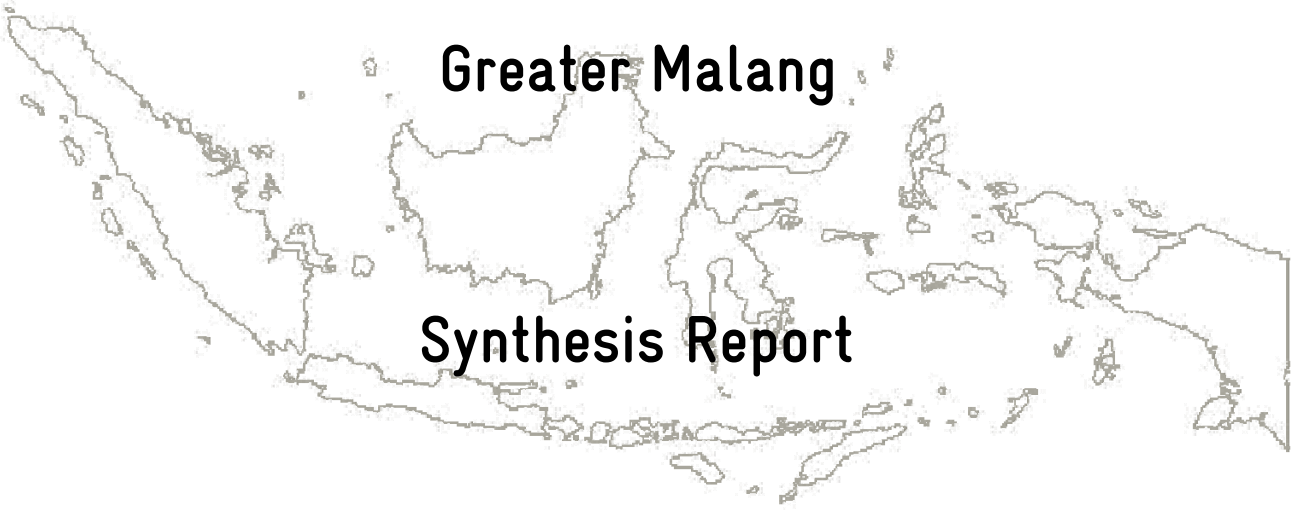
Climate Change Risk and Adaptation Assessment

Greater Malang



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Foreword by the Deputy Minister for Environmental Damage Control and Climate Change

The impacts of climate change are already being felt all over Indonesia: extreme climate events have hit several parts of Indonesia in the past and have shown that the country is highly vulnerable to the impacts of climate change. Therefore we need real action to improve community resilience to foster resistance to shock and climate disruption, as an essential component for sustainable development. Indonesia has a coastline of approximately 80,000 km and more than 17,000 islands. Many economic activities are carried out in coastal areas and many people's livelihoods depend on sectors that are highly sensitive to climate change, such as the agricultural sector. Due to these geographical conditions, Indonesia is highly vulnerable to climate change. Increasing the resilience to climate change is therefore an important task.

Even though future climate - as a result of climate change - can be said to be subject of uncertainty, we must begin now to develop a strategy to address issues of climate variability and to understand the impact based on the knowledge that the most cutting-edge techniques available up to date can provide us with.

Vulnerability to climate change is often specific to the local context. Hence, understanding climate change impacts at the local level is important and fundamental for addressing climate change. This can be best achieved by the implementation of a Risk and Adaptation Assessment to climate change. Such an assessment can be done at a general level (macro scale), intermediate level (meso scale) or detailed level (micro scale), depending on what kind of information is required.

The Government of Indonesia, through the Ministry of Environment and with support from AusAID and GIZ, has conducted a Risk and Adaptation Assessments to climate change (Krapi) at several pilot sites, for the island of Lombok, for South Sumatra Province, for the Greater Malang area (meso scale) as well as the for the City of Tarakan (micro scale). The implementation of these studies began with a public consultation to identify vulnerable sectors affected by climate change, it continued with a synchronization of programs at local and national levels, and ended with the integration of recommendations from the assessment of options and climate change adaptation strategies into local development and spatial planning.

There are many things that can be learned from each assessment as well as from the context and particularities of the different regions. Some important lessons learned are:

- The importance of ensuring the availability and accessibility of data series that can be used for the Risk and Adaptation Assessment, especially for the preparation of information for current and projected climate change (esp. rainfall patterns, temperature) and sea level rise;

- The importance of ensuring the availability and accessibility of data related to social, economic and development planning, present and future, so that the Climate Risk can be better estimated;
- The importance of increasing the amount of available resources and capacities, including funding for adaptation action itself but also for the continued formation of experts through increased funding for research and development.
- The importance of exploring the potential of local knowledge when it comes to climate change adaptation.
- The importance of synchronizing and harmonizing national and regional development programs with the climate change adaptation options proposed by the experts.

The studies conducted in South Sumatra Province, the City of Tarakan and Greater Malang (District of Malang, Cities of Batu and Malang) identified four sectors that are particularly vulnerable to the impacts of climate change, namely the coastal sector (including fisheries and marine affairs), the water (including water resources, floods and landslides), agriculture, and health sectors. Recommendations from this study may be one input for the development planning processes in South Sumatra Province, City of Tarakan and Malang (District of Malang, Cities of Batu and Malang) through the integration of its results into the RPJMD, RPJP, and other planning tools.

The implementation of this study is expected to be a best practice example for addressing climate change at local level, and it is expected to be replicated in other areas in Indonesia in order to increase Indonesia's resilience to the impacts of climate change.

While carrying out this study, the local governments of South Sumatra Province, the City of Tarakan and the Greater Malang (District of Malang, Cities of Batu and Malang) have greatly supported the process. Hereby, I would like thank them for their continued and valuable contribution.

Jakarta, June 2012

Deputy MENLH
Deputy Minister of Environmental Damage Control
and Climate Change

Arief Yuwono

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1. Description and Strategic Issues of Greater Malang

1.1 Physical conditions

1.1.1 Geographical Setting of Greater Malang

Greater Malang comprises three neighbouring administrative areas; i.e. Malang City, Batu City, and Malang District, located at $112^0$17'12.25"- $112^0$57'28.17" East and $7^0$43'58.71" - $8^0$1'59.65" South, with a total area equal to 3,458 km^2. According to East Java in Numbers (2009), details of the geographical setting of each areas is as follows; a) Malang District is located at $112^0$17'12.25"- $112^0$57'28.17" East and $7^0$45'41.86"- $8^0$27'53.58" South with an area of 3,519 km^2 (East Java in Numbers 2009); b) Batu City is located at $112^0$28'19.72"- $112^0$35'26.68" East and $7^0$43'58.71"- $7^0$56'28.28" South with an area of 189 km^2; and c) Malang City is geographically located at $112^0$34'39.11"- $112^0$40'37.12" East and $7^0$55'11.05"- $8^0$1'59.65" South with an area of 110 km^2.

Based on data from East Java in Numbers (2009), administratively, Malang District consists of 33 subdistricts and 12 administrative-villages (*kelurahan*) and 378 villages (*desa*), i.e. 117 located in urban areas and 273 in rural areas. As for Malang City, it is divided into five subdistricts with 57 villages, while, Batu City is divided into three districts with 24 villages of which 12 are spread in urban areas and 12 in rural areas.

Table 1.1 Administrative Area of Greater Malang

Subdistrict	Area (Ha)	Number of Village	Subdistrict	Area (Ha)	Number of Village
Malang District			22. Pakisaji	3,841	12
01. Donomulyo	19,260	10	23. Tajinan	4,011	12
02. Kalipare	10,539	9	24. Tumpang	7,209	15
03. Pagak	9,008	8	25. Pakis	5,362	15
04. Bantur	15,915	10	26. Jabung	13,589	15
05. Gedangan	13,055	8	27. Lawang	6,823	12
06. Sumber manjing	23,949	15	28. Singosari	11,851	17
07. Dampit	13,531	12	29. Karangploso	5,874	9
08. Tirtoyudo	14,196	13	30. Dau	4,196	10
09. Ampelgading	7,960	13	31. Pujon	13,075	10
10. Poncokusumo	10,299	17	32. Ngantang	14,770	13
11. Wajak	9,456	13	33. Kasembon	5,567	6
12. Turen	6,390	17	Malang City		
13. Bululawang	4,936	14	34. Kedung kandang	3,989	12
14. Gondanglegi	7,974	14	35. Sukun	2,097	11
15. Pagelaran	4,583	10	36. Klojen	883	11
16. Kepanjen	4,625	18	37. Blimbing	1,777	11
17. Sumber pucung	3,590	7	38. Lowokwaru	2,260	12
18. Kromengan	3,863	7	Batu City		
19. Ngajum	6,012	9	39. Batu	4,546	8
20. Wonosari	4,853	8	40. Junrejo	2,565	7
21. Wagir	7,543	12	41. Bumiaji	12,798	9
Total of Greater Malang				328,620	471

Greater Malang area has varied topographical characteristics including a coastal area in the south, low-land, high-land, and mountainous areas. The topography of Greater Malang is a plateau area which is surrounded by several mountains and lowlands with altitudes of 250-500 meters above sea level. The plateau area is an area of limestone hills (Kendeng Mountains) in the southern part with altitude 0-650 meters above sea level. While, the slope of the Tengger-Semeru area in the eastern part stretches from north to south at an altitude of 500-3600 meters above sea level and slopes at the Kawi-Arjuno west at an altitude of

500-3300 meters above sea level. There are nine mountains and at least one mountain located in each direction in Greater Malang.
The main water sources in Greater Malang come from rivers and water springs. There are 10 major rivers in the Greater Malang area; i.e. Brantas, Metro, Jilu, Cokro, Rejoso, Amprong, Welang, Lesti, Ngotok Ring Kanal, and Lahor. Among them, the Brantas River is the largest and longest river in East Java, with its upstream located in Batu City. However, despite its size, the river Brantas and its watershed is considered as critical in terms of environmental degradation. The watershed lacks the ability to store water in the dry season, thus influencing the magnitude and frequency of flooding, sedimentation, and siltation in reservoirs and rivers increase.

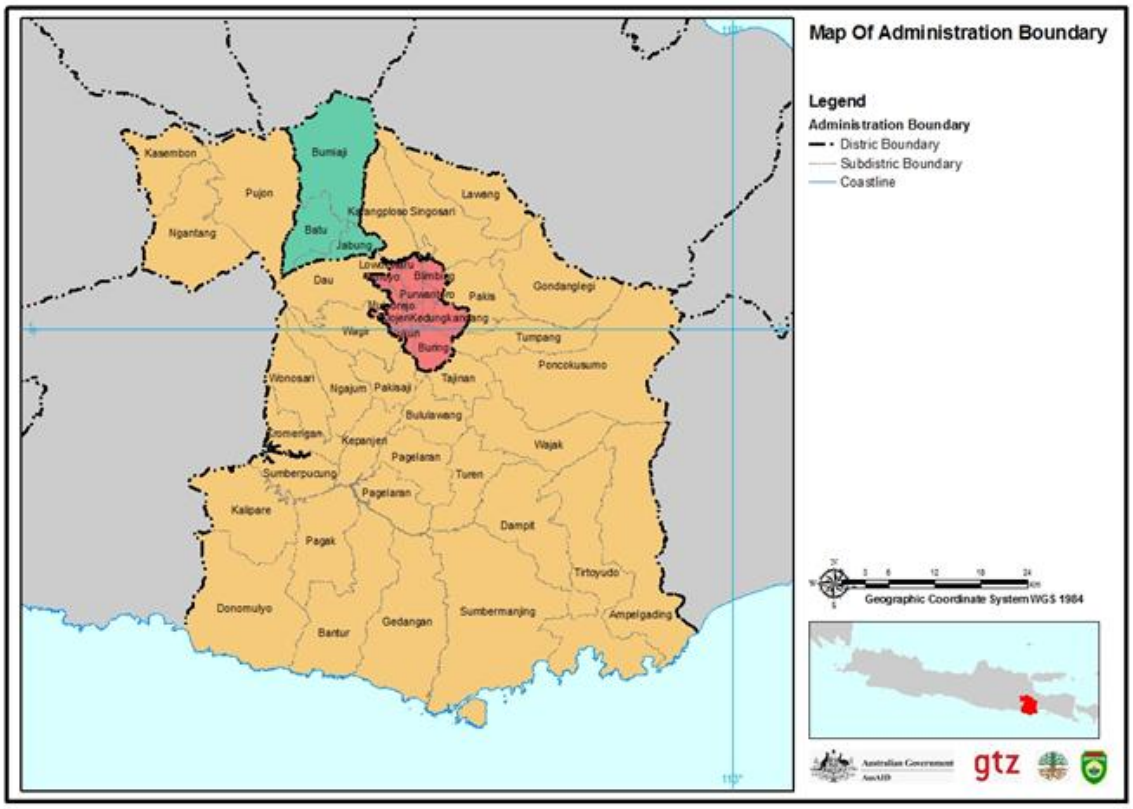


Figure 1. 1 Map of Greater Malang Area

1.1.2 Physical Development Growth in Greater Malang

Since the study is conducted at a meso-level, consideration of physical development is limited to the characteristics of the area, i.e. as built-up environment – urban or rural area, and main infrastructure related to the issues being addressed. As it can be seen from the figure below, basically in the baseline conditions, a concentration of built-up areas can be found in Malang City, some parts of Batu City, and distributed throughout the north-centre and centre part of Malang District; i.e. indicated by the rose-colour-shaded area. In total, these built-up areas occupy 22,2% of total area, i.e. around 72,917 Ha. The distribution of built-up area and its future projection is especially important in determining the risk in the water and health sectors.

On the other hand, the agriculture sector is especially concerned with the distribution of agricultural area. As baseline conditions the distribution is as follows; a) wetland agriculture, total area size 53,356 Ha (16,2% from total area), b) dryland agriculture, total area size 102, 927 Ha (31,3% from total area), and c) plantation, total area size 19,578 Ha (6% from total area).

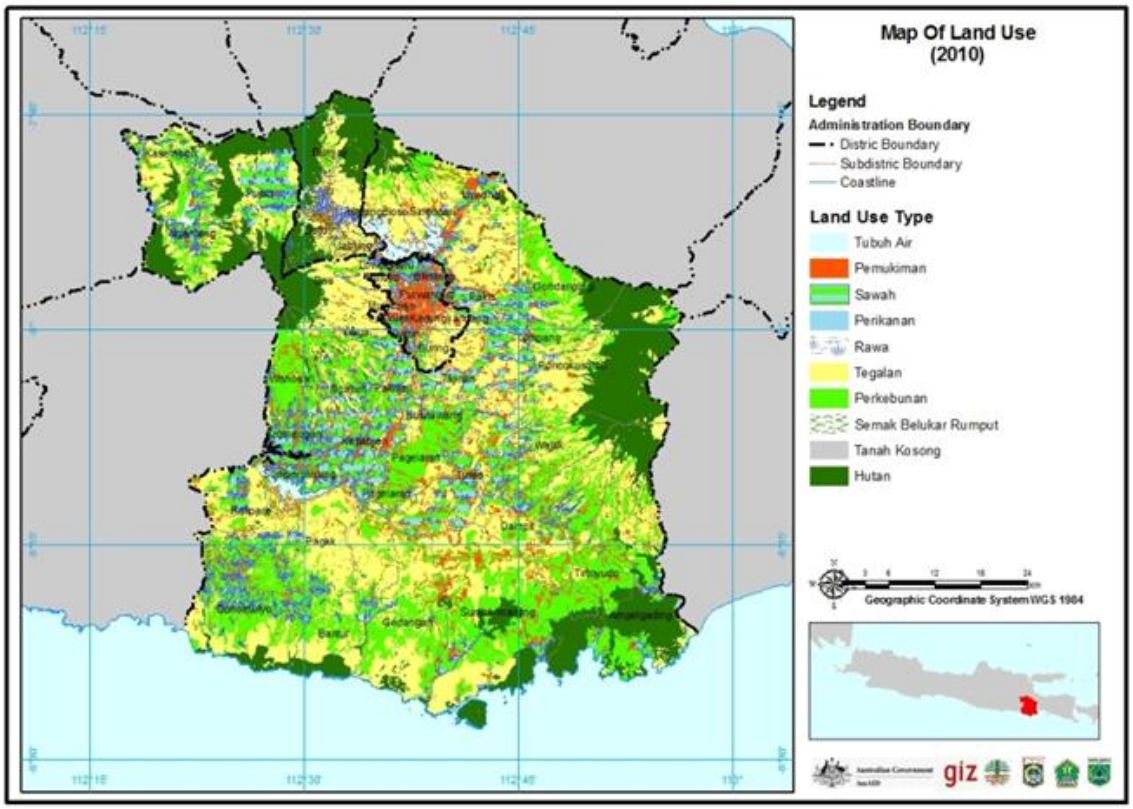


Figure 1.2 Land-use Map of Greater Malang in Baseline Condition

1.2 Socioeconomic conditions

1.2.1 Population

Greater Malang is home for 3,349,503 people in the baseline conditions, based on the local statistical agency (BPS, 2010). According to the same source, the details for each administrative area at baseline conditions are as follows: a) total population of Malang District (data recored in 2008) is 2,413,779 people with population density of 810 people/km^2; b) total population of Malang City (data recorded in 2008) is 816,637 people with population density 7,420 people/km^2; and c) total population of Batu City is 119,087 people (data recorded in 2008) with population density of 925 people/km^2. It should be noted that the total population in Malang District is the second largest in East Java Province. With a vast surface area, Malang District has a lower population density compared to Malang City or Batu City.

Population growth rate of Malang District based on the 2000census, is about 0.67% per year. The region with the highest population growth rate is Pakis Subdistrict with a growth rate of 2.07%, while the lowest is Ngajum Subdistrict with -6.23%. The largest single population is located in Singosari Subdistrict with139,594 people (2000), while the highest population density is Kepanjen Subdistrict with 2,019 people/km^2. Malang City has a growth rate 0.55% per year. The area with the highest population growth is Kedungkandang Subdistrict with 2.72% and the lowest is Klojen Subdistrict with about -1.96%. The largest population is located in Sukun Subdistrict with 162.094 people (2000) 13,307 people/km^2. The largest population in Batu City is located in Batu Subdistrict 84.829 people. Batu Subdistrict also has the highest density of population with 1,866 people/km^2.

Table 1.2 Population and Population Density in Greater Malang

Subdistrict	Area Size (km^2)	Population	Population Density (per Km^2)	Subdistrict	Area Size (km^2)	Population	Population Density (per Km^2)
Malang District				Pakisaji	38.4	74,953	1,952
Donomulyo	192.6	73,047	379	Tajinan	40.1	49,949	1,246
Kalipare	105.4	67,045	636	Tumpang	72.1	74,839	1,038
Pagak	90.1	50,672	562	Pakis	53.6	123,034	2,295
Bantur	159.2	71,294	448	Jabung	135.9	70,522	519
Gedangan	130.6	55,079	422	Lawang	68.2	91,358	1,340
Sumbermanjing	239.5	97,034	405	Singosari	118.5	152,873	1,290
Dampit	135.3	117,348	867	Karang-ploso	58.7	54,518	929
Tirtoyudo	142.0	62,923	443	30. Dau	42.0	56,112	1,336
Ampelgading	79.6	57,537	723	Pujon	130.8	61,618	471
Poncokusumo	103.0	93,117	904	Ngantang	147.7	58,015	393
Wajak	94.6	81,284	859	Kasem-bon	55.7	31,069	558
Turen	63.9	112,210	1,756	**Malang City**			
Bululawang	49.4	61,374	1,242	Kedung-kandang	39.9	162,941	4,084
Gondang-legi	79.7	78,619	986	Sukun	21.0	175,772	8,370
Pagelaran	45.8	66,125	1,444	Klojen	8.8	127,415	14,479
Kepanjen	46.3	93,186	2,013	Blimbing	17.8	171,935	9,659
Sumber-pucung	35.9	54,773	1,526	Lowok-waru	22.6	182,794	8,088
Kromengan	38.6	39,222	1,016	**Batu City**			
Ngajum	60.1	50,247	836	Batu	45.5	97,881	2,151
Wonosari	48.5	43,984	907	Junrejo	25.7	50,447	1,963
Wagir	75.4	76,592	1,016	Bumiaji	128.0	58,652	458
Greater Malang					3,286.5	3,429,409	1,043

1.2.2 Economic Structure

Since the context of CCRAA will be mainstreamed into development plans and the sectors it covers greatly affect the economy of these areas, it is useful to explore the current economic structure of Greater Malang through the lens of gross regional domestic product. Table 1.3 below presents the information.

