ij} P_j - c_j$$

where :

Π_i = Net income in year i

x_j = Crop area of crop j

π_{ij} = Gross margin crop j (Rp ha^{-1})

C = Farming input cost (Rp)

T_i = Tax

Y_{ij} = Crop j productivity (kg ha^{-1})

P_j = Price of crop j (USD kg^{-1})

c_j = Variable cost of crop j (USD ha^{-1})

BC Ratio calcuted using equation below :

$$\text{BC ratio} = \frac{\sum_{t=1}^{n} \frac{B^t}{(i+1)^t}}{\sum_{t=1}^{n} \frac{C^t + K}{(i+1)^t}}$$

where :

C = Capital at the beginning period

B^t = Total revenue to year t

C^t = Total cost to year t

Farmers losses due to floods and droughts depend on flood and drought duration. Flood duration for five days and more than five days lead to production loss 30 and 100 percent respectively. Drought period 1-2 months, and more than two months lead to production loss 20 and 50 percent (Agricultural Office of Bandung district, 2005).

RESULTS AND DISCUSSION

Climate related problems at Ciparay and Bojongsoang Sub District

Ciparay dan Bojongsoang sub-Districts are central of food crops in Bandung District. Paddy is the main food crop in these villages. Most of agriculture areas are irrigated, only a few are rainfed ricefields. Farmers in these two villages normally planted rice twice a year in the irrigated areas and once a year in rainfed areas. The first crop is planted in wet season (November-February) with peak planting time in January, and the second crops in dry season (March-June) with peak planting time in May. Maize is the second main crops after rice. Other crops are cassave, sweet potato, onion, long bean, chilli, cucumber, and some other vegetable crops. Soybean is planted only by very few farmers (Figure 1).

In these area, rainfall variability is very strongly related with ENSO events. It was also found that during *El-Niño* year, the onset of rainy season could delay about one to two month. In Normal years the onset of rainy season normally starts end of October, but during *El-Niño* years the onset of rainy season could delay to end of November to January. Figure 2 suggests that *in El-Niño* years the chance to have the onset of rainy season late November is more than 80%, while in

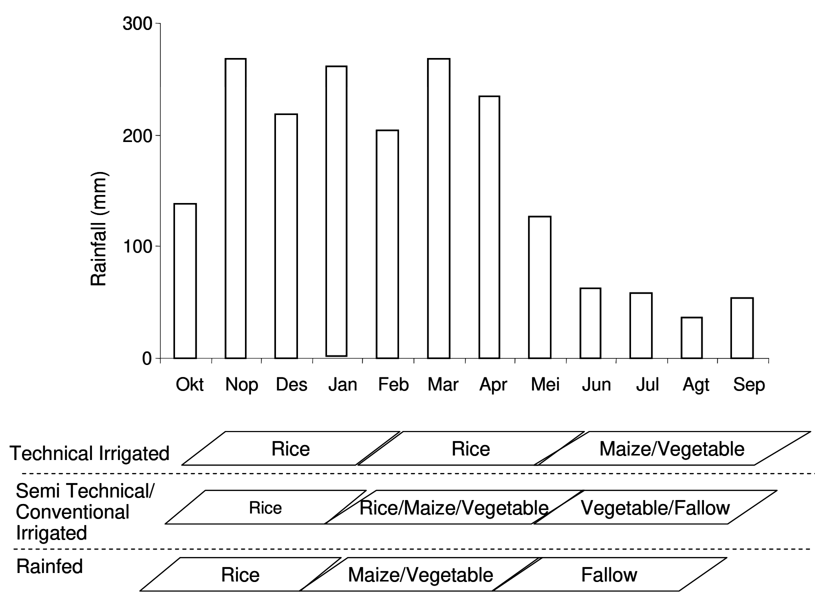

Figure 1. Cropping pattern at ricefield in Sumbersari and Tegalluar village

Gambar 1. Pola tanam pada lahan sawah di Desa Sumbersari dan Tegalluar

December it is about 40%. The delay in onset of rainy season may delay the planting time of the second crop, and this will expose the second crop to high drought risk.

