Rural Response to Climate Change:

A Lessons-learned from Indonesia[1]

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Abstract

Changes in climate provides new unexpected and uncertain phenomena for farmers to adapt their farming strategies. Relying on past experience only would not help farmers to anticipate the future climate situation. Observation on the present problems of farming strategies in relation to changes in weather condition needs to be improved significantly, so as to enable them to develop their farming strategies better and to reinterprete their cosmologies. The cases from Indonesia (Yogyakarta and West Java) reveal the advantages the farmers gained by enriching their exisiting knowledge through detailed daily rainfall measurement and agroecosystem observation. Farmers, however, faced some constraints in organizing their activities through collection action in carrying out the observation and addressing vulnerability based on water management and availability as common pool resources. The paper examines the process of facilitating farmers to be rainfall-observers in their own fields, its benefits to their knowledge and practical advancement, as well as the constraints the farmers and researchers had in building up a collaborative research and addressing farmers' vulnerability in a changing climate.

Keywords: collaborative research, rainfall measurement, knowledge enrichment, individual and collective action, addressing vulnerability, lessons-learned.

LEARNING FROM CLIMATE CHANGE: AN INTRODUCTION

> It was not a quite surprising phenomenon when I found the lodging of paddy in the fields towards harvesting time following hard winds the days before. Usually farmers referred to Chinese New Year (*Tahun Baru Cina*) as the critical time for their paddy at the generative stage. Chinese New Year was known as bringing lots of rains and winds from the west and could cause the lodging of paddy.

The lodging of paddy close to harvesting time is only one example of the hardships farmers have to face every year. That is the consequence of a particular weather condition at a certain stage of the growth of paddy. Though the phenomenon is

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recurrent every year, farmers could not always escape from that situation. Various other pests and diseases outbreaks are also common with its complex causal relata (see Winarto 2004, 2006). Those are the realities where meteorological and climatological factors affect the growth of crops. By experiencing the repetitive hazards, farmers do their best to develop coping strategies to avoid further damages. For generation-to-generation farmers have learned of how to adapt to their changing habitat (see for example Waddell 2009; Dove and Carpenter 2009; Crate and Nuttal 2009).

Recently, farmers do not only face similar hazards at a particular period in the cycle of crop cultivation, but also the unprecedented changes in weather and climate which caused unexpected damages on their crops. In the last three years, people in the tropical areas have been suffering from the sudden-fast changes of weather. The La-Niña in 2008/09 was followed by El-Niño in 2009 and, again, by La-Niña in 2010. The continuous rain in 2010 without any break means that farmers do not have any dry season that year. That was something very peculiar that they could not understand the causal factors nor the processes leading to the occurrence of risks and effects on their habitat. Their cropping patterns that had been developed generation-to-generation based on the monsoon seasons could no longer be sustained in such a very strange weather. Daily news in the newspapers and other media report various damages on farmers' crops and problems in the grass-roots' livelihood, such as: damages on chili, tobacco, maize, sugarcane, fruits, and pests/diseases outbreaks on rice crop elsewhere in Java (see various reports in *Kompas* 2010 and local newspapers, e.g. *Kedaulatan Rakyat* 2010). In a sudden, farmers' adaptive strategies in response to their habitat lose place. In assessing this kind of situation, Crate and Nuttal (2009:12) argue that:"..., climate change is ultimately about culture, for in its wake, more and more of the intimate human-environmental relations, integral to the world's cultural diversity, lose place."

It has not been part of farmers' knowledge that the changes this year and in the future may not be similar to the present and the past.

> One day in April 2009, there was a very heavy rain in Wareng in the regency of Gunungkidul, Yogyakarta province. A farmer, Amir said to Prahara: "My old grandmother used to say that the rain in April was usually *pral-pril* [very few and seldom], but now it is *bar-ber* [very heavy] as in December." While observing his flooded field, the farmer told Prahara further that: "The climate is changing, *mas*." (Winarto *et al.* 2010a).

Such is an example of farmers'query questioning their local cosmological knowledge that is not in line with the reality they face nowadays. Though the farmers know that the reason for that discrepancy is climate change, are they ready to respond to the sudden extreme changes in weather condition? Based on our observation so far, we incline to say "no". If so, how could we do something to assist them in such a condition? That is the question we would like to address in this paper.

Referring to Roncoli *et al.* (2003:181)'s argument that: "Recollections of the past, observations of the present, and expectations for the future shape our experience of climate phenomena and our understanding of climate information", how could we explain Amir's confusion? It is likely that relying on the recollections of the past does not help the farmers since the present situation might be different from the past. Without any additional knowledge and information in advance that the rainy season of 2008/09 was a La-Niña year followed by El-Niño in the beginning of rainy season of 2009/10 and a very sudden change to La-Niña in 2010, they could not understand the climate phenomena, and thus did not apply any precautious steps to avoid any failure in their farming strategies. Their expectations of future harvests would also be jeopardized without any ability to anticipate and adapt to sudden changes in weather condition. As Roncoli (2006:81) says,:

> Resilience defined as the capacity to buffer shocks and the flexibility to adapt to changed conditions, depends,..., on having timely, accurate, and credible information (Kane and Yohe 2000, p.3). Information management, including the processes whereby decision makers access information, ascertain the credibility of sources, combine various types of knowledge, and learn from their experience, is critical to adaptation.

Yet, farmers have not received any timely and appropriate information of near-future changes, nor in the form they could implement it straight away. We argue that in the absence of such information to enrich farmers' knowledge, reinterpret their memory, and modify their farming strategies following any indication of increasing climate variability and change, it would be hard for them to prepare for and survive in the ongoing changes of climate (Winarto *et al*. 2010a). The situation becomes more complicated with the reality that "...climate change is a threat multiplier. It magnifies and exacerbates existing social, economic, political and environmental trends, problems, issues, tensions, and challenges (Crate and Nuttal 2009:11)." If so, how could the farmers survive?