Table 1.3 Gross Regional Domestic Product of Areas in Greater Malang – 2009
(Current Prices)

Economic Sector	Malang City		Batu City		Malang District	
	Amount (Rp.Million)	Share (%)	Amount (Rp. Million)	Share (%)	Amount (Rp. Million)	Share (%)
Agriculture	108,559.58	0.41%	496,555.55	18.70%	7,979,506.96	28.75%
Mining and quarrying	9,766.16	0.04%	5,124.86	0.19%	627,345.59	2.26%
Manufacturing	9,173,767.78	34.33%	193,540.49	7.29%	5,620,750.62	20.25%
Electricity, water and gas	95,172.09	0.36%	41,347.96	1.56%	495,120.67	1.78%
Construction	834,449.38	3.12%	49,774.12	1.87%	529,867.51	1.91%
Trade, hotel and restaurant	9,286,009.72	34.75%	91,307.17	3.44%	6,601,750.13	23.79%
Transportation and communication	1,271,718.17	4.76%	113,000.22	4.26%	1,364,881.52	4.92%
Financial services	2,790,682.99	10.44%	404,575.60	15.23%	1,037,949.17	3.74%

Government and other services	3,153,023.91	11.80%	188,005.11	7.08%	3,497,632.92	12.60%
Total (with oil and gas)	26,723,149.79	100.00%	2,655,639.11	100.00%	27,754,805.09	100.00%

Source: a) Malang City in Numbers (2009) – at current price, data year 2009; b) Batu City in Numbers (2009) – at current price, data year 2009; c) Malang District in Numbers (2009) – at current price, data year 2009

From the table above, it can be seen that the economy of Greater Malang is dominated by Malang District and Malang City, while Batu City's economy is lagging behind. In terms of structure, it can be seen that Malang City is supported by its manufacturing and trade-hotel-restaurant sector, which indicates the dominant contribution of urban sectors; even when compared with the same sector in Batu City and Malang District. On the other hand, for Batu City and Malang District, the largest share of GRDP still comes from the agriculture sector. While in Malang District the economic contribution of agriculture is followed by that from trade-hotel-restaurant and the manufacturing sector, in Batu City it is followed by financial services.

1.3 Strategic Issues

The impact of climate change has specifically been addressed as a strategic issue in Greater Malang, as well as in East Java Province in general. In the East Java Province Spatial Plan, it has already been acknowledged that issues on global warming and climate change are one of its considerations. In addition, these considerations are being compounded with other strategic issues which are also related to the context of this research[1]; i.e. issue of food security due to the decline of the agricultural sector and the issue of environmental degradation in the Brantas watershed of which one of the implications is the occurrence of flood and landslide. In addition to the latter, the Brantas watershed is also defined as being an environmentally strategic provincial area.

In all three areas of Greater Malang, the consideration of climate change as a strategic issue is varied; i.e. understood through the perspective of a review process of three development planning documents of each area[2]. Generally, the term is used as one of the environmental issues in Malang City, Batu City, and Malang District is either climate change or global warming, . However, none of the areas in reality already have an adequate preparation of policy for adaptation to climate change impact. So far, it is only Batu City which in its Medium-term Development Plan (RPJM) specifically mentioned that the impact of climate change will affect its agriculture. Therefore, the strategic issues are pursued further by looking at key points of each sector being analysed in the CCRAA and how its conditions will be threatened by the impact of climate change; i.e. water, agriculture, and health sector.

In terms of strategic issues in water resources, being located in the upstream of Brantas River gives the Greater Malang area a great responsibility to maintain the water supply capacity. However, paradoxically, the development of urban areas in the upstream will drive landuse change which will affect the balance of water availability. Landuse change will decrease the size of the catchment area thus leading to more run-off, and reducing the availability of groundwater and springs may dry up. Another impact of urban development is the increased water demand; thus affecting other sectors such as agriculture, economy and health. Thus, water availability is avery crucial issue in Greater Malang; for instance it is believed that the size of the water reserve in Malang City has reduced over the last 20 years, and there is now only ten percent left[3]. This condition is mainly as a result of land use change into settlement and commercial zones. In addition, in terms of flood hazard, Perum

[1] Extracted from East Java Spatial Plan 2011 – 2031 (Final Document)
[2] See further in Chapter 7
[3] See Water Sector Report for Greater Malang, Setiawan, B. et al, 2011, p.21

Jasa Tirta I recorded six floods in the Greater Malang which caused serious impact between 2002-2006[4].

The following strategic issue is related to agricultural activities, especially their importance for Batu City and Malang District; i.e. agriculture is the highest contributor to GDP in both areas as well as the main livelihood source indicated by its highest absorbption of workforce. However, its productivity is affected by climate conditions, there are several strategic issues specifically for the agriculture sector in Greater Malang, as follows[5]:

a) Intense rainfall often causes flooding of agricultural land, thus leading to crop failure, i.e. in wetlands paddy field. However, rainfall is concentrated only in a few months while the remainder of the year is dry, causing drought, i.e. in drylands such as in Donomulyu, Bantur, Gedangan, Sumbermanjing, Pagak, Ampelgading, and Pancokusumo Subdistricts.
b) The beginning of the rainy and dry seasons has changed, thus farmers are having difficulties in determining the initial time for the planting season; i.e. both in dryland and rainfed, e.g. Donomulyu, Bantur, Gedangan, Sumbermanjing, Pagak, Ampelgading, and Pancokusumo Subdistricts.
c) The rainy season has shifted into a shorter period thus followed by a short planting season. Therefore, farmers tend to prefer short-lived crops (*palawija*), e.g. in Donomulyu, Bantur, Gedangan, Sumbermanjing, and Pancokusumo Subdistricts.
d) The availability of water resources for agricultural land has decreased, thus triggering conversion into non-agricultural lands such as in Kedungkandang, Sukun, Blimbing, Lowokwaru, Batu, Junrejo, and Bumiaji Subdistrict.

The final strategic issues is related to health and its relation to climate change impact. Basically the climatic variation, rise of temperature and percipitation is believed to be plausibly affecting the incidence of several diseases; i.e. in this case dengue fever, malaria, and diarrhea. However, the status of health-related development in Greater Malang may increase or reduce vulnerability to impact of climate change, i.e. incidence of those diseases. There are several strategic issues related to health, as follows[6]:

a) Almost every PHC in Malang City already meet this target except Janti, Pandanwangi, Dinoyo, Kendalsari PHC. Districts with low UCI coverage need serious attention since they possess a higher risk of infectious diseases and epidemic event occurrence;
b) The high prevalence of communicable disease in Malang City is influenced by community behaviour, economic conditions, environment and climate factors. In 2008, four epidemic events occurred in Malang City, with dengue fever as the highest outbreak. This happened because most areas in Malang City are highland areas with a mild temperature which is very suitable for Aedes Aegepty's breeding site.
c) Among areas in Greater Malang, Malang City is equipped with adequate health facility and medics; i.e. nine general hospitals, 15 PHCs, 641 IHCs, and 2.925 medics.
d) In relation to sanitation conditions, Malang City is leading with the level of coverage as follows: 1) 75,51% coverage of clean water, 2) 76,62% houses with healthy wastewater facilities, and 3) 76,99% of houses with good-latrines.

[4] For details refers to Water Sector Report for Greater Malang, Setiawan, B. et al, 2011, p.22
[5] See further in Agriculture Sector Report for Greater Malang, Handoko and Ruminta, 2011
[6] See further in Health Sector Report for Greater Malang, Sofyan, A., 2011

2. Supporting Scientific Data

2.1 Climate Analysis and Projection

2.1.1 Mean Annual Pattern of Rainfall and Temperature in Greater Malang

The Greater Malang Region, which is situated in the East Java Province of Indonesia, now consists of three administrative regions i.e. Malang and Batu Cities (kota), and the districts (kabupaten) of Malang. Because of its unique climate, there have been centres for agricultural activities in Malang since the Dutch colonial era. However, past climate studies specific to the area are difficult to find. Nevertheless, information about the climate of Malang may be found in more recent studies of the Brantas catchment area.

The climate of Malang, as part of Java, is basically governed by the Asia-Australian monsoon. The west monsoon occurs during the Asian winter (December-January-February) and normally brings rain, while the east monsoon that occurs during the Australian winter (June-July-August) is usually dry. We used both long-term globally gridded data (1900-2008) provided by GPCC and local observational data provided by PUSAIR-PU of the ministry of public works (1980-2009) to calculate the mean annual rainfall of Malang area. As shown in Figure 1.1, the rainfall of Malang is predominantly monsoonal in type with one single peak around January. This result is consistent with other studies such as that reported by Aldrian and Djamil (2006). Although there are some discrepancies, both global data and local observations clearly show similar annual patterns (Figure 1.1 (a)). Results of further analysis of global data from 1951 to 2008 (Figure 1.1 (b)) indicate that there have been relatively large inter-decadal variations in the rainfall of each month, especially in March. These variations may affect the onset and length of the rainy season, which occurs around October, and also the length of the dry season in each individual year.

Long-term temperature records for the Malang area are only available in the form of globally gridded temperature data provided by the University of Delaware (UDEL). Similar to that of Figure 2.1 (b), the annual variations of monthly mean temperature analysed from UDEL data are depicted in Figure 2.2. It can be seen that temperature has two peaks corresponding to the equinoxes with the “coldest” temperature occurring in July during the Australian winter. The annual temperature variations are also characterised by inter-decadal changes with a long-term average of around 25° C as Malang has relatively high elevation. It should also be noted that the highest mean temperatures have been observed during the last decade (data of 2001-2008), which will be discussed further in the next sections.

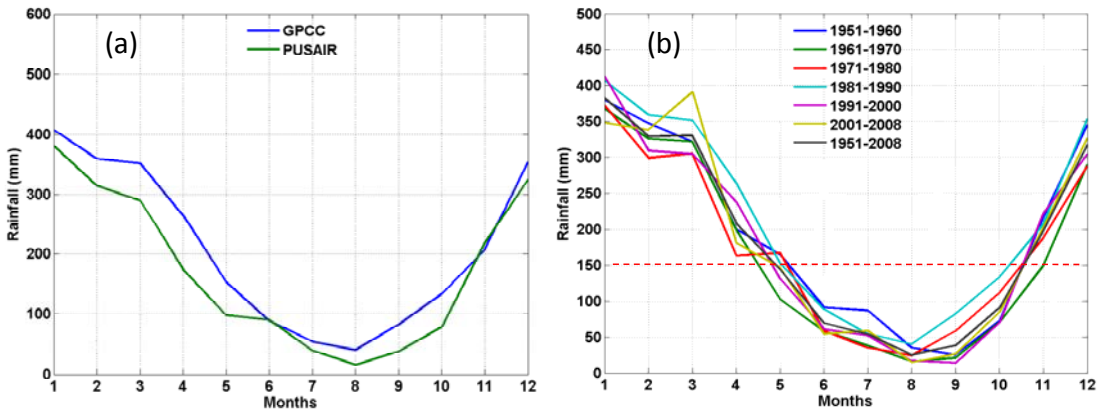


Figure 2. 1 Mean annual variation of monthly rainfall in Malang
(a) comparison between global data (GPCC) and local observations (PUSAIR) during 1981-2008period and (b)mean decadal pattern since 1951 analyzed from the global data. Red dashed line indicates the rainfall of 150 mm, which can be used as a threshold for defining dry season.

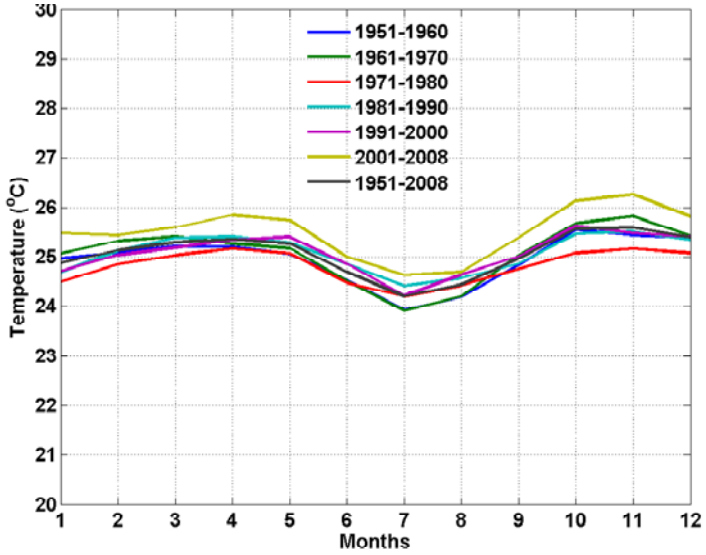


Figure 2. 2 Mean annual variation of monthly mean temperature in Malang analyzed from globally gridded temperature data provided by the University of Delaware (UDEL).

2.1.2 Historical Climatic Hazards: Trend, Variability, and Extremes

Climatic change may be manifested by the changes in two main statistical parameters, namely mean and variance, of any weather/climate variables observed throughout at least two consecutive climatic periods. By WMO definition, a climatic period is defined as 30 years time span. Secular change in surface temperature is always of interest to analyse in conjunction with the global warming issue. Figure 1.3 shows long-term fluctuations in surface temperature analysed for Malang from the UDEL temperature data. It can be seen that the three linear trend lines calculated for the last 25, 50, and 100 years all show increasing patterns with the largest increase of 0.69° C during the last 25 years.

The temperature trends of Surabaya and Pasuruan have been analysed by Harger (1995) with inferred positive trends of 1.4 and 1.0 per century. We also analysed the temperature trend of other regions from the same data set and our results indicate that the increase of temperature during the last 25 years is of regional scale and may have been affected by global warming. It should be noted that large changes in the temperature trend occurred after the mid 1970s, which marked the “Climate Shift” phenomenon. The origin of the phenomenon is still a matter of debate but IPCC scientists suspect that anthropogenic global warming was the main cause. It seems to differ from previous decades, which are marked by larger inter-decadal fluctuations in surface temperature.

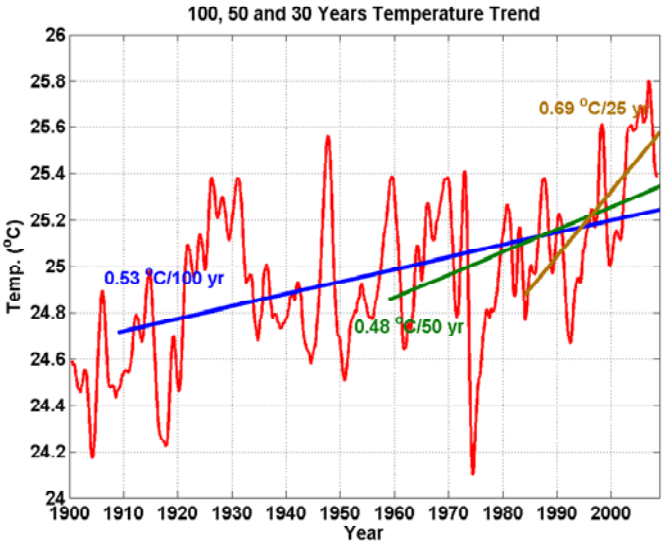


Figure 2. 3 Temperature fluctuations and linear trends calculated from UDEL temperature data for Malang. Blue, green, and orange lines indicate the linear trends of the last 100, 50, and 25 years. Running mean smoothing was applied to monthly temperature data before plotting.

2.1.2.1 Inter-annual Rainfall Variabilities

Unlike the case with temperature, trend analysis is not suitable for identifying the hazard of rainfall change because long-term fluctuations in rainfall data are much larger compared to the secular trend. Therefore, the hazard of rainfall change is better analysed in terms of inter-annual and inter-decadal variabilities.

In the tropics, rainfall variations at the inter-annual time scale are known to be largely affected by global climatic phenomena known as El Niño Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD). These phenomena are related to the dynamic behaviour of the Pacific and Indian Oceans, which are manifested as temporal and spatial variations in Sea Surface Temperature (SST). Indices that represent the climatic events associated with ENSO and IOD have been developed based on SST measurements. Scatter plots in Figure 1.4 show the correlation between ENSO and IOD indices with Standard Precipitation Index (SPI) of Malang. SPI is one of the simplest indices to represent drought level based on certain statistical distribution of rainfall observed at a specific location. Thus, SPI signifies the deviation of rainfall amount during a period of time (one-, three-, six-, twelve-monthly, and so on) from its local long-term mean. In Figure 1.4, six-monthly SPI values are presented with more negative (less than -0.9) SPI means more severe drought event.

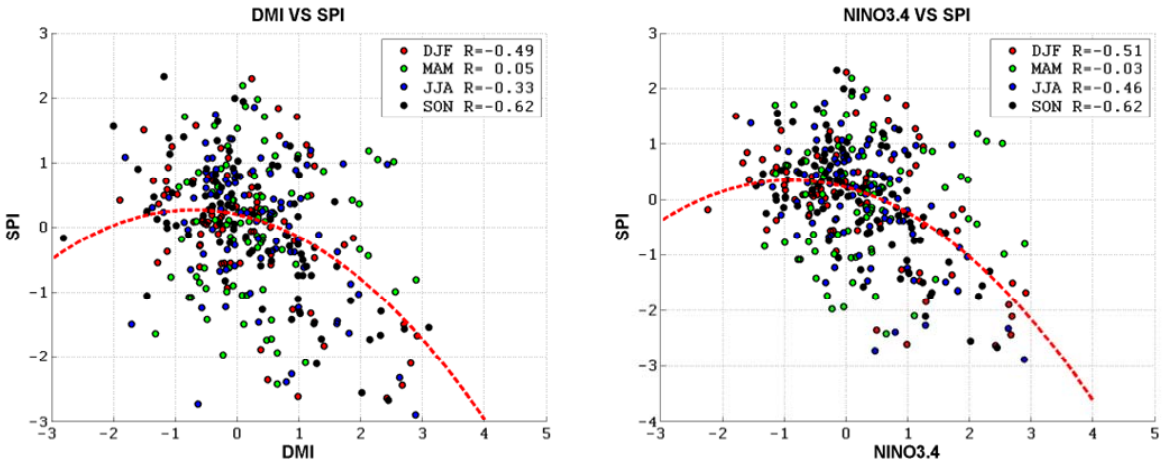


Figure 2. 4 Correlation between 6-monthly Standardized Precipitation Index (SPI) calculated from rainfall of Malang (from GPCC data) and Dipole Mode Index (DMI)(left) as well as ENSO index (Nino3.4 sea surface anomaly)(right).

From Figure 2.4, it can be seen that drought events in Malang are correlated with strong El Niño and Dipole Mode (+) events. Correlation between El Niño and SPI is somewhat higher but same correlation is found for September-October-November, when the impacts of both El Niño and Dipole Mode(+) are strongest. In this case, it is assumed that the strength of ENSO/Dipole Mode is represented by the absolute value of the indices. However, it should be noted that negative events (La Niña/Dipole Mode (-))can be associated with wet climate conditions in average but not extreme ones. As indicated in Figure 1.4, the most extreme "wetness" level occurs during neutral (weak ENSO and IOD) events but with a large spread in the SPI data. This implies that the neutral ENSO-IOD state imposes uncertainty in the rainfall of Malang. We found similar and consistent results for the correlations between SPI in Indonesia with ENSO/IOD events.

ENSO is a quasi-periodic phenomenon, by which the state of the Pacific Ocean swings between cool (La Niña) and warm (El Niño) phases. El Niño may occur every two to five years and recent investigations suggest that El Niño frequency tends to be higher. However, data for the past one and a half centuries indicate that strong El Niño events, which may cause severe drought only reoccur about once every 20 years. The impact of more frequent changes between El Niño and La Niña will be more likely associated with frequent occurrence of the neutral state, in which rainfall conditions of Malang maybe more unpredictable.