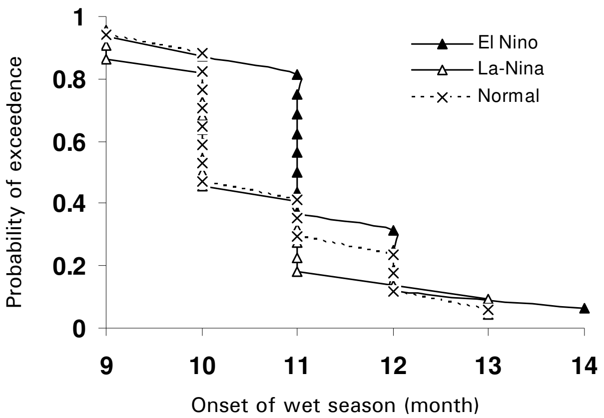

Figure 2. Probability of execeedence for onset of rainy season for *El-Niño*, *La-Niña*, and Normal years

Gambar 2. Peluang terlampaui awal musim hujan untuk tahun El-Niño, La-Niña, dan Normal

From interview with farmers in the two villages, it was indicated that flood commonly occur between January and April (flood risk increases when monthly rainfall in these months increase above 300 mm), while drought commonly develops in May (Figure 3). Drought affects second crops when rainy season ended earlier or rainfall in the dry season fall far below normal. Too late planting for the second rice crop happened due to much delay on the onset of rainy season and it may also cause drought. These conditions commonly occur *in El-Niño* 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-Niña* years. At the beginning of wet season (October and December) drought can also occurs. Delay of onset of rainy season and the occurrence of false rain causes crop losses (seedlings fail to be transplanted).

Although almost every year these two villages suffer from flood and drought, but farmers always arrange the farming system with assuming that condition is normal. Farmers normally start planting in November whenever one or two days rain occurs. According to farmers, big floods had been occurred in 1984, 1993, 1998, 2001, 2003, and 2005 especially between January to April. After floods, farmers always replant their land with rice and consequently it delay their planting time for second crops. In most cases, farmers can not get good yields due to drought. Whenever ENSO occurs,

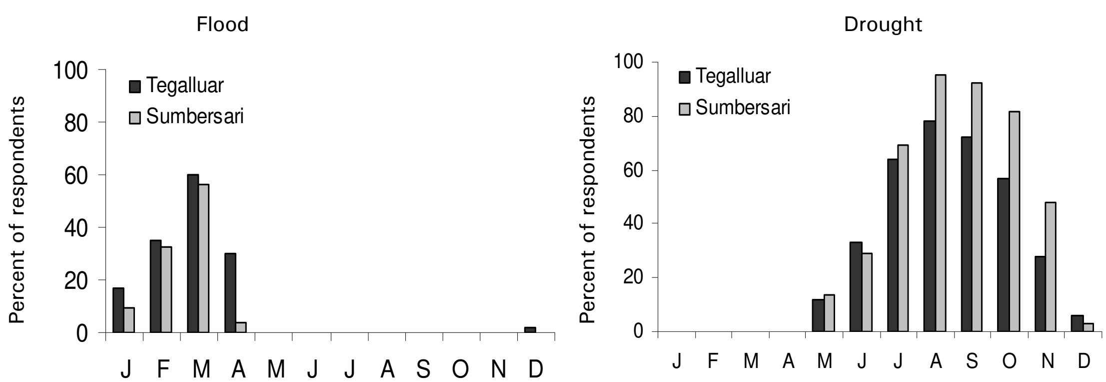

Figure 3. Temporal variation of flood and drought occurrence according to farmers at Sumbersari and Tegalluar villages

Gambar 3. Variasi antar waktu banjir dan kekeringan menurut petani responden di desa Sumbersari dan Tegal Luar most of farmers is always suffering from drought and flood and leads to significant crop failure (Figure 4).