Learning from the lessons we experienced in Gunungkidul, Yogyakarta, and Indramayu, West Java, Indonesia, we argue in this paper that in the current ongoing climate change, farmers are facing an increased degree of vulnerability. In such a situation and in the absence of any incoming timely and appropriate information, improving their own knowledge and experience of the climate change consequences on their fields and crops is a promising way for the development of their cognitive map and capability to response better. In this paper we share our experience in making farmers "rainfall-observers" on the basis of our collaboration with the expert on agrometeorology and the farmers themselves. The first part of this paper examines the increased vulnerability the farmers face at present. In addressing that, a collaborative work between scholars and farmers was built in measuring rainfall and observing farmers' fields and crops. We discuss this in the second part of this paper. What benefits the farmers gain from our collaborative works in improving their agroecosystem analysis and practices are presented in the final part of this paper.

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THE INCREASED VULNERABILITY AND OPPORTUNITY IN THE CONDITION OF CLIMATE CHANGE

“Environmental change and economic globalization are exacerbating vulnerabilities for some areas and groups, while expanding opportunities for others,” says Roncoli (2006:81) referring to Reully & Schimmelpfenning (1999), and O’Brien & Leichenko (2000) (in Roncoli 2006). We also discovered such a condition following the unprecedented changes of climate in the past two years (2008—2010) in Yogyakarta and West Java. Farmers who cultivate crops in different conditions of ecosystem experienced diverse consequences: increased vulnerability for farmers in some places and opened up opportunities for farmers in other places. As stated by Roncoli (2006:82), “Vulnerability is not merely a function of climate but is shaped by social determinants. The latter has been conceptualized as bundles of rights and claims to resources that can be mobilized to meet livelihood goals...” While agreeing with that, we argue that not only vulnerability, but also opportunity is a consequence of both climate and social factors. Instead of rights and claims to resources only that shape the social determinants (Roncoli 2006), what Ribot and Peluso (2003) say as “access” also plays a significant role. Ribot and Peluso (2003:153) define access as the ability to benefit from things—including material objects, persons, institutions, and symbols. They exemplify further the notion of access as bundles and webs of powers that enable actors to gain, control, and maintain access (Ribot and Peluso 2003:154—155).

Portraying the vulnerable condition the farmers in Indramayu have to face annually, they formulate the following phrase: “Indramayu is being flooded when the rain comes, and being drought when the dry season comes.” Farmers who always experience such a situation are particularly those whose lands are close to the sea-shore. Their areas are located in the low-land coastal zone with the elevation of only 0—4 m asl. All rivers, streams, and drainage irrigated-canals from the upper- and middle-zones are flowing to those areas, flooding the houses and rice fields under heavy and intense rains. The construction of various buildings not only for houses, shops, and restaurants, but also for the state oil company’s drilling (Indonesian Petroleum company: *Pertamina*) with its pipes and drainages constrain the flow of water from farmers’ fields into the sea (see Kristiyanto 2010). Under the flood, it is not possible for farmers to only plant the seedling once. Up to three times transplanting are common. On the contrary, farmers cannot get “access” to water resources from irrigation canals in the dry season. Cultivating paddy in the dry season is like a gambling. It remains a question whether they could harvest any yields. That is the risk the farmers face. Why?

The location of coastal zone areas is far from the main source of water for irrigation for some parts of Indramayu, located south in the adjacent regency (Majalengka). Within the irrigation scheme, the coastal area belongs to the 3rd irrigation schedule and at the far end of the irrigation canals. Along the way from the main reservoir in the south up to the coastal zone, the water have been “robbed” by people in the adjacent regency and in the southern part of Indramayu. Without any irrigation canals, the people surrounding the main canal from the reservoir to Indramayu regency “steal the water for Indramayu people” by pumping the water from the canal into their rice fields. The heavy water-pumps can amount to 40 pumps along 7 km distance from the reservoir to the regency boundaries, operated by local people hired by the local village leaders. Power and capital play a role here in gaining the “access” to use the water allocated for neighbouring people. The story does not stop there. There are 12 water-gates between the main water-gate in the southern part of Indramayu up to the coastal zone. Each water-gate was controlled by the person related to the head of the regency. Towards the dry planting season, they will not release the water without some cash paid by farmers. “Water mafia”, that is the term used by farmers to name such an “illegal-bribery” practice. Bribing only is not enough. The farmers have to ensure that the gate would not be closed as soon as they leave the water-gate. “Accompanying the released water (*menggiring air*)”, that is what the farmers used to do (see Kristiyanto 2010).

Another similar way of “stealing” water is done by farmers themselves whose areas are located in the upper stream of rivers or irrigated canals. Only after flooding all rice fields in their own areas, the farmers release the water to the next rice-fields. As a consequence, rice fields in the northern part would always get the irrigated water at the very end. Without any strict regulation, control, and punishment from those in the authority, people would keep “stealing” water and/or restraining water by those playing their “power”. As stated by von Benda-Beckmann (2007:263), “...water scarcity (or relative scarcity) increasingly leads to conflicts in the context of an ever more complex constellation of actors interested in controlling and using water.” Based on his research in West Sumatera, Indonesia, Von Benda-Beckmann (2007:266) further says,

> The notion that water is something whose use is not, and cannot be, exclusive to individual control and appropriation but rather is a common-pool resource therefore is quite prominent. Water, ..., is perceived and legally treated as a common good over which socio-political organizations such as the state or village claim the right to regulate and distribute it.

