THE IMPACT OF URBAN GROWTH ON FOOD SECURITY AND THE ROLE OF PLANNING (CASE STUDY: MOJOKERTO REGENCY, INDONESIA)

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Enschede, The Netherlands, December 2015

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Specialization: Urban Planning and Management

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ABSTRACT

A better understanding of the impact of urban growth on agricultural land and food security is necessary for the design of appropriate strategies. Review of the existing of planning on food security is also important to improve the level of food security. Therefore, the aim of this research is to investigate whether a relationship can be found between agricultural land, urban growth and food security and to evaluate the role of planning on food security. The research was conducted in Mojokerto Regency, Indonesia.

In this research, secondary data from three years (2005, 2009 and 2013) were used to analyse food security and vulnerability. The method was based on three dimensions and nine indicators of food security. Land cover maps were generated for each year to support the statistical data. Planning documents were reviewed to obtain information about the extent to which food security had been taken into account in planning. Finally descriptive analysis was used to explain the trends of urban growth, agricultural land, food security and the role of planning.

The result, based on food security and vulnerability composite index (FSVCi), showed an increase in the level of food security in 2005, 2009 and 2013. At the same time, urban area increased and the loss of agricultural land also increased. In addition, planning review showed that all nine indicators of the three food security dimensions were taken into account in the planning but not directly use food security as the aim.

The finding shows that the relationship between agricultural land, urban growth and food security cannot be concluded yet and need further research. At the same time, even though attention about food security has not directly stated in planning but those documents consider all indicators of food security which could have mitigated the adverse effects of land cover change on food security.

Keywords: Urban growth, food security, agricultural land, the role of planning

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1. INTRODUCTION

1.1. Background

Land is a finite resource. The increasing population growth means that the need for land for activity will increase as well. Conflicting demands on land use often arise along with diverse interests. Over the past several decades nearly 50% of the land surface has been transformed by direct human activities such as agriculture, food production, urbanization and industrial development (Steffen et al., 2004).

Based on United Nations Department of Economic and Social Affairs (UN DESA) report (UN DESA 2014), 54% world population lives in urban areas and expected to increase to 66% in 2050. The urban population has grown rapidly from 746 million in 1950 to 3.9 billion in 2014 and about 53% urban population is in Asia. As a result several challenges will emerge such as housing and infrastructure.

Urban growth is caused by several factors: economic growth, population growth, industrialization, demand of more living spaces and failure to enforce planning policies. Urban growth also has implications such as loss in farm land, open spaces and urban sprawl (Bhatta, 2010).

To meet the demand as population growth, current food production level expected to increase about 50% by 2050 from production in 2000. Meanwhile farm land will be lost for about 0.67million km^2 in 2050 caused by urban development. As a result food production will about 25% less than it should. Furthermore world food prices are expected to increase about 30% to 50%. Increasing world food price as a result of not meeting food demand will result food insecurity (UNEP, 2009).

According to Food and Agricultural Organization (FAO, 1996): "*Food security exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life*" (p4). WHO has determined three dimensions of food security: food availability, food access and food use (WHO, 2015).

The first dimension of food security is food availability. Food production provides the base of food security as it is a key determinant of food availability. Food availability commonly associate with supply side. Sufficient food production it means enough food can be accessed. On the other hand, insufficient food could lead to inadequate dietary intake and end up in food insecurity.

Food accessibility is the second dimension of food security. This dimension generally as demand side of food security. There are two types of access in this dimension, namely physical and economic. Acces to food closely related to poverty and livelihood. A study has been done in India revealed that food insecurity occur not only because of less food production but also due to they were lived in poverty so they cannot access the food due to economic reason (Panneerselvam, Hermansen, Halberg, & Arthanari, 2014). Poor household categorized as prone to food security since they don't have enough money to access food for their family even though food is available in the market (Maitra & Rao, 2015).

Moreover physical access also has important role related to food security. An adequate road infrastructure will lead to more effective cost for food supply and the result is food available with lower prices for consumers. In adequate access to food due to poverty could lead to food insecurity.

The last dimension of food security is food use or food utilization. This dimension reflect how food utilized in proper way to fit dietary needs and to achieve an active and healthy life. People will not live healthy and longer even they have enough food to eat but they cannot utilize their food consumption. If an area or an individual is food secure from the point of view of food availability and food access, but overall food insecurity will still depend upon factors like the nutritional status of people particularly children which depend on the literacy of mothers, access to health infrastructure and basic amenities like access to safe drinking water, sanitation, etc. (Dewan Ketahanan Pangan, 2015). Improper utilization of food due to inadequate maternal and child care, unhealthy environment, insufficient access to basic services (water and health services) also could lead to food insecurity.

Food security can be obtained when three dimensions achieve simultaneously. Food security influenced by how relationship of those three dimensions. Food insecurity occurs when this connection is broken. Food insecurity can be defined as the inability of people to meet their minimum dietary need for present and future purposes (Szeto, 2013). Several factors that could be as causes of food insecurity have been identified such as inappropriate policies, poverty, population growth, declining food production, poor infrastructure, difficulty to access clean water and disease (Riely, Mock, Cogill, Bailey, & Kenefick, 1999).

California is known as fastest growing state. More than 400.000 new residential are built per year. Between 1990 and 2004 over 202.000 ha area converted to urban uses and more than 90% population live in the midst of the most productive farmland (Thompson, 2007). Furthermore, economic growth in China that began in 1990 triggered rapid industrialization and urbanization leading to reduce agricultural land. The result is increasing risk of food supply and become dependence on imports (Wu, Y., Zhang, X., Skitmore, M., Song, Y., & Hui, 2014).

Nowadays, China become more industrialised and urbanised that lead to more dependent on import to fulfil their food demand (Anderson & Strutt, 2014). A study has been done in China and India about the increasing of food price as the result not meeting between food supply and demand. Its happens because of the demand of food growing fast as a result of huge population (about 37% of world population) and high economic growth rates (7-12%) (Gandhi & Zhou, 2014).

Special Economic Zones (SEZ) were established in Polepally India in 2010. The impacts of the establishment of SEZ are loss of farmland, unemployment and food insecurity. In addition, based on a survey that was conducted among 370 respondents in the same area, the number of farmers decreased from 358 before SEZ (2010) to 192 because of loss of their farm land. Furthermore, 85% respondents were reporting that food production declined and 89% respondents said food availability decreased and getting worse after the establishment of SEZ (Rawat, Bhusan, & Surepally, 2011).

Planning for food security is important for a number of reasons ranging from the quantitative supply of food to feed individuals, as well as nutrition and health issues. Planners traditionally have not made food as their priority in government policy and regulations. It can be happened because of their lack of

acknowledgement of food security. Food system is looked as "a stranger to the planning field" (Pothukuchi &Kaufman, 2000 as cited in Szeto, 2013).

A study has been done in Oregon, United States of America (USA) about to what extent a spatial planning program can reduce urban growth impact on land conversion. The result is the planning program was successfully to reduce land conversion within urban growth boundaries but remain debatable for outside urban growth boundaries (Kline & Alig, 1999).

There are many regulations implemented in order to protect agricultural land conversion in Indonesia such as Law no 41 year 2009 about sustainable agricultural land protection, however in fact there are a lot of farmer tend to sell their agricultural because difficulties in financial (Konig et al., 2010). On the other hand, Rantini & Prabatmodjo (2014) argue that some farmers show positive attitude that they will keep their land as long as there is an incentive from the government.

1.2. Study Area

In 2010, Indonesia population has reached about 237 million and approximately 57% (136.6 million) lived on Java Island while the area of Java Island is only about 6.77% (126, 700 sq.km.) of the total land area of Indonesia (1,910,931 sq.km.). It means more than 57% of population do their activities on the island of Java ("Statistics Indonesia," n.d.-a). Population density on the island of Java reached more than 1078 per sq.km. It means large pressure on land and the result is the conversion of prime agricultural land into build up area (residential and industrial area)(Verburg, Veldkamp, & Bouma, 1999).

Based on MP3EI (Master Plan for the Acceleration and Expansion of Indonesia's Economic Development) 2011-2025 Java Economic Corridor which is located on Java Island is to develop as a driver for National Industry and Service Provision (see Fig.1). One thing to note is the capital city of East Java Province, Surabaya becomes one of the Mega Economic Centres. Surabaya Municipality along with five other cities namely Gresik, Bangkalan, Mojokerto, Sidoarjo and Lamongan incorporated in the Gerbangkertosusila Metropolitan or Greater Surabaya contribute to economic activities that focus on food, beverages and shipbuilding industry.

Besides being a driving force in the economic, the provinces on the island of Java is also as the largest contributor for agricultural products (about 52.6 %), namely rice. Based on the report of BPS from the total harvest (about 71 million ton) in 2013, the largest contributor is West Java Province nearly 12.1 million ton (17%) followed closely by East Java Province around 12.09 million ton (16.9%) ("Statistics Indonesia," n.d.-b)

Figure 1. Map of 6 Indonesian economic corridors

Source: (MP3EI, 2011)

This research will be conducted in Mojokerto regency, Jawa Timur Province Indonesia. It is located between latitudes 7° 18' 35"and 7° 47' 30" S and longitudes 111° 20' 13"and 111° 40' 47" E. The total area of Mojokerto Regency is 977 km². The average elevation of Mojokerto Regency is 64m above sea level. Mojokerto Regency consist of 18 districts. The capital city of Mojokerto Regency is Mojosari (Central Statistical Bureau of Mojokerto Regency, 2014).

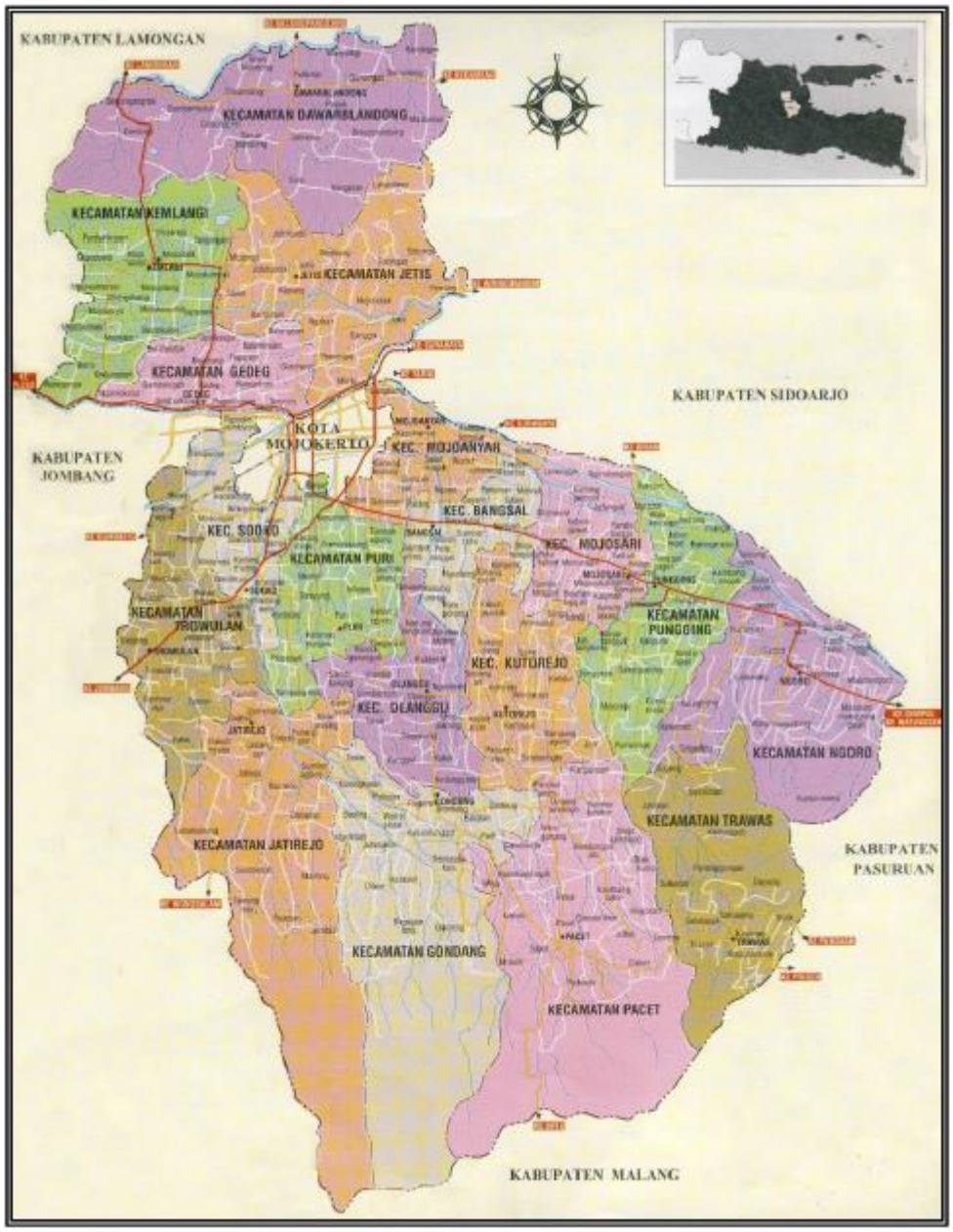

Figure 2. Map of Mojokerto Regency administrative boundary

Source: (Central Statistical Bureau of Mojokerto Regency, 2014)

1.3. Research Problem

Become one of the members of Greater Surabaya, Mojokerto Regency has an important role in several sectors such as agriculture and industry. In addition, population growth which lead into urban growth in Mojokerto Regency is contradictory to the area of agriculture (Central Statistical Bureau of Mojokerto Regency, 2014). Those factors feared will cause problems on food security.

There are some elements that might affect either directly or indirectly on food security, namely urban growth, agricultural land conversion and the role of planning (Bhatta, 2010; Kline & Alig, 1999; Rawat et al., 2011; Thompson, 2007; UNEP, 2009; Verburg et al., 1999). Therefore, this study aims to investigate whether a relationship can be found between agricultural land, urban growth and food security in Mojokerto City and to evaluate the role of planning on food security in order to gain a deeper insight to be taken as consideration for better development plan in the future.

1.4. Research Objectives

1.4.1. General objective

The main objective of this research is to analyse the impact of urban growth on food security and the role of planning on food security.

1.4.2. Research objectives

In order to achieve the main research objective the following objectives are set for the study:

1. To understand the trends and spatial variation of food security in Mojokerto Regency
2. To analyse the trends in loss of agricultural land, urban growth and the role of planning related to food security trends and spatial variation in Mojokerto Regency.

1.5. Research Questions

The research questions are formulated based on objectives:

1. To understand the trends, spatial variation and pattern of food security in Mojokerto Regency
   a. What are the trends of food security in Mojokerto Regency?
   b. How is the spatial variation and pattern of food security in Mojokerto Regency?
   c. Where is the area that most at risk of food insecurity?
2. To analyse the trends in loss of agricultural land, urban growth and the role of planning related to food security trends and spatial variation in Mojokerto Regency
   a. What are the trends in loss of agricultural land and urban growth in Mojokerto Regency?
   b. Is food security taken into consideration in local plans?

1.6. Thesis Structure

There are six chapters in this research. Introduction that contains of research problem, objectives and questions will be in the first chapter, followed by literature review that related with the research topic in second chapter. The third chapter is about research methodology including methods and materials that will be used in this research. The result of this study will be discussed in the chapter fourth. The fifth chapter will discuss about the result and answer the research questions. Finally, conclusions will be in the chapter sixth.

2. LITERATURE REVIEW

2.1. Food Security

Food security has a number of different interpretations and definitions. Some of popular definition as follow: Inter-American Institute for Cooperation on Agriculture (IICA):

> "*Food security is defined as the existence of the necessary conditions for human beings to have physical and economic access, in socially acceptable ways, to food that is safe, nutritious and in keeping with their cultural preferences, so as to meet their dietary needs and live productive and healthy lives"* (IICA, 2009, p1).

According to World Health Organization as cited in Bajagai (2013, p1), food security means:

- *All people at all times have both physical and economic access to enough food for an active, healthy life;*
- *The ways in which food is produced and distributed are respectful of the natural processes of the earth and thus sustainable;*
- *Both the consumption and production of food are governed by social values that are just and equitable as well as moral and ethical;*
- *The ability to acquire food is ensured;*
- *The food itself is nutritionally adequate and personally and culturally acceptable; and*
- *The food is obtained in a manner that upholds human dignity."*

WHO has determined three dimensions of food security: food availability, food access and food use (WHO, 2015).

Meanwhile Food and Agricultural Organization (FAO, 1996) define: "*Food security exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life*" (p4) . FAO (2009) distinguish four dimensions of food security: availability (food supply), accessibility (access in both physical and economic to food supply), and utilization (utilize food supply to meet minimum nutrient requirement) and stability of three previous dimensions. The four dimensions and a set of indicator can be seen in appendix A.

World Food Summit (1996) redefined the term food security and focus to the linkage between food, nutrition and health. It is logical if the measurement of food security should include these three dimensions (FAO, 1996).

In the Indonesian context (Republic of Indonesia, 1996), food security is defined as the food fulfilment conditions of households that are reflected in

- The availability of adequate food, both in quantity and quality (availability);
- Distribution of food is equitable and affordable (accessibility);
- Food is safe to utilize (utilization).

According to definitions above, it means food security is food available and accessible to meet minimum nutrient requirement for anyone.

2.2. Food Security Measurement

Even though food security accurate measurement is important in a research, there is no perfect method to measure food security that capture all aspects (Wineman, 2014). According to Pérez-escamilla & Segall-Correa (2008), there are five methods commonly used in food security measurement, namely FAO methods (based on calories intake per capita), household expenditure surveys (based on household expenditures on food and other), dietary intake assessment (depend on participant memories about food that they consume), anthropometry (based on proportion of weight and height of infant) and experience-based food insecurity scales (based on socio cultural context). All methods have advantages and disadvantages. It depends on, the purpose, the budget available and at which level (national/regional/household/individual) the research will be conducted.