The interview has come up with the results that most of farmer aware climate has been changed and recently there is a trend uncertainly rainfall pattern (84% of respondent). Nevertheless, they are still using traditional way to determine the beginning of planting season. Farmers normally start planting whenever one or two days rain occurs. Similarly, in dry season if the land still receives one or two days rain farmers often plant their land again. The farmers do not really bother with likely climate condition in the following months. In long dry season (*El-Niño* years), the crops will suffer from drought. Since risk of climate hazard in this village is very high, farmers have high expectation to a person who has ability to forecast flood, since his forecast is almost true. However, he informed the farmers about flood forecast after the farmers plant their land. Thus, the forecast has not be used anymore.

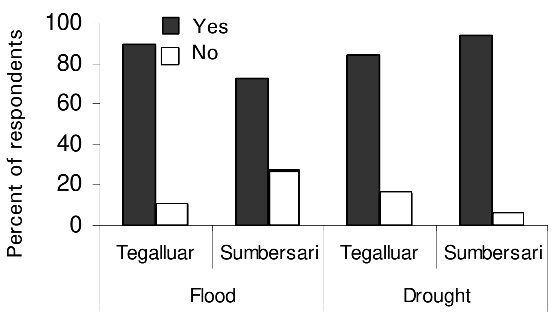

Figure 4. Crop failure caused by flood and drought according to farmers at Sumbersari and Tegalluar villages

Gambar 4. Gagal panen sebagai akibat banjir dan kekeringan menurut petani responden di Desa Sumbersari dan Tegalluar

ENSO and rainfall teleconnection and its relationship with flood and drought occurrences

Recent studies suggested that SST in Nino 3.4 have significant correlation on rainfall in Indonesia (Hendon, 2003; Aldrian and Susanto, 2003, Giannini *et al*, 2006). Relationship between SSTA Nino 3.4 and rainfall variability in *El-Niño* years in Ciparay sub-district figured as follows :

1. In rainy season 1986/1987, SST anomaly in Pacific at that time was consistent rising that caused low rainfall and rainy season ended earlier and then rainfall in dry season 1987 was below normal due to SST anomaly still rising (Figure 5a).
2. Increasing SST anomaly in rainy season 1991/1992 caused rainy season ended earlier and rainfall was below normal, and then SST anomaly is rapidly falling in dry season 1992 caused above normal rainfall and onset rainy season 1992/1993 started earlier with above normal rainfall (Figure 5b).
3. If SST anomaly is rapidly rising to above normal as occurred in middle 1997 due rainfall in dry season 1997 was below normal and onset of rainy season 1997/1998 delayed. In the following year SST anomaly was consistently fall to negative resulted above normal rainfall during rainy and dry season 1998 (Figure 5c).
4. SST anomaly was consistently rising from the middle to end of 2002 year caused below normal rainfall in dry season 2002 and delay of onset rainy season until February 2003. Then SST anomaly started rising to normal condition in May 2003 untill end of 2003 cause normal dry season 2003 and rainy season 2003/2004 (Figure 5d).

Drought and flood are two different type natural hazard. Drought is a slow-onset natural hazard often referred as creeping phenomenon. Because of the creeping phenomenon of drought, its effects accumulate slowly over a subtantial period of time and its impact spread over a larger area. Otherwise, flood is a suddenly natural hazard and its impact in a smaller area. Flood occur in areas near the riverside where farmers, wanting to make a good use of the land, start sowing the lowland. When a heavy rainfall occurs, it cause an overflow in the rivers and devastated the crops.

