Migration as a coping strategy of Indonesian farmers in the face of climate change

I Hidayati

Research Center for Population, LIPI, Gedung Widya Graha LIPI, Jalan Gatot Subroto No 10, Jakarta Selatan, 12710, Indonesia
Corresponding author: inayah.hidayati@gmail.com

Abstract. This research explains an increase in migration flow of the Indonesian farmer that occurs as a result of climate change's impact. Crop failure has disrupted the livelihoods of the population, so they have to do coping strategies to fit their livelihood. The explanation in this research is to understand the coping strategy of Indonesian farmers in dealing with climate change. Temporary migration is the last battle that can be done by farmers. This research applied a qualitative method to explore the coping strategy of the farmer with data from in-depth interviews, FGDs and observation. The results showed that the farmer had made several coping strategies for climate change. When the harvest fails, farmers migrate temporarily to the nearest town. The types of work carried out by farmers are very diverse, including trading and construction. Temporary migration is a final choice for survival and fulfill their livelihood. The ability to cope itself is influenced by various factors, such as gender, age, social capital, social networks, and the level of knowledge of the community.

1. Introduction
Agricultural is a sector that is vulnerable to climate change [1]. Dependence on considerable weather for agricultural business is the leading cause, especially agricultural area has limitations in the field of water resources, infrastructure and technology. Climate change has increased the risk to agricultural sector activities, from the threat of crop failure, the emergence of new diseases and disasters that have never been experienced before [2][3]. The significant impacts of climate change that affect the agricultural sector are shifting seasons and rising temperatures. An increase in air temperature due to global warming has an impact on an increase in pests and diseases which in turn causes a decrease in agricultural productivity, mainly seasonal crops, both for food crops and plantations. This is because the life cycle of deep seasonal crops is greatly influenced by air temperature, day length, and availability of water in the soil. The decline in agricultural production also occurs due to the negative impacts of extreme climates, such as floods and droughts that can result in crop failure and crop failure.

Lamongan Regency, East Java is an area with an agricultural typology with the primary type of agricultural food being rice. The agricultural sector on the island is vulnerable to the impacts of climate change. This vulnerability is indicated by the hazard of crop failure due to drought, primordial failure and the achievement of quantity and quality of production due to drought, changes in climate variability in the form of frequency and quantity of excessive rainfall before harvest [2][4][5].

Studies on the vulnerability of households to the impacts of climate change have not been widely carried out in Indonesia. Most studies focus on the impact of climate extremes on farmers and the factors that influence farmers' adaptation. The failure of the agricultural sector in the long term will encourage the population to seek alternative sources of income, including migration with economic motives.
Migration carried out by farmers generally consists of internal migration or international migration by becoming migrant workers abroad.

2. Methods
This paper describes the condition of the area in Lamongan Regency and understands the analysis of the vulnerability of the impact of climate change on areas and farmer households that trigger migration flows with economic motivation. The data used for description and analysis are primary data and secondary data. Primary data comes from Research Center for Population-LIPI research series on migration and climate change in 2010–2014. Data collection using a qualitative approach with a focus group discussion method and in-depth interviews with several parties who know about agriculture and climate change. The informants in this study were male farmers who have experience in temporary migration, farmer wives who help their husbands in the fields and manage mat crafts, local village officials, traditional and religious leaders. The focus group discussion gathered around six respondents with homogeneous characteristics (gender, age and occupation). This study used data from three focus group discussions and several in-depth interviews. The secondary data uses publications from Statistics Indonesia and local government data.