Another example is the state’s decision in the construction of irrigation canals so that some areas in the same regency, Indramayu, do not get any irrigated water at all. Those are the areas beyond the far end of irrigation canals originating from two main reservoirs: Salam Darma in the west (receiving water from the large dam in West Java: Jatiluhur reservoir), and Rentang in the south (see Map 1 of Indramayu Regency and the two main reservoirs). Accordingly, different from rice fields in other irrigated areas, farmers cultivating dry-rainfed fields (*sawah tadah hujan*) could only plant rice once in the rainy season, relying on rainfall and ground-water resources, and have to take risks if they plant paddy in the dry season. In the other places on the coastal zone, the water-gates and irrigation canals built during the Dutch period were damaged and had never been repaired by the authorities. The intrusion of salty water and the inundated of the coastal rice fields led the farmers to replace their rice fields into fish- and shrimp-ponds and moved the rice planting further inward. Those fields were also relied on rainfall for rice cultivation.

The 2010 La-Niña situation with continuous rains throughout the year thus provided opportunity for the rain-fed farmers to plant paddy in the dry season with a greater certainty of gaining yields. One farmer expressed his intention to continue planting paddy for the third time learning of the continuous rain up to early August 2010, the possible ongoing La-Niña, and the yields he could earn in the past second dry season planting. It did not mean, however, that the yields they earned were quite satisfactorily. Why? Some farmers in the dry-rain fed areas in Central Java said that the yields were lower than they were expecting due to heavy rains during “plants’ copulation”.

Heavy and intense rains during dry season of 2009 and again in 2010 also increased the vulnerability of planting multiple crops in the hilly dry-rainfed carst-ecosystem area in Gunungkidul. Farmers in Gunungkidul used to plant tobacco in the second planting season soon after harvesting paddy when the rains become less and less, or in Amir’s word: “*...hujan pral-pril* (small rains).” With the heavy and continuous rains in April onwards, tobacco would of course be damaged. Even though the farmers could harvest some tobacco leaves, they soon experienced hardship in drying up the leaves without enough sunlight. Other vegetables such as chili, soybean, maize could not grow well too. The opportunity to earn cash in the past two years thus reduced significantly.

High intense rainfall in such an ecosystem during rainy season also increased the vulnerability for farmers in the dry-rainfed carst-ecosystem who never built a drainage system. Draining water such as those in the lowland irrigated rice fields is unnecessary in their carst-ecosystem with high porousity of soil. It is not the case though when the rainfall reached up to 120--140 mm at the end of November 2008. For the first time in their life-experience as farmers, their fields planted with rice and maize of less than 30 days old were being flooded. They could not easily drained the excessive water in their fields and thus, their plants were getting damaged (being rotten). Drainage system has not been part of their “culture of farming” and thus, collective action in building up drainage canals has never been practiced (see Winarto *et al.* 2010b).

A different story of vulnerability was experienced by farmers in the irrigated low-land rice fields on the north coast of West Java. The sudden change of climate with intense-heavy rains in early 2010 following the drought at the end of 2009 increased the air-humidity in the fields. Such a situation was conducive for the growth of various kinds of pests and diseases, in particular brown plant-hopper. Severe damages on plants due to the unprecedented outbreaks of brown plant-hopper in the rainy season were experienced by real, in particular among those who kept spraying insectidices injudiciously that killed the pests’ predators (Ratri 2010; Nurahayu 2010). A further consequence was the continued damage on paddy followed by the spread of virus in the dry season planting brought by the brown plant hopper as the vectors of the disease (Indramayu farmers narrative report, 2010). The situation was different for those who persistently avoiding the use of chemical insecticides if unnecessary, planting their own cultivar, and/or transplanting seedlings in the so-called System of Rice Intensification method (see Rahayu 2010; Sarma, personal communication 2010).

The interplay of various factors of both the natural phenomena of climate change, water resources, people's power, interests and practices in "using water as the common good" as well as farmers' practices in controlling pests and diseases affect both the vulnerability and opportunity the farmers had in the past extreme conditions of weather. With the ongoing climate change in the future, assisting farmers to response better is in great need, but how could we do that?

MEASURING RAINFALL, OBSERVING AGROECOSYSTEM

A group of farmers in Gunungkidul and Indramayu were first learned of measuring rainfall and soil humidity in the so-called Climate Field School (CFS) organized by the agency under the responsibility of the Ministry of Agriculture. Various concepts and ideas of weather and climate were also introduced to the groups of farmers participating in the schools (see Boer 2009; Prakarma 2009; Winarto *et al.* 2010; Rahayu 2010). Information of projected rainfall has also been disseminated by the Meteorology, Climatology, and Geophysics Office (BMKG) in Jakarta. The question remains as to what extent those training and information really are of any significant help to the farmers to improve their anticipation and adaptive capability to climate change? Some changes in farming strategies to adapt better to the condition of drought were found among the CFS alumni in Gunungkidul (see Winarto *et al.* 2010a; Winarto *et al.* 2010b); and in Indramayu (see Rahayu 2010). Unfortunately, the farmers' learning process were no longer being facilitated by the agricultural extension workers whereas changes in weather condition have been going on. Even though farmers are good observers of their own environment, without any ongoing facilitation, it would not be easy for them to understand and interpret the unprecedented and unexpected changes of weather conditions which have its further impacts on the growth of their crops. An ongoing learning process is indeed necessary. Farmers do need institutionalized training (see Stigter 2009; Winarto *et al.* 2010a).

Throughout our collaborative work with the farmers in improving their observability—which in their own term is called as *ilmu titèn*—we learned of their enthusiasm after day-to-day measuring rainfall and observing fields and crops. From early November 2008 up to June 2009 in Gunungkidul, Yogyakarta,[3] and from early October 2009 up to February 2010 which was then continued individually up to

[3] During Yunita Winarto's term as the holder of the Academy Professorship Indonesia in Social Sciences and Humanities under the auspices of KNAW and AIPI at Gadjah Mada University, Yogyakarta (2006—09).