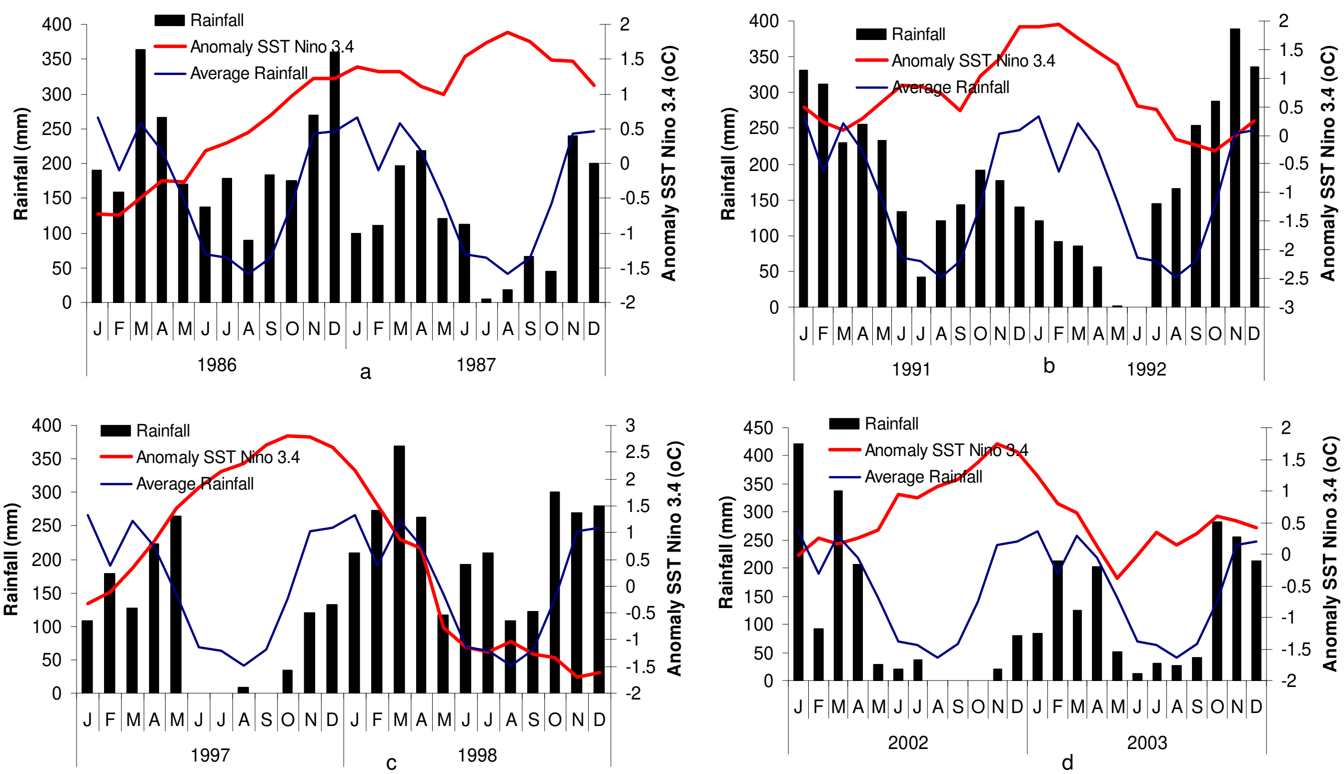

Figure 5. ENSO development and rainfall in Ciparay Sub-District

Gambar 5. Perkembangan ENSO dan curah hujan di Kecamatan Ciparay

Figure 6 showed total ricefield damaged area due to flood and drought in Bandung district in the period of 1989-2010. Flood occured if rainfall anomaly in rainy season was more than 100 mm month^{-1} above normal, while drought occur if rainfall in dry season is below normal and period of dry season become longer than normal condition. Flood and drought occurred almost every year but increased significantly in ENSO years. Flood occurred in rainy season 1995, 1998, 2001, and 2005, and drought occurred in dry season 1991, 1994, 1997, 2003, and 2007. From interview with farmers, it was indicated that flood commonly occur between January and April (flood risk increases when monthly rainfall in these months increase above 300 mm), while drought commonly develops in May. At the beginning of rainy season (October and December) drought can also be occurred. The delay of onset of rainy season and the occurrence of false rain causes seedlings fail to be transplanted and farmers loosed their crops.

Economic loss due to flood and drought

In recent decades there have been major advances in short term and seasonal weather forecasting, as well as in long-term climate modeling. These have yielded major improvement in early warning and advisories as well as in long-term planning. This is resulting in increasing emphasis on proactive rather than reactive management of the adverse consequences of extreme weather events and anomalous climatic conditions on agriculture. It is also increasing the diversity of option available to farmers and others in the agricultural sector to manage impacts. Increasingly, farm managers or other practitioners are seeking more rational and quantitave guidance decision making including cost benefit analysis (Sivakumar and Motha, 2007).