3. Results and discussion
Lamongan Regency is one of the regencies located on the north coast of East Java, where part of the coastal area is in the form of karst hills. This formation is a continuation of a series of the North Cretaceous Mountains whose territory extends from west to east of Java Island which includes the districts of Pati, Grobogan, Rembang, Blora, Tuban, Bojonegoro, and Lamongan [6]. The North Cretaceous Mountains are a karst area whose primary forming rock is limestone. The characteristic of this area is that it is dry on the ground surface but has great underground water potential. The type of rock in this area allows the formation of underground rivers because of the nature of limestone that passes water, and the level of water porosity is very high so that rainwater is easily absorbed. The rainwater is trapped in the space between the soil and the deep rocks which are known as aquifers. Karst areas are vulnerable to climate change, significantly when the rain cycle is disrupted. Changing the rain cycle to a very long dry season causes severe drought because groundwater availability in karst areas is highly dependent on rainwater abundance. Conversely, when it rains with high and continuous rainfall, it can result in landslides because of the easily destroyed nature of limestone.

3.1. Vulnerability of agricultural areas
With its sloping topography, Lamongan Regency is an agricultural-based area. More than half of the area is agricultural, especially rice-type food agriculture [7]. Lamongan itself is a “rice granary” in East Java Province. In Lamongan Regency, most of the population or as much as 63.71 per cent are engaged in the agricultural sector [4][7]. The agricultural sector, especially the food agriculture sector, is a sub-sector that is quite influential in determining economic growth in Lamongan Regency. Agricultural business in Lamongan Regency is supported by the flow of the Bengawan Solo River which extends from west to east along 63 kilometres [7]. The river flow can irrigate agricultural areas in Lamongan Regency, especially in the northern region during the dry season. The availability of water resources makes the residents of Lamongan Regency depend on paddy fields. Figure 1 shows more than half of the land use reserved for paddy fields.

This research conduct in two villages which have agricultural characteristics with paddy fields, namely Mantup and Rumpuk villages in Mantup District. The village's location is in the southern part of Lamongan Regency, where the majority are is agricultural areas. Most of the types of work performed by residents in the District of Mantup are in the agricultural sector as farmers. The dominance of employment in agriculture shown by the use of land in the two research villages, most of which is for rice fields. More than 90 per cent of land use in the District of Mantup is paddy fields.
District of Mantup is in the southern part of Lamongan, which is plain and suitable for use as rice field farming. Likewise in the village of Rumpuk, land use in this village is also dominated for rice fields up to 90.5 per cent of its area [8]. Adequacy of water in this area allows Mantup District to become an agricultural area. The available water resources also allow Mantup to plant rice commodities that require much water. Mantup sub-district has an average height of 2 meters above sea level [8]. The location of this sub-district is also far from the northern coast of Java Island.

In 2019, the planting/harvested area for rice commodities experienced a decline. The rice production trend in Lamongan Regency from 2000 to 2019 tended to be stable without a significant increase or decrease. However, since 2010 there are a declining in rice production in East Java due to crop failures due to climate change. Agricultural activities are activities that will experience vulnerability to climate change. Agricultural activities are closely related to climatic conditions. Especially for food crops that are vulnerable to changing climatic conditions. In 2010-2011, there were crop failures even in Lamongan Regency due to climate change and extreme weather conditions. Farming communities who previously had a traditional planting calendar have changed. The timing of planting food crops is experiencing chaos due to climate change.

With land-use dominated by agricultural land, especially rice fields, most of the population in the Mantup District, both in the villages of Mantup and Rumpuk, work in the agricultural sector. The dominance of the livelihoods of most of the population in the village of Mantup as farmers of food crop agricultural land is firm because it is supported by the fertile land conditions and supports the agricultural business. With climate change, the people in this village are also still surviving in the agricultural sector because they have additional jobs as agricultural labourers, especially sugar cane farming which is less affected by climate change such as rice.