November 2010 in Indramayu,[4] both parties—farmers and scholars—have been experiencing an advancement of our knowledge of rainfall variability and its implication on farmers' fields. Throughout those periods of time, we were facilitating farmers in measuring rainfall in numerics and paying close attention on the implication of particular rainfall to the agroecosystem condition of their fields: on soil, water, plants, pests, and diseases. See the photos of one farmer in Gunungkidul measuring rainfall trapped in the rain-gauge made in the USA and the farmer's rain-gauge made by one farmer in Indramayu (Photo 1 and 2).

Photo 1. A farmer in Gunungkidul was measuring rainfall

(Photo by Winarto, 2009)

4 During Yunita Winarto's term as the holder of the Academy Professorship Indonesia in Social Sciences and Humanities under the auspices of KNAW-AIPI at Universitas Indonesia, Depok (2009—11).

Photo 2. Farmers' made rain-gauge, Indramayu 2009

(Photo by Winarto, 2009)

If measuring rainfall was not a very novel practice by those who were trained in CFS, it was not the case with farmers who did not join the CFS. If only several farmers measured the rainfall once in 10 days throughout the training in CFS, farmers did the measurement daily throughout our collaboration. Observing the agroecosystem condition of their fields was thus being carried out everyday as well. Farmers were used to go to the field to do their observation. However, the significant difference from their own habit was the practice of taking notes of their observation. Farmers did not have any problem in writing up the rainfall in milimeters together with the other set of information (day, date, time, age of plant, and rainfall characteristics). Documenting the 10-days agroecosystem condition, on the other hand, was not as easy as we thought. Simplifying the complex empirical reality of their fields and crops is a constraint in writing them down in a piece of paper. Another constraint was articulating the statements in a written form. Gradually, farmers were getting used of that habit, though they were not able to write-down completely all the components of their fields' agroecosystem. See Table 1 and 2 for the data-sheets, and photo 3 for a farmer's note-book of rainfall data.

Table 1. Data-sheet for rainfall measurement (Gunungkidul, Yogyakarta)

Rainfall Measurement for 10 days Observation

Sedio Mulyo Farmers-Group, Wareng IV, Gunungkidul, Yogyakarta

Farmers' name :..
Field location :..
APRIL 2009

No.	Day	Date	Observation time	Amount (mm)	Notes
1.					

2					
3					
4					
5					
6					
7					
8					
9					
10					

Source: API team's document (see Winarto *et al.* 2010a)

Note: In Indramayu, the farmers expressed their need to relate the date and the rainfall measurement with the age of plant. This item was inserted as a column between Observation Time and Amount of rainfall (mm).

Table 2. Data-sheet for agroecosystem observation

Observation Data Sheet

Date:...........up to................2009

Farmer's Name :..
Field location :..
Soil type :..

No.	Point of Observation	Observation result
1	Land management	
2	Crops and varieties	
3	Pests & diseases and control strategies	
4	Fertilizing: Stages and dosagesi	
5	Seedling strategy	
6	The growth of crop/s	
7	Water condition	
8	The depth of roots	
9	For Gunungkidul: evaluation of "rain-harvesting method'	

Source: API-team's document, 2009 (see Winarto *et al.* 2010a)

Photo 3. A Farmer's note-book of rainfall data

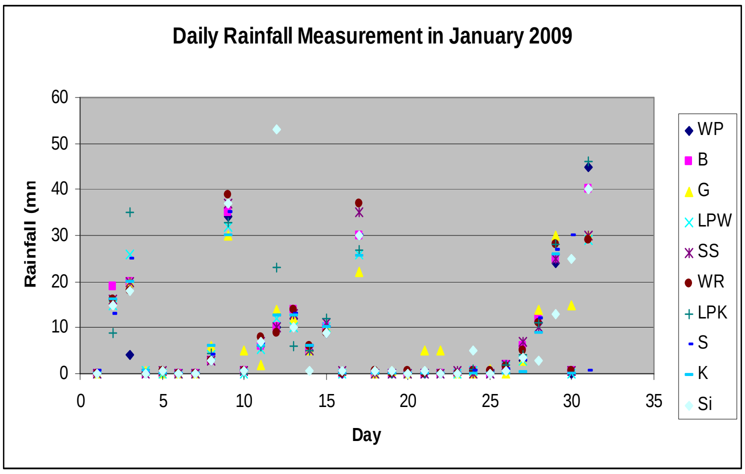
(Photo by Winarto, 2009)

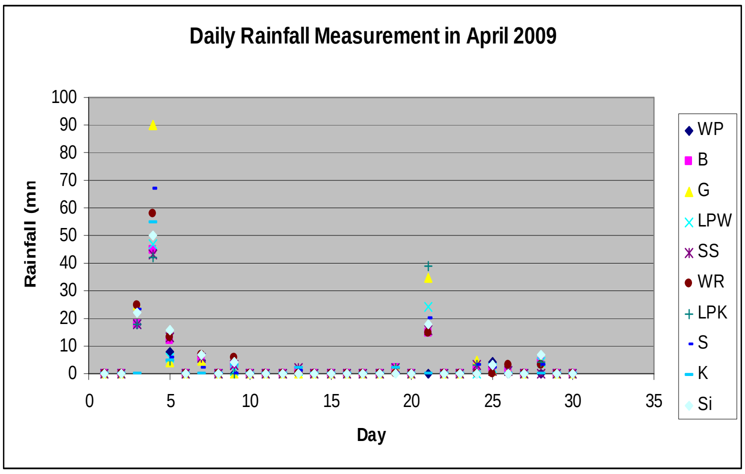
Individual or a pair of farmers did the job for one point-of-observation. The number of rainfall-stations (points-of-observation) varied in each place. In Gunungkidul, only 10 points-of-observation were defined following the number of rain-gauges ordered from USA and the size of fields under observation. In Indramayu, by considering the diverse ecosystems spread all over the regency and the large size of the area, 50 locales were first decided to be the points-of-observation spread from the west to the east and from the north to the south. Though the measurement and observation was carried out by individual or a pair of farmer/s, there was a need to share, discuss, and evaluate the results collectively. The farmers in Gunungkidul decided to have the regular evaluation every two decadal (10 days) period, whereas in Indramayu for every three decadal period. By doing that, they also collectively assessed the ongoing condition of weather and discussed the possible strategies in response to the current and future possible changes of climate. Questions and answers were raised during the agrometeorologist's visit in both places. That was also the opportunity for us to examine and collect the data submitted by each farmer. How to process the data and what to follow next?