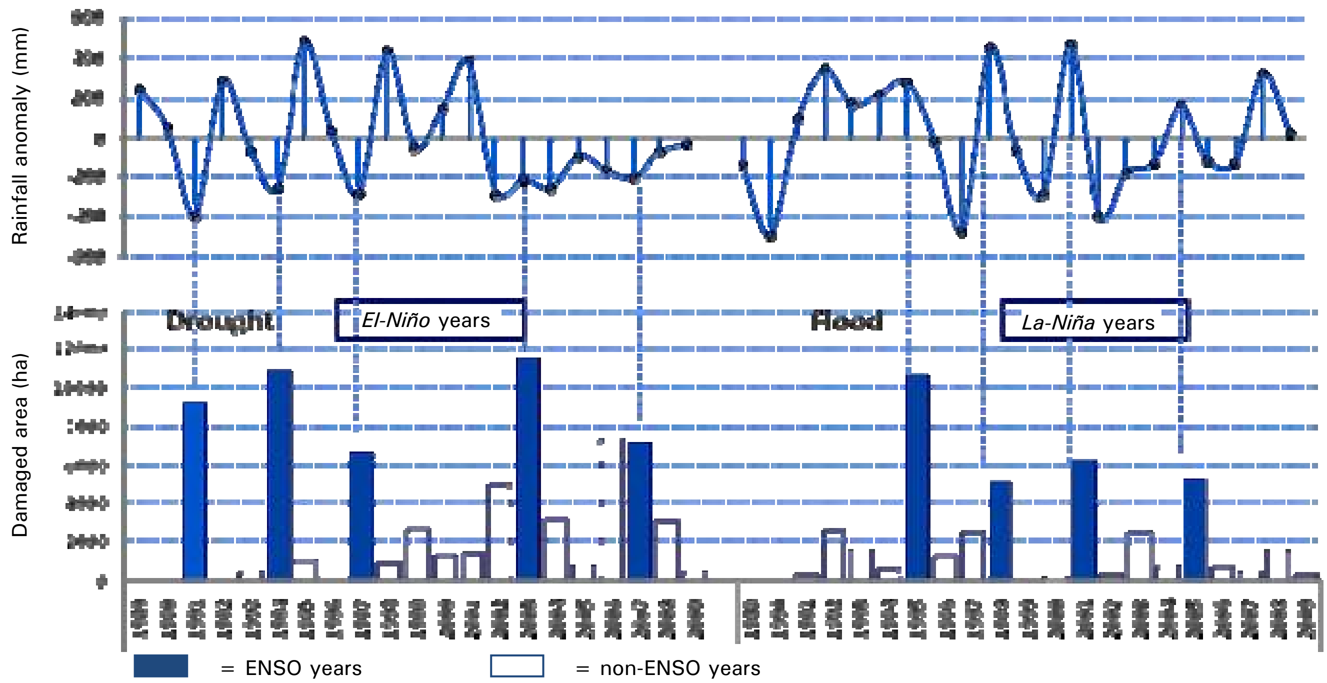

Figure 6. Relationship between rainfall anomaly and flood and drought events in Bandung District

Gambar 6. Hubungan antara anomali curah hujan dengan kejadian banjir dan kekeringan di Kabupaten Bandung

Table 1. BCR and net income per ha according to farmer types

Tabel 1. BCR dan pendapatan bersih per ha menurut tipe petani

Villages	Crop	Farmer types	Wet season		Dry season 1	
			BCR	Net income	BCR	Net income
				USD ha^{-1}		USD ha^{-1}
Sumbersari, Ciparay Sub-District	Rice	Onwer-cultivator	1.91	241	1.49	107
		Tenant	1.48	152	1.19	57
		Share cropper	1.37	133	1.22	60
Tegalluar, Bojong Soang Sub-District	Rice	Onwer-cultivator	1.88	210	1.32	75
		Tenant	1.59	167	0.98	-4
		Share cropper	1.34	118	1.19	50

Benefit Cost Ratio (BCR) analysis suggests that most of farmers can get benefit from their crops. All the BCR were higher than 1.0 with exception for 2nd crops from tenant (Table 1). In general the average net income of tenants and share croppers per hectare were lower than those of the owner-cultivator. This is because the cost of production for the tenant is higher than the owner cultivators as they have to pay the land rent, while the income of the share cropper will be less since they have to share their crop with land owners.