2.1.2.2 Inter-decadal Variations of Rainfall and Temperature

Rainfall variations at the inter-decadal time scale are quite important in the analysis of climate change. As previously mentioned, a climatological period is defined by WMO as a 30-year time window so that inter-decadal variations may have significant contribution to a component of detected climate change. Recent studies indicate that two oceanic variations known as Pacific Decadal Oscillation (PDO) and North Atlantic Oscillation (NAO) may influence the climate in Asia and Australia at an inter-decadal time scale.

Figure 1.5 shows box plots of inter-decadal rainfall time series (each box represents statistics of ten-year rainfall data) at Malang during the period of 1951 to 2009. It can be seen that, during the 1960s, the dry season (June-July-August) was relatively dryer compared to other decades. In contrast to that, the dry season was relatively wetter during the 1980s. Similar variations can be found for September-October-November period but with the leading phase. These results may indicate that the inter-decadal rainfall variations were caused by the gradual changes in the strength of the monsoon. In this case, the changes

first affected the dry-to-wet transition period before they caused stronger dry monsoons to occur.

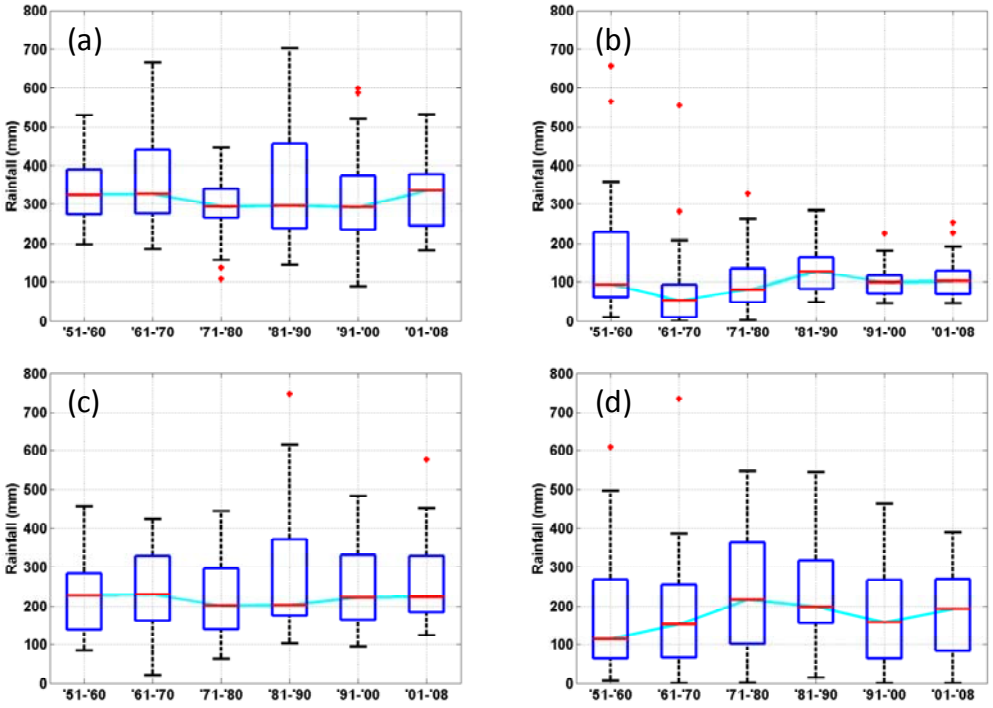
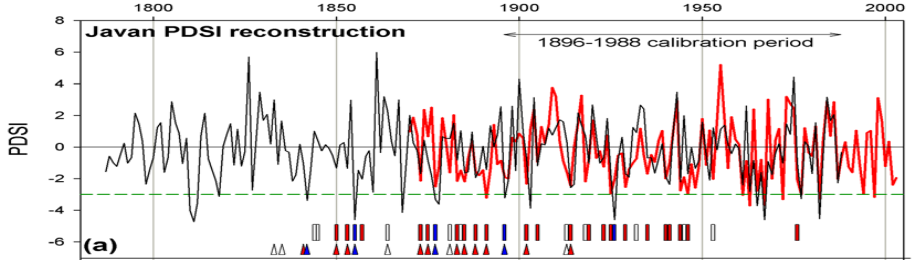


Figure 2. 5 Box-plot of inter-decadal rainfall time series of Malang (calculated from GPCC data) for (a) December-January-February, (b)June-July-August, (c)March-April-May, and (d)September-October-November. Each box represents the statistics of ten-year rainfall with cyan-colored lines connects the median values.

We also analyzed rainfall data of Tarakan and East Kalimantan, and found a similar pattern of a “dryer” dry season during the 1960s. We have not investigated the cause of the phenomenon but it is of interest to note that our results are consistent with that of D’Arrigo et al. (2006) who analysed the variations of Palmer Drought Severity Index (PDSI) as shown in Figure 1.6. It can be seen that, for the past sixty years or so, the climate of Java was relatively dryer during the 1950s to 1960s. It should be clear that inter-decadal changes in rainfall could cause a long-term negative rainfall anomaly. The effects of such negative rainfall anomalies will be more severe if combined with higher temperature due to global warming. Therefore, meteorological drought is one of the climatic hazards that must be seriously considered and anticipated in Malang, with or without global climate change.

Inter-decadal variations in temperature do not show specific climatic phenomena but Figure 1.7 clearly shows the increasing trend of surface temperature. This result confirms that the large changes, as previously mentioned, occurred during 1970s to 1980s due to the climate shift.



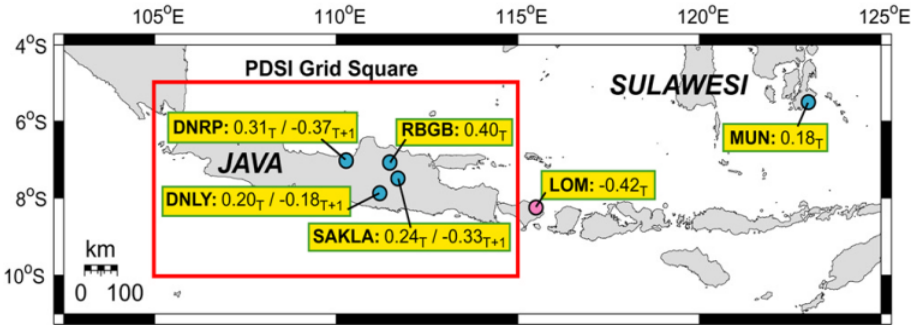


Figure 2. 6 Results of historical drought in Java Island analysis that has been reported by D'Arrigo et al. (2006). Upper panel : calculated (red line) and reconstructed Palmer Drought Severity Index (PDSI; black line) over Java Island. Lower panel: locations of tree-ring samples.

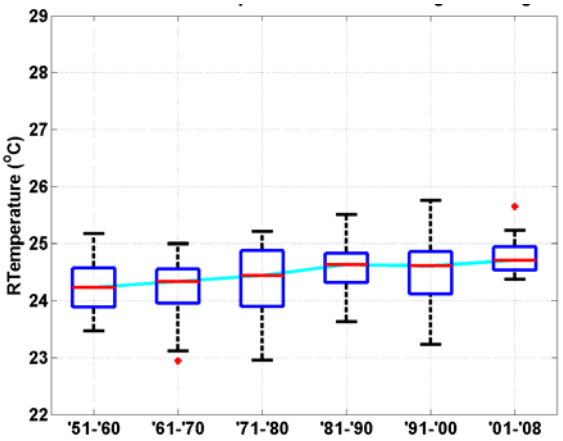


Figure 2. 7 Decadal plots of temperature variations (Similar to Figure 1.5 except for temperature in June-July-September).

2.1.3 Projection of Future Rainfall and Temperature Changes

Although there is a high degree of uncertainty, climate projection into several decades in the future is a fundamental element of climate change impact assessment. Two approaches may be used for climate projections: (i) projection based on empirical regression model, and (ii) projection based on the output of Global Circulation Models (GCMs). In this study, the former is only applied for rainfall projection, while the latter is used for both rainfall and temperature projection.

2.1.3.1 Empirical Projection of Inter-decadal Rainfall Variations

As previously mentioned, interdecadal rainfall variability may be associated with global oceanic variations known as PDO and NAO. Thus, an empirical regression between PDO and NAO indices and smoothed (or low-pass filtered) rainfall model can be developed to predict the trend of rainfall changes in the next couple of decades. Results of the empirical regression is presented in Figure 1.8. The regression parameters were chosen so as to obtain the best fit for the observation during the testing period i.e. the period in which observational data were not included in the calculation of regression parameters.

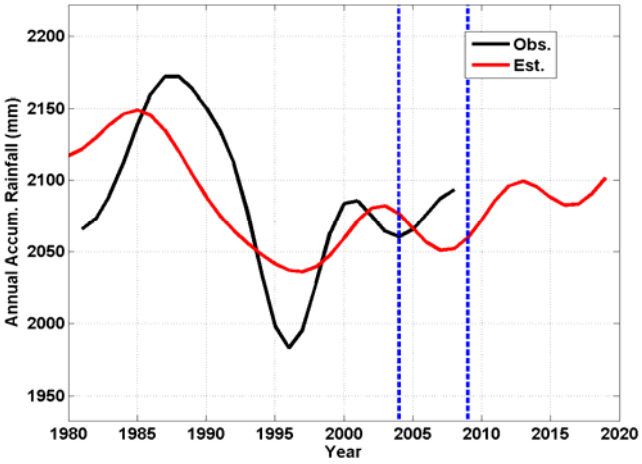


Figure 2. 8 Result of empirical regression between PDO and NAO indices and smoothed annual rainfall observed over Malang (black line).
Time window between blue dashed lines indicate "testing" period and red line shows projected rainfall until 2019.

Despite the differences in phase and amplitude, the projected rainfall shown in Figure 1.8 depicts similar inter-decadal rainfall variations with observations. Moreover, the empirical projection is mainly used for obtaining a qualitative view of future trends in the range of rainfall changes. This result indicates that, until the end of this decade, there will be only modest inter-annual rainfall variations, probably due to ENSO or Dipole Mode events.

2.1.3.2 Rainfall Projection Based on GCM Outputs

Global Circulation Models (GCMs) are the only tool that we can use to study the possible states of Earth's climate in the far future. Outputs of seven GCMs contributed for the IPCC AR-4 (the 4th Assessment Report) are used in this study to obtain projections of rainfall in Malang. Three carbon emission (SRES) scenarios i.e. B1 (low), A1B (moderate), and A2 (high) were chosen. The common problems with these GCM data for regional or local climate change risk assessment are the low horizontal grid resolution and the diverse results of rainfall estimation, especially in the tropical regions. In this study, a simple ensemble averaging and bias correction method has been applied to the GCM outputs to produce the rainfall projections as shown in Figure 2.9. It is found that almost all of the seven IPCC models that we have selected failed to produce rainfall variations. In Figure 1.9, the best model was obtained by using a correlation coefficient against observational data as weights for each model in the ensemble averaging process.

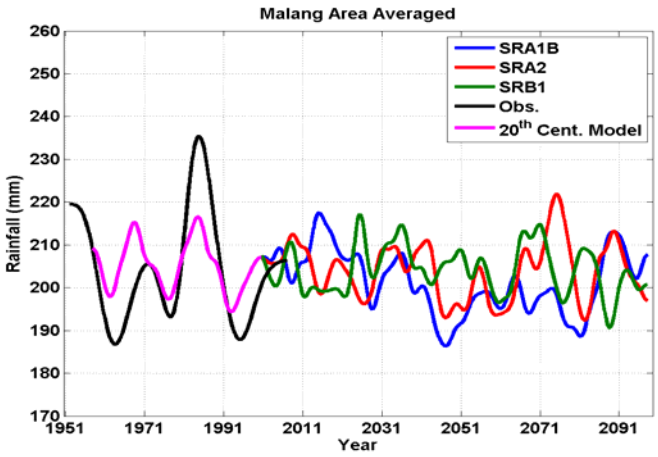


Figure 2. 9 The projected rainfall variations of Malang in the 21st century based on GCM output. Blue, green, and red lines respectively represent the results of B1, A1B, and A2 SRES scenarios with extension back to 1951 (20th century; magenta line). Smoothing by moving average was applied to the monthly time series before plotting.

Although the models shows large discrepancy from observations, the future rainfall variations projected using A1B scenario is consistent with that of empirical results. Accordingly, it is important to note that drought hazard is projected to occur around the 1950s. This result agrees with previous study by Naylor et al. (2007), who analyzed projected rainfall changes in 1950 (only). They concluded that in East Java, the dry season would be longer and the onset of monsoon would be delayed by about 30 days. Our results show that the trend of decreasing rainfall around 1950 is consistently shown by all scenarios. It should be noted that rainfall projection is produced for spatial grids over Greater Malang region. In order to provide more detailed spatial variations, we have developed a different method of rainfall projection based on Constructed Analogue (CA) method. For the case of Malang area, we used the two methods complementarily. In this case, we have used high quality rainfall observations provided by PUSAIR, although the data are only available for less than 30 years. We prefer to use this method because it is possible to produce rainfall projection with high spatial resolution that is required in sectoral analyses. However, detailed spatial variation produced by the projected rainfall data should be interpreted cautiously because it may contain meaningless artefacts. Thus, attention should be paid more to the average trend rather than detailed spatial variation.

We further analyzed the GCM outputs of A1B scenario using CA method and presented the result in Figure 2.10. In this case, we restricted the projection to focus on the period between present and 2030. In spite of discrepancies in the trends shown by the three (empirical regression, BSCD, and CA) methods, we can still notice that in general the average rainfall (monthly or yearly) is projected to remain about the same or increasing. So, the climate of Malang area can be expected to be as wet as, or wetter than, present day until 2030. The potential hazard of decreasing rainfall is maybe greater after 2030. In particular, it is worth noting that the decreasing trend of rainfall around 2050 is consistent with Naylor et al. (2007) who pointed out that rainy season in East Java will be delayed by around 30 days during the period.

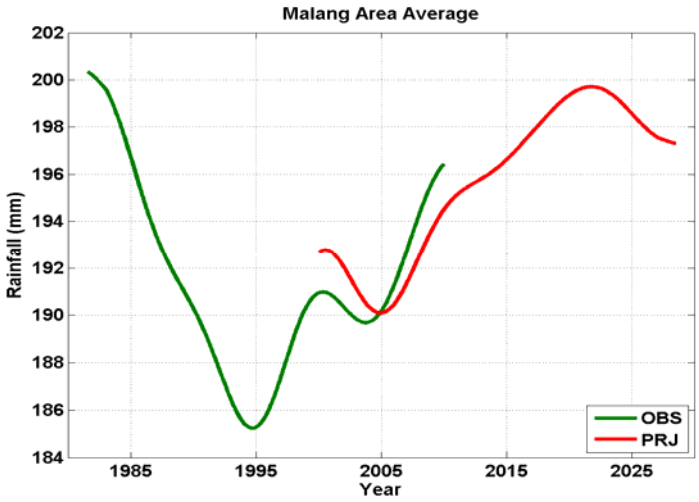


Figure 2.10 Similar to Figure 2.10 except for the results of CA method with smoothed time series of PUSAIR monthly rainfall (green) and SRES A1B analogue projection (red).

Figure 2.11shows the spatial pattern of the changes of the projected May rainfall from the baseline (taken as 1980 to 2000 period) in two consecutive decades of 2011-2020 and 2021-2030 with interpolated (and extrapolated) grid values. It can be seen that the pattern consistently indicates decreasing rainfall over the eastern part and increasing rainfall over the region of higher topography on the western side. The decreasing pattern of the rainfall is even more prominent for June rainfall, as shown in Figure 2.12. This may indicate that the climate of Malang region will be more influenced by the dry Australian monsoon that probably continues strengthening until 2050s. Stronger Australian summer monsoon (east monsoon over Java Island) may cause the delay of rainy season, as pointed out by Naylor et al. (2007).

During the next two decades, however, the transitional changes in monsoon circulation and higher frequency of ENSO cycle will result in more uncertain seasonal rainfall patterns. Therefore, rather than decreasing trend of rainfall, higher climatic variabilities will likely contribute more to climatic hazards.

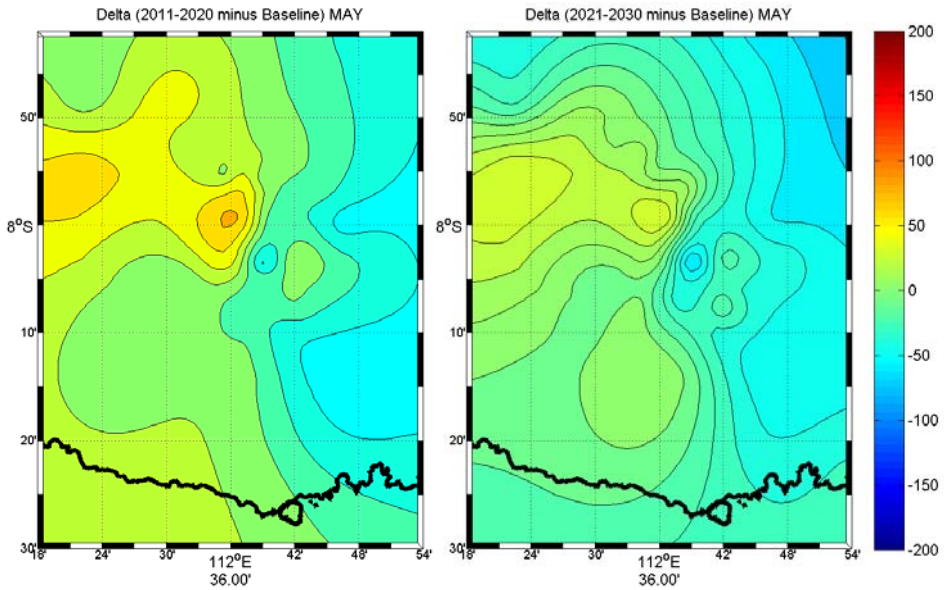


Figure 2.11 Spatial pattern of changes in the projected May rainfall in two consecutive decades of 2011-202 (left) and 2021-2030 relative to baseline observation period of 1980-2000 (data of PUSAIR.

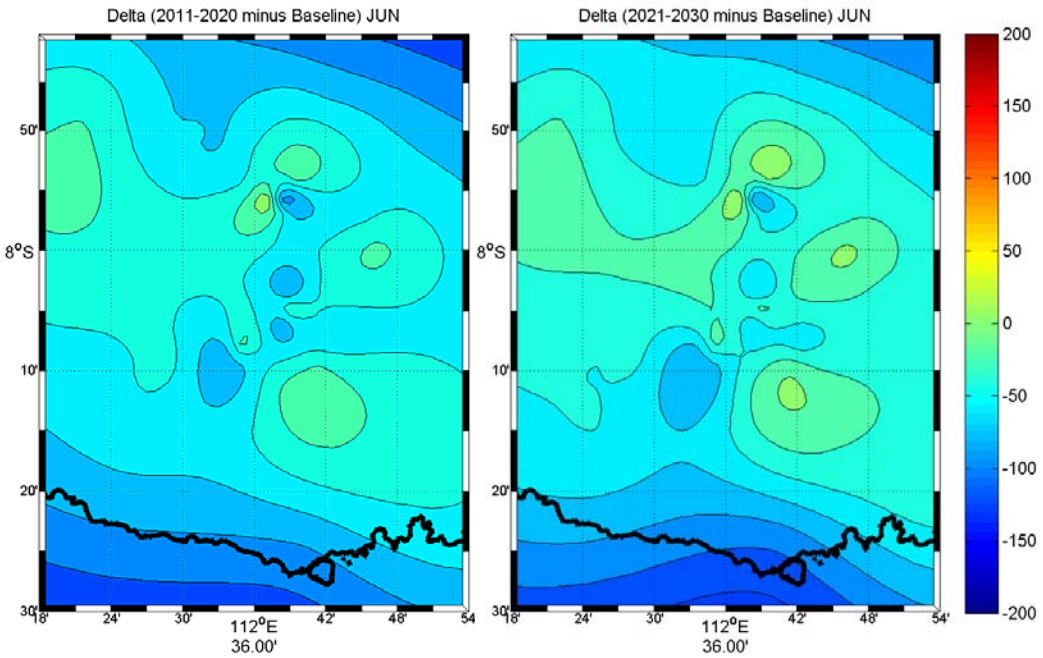


Figure 2.12 Same as Figure 2.11 but for June rainfall.