FAO method using food balance sheets and energy intake to calculated calories per capita at national level based on household income and expenditure surveys data. There are several data needed to apply this method in a country. First, data about total calories available. Second, data about number of population. Third, variation of calorie intake coefficient and the last is minimum per capita average caloric requirement cut off point.

The advantages of this method are inexpensive and the data needed are available and frequently updated in almost all country. This method also has disadvantages: a. quality of dietary is not taken into account, b. assumes that food security achieved when caloric consumption above minimum caloric standard, c. in fact, as a function of physical activity degrees age and gender, among other factors, determining an average per capita caloric requirement cut off point has several conceptual weaknesses (Pérez-escamilla & Segall-Correa, 2008).

Another assessment called dietary intake method. There are three different methods to measure individual dietary intake, a. food record, b. food frequency questionnaire and c. 24-hour recall. Food frequency and 24-hour recall methods highly depend on respondents' memory meanwhile food record method rely on respondents' record about food that they are consumed.

The advantages of dietary intake assessment are: a. it can measure not only food availability but also food consumption directly, b. caloric intakes and quality of dietary at individual level addresses, c. it can be used for mapping intra household food consumption pattern related to gender from local to national level, d. 24-hour recall can be used to understand recent dietary intake pattern meanwhile food frequency questionnaire for longer term (Bashir & Schilizzi, 2012).

Unfortunately, 24-hour recall and food frequency methods highly depend on the participants' memory that lead to potential measurement error. In case of 24-hour recall, participants have to recall and report accurately what they ate the day before, how the method of food preparation. Dietary intake methods have advantage to determining food insecurity in individual level. On the other hand these methods have several limitations, a. very expensive, b. high level of potential miscalculation and measurement error, c. needed highly trained and very skilled personnel. Those disadvantages explain why dietary intake surveys no longer used by countries (Pérez-escamilla & Segall-Correa, 2008).

In Africa, three dimensions of food security were used to conduct food security assessment. Those three dimensions are food availability, food access and food utilization (International Federation of Red Cross

and Red Crescent Societies, 2006). Furthermore, three dimensions (food availability, food access and food absorption) also used to develop food security index in Cambodia (World Food Programme, 2005).

World Food Programme (WFP) provide a guidelines for food security and vulnerability analysis (FSVA) that possibly adjusted based on local characteristic (World Food Programme, 2009) since there is no single, direct measure of food security.

FSVA approach method is adopted as standard to measure and to map food security in Indonesia. This method based on three dimensions of food security availability, accessibility and utilization (Minister of Agriculture, 2010). The advantages of this methods is trying to interconnect those three dimensions (food availability aggregation, how household access to food and how food utilized by individual) in order to simplify the complexity of food security. The FSVA could answer three key questions related to food security. First, where are the area most insecure?; second, how many are they?; and the last, what are the main determinants of food insecurity?

2.3. Food Security Framework

The Food Security Framework based on The Food and Nutrition Security Conceptual Framework from the Strengthening Emergency Needs Assessment Capacity (SENAC) Project which is a multi-donor funded of World Food Programme (WFP). The Food and Nutrition Security Conceptual Framework is based on UNICEF's Nutrition Framework and the UK Department for International Development (DFID) Sustainable Livelihoods Framework (see appendix C).

There are three dimensions of food security namely food availability, food access, and food utilization in the Food and Nutrition Security Conceptual Framework which is adopted by the Comprehensive Food Security and Vulnerability Analysis (CFSVA). The concept of food security is included the nutritional dimension, regarding the important of nutrient beyond just calories. Those three elements then linked to households' asset endowment, livelihood strategies, and political, social, institutional, and economic environments (World Food Programme, 2009). The analysis of food security in Indonesia context is based on an understanding of Food and Nutrition Security and Vulnerability highlighted in the Food and Nutrition Security Conceptual Framework (Dewan Ketahanan Pangan, 2015).

There are several factors could influence food security status of individual or household: a. broad range of agro environmental, b. socio-economic, c. biological and d. interaction among those factors. There is no single, direct measure of food security related to the concept of health and social welfare. However, using interrelated three distinct of food security dimensions (food availability aggregate, food access of household and food utilization of individual) can simplify the complexity of food security.

Addressing all three separate dimensions should be done for achieving food security, ensuring that:

- There is a sufficient of physical presence of food in the area through domestic production as the base of food availability, commercial imports (traded food through market mechanism and stocks held by traders and in government reserves), and food aid by the government and/or agencies;
- Household livelihoods provide adequate access (physical and economic) for all members of the household. and

- The utilization of those food supplies is appropriate to meet the specific dietary and health needs of all individuals within a household. Women have important and multiple role related to food utilization in terms of food security. They are not only highly responsible for preparation, consumption and distribution among the family members but also caretakers of family welfare. However, in developing countries most women suffer from illiteracy due to lack access to education. As a result, food and health facilities are not properly utilized for the benefit of their family members due to lack of information (UNICEF, 1990). Women's nutrition and health status have an important impact on child development especially during pregnancy and lactation. Reduce energy and nutrient intake during pregnancy is likely to cause growth retardation in the embryo leading to low birth weight, physical disadvantage even death at birth (UNICEF, 1990).
  The availability of heath service be expected to improved women and children health. Another basic service is access to clean water. Water is an indicator closely related to the third pillar of food security (food utilization). Water is essential for life. People need water for their daily life. The proper way of clean water usage is through hygienic handling of food by the use of sufficient clean water during its preparation to avoid food contamination (German WASH Network, 2011).

Food insecurity problems are currently more complex, process for identifying and selecting relevant indicators for dimensions of food security are crucial (Pangaribowo, Gerber, & Torero, 2013). There is no best indicator, best measure of an indicator, or best analysis of an indicator in a generic sense (Habicht and Pelletier 1990 as cited in Pangaribowo et al., 2013).

According to Barrett (2010), food security concept is complex. A set of indicators are needed to summarize the complexity of food security and capture the all dimensions of food security since the complexity cannot be summarized by a single indicator. More a wide range of indicators are needed to reflect more complex phenomenon, e.g. health status.

Maxwell and Smith (1991) (as cited in Pangaribowo et al., 2013), distinguish food security indicators in to two terms, namely process indicators and outcome indicators. Process indicators explain about indicators that related to food supply and food access, meanwhile outcome indicators serve as proxies of food utilization. Health status of individual (particularly children) is representation of the outcome of food utilization. Maxwell and Frankenberger (1992) (as cited in Eneyew & Bekele, 2012) explained that outcome indicators are grouped in to direct and indirect or proxy indicators. Medical status is one of direct indicators of food utilization. Nutritional status, livelihood potential ration are included indirect indicators of food utilization (Alison & Slack, 1999, as cited in Eneyew & Bekele, 2012).

In analysing, researcher use different approaches for an aspect of food security measurement to select an indicator. Proxy indicators are used if a variable is difficult to measure directly (Barrett, 2010). Some food security indicators are difficult or expensive to calculate directly because some reasons: it is time consuming and expensive and it reflects complex process. It needs proxy indicator to assess food security (Riely, Mock, Cogill, Bailey, & Kenefick, 1999).

Vulnerability is defined as condition of society or a household exposure and sensitivity to future shock. The ability of a household or community to face the risk posed by shock (physical: e.g. droughts, floods; economic and conflict) determined by the characteristic of society, a household or community asset base and the subsistence and the strategies to pursue food security (World Food Programme, 2009)

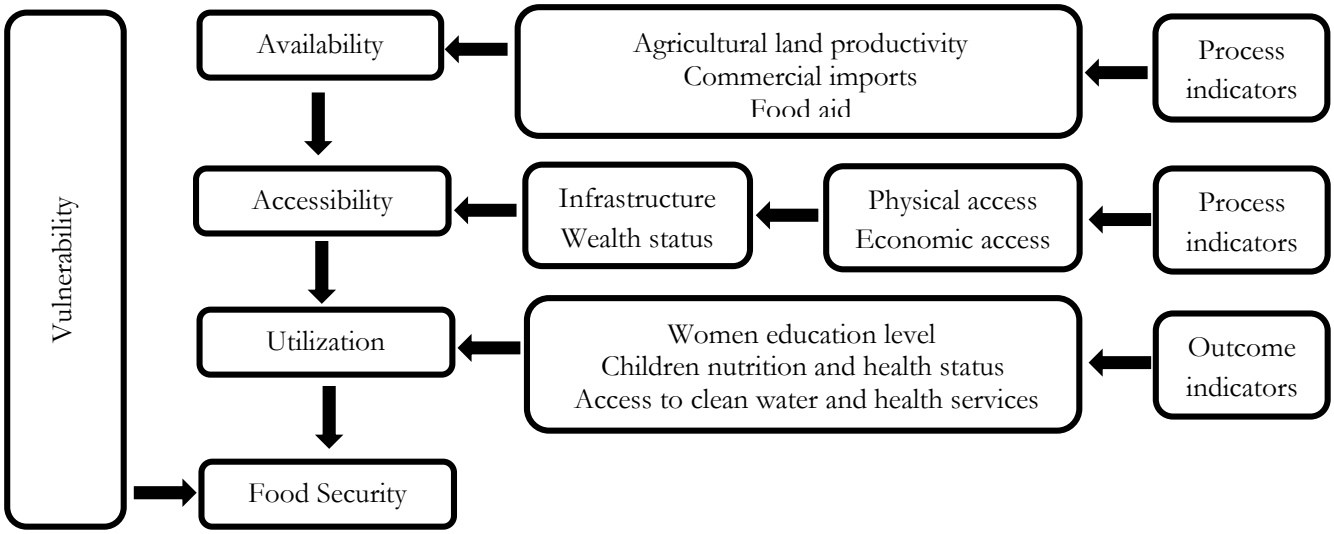

Figure 3. Concept of food security

Source: (Developed by Author, 2015)

2.4. Urban Growth and Food Security Framework

Urban growth is spatial and demographic process (Clark, 1982, as cited in Bhatta, 2010). The first most importance factor of urban growth is population growth. As population growth, it will triggering rapid development of housing and other urban infrastructure. It means the demand of area for live and activities will increase as well. As the result non-built up area converted in to built-up area (Bhatta, 2010).

Urban expansion is unavoidably especially in clearing surrounding fertile agricultural land. Thus agricultural land move on less suitable areas of lower productivity. Urban growth causes loss of agricultural land and open space (Du et al., 2014).

In the period of 2000 until 2025, urban growth in the United States of America estimated will consume 14 million acres of agricultural land and environmentally sensitive land and 5 million acres of other lands. This phenomenon is enough to depict the world scenario (Burchell et al. 2005, as cited in Bhatta, 2010).

The urban growth and food security framework (figure 4) of this study is to analyse the impact of urban growth on food security. Assume that urban growth has impact on agricultural land conversion into build up area.

Furthermore the loss of the agricultural land will influence food security. At this point, the role of planning is needed to control urban growth and agricultural land conversion in order to prevent the occurrence of food insecurity. Closed system will be used as approach in this research. It means Mojokerto Regency consider as a food self-sufficient area but remains committed to external trade. The results of this study are expected to be considered for better planning.

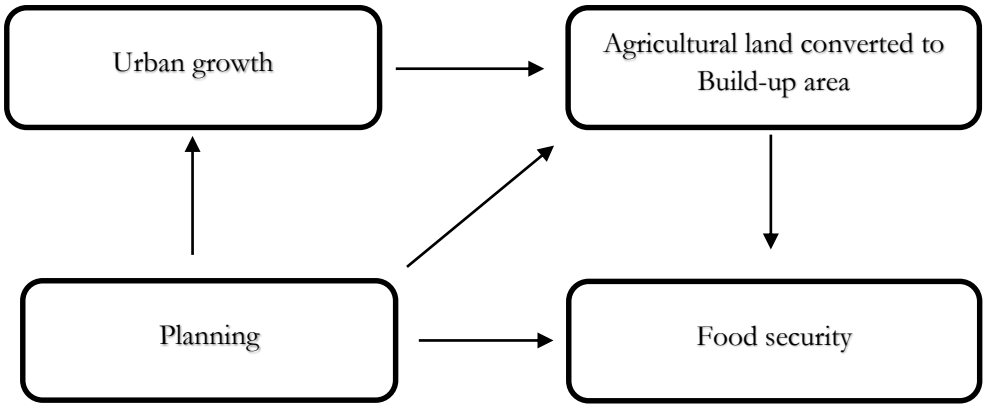

Figure 4. Conceptual framework

2.5. The Role of Planning on Food Security

There are two factors have to consider in planning for food security. First is environmental opportunities and constraints and second is Social and economic (Caldwell, Collett, Ludlow, Sinclair, & Whitehead, 2011).

Awareness and regulation are important part in planning for food security. Regulations can be an essential tools to control urban development and avoid urban sprawl (Caldwell et al., 2011).

Planning related to food security is important. In developing countries especially in Asia, planning generally focus on food availability and food access. Through planning, government provide a framework to optimize food production, effective and efficient food distribution and food accessible both in physical and economic way (Szeto, 2013).
There are some local regulations related to food security in Indonesia context. First is RPJPD (Long term of local department plan). RPJPD is a planning document for the period of 20 (twenty years). It contains the vision, mission, and direction of development of the region which refers to the National/Provincial RPJP. Second is RPJMD (Medium term of local department plan). RPJMD is the manifestation of mayor/regent visions, missions and programs for next five years. In preparation of RPJMD refers to RPJPD and RPJM (National/regional). Those two regulations are grouped as development plan documents. Development plan document is one of the two references for implementation of development in Indonesia (Republic of Indonesia, 2004).

The other reference for development implementation is RTWRD (Local spatial plan). It contains of principles, vision, mission, goals, policies, strategies and spatial planning of the region. RTRWD not only as operational tool for development implementation but also as reference for RPJPD and RPJMD drafting (Local Goverment of Mojokerto Regency, 2012).

3. METHODOLOGY

3.1. Datasets

The following table shows several data that will be used to support several analysis in this research.

Table 1. Datasets

Data	Source	Year	Scale	Projection	Data Use
Mojokerto Regency in Figures : -Population growth -Agriculture production -Agricultural land -Health Facilities -Nutrient status -Household in poverty -Electricity and water Consumers	Central Statistical Bureau	2005 2009 2013		NA/ Tabular data	Food security analysis
- Landsat Landsat 7 ETM+ image - Acquisition date: 2 October 2005 Cloud cover: 5% - Landsat 7 ETM+ image Acquisition date: 29 October 2009 Cloud cover: 0% - Landsat 7 ETM+ image Acquisition date: 21 August 2013 Cloud cover: 4%	USGS	2005 2009 2013	30m resolution	WGS 1984 UTM Zone:49S	Land cover change analysis
Mojokerto Spatial Planning: - Administration boundary	Local Planning Board	2010		NA	Food security and Land cover change analysis
Local Regulation of Mojokerto Regency: -RPJP 2005-2025 - RPJMD 2011-2015 - RTRW 2012-2032	Local Planning Board	2005 2011 2012		NA/ Document	The role of planning analysis

USGS: United States Geological Survey
ETM+: Enhanced Thematic Mapper Plus
RPJP: Long Term of Local Development Plan (Local Government of Mojokerto Regency, 2005)
RPJMD: Medium Term of Local Development Plan (Local Government of Mojokerto Regency, 2011)
RTRW: Regional Spatial Plan (Local Goverment of Mojokerto Regnency, 2012)

3.2. Software

MS Office 2013 are required for reporting, data analysis and flow charts development. ERDAS Imagine 2014 will be used for image processing and supported by ArcGIS 10 and Google earth pro to generate random point and visual ground checking for accuracy assessment.

3.3. Methods

Several analysis (food security analysis, land cover change analysis, and the role of planning analysis) will be used in this study to find out the impact of urban growth on agricultural land and food security and the role of planning on food security. There are three main approaches to answer research questions based on research objectives: food security analysis, land cover change and the role of planning analysis.

3.3.1. Food security analysis

In this research, Food Security and Vulnerability Analysis (FSVA) approach will be used to generate Food Security and Vulnerability Composite index (FSVCi). This approach use three dimensions of security, namely availability, accessibility and utilization. But this research will not analyse vulnerability. Since this region at those years never expose to the risk factors of becoming food insecure based on deforestation, rainfall fluctuation (drought, flood, windstorm), natural disaster (typhoon, flood, drought, volcanic eruption, earthquake, tsunami, landslide, wave and abrasion, epidemic, pest infestation, forest fires, and settlement fires), and damaged area (decreased crop production due to natural disaster).

FSVCi will be developed for 18 district and at regency level. Several data such as socio economic and demographic are used to generate food security composite index year. FSVCi is developed by combining nine individual index of nine food security indicators from three dimensions of food security. An area also can be classified it status of food security based on nine indicator of food security. Those nine indicators are as follow:

Table 2. Dimensions and indicators of food security

No	Dimensions	Indicators	
1	Availability	Normative cereal consumption ratio per capita per day of net availability of rice+ maize + cassava + sweet potato (Z1)	Food Security and Vulnerability Composite Index
2	Accessibility	- Percentage of household below poverty line (Z2) - Percentage of village with inadequate connectivity/road network for minimum four wheel vehicles/poor road infrastructure (Z3) - Percentage of household without access to electricity (Z4)	
3	Utilization	- Percentage of infant mortality (Z5) - Percentage of children underweight (Z6) - Percentage of women who are illiterate (Z7) - Percentage of household without access to clean water (Z8) - Percentage of household who live more than 5 km from the health facilities (Z9)	

Measuring individual index (Minister of Agriculture, 2010)

Food Availability

Food availability will be calculated based on domestic cereal production (Dewan Ketahanan Pangan, 2015).