BC ratio in normal condition, flood and drought of paddy-paddy-fallow cropping pattern are 2.02, 1.19 and 1.46 respectively. Damaged on paddy rice due to flood is higher, because floods that occured more than five days lead total damaged, while drought that occurred 1-2 months lead to production loss by 50% (Figure 7).

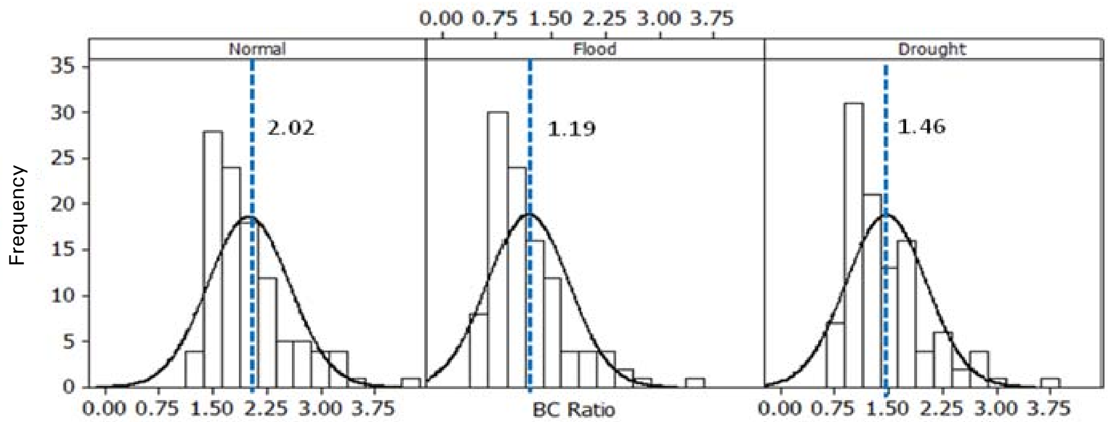

Figure 7. BC Ratio on normal, flood, and drought conditions of paddy-paddy-fallow cropping pattern

Gambar 7. BC Rasio pada kondisi normal, banjir, dan kekeringan pada pola tanam padi-padi- bera

Crop failure due to extreme climate especially flood and drought reduces small land holder farmer income. Many farmers will have negative annual income when either first or second crops fail. Annual net income of 134 respondents with no crops fail is 267 USD. If fist crop fails due to flood the farmers have losses of USD 300 USD with annual income 33 USD. If second crop fails due to drought farmers have losses 200 USD with annual net income USD 67 USD (Figure 8).

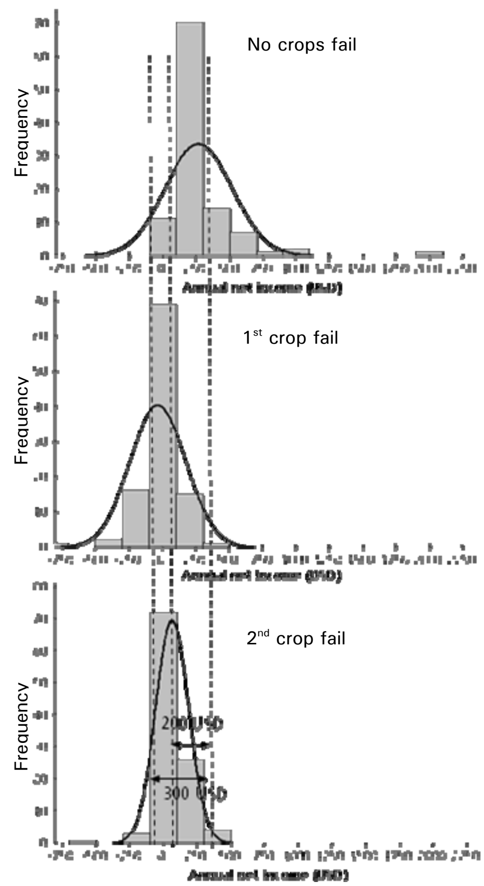

Figure 8. Distribution of annual net income under normal, flood, and drought years of the 134 respondent farmers