Farmers are good observers. Their empirical knowledge which they themselves called as *ilmu titèn* are rich and details. They store those knowledge in their minds and memories in lexicons and share them one another through conversations and other means of farmer-to-farmer transmission. Writing down their empirical observation is not only a new habit for them to do, but also a new way of sharing their ideas, thought, and knowledge to the "others" coming from their own or others' worlds. "Textualising lexical knowledge", that was what the farmers experienced (see Ellen 2004:438). Yet, a question remains following the farmers' efforts to textualize their lexical knowledge. What kind of forms would be effective in presenting their "texts" to one-another and particularly to the expert in agrometeorology? Through an ongoing reflexivity, at last we decided to help translating the farmers' data into graphics and matrix. Once the data are transformed into those means and are able to being read and interpreted by the scientist, farmers' discoveries are becoming part of "intersubjective representation" or "memory externalisation" (Ellen 2004:433—434 following Bruner 1996). In Bruner's explanation (in Ellen 2004:433), through "memory externalisation", "...ideas and 'facts' become independent of those individuals who innovated them, and remain as part of the 'exogram' because they are formally necessary for the descriptive and explanatory system to work (...)." For enabling the agrometeorologist to read, interpret, analyze, and explain the facts to the farmers, transforming those facts into the 'exogram' is necessary. By allowing this to happen, we did facilitate the transformation from the local-empirical lexical knowledge to the textual external memory through the intersubjective representation (see Ellen 2004). The followings are the products of that process in the form of graphic and matrix. See Figure 1 for the daily ranfall graphics and Appendix 1 for the matrix of agroecosystem observation.

Figure 1. Daily rainfall graphic (Wareng, Gunungkidul)

January 2009 and April 2009





Source: Farmers' data collection, Wareng, 2008/09 (see Winarto *et al.* 2010a, 2010b). For monthly agroecosystem observations of January 2009 and April 2009, see Appendix 1.

On the basis of his reading and interpretation of the data from 2008/09 rainfall season in Wareng in the form of graphics and matrix, Stigter argues that:

> In general, this was of course a year with rather too much water. Differences in rainfall or even in rainfall distribution (with the exception of April and May for the latter....) therefore hardly were of influence on the growth of crops. The rather large differences in crop performances (particularly rice and maize) are almost completely due to the soil (moisture) conditions after the rains, where positions of the field, drainage conditions, soil type, provision with nutrients and choice of crops/varieties were determining factors, not the rainfall differences between places (see Stigter 2010; Winarto *et al.* 2010a).

By reading the graphics of rainfall distribution and the matrix of agroecosystem conditions, Stigter could formulate his assumption that a set of factors — not the rainfall differences or distributions differences (except possibly the distribution differences for two particular months at the very end of the season) — were likely to be the determining factors of crop performances in different places. One among the factors was the soil moisture condition after the rains. Such a scholarly assumption based on farmers' data collection on local conditions — through data processing and analyses in scientific domain — is an example of how the products of farmers' observations were interpreted, explained, and later on be presented in the ways that could be understood by the farmers after being embedded in the scientific process. Such is the result of the joint production of image and knowledge as argued by Strauss (2003:53), without loosing the intimate local knowledge of particular places. The decision to have 10 points-of-observation spread in the area of one village and its adjacent ones in Gunungkidul, and 50 points-of-observation from one regency in Indramayu has the aims of capturing the local weather condition and its variability which could be missing in the weather information covering a much larger region (Winarto *et al.* 2010a).

Another aims to achieve were enriching the farmers' own *ilmu titèn* with meteorological and climatological components, advancing their response capability towards changing conditions of weather while also finding the most "vulnerable risk" the farmers have for further thought of solving the problem. At this early stage of farmers' learning process, what benefits have they gained so far?

TOWARDS AGROMETEOROLOGICAL ANALYSIS AND RESPONSE STRATEGIES TO CLIMATE CHANGE?

It was a coincident that at the time the farmers in Gunungkidul began their daily observation for three consecutive planting seasons from November 2008 to June 2009, they experienced the condition of La-Niña of 2008/09. At the time the farmers in Indramayu started the same activities, they had to face the very dry weather of El-

Niño in 2009 followed by a sudden La-Niña of 2010. Therefore, they had very rich experience of responding to those unprecedented changes while improving their understanding of weather and climate. In the two places, we observed several improvements in: 1) farmers' capability in equating their local taxonomy of rainfall with numerics; 2) farmers' analyses of their fields' agroecosystem by incorporating the components of meteorology/climatology; and 3) their learning to adjust to the strange weather condition leading to either future planning or present strategies.

From Lexical-qualitative to Numerics-quantitative Rainfall Categories

After learning from measuring rainfall by using rain gauges, we observed the gradual improvement of farmers' knowledge by incorporating the numerics of rainfall in their existing schema (see Strauss and Quinn 1997 for "schema"). The shift in farmers' mind was not merely textualising their lexical knowledge of rain (see Ellen 2004 of textualising lexical knowledge), but also quantifying their qualitative categories of rain. Using numbers to refer to a particular condition of rain was what we observed only after few months measuring rainfall. We felt an aura of enthusiasm and curiosity among the farmers who had the interest to know more of such a correspondence of different conditions of rain. Farmers' sensitivity in quantifying rain was indeed growing day-by-day.