- Normative cereal consumption ratio per capita per day of net availability of rice+ maize + cassava + sweet potato (Z1)

  Data: Food production (paddy, maize, cassava and sweet potato) in a district and population in a district
  To obtain Z1 an equation will be used as follow:

$$Z1 = \frac{Normative\ cereal\ consumption\ per\ capita\ per\ day}{Food\ availability}$$

  Normative cereal consumption per day per capita=300 gram

Based on Widya Karya Nasional Pangan dan Gizi/WNPG (National Forum for food and nutrition) VIII in 2004, the average rate of adequate energy per capita per day (in Indonesia) is 2200 kilo calories. More or less, about 50% (1100 kilo calories) of energy comes from cereal. 1,100 kilo calories is equal to 300 gram of cereal (Hanani, 2009).

$$Food\ availability\ (gram) = \frac{Food\ production\ (Paddy + Maize + \left(\frac{1}{3}\right)cassava + \left(\frac{1}{3}\right)sweet\ potato)}{Population\ x\ 360}$$

Food Accessibility

- Percentage of household below poverty line (Z2)
  Data: Total households in a district (Z2a) and total households below poverty line in a district (Z2b)
  The equation to acquire Z2 is as follow:

$$Z2 = \frac{Z2b}{Z2a} x100\%$$

- Percentage of village with inadequate road network for minimum four wheel vehicles (poor road infrastructure) (Z3)
  Data: Total Villages in a district (Z3a) and Total villages with poor road infrastructure (Z3b)
  To obtain Z1 an equation will be used as follow:

$$Z3 = \frac{Z3b}{Z3a} x100\%$$

- Percentage of household without access to electricity (Z4)
  Data: Total households in a district (Z4a) and total households without access to electricity in a district (Z4b)
  The equation to acquire Z4 is as follow:

$$Z4 = \frac{Z4b}{Z4a} x100\%$$

Food Utilization

- Percentage of infant mortality (Z5)
  Data: Total new-borns in a district (Z5a) and total new-borns (who died) in a district (Z5b)
  The formulation to obtain Z5 is as follow:

$$Z5 = \frac{Z5b}{Z5a} x100\%$$

- Percentage of children underweight (Z6)
  Data: Total children in a district (Z6a) and total children underweight in a district (Z6b)
  The equation to obtain Z6 is as follow:

$$Z6 = \frac{Z6b}{Z6a} x100\%$$

- Percentage of women who are illiterate (Z7)
  Data: Total women in a district (Z7a) and total women who are illiterate in a district (Z7b)
  The equation to acquire Z7 is as follow:

$$Z7 = \frac{Z7b}{Z7a} x100\%$$

- Percentage of household without access to clean water (Z8)
  Data: Total households in a district (Z8a) and total households without access to clean water in a district (Z2b)
  The equation to acquire Z8 is as follow:

$$Z8 = \frac{Z8b}{Z8a} x100\%$$

- Percentage of household who live more than 5 km from the health facilities (Z9)
  Data: Total households in a district (Z9a) and total households who lived more than 5 km from the health facilities in a district (Z9b)
  The equation to acquire Z9 is as follow:

$$Z9 = \frac{Z9b}{Z9a} x100\%$$

All value for each indicator must be normalized into index (scale 0-1) in order to maintain consistency data unit measurement using equation as follow:

$$Index\ Xij = \frac{Xij - Xi\ min}{Xi\ max - Xi\ min}$$

Where:
X ij = indicator value
Xi min = the minimum value of indicator
Xi max = the maximum value of indicator

Measuring FSVCi

$$FSVCi = \frac{1}{9} \times (Z1i + Z2i + Z3i + Z4i + Z5i + Z6i + Z7i + Z8i + Z9i)$$

Where:
Z1i: Index of normative cereal consumption ratio per capita of net availability of rice+ maize + cassava + sweet potato
Z2i: Index of household below poverty line
Z3i: Index of villages with inadequate road network for minimum four wheel vehicles
Z4i: Index of household without access to electricity
Z5i: Index of infant mortality
Z6i: Index of children underweight
Z7i: Index of women who are illiterate
Z8i: Index of household without access to clean water
Z9i: Index of household who live more than 5 km from the health facilities

FSVCi will be categorised in to six classes: 1. Very high food insecurity (>0.80), 2. High food insecurity (>0.64-0.80), 3. Moderate food insecurity (>0.48-0.64), 4. Moderate food insecurity (>0.32-0.48), 5. High food security (>0.16-0.32) and 6. Very high food security (≤0.16) (Hanani, 2009)

3.3.2. Land cover change analysis

There are two types of data source that will be used in this analysis. First, statistical data of agricultural land (2005, 2009, and 2013) from Central Statistical Bureau. Second, Satellite imagery from USGS to generate information about built up area trend since there is no data about it from Central Statistical Bureau. Even though there will be redundancy about agricultural land area. This has become one of the limitations of the study.

A series of Landsat satellite imagery (2005, 2009, and 2013) will be used for land cover change detection and analysis. Landsat satellite imagery has temporally continuous remotely sensed dataset of earth land surface that proved useful for urban growth monitoring (Liu & Yang, 2014; Kaufmann & Seto, 2001). The selection of satellite imagery is based on consideration that moderate resolution (30 meters) is sufficient for land cover change detection at regency level. An administration boundary from local planning board was used to clip study area. Supervised with maximum likelihood method will be used in this analysis. Land cover maps will be produced for the year 2005, 2009 and 2013 distinguishing the following 5 classes: built up area, agricultural land, water, forest, and bare soil.

Image classification will be verified the validity using an accuracy assessment. 125 random points were generated as sample points in the classified image. Normally, visual check of actual land cover will be observed directly in the field. However, in this research, Google earth pro will be used to visual land cover check as fieldwork is not possible.

Information about the rate and the number of the land cover changes for each class can be extracted using map algebra and field calculator operation in GIS. The results of this analysis are: 1. Map that visualise the changes in five classes, 2. Information about the rate of change each class.

Combination of statistical data and remote sensing imagery are useful to obtain data for planning analysis in a cost effective and timely manner

3.3.3. The role of planning analysis

Descriptive analysis will be used to evaluate the role of planning on food security. Several local plans documents (medium term of local development plan (RPJM 2011-2015), long term of local development plan (RPJP 2005-2025) and regional spatial plan (RTRW 2012-2032)) will be reviewed in order to verify to which extent government attention given to food security.

The review based on three dimensions and nine indicators of food security. From the result can be found which indicator has more attention from government. On the contrary it also has information which indicator has less attention from government. According to the result of indicator review, information about which dimension of food security has major and less concern from government.

3.4. Methodological flowchart

The overview of data processing and analysis to achieve research objective is shown in figure 5 below. There are 2 large groups based on research objectives. First group describes that statistical data were used to develop FSVCi for 18 districts and at regency level. Second group illustrates that two activities will be conducted (generate land cover maps and plan review). Land cover maps in 5 class and plan review matrix will be produced. The result from the first and second group will be analysed using descriptive analysis.

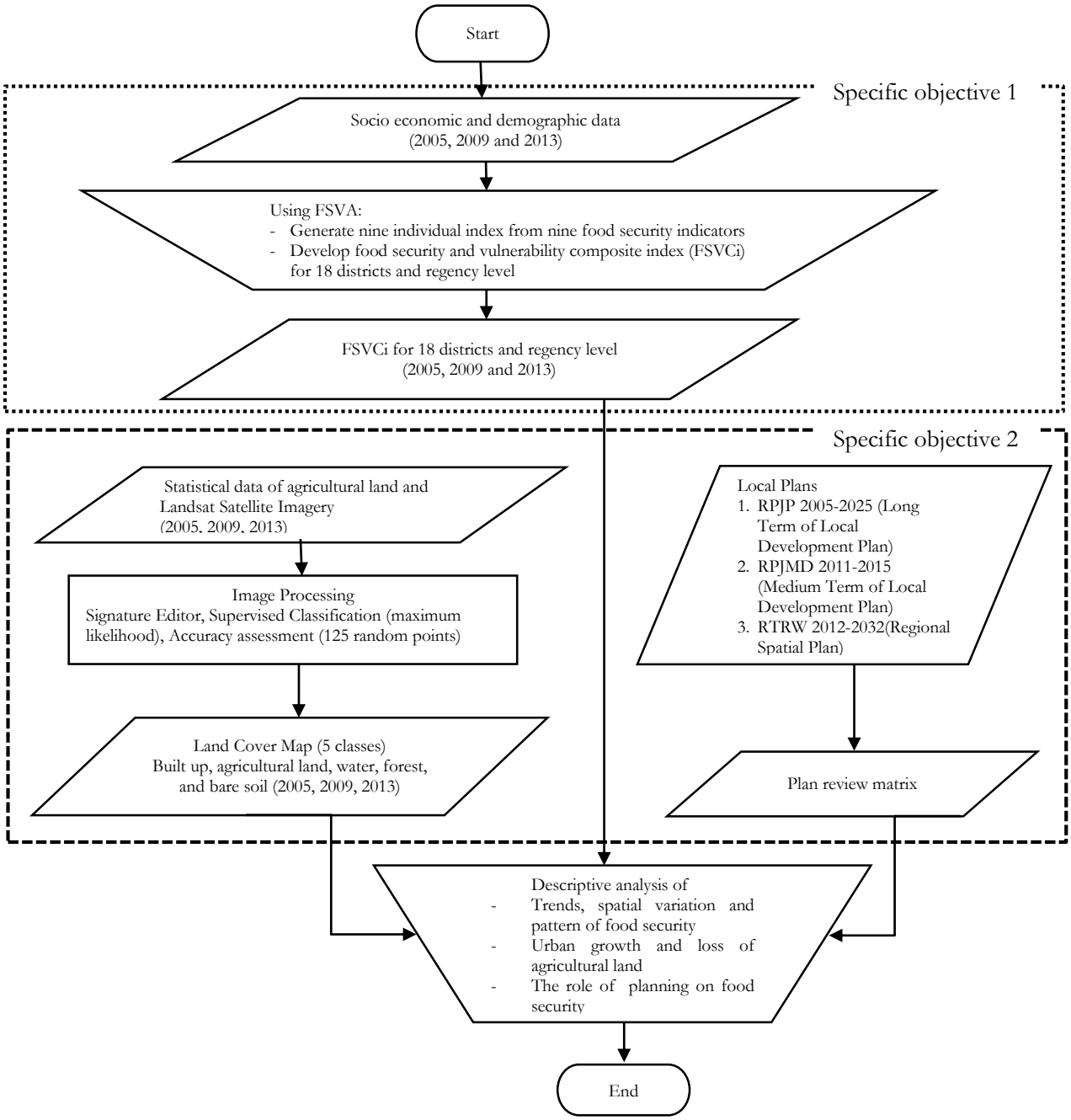

Figure 5. Methodological flowchart

4. RESULTS

4.1. The trend of food security in Mojokerto Regency

The trend of food security in Mojokerto Regency based on food security and vulnerability composite index (FSVCi). Food security and vulnerability composite index of Mojokerto Regency was generated using food security and vulnerability analysis (FSVA) approach. There were 3 dimensions and nine indicators of food security were used to generate FSVCi both at district and regency level.

Food Availability

Food availability based on indicator value of normative cereal consumption ratio per capita per day of net availability of rice+ maize + cassava + sweet potato (Z1)
This calculation based on domestic cereal production since there is no data for commercial import and food aid at district level or regency level.
If Z1 shows value >1.00, it means the area was consider as food insecurity area. On the contrary if Z1 shows value ≤1.00, it means food security area.

Table 3. Normative cereal consumption ratio per capita per day (Z1)

No	District	Z1 (Normative cereal consumption ratio per capita per day)					
		Food availability 2005 (Gram/capita/day)	Food availability 2009 (Gram/capita/day)	Food availability 2013 (Gram/capita/day)	Z1 2005	Z1 2009	Z1 2013
1	Jatirejo	1515.30	1721.82	1285.82	0.20	0.17	0.23
2	Gondang	2040.08	2226.05	2008.94	0.15	0.13	0.15
3	Pacet	2539.20	2879.40	2797.05	0.12	0.10	0.11
4	Trawas	2274.81	2133.99	1657.94	0.13	0.14	0.18
5	Ngoro	1656.87	795.78	811.07	0.18	0.38	0.37
6	Pungging	1089.03	1240.12	1007.93	0.28	0.24	0.30
7	Kutorejo	1240.40	1674.03	1615.48	0.24	0.18	0.19
8	Mojosari	716.50	653.88	564.93	0.42	0.46	0.53
9	Bangsal	753.99	827.98	788.29	0.40	0.36	0.38
10	Mojoanyar	980.75	1012.09	823.07	0.31	0.30	0.36
11	Dlanggu	2254.51	2148.92	1960.82	0.13	0.14	0.15
12	Puri	871.33	1035.78	1037.41	0.34	0.29	0.29
13	Trowulan	675.82	873.98	886.47	0.44	0.34	0.34
14	Sooko	345.27	357.22	333.32	0.87	0.84	0.90
15	Gedeg	147.98	282.39	162.50	2.03	1.06	1.85
16	Kemlagi	1194.60	1071.85	806.27	0.25	0.28	0.37
17	Jetis	896.59	625.81	639.36	0.33	0.48	0.47
18	Dawarblandong	1720.91	2695.57	2029.95	0.17	0.11	0.15

From table 3 it can be seen that food availability increased in 12 districts from 2005 to 2009 but decreased for the rest 6 districts. This situation changed from 2009 to 2013. Only 4 districts (Ngoro, Puri, Trowulan and Jetis) increased their food availability.

A better condition of district related to Z1 if a district has value of Z1 lower than other districts. From table 3, it can be seen that in 2005, Pacet district was the district with lowest value of Z1 (0.12). It means district of Pacet has normative cereal consumption ratio per capita per day of net availability of rice, maize, cassava and sweet potato better than other district. On the other hand, at the same time Gedeg district was the district with the highest value of Z1 (2.03). It means Gedeg district was the district with the lowest of normative cereal consumption ratio per capita per day of net availability of rice, maize, cassava and sweet potato and consider as a district insecure of food security than other districts. It due to many areas that should be planted for cereal production were used to non-cereal production especially sugar cane. It due to there is a factory for sugar production in Gedeg district namely P.G.Gempolkerep.

The condition remained the same in 2009, even though Z1 value of Gedeg District decreased significantly (almost half) from 2009. In 2013, almost all districts increased their Z1 value except Ngoro District (decreased) and Trowulan District (remain stable). District of Pacet was still considered as district with the lowest value for Z1 meanwhile Gedeg District was the highest (nearly double its value in 2009).

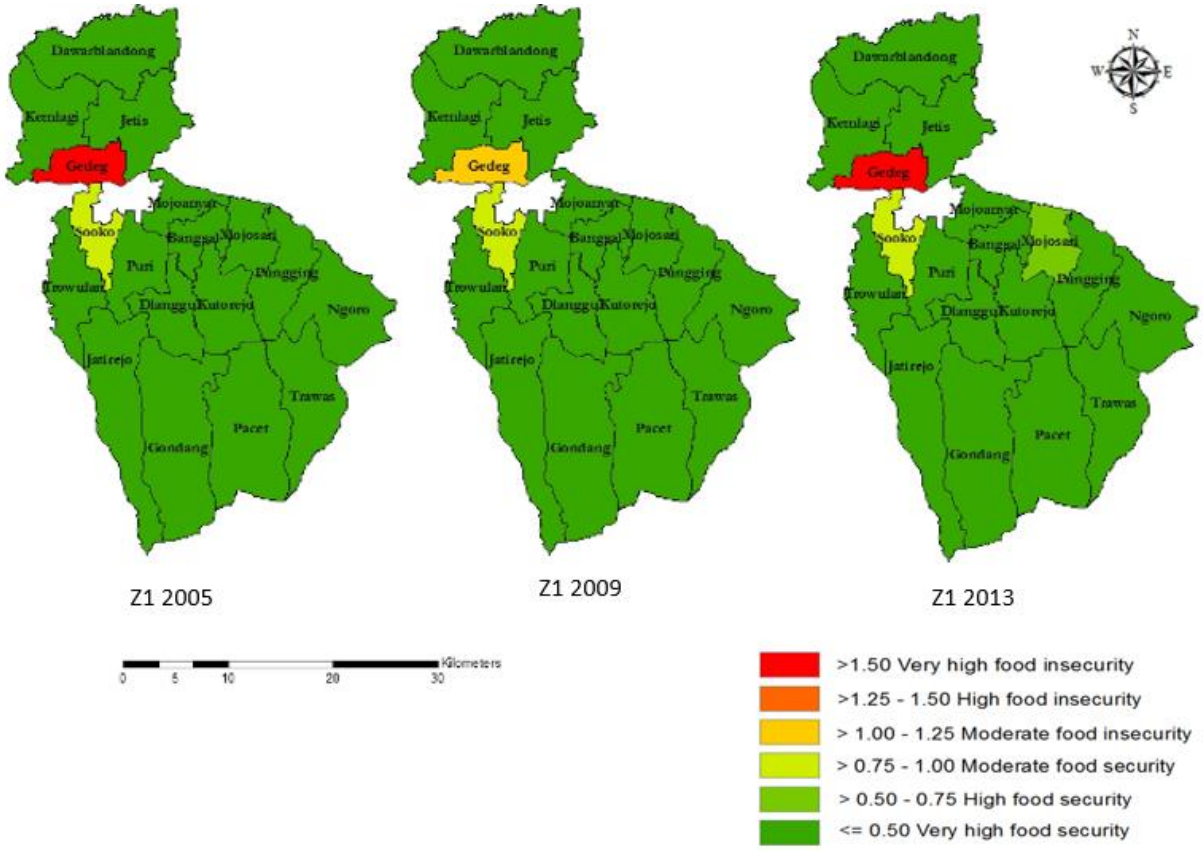

Figure 6. Spatial pattern of normative cereal consumption ratio per capita per day (Z1)

From the figure 6, it can be seen that there was spatial pattern based on value of Z1. Districts that have higher value of Z1 than others located in the middle of the area of Mojokerto Regency. In 2005, districts in Mojokerto Regency were classified in to three classes (Very high insecurity (1 district), moderate food security (1 district) and very high food security (16 district). A district was changed its classification from very high food insecurity in to moderate food insecurity in 2009. Little change occurred in 2013. Districts were classified in to four classes in 2013 (Very high insecurity (1 district), moderate food security (1 district), high food security (1 district) and very high food security (15 district).There were three districts (Gedeg, Sooko and Mojosari) that have value of Z1 higher than others. Those three districts were residential areas and considered as top three districts with the highest population (see appendix E). Gedeg and Sooko have direct border with Mojokerto Municipality which is consider as centre of business development. Similar situation can be seen in Mojosari District. It is known as capital city of Mojokerto Regency and as centre of business development too.