2.1.3.3 Temperature Projection

Temperature projection has also been made based on GCM output using methods similar to that of rainfall, and the results are presented in Figure 2.13. It can be seen that the model matches the temperature trend over the last 25 years, which signifies the effect of global warming. All scenarios have projected similar temperature trends until 2030 with an increase of about 1°C compared to the 1961-1990 baseline period. Based on the IPCC model, the temperature will further increase by about 2°C by the end of the 21st century with A1B and A2 scenarios.

As with rainfall, we produced temperature projections on spatial grids but we found that the data do not show consistent variations with topography. Therefore we have made corrections based on simple a diabatic lapse rate by which temperature decreases with height by about 1^{o}C every 100 m. It should be noted that we also used the temperature observed at Karang Ploso climatological station of BMKG to make gross bias correction before applying adiabatic correction. The projected surface temperatures do vary from month to month with highest increase around April-May and October-November and lowest increase in July.

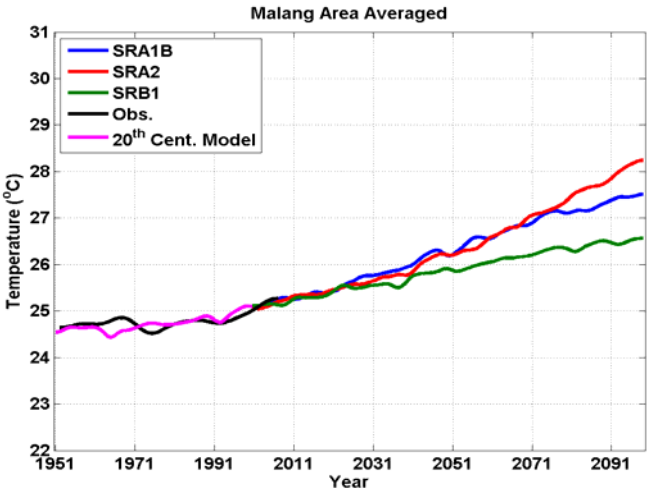


Figure 2. 13 The GCM out based projected temperature of Malang for the 21st century with an extension back to 1951 (20th century). Data has been smoothed to show only the long-term trend.

It should be clear that IPCC models mainly take the effect of solar radiation and the trapping of long wave radiation by CO_2 to produce the temperature increase, while weather processes seem to give less significant contribution for the creating the temperature trends. It is quite interesting, however, that averaged temperatures in September and October do not change much during two consecutive decades of 2001-2010 and 2011-2020. In this case, more temperature increase has been projected for the months of January to June. This seems to be consistent with the decrease of rainfall during rainy-to-dry season transition period due to the strengthening of dry Australian monsoon as previously discussed.

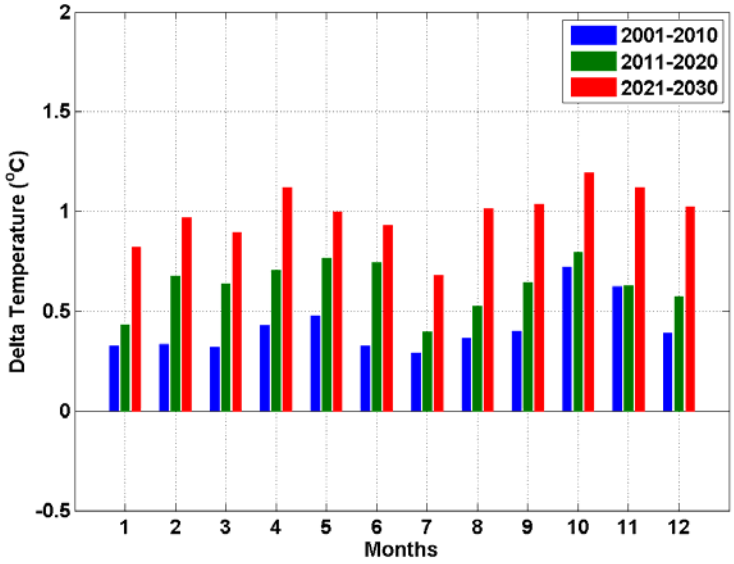


Figure 2.14 Pattern of changes in the projected rainfall in three consecutive decades of 2001-2010 (blue), 2011-2020 (green), and 2021-2030 (red) relative to baseline observation period of 1980-2000 (data of PUSAIR).

2.1.4 Analysis of Extreme Events

Information about extreme events is important in climate change risk assessments. Analysis and projection of extreme events are, however, more difficult to perform because it requires more detailed and accurate data. Long records of observed daily temperature and rainfall are at least needed to analyse the extreme events, while GCM outputs with daily time resolution are also required for the projection. In tropical regions, extreme temperature

events such as heat wave are very rare events. Therefore, only several aspects of extreme rainfall events in Malang are briefly discussed below.

2.1.4.1 Historical Records of Extreme Rainfall

Extreme rainfall events can be analyzed in various ways but data with high temporal resolution are always needed. In this case, daily rainfall data provided by PUSAIR are quite useful to analyse the distribution of extreme rainfall events, although the time span (most stations recorded data less than 30 years) is still quite limited for climate change studies. In order to analyse the probability of extreme events, we propose the use of the "probability of exceedance" curve as shown in Figure 1.11. It can be seen that, for example, 150 mm rainfall/day has a probability of about 40% to occur once in 10 year. For comparison, results of "return periods" calculated by Nippon Koei Co. Ltd. (Hidayat et al., 2008) show that over the Madiun Basin, rainfall with 141 mm/day has a return period of 100 years.

According to the definition of BMKG, 100 mm/day is considered as a very heavy rainfall event. In Figure 1.11, it can be seen that the probability of 100 mm/day rainfall is 80% to occur in 5 years and 60% to occur in 2 years. If 100 mm rainfall is to cause flooding in Malang, then all drainage systems should be designed at least to withstand this rainfall amount. We leave it to the water sector experts to do further analysis of these data.

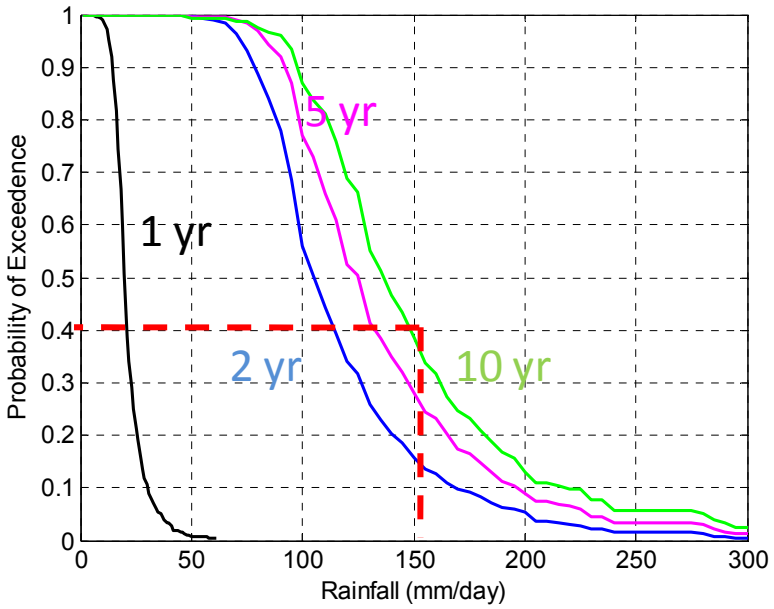


Figure 2. 15 Probability of exceedence calculated from daily rainfall observations over more than 40 stations provided by PUSAIR-PU with a time span from 1981 to 2009.

2.1.4.2 Future Changes in the Probability of Extreme Rainfall

One of the challenging problems in our work is how to find useful relationships between the distribution of monthly and daily rainfall data. Extreme events can be statistically represented by the data falling into the uppermost percentiles of the distribution. For example, P90 represents values that exceed the 90th percentile of the cumulative distribution. With this definition, we can combine all data for analyzing the correlation pattern between the monthly and daily rainfall. From available daily rainfall data of Malang, we calculated the probability of occurrence of daily rainfall larger than the threshold of the 90th, 95th, and 98th percentiles in each month corresponding to classes of monthly rainfall. The results are presented in Figure 2.16. It is also quite interesting that the highest (more than 10%) probability of occurrence of extreme events corresponds to monthly accumulated rainfall between 250 to 450 mm. Thus,

extreme monthly rainfall does not necessarily correlate with extreme daily rainfall. In fact, extreme daily rainfall has the strongest correlation with “moderate” monthly rainfall.

We have not found exact explanation for correlation pattern (Figure 2.16), but further inspection revealed that the rainfall during March-April-May period shows the most significant shift in their distribution (see Figure 2.17). We suspect that extreme daily rainfall may occur more often during monsoon transition periods or during the rainy season with relatively frequent “break” periods. More detailed investigation is required to proof the hypothesis and better understand the mechanism.

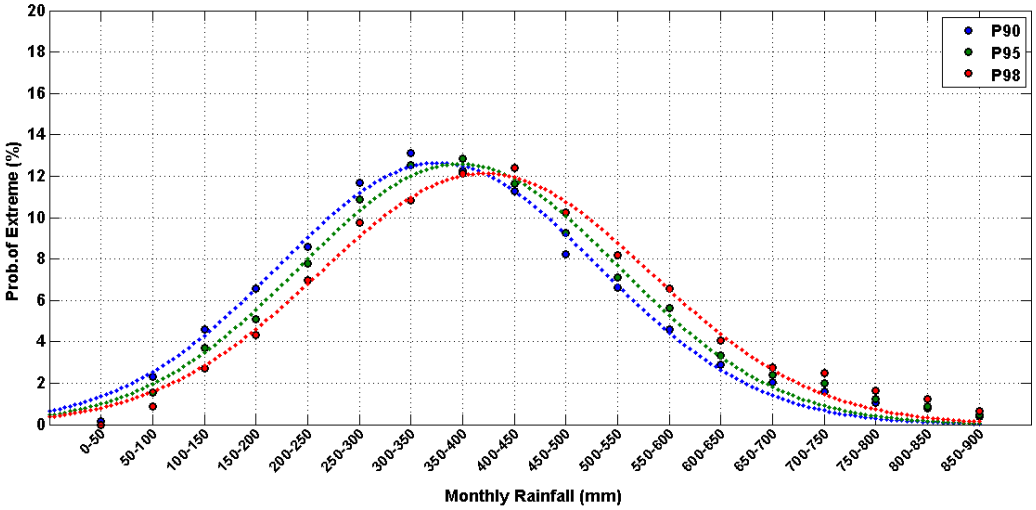


Figure 2.16 Curves that represents the relationships between the probabilities of occurrence of extreme rainfall (values exceeding the threshold of 90th percentile) as a function of classes of monthly rainfall.

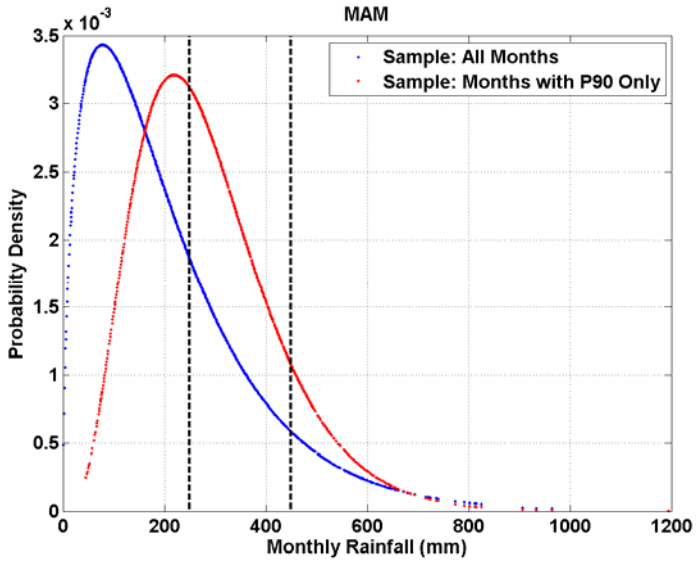


Figure 2.17 Probability distribution shifts of occurence of extreme rainfall in all months (blue) and sampled moths with P90 (red)

Having found that the monthly rainfall of 250-450 mm can be used as a proxy for extreme daily rainfall event, we then analyzed the future changes in its probability of occurrence. Figure 2.18 depicts the calculated probability of occurrence of 250-450 mm monthly rainfall from observed and projected data binned into decadal periods. In this case, we only used monthly rainfall projection with SRES A1B scenario for Malang area. Despite the discrepancy between projected and observed probability over the 2001-2010 period, it is

clear that an increase in the probability of extreme events is projected in the GCM outputs. Particularly, this result indicates that an average increase of about 5% is possible to occur within the next two decades.

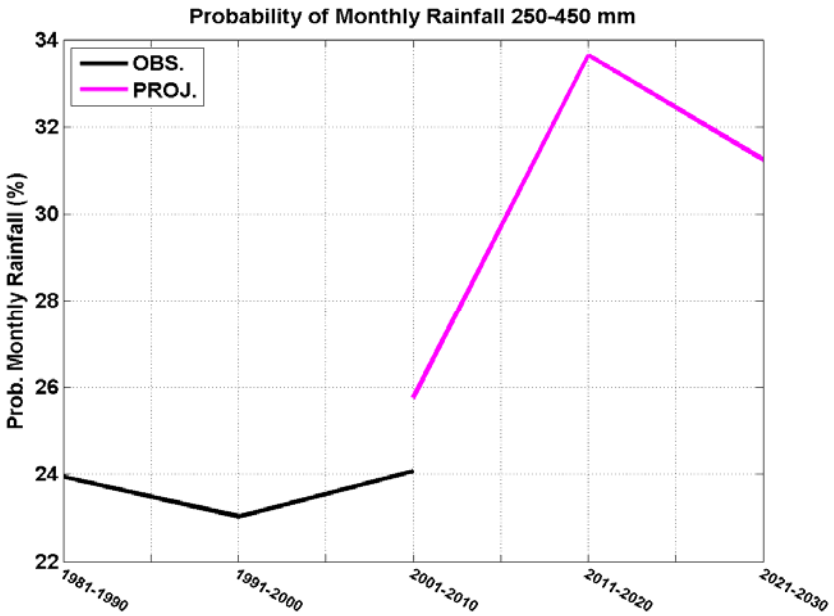


Figure 2.18 Probability of occurrence of 250-450 mm monthly rainfall from observed and projected data binned into decadal periods

3. Risk and Adaptation Assessment Methodology

This part will discuss the approach, framework, and methods being used to assess climate hazard, vulnerability, and risk in Greater Malang. In addition, assumptions for the future trends (related to climatic and non-climatic hazard) and problem simplification will also be explained here, since it affects the methods used for assessing hazard and vulnerability.

3.1 Approach, Conceptual Framework, Steps, and Time Frame

Recent studies on Climate Change Impact, Adaptation, and Vulnerability (CCIAV) suggest that there are at least five types of approach[7]; i.e. conventional approaches, consists of impact assessment, adaptation assessment, vulnerability assessment, and integrated assessment[8]. As for the fifth approach, it can be inferred as an emerging approach in CCIAV, as it adopts a risk assessment framework. The fifth approach has begun to mainstream climate change adaptation into the enactment of development policy (IPCC, 2007). In addition, there has also been some shifting from research driven into a more integrated approach towards policy-making, in which decision makers and the entire set of stakeholders participate in the assessment and sometimes act as the initiator (UNDP, 2005). In the context of mainstreaming climate change into development policy in Indonesia, it is recommended to differentiate climate risk and adaptation assessment into macro, meso and micro levels therby aligning it to the hierarchical structure of government: national, province and local (see Table 3.1). Each level of assessment represents the detail of analysis taken; hence it indicates the level of accuracy of the results which corresponds to the adaptation needs for each level of government's structure. The method of this study is a meso-level approach with the province as the administrative location of the study. Therefore, it is less detailed than other studies such as Climate Risk and Adaptation Assessment in Tarakan City (micro-level study). As a meso-level study, the impact of climate change will beanalysed in the sense that it would affect selected sectors within the kecamatan level.

Table 3.1 Various Levels of Risk and Adaptation to Climate Change

Scale	Data and Analysis	Scope	Level of Planning	Accuracy	Finance
Macro	Qualitative	National	Adaptation Policy	Low	Low
Meso	Combination of qualitative and quantitative	Provincial	Adaptation Strategy	Medium	Medium
Micro	Quantitative	Local	Adaptation Actions	High	High

Source: modified from Messner (2005) in Suroso (2008)

A risk assessment framework has been well developed within natural disaster communities and has started to be adopted in the study ofclimate change (Klein, 2004). Since the Third Assessment Report, the definition of vulnerability from the IPCC has been improved to take into account social vulnerability (O'Brien, et al., 2004) and to reconcile it with risk assessment (Downing and Patwardhan, 2005). The framework and methods for vulnerability assessment must also include adaptive capacity indicators (Turner, et al., 2003; Schroter, 2005; O'brien and Vogel, 2006).

[7]Assessment approach can be defined as direction and scope of study in which particular assessment being conducted. An approach may consist of several different methods. In addition, method itself is being defined as a systematic analytical process.

[8]See "*Decentralized Vulnerability Assessment to Climate Change Assessment in Indonesia: Using Regional-Multi Sector Approach at Provincial Level*", in Suroso (2008).

Affeltranger, et al. (2006) proposed a risk notation (Risk), as a function of Hazards and Vulnerability using the formula[9]:

Risk (R) = Hazards (H) X Vulnerability (V)

IPCC (2001) defines vulnerability as follows: "a function of character, magnitude and rate of Climate Change and the variation to which a system is exposed, its sensitivity and its adaptive capacity". In the context of risk and adaptation assessment to climate change, based on the risk notation from Affeltranger, et al. and vulnerability definition from the IPCC above, we can determine two definitions as follows:

1) Hazard due to climate change is a function of characteristic, magnitude, and rate of climate change and variability.
2) Vulnerability of a system to climate change is a function of exposure, sensitivity, and adaptive capacity.

As follows, here are the general steps of climate risk and adaptation assessment being done in Greater Malang:

1) Formulation of Problems and Identification of Vulnerable Sectors to Climate Change
This step is very important in laying the foundation for the study. Techniques which can be implemented include brainstorming, public consultations, and focus group discussions. This step is aimed to determine sectors which are considered to be vulnerable to climate change and also as a forum for early interaction with stakeholders in concerned regions. In this step, we can also communicate on data needs and availability between the experts involved in this study and related institutions in the region.

2) Analysis of Hazard due to Climate Change
In this step, the character, magnitude, and rate of hazards are analysed based on current and historical climate information, and also future projections of climate change.

3) Analysis of Vulnerability of Sectors due to Climate Change Impact
In this step, identification of vulnerability indicators, data collection, and analysis of GIS (Geographic Information System) are conducted. Then vulnerability maps can be produced.

4) Analysis and Evaluation of Climate Risk for Sectors
As defined by Affeltranger, et al. (2006), risk is a result of overlay between hazard and vulnerability. Thus, risk levels are obtained from overlay between maps resulted by Step 2 and Step 3 above.

5) Formulation of Adaptation Strategies for Sector
Having completed Step 1 to Step 4, a good understanding on the level of risk of vulnerable sectors will be obtained so that appropriate adaptation strategies/measures can be identified to respond to climate change impact.

6) Multi-Risk Assessment and Adaptation Prioritisation
After the risk assessment is completed by each sector and has been followed by initial adaptation recommendations, the multi-risk assessment and adaptation prioritisation are started. In a multi-risk assessment, the study overlays all the general risk profiles of sectors in Greater Malang, as well as its regional/conceptual adaptation . Therefore, particular districts/cities exposed to more than one hazard can be identified. In addition, the adaptation prioritisation is conducted through an iterative process of short-listing the District based on its vulnerability components.

7) Mainstreaming Adaptation Strategies into Development Policies
Climate risk assessment and policy making do not occur in a vacuum, particularly within the provincial government context. Climate change is only another factor to consider among the many aspects that government already takes into account in all its policy-making. Climate change considerations may revise policies through the application of risk management processes in prioritising adaptation options.

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[9]See further on*Decentralised Vulnerability Assessment to Climate Change Assessment in Indonesia: Using Regional-Multi Sectoral Approach at Provincial Level* by Suroso (2008).