As in the village of Mantup, the conditions of employment in Rumpuk are also dominated by the agricultural sector. The massive composition of the population working in the trade sector in the village of Rumpuk was triggered by the impact of climate change which disrupted agricultural activities. So that many residents work in the trade sector. Many people in the village of Rumpuk carry out trading activities outside of Lamongan Regency to sell mats and beds (cots). People who sell outside Lamongan Regency generally do their activities when they are not working on their rice fields. For 2011, due to crop production, especially rice crop failure due to pest attacks, the intensity of trading activities is getting bigger because relying solely on land cannot meet the economic needs of the family. The phenomenon of Lamongan residents carrying out temporary migration can be identified from their presence in Surabaya to trade [9]. Temporary migration carried out by residents has even had an impact in the form of remittances used by the left behind family [10]. Leaving agriculture for a while is an effort to fulfill their livelihood. After conditions allow the farmers to return to their villages and start farming businesses.

The three main factors of climate change that have an impact on the agricultural sector are changes in rainfall patterns and climate extremes, increased air temperatures, and rising sea levels. One of the

![Figure 1. Land use by type in Lamongan Regency [8]]
impacts of climate change is the shifting of seasons and rainy patterns which will significantly affect agricultural activities from shifting planting times, seasons and cropping patterns. The agricultural areas experiencing the most significant impact of climate change are agricultural land in the highlands. With high rainfall, this area is most vulnerable to erosion, but on the other hand, when there is a long drought, the highlands will also suffer the worst impacts.

In agricultural areas, climate change has an impact of crop failure on agricultural land that is vulnerable to climate change. The agricultural sector will become vulnerable if it experiences difficulties in maintaining and saving optimal productivity levels in the face of climate change. Food crops, especially rice, are the types of agricultural commodities that are most vulnerable to climate change because in general, they are seasonal crops that are relatively sensitive to shortage and excess of water. The crop failure that occurred in the Mantup was triggered by erratic climate and weather conditions. Planting schedules and patterns have undergone many changes. This change has a significant impact on farmers in Mantup because generally farmers there are traditional farming which is very dependent on climate and weather. The impact of climate change that most disturbs traditional cropping patterns is rainfall. The trend that occurs in rainfall patterns is the tendency of the dry season to be longer. Typically, the average rainy season per year in Lamongan Regency is longer than the dry season. One of the efforts made by farmers in overcoming the impact of climate change is eradicating simple pests and diseases with the ingredients around them, such as laundry soap, bleach and clothing fragrances. This effort is quite successful in reducing pests and plant diseases. However, for the problem of changing the planting season, no action could be made because not all agricultural land was irrigated. Even some irrigation has dried up and is not operating.

3.2. Migration as a coping strategy
Several studies have shown that the impacts of climate change will increase in the future as the frequency of extreme weather increases. This condition is also expected to increase migration flows as a result of climate change [10][11]. To avoid uncontrolled migration, the government or community institutions in the area of origin should anticipate to direct or control migration as a result of climate change. Anticipation can be done by issuing various policies or programs related to migration management in order to minimize the negative impact of migration as a result of climate change [12].

Most of the actors of mobility as a result of climate variability are farmers, the majority of whom are low educated and do not have skills so that it will be challenging to compete for jobs in other areas. Therefore, it is essential to manage individual population migration as a result of climate change to avoid the emergence of various problems, both in the destination area and in the area of origin, at the family, community and regional level.

Based on in-depth interviews with village leaders and community members, it was found that the prolonged dry season caused some residents to migrate to other areas. This is done because the majority of the population in this village depends on the dry land agricultural sector with limited agricultural infrastructure, narrow land ownership, and narrow non-agricultural livelihood access. This condition makes residents have to look for sources of livelihood outside the village, primarily when agricultural land cannot be cultivated in the dry season. The following in-depth interviews with a sub-village official and a mat trader from the village of Rumpuk illustrate that the mobility of the people from this village has been going on for some time and generally for work or business.