> Towards the end of November 2008, Anantasari visited Arni, a rainfall-observer in Gunungkidul. Anantasari told Arni of the heavy rains for several hours in Yogyakarta the day before. Spontaneously, Arni told Anantasari that yesterday the rain was also very heavy in Wareng: "The rainfall was up to 117mm, the rain was very heavy and had long duration." Arni continued her story: "The rain flooded the field, and the plants were also covered by water." (see Winarto *et al.* 2010b)

Only after around two weeks measuring rainfall, Arni could cite the numbers of the very heavy and intense rain the day before. Relating the condition of rainfall and the numerics, that was what she learned. She also observed directly the implication of such a heavy-intense rain of 117mm on her field and crops. Since farmers also asked their family members to go to the field substituting him/her measuring rainfall, the learning was also gained by their families.

> In February 2009 when Anantasari just drop off from the bus from Wonosari, the capital town of Wonosari district, she met Gini, the wife of one rainfall-observer. Gini asked straight away to Anantasari: "Mam, was it rain in Yogya? Here we only had small rains, only less than 5 mm." Anantasari was astonished with that spontaneous statement though she had not asked anything yet to her. (see Winarto *et al.* 2010b).

Those are only few examples of so many other stories of how the farmers gained such a skill. The numerics of rainfall become new element in farmers' schema which is cited with the existing element of lexical rainfall condition.

Since the farmers were experiencing an abnormal condition of weather, they soon realized that their existing local knowledge did not apply to that particular year (of 2008—09 in Gunungkidul). They could not explain "Why in a sudden, the rains at the end of November were very heavy after a long drought?" or "Why the rainfall in

April, which used to be only *pral-pril* is now similar to *udan bar-ber* in December?" A farmer explained his thought:

> "...as happened yesterday, up to 45 mm of rainfall in April was quite high in comparison to previous years. Last year it was not like that. There were rains in April, but not up to 43, 30 mm... Last year it could only reach 10 mm based on my estimation... if we had the rain-gauge to measure it." (see Winarto *et al.* 2010a)

The farmer's last statement reveals his capability to do the estimation of the rainfall-numerics after gaining new skill to do that. He could apply his current knowledge of rainfall in numerics to the last year's experience prior to measuring rainfall, though he raised this statement in his question and curiosity.

On the basis of farmers' learning and their capability to equate a rainfall condition with numerics, we were able to draw the Gunungkidul farmers' rainfall taxonomy in both lexicon and numerics. See Table 3. The interesting thing found in the table is the farmers' own identification of the rainfall characterstics by looking at its impacts on soil.

Table 3. Rainfall classification in lexicon and numerics

No.	Categories of rain in local terms	Rain characteristics	Impacts on soil	Equivalent in numerics
1.	*Udan kremun*	Small rain, very soft, short duration	No trails on the soil	Can't be measured (0 mm)
2.	*Udan thletik*	Fast-small rain, lasts only a minute	No trails on the soil	Can't be measured (0 mm)
3.	*Udan gerimis*	No sound of the rain, can be felt by hands, long duration	No trails on the soil in short duration of rain. Drops on the crops in long duration of rain.	0.5—5 mm (depends on rain duration).
4.	*Udan tretak-tretik:* a. *Udan tretak-tretik sedèlo* b. *Udan tretak-tretik suwé*	Small rain with the sound as: *"thik-thik"* on the roof. Some farmers categorize this rain similar to no. 3. a. Short duration b. Long duration	Some trails on the soil: the soil becomes wet in both the short- and the long-duration of rain, but no standing water in the field.	a. 1—3 mm. b. 3—5 mm.
5.	*Udan pral-pril*	Small rain in April which does not fall every day, only once in a while either in short- or long	Simlar trails to no. 4 (soil becomes wet, but no standing water in the field)	1—5 mm or 5—10 mm.

		short- or long-duration. Sound on the roof.		
6.	*Udan ora deres nanging kerep* (not heavy but frequent-intense)	Not heavy, but noisy on the roof with long-duration of rain. Another term: "*udané awèt*" (persisting rain)	On top of "red-soil": the soil becomes very wet. On top of "heavy-black soil": some standing water on the soil.	<30 mm.
7.	*Udan deres bres*	Heavy rain, very noisy on the roof, harder than no. 4, but usually does not persist in a long-duration of rain.	The soil becomes very wet, sticky, and leaves holes when people step on it.	>30 mm.
8.	*Udan bar-ber* (very heavy rain) and *banjir* in very heavy-intense rain which flooded the field.	Heavy rain in September, October, November, December; high frequency and intensity, long duration.	If the rain lasts for one day, there will be standing water in the field, especially on heavy black soil. In the absence of drainage, the field becomes flooded.	**>**70 mm. (in 2008/09, up to >100 mm)

Source: Fieldnotes of Anantasari in Wareng, Gunungkidul, 2008/09 (see Winarto *et al.* 2010a, 2010b).

Similar process of enriching their schema was also found in Indramayu, though their rainfall classification is not as extensive and detailed as farmers in Gunungkidul. Why? For many parts of Indramayu farmers rely on irrigation water rather than on rainfall to begin their planting schedule and to grow their crops. Now, by participating in the rainfall measurement, they began to be more alert and carefully observed the rainfall condition, the numerics, and its implication on their fields and crops. What kind of improvement did they gain in their agroecosystem analyses?

Developing Agrometeorological Analysis

Farmers' learning process was indeed being enriched with the ongoing changes of climate. The new understanding was thus being activated daily and seasonally. From daily farmer-to-farmer's conversation and farmers' discussion in bi-decadal or three-decadal evaluation, they questioned the abnormal characteristics of rain in 2008—09 (La-Niña year) in Gunungkidul and of 2009 drought (El-Niño) in Indramayu. Farmers became more alert and thus, critically questioned the uncommon phenomena. The followings are some examples of farmers' queries:

> The heavy rains at the end of March up to early April damaged all maize crops planted by Amir. “Before the rains were not like this... in April I planted maize and did not grow because of no rains at all,” argued Amir. Diyo also said that “In reality, maize can grow well under small rains. But, now, the rains are so heavy. Soon after planting maize, the rains came and all the plants became weak... died off.” Another farmer, Sih, complained by also quoting the rainfall in numerics: “My field in Balong has not been tilled again yet, the maize died since there was a very heavy rain yesterday up to 70mm, *wah,* my field became a lake... This April is very unusual... climate change...” (Winarto *et al.* 2010b)

Such were Gunungkidul farmers’ interpretations and complaints of the very uncommon weather phenomenon in April 2009 which damaged maize used to be planted in the dry season. Two other crops were also seriously affected by the continuous rain, namely: chili and tobacco.