The emphasis here is on understanding the scope and variation of climate change, and applying risk assessment as a method to determine adaptation responses based on the risks. 'Best' knowledge of climate change, together with use of risk assessment procedures, can help local government prepare to help the community adapt to known climate change.
Risk management is well fitted into plan making and review processes at the stages where issues are being identified and a range of possible response options are evaluated. The iterative process of plan formulation, monitoring and evaluation enables for revision of plans over time to take account of improved understanding of risks due climate change. In considering climate change issues, the period over which the decision will have effect is of fundamental importance. Generally, whenever a decision is likely to have effects that will last 30 years or more, the implications of climate change should be taken into account.

In general, the climate risk assessment for Greater Malang area will be conducted for both the baseline situation and future projection. For baseline analysis, year 2010 is being used as reference, thus almost all of the single year data were dated 2010 and historical data ends in 2010. The climatic projection being done in supporting scientific data part of this assessment is until 2100; in addition it is divided into 30 year periods. As for the risk projection, 2030 was chosen as the projected year situation. Therefore, hazard, vulnerability, and risk projection are dated this year as the end of projection; in addition several analyses divide each 5 year period as their stages. The selection of year 2030 as the end year is also due to the time frame of the development system in Malang; i.e. compatible with the General Spatial Plan (RTRW) that planned until 2030. As the Long-Term Development Plan (RPJP) was actually dated to be legal until 2025, it will still be compatible since the RTRW used it as a reference, and also the staging for each 5 years helps to make them compatible with each other.

3.2 Methodology for Hazard Analysis

Analysis of each hazard type is conducted using different methods or models, with different inputs or parameters. Most parameters used in the analysis are taken from the supporting scientific data study results as summarised in the previous chapter. The hazard analysis is performed for current conditions, as a baseline, and the for the future, which has taken into account the climate projection in the methods or models. The list of methods or models and the parameters used in hazard analysis for each hazard type is provided in the table below.

Table 3.2 Method/Model and Parameters in Hazard Analysis

Hazard Type	Method/Model	Main Parameters
Agriculture	Crop production decline	Crop productions Crop yields Harvest area
Water: Flood	HECRAS	Rainfall SLR Soil type Land use change
Water: Landslide	GEOSLOPE	Rainfall Soil type Land use change
Water: Shortage	Water balance	Rainfall Temperature Soil type Land use change
	Water budget	Total Run-Off Population

		Land use
	FEM WATER	Aquifer geometry Permeability Groundwater storage
Health: Dengue, Malaria, Diarrhea	Regression and correlation model	Rainfall Temperature Incidence rate

3.2.1 Water Sector Hazards Model and Scenario

In detail, a water shortage hazard in baseline conditions is being defined as a decrease in water availability (DoWA) plus value of water demand (WD), being divided by the total water availability. The DoWA and total water availability for baseline conditions are calculated using the water balance analysis method. The result of the water balance analysis is expressed in terms of total runoff (TRO), direct runoff (DRO), and groundwater storage (GW). In addition, Cumulative Distribution Function (CDF) analysis is used to calculate the total runoff (TRO) resulting from the water balance analysis. Therefore, DoWA also can be inferred as a probability of the decrease of water compared to the normal condition. In this sense 50% TRO based on conditions from 1960 – 1990 was being defined as a reference; thus a value below 50% TRO would be concluded as a water availability shortage. On the other hand, water demand is the aspect that may raise the water shortage hazard. In this study, water demand is calculated spatially based on domestic and industrial use, for the baseline situation; as for the projection, the calculation is based on population projection and type of land use based on The RTRW of Greater Malang.

Flood hazard modeling was conducted through the usage of land use, rainfall, discharge, and digital elevation map (DEM). Both baseline and projection of flood hazard analysis was conducted through the Watershed Modeling System (WMS). As the first step on WMS, land use plays a vital role to determine the roughness of the surface of the land; it may affect the overland flow, discharge, and runoff behavior of a particular watershed. Each land use type in Greater Malang, is then assigned a specific roughness value, for the baseline and future situations based on the RTRW of Greater Malang. The second step in the WMS is to delineate the watershed, banks, and to determine the centre line of the stream. Afterwards the flood analysis is transferred to hte HECRAS model to analyse the discharge and water level data.

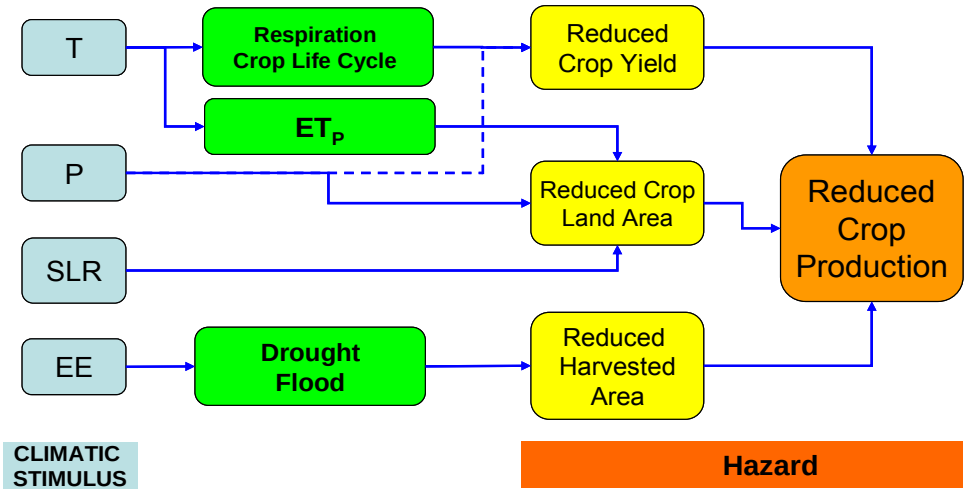
The landslide hazard model is developed by using the concept of extreme rainfall and unique relationships between rainfall characteristics, hydraulic conductivity, suction, and water content of unsaturated soil to evaluate the minimum suction distribution and factor of safety of soil slope. The development of landslide modeling is based on a decreasing value of cohesion from an existing value to the last possible value. Hence the decrease indicates that extreme rainfall that infiltrated the ground changes unsaturated soil to saturated soil. In this analysis, rainfall is a key factor in determining groundwater recharge and changes in the amount frequency, duration, and intensity. Rainfall has a significant impact on groundwater resources when its response to rainfall has a longer lag time than the correspondence between hydrological responses in surface water systems. The ground water table recharge is estimated using the CRD method based on existing rainfall data from 2001-2010, as for the projection it was calculated for the period 2011-2030. The projection itself is divided into two parts, 2011-2020 and 2021-2030. The CRD method needs infiltration and pumping data for several different locations to estimate the change of groundwater elevation.

3.2.2 Agriculture Sector Hazards Models and Scenarios

Hazards of climate change in the agricultural sector are triggered by stimuli such as:

- Increasing the average air temperature
- Changes in rainfall patterns, both in intensity and periods of rainfall
- Extreme weather events in the form of El Niño and La Niña

These climatic stimuli have an impact on the physiological processes of crops, and furthermore, either directly or indirectly, on the production of food crops.



T : Temperature, P : Precipitation,
EE : Extreme Event, ETp : Potential Evapotranspiration
SLR : Sea Level Rise,

Figure 3.1 Flow chart of climatic stimuli analysis and hazard potency of climate change on agricultural sector

Vulnerability, risk, and adaptation assessment of climate change on agriculture in Greater Malang is a Meso-Level Study which examines the phenomena and the vulnerability of the agricultural sector to climate change. The study is focused on analysing the impact of climate change and climate variability, such as monthly temperature and changes in rainfall patterns, as well as increased frequency and intensity of extreme events, such as La Niña and El Niño.

Hazards of climate change in the agriculture sector to be assessed are (1) the potential decrease in food crop production as a result of (2) decreased productivity (yield) and (3) decrease in harvested area. The food crop to be assessed in Greater Malang are wetland and dryland paddy, as well as corn.

In terms of crop yield hazard, increased temperature is a climatic stimulus to increase respiration rate and shorten plant age. In addition, the increase of air temperature will cause an increase in potential evapotranspiration and reduce the land area receiving irrigation. Rainfall determines the availability of water for plants, especially on rainfed land by assuming a period of rainfall is spread evenly over the crop growing season.

In terms of reduced harvested area, increased air temperatures will cause an increase in crop evapotranspiration, thereby increasing crop water requirements. As a result, irrigated land area that can be filled with water needs will be reduced. Potential evapotranspiration that is used as the basis for the calculation of irrigation water can be calculated from air temperature using a formula from Thornwaite & Matter. In addition to the effect on the yield, low rainfall can result in in drought and cause crop failure. Conversely, excessive rainfall will cause flooding and crop failure. In this analysis, the decline in harvested area due to drought

or flood is derived from the relationship between harvested area and rainfall during the growing season of plants.

Finally, the hazard of decreased crop production as an impact of climate change from irrigated farms caused by rising temperatures and rainfall are calculated based on the decreased yield and the harvest areas due to climate change. Harvested area is calculated from the irrigated land area which is affected by temperature which increases crop water demand and is not influenced directly by rainfall. In addition, the effect of sea level rise is expected to inundate most of the agricultural land and that is calculated separately. The calculation of the decrease in rainfed lowland rice production is the same as irrigated lowland rice, except the harvest area is influenced by rainfall and not irrigation effects.

The impact of climate change on corn production is calculated as in the calculation of the impact on rainfed rice production but using different parameters.

3.2.3 Health Sector Hazard Model/Scenario

Diarrhea is a water-borne disease that is strongly affected by change in climatic factors, such as drought, sea level rise, and rainfall pattern, that distress water resources and sanitation (WHO, 2003). Moreover, a large amount of scientific evidence suggests that DHF and malaria are the top vector-borne diseases that are strongly affected by change in climate stimuli, such as temperature, precipitation, and humidity. Hazard analysis is more focused on aspects with high-potential changes due to climate change. After conducting FGDs with health-related experts, analyses of hazards to health sector include vector-borne diseases hazard analysis (DHF and malaria) and water-borne diseases (diarrhea).

To analyse climate change impact to vector-borne disease, such as malaria, at the very least, we need data for:
(1) Population scenarios;
(2) Variability and climate change scenarios;
(3) Humans' immunity to vector infection and vector borne level to humans;
(4) Vectors' immunity probability to environmental factors: temperature and rainfall;
(5) Vector transmission potential: vector capacity, vector reproduction level, vector quantity density, vector incubation period, and temperature range during incubation.

Even so, currently, disease vector distribution data in Indonesia is only limited to a few specific areas in Indonesia; thus there is no complete national data for all of Indonesia. So, in this study, we use relevant disease event data as proxy. Proxy is data which is considered to represent a parameter with a certain level of accuracy. In this case, disease event is used as a disease vector distribution proxy. In this study, we used incidence rate (IR) data of 3 infectious diseases which are malaria, dengue fever, and diarrhea, because the three are the main diseases which have a high incidence rate in Indonesia. Thus, in order to see correlation between climatic factors and DHF and malaria cases, daily, weekly or monthly data is required. Based on a field survey, secondary data collecting, and interviews in Greater Malang, monthly DHF, malaria and diarrhea data for 2007-2010 are available.

Compartment model uses a deterministic approach as illustrated in Figure 3.2. This schematic explains the basic process of DHF infection. The model shows the circle process between healthy and ill persons. The mosquitoes are the outer factor which carries the virus in the first place. Then the non-virus carrier mosquitoes could become the carrier when they bite the ill person. There are two important variables, so called the b and μ. The b refers to the power of mosquitoes to bite, while the μ is the possibilities of people to get infected by the dengue virus. These two coefficients vary depending on the spatial, climatic or social conditions.

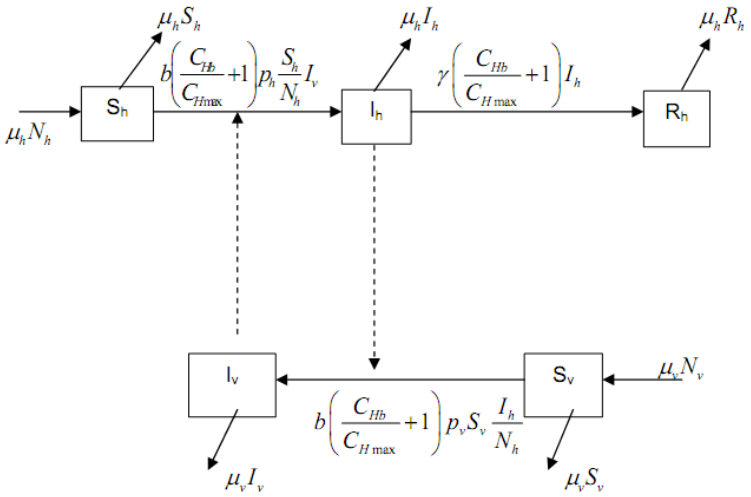


Figure 3. 2 Schematic of the compartement modeling of DHF

$$\begin{cases} \frac{dS_h}{dt} = \mu_h N_h - b\left(\frac{C_{Hb}}{C_{H\max}}+1\right)p_h\frac{S_h}{N_h}I_v - \mu_h S_h \\ \frac{dI_h}{dt} = b\left(\frac{C_{Hb}}{C_{H\max}}+1\right)p_h\frac{S_h}{N_h}I_v - \left(\gamma\left(\frac{C_{Hb}}{C_{H\max}}+1\right)+\mu_h\right)I_h \\ \frac{dR_h}{dt} = \gamma\left(\frac{C_{Hb}}{C_{H\max}}+1\right)I_h - \mu_h R_h \end{cases}$$

$$\begin{cases} \frac{dS_v}{dt} = \mu_v N_v - b\left(\frac{C_b}{C_{\max}}+1\right)p_v S_v\frac{I_h}{N_h} - \mu_v S_v \\ \frac{dI_v}{dt} = b\left(\frac{C_b}{C_{\max}}+1\right)p_v S_v\frac{I_h}{N_h} - \mu_v I_v \end{cases}$$

With:
Sh = Susceptible human (Healthy person)
Ih = Infected human (Ill Person)
Iv = Invected mosquitos
Sv = Susceptible mosquitos
Rh = Recovered human

The calculation of the compartment model for malaria and diarrhea is applied similarly. However, there are slight differences in the equation used in these calculations, since the process of disease development is also different.

3.3 Methodology for Dynamic Vulnerability Analysis

The vulnerability assessment in this study is conducted differently from a previous study (Lombok Island Climate Risk and Adaptation Assessment), i.e. by incorporating the changing conditions of variables being measured. Thus it is called the dynamic vulnerability assessment. In order to guide the analysis, several rules are established as attributes of the dynamic vulnerability framework in this study. Those rules are as follows:

- Indicators used in the vulnerability assessment in each sector are different.
- The unit of analysis for some indicators assessed at a provincial level may also be different to the ones at the district level. For Meso-Level MSA (province) the unit of analysis is district or subdistrict. Meanwhile, for Micro-Level MSA (district), the unit of analysis is subdistrict or village.

- For some indicators, for which the spatial data (image) is available, the actual size of the image is used in the analysis.
- For indicators that are dynamic in nature, its change in pattern may be used to project its future condition.

From consultation with experts of all sectors (Agriculture, Water, Coastal, and Health), indicators that are used in the vulnerability assessment, using the equation that vulnerability (V) is a function of exposure (E), sensitivity (S) and adaptive capacity (AC), are in the table below. Indicators that are dynamic in nature, and thus its change may be analysed in the vulnerability assessment, are marked as (D).

Table 3.3 Indicators for Vulnerability Assessments

Hazard Type	VA Components	Indicators
Water: Shortage	Exposure	Demand for water provision (D)
	Sensitivity	Type of water resources Water quality
	Adaptive capacity	People's welfare (housing type and income per capita) (D) PDAM network (As proxy to access to drinking water (D)
Water: Flood and Landslide	Exposure	Urban population density (population per urban area) (D) Land use (D)
	Sensitivity	Function and status of critical infrastructure (D)
	Adaptive capacity	People's welfare (housing type and income per capita) (D) Drainage (flood) or road (landslide) network (D)
Agriculture: Crop Production Decline	Exposure	Size of agricultural area (D) Number of people working in agriculture (D)
	Sensitivity	Size of non-irrigated field (D) Farmer's income (D) Topography
	Adaptive capacity	Irrigation network (D) Education level (D) Share of Agriculture Sector in GDRP
Health: Dengue	Exposure	Urban population (D)
	Sensitivity	Type of water supply (with PDAM or not) (D) Urban population density (D) People's mobility (D)*
	Adaptive capacity	Provision of health facility (D) Accessibility to health facility (D)
Health: Malaria	Exposure	Population living near breeding site (swamp ricefield, forest, or inundated areas) (D)
	Sensitivity	Distance to breeding site Availability of mangrove area (D) Type of housing (permanent or not) (D) Sensitive population (fisherman, fish farmer, forester((D)*
	Adaptive capacity	Provision of health facility (D) Accessibility to health facility (D)
Health: Diarrhea	Exposure	Urban population (D)
	Sensitivity	Type of sanitation (toilet or not) (D) Type of water supply (PDAM or not) (D) Prolonged flood area Proportion of sensitive population (infant and senior) (D)
	Adaptive capacity	Immunization program (D) Provision of health facility (D) Availability of clean water (PDAM network) (D)

Note: * is not used in the analysis due to lack of data.

At the time of vulnerability analysis for each hazard, the value of each indicator may be different, thus in order to assign weight for each indicator for each hazard, two methods may be used, i.e. expert judgment and analytical hierarchical process (AHP). The expert judgment method is simpler; the sector's expert determines the weight for each indicator based on the expertise. The AHP method involves several steps, starting from developing a questionnaire based on the list of indicators, distributing the questionnaire to experts familiar with the substance (at least three, including the sector's expert), inputting the responses to

the questionnaire into a computer program called Expert Choice, then running the program, with the result being the weight of each indicator.

3.4 Methodology for Risk Analysis

Risk analysis is conducted with a basic model of risk as a function of hazard and vulnerability. There are two types of risk calculated in this study, one is the current risk as a baseline, and another one is the future risk that takes into account climate projection in year 2030. The current risk is measured based on current hazard and vulnerability, while the future risk is measured based on projected hazard using IPCC SRES A1B scenario and projected vulnerability. In projecting vulnerability, two main data sources are used, i.e. anything related to spatial data such as land use and road network, the Spatial Structure and Pattern Plans in the Local Spatial Plan document is used as reference. Furthermore, anything related to population or population projection for 20 years from the current year is calculated using the available annual growth rate.

For both risk assessments, the risk level is determined from the combination of hazard and vulnerability levels as illustrated in the chart below.

Table 3.4 Chart for Risk Analysis

		HAZARD				
VULNERABILITY		Very Low	Low	Moderate	High	Very High
	Very Low	VL	VL	L	L	M
	Low	VL	L	L	M	H
	Moderate	L	L	M	H	H
	High	L	M	H	H	VH
	Very High	M	H	H	VH	VH

3.5 Methodology for Adaptation Formulation and Prioritisation

Climate change adaptation according to UNFCCC (2008: 10) is “a process through which societies make themselves better able to cope with an uncertain future”. Thus, “adapting to climate change entails taking the right measures to reduce the negative effects of climate change (or exploit the positive ones) by making the appropriate adjustments and changes”. Basically there are two categories of adaptation: reactive, in which immediate actions are required, and anticipatory, which could take more time to implement. In developing adaptation option for each hazard, the sector’s experts work based on risk maps resulting from the risk analysis, either for the baseline or future condition. From the risk maps a typology of a area can be observed, based on its characteristics. The sector’s experts look at this typology and then outline recommendation for adaptation Option. Those options may consist of hard or soft adaptation measures. The basic principle in outlining the adaptation Option is that in order to reduce risks from climate change, the adaptation should aim at reducing the vulnerability, which means either reducing the exposure and sensitivity, or increasing the adaptive capacity. Thus when outlining the adaptation Option, the sector’s experts must always review the conditions of each indicator used in the dynamic vulnerability assessment in order to identify correctly the cause of vulnerability or risk that one area has.