“….. The seasonal workers are also from this village. They sell their products in Mojokerto, Gresik, and Lamongan sells pallets, beds, and cupboards. Apart from selling, the seasonal workers are construction workers; some go to Surabaya, to join projects. They leave the planting season and when it is harvest season they come back again. The term is seasonal.” (Sp, a mat seller from Rumpuk village)

In the last one and a half years, the village of Rumpuk has also faced a prolonged rainy season so that agricultural land cannot produce optimally, even causing crop failure. This condition encourages
some of the population, especially men, to leave the village for the surrounding districts to look for work, for example to Gresik, Surabaya and Mojokerto. However, it cannot be ignored that current and past experiences of mobility influence the flow of population mobility. This means that the decision to migrate tends to be more comfortable for residents in migration-sending areas to make than in non-migration-sending areas.

The villages of Rumpuk and Mantup have dryland agricultural areas that are highly dependent on climatic conditions. The dry season is a dry season for farmers, especially those with narrow land and landless farmers. There are not many jobs as agricultural labourers in the village, as well as jobs outside the agricultural sector are also very limited.

In migration studies, it is well known that environmental conditions are one of the many factors that motivate a person to carry out population mobility. Environmental factors can be the main factor that causes a person to migrate, but generally through other factors, such as sources of livelihood [13]. This can be understood from disturbances in environmental conditions (including weather anomalies) which cause people’s livelihoods to be disturbed so that a person changes their place of residence, either temporarily or permanently.

In other words, population mobility is one way to cope with environmental changes (such as floods and droughts), which have an impact on human life. However, migration flows and patterns depend on the frequency, duration and severity of environmental changes that occur [11]. For example, a person will carry out population mobility due to environmental changes if the frequency of disasters (environmental changes) has occurred frequently, for a long time, and has had a significant impact on their lives. This condition also applies to the incidence of population mobility due to the impact of climate change.

In the context of this research, the impacts of climate change felt by the communities were still short-lived, roughly the last two years. Therefore, the flow of migration due to the impact of climate change is not yet visible, however, in open interviews and group discussions, it was found that there was a tendency to increase the flow of migration out of the village, especially in Rumpuk village. They went outside the village because the yields of rice and the second crop other than rice (Indonesian: palawija) fell a lot, some even experienced crop failure.

The qualitative information illustrates that the impacts of climate change are a driving factor for migration through an intermediate factor of livelihoods. Crop failure has disrupted the livelihoods of the population, so they have to do coping strategies to fit their livelihood [14]. Temporary migration is the last battle that can be done by farmers. When the harvest fails, farmers migrate temporarily to the nearest town. The types of work carried out by farmers are very diverse, including trading and construction. Temporary migration is a final choice for survival and fulfil their livelihood. The ability to cope itself is influenced by various factors, such as gender, age, social capital, social networks, and the level of knowledge of the community. These findings indicate that the potential for migration deserves the attention and consideration of policymakers and observers of migration studies.

4. Conclusions
Migration related to climate variability does not stand alone but is influencing by other factors such as social, economic, political, demographic and environmental. Besides, the decision to migrate also depends on the characteristics of the household and among other factors that can facilitate migration related to climate variability. Migration carried out by farmers is an internal migration as well as international migration. Migration flows due to the impact of climate variability will increase in the future in line with the increasing impact of climate variability, including changes in rainfall and extreme weather which is increasingly frequent. The impact of migration due to climate change is that farmers can fulfill their livelihoods by diversifying their jobs. When agricultural land cannot provide economic income, farmers can seek it by doing other work through temporary migration. Therefore, different migration management is needed compared to the usual migration management. Migration management referred to in this research is all efforts/policies/programs either carried out by the government or non-
governmental organizations to be related to efforts before migration, during the migration process due to the impact of climate variability and when migrants return to their areas of origin.

Acknowledgments
This article is a part of the research report series by H Romdiati, M Noveria, B Setyawan, A Latifa, Fitranita, M A Malamassam and I Hidayati (2010-2014) about climate change and population mobility. This research fully funded by the Indonesian Institute of Sciences (Indonesian: Lembaga Ilmu Pengetahuan Indonesia or LIPI).