Gambar 8. Distribusi pendapatan bersih pada tahun normal, banjir, dan kekeringan dari 134 petani responden

Strategies to address flood and drought problems

Based on Clarkson *et al* (2006), there are six requirements that must be met if farmer are to manage risks related to climate extremes. These include a) awareness that weather and climate extremes will be impact on farm operations, b) understanding of weather and climate processes, including the cause of climate variability and change, c) historical knowledge of wheather extremes and climate variability for the location of the farm operations, d) analytical tools to describe the weather extremes events and clmate variability, e) forecasting tools or access to early warning and forecasting conditions, to give advance notice of likely extreme events and seasonal anomalies; and f) ability to apply the warnings and forecasts in decision making.

However, the adoption of climate forecast information by users in many countries, particularly developing countries is still low. Most farmers used their own decision and do not consider recommendation issues by the local authorities. The main reasons causing low level of farmers adoption to climate forecast information are (i) climate forecast information contain probability which are difficult to understand by users, (ii) current dissemination system of the climate forecast is still not effective, (iii) capacity of users in translating climate forecast information for practical use is limited, (iv) there is no specific program being set up at provincial and local level to optimize the use of climate/climate forecast information in agriculture decision making.

Based on the interviews with local authorities and farmers to assess the need of local community to climate forecast information and to identify what factors determine the adaptation capacity, there are some suggestions to increase awareness of decision maker and of extension workers to climate extremes events and their ability to manage climate risk as follows : a) conduct intensive discussion with extension workers about the results of the forecast and how to interpret the forecast in proper ways, b) increase capacity of the extension workers to use hardware and software for accessing climate forecast, c) arrange training for extension workers how to disseminate result of forecast to the farmer and how to use the information especially in determining planting period, d) discuss with decision maker in province level to give better perception about the importance of transformation of climate forecast to the farmer, and to get financial and regulation support, e) give a better perspective about the importance of institutional support and availability of extension workers to guarantee forecast information could reach the farmer timely and in a simple way, and f) build intensive communication or coordination between extension workers and farmers' associations such as Water User Farmer Association and Farmers' Cooperative, so level of adoption to climate forecast become better.

CONCLUSIONS

1. Rainfall variability is very strongly related with ENSO events in Bandung District. It was found that in *El-Niño* years the chance to have the onset of rainy season late November is more than 80%, while in December it is about 40%. The delay in onset of rainy season may delay the planting time of the second crop, and this will expose the second crop to high drought risk.
2. Sea Surface Temperature (SST) in Tropical Pacific has significant effect on rainfall in Ciparay and Bojongsoang sub-Districts. A consistent rising of SST anomaly causes delay of rainy season, longer period of dry season, and below normal rainfall, while falling of SST anomaly causes high intensity of rainfall in the rainy season and shorter period in the dry season. Flood occurs if rainfall anomaly in the rainy season is more than 100 mm/month above normal, while drought occur if rainfall in the dry season is below normal and period of dry season become longer than normal condition.
3. Crop failure due to extreme climate events especially flood and drought reduce small land holder farmer income. Many farmers have a negative annual income when either first or second crops have failed. If no crops fail, farmer annual net income is 267 USD. If first crop fails due to flood the farmers have lost about USD 300 and If second crop fails due to drought farmers have lost about USD 200.
4. There are important suggestions to increase awareness of decision maker, extension workers and farmers to climate extremes events and their capacities to manage climate risk as follows:

discuss with decision maker in province level to give better perception about the importance of transformation of climate forecast to the farmer, conduct some training to extension workers how to interpret climate forecast, how to use hardware and software for accessing climate forecast, how to disseminate result of forecast to the farmer and how to use the information especially in determining planting period.

REFERENCES

Aldrian, E. and R.D. Susanto. 2003. Identification of Three Dominant Rainfall Regions within Indonesia and Their Relationship to Sea Surface Temperature. International Journal of Climatology 23:1435-1452.