In mainstreaming of the CCRAA into development plans, prioritisation of adaptation options is based on stakeholders consultation where preferred adaptation options are assessed. Tools used in this consultation are (1) the Hedonic-Qualitative Cost Benefit Analysis (HQCBA) worksheet and (2) the Importance Level Rating (ILR) matrix. The stakeholders identify what factors that determine the likelihood of executing the proposed adaptation option into real action. The preferred adaptation for each sector is determined either based on the result of HQCBA worksheet (the highest score option) or the ILR matrix (the most rated option).

4. Risk Assessment and Adaptation Option of Water Sector

4.1 Hazard Analysis

As is being done for the Tarakan and South Sumatra reports, the Malang report also consists of three hazard analyses in the water sector; i.e. flood, landslide and water shortage. These hazards are affected by climatic and non-climatic drivers. The climatic drivers consist of temperature and precipitation which is used for hydrology and groundwater modelling. There are also nine non-climatic drivers that are calculated in hazard analysis; i.e. population density, land-use, water demand, PDAM network, infrastructure, government programmes, and society welfare.

GSSHA (Gridded Surface-Subsurface Hydrologic Analysis) is being used as the analytical method for the flood hazard model, while climate driver and land use change are considered as parameters. Afterwards, GEOSLOPE is being used for the landslide hazard model while climatic drivers and land-use change are also used as parameters. For the water shortage hazard, water balance and FEM are used as the model which incorporates climate drivers, population growth, and land-use change as its main parameters for projection.

4.1.1 Hazard Analysis of Flood

A flood hazard model analysis was calculated for each watershed. However, the overall analysis of flood hazard in Greater Malang is based on the extreme runoff for the baseline conditions that shows that Malang City has the largest area with very high potential flood hazard. Meanwhile, based on the projection result, Malang District will be threatened by the largest area of very high potential flood hazard. In the baseline conditions, a very high level of hazard covers mostly residential and built-up areas. On the other hand, according to the projection results, by that time, the area with a very high level of hazard will cover residential areas, commercial and services areas, industrial areas, the airport and public facilities.

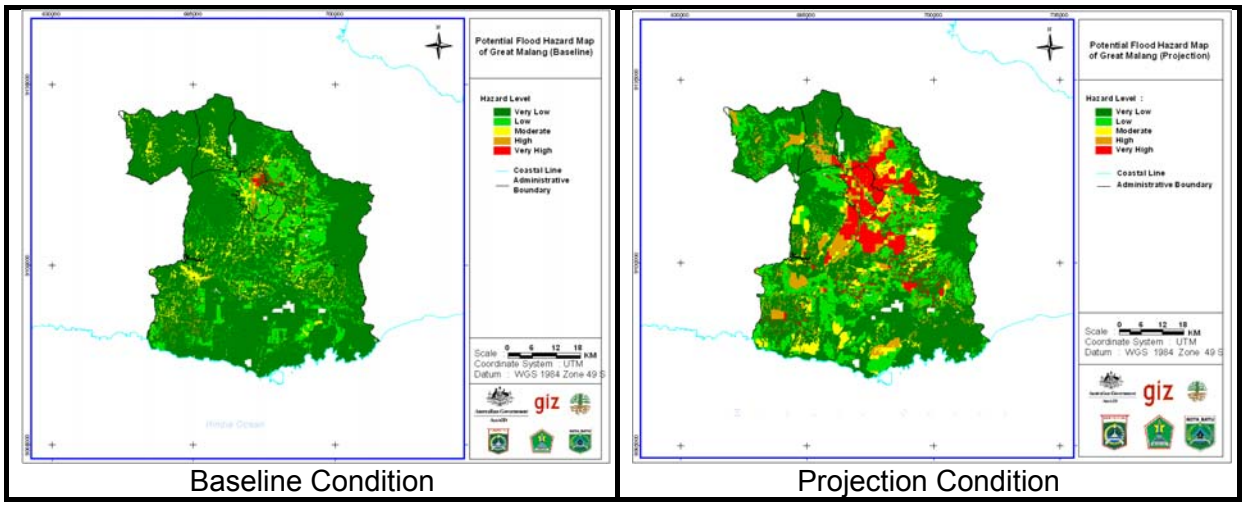


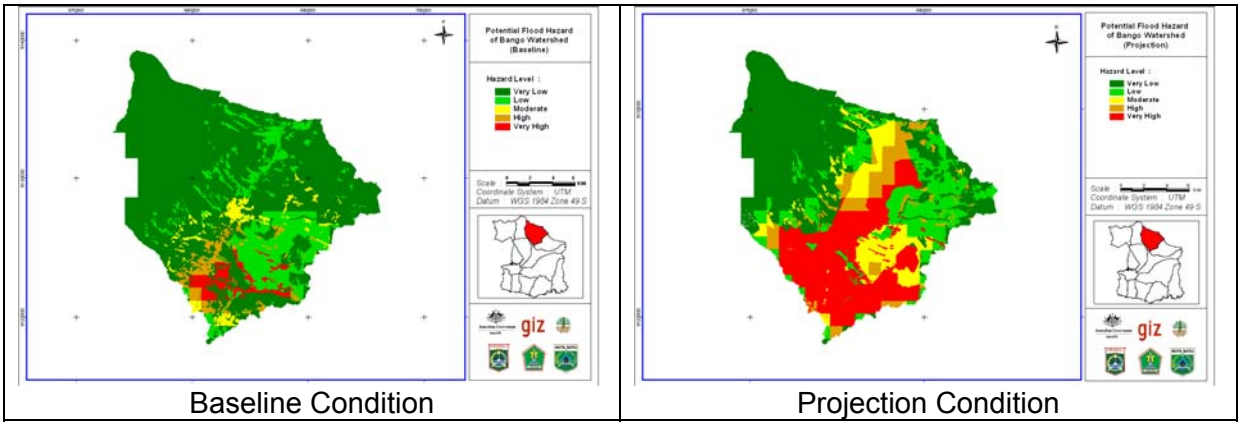
Figure 4.1 Flood Hazard Map of Greater Malang

For the baseline conditions, the total area size of very high level of flood hazard areas for Malang District is 4.52 km^2 and for Malang City is 5.96 km^2. On the other hand, in the projection conditions, the analysis indicates that the total area size of very high level of hazard will be 261.15km^2 in Malang District, 78.32 km^2 in Malang City, and 6.65 km^2 in Batu City. The summary of the flood hazard in Greater Malang can be seen in Table 4.1 below.

Table 4.1 Area Size of Flood Hazard Area in Greater Malang

Hazard Level	Malang District		Malang City		Batu District	
	Baseline (km^2)	Projection (km^2)	Baseline (km^2)	Projection (km^2)	Baseline (km^2)	Projection (km^2)
Very Low	4,101.87	18,317.75	34.94	2.00	180.14	154.49
Low	439.02	787.49	37.65	9.54	2.33	7.43
Moderate	143.14	268.66	15.65	8.68	16.09	0.40
High	30.32	213.06	15.77	11.26	0.02	27.16
Very High	4.52	261.15	5.96	78.32		6.65

Based on the hazard analysis in the baseline conditions, the result for each watershed shows that the Bango watershed is the area which has a very high level of flood hazard. In the projection conditions, extreme rainfall will be increased 67% from baseline condition. Based on spatial planning documents, the Bango watershed will mostly be covered by dry-land agriculture, residential area, industrial and warehousing area, the airport, commercial & services area, and a military area.



Baseline Condition | Projection Condition

Figure 4.2 Flood Hazard of Bango Watershed

In the baseline and projection conditions, the Bango watershed has five levels of hazard, whose details can be seen in Table 4.2 below. In general, it can be seen that the size of area with very high, high, moderate, and low levels of hazard will increase at the time of the projection conditions. The area which is threatened by very high and high levels of hazard mostly cover vital infrastructures such as industrial areas, commercial and services areas, the airport, and the military area. If the flood hazard endangers these areas, it will have a significant effect on the economic activities in Malang District and Malang City.

Table 4.2 Hazard Level of Bango Watershed

Hazard Level	Baseline (km^2)	Projection (km^2)
Very Low	228.58	127.16
Low	52.38	51.67
Moderate	9.86	31.52
High	11.23	25.10
Very High	10.32	77.22

4.1.2 Hazard Analysis of Landslide

In the landslide hazard analysis, the ground water table (GWT) recharge is the input for modelling. The GWT recharge map analysis uses a cumulative rainfall departure (CRD) map

as a climatic driven factor. As seen in figure 4.3, the GWT recharge map of December 2006 is the driest month and the GWT recharge map of December 2007 is the wettest month.

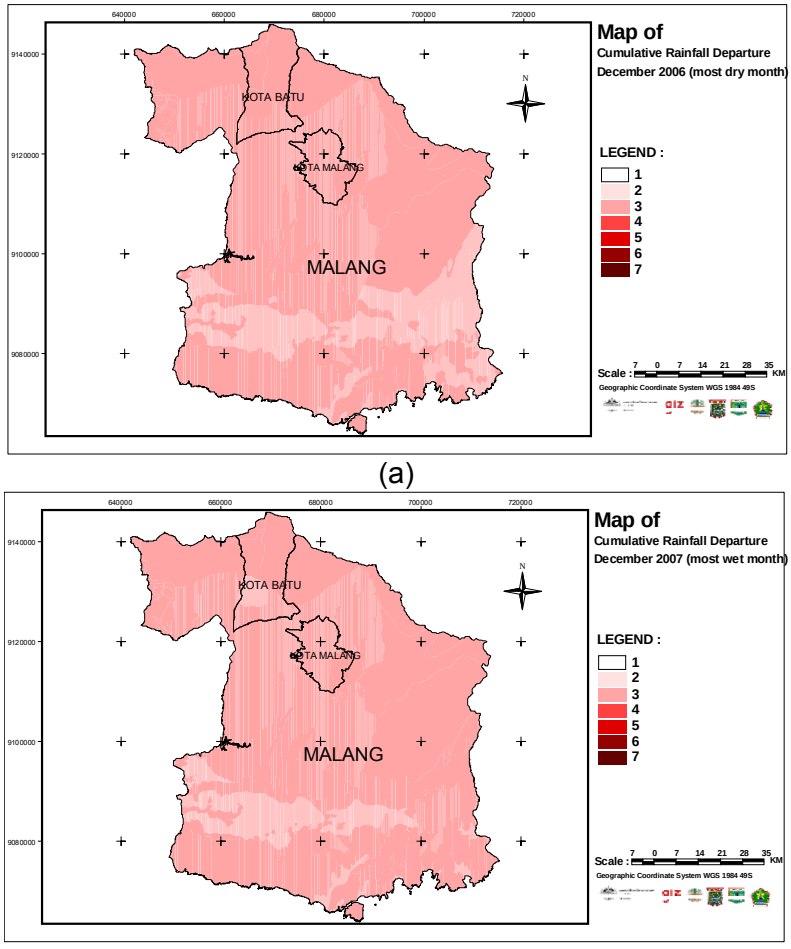
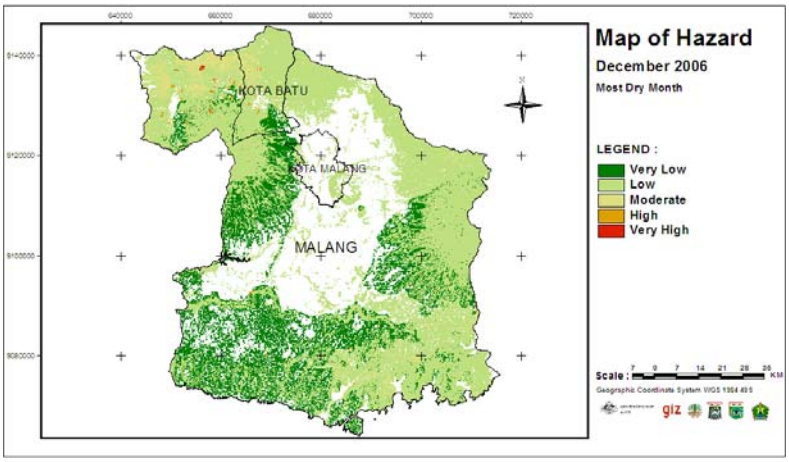


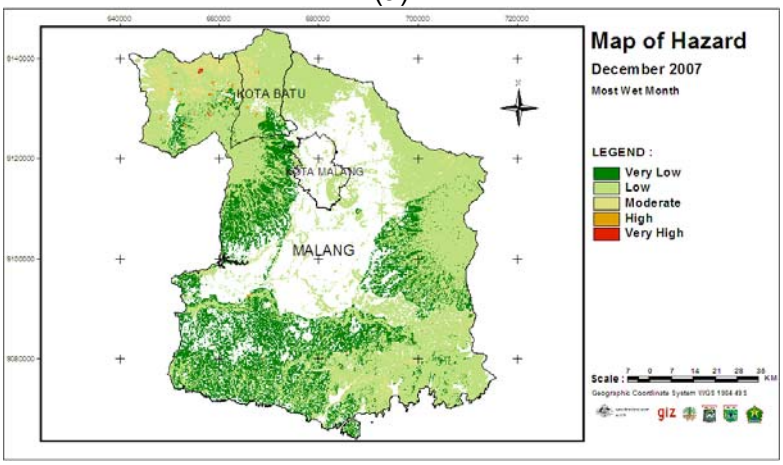
Figure 4.3 (a) GWT Recharge Map of December 2006 – driest month, (b) GWT Recharge Map of December 2007 – wettest month

As can be seen in the figure above, the GWT recharge map in December 2006 and the GWT recharge map in December 2007 look similar; i.e. indicating insignificant difference between conditions in the driest and the wettest months. Based on the GWT recharge map, the hazard baseline maps of December 2006 and December 2007 as shown in Figure 4.4 below.

Similar to the GWT recharge map, there are no significant differences between the hazard baseline maps of December 2006 and December 2007. The hazard baseline map in December 2006 is the wettest month while December 2007 is the driest month. The difference between the driest month and the wettest month is not significant because the rainfall is not the direct factor of landslide. Rainfall as the trigger of landslide infiltrates unsaturated and saturated zones. It is because the ground water table recharge and soil strength decrease.



(a)



(b)

Figure 4.4 (a) Hazard Baseline Map of December 2006 – wettest month (b) Hazard Baseline Map of December 2007 – driest month

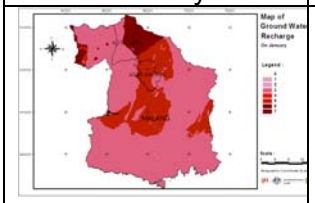
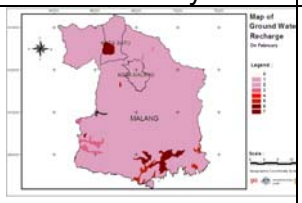
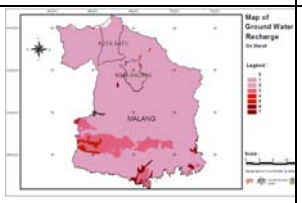
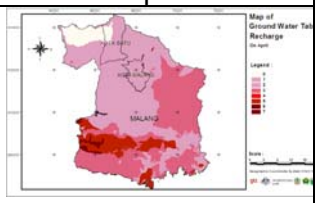
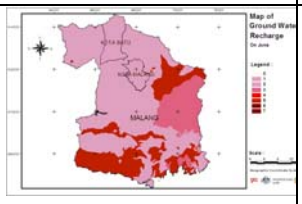
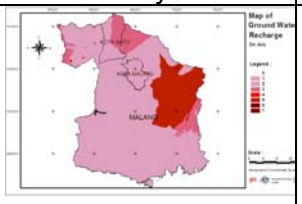
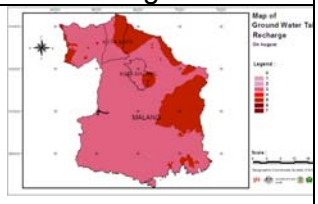
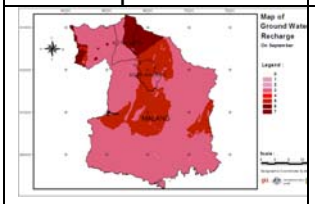
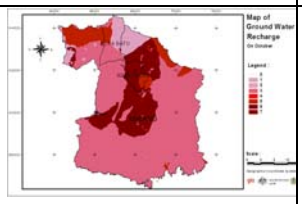
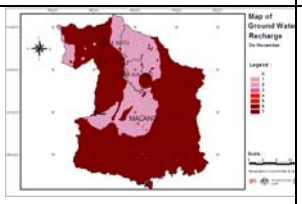
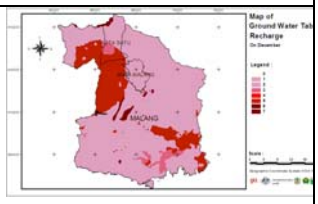
The total areas for each hazard level in both December 2006 and December 2007 can be seen in Table 4.3 below.

Table 4.3 Are Size of Landslide Hazard in December 2006 and December 2007

Rank	Hazard (m^2)	
	Dec 2006	Dec 2007
	Driest month	Wettest month
Very Low	1,219,690,000	1,218,450,000
Low	2,431,320,000	2,432,560,000
Moderate	95,300,000	94,990,000
High	17,720,000	18,030,000
Very High	1,130,000	1,130,000

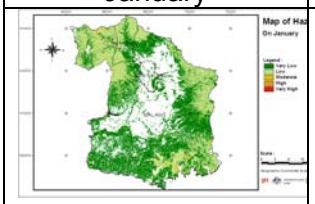
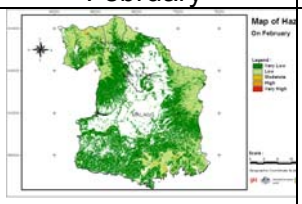
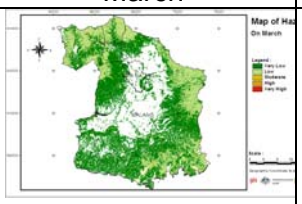
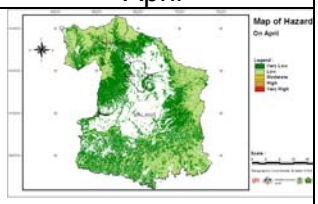
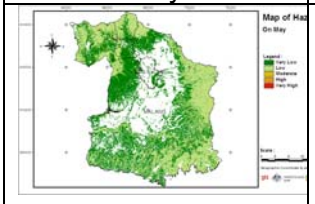
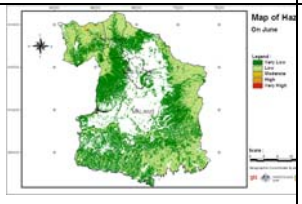
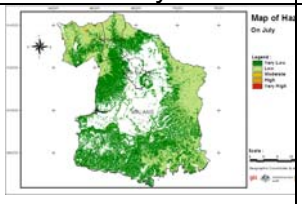
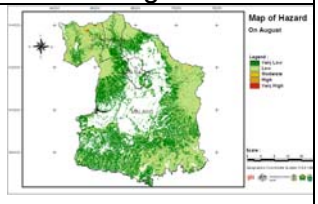
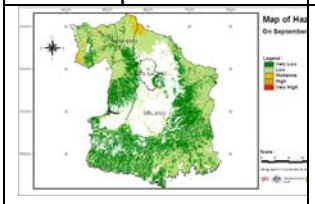
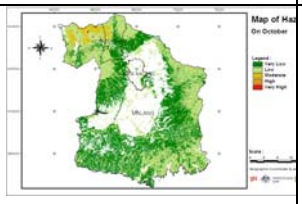
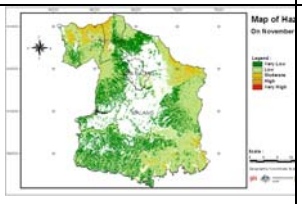
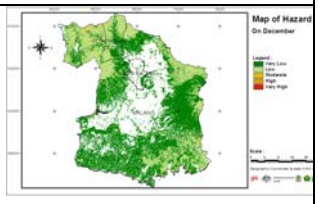
Based on the baseline conditions, the projection condition are generated from quantitative operations to landslide historical maps, slope maps, geology maps, and the ground water table (GWT) recharge maps of projection conditions. Table 4.4 below shows the map of the ground water table (GWT) recharge projection (2012-2030).

Table 4.4 Monthly Ground Water Table Recharge of Greater Malang

January	February	March	April
			
May	**June**	**July**	**August**
			
September	**October**	**November**	**December**
			

Monthly ground water table recharges (table 4.16) increase in January, August, September, October, and November, while they decrease in February, March, April, May, June, and July. From the map of GWT recharge above, the projection maps of the landslide hazard are thus produced as can be seen in Table 4.5.