References
[1] Fellmann T 2012 The assessment of climate change-related vulnerability in the agricultural sector: reviewing conceptual frameworks Building resilience for adaptation to change in the agriculture sector ed A Meyback, J Lakosi, S Resfern, N Azzu and V Gitz (Rome: FAO) pp 37–61
[2] Romdiati H, Noveria M, Setyawan B, Latifa A, Fitranita, Malamassam A and Hidayati I 2010 Perubahan struktur penduduk dan strategi adaptasi terhadap perubahan iklim dalam konteks ketahanan ekonomi rumah tangga (Jakarta: PPK-LIPI)
[3] Slater R, Peskett L, Ludi E and Brown D 2007 Climate change, agricultural policy and poverty reduction—how much do we know Natural Resource Perspectives Series No. 109 (London: Overseas Development Institute) p 6
Mutekwa V T 2009 Climate change impacts and adaptation in the agricultural sector: The case of smallholder farmers in Zimbabwe Journal of Sustainable Development in Africa 11 237–56
Saptutyningsih E, Diswandi D and Jaung W 2020 Does social capital matter in climate change adaptation? A lesson from agricultural sector in Yogyakarta, Indonesia Land use policy 95 104189
[4] Pemerintah Kabupaten Lamongan (Lamongan Government) 2010 Rencana pembangunan jangka menengah Kabupaten Lamongan 2010-2015 (Lamongan, Indonesia: Pemerintah Kabupaten Lamongan)
[5] Romdiati H, Noveria M, Setyawan B, Latifa A, Fitranita, Malamassam A and Hidayati I 2013 Struktur penduduk Kabupaten Lamongan, Jawa Timur: Dampak terhadap ketahanan ekonomi rumah tangga (Yogyakarta: Pintal) p 153
[6] van Bammelen R W 1949 The geology of Indonesia (The Hague, Government Printing Office)
[7] BPS Kabupaten Lamongan 2019 Lamongan dalam angka 2019 (Lamongan, Indonesia: Badan Pusat Statistik Kabupaten Lamongan)
[8] BPS Kabupaten Lamongan 2019 Kecamatan Mantup dalam angka tahun 2019 (Lamongan, Indonesia: Badan Pusat Statistik Kabupaten Lamongan)
[9] Romdiati H and Noveria M 2008 Mobilitas penduduk musiman di Kota Surabaya: dampaknya terhadap lingkungan permukiman kumuh Jurnal Kependudukan Indonesia 3 37–50
[10] Hidayati I 2020 Migration and rural development: The impact of remittance IOP Conf. Series: Earth Environ. Sci. 561 012018
[11] International Organization for Migration (IOM) 2009 Migration, environment and climate change: Assessing the evidence ed F Laczko and C Aghazarm (Switzerland: IOM)
[12] Call M A, Gray C, Yunus M and Emch M 2017 Disruption, not displacement: environmental variability and temporary migration in Bangladesh Glob. Environ. Change 46 157–65
Mcleman R A and Hunter L M 2010 Migration in the context of vulnerability and adaptation to climate change: insights from analogues Wiley Interdiscip. Rev. Clim. Change 1 450–61
Black R, Bennett S R, Thomas S M and Beddington J R 2011 Migration as adaptation Nature 478 447–49
Tacoli C 2009 Crisis or adaptation? Migration and climate change in a context of high mobility Environment and Urbanization 21 513–25
[13] McAdam J 2010 Climate change and displacement: Multidisciplinary perspectives (Oxford: Hart
[14] Boano C, Zetter R and Morris T 2007 Environmentally displaced people: Understanding the linkages between environmental change, livelihoods and forced migration (Oxford: Refugee Studies Centre, University of Oxford)

Chambers R 1987 Sustainable livelihoods, environment and development: Putting poor rural people first IDS Discussion Paper 240 (Brighton: IDS)