In contrast, farmers in Indramayu questioned the very dry weather in October 2009, the unusual phenomenon for years. Some farmers even could not memorize when was the last time they experienced such a very strange drought in the beginning of rainy season. Farmers who relied on irrigation water were waiting for the water to come which they did not know when if there were no rains at all. They soon realized that the planting season would start very late. Since they began to measure rainfall, they knew exactly that for days in October no single drop of water were trapped in their rain-gauge. Though there were patchy rains in mid of October, only towards the end of October (around 24th—25th of October 2009) there were some rains in diverse distribution among the 50th points-of-observation (see Winarto *et al*. 2010a). For those who relied on rainfall, such as some farmers on the north-coast of Indramayu (Cantigi), they were referring to the total amount of rainfall and the soil condition following the rains as an indicator when to start sowing seeds. One alumni CFS told Winarto that: “If the rains reached 11mm, and the soils are soft enough, I could start sowing seeds by using digging stick... Probably after two more rains to come...” He was able to cite the amount of rainfall by referring to his experience following his training in the CFS the year before enriched by his own observation and experience.

The farmers’ queries and remarks of the ongoing experience while also carrying out daily observation are indicators of how alert and curious they are. The rain or the drought condition was referred to in relation not only to the trails on soil as stated in Table 3, but also to other elements of agroecosystems such as: the kind of crops, their age and growth performance, the resistance to drought, to soil moisture conditions, and also to pests and diseases. Based on that we argue that farmers’ agrometeorological analyses were in the “making”. See the following table for a compilation of farmers’ interpretation.

Table 4. Towards agroecosystem analyses?

No.	Rainfall condition	Farmers' interpretation
1.	15—25 mm	The ideal condition for paddy: good for the growth of paddy, but not too frequent. Minimal two times raining in a week. But, it would also depend on the type of soil.
	25 mm	It is good for chili, but not as continuous rain (daily rain). Two or three times a week are good. There should not be too much rain.
2.	Maks.30 mm	Good for maize, but not as a very heavy rain, just medium and not continuously. Intermittent rain is good: once in 3 days, so that the soil becomes soft (*tangkleng*).
	50 mm	Enough for maize. The crop can grow fat. But preferably only rain once a week.
3.	40 mm	If the rains up to 40 mm (in the beginning of the dry season), the plants will be damaged, because the soil is too wet. If there is sunshine in 10 days from now, the water could be absorbed, so there won't be any standing water on the ground. The Javanese used to say that "the water has not dried up yet when it is being flooded again". No time to dry up the soil.
4	>100mm	The field was flooded while the crops (paddy and maize) were still young, so the plants would be damaged: being retarded and/or rotten.

Source: Fieldnotes of Kristiyanto and Prahara, Wareng, Gunungkidul, 2008/09 (also see Winarto *et al.* 2010a, 2010b).

Those cited in the table are only some examples of many more stories of how the farmers were interpreting the current phenomena by incorporating their previous and recent experience and referring to the rainfall condition in both qualitative and quantitative terms. On the basis of such experience, what would they do in responding to the uncertain condition of future weather?

Learning from Experience, Modifying Strategies?

Growing crops in the dry-rainfed carst-ecosystem for years with more drought than heavy rains did not make the farmers ready for draining the excessive water under heavy, intense, and continuous rains. On the contrary, they were trained by the CFS' facilitator towards the end of the "school" in 2007 to build additional ridges inside their fields to prevent water as a means to anticipate drought. Farmers did indeed gain some benefits from building those ridges in the rainy season of 2007/08 without excessive rains (see their improved yields in rice of 2007/08 rainy season harvesting in Winarto *et al.* 2010a, 2010 b). Unfortunately, it did not work well under the La-Niña condition in the rainy season of 2008/09. They learned that “one-time recommendation” is not suitable for different weather condition. Responding to the sudden floods which could damage their crops, farmers took diverse actions, among others: breaking the ridges, making holes in the dikes, making drainages, or can’t do anything due to the low elevation of the fields or the location of the fields surrounded by other neighbouring fields. The major lessons-learned is thus learning for the need to understand better the probable future weather condition. A farmer in Gunungkidul expressed her learning that: “If the rain has reached 70mm and rains are still coming, I will soon make drainages.” To assist farmers better in their decision, a timely transmission of simple weather prediction to the farmers would of course be beneficial.

Since making drainages has not been part of their “culture”, the question is how to manage the collective construction of drainages under heavy rains for larger area of rice fields where the neighbouring farmers come from different administrative units? Here the problem covers not only technical aspect of building up drainages, but also social and cultural dimensions of managing a collective action. In such a situation, the role of higher level authority, such as village or district leader, is important. Yet, taking up collective action among individuals owning their private lands criss-crossing administrative boundaries is not easy. Those in authority even complained that they could not enforce individual farmers to follow. They do not have any rights to instruct those who have individual “access” to their lands. They even do not have power to enforce people under different administrative authorities. The “common problems” under the peculiar weather condition could not thus be solved easily. Accordingly, making drainages if necessary, again, falls into individual hands.