Table 4.5 Monthly landslide hazard of the Greater Malang

January	February	March	April
			
May	**June**	**July**	**August**
			
September	**October**	**November**	**December**
			

Based on the size of the hazard level area, the very high level of landslide hazard vary from 6.020.000 m^2 to 1.240.000 m^2; it is higher in October and November. The area of high level of landslide hazard, varies from 11.600.000 m^2 to 6.420.000 $m^{2;}$ it is higher in the period January to August. For the moderate landslide hazard level, the area varies from 199.430.000 m^2 to 540.000 m^2, being higher in November. Based on its level, November has one of the highest landslide hazard probabilities.

4.1.3 Hazard Analysis of Water Shortage

The water shortage hazard is analysed based on the direct impact of climate change and the physical potential hazard. The decreasing risk of water availability in the Greater Malang Region is generally dominated by a moderate-high risk level. Moderate risk level is distributed around Malang City from the west, the in the north and into the south. These hazard levels are located in Brantas Hulu watershed. The higher hazard levels located in the west, the east and moving towards to the south direction are morphologically areas with valleys or mountains. The map of the water shortage hazard in the baseline and projection conditions is shown below.

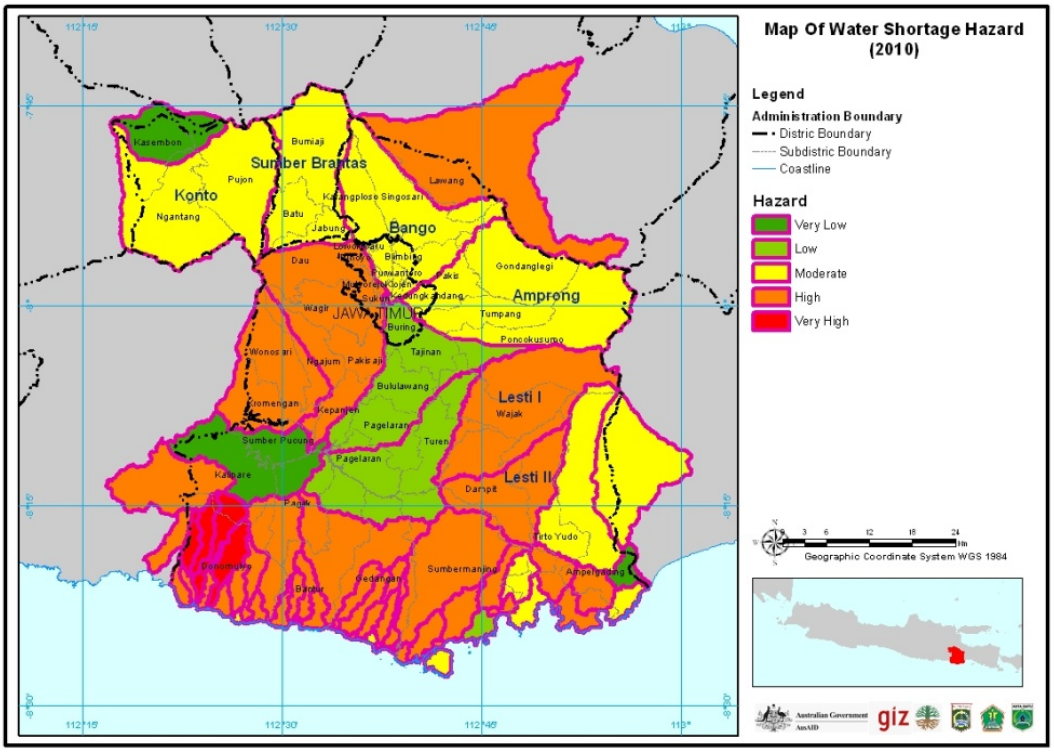


Figure 4.5 Map of Water Shortage Hazard in Baseline Condition

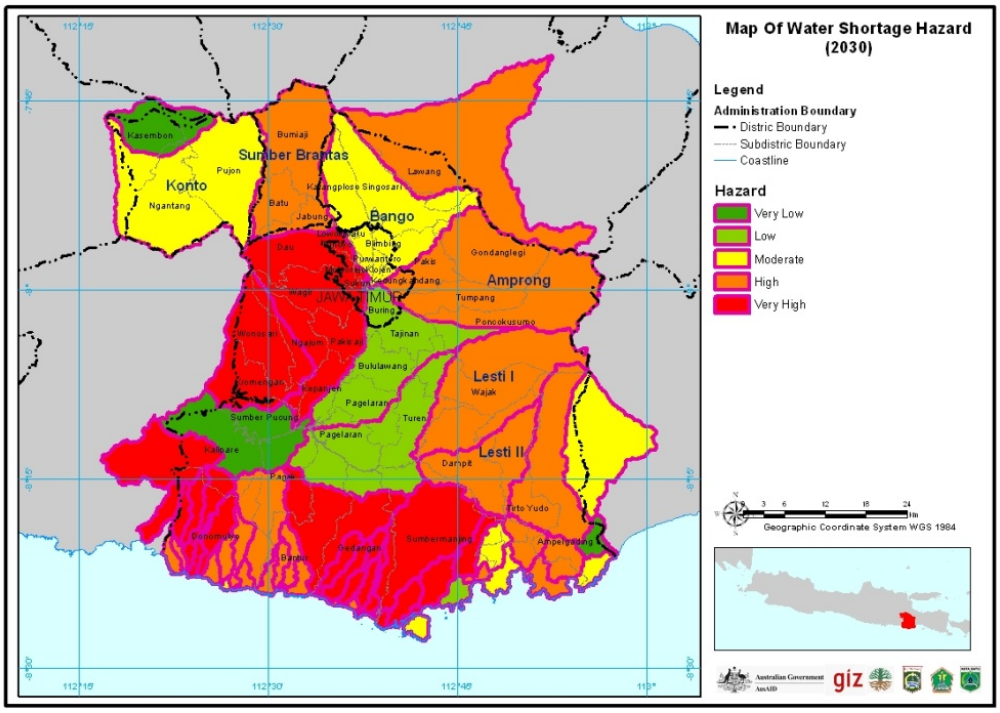


Figure 4.6 Map of Water Shortage Hazard in Projection Condition

Table 4.5 below shows the summary of water shortage hazard. The table consists of the baseline and the projection conditions for each hazard level and each watershed.

Table 4.6 Water Shortage Hazard and It's Distribution in Baseline and Projection

Level of WS[1] Hazard	Current (baseline), 2010					
	DoWA[2]current-baseline (m^3/month)	WD[3]2010 (m^3/month)	WA_{2010} (m^3/month)	% WS	Watershed	District/City
Very High	494,575.79	9,716,490.84	4,820,417.32		IIIA	Malang District
High	12,267,816.09	191,816,470.59	121,790,999.88		Lesti, IIA, IIIA, IIIB, V	Malang City, Malang District
Moderate	7,570,055.39	135,242,712.12	117,956,202.88		Kopto, Bango, SumberBrantas, Amprong	Batu City, Malang City, Malang District
Low	10,424,687.55	106,659,197.24	49,720,702.13		Pagelaran	Malang City, Malang District
Very Low	17,304,500.57	22,025,425.20	195,122,920.14		Kesamben, SumberPucung	Malang District
Level of WS[1] Hazard	Projection, 2030					
	DoWA[2]projection-baseline (m^3/month)	WD[3]2030 (m^3/month)	WA_{2030} (m^3/month)	% WS	Watershed	District
Very High	9,067,071.02	139,118,136.17	63,591,647.80		SumberPucung,	Malang City, Malang District
High	8,106,292.34	169,368,515.50	111,984,389.80		SumberBrantas, Amprong, Lesti	Batu City, Malang City, Malang District
Moderate	5,074,726.27	85,199,199.49	67,047,872.04		Konto, Bango	Malang District, Malang City
Low	10,424,687.55	63,548,438.58	106,649,805.71		Pagelaran	Malang City, Malang District
Very Low	26,798,025.73	23,661,927.90	185,629,394.97		Kesamben, Sumber Pucung	Malang District

4.2 Vulnerability Analysis

Vulnerability for each hazard due to climate change is analysed based on the identified hazard; i.e. vulnerability to water shortage, vulnerability to floods, and vulnerability to landslides. For each vulnerability, the components that are analysed are population density, land use, role of infrastructure, water demand, water source, and population welfare. Thus, the vulnerability of the water sector hazard consists of three components; i.e. exposure, sensitivity, and adaptive capacity. Each component has its own indicators.

There are a few assumptions that are used in the vulnerability analyses, as follows: 1) the value of each indicator is dynamic, 2) the value approach of projection is linier and 3) the unit of spatial analysis is the subdistrict. There are six primary components of vulnerability based on their significance to the hazard and availability of data. The six primary components are population density, land-use, role of infrastructure, water demand, water source, and population welfare. For each vulnerability component, the analysis for both baseline (2010) and projection (in 2030) have been calculated.

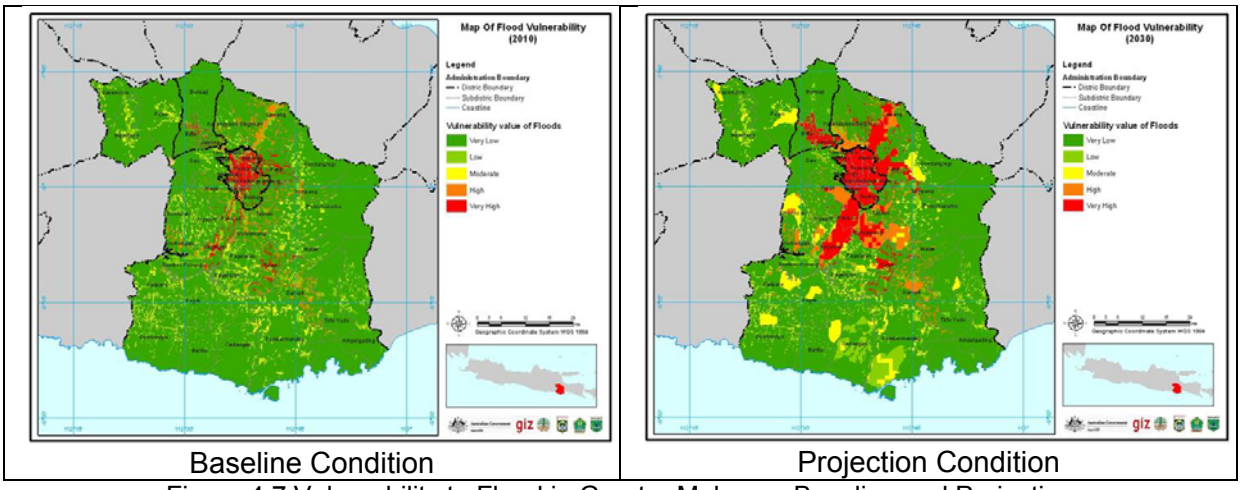
4.2.1 Vulnerability Analysis to Flood

The vulnerability analysis to flood hazard was carried out by incorporating four components; population density and land use for exposure component, role of infrastructure for sensitivity component, population welfare, and government programme for adaptive capacity.
Table 4.7 below shows the vulnerability components along with the indicators and weighting for the GIS analysis.

Table 4.7 Components and Indicators of vulnerability to flood

Components	Indicators	Sub-indicators	Weighting
Exposure	Population density	Population and population growth per subdistrict	0.53
	Land use	Land use as in regional planning	0.23
Sensitivity	Role of infrastructure	Road infrastructure	0.18
Adaptive Capacity	Population Welfare	Population's income	0.06

Based on the analysis of vulnerability components, the maps of water vulnerability to floods for baseline and projection period being drawn as shown in Figure 4.9 below.



Baseline Condition | Projection Condition

Figure 4.7 Vulnerability to Flood in Greater Malang – Baseline and Projection

In the baseline period (2010), the area with the highest vulnerability to flood is predominantly the whole area of Malang City. The other regions with a very high vulnerability level in the baseline period are: a) some parts of Batu subdistrict and Jabung subdistrict (Batu City), b)

the southern parts of Karangploso and Singosari, and the centre part of Lawang (Malang District); c) almost all region of Pakis district, Pakisaji, and Kepanjen district (Malang District); d) parts of Batulawang and Turen (Malang District); and e) some small parts of Tajinan, Tumpang, and Wagir district (Malang District).

Afterwards, there are some regions which become more vulnerable in the projection period, i.e. a) the whole region of Malang City; b) most parts of Batu City, especially the centre to southern part (some parts of Batu district and Jabung district); b) following subdistricts in Malang District: Karangploso, Singosari, Lawang, Pakis, Pakisaji, Kepanjen, Batulawang, Turen, Wagir, Wajak, Tumpang, Dampit, Ngajum, Kromengan, Wonosari, and Tajinan.
The summary of changes in vulnerability to flood from baseline to projection conditions in each area can be seen in Table 4.8 below.

Table 4.8 Change in Vulnerability to Floods (Baseline and Projection Condition)

No.	District / City	Subdistrict	Vulnerability Level Change	
			Baseline Condition	Projection Condition
1.	Malang City	Blimbing	Mostly very high	All region of the district is very high.
		Purwantoro	Mostly very high	All region of the district is high .
		Kedungkandang	Mostly very low. Some small areas in the west are low to very high	Mostly very high. A significat part in the south is very low to low
		Buring	Mostly low to very low; some scatrered small areas of high.	Mostly very high. Some small areas in the south are low.
		Sukun	Low to very high.	Almost all region is very high.
		Klojen	low to very high.	All regio is very high.
		Mulyorejo	Almost all regions is very high.	All regio is very high.
		Dinoyo	Very low to low except in east parts are moderate to very high.	Almost all region of the district is in very high.
		Lowokwaru	Mostly low to moderate; a small part in the west-south is very high.	All regio is very high.
2.	Batu City	Jabung	Mostly very low. Some scattered areas of low to high.	Almost all region in the centre-south east parts are very high
		Batu	Mostly very low. Some scattered areas of low to high.	Almost all regions in the centre-north parts are very high.
		Bumiaji	All region is in very low.	Some small areas in the centre are low.
3.	Malang District	Karangploso	Mostly very low except some scattered areas of moderate to high.	The south-centre region becomes high
		Singosari	Mostly very low except a significant area in south region and some scattered area in centre to the north region are high	The high in the south region and scattered area in the centre region become very high and the area become wider.
		Lawang	Mostly very low except a significant area in centre region and some scattered area in the centre to the north region are high	The high in the centre to the north region become very high and the area become wider
		Gondanglegi	Almost all region is very low except some small scattered areas in the wwest region are moderate	The scattered area of moderate in the west region become unity and significant area. The others area are still low.
		Pakis	Some scattered areas in the centre region are high. The others region are low	The very high. area become wider. Also, some area of high. becomes dominant area.
		Tumpang	Mostly very low to low except a significant area in centre region is high and some scattered areas are low to very high	The high in the centre region become very high and wider. The scattered areas of low to very high vstill present
		Poncokusumo	Mostly very low except some scattered areas in the west region are moderate to low	The pattern and area of are not changing significantly except in the soutwest region
		Ampelgading	Mostly very low except some scattered areas from the north to the south region are moderate.	The pattern and area of vulnerabilities are not changing significantly except in the centre become wider

No.	District / City	Subdistrict	Vulnerability Level Change	
			Baseline Condition	Projection Condition
		Tirtoyudo	Almost all region is very low.	Mostly very low; some regios are low.
		Wajak	Mostly very low to low except some scattered areas in the centre-west region are moderate.	Mostly still very low to low, the scattered areas of moderate become wider and some are become high.
		Tajinan	Mostly very low except some scattered areas are moderate to high.	Some of the scattered areas become unity and wider and some of its area become very high
		Batulawang	Mostly very low to low with some scattered areas of moderate to very high	Almost all region is in very high to high
		Turen	Mostly very low to low with some scattered areas of moderate to very high	Up to 50% of total area is very high, distributed in all region, especially in the centre.
		Dampit	Mostly very low to low with some scattered areas of moderate to high	Scattered areas of high in the centre becomes unity and wider
		Sumbermanjing	Mostly very low. Some scattered areas of moderate	Mostly low to very low . Some scattered areas of moderate
		Gedangan	Mostly very low to low	Mostly very low to low with some scattered areas of moderate in the soutwest region and northeast region
		Pagelaran Utara	Mostly very low with some scattered areas of moderate v	The scattered areas of moderate become wider and the rank of some of the area are high.
		Pagelaran Selatan	Mostly very low with some scattered areas of moderate	The scattered areas of moderate v become wider and the rank of some of the area are high.
		Bantur	Almost all region is low except in the north is some scattered areas of moderate	Mostly very low to low. A significat wide of moderate in the centre region
		Kepanjen	Mostly very low to low with some scattered areas of very high in the centre region	Amost all region is very high with some scattered areas of high
		Pakisaji	Mostly very low to low with some scattered areas of very high	All region is very high
		Ngajum	Mostly very low with scattered areas of low to moderate	Very low still dominant. Scattered areas become wider with the rank are low to very high
		Kromengan	Mostly very low v with scattered areas of low to high	The scattered areas of moderate to high become wider.
		Sumberpucung	Mostly very low to low.	Mostly very low to low, some scattered areas of moderate v in the south
		Pagak	Mostly very low to low	Not much chage, except a significat area of moderate in the centre
		Donomulyo	Mostly very low to low with some scattered areas of moderate	The scattered areas of moderate become wider
		Kalipare	Mostly very low to low with some scattered areas of moderate	The scattered areas of moderate become wider
		Wonosari	Mostly very low to low with some scattered areas of moderate	The scattered areas of moderate become wider and the rank of some of the areas are high
		Wagir	Scattered area ranges from low to very high.	Area of very high becomes dominant
		Dau	Mostly very low. Some scattered area of moderate in the east	The scaterred areas become very high to moderate.
		Pujon	Mostly very low. Some scattered area of moderate in the east	The scaterred areas of moderate become wider
		Ngantang	Mostly very low. Some scattered area of moderate in the east	The scaterred areas of moderate become wider
		Kasembon	Mostly very low. Some scattered area of moderate in the east	The scaterred areas of moderate become wider

4.2.2 Vulnerability to Landslide

The indicators for each vulnerability component to landslide hazard are the same as those applied to flood. Using specific weighting for each indicator, vulnerability maps for both baseline and projection are drawn for the Greater Malang area. Table 4.9 below shows the components, indicators and weighting in measuring vulnerability to landslide hazard.

Table 4.9 The Components and Indicators of Vulnerability to Landslides

Components	Indicators	Sub-indicators	Weighting
Exposure	Population density	Population and population growth per subdistrict	0.54
	Land use	Land use as in regional planning	0.22
Sensitivity	Role of infrastructure	Road infrastructure	0.18
Adaptive Capacity	Population Welfare	Population's income	0.06

Based on the available data the vulnerability analysis to landslide in the baseline year (2010) is shown in Figure 4.10 below. The most vulnerable area, due to very high level of vulnerability is located in Malang City., Several scattered points having similar vulnerability (very high and high level of vulnerability) spread in Batu City and in the centre and northern part of Malang District.