Table 4. Normative cereal consumption ratio per capita per day Z1 at regency level

No	Regency	Z1 (Normative Cereal Consumption ratio per Capita per Day)					
		Food availability 2005 (Gram/capita/day)	Food availability 2009 (Gram/capita/day)	Food Availability 2013 (Gram/capita/day)	Z1 2005	Z1 2009	Z1 2013
1	Mojokerto	1203.98	1234.91	1098.90	0.25	0.24	0.27

At regency level (table 4), normative cereal consumption ratio per capita per day of net availability of rice + maize + cassava and sweet potato (Z1) was slightly decreased from 1203.98 (g/c/d) in 2005 to 1234.91 (g/c/d) in 2009. In the 2013, cereal availability per capita per day dropped for about 11 % (from 1234.9 (g/c/d) to 1098.90 (g/c/d) respectively).

In addition, the population was increased from 2005 to 2009 (from 933.340 to 1.070.579) and continue increased from 1.070.579 (2009) to 1.162.630 (2013). It means, from 2005 to 2009 food production increased. As a result, value of Z1 slightly decreased (It means Z1 in 2009 better than in 2005) even though the number of population inclined. Meanwhile, in 2013 Z1 condition worse than in 2009. The value of Z1 increased due to population growth faster than food production.

Food Access

There are three indicators related to food access, namely percentage of household below poverty line (Z2), percentage of villages with inadequate road infrastructure (Z3) and percentage household without access to electricity (Z4).

If the percentage of household below poverty line (Z2) shows value >20%, it means the area was consider as food insecurity area. On the contrary if Z2 value $\leq$20%, it means food security area.

Table 5. Percentage of household below poverty line (Z2)

No	District	Total Household in a district			Household below Poverty line			Percentage of Household Below Poverty Line (%)		
		2005	2009	2013	2005	2009	2013	2005	2009	2013
1	Jatirejo	10713	12209	14745	3031	3277	2428	28.29	26.84	16.47
2	Gondang	11649	12490	15070	3166	2974	2918	27.18	23.81	19.36
3	Pacet	16096	17405	20390	3947	2959	2647	24.52	17.00	12.98
4	Trawas	8377	8921	10271	993	699	311	11.85	7.84	3.03
5	Ngoro	19497	22793	26658	2543	3161	2845	13.04	13.87	10.67
6	Pungging	20275	21803	25169	2687	2531	2241	13.25	11.61	8.90
7	Kutorejo	15450	17854	21495	3581	3291	3483	23.18	18.43	16.20
8	Mojosari	19733	22187	25968	1633	1633	1411	8.28	7.36	5.43
9	Bangsal	13878	14741	18820	1033	976	599	7.44	6.62	3.18
10	Mojoanyar	12765	13869	17601	1190	1132	567	9.32	8.16	3.22
11	Dlanggu	13680	15998	24600	2431	2402	2340	17.77	15.01	9.51
12	Puri	18649	20206	25377	2234	2391	2014	11.98	11.83	7.94
13	Trowulan	17267	21555	23917	3941	3431	3141	22.82	15.92	13.13
14	Sooko	18048	19884	20277	3018	3233	2870	16.72	16.26	14.15
15	Gedeg	12957	17919	19637	2260	2178	2313	17.44	12.15	11.78
16	Kemlagi	15136	17056	17093	5575	4970	4947	36.83	29.14	28.94
17	Jetis	21063	24468	28658	4002	3535	3143	19.00	14.45	10.97
18	Dawarblandong	14408	15153	16240	5184	4576	5193	35.98	30.20	31.98

Table 5. Describes that almost all districts experienced fluctuation in number of household below poverty line over three different years (2005, 2009 and 2013) (2005, 2009 and 2013). In term absolute number Pacet district was the district that has experienced the largest decline in the number of household below poverty line over three different years (2005, 2009 and 2013). By contrast, Ngoro district was the district has experienced the largest incline three different years (2005, 2009 and 2013). Trawas district was considered as district with smallest number of household below poverty line over three different years (2005, 2009 and 2013), meanwhile Dawarblandong was the highest.

In term of percentage, Jatirejo was the district with significantly decreased over three different years (2005, 2009 and 2013) (11.82%). Meanwhile, Ngoro and Dawarblandong districts were considered as top two district with small reduction in number of household below poverty line (2.85%, 4%) respectively.

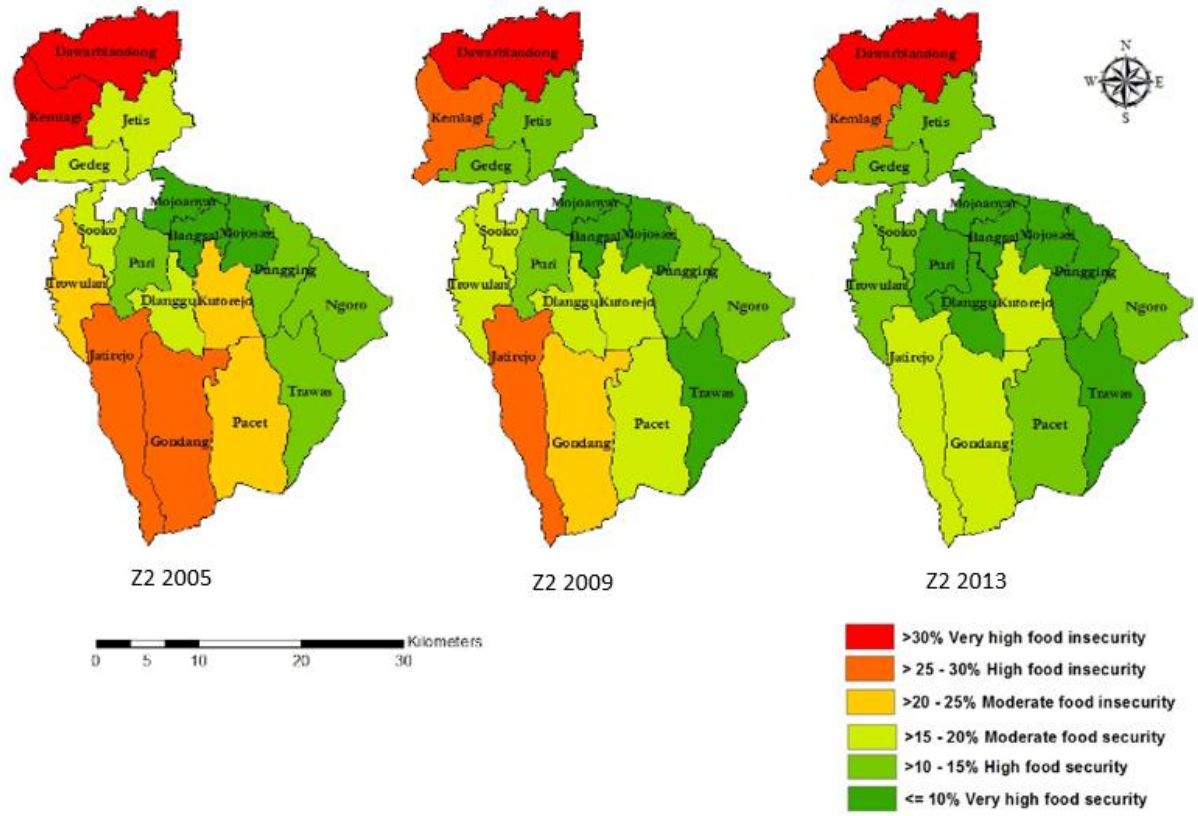

Figure 7. Spatial pattern of household below poverty line (Z2)

Table 5 shows that almost all districts decreased the percentage of household below poverty line in three different year (2005, 2009 and 2013) with exception of Kemlagi and Dawarblandong Districts.

From the figure 7, it can be seen, a district was experienced very high food insecurity located on northern part of Mojokerto Regency in three different year. Moreover, a district was classified as high food security over three different years (2005, 2009 and 2013) (2005, 2009, and 2013). Situated on east part of Mojokerto Regency. In addition, three districts located in the middle of Mojokerto regency were classified as very high food security over three different years (2005, 2009 and 2013).

Related to the percentage, trend and variation, and spatial pattern of villages with inadequate road network for minimum four wheel vehicles (poor road infrastructure) (Z3), all villages in all districts in Mojokerto Regency have been connected with the road that passable four wheeled vehicles.

For the percentage, trend and variation, and spatial pattern of household without access to electricity (Z4), all households in all districts have access to electricity.

There are no spatial patterns for Z3 and Z4 due to they have same value for all districts.

Table 6. Percentage of household below poverty line (Z2) at regnecy level

No	Regency	Total Household in a district			Household below Poverty line			Percentage of Household below poverty line Z2 (%)		
		2005	2009	2013	2005	2009	2013	2005	2009	2013
1	Mojokerto	279641	316511	371986	52449	49349	45411	19.16	15.92	12.66

Overall, from 2005 to 2009, households lived in poverty was decreased by 3.42%. The condition even better in 2013, poverty was decreased by 3.26%.

Even though at regency level the percentage of household live in poverty less than 20% in 2005, there were 7 districts (38% of total districts) have percentage of household live in poverty more than 19%. Furthermore, in 2013, there were 8 districts have percentage of poverty above at regency level. In addition, more than 30% of them were lived in the north part of Mojokerto Regency.

Food utilization

Food utilization is determined by five indicators value, percentage of infant mortality (Z5), percentage of Children underweight (Z6), percentage of women who are illiterate (Z7), percentage of household without access to clean water (Z8), percentage of household who live more than 5 km from the health facilities (Z9).

If the percentage of infant mortality (Z5) shows value >45%, it means the area was consider as food insecurity area. On the contrary if Z5 value $\leq$45%, it means food security area.

Table 7 describes that all districts decreased the number of infant mortality from 2005 to 2009. Meanwhile, from 2009 to 2013, there have been increasing value of infant mortality in 5 districts. From the table 7, it shows that Kemlagi (in 2005), Jatirejo (in 2009 and 2013) became districts with the highest percentage of infant mortality (Z5). In 2013, varied for each district. More than half of them decreased (11 districts), 7 districts increased and one district remain stable. In 2013, Jatirejo was considered as district with the highest value of infant mortality (Z5) meanwhile Bangsal was the lowest.

In term of absolute number of infant mortality, Kemlagi and Trowulan districts were considered as districts that have experienced the greatest decrease in number of infant mortality.

Table 7. Percentage of infant mortality (Z5)

No	District	Total New born in a district			New born Who are die			Z5 (%)		
		2005	2009	2013	2005	2009	2013	Z5 2005	Z5 2009	Z5 2013
1	Jatirejo	730	833	701	18	7	11	2.47	0.84	1.57
2	Gondang	673	716	894	12	1	5	1.78	0.14	0.56
3	Pacet	769	885	884	11	7	5	1.43	0.79	0.57
4	Trawas	388	430	396	6	0	1	1.55	0.00	0.25
5	Ngoro	1146	1185	1155	22	1	7	1.92	0.08	0.61
6	Pungging	1142	1188	1132	22	6	5	1.93	0.51	0.44
7	Kutorejo	825	933	912	18	4	6	2.18	0.43	0.66
8	Mojosari	1113	1382	1212	17	7	4	1.53	0.51	0.33
9	Bangsal	694	775	857	7	6	0	1.01	0.77	0.00
10	Mojoanyar	566	867	686	11	5	1	1.94	0.58	0.15
11	Dlanggu	791	827	821	16	4	1	2.02	0.48	0.12
12	Puri	1128	1086	1019	12	6	6	1.06	0.55	0.59
13	Trowulan	1250	1185	1085	23	4	2	1.84	0.34	0.18
14	Sooko	789	946	1186	7	2	3	0.89	0.21	0.25
15	Gedeg	849	936	894	16	6	5	1.88	0.64	0.56
16	Kemlagi	812	1028	882	22	7	1	2.71	0.68	0.11
17	Jetis	1218	1231	1247	18	2	4	1.48	0.16	0.32
18	Dawarblandong	631	750	733	12	6	2	1.90	0.80	0.27

There was no spatial pattern for Z5 because all of districts were classified in to one class (very high food security)

Table 8. Percentage of infant mortality (Z5) at regency level

No	Regency	Total New borns in a district			New borns Who are died			Z5 (%)		
		2005	2009	2013	2005	2009	2013	2005	2009	2013
1	Mojokerto	15514	17183	16696	270	81	69	1.74	0.47	0.41

Overall, the percentage of infant mortality at regency level was declined in three different year (2005, 2009 and 2013). It was only 1.74% in 2005 and even better in the 2009 and 2013 by decreasing for about 1.30% in 2009 and slightly decreased in 2013.

If the percentage of children underweight (Z6) shows value >15%, it means the area was consider as food insecurity area. On the contrary if Z6 value ≤15%, it means food security area.

Table 9. Percentage of children underweight (Z6)

No	District	Total children in a district			Total children underweight			Z6 (%)		
		2005	2009	2013	2005	2009	2013	2005	2009	2013
1	Jatirejo	2362	2888	3015	69	86	49	2.92	2.98	1.63
2	Gondang	2273	2872	2748	73	101	18	3.21	3.52	0.66
3	Pacet	2812	4802	3452	47	53	61	1.67	1.10	1.77
4	Trawas	1258	1284	1470	29	24	7	2.31	1.87	0.48
5	Ngoro	3538	4559	4948	130	87	93	3.67	1.91	1.88
6	Pungging	3759	4367	4430	113	133	117	3.01	3.05	2.64
7	Kutorejo	4713	3719	4103	136	105	64	2.89	2.82	1.56
8	Mojosari	4466	4683	3987	48	98	60	1.07	2.09	1.50
9	Bangsal	2482	2551	3105	68	62	40	2.74	2.43	1.29
10	Mojoanyar	2354	2909	2954	34	55	26	1.44	1.89	0.88
11	Dlanggu	3056	3040	3444	173	33	19	5.66	1.09	0.55
12	Puri	3379	3810	2962	86	53	52	2.55	1.39	1.76
13	Trowulan	2410	4710	5359	52	117	53	2.16	2.48	0.99
14	Sooko	3698	4240	4815	111	97	48	3.00	2.29	1.00
15	Gedeg	3317	3570	3950	123	139	80	3.71	3.89	2.03
16	Kemlagi	3278	4079	3678	153	95	44	4.67	2.33	1.20
17	Jetis	4950	5432	6331	142	59	45	2.87	1.09	0.71
18	Dawarblandong	2846	2928	3133	176	64	31	6.18	2.19	0.99

Table 9 illustrates the trend and variation of children underweight (Z6) in 18 districts for three years (2005, 2009 and 1013). It describes that in 2005 there were 2 districts (Dawarblandong and Dlanggu) with the number of children underweight higher than other districts. In 2009, Dlanggu remarkably became top 2 districts with lowest number of children underweight. Meanwhile Gedeg and Pungging Districts were the districts with higher s in 2009. In 2013, only Pungging district was the district with the highest number of children underweight. In addition, Pungging was considered as a district with slightly changed in number of children underweight Meanwhile, Dlanggu district was considered as the most successful district in reducing the number of children underweight.

There was no spatial pattern for Z6 due to all districts were classified in to one class (Very high food security)

Table 10. Percentage of children underweight (Z6) at regency level

No	Regency	Total children in a district			Total children underweight			Z6 (%)		
		2005	2009	2013	2005	2009	2013	2005	2009	2013
1	Mojokerto	56951	66443	67884	1763	1461	907	3.10	2.20	1.34

In 2005, the percentage of children underweight was 3% in regency level. The percentage of children underweight was decreased for about 0.9% in 2009 and for about 0.865 in 2013. There were 5 districts that had value more than at regency level in 2005 and became 8 districts in 2013. Even though there were

decreasing in percentage of children underweight in regency level, the number of district with value more than regency level increased.

If the percentage of women who are illiterate (Z7) shows value >20%, it means the area was consider as food insecurity area. On the contrary if Z7 value ≤20%, it means food security area.

Table 11. Percentage of women who are illiterate (Z7)

No	District	Total women in a district			Total women Who are illiterate			Z7 (%)		
		2005	2009	2013	2005	2009	2013	2005	2009	2013
1	Jatirejo	18709	20216	22375	2385	2089	2414	13	10	11
2	Gondang	18883	20710	22436	2051	1936	2147	11	9	10
3	Pacet	25194	27662	29979	3562	3790	3855	14	14	13
4	Trawas	13615	14677	15869	1279	1432	1955	9	10	12
5	Ngoro	32807	38180	41778	5734	6025	6120	17	16	15
6	Pungging	32966	35966	39157	3415	3595	3786	10	10	10
7	Kutorejo	27561	29739	32816	2981	3034	3186	11	10	10
8	Mojosari	30938	37440	40228	2354	2553	2699	8	7	7
9	Bangsal	21778	24355	26370	1974	2292	2439	9	9	9
10	Mojoanyar	22494	24056	25786	1658	1769	2042	7	7	8
11	Dlanggu	24007	27198	29366	2357	2620	2408	10	10	8
12	Puri	30232	35458	39411	1986	1951	2305	7	6	6
13	Trowulan	30730	35568	39303	2988	3534	3364	10	10	9
14	Sooko	29715	36107	39168	1792	1950	2036	6	5	5
15	Gedeg	26253	29812	30769	1863	2117	2390	7	7	8
16	Kemlagi	27286	29201	31374	4128	4384	4580	15	15	15
17	Jetis	34362	40528	43855	3712	3607	3933	11	9	9
18	Dawarblandong	23806	25591	27545	3392	3328	3644	14	13	13

Related to the trend and variation of women who are illiterate (Z7) in percentage , from table 11 can depict that in 2005, Ngoro and Kemlagi were consider as top two district with the highest percentage of female illiteracy. The condition remained the same in 2009 and 2013. Meanwhile, sooko was considered as district with the smallest percentage of female illiteracy over three different years (2005, 2009, and 2013).

Overall percentage and trend of women who are illiterate in all districts remain stable and slight fluctuated over three different years (2005, 2009, and 2013). Only Trawas District slightly increased over three different years.

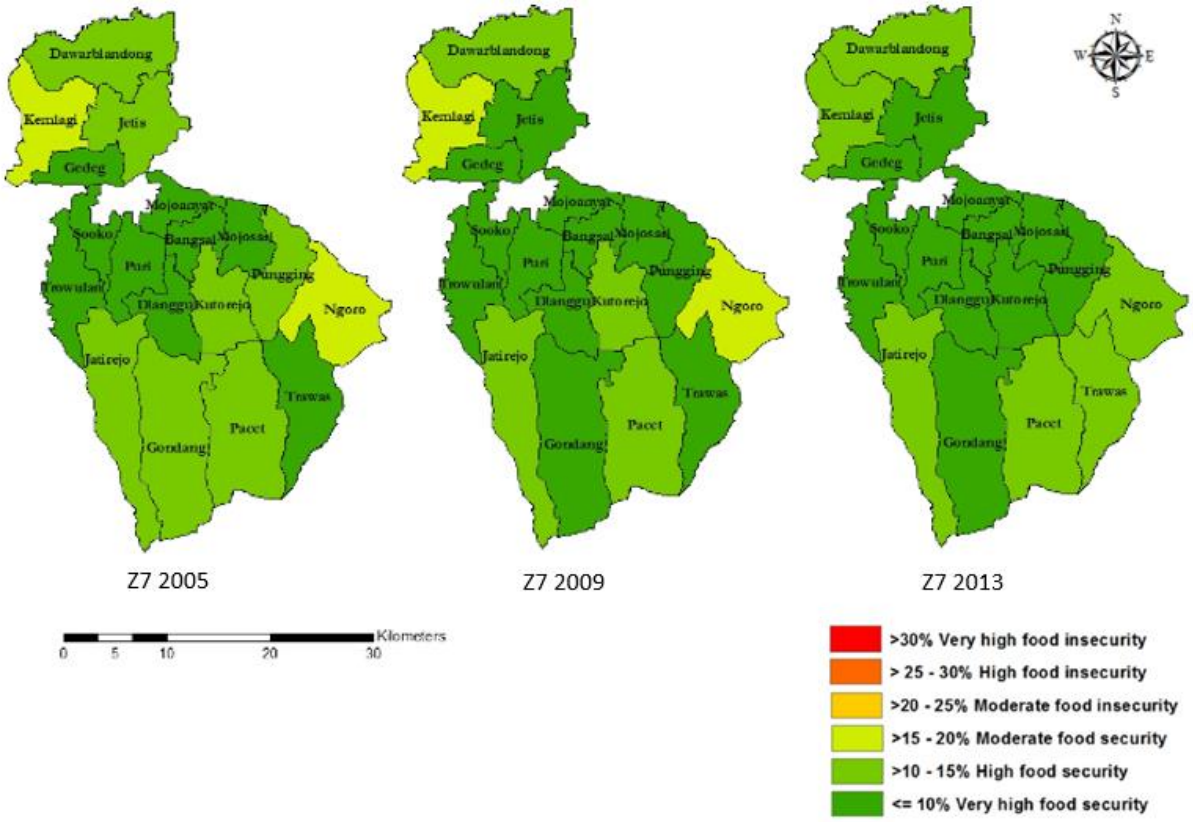

Figure 8. Spatial pattern of women who are illiterate (Z7)

From the figure 8, it can be seen that the highest value of Z7 located in Northwest and southeast part of Mojokerto regency (for 2005 and 2009) whilst in 2013 remained the same with only plus one district in southwest part of Mojokerto Regency.

Table 12. Percentage of women who are illiterate (Z7) at regency level

No	Regency	Total women in a district			Total women Who are ileterate			Z7 (%)		
		2005	2009	2013	2005	2009	2013	2005	2009	2013
1	Mojokerto	471336	532464	577585	49611	52006	55303	11	10	10

In 2005, the percentage of female illiteracy was 11%. The percentage slightly decreased for only about 1% in 2009 and remain stable in 2013. There were 5 districts with percentage more than 11% in 2005. Moreover, in 2009 only three districts had percentage more than 10%. Meanwhile, in 2013 the number of district with percentage more than 10% became 6 districts.

If the percentage of household without access to clean water (Z8) shows value >50%, it means the area was consider as food insecurity area. On the contrary if Z6 value ≤50%, it means food security area.

Table 13. Percentage of household without access to clean water (Z8)

No	District	Total Household in a district			Total Household without access to clean water			Z8 (%)		
		2005	2009	2013	2005	2009	2013	2005	2009	2013
1	Jatirejo	10713	12209	14745	1352	1671	2422	12.62	13.69	16.43
2	Gondang	11649	12490	15070	0	0	0	0.00	0.00	0.00
3	Pacet	16096	17405	20390	895	785	701	5.56	4.51	3.44
4	Trawas	8377	8921	10271	0	0	0	0.00	0.00	0.00
5	Ngoro	19497	22793	26658	2965	3284	4180	15.21	14.41	15.68
6	Pungging	20275	21803	25169	4095	4877	3405	20.20	22.37	13.53
7	Kutorejo	15450	17854	21495	2978	4019	4277	19.28	22.51	19.90
8	Mojosari	19733	22187	25968	3284	4892	1927	16.64	22.05	7.42
9	Bangsal	13878	14741	18820	1931	2311	5258	13.91	15.68	27.94
10	Mojoanyar	12765	13869	17601	1393	1393	2051	10.91	10.04	11.65
11	Dlanggu	13680	15998	24600	1186	1178	2849	8.67	7.36	11.58
12	Puri	18649	20206	25377	1025	0	2151	5.50	0.00	8.48
13	Trowulan	17267	21555	23917	1659	2073	2067	9.61	9.62	8.64
14	Sooko	18048	19884	20277	1173	1294	1927	6.50	6.51	9.50
15	Gedeg	12957	17919	19637	675	697	2114	5.21	3.89	10.77
16	Kemlagi	15136	17056	17093	1032	1125	3905	6.82	6.60	22.85
17	Jetis	21063	24468	28658	1457	1569	1639	6.92	6.41	5.72
18	Dawarblandong	14408	15153	16240	2478	2513	3058	17.20	16.58	18.83

From the table 13, it can be seen that Pungging was considered as a district with the highest value of household without access to clean water in 2005. In 2009, Kutorejo was district with the highest value of Z8 followed closely by Pungging district. In 2013, Bangsal district was recorded as a district with the highest value of Z8. By contrast, Gondang and Trawas were district with the lowest value of Z8 over three different years (2005, 2009 and 2013). Pungging, Kuterojo and Bangsal districts were considered as district with the highest value of Z8 in three different year (2005, 2009 and 2013 respectively.

The trend of Z8 slightly fluctuated over three different years (2005, 2009, and 2013) with some exception of Mojosari, Bangsal, Puri, Gedeg and Kemlagi.

There was no spatial pattern for Z8 since all districts were classified into one class (very high food security)

Table 14. Percentage of household without access to clean water (Z8) at regency level

No	Regency	Total Household in a district			Total Household without Acces to clean water			Z8 (%)		
		2005	2009	2013	2005	2009	2013	2005	2009	2013
1	Mojokerto	279641	316511	371986	29578	33681	43931	11	11	12

There was 11% of household without access to clean water in 2005. The condition did not change in 2009 and slightly inclined in 2013 (12%).

Related to the percentage, trend and variation, and Spatial pattern of households who live more than 5 km from the health facilities (Z9), All Households in all districts in Mojokerto Regency were located within 5 km from health facilities, therefore there was no trend and variation, and spatial pattern of households who live more than 5 km from the health facilities.

Food security trend in Mojokerto Regency

Food security trend in Mojokerto Rgency based on FSVCi that was generated using three dimensions and nine indicators of food security.

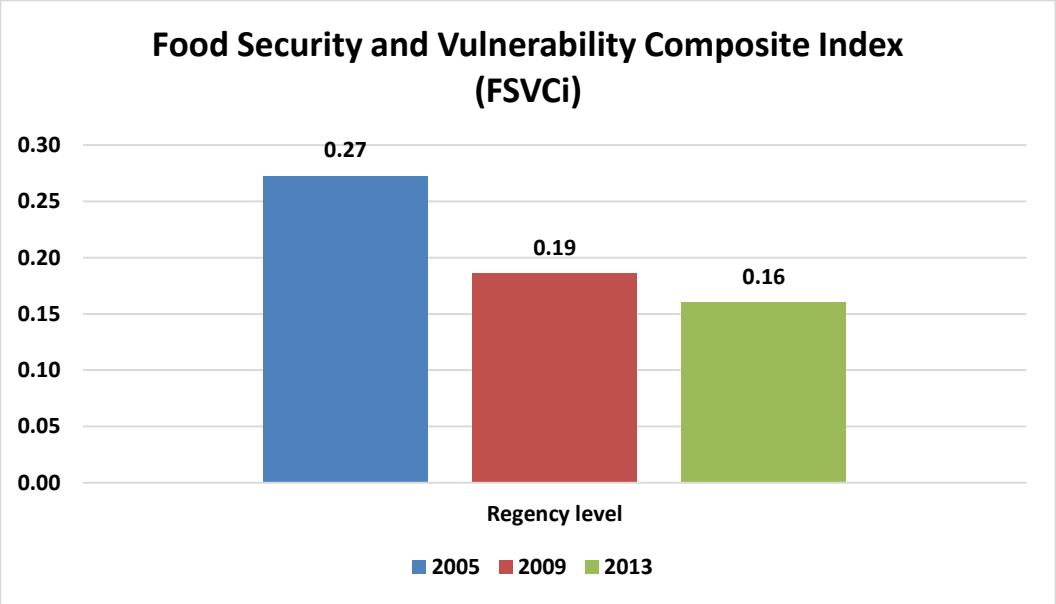

Figure 9. Food security and vulnerability composite index FSVCi at regency level

The graph (figure 9) illustrates that the trend of FSVCi decreased from 2005 (0.27) to 2009 (0.19) and continue decreased in 2013 (0.16). It means the vulnerability of food security decreased from 2005 to 2013 (The lower the index value means food security better/improve). Overall, FSVCi at Mojokerto Regency remain in the same level (High Food Security, FSVCi: >0.16-0.32) even though their FSVCi decreased from 2005 (0.27) to 2009 (0.19). In 2013, FSVCi was classified in the highest class of food security (Very high food security, FSVCi: ≤ 0.16).

4.2. Spatial variation and pattern of food security in Mojokerto Regency

Related to Food Security Composite Index (FSVCi) in 18 districts, from the table 15, it can be seen that Kemlagi (0.43) and Dawarblandong (0.45) districts were the top two districts with highest value of FSVCi (by factor more than four) from the lowest district (Puri, 0.16) in 2005.

Overall, All districts in Mojokerto Regency decreased their FSVCi from 2005 to 2009 furthermore 14 districts decreased from 2009 and 2013. Meanwhile three districts were increased and only one district remain stable.

One thing to keep in mind, the lowest value of FSVCi means the better condition of food security. If the index shows value >0.48, it means the area was consider as food insecurity area. On the contrary if the index ≤0.48%, it means food security area.

Table 15. Food security and vulnerability composite index (FSVCi) in 18 districts

No	District	FSVC Index (FSVCi)		
		2005	2009	2013
1	Jatirejo	0.36	0.27	0.25
2	Gondang	0.26	0.17	0.12
3	Pacet	0.26	0.19	0.16
4	Trawas	0.17	0.09	0.08
5	Ngoro	0.35	0.24	0.24
6	Pungging	0.30	0.24	0.19
7	Kutorejo	0.34	0.25	0.22
8	Mojosari	0.20	0.19	0.11
9	Bangsal	0.21	0.20	0.18
10	Mojoanyar	0.19	0.14	0.10
11	Dlanggu	0.31	0.14	0.10
12	Puri	0.16	0.08	0.12
13	Trowulan	0.27	0.19	0.13
14	Sooko	0.21	0.16	0.14
15	Gedeg	0.34	0.21	0.25
16	Kemlagi	0.43	0.28	0.30
17	Jetis	0.25	0.14	0.12
18	Dawarblandong	0.45	0.29	0.27

Classification of FSVCi:

1 > 0.80 Very high food insecurity

2. > 0.64 - 0.8 High food insecurity

3. > 0.48 - 0.64 Moderate food insecurity

4. > 0.32 - 0.48 Moderate food security

5. > 0.16 - 0.32 High food security

6. ≤ 0.16 Very High food security

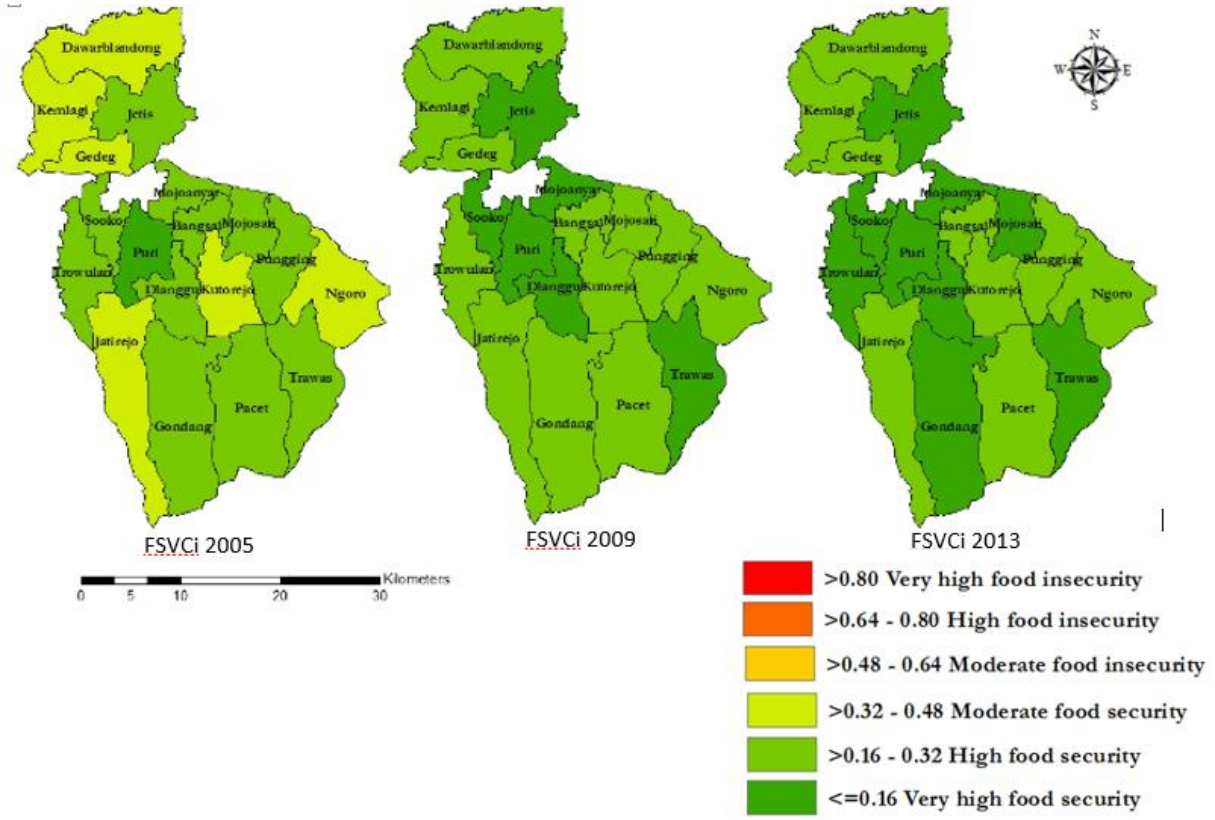

Figure 10. Spatial pattern of food security and vulnerability index (FSVCi)

From the table 15 and figure 10, it can be seen that all districts in Mojokerto Regency decreased their FSVCi from 2005 to 2009. Furthermore, more than 75% of districts (14 districts) were increased their FSCVi from 2009 to 2013) only four districts (Ngoro, Puri, Gedeg and Kemlagi) were increased their FSVCi in 2013. Dawarblandong District was the highest district in 2005 and 2009, meanwhile in 2013 Kemlagi District was the highest.

Figure 10 describes that six districts moved from moderate food security to high food security class and five districts have changed from high food security to very high food security from 2005 to 2009. From 2009 to 2013, there were three districts moved from high food security to very high food security. Puri was the only district that remain at the same class (Very high food security) over three different years (2005, 2009 and 2013).

4.3. The area that are most inscure of food security in Mojokerto Regency

The area which are insecure of food insecurity similar in three different year. In 2005, Dawarblandong, and Kemlagi were the two top district with the highest value of FSVCi. The condition remained the same in 2009 and 2013. One interesting point was both districts located in the north part of Mojokerto Regency.

Kemlagi district was consider as an area that need more attention based on value of FSVCi in 20013. FSVCi of kemlagi district is 30. It nearly reached the highest cut off point of high food security level, 32. Population in Kemlagi district in 2013 is 62795 inhabitans. Kemlagi district consider as an area that should get more

attention in access to clean water (Z8), woman who are illiterate (Z7) and household below poverty line (Z2).

Dawarblandong with 54660 inhabitants was in second place need attention due to its value of FSVCi is 27. Household below poverty line (Z2) is consider as first priority to get more attention followed by woman who are illiterate (Z7) and access to clean water (Z8).

4.4. The trend in loss of agricultural land and urban growth in Mojokerto Regency

Loss of agricultural land trend

Based on statistical data, the trend and variation of agricultural land in 18 districts can be seen in table 16.

Table 16. The absolute amount of Agricultural land (ha) in three different year (2005, 2009 and 2013)

Distric	Area	Absolute amount of Agricultural land					
		2005		2009		2013	
	(Ha)	Ha	%	Ha	%	Ha	%
Jatirejo	8528	2182	25.59	2178	25.54	2178	25.54
Gondang	11360	2237	19.69	2237	19.69	2135	18.79
Pacet	9852	2913	29.57	2913	29.57	2848	28.91
Trawas	6608	777	11.76	777	11.76	777	11.76
Ngoro	6917	1295	18.72	1295	18.72	1293	18.69
Pungging	4485	2543	56.70	2543	56.70	2405	53.62
Kutorejo	4639	2660	57.34	2660	57.34	2660	57.34
Mojosari	3050	1559	51.11	1539	50.45	1539	50.45
Bangsal	2378	1506	63.32	1506	63.32	1506	63.32
Mojoanyar	2485	1491	60.01	1491	60.01	1491	60.01
Dlanggu	3744	2575	68.78	2573	68.73	2573	68.73
Puri	3789	2351	62.05	2351	62.05	2250	59.38
Trowulan	4656	2469	53.02	2469	53.02	2469	53.02
sooko	2502	1334	53.31	1269	50.71	1256	50.19
Gedeg	2668	1638	61.40	1635	61.29	1600	59.97
Kemlagi	5860	2610	44.54	2610	44.54	2610	44.54
Jetis	6078	2602	42.81	2601	42.80	2519	41.45
Dawarbalndong	8144	2434	29.89	2434	29.89	2434	29.89

Table 16 describes that there was slight change from 2005 to 2009. Agricultural land decreased in 6 of 18 districts. Meanwhile from 2009 to 2013 half of districts experienced decline in the number of agricultural land area. Overall, more than half of districts in Mojokerto Regency decreased their agricultural land from 2005 to 2013. Pungging was considered as district with the highest loss of agricultural land (138 ha).

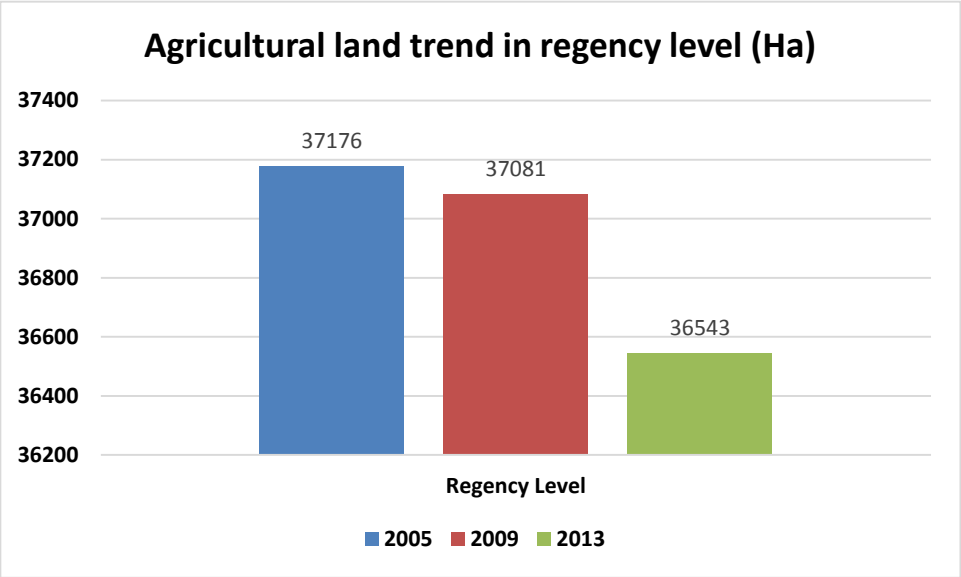

Figure 11. Agricultural land at regency level

Meanwhile at regency level (figure 11) agricultural land trend declined over three different years (2005, 2009 and 2013). It was slight decreased (95ha) from 2005 to 2009. Sooko district was considered as district with the highest number of loss agricultural land (65ha). In the second period (from 2009 to 2013), more than 600 ha of agricultural land was lost in Mojokerto Regency. There were three districts (Pungging, Gondang and Puri) have loss of agricultural land more than 100 ha (138 ha, 102ha and 101ha respectively).

Urban growth trend

Urban growth trend based on land cover map that generates from Landsat satellite imagery in three different year (2005, 2009 and 2013).

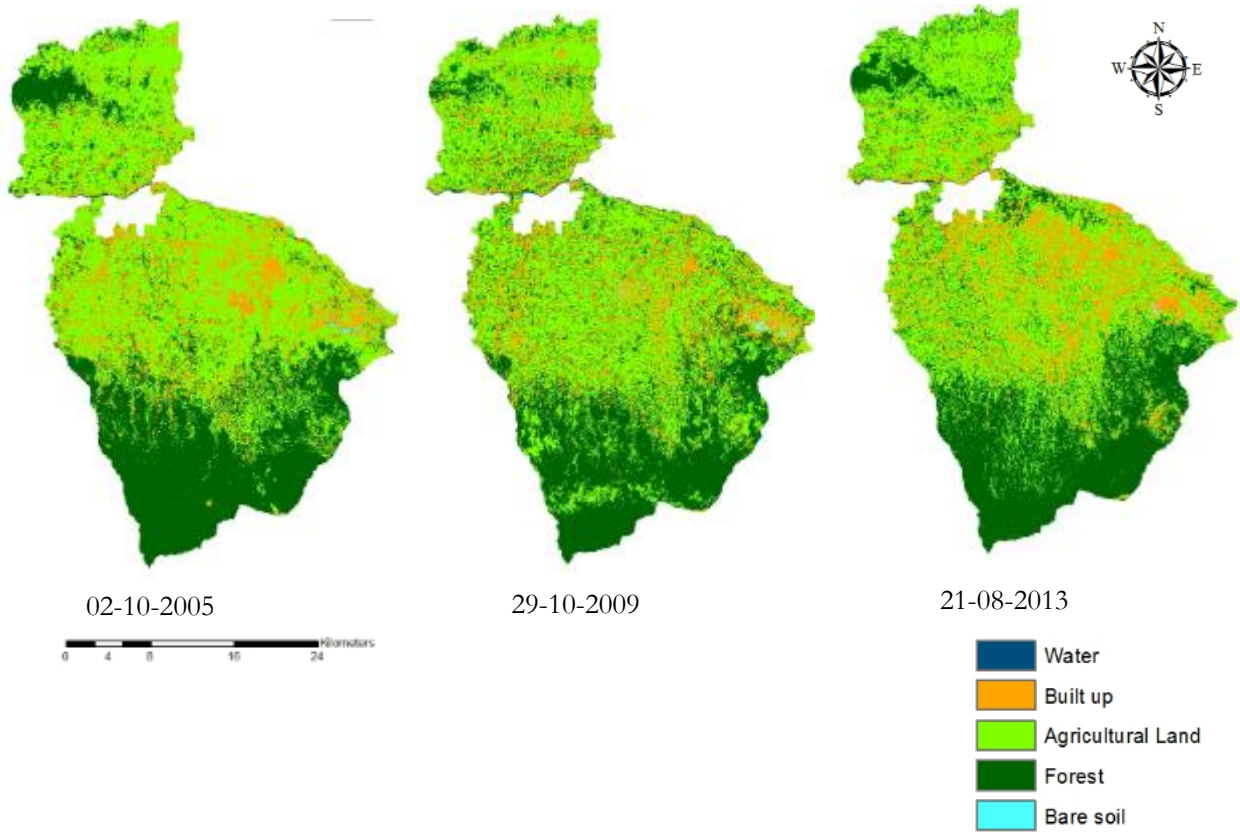

Figure 12. Land cover map

Table 17. Land cover area

Class	2005		2009		2013	
	Ha	%	Ha	%	Ha	%
Water	257	0.3%	284	0.3%	159	0.2%
Built up	14372	14.7%	14922	15.3%	15846	16.2%
Agricultural Land	48493	49.6%	48213	49.3%	47713	48.8%
Forest	34415	35.2%	34024	34.8%	33941	34.7%
Bare soil	206	0.2%	300	0.3%	85	0.1%
Total	97743	100.0%	97743	100.0%	97743	100.0%
Overall classification accuracy	73.6%		80.0%		81.6%	
Overall kappa statistics	0.67		0.75		0.77	

From table 17, it can be seen that the percentage of built up area was increased about 0.6% in the first period (2005-2009) and continued in the next period (2009 to 2013). Built up area was increased about one and half times than previous period (0.9%).

From the figure 12 it can be seen that the most area which has experienced urban growth located in the middle part and eastern part of Mojokerto Regency.

There is a difference about agricultural land between statistical data and data that generate from Landsat satellite imagery.

4.5. Food security consideration in planning

There are three plans have been reviewed in order to find out to what extend government concern to food security. Plans review based on three dimensions and nine indicators of food security.

Table 18. Plan review matrix

Plan	Dimensions								
	Availability	Accessibility			Utilization				
	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8	Z9
RPJPD (2005-2025)									
- Poverty reduction		√							
- Infrastructure development	√		√	√				√	√
- Increase agricultural production	√								
- Agricultural land protection	√								
- Water system management	√							√	
- Health					√	√		√	
- Education							√		
RPJMD Phase I (2006-2010)									
- Poverty reduction		√							
- Increase agricultural production	√								
- Infrastructure development	√		√	√				√	√
- Health					√	√		√	
- Education							√		
Phase II (2011-2015)									
- Poverty reduction		√							
- Increase agricultural production	√								
- Infrastructure development	√		√	√				√	√
- Agricultural land protection	√								
- Health					√	√		√	
- Education							√		
RTRW 2012-2032									
- Poverty reduction		√							
- Infrastructure development	√		√	√				√	√
- Agricultural sector as major concern for the next 20 years	√								
- Base of regional food production	√								
- Increase agricultural production	√								
- Agricultural land protection	√								
- Sustainable agricultural land	√								
- Water system management	√							√	

Z1 and Z2 are the indicators that have most attention in RPJPD plan document. Z3, Z4, and Z9 are in the second place. Meanwhile Z2 and Z7 in the third place.

RPJMD phase I concern to Z1, Z3-8. The plan were not explicitly explain about Z2, Z3 and Z9. All indicators have attention from government through RPJMD phase II. Z1 and Z8 are still as major concern.

RTRW highly correlated to spatial. Therefore, it does not have any concern to Z5-Z7. The most attention is given to Z1.

Related to first dimension of security (food availability), there were some programs in the plan documents that could improve food productivity. Those programs are agricultural land protection, infrastructure development and water system management (irrigation).

Three indicators of second dimension of food security (food accessibility) were stated in all plans. Meanwhile all indicators of the last dimensions of food security (food utilization) were stated in 2 plan documents (RPJP and RPJMD) and some of them (access to clean water and health facility) were stated in RTRW.

Overall, from table 18 it can be seen that all dimensions and indicators of food security were stated in all plans, actually those plans did not explicitly stated about food security. They were just as effect of other policy, such as poverty reduction, the main purpose is to increase prosperity but it also could contribute to food security.

Z1: Normative cereal consumption ratio per capita of net availability of rice+ maize + cassava + sweet potato.
Z2: Household below poverty line
Z3: Villages with inadequate road network for minimum four wheel vehicles
Z4: Household without access to electricity
Z5: Infant mortality
Z6: Children underweight
Z7: Women who are illiterate
Z8: Household without access to clean water
Z9: Households who live more than 5 km from the health facilities

5. DISCUSSION

5.1. The trend of food security in Mojokerto Regency

Food security in Mojokerto Regency was developed by three dimensions, namely food availability, food access and food utilization. Food availability in this regency is approached as a closed system. It means, food availability based on domestic cereal production only. Food availability from imports are not taken into account in this research due to: first at country level, Indonesia were considered as net exporter of food (FAO, 2015). Second, food stock held by Jawa Timur Province and Mojokerto Regency Government is more than the demand (Central Statistical Bureau of Jawa Timur Province, 2015; Central Statistical Bureau of Mojokerto Regency, 2015). The implication of those factors could strengthen food availability in Mojokerto Regency. It means Mojokerto Regency can increases its agricultural productivity (see appendix E).

Food availability determined by cereal production, population and normative cereal consumption per capita. Based on the result, even though there was an increased on cereal production from 2005 to 2009 but the trend showed decreased from 2009 to 2013. Meanwhile, population increase. This situation could lead to food insecurity due to population growth faster than food production.

The second dimensions is food access. There are two types of food access related to food security. First is physical access. Physical access is not consider as problem in the area of study since all district have good infrastructure related to road network. And access to the electricity. Have access to electricity is expected to trigger the creation of more economic activities that can increase people's incomes. Increasing in income is expected to reduce poverty. Furthermore, economic access to food will be increased. The second type of access is economic. The number of households who live in poverty was declined.

Increasing economic access has positive and negative impacts on food security index. The positive impact is the reduction of poverty that can leads to decrease the food security index. While the negative impact is the increasing of purchasing power will increase demand for food. If the demand for food cannot be met by food availability it will cause increasing the value of food availability indicator, which means contribute to increased food security index value. One thing to note, that a positive impact if the indicator could lower the index. The smaller an index value means the better conditions of food security.

The last dimensions of food security is food utilization. Food utilization based on five indicators: health facility, access to clean water, female illiteracy, infant mortality and children underweight. From the result, all households in all districts in Mojokerto Regency lived within 5 km from health facilities. The existing health facilities are expected to increase public health through provide information about health and encourage people to take benefits from health facilities. Meanwhile for access to clean water and female illiteracy have less positive contribution to food security due to their value remain stable over three different years.

Based on indicator value of food utilization, it can be seen that in general, food utilization has positive contribution to increase food security. Positive contribution came from the decline of the number infant mortality and children underweight. This shows that food utilization in proper way has a very important role during pregnancy and children growth period (UNICEF, 1990). This can only be achieved with the support of several factors. The first factor is the access to food, both physically and economically. The second factor is the information about health and access to health facilities. The third factor is the availability of food to be used appropriately based on the needs and health standards.

Food utilization in this research using five indicators which are infant mortality, children underweight, women who are illiterate, access to clean water, and household who live more than five kilometres. All of them are proxy indicators. Infant mortality is a proxy indicator for health status, meanwhile children underweight, women who are illiterate, access to clean water, and household who live more than five

kilometres are proxy indicators for individual food intake (particularly children). In this research, known that infant mortality decreased significantly in the last two years (2009 and 2013). As one of proxy indicator, it is not relevance any longer, due to very small percentage on its index. The same condition for children underweight, access to clean water, and household who live more than five kilometres.

FSVCi at Mojokerto Regency has improved over three different years (2005, 2009 and 2013). The FSVCi was developed using food security and vulnerability analysis based on three dimensions and nine indicators of food security (Minister of Agriculture, 2010). Food security in Mojokerto is better than at Jawa Timur (East Java) Province level.

Based on value of indictors in 2013, the value Z8 (Access to clean water) is lower for about 50% than at province level (Mojokerto: Regency: 11.8%, Province: 27.3%). For female illiteracy indicators (Z7) at Mojokerto was 9.6% whilst at province was 13.9%. Only for Z2 (poverty) value at Mojokerto regency has value similar to at province level (12.66, 12.73 respectively). Others value were slightly below province level (Dewan Ketahanan Pangan, 2015).

There have been different methods used to assess food security, but there is no gold standard for the analysis of food security. Wineman (2014) used three component of household food security, which are quantity (how much food is available for consumption), quality (diet diversity and nutritional adequacy) and stability (regularity of current food supply and security of future food supply) by building an index that spans the three dimensions using PCA methods. According to Barrett, (2010) if each indicator on composite index weighted equally it allows for an easy understanding. Complex weighting method e.g. using PCA might be justified theoretically but it is not easy to interpret the indices and their changes.

On the other side, Bashir, Naeem, & Niazi, (2010) calculated food security status by using the calorie intake method for a 7 days recall method of food consumption by the households was used. Food security was defined as daily per capita calories intake for Pakistan. It calls secure food security if it's up to 2450 kcal. This method has several limitations, a. very expensive, b. high level of potential miscalculation and measurement error, c. needed highly trained and very skilled personnel. Those disadvantages explain why dietary intake surveys no longer used by countries (Pérez-escamilla & Segall-Correa, 2008).

Several studies about food security also have been done in East Java Province Indonesia. In general, the study was used FSVA method. Three dimensions (availability, accessibility and utilisation) of FSVA Indonesia were used. The difference is the indicators that used.

Study have been done in 7 cities in East Java Province Indonesia. 2 indicators were used for availability. Meanwhile for accessibility and utilisation were used 6 indicators and 3 indicators respectively. All indicators were selected using principle component analysis. Vulnerability was not taking into account in analysis without any explanation (Hanani, 2009). In addition, another study has been done in Bangkalan regency east java province Indonesia. 10 indicators were used. Food availability, accessibility and utilisation were used 2, 3 and 6 indicators respectively. Vulnerability was not taking into account in analysis due to data availability (Suhartono, 2010).

Different indicators of dimensions of food security were selected in order to select indicators which are suitable for characteristic of the region. Based on this research, in addition there are two indicators (poor road infrastructure and access to electricity) also seems no longer relevant to use as indicators in Mojokerto Regency.

5.2. Spatial variation and pattern of food security in Mojokerto Regency

FSVCi in Mojokerto Regency was classified in to three different classes in 2005 namely moderate food security, high food security and very high food security. Meanwhile in 2009 and 2013 became two classes (high food security and very high food security). There was improvement in food security condition from 2005 to 2013. In 2005, only one district was classified as very high food security, 11 (61%) districts were categorized as high food security and 6 (33%) districts were grouped in moderate food security. In 2013 the

condition was changed significantly. There were 10 (55.56%) districts classified in to very high food security. Meanwhile 8 (44.44%) districts were classified as high food security. The spatial pattern of FSVCi disperse on the area of study (see figure10).

Food security status in Mojokerto Regency is better than at province level. Based on the result in 2013, all districts in Mojokerto Regency was classified into two classes (high food security and very high food security) meanwhile at province level food security level was classified into four classes (moderate food insecurity, moderate food security, high food security and very high food). (Dewan Ketahanan Pangan, 2015).

5.3. The area that are most insecure of food security

The condition of food security in Mojokerto Regency range from moderate to very high food security. The location of the lowest level of food security was similar over three different years.

In 2005, most of the area which has lower level of food security were located on the northern part of area study. The two top district with the highest value of FSVCi (worse) were Dawarblandong and Kemlagi Distrcis with value 0.45 and 0.43 respectively. Even though they were classified as moderate food security class, the value nearly reach minimum value of moderate food security class (>0.48-0.64). The rest were located spread in the middle of Mojokerto Regency (see figure 10).

The two top districts with highest of FSVCi (more insecure of food security) in 2005 are same with in 2009. Dawarblandong and Kemlagi were consider as more vulnerable districts than others. The different is the value of FSVCi decrease (better) than in 2005. Although they were considered as more vulnerable districts, they were classified as high food security (improve than in 2005).

Kemlagi and Dawarblandong were still as top two districts with the highest value of FSVCi in 2013. They only exchange their position. The value of FSVCi is also slightly change. However, they were remained in same class (high food security).

Based on the results, Dawarblandong and Kemlagi was the district with the highes value of food security and vulnerability composite index (FSVCi). Those two districts (Dawarblandong and Kemlagi) have to face similar problems, such as poverty, female illiteracy, and access to clean water. Those two districts located in less developed area due to far from city centre and central business development.

Previous study showed that household below poverty line, female illiteracy and access to clean water could lead to food insecurity (UNICEF, 1990;German WASH Network, 2011).

5.4. Trend of loss of agricultural land and urban Growth in Mojokerto Regency

Combination of statistical data and supported by land cover map proved useful to illustrate the trend of agricultural loss and urban growth in Mojokerto Regency.

From the statistical data it can be seen that the amount of agricultural land was decreased from 37.176 in 2005 to 37.081 in 2009. The trend was continued from 2009 to 2013. In this period, agricultural land lost more than five-fold, (from 37.081 in 2009 to 36543 in 2013. Pungging district was considered as a district with the highest loss of agricultural land.

Meanwhile population in Mojokerto was increased over three different years (2005, 2009 and 2013). Population was increased from 933.340 in 2005 to 1.070.579 in 2009 (3%). The population became

1.162.630 in 2013 (increased by 2%). However, the trend of population growth was slightly decreased by 1% from 2005-2009 to 2009-2013.

Furthermore, urban growth was detected increased over three different years (2005, 2009 and 2013). Urban growth was analysed based on land cover map that was generates from Landsat satellite imagery. This is proven the useful of land cover change detection to monitor urban growth (Kaufmann & Seto, 2001).

Using Landsat satellite imagery to generate information about urban growth also generate information about agricultural land. There is a difference about agricultural land between statistical data and data that generated from Landsat satellite imagery. There are two possibilities, first, based on accuracy Assessment report (see appendix F), there are error classification that could lead to miscalculation about agricultural land. Second, using different method (between using Landsat for LULC and institutional survey for statistical data by Central Statistical Bureau) to generate information about agricultural land.

Until this point, the relationship between urban growth and loss of agricultural land with food security in Mojokerto Regency cannot be concluded yet. This could be caused by several thing: First, indeed population, urban growth and loss of agricultural land increased. However, the annual rate of changes could be too low to have influence on food security status. Second, food production loss due to loss of agricultural land could be covered by increasing productivity level. Increasing productivity level per hectare can compensate the loss of agricultural land if there is investment in food production technology and capital for household to access it. Lastly, only one of nine indicators that use to calculate FSVCi directly connected to agricultural land.

Food productivity can be increased through intensification methods such as, using quality seeds, appropriate fertilizer, optimize irrigation, and using other food production technology (Hasan, 2010). Productivity of paddy, maize in Mojokerto Regency in 2009 increased, but decreased for cassava and sweet potato. In 2013, only maize increased, meanwhile others decreased (see appendix E).

Nevertheless, the trend of decreasing in agricultural land should not be underestimated. This indicates a potential loss of agricultural land in the future will increase. It will also influence on agricultural production. Declining in agricultural production will also affect food security conditions. Food security and vulnerability composite index would increases (means food security become worse) if agricultural production dropped while the demand increases along with population growth.

5.5. Food security consideration in planning

Based on the result of plans review it is still unclear whether the government has concern on food security through their plan document. All indicators were included in the document but not directly linked to food security. For example poverty reduction, the main purpose is to increase prosperity but it also could contribute to food security. The attention of the government through the plan is expected to increase food security condition.

5.6. Research limitation

This research only based on secondary data, therefore further rigorous investigation in some areas is needed to reveal phenomenon (e.g. why a district that has not experience loss of agricultural land has lower productivity) that cannot be explained by secondary data.

Normally, check of actual land cover observed directly in the field. Google earth imagery was used for accuracy assessment, since no fieldwork was possible.

Using nine indicators of FSVA which is provided by Indonesian Government not always suitable to assess food security in all region in Indonesia. In this research, most of the indicator mainly proxy indicators for food utilization are no longer irrelevant with recent condition in Mojokerto Regency.

5.7. Future research recommendations

Considering limitation of this research, primary data (e.g. collect through key informant interview) is important to obtain information that cannot be derived by secondary data. For example, explanation why in a district has very low agricultural production meanwhile there is no loss of agricultural land based on statistical data.

Alternative indicators are very important to anticipate the unfulfilled the needs of data and irrelevant based on existing methods. This is due to the possibility of local conditions are not the same each other. For an example, for the archipelago region, sea/water transportation access is more important than the road access. The absence of one or more data because there is no alternative indicator that corresponds to the area of study will clearly affect food security index value.

6. CONCLUSION

6.1. Conclusion

The trends, spatial variation and pattern of food security in Mojokerto Regency

Food security and vulnerability composite index (FSVCi) was decreased from 2005 to 2013. It means there have been improvement of food security. There were several contributing factors, such as household below poverty line, female illiteracy, infant mortality, and children underweight.

From 2005 to 2009, there were 11 districts changed its classification. Most of them located on northern and middle part of Mojokerto Regency. In the next phase, three were districts situated in the middle and south part of area moved to different class. One interesting point was some districts (Puri, Bangsal, Pungging and Pacet) remain in the same classification and their location dispersed.

The lowest class of index in 2005 Mojokerto was moderate food security. There were six districts recorded in moderate food security class. Three of them (Gedeg, Kemlagi and Dawarblandong) located in the northern part area. Gedeg has to deal with food availability meanwhile Kemlagi and Dawarblandong have to face problem related to poverty. The rest districts (Jatirejo, Kutorejo and Ngoro) have to face different problems (poverty, access to clean water and female illiteracy respectively).

The condition has changed in 2009. The lowest value of FSVCi in district level categorized in high food security class. Two-thirds of the total districts classified in this class. Dawarblandong, Kemalgi and Jatirejo districts were considered as more insecure area due to they were on top three of highest value of FSVCi). Those districts are highly correlated with issues of poverty and female illiteracy.

In 2013, 50% of all districts were classify as high food security. Kemlagi and Dawarblandong were considered as top two districts with the highest value of FSVCi and followed by Jatirejo and Gedeg in third place. Poverty was still as main issue for each district followed by female illiteracy and food availability.

Overall , poverty, female illiteracy, access to clean water and food availability were consider as top four main issues related to food security in Mojokerto Regency.

Nevertheless, food security condition improve, even though the improvement tend to be slowed.

Loss of agricultural and urban growth trend related to food security trend

The loss of agricultural land trend and population were increased. The difference was the rate for agricultural land lost increased meanwhile the rate of population decreased. In addition, urban growth was increased over time. The trend of food security level slightly improved which is also contributed by agricultural productivity.

All local plans were not directly linked to food security. Even though agricultural and access to clean water were considered as indicators that had more attention from local government. The government attention through plans could has positive contribution to increase food security condition.

Composite index (FSVCi) and the loss of agricultural seem contradictory. The FSVCi trend was improved over three different years (2005, 2009 and 2013) on the other hand loss of agricultural land was also increased. The impact of urban growth on food security due to loss of agricultural land is still need further research. It due to, even though agricultural land has important role on food security through food availability, there are other factors that not directly linked (food access and food utilization).

This research was conducted with the perspective that it will useful for local government of Mojokerto regency. Combination of statistical data and remote sensing imagery are useful to obtain data for planning analysis in a cost effective and timely manner

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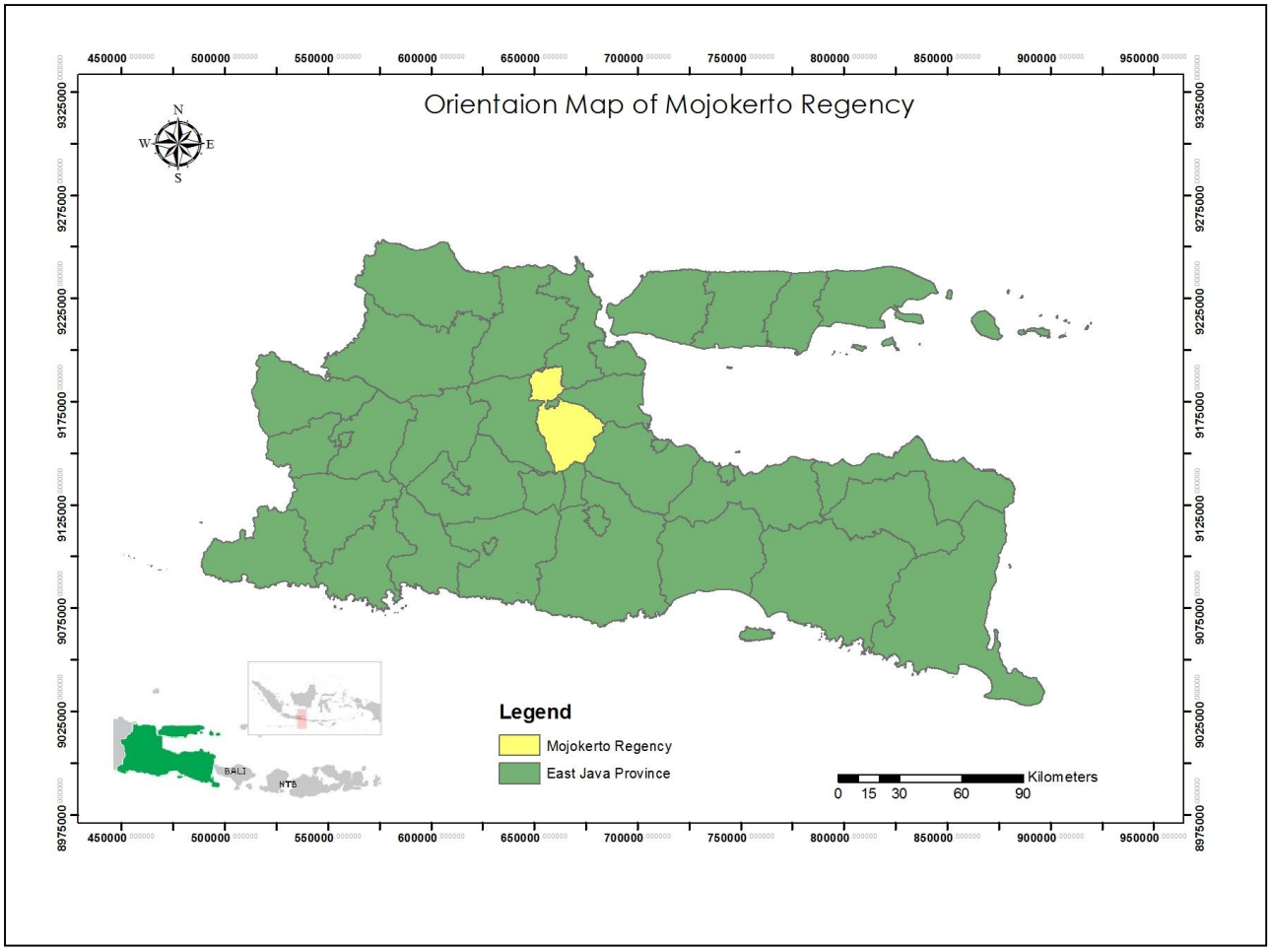
APPENDIX A. Food Security Dimensions and Indicators.

Availability	Accessibility	Utilization	Stability
1. Average dietary energy supply adequacy; 2. Average value of food production; 3. Share of dietary energy supply derived from cereals, roots and tubers; 4. Average protein supply; 5. Average supply of protein of animal origin.	1. Percent of paved roads over total roads 2. Road density 3. Rail lines density 4. Gross domestic product per capita (in purchasing power equivalent) 5. Domestic food price index 6. Prevalence of undernourishment 7. Share of food expenditure of the poor 8. Depth of the food deficit 9. Prevalence of food inadequacy	1. Cereal import dependency ratio 2. Percent of arable land equipped for irrigation 3. Value of food imports over total merchandise exports 4. Political stability and absence of violence/terrorism 5. Domestic food price volatility 6. Per capita food production variability 7. Per capita food supply variability	1. Access to improved water sources 2. Access to improved sanitation facilities 3. Percentage of children under 5 years of age affected by wasting 4. Percentage of children under 5 years of age who are stunted 5. Percentage of children under 5 years of age who are underweight 6. Percentage of adults who are underweight 7. Prevalence of anaemia among pregnant women 8. Prevalence of anaemia among children under 5 years of age 9. Prevalence of vitamin A deficiency in the population 10. Prevalence of iodine deficiency

Source :(FAO, 2013)

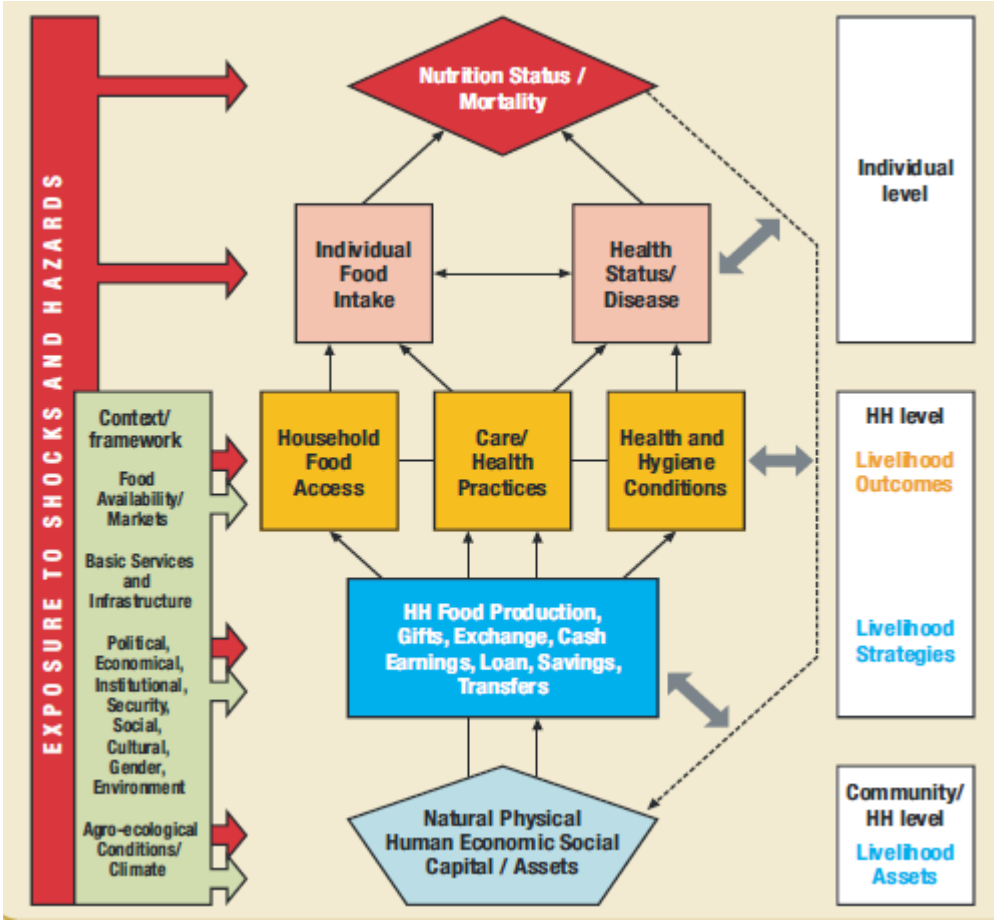
APPENDIX B. The Map of Study Area

1. Orientation map of Mojokerto Regency



Source: (Local Planning Board of Mojokerto Regency, 2010)

APPENDIX C. FOOD AND NUTRITION SECURITY FRAMEWORK



Source: (World Food Programme, 2009)

APPENDIX D. Classification of Indicators

Food Availability

Classification of Z1 (Cereal consumption ratio per capita per day):

1. > 1.50 Very high food insecurity
2. > 1.25 - 1. 50 High food insecurity
3. > 1.00 - 1.25 Moderate food insecurity
4. > 0.75 - 1.00 Moderate food security
5. > 0.50 - 0.75 High food security
6. ≤ 0.5 Very High food security

Food Accessibility

Classification of Z2 (percentage of household below poverty line):

1. > 30% Very high food insecurity
2. > 25 - 30% High food insecurity
3. > 20 - 25% Moderate food insecurity
4. > 15 - 20% Moderate food security
5. > 10 - 15% High food security
6. ≤ 10% Very High food security

Classification of Z3 (Percentage of village with inadequate road network for minimum four wheel vehicles (poor road infrastructure):

1. > 30% Very high food insecurity
2. > 25 - 30% High food insecurity
3. > 20 - 25% Moderate food insecurity
4. > 15 - 20% Moderate food security
5. > 10 - 15% High food security
6. ≤ 10% Very High food security

Classification of Z4 (percentage of household without access to electricity):

1. > 50% Very high food insecurity
2. > 40 - 50% High food insecurity
3. > 30 - 40% Moderate food insecurity
4. > 20 - 30% Moderate food security
5. > 10 - 20% High food security
6. ≤ 10% Very High food security

Food Utilization

Classification of Z5 (percentage of infant mortality):

1. > 55% Very high food insecurity
2. > 50 - 55% High food insecurity
3. > 45 - 50% Moderate food insecurity
4. > 40 - 45% Moderate food security
5. > 35 - 40% High food security
6. ≤ 35% Very High food security

Classification of Z6 (percentage of children underweight):
1. > 25% Very high food insecurity
2. > 20 - 25% High food insecurity
3. > 15 - 20% Moderate food insecurity
4. > 10 - 15% Moderate food security
5. > 5 - 10% High food security
6. ≤ 5% Very High food security

Classification of Z7 (percentage of women who are illiterate):
1. > 30% Very high food insecurity
2. > 25 - 30% High food insecurity
3. > 20 - 25% Moderate food insecurity
4. > 15 - 20% Moderate food security
5. > 10 - 15% High food security
6. ≤ 10% Very High food security

Classification of Z8 (Percentage of household without access to clean water):
1. > 70% Very high food insecurity
2. > 60 - 70% High food insecurity
3. > 50 - 60% Moderate food insecurity
4. > 40 - 50% Moderate food security
5. > 30 - 40% High food security
6. ≤ 30% Very High food security

Classification of Z9 (percentage of household who live more than 5 km from the health facilities):
1. > 60% Very high food insecurity
2. > 50 - 60% High food insecurity
3. > 40 - 50% Moderate food insecurity
4. > 30 - 40% Moderate food security
5. > 20 - 30% High food security
6. ≤ 20% Very High food security

APPENDIX E. Indicator Value

1. Food availability

Productivity

	Paddy (quintal/ha)			Maize (quintal/ha)		
	2005	2009	2013	2005	2009	2013
Mojokerto Regency	60.64	63.96	61.28	55.95	57.89	59.59
East Java Province	54.3	60.19	60.01	36.47	40.67	48.03
Indonesia	45.74	49.99	51.52	34.54	42.37	48.44

	Cassava (quintal/ha)			Sweet potato (quintal/ha)		
	2005	2009	2013	2005	2009	2013
Mojokerto Regency	255.37	196.57	166.89	399.89	325.8	230.36
East Java Province	159.48	155.30	214.10	108.82	100.36	205.44
Indonesia	159.00	187.46	224.60	104.13	111.92	147.47

Population

No	District	Area (sq km)	Population (absolute)			Density (per sq. km)		
			2005	2009	2013	2005	2009	2013
1	Jatirejo	85.11	37471	40959	44946	440.27	481.25	528.09
2	Gondang	113.37	37813	41608	45086	333.52	367.00	397.67
3	Pacet	98.32	50162	55351	60137	510.19	562.97	611.64
4	Trawas	65.94	27040	29249	31667	410.05	443.55	480.22
5	Ngoro	69.03	64302	76295	83482	931.51	1105.25	1209.37
6	Pungging	44.76	65374	72367	78737	1460.45	1616.68	1758.98
7	Kutorejo	46.30	54595	60179	66456	1179.28	1299.89	1435.48
8	Mojosari	30.44	61501	75855	81410	2020.15	2491.64	2674.11
9	Bangsal	23.73	44181	49251	53397	1861.59	2075.21	2249.91
10	Mojoanyar	24.80	44027	48678	52197	1775.52	1963.08	2105.00
11	Dlanggu	37.38	47887	54470	58894	1281.05	1457.16	1575.51
12	Puri	37.81	60094	71380	79395	1589.26	1887.74	2099.70
13	Trowulan	46.47	61818	71663	79461	1330.24	1542.09	1709.89
14	Sooko	24.97	56280	73036	79046	2253.62	2924.58	3165.23
15	Gedeg	26.62	51965	59990	62096	1951.77	2253.18	2332.28
16	Kemlagi	58.48	54020	58147	62795	923.70	994.27	1073.75
17	Jetis	60.65	68454	81542	88768	1128.61	1344.40	1463.53
18	Dawarblandong	81.28	46356	50559	54660	570.33	622.04	672.49
	Regency Level	975.49	933340	1070579	1162630	956.80	1097.48	1191.85

2. Village with poor road infrastructure in a district

Percentage of villages with inadequate road network for minimum four wheel vehicles (poor road infrastructure) (Z3)

No	District	Total village in a district			village with poor road infrastructure in a district			Z3 (%)		
		2005	2009	2013	2005	2009	2013	2005	2010	2013
1	Jatirejo	19	19	19	0	0	0	0	0	0
2	Gondang	18	18	18	0	0	0	0	0	0
3	Pacet	20	20	20	0	0	0	0	0	0
4	Trawas	13	13	13	0	0	0	0	0	0
5	Ngoro	19	19	19	0	0	0	0	0	0
6	Pungging	19	19	19	0	0	0	0	0	0
7	Kutorejo	17	17	17	0	0	0	0	0	0
8	Mojosari	19	19	19	0	0	0	0	0	0
9	Bangsal	17	17	17	0	0	0	0	0	0
10	Mojoanyar	12	12	12	0	0	0	0	0	0
11	Dlanggu	16	16	16	0	0	0	0	0	0
12	Puri	16	16	16	0	0	0	0	0	0
13	Trowulan	16	16	16	0	0	0	0	0	0
14	Sooko	15	15	15	0	0	0	0	0	0
15	Gedeg	14	14	14	0	0	0	0	0	0
16	Kemlagi	20	20	20	0	0	0	0	0	0
17	Jetis	16	16	16	0	0	0	0	0	0
18	Dawarblandong	18	18	18	0	0	0	0	0	0

- There is no spatial pattern of villages with inadequate road network for minimum four wheel vehicles (poor road infrastructure) (Z3) due to they have same value

3. Household without access to electricity (Z4)

- Percentage, ,trend and variation, and spatial pattern of household without access to electricity (Z4)
  All households in all districts has access to electricity.

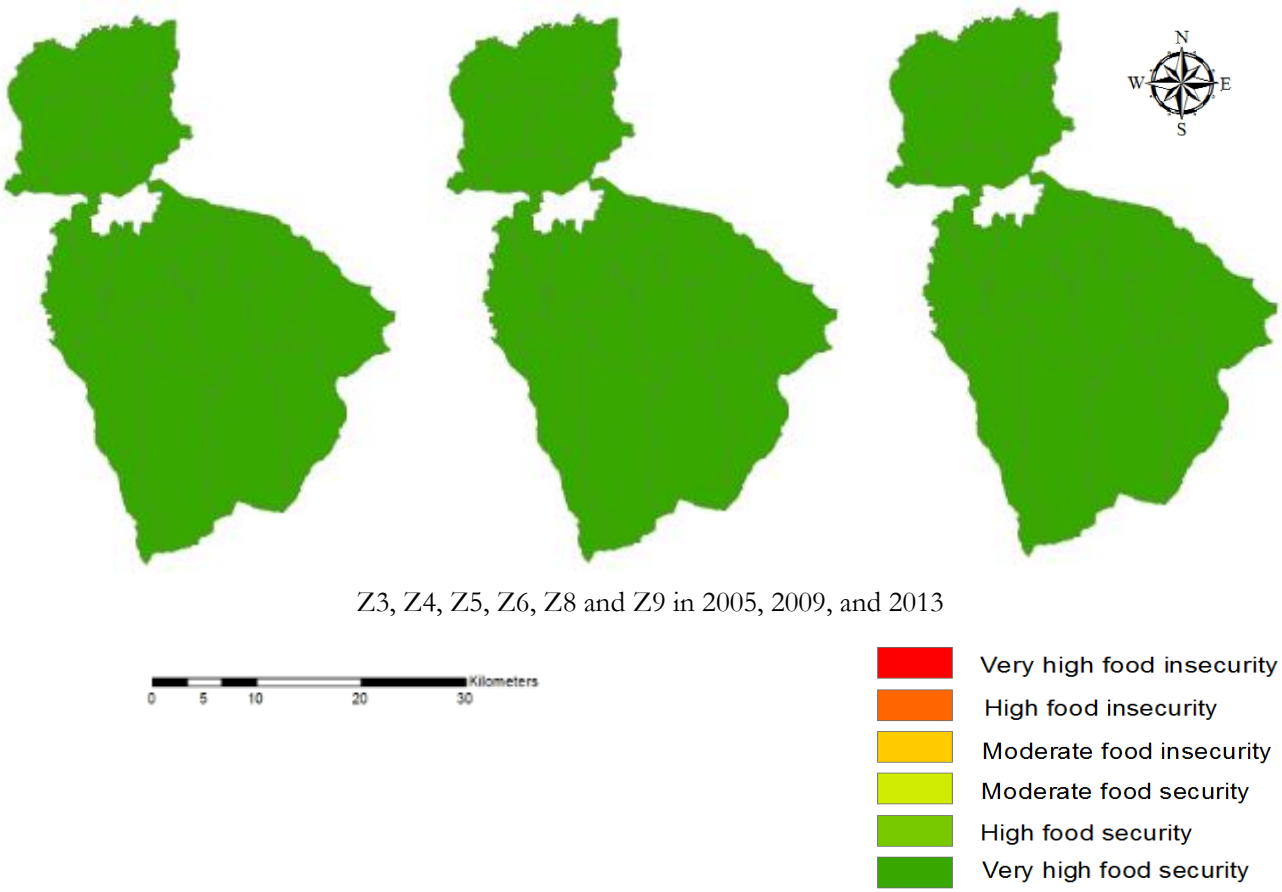
No	District	Total Household in a district			Household without Access to Electricity			Z4 (%)		
		2005	2009	2013	2005	2009	2013	2005	2009	2013
1	Jatirejo	10713	12209	14745	0	0	0	0	0	0
2	Gondang	11649	12490	15070	0	0	0	0	0	0
3	Pacet	16096	17405	20390	0	0	0	0	0	0
4	Trawas	8377	8921	10271	0	0	0	0	0	0
5	Ngoro	19497	22793	26658	0	0	0	0	0	0
6	Pungging	20275	21803	25169	0	0	0	0	0	0
7	Kutorejo	15450	17854	21495	0	0	0	0	0	0
8	Mojosari	19733	22187	25968	0	0	0	0	0	0
9	Bangsal	13878	14741	18820	0	0	0	0	0	0
10	Mojoanyar	12765	13869	17601	0	0	0	0	0	0
11	Dlanggu	13680	15998	24600	0	0	0	0	0	0
12	Puri	18649	20206	25377	0	0	0	0	0	0
13	Trowulan	17267	21555	23917	0	0	0	0	0	0
14	Sooko	18048	19884	20277	0	0	0	0	0	0
15	Gedeg	12957	17919	19637	0	0	0	0	0	0
16	Kemlagi	15136	17056	17093	0	0	0	0	0	0
17	Jetis	21063	24468	28658	0	0	0	0	0	0
18	Dawarblandong	14408	15153	16240	0	0	0	0	0	0

4. Households who live more than 5 km from the health facilities (Z9)

Percentage of households who live more than 5 km from the health facilities (Z9)

No	District	Total Household in a district			Household who are live >5km from HF			Z9 (%)		
		2005	2009	2013	2005	2009	2013	2005	2009	2013
1	Jatirejo	10713	12877	14745	0	0	0	0%	0%	0%
2	Gondang	11649	13373	15070	0	0	0	0%	0%	0%
3	Pacet	16096	18302	20390	0	0	0	0%	0%	0%
4	Trawas	8377	9144	10271	0	0	0	0%	0%	0%
5	Ngoro	19497	23467	26658	0	0	0	0%	0%	0%
6	Pungging	20275	22658	25169	0	0	0	0%	0%	0%
7	Kutorejo	15450	18656	21495	0	0	0	0%	0%	0%
8	Mojosari	19733	23203	25968	0	0	0	0%	0%	0%
9	Bangsal	13878	15551	18820	0	0	0	0%	0%	0%
10	Mojoanyar	12765	14347	17601	0	0	0	0%	0%	0%
11	Dlanggu	13680	16499	24600	0	0	0	0%	0%	0%
12	Puri	18649	21243	25377	0	0	0	0%	0%	0%
13	Trowulan	17267	22443	23917	0	0	0	0%	0%	0%
14	Sooko	18048	20756	20277	0	0	0	0%	0%	0%
15	Gedeg	12957	18346	19637	0	0	0	0%	0%	0%
16	Kemlagi	15136	17248	17093	0	0	0	0%	0%	0%
17	Jetis	21063	25353	28658	0	0	0	0%	0%	0%
18	Dawarblandong	14408	15520	16240	0	0	0	0%	0%	0%

5. There is no spatial pattern of villages with inadequate road network for minimum four wheel vehicles (poor road infrastructure) (Z3), household without access to electricity (Z4) households who live more than 5 km from the health facilities (Z9) due to they have same value. In addition, same condition for infant mortality (Z5), children underweight (Z6) and household without access to clean water (Z8) because there were in the same class.



Z3, Z4, Z5, Z6, Z8 and Z9 in 2005, 2009, and 2013

APPENDIX F. Accuracy Assessment Report

Accuracy report for land cover map 2005

ERROR MATRIX

Reference Data

Classified Data	Unclassified	Water	Built up	Agriculture	Forest	Bare soil
Unclassified	0	0	0	0	0	0
Water	0	15	0	10	0	0
Built up	0	0	15	4	1	5
Agriculture	0	0	2	22	1	0
Forest	0	0	2	1	22	0
Bare soil	0	0	5	2	0	18
Column Total	0	15	24	39	24	23

----- End of Error Matrix -----

ACCURACY TOTALS

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
Unclassified	0	0	0	---	---
Water	15	25	15	100.00%	60.00%
Built up	24	25	15	62.50%	60.00%
Agriculture	39	25	22	56.41%	88.00%
Forest	24	25	22	91.67%	88.00%
Bare soil	23	25	18	78.26%	72.00%
Totals	125	125	92		

Overall Classification Accuracy = 73.60%

----- End of Accuracy Totals -----

KAPPA (K^) STATISTICS

Overall Kappa Statistics = 0.6700

Conditional Kappa for each Category.

Class Name	Kappa
Unclassified	0
Water	0.5455
Built up	0.5050
Agriculture	0.8256
Forest	0.8515
Bare soil	0.6569

----- End of Kappa Statistics -----

Accuracy report for land cover map 2009

ERROR MATRIX

Reference Data

Classified Data	Unclassified	Water	Built up	Agriculture	Forest	Bare soil
Unclassified	0	0	0	0	0	0
Water	0	21	1	3	0	0
Built up	0	0	15	9	1	0
Agriculture	0	0	2	20	3	0
Forest	0	0	0	4	21	0
Bare soil	0	0	1	1	0	23
Column Total	0	21	19	37	25	23

----- End of Error Matrix -----

ACCURACY TOTALS

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
Unclassified	0	0	0	---	---
Water	21	25	21	100.00%	84.00%
Built up	19	25	15	78.95%	60.00%
Agriculture	37	25	20	54.05%	80.00%
Forest	25	25	21	84.00%	84.00%
Bare soil	23	25	23	100.00%	92.00%
Totals	125	125	100		

Overall Classification Accuracy = 80.00%

----- End of Accuracy Totals -----

KAPPA (K^) STATISTICS

Overall Kappa Statistics = 0.7500

Conditional Kappa for each Category.

Class Name	Kappa
Unclassified	0
Water	0.8077
Built up	0.5283
Agriculture	0.7159
Forest	0.8000
Bare soil	0.9020

----- End of Kappa Statistics -----

Accuracy report for land cover map 2013

ERROR MATRIX

Reference Data

Classified Data	Unclassified	Water	Built up	Agriculture	Forest	Bare soil
Unclassified	0	0	0	0	0	0
Water	0	24	0	1	0	0
Built up	0	0	18	7	0	0
Agriculture	0	0	3	22	0	0
Forest	0	0	0	2	23	0
Bare soil	0	0	10	0	0	15
Column Total	0	24	31	32	23	15

----- End of Error Matrix -----

ACCURACY TOTALS

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
Unclassified	0	0	0	---	---
Water	24	25	24	100.00%	96.00%
Built up	31	25	18	58.06%	72.00%
Agriculture	32	25	22	68.75%	88.00%
Forest	25	23	23	100.00%	92.00%
Bare soil	15	25	15	100.00%	60.00%
Totals	125	125	102		

Overall Classification Accuracy = 81.60%

----- End of Accuracy Totals -----

KAPPA (K^) STATISTICS

Overall Kappa Statistics = 0.7700

Conditional Kappa for each Category.

Class Name	Kappa
Unclassified	0
Water	0.9505
Built up	0.6277
Agriculture	0.8387
Forest	0.9020
Bare soil	0.5455

----- End of Kappa Statistics -----