Learning from the damaged tobacco leaves and yields’ reduction under the La-Niña of 2009, a farmer expressed his thought: “If at the end of rainy season, the rains are still high and continuously coming, how if I plant paddy in the dry season instead of tobacco?” However, under no warning of the worse La-Niña of 2010 after a very dry weather in the rainy season of 2009, farmers did not gain a strong confidence to take an entirely different strategy. One-time experience was not enough to drive their decisions to make a change without any certainty of weather forecast in the future. Tobacco is also the main cash-crop for direct sale to a cigarette company. Hence, the market is secure. The cash is in hands The company’s extension-worker also kept his works in assisting farmers growing tobacco. Thus, in a limited option for income generation from other crops or livelihood activities, farmers do not dare to take risks under uncertain weather condition. Responding to the hazards, some farmers decided to pull-off the damaged plants and planted the new ones in different sites of their fields. In their belief, replanting tobacco at the same site means that the disease will affect the new plants (see Winarto *et al.* 2010b). The rests, however, could not do anything. Again, the social-economic factors are constraining ‘response farming’ to grow. Altering the yearly farming pattern is not easy. For other crops such as vegetables and chili, farmers could prepare themselves for the possible excessive rains by increase the height of the ridges, or by delay their planting for maize and beans.

How if the weather condition was so determining and not providing any option for farmers to choose as the case with the 2009 El-Niño? For farmers in Indramayu with diverse condition of ecosystems and vulnerability, the three-decadal evaluation meeting provided a good opportunity for learning from one-another's experience. Thanks to those who have gained experience of cultivating paddy in the rain-fed ecosystem, the farmers who used to plant paddy under the irrigation system could learn from the first farmers' strategies. The dry rainy season of 2009 was similar to the dry-planting season for rain-fed farming. Thus, the rain-fed farmers could share their experience of making "dry-nursery seed-bed" (*ngipuk*) instead of "wet-nursery seed-bed" (*nyemai*), or "sowing seeds by using digging stick" (*tabela*)instead of making nursery. The latter—called as *nonjo* by farmers in Gunungkidul—has become popular in the past three years among dry rain-fed farmers in that area to prevent the humidity and avoid the exposure of seeds to drought. Another idea discussed by the farmers was the need to appropriately select rice varieties to be planted in the short rainy season duration, and those which would be resistant to pests and diseases. Farmers knew that planting late would cause problems of pest and disease outbreaks at the time the strong winds and heavy rains come at a younger age of paddy. Reaching consensus of what to anticipate better for the coming unpredictable months was one significant achievement the farmers made. One farmer told Winarto that he followed the advice of his fellow farmers of making "dry-nursery seed-bed" instead of the wet-one. It did help him saving the seedlings. Another shared idea was the need to make "ground-water reservoir" by tapping the water-leakage and using the water later if necessary.

Whilst the dry-rain fed farmers due to the unavailability of irrigatied water in Indramayu gained some opportunities to plant paddy for the second time and even for the third time, farmers in the wet irrigated areas with additional water originating from draining canals experienced excessive flood in the continuous rains of 2010 La-Niña. As a result, the high humidity in their fields provided very conducive grounds for pests, viruses, and bacteria to grow. It is interesting to note that there were diverse degrees of damages among different rice fields, and even among the adjacent ones. How to explain that? Nurahayu (2010) discovered that different strategies in spraying insecticides: the injudicious intensive use of chemical insecticides and the selected less intensive sprayings could lead to the more severe damages in the first rather than in the latter. Some rainfall-observer farmers argued that the less they used chemical pesticides and inorganic fertilizers would hel preventing the sever outbreaks of brown planthopper. The other practices that could prevent the severe outbreaks were reducing the amount of urea (N), planting farmers' own cultivar than the high yielding varieties, and implementing the System of Rice Intensification (SRI) method. Most of them have already experienced training in various kinds of Farmer Field Schools and activated those learning when they faced the unprecedented outbreak of pests and diseases. Proudly and convincingly those farmers reminded their fellows to keep persistently practicing the more sustainable strategies. It is inevitable though that the outbreak of diseases caused by virus brought by brown planthopper was a reality that increased farmers' burdens.

The practice of diverse strategies along with their consequences on the infestation of pests and diseases contributed to farmers' learning through the emergence of those realities in farmers' extra-personal structures. Furthermore, farmers' own learning mechanisms through observation, comparison, finding evidences, interpretation, conversation, and imitation would be the effective means of either adopting or ignoring those strategies (see Borofsky 1987; Winarto 2004).

INSTITUTIONALISING THE LEARNING PROCESS: AN URGENT NEED

Farmers' learning as well as struggles in the past two years of the ongoing changes of weather and climate present the critical stage they are now experiencing in their life as crop producers. Not only their environment is now changing, but also their incapability to refer to their memories, existing cosmological knowledge, and traditional cultivation practices in interpreting the unprecedented changes. What Crate and Nuttal say (2009) that the intimate human-environment relationshop is now losing place is real. The situation is more complicated with the non-conducive, as well as damaging infrastructures that supposed to facilitate and thus sustain farmers' production. In such a condition, farmers are creative and innovative in finding strategies to stay survive. Yet, without improving their knowledge and understanding of climate change, and experiencing directly the rainfall condition, its variability and impacts on field and crops, it would not be easy for them to interpret the incoming information, if any, their own experience, and local cosmological knowledge.

The rich lessons-learned we gained from the past two years of collaborating with an expert in agrometeorology and groups of farmers in improving their learning teach us that farmers are "human being" who are very eager and enthusiastic to advance their knowledge and strategies. Unfortunately, the training they received from the state agencies usually falls short once the project terminates as what the farmers learned from Climate Field School introduced by the authority. Climate change and its variability do, however, vary from time to time without any certainty of its form and implications on farmers' fields and crops. An institutionalization of long-term farmers' learning process is thus an urgent need. The provision of timely "simple weather prediction" in its appropriate form would also be very beneficial for the farmers as a referral for taking action in a particular weather condition. With appropriate facilitation and support, farmers would be able to enrich their knowledge and take action accordingly.

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