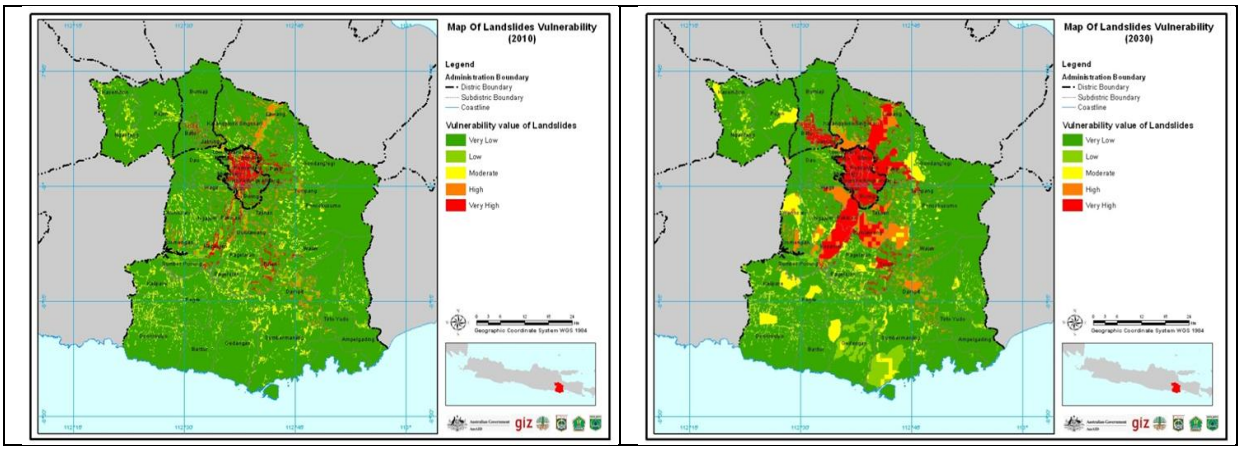


Figure 4.8 Vulnerability to Landslide in Greater Malang – Baseline and Projection

Using the projected data for 2030, it is possible to draw a vulnerability map for that year as seen in the figure above. In general, the pattern that can be observed is that the vulnerability will worsen since the very high level vulnerable area increases significantly in Malang City, Batu City, and in the centre and northern parts of Malang District. Due to the identical vulnerability between landslides and floods, in general the vulnerability level of landslides and its distribution are also identical with the floods, both in the baseline and projection periods.

4.2.3 Vulnerability to Water Shortage

The vulnerability to water shortage consists of three components and indicators: water demand as an indicator of exposure, water resources as an indicator of sensitivity, and population welfare as an indicator of adaptive capacity.

The weighting result for each component as a result of the pair-wise comparison which is done by the water sector experts is given in table 4.10 below.

Table 4.10 The Components and Indicators of Vulnerability to Water Shortage

Components	Indicators	Sub Indicators	Ratio
Exposure	Water Demand	Population water demand	0.5
		Land use water demand	

Sensitivity	Water Resource	Installation water; or bottling or packing water; pumping water, well, spring; river/lake, rain water; others water resources.	0.32
Adaptive Capacity	Population Welfare	society's income	0.18

Based on the analyses of water demand, water sources, and population, the map of vulnerability to water shortage hazard for baseline and projection periods is shown in Figure 4.9 below.

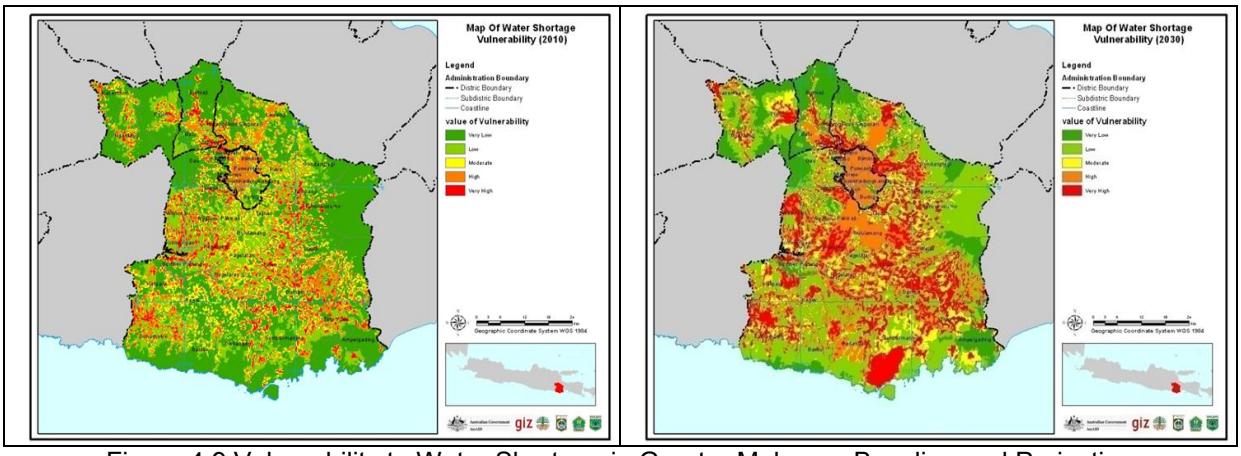


Figure 4.9 Vulnerability to Water Shortage in Greater Malang – Baseline and Projection

In the baseline period, the most vulnerable areas to water shortage are Jabung, Batu and Bumiaji in Batu City; Pujon, Ngantang, Donomulyo, Dampit, Kepanjen, Sumbermanjing, Gedangan, Dampit, Turen, Tirtoyudo, Tumpang, and Poncokusumo in Malang District. In the projection, regions that need to be prioritised in reference to adaptation based on the distribution of high to high vulnerability level and its changes are: 1) The whole of Malang City; 2) centre and southern part of Batu City; 3) the northern part of Malang District (Kasembon, Pujon, Ngantang, Karangploso, Lawang, south Singosari; middle of Malang District (Pakis, Gondanglegi, Tumpang, west Wajak, Batulawang, Pakisaji, Kepanjen, Kromengan,Turen, Sumberpucung); and the lower or southern of Malang District (Dampit, centre of Ampelgading, south of Sumbermanjing, Gedangan, Bantur, Donomulyo, Pagak, Kalipare).

In general, the vulnerability conditions to water shortage hazard of Greater Malang is increasing from the baseline to the projection period. By looking at the map of watersheds as in Chapter 4 of the full report, the regions experiencing significant increase of vulnerability from the baseline to the projection period for each watershed is shown in Table 4.11 below.

Table 4.11 Vulnerability Change to Water Shortage in Baseline (2010) and Projection (2030) Condition

No.	District / City	District	Vulnerability Level Change	
			Baseline Condition	Projection Condition
1.	Malang City	Blimbing	Mostly very high	All regions of the district are very high.
		Purwantoro	Mostly very high	regions of the district are high .
		Kedungkandang	Mostly very low. Some small areas in the west are low to very high	Mostly very high. A significat part in the south is very low to low
		Buring	Mostly low to very low; some scatrered small areas of high.	Mostly very high. Some small areas in the south are low.
		Sukun	Low to very high.	Almost all regions of the district are very high.
		Klojen	low to very high.	All regions of the district are very high.

No.	District / City	District	Vulnerability Level Change	
			Baseline Condition	Projection Condition
		Mulyorejo	Almost all regions are very high.	All regions of the district are very high.
		Dinoyo	Very low to low except in east parts are moderate to very high.	Almost all region of the district is in very high.
		Lowokwaru	Mostly low to moderate; a small part in the west-south is very high.	All regions of the district are very high.
2.	Batu City	Jabung	Mostly very low. Some scattered areas of low to high.	Almost all region in the centre-south east parts are very high
		Batu	Mostly very low. Some scattered areas of low to high.	Almost all regions in the centre-north parts are very high.
		Bumiaji	All region is very low.	Some small areas in the centre are low.
3.	Malang District	Karangploso	Mostly very low except some scattered areas of moderate to high.	The south-centre region becomes high
		Singosari	Mostly very low except a significant area in south region and some scattered area in centre to the north region are high	The high in the south region and scattered area in the centre region become very high and the area become wider.
		Lawang	Mostly very low except a significant area in centre region and some scattered area in the centre to the north region are high	The high in the centre to the north region becomes very high and the area becomes wider
		Gondanglegi	Almost all region is very low except some small scattered areas in the wwest region are moderate	The scattered area of moderate in the west region becomes a whole and significant area. The others area are still low.
		Pakis	Some scattered areas in the centre region are high. The others region are low	The very high. area becomes wider. Also, some area of high. becomes dominant area.
		Tumpang	Mostly very low to low except a significant area in centre region is high and some scattered areas are low to very high	The high in the centre region becomes very high and wider. The scattered areas of low to very high vstill present
		Poncokusumo	Mostly very low except some scattered areas in the west region are moderate to low	The pattern and area are not changing significantly except in the soutwest region
		Ampelgading	Mostly very low except some scattered areas from the north to the south region are moderate.	The pattern and area of vulnerabilities are not changing significantly except in the centre become wider
		Tirtoyudo	Almost all region is very low.	Mostly very low; some regios are low.
		Wajak	Mostly very low to low except some scattered areas in the centre-west region are moderate.	Mostly still very low to low, the scattered areas of moderate become wider and some are become high.
		Tajinan	Mostly very low except some scattered areas are moderate to high.	Some of the scattered areas become unity and wider and some of its area become very high
		Batulawang	Mostly very low to low with some scattered areas of moderate to very high	Almost all region is in very high to high
		Turen	Mostly very low to low with some scattered areas of moderate to very high	Up to 50% of total area is very high, distributed in all regions, especially in the centre.
		Dampit	Mostly very low to low with some scattered areas of moderate to high	Scattered areas of high in the centre becomes unity and wider
		Sumbermanjing	Mostly very low. Some scattered areas of moderate	Mostly low to very low . Some scattered areas of moderate
		Gedangan	Mostly very low to low	Mostly very low to low with some scattered areas of moderate in the soutwest region and northeast region
		Pagelaran Utara	Mostly very low with some scattered areas of moderate v	The scattered areas of moderate become wider and the rank of some of the area are high.
		Pagelaran Selatan	Mostly very low with some scattered areas of moderate	The scattered areas of moderate v become wider and the rank of some of the area are high.
		Bantur	Almost all region is low except in the	Mostly very low to low. A significat wide

No.	District / City	District	Vulnerability Level Change	
			Baseline Condition	Projection Condition
			north is some scattered areas of moderate	of moderate in the centre region
		Kepanjen	Mostly very low to low with some scattered areas of very high in the centre region	Amost all region is very high with some scattered areas of high
		Pakisaji	Mostly very low to low with some scattered areas of very high	All region is very high
		Ngajum	Mostly very low with scattered areas of low to moderate	Very low still dominant. Scattered areas become wider with the rank are low to very high
		Kromengan	Mostly very low v with scattered areas of low to high	The scattered areas of moderate to high become wider.
		Sumberpucung	Mostly very low to low.	Mostly very low to low, some scattered areas of moderate v in the south
		Pagak	Mostly very low to low	Not much chage, except a significat area of moderate in the centre
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		Kalipare	Mostly very low to low with some scattered areas of moderate	The scattered areas of moderate become wider
		Wonosari	Mostly very low to low with some scattered areas of moderate	The scattered areas of moderate become wider and the rank of some of the areas are high
		Wagir	Scattered area ranges from low to very high.	Area of very high becomes dominant
		Dau	Mostly very low. Some scattered area of moderate in the east	The scaterred areas become very high to moderate.
		Pujon	Mostly very low. Some scattered area of moderate in the east	The scaterred areas of moderate become wider
		Ngantang	Mostly very low. Some scattered area of moderate in the east	The scaterred areas of moderate become wider
		Kasembon	Mostly very low. Some scattered area of moderate in the east	The scaterred areas of moderate become wider

4.3 Risk Analysis

The risks of climate change, magnitude, and spatial distribution are determined by the level of hazard and vulnerability; risk is a function of hazard and vulnerability (Affeltranger et al, 2006). In this sub chapter, the result of risk analysis for Greater Malang in the water sector, both for baseline and projection will be explained and visualised in maps. The map is developed from the overlay of two maps that were produced previously; i.e. map of hazard and map of vulnerability. The risk scheme for the water sector can be seen from the figure below.

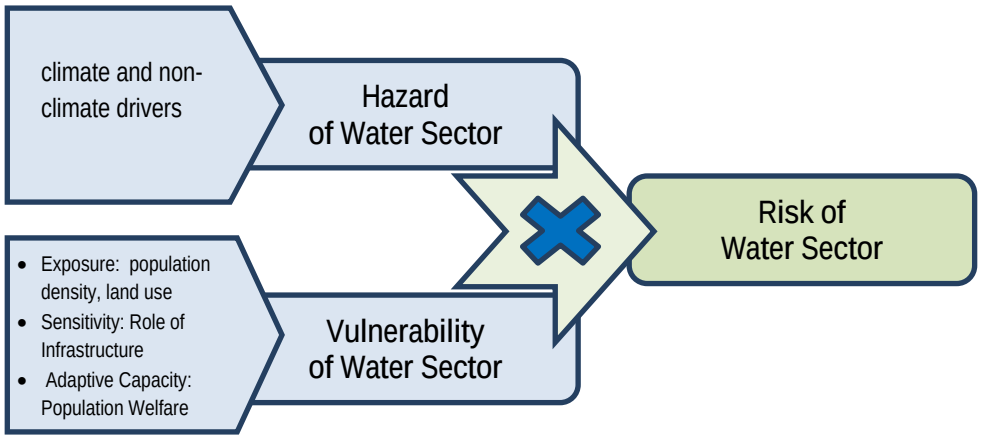
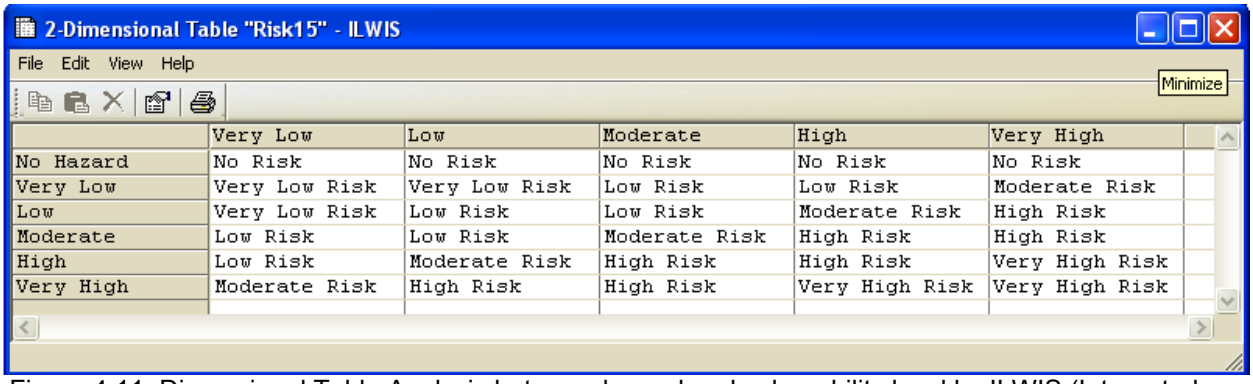


Figure 4.10 Risk Scheme

4.3.1 Risk Analysis of Flood

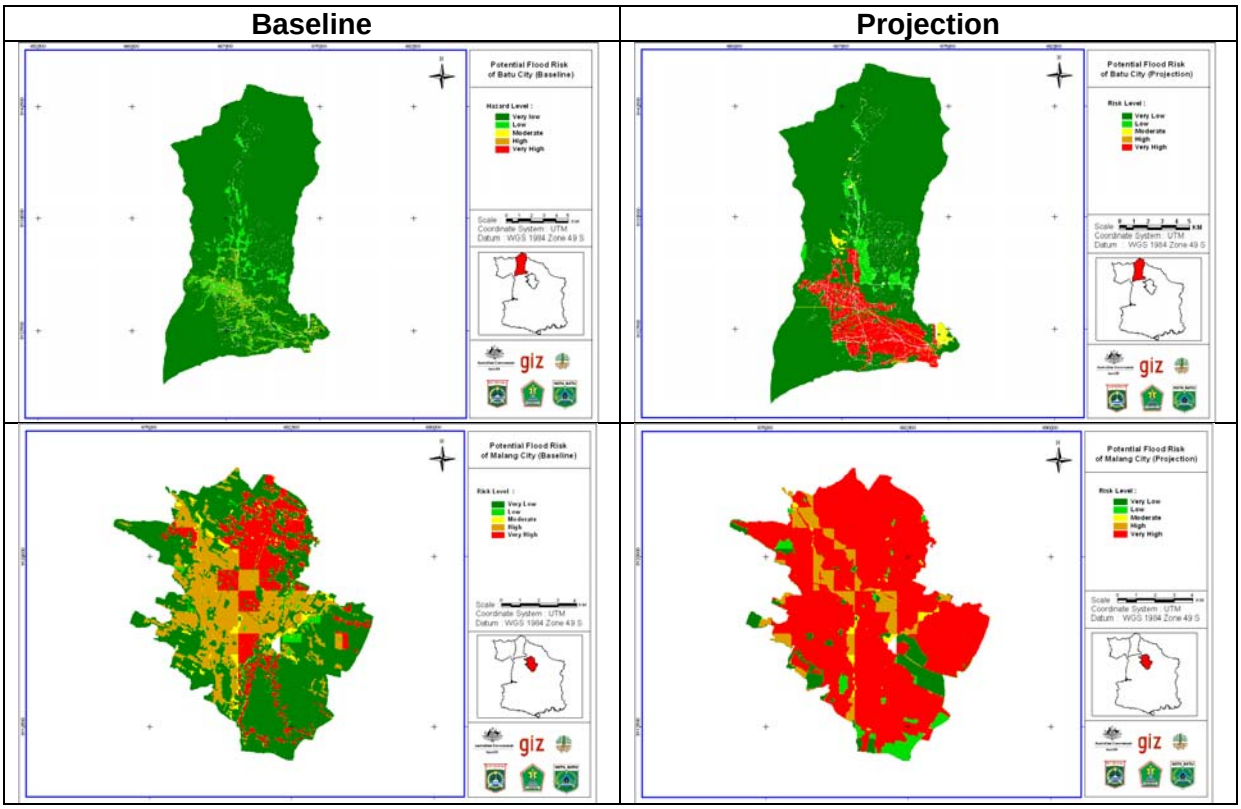
The risk level map is gained from the two Dimensional Table analyses between hazard and vulnerability levels by the ILWIS (Integrated Land and Water Information System) application (Figure 5.16).



	Very Low	Low	Moderate	High	Very High
No Hazard	No Risk	No Risk	No Risk	No Risk	No Risk
Very Low	Very Low Risk	Very Low Risk	Low Risk	Low Risk	Moderate Risk
Low	Very Low Risk	Low Risk	Low Risk	Moderate Risk	High Risk
Moderate	Low Risk	Low Risk	Moderate Risk	High Risk	High Risk
High	Low Risk	Moderate Risk	High Risk	High Risk	Very High Risk
Very High	Moderate Risk	High Risk	High Risk	Very High Risk	Very High Risk

Figure 4.11 Dimensional Table Analysis between hazard and vulnerability level by ILWIS (Integrated Land and Water Information System)

The risk map of flood both in the baseline and projection conditions can be seen in Figure 4.12 below.



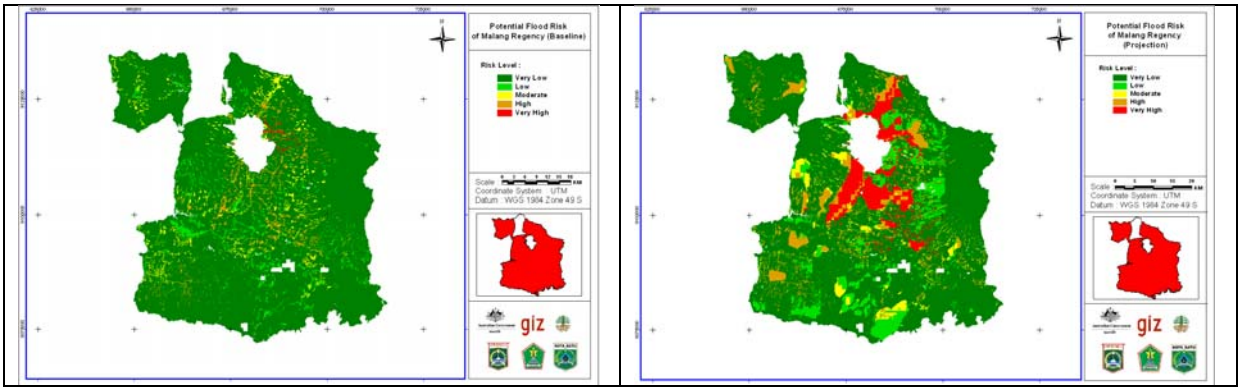


Figure 4.12 Risk Flood of Greater Malang – Baseline and Projection

In the baseline conditions, the area which most constitutes the highest risk is Malang city; i.e. 18.67 % of the Malang City area experiences a very high level of flood risk. As for the projection conditions, almost all of the Malang City area (80.23 %) is estimated to experience major floods due to a very high level of risk. The summary of the estimated flood risk area of Greater Malang