Alimoeso, S., R. Boer, S.W.G. Subroto, E.T. Purwani, Y. Sugiarto, R.M.K. Rahadiyan, and Suciantini. 2002. Distribution of Drought Prone Rice Growing Area in Indonesia. Directorate of Plant Protection, Ministry of Agriculture, Jakarta (in Indonesian).

Anonymus. 2006. Annual Report 2005. Bandung District Agriculture Office.

Battisti, D.S., D.J. Vimont, R. Naylor, W. Falcon, and M. Burke. 2006. Downscaling Indonesian Precipitation: Present and Future Climate Scenario. Paper presenting in rountable discussion on coping with Climate Variability and Change in Food Production. Bogor. November 2006.

Boer, R. 2002. Pre-assessement of Vulnerable Site to Extreme Climate Event: Site Selection for Pilot Project on Crop Management and Exteme Climate. Project Report. Asian Disaster Preparedness Centre-Laboratory of Climatology, Bogor Agricultural University

Boer, R. and A.R. Subbiah. 2005. Agricultural droughts in Indonesia. Pp 330-344. *In* V.K. Boken, A.P. Cracknell, and R.L. Heathcote. Monitoring and Predicting Agriculture Drought. Oxford University Press.

Cane, M.A., G. Eshel, and R.W. Buckland. 1994. Forecasting Zimbabwean maize yield using eastern equatorial Pacific sea surface temperature. Nature 370:204-205.

Clarkson, N.M., G.Y. Abawi, G.B. Graham, F.H.S. Chiew, R.A. James, J.F. Clewet, D.A. George, and D. Berry. 2006. Seasonal streamflow forecasts to improve management of water resources: Major isssues and future directions in Australia. Pp 653-658. *In* Proceeding of 26 th National and 3rd Internationmal Hidrology and Water Resources Symposium of the Institution of Engineers, Australia. Perth Australia.

Giannini, A. 2006. Seasonality in The Predictability of Indonesian Monsoonal Climate. Paper presented at International Workshop on Use of Ocean Observations to Enhance Sustainable Development-Training and Capacity Building Workshop for the Eastern Indian Ocean, Bali, 7-9 June 2006.

Hansen, J.W., A.W. Hodges, and J.W. Jones. 1998. ENSO influences on agriculture in the southeastern United States. Journal of Climate 11:404-411.

Hendon, H.H. 2003. Indonesian rainfall variability : impacts of ENSO and local air-sea interaction. J. Climate (16):1775-1790.

Kirono, D.G.C., N.J. Tapper, and J.L. Mc Bride. 1999. Documenting Indonesian rainfall in the 1997/1998 El-Niño event. Physical Geography 20(5):422-435.

Kirono, D.G.C. and I.J. Partridge. 2002. The climate and the SOI. Pp. 17-24. *In* I.J. Partridge and M. Ma'shum (ed). Will It Rain? The Effect of The Southern Oscillation and El-Niño in Indonesia. Queensland Government, Department of Primary Industry, Australia.

Meinke, H. and R. Boer. 2002. Plant growth and the SOI. In I.J. Partridge and M. Ma'shum (ed) Will It Rain? The effect of the Southern Oscillation and El-Niño in Indonesia. Queensland Government, Department of Primary Industry, Australia. p. 25-28.

Naylor, R.L., W.P. Falcon, D. Rochberg, and N. Wada. 2001. Using El-Niño/southern oscillation climate data to predict rice production in Indonesia. Climatic Change 50: 255-265.

Naylor, R.L., D.S. Battisti, D.J. Vimont, W.P. Falcon, and M.B. Burke. 2007. Assessing risks of climate variability and climate change for Indonesian rice agriculture. *Pp* 7752-7757. *In* Proceeding of the National Academic of Science.

Sivakumar, M.V.K. and R.P. Motha. 2007. Managing Wheather and Climate Risk Management in Agriculture. Springer. P 503.

Surmaini, E. and E. Susanti. 2009. Global climate indices and its effect on extreme climate events in Indonesia. Indonesian Journal of Agriculture 2(2):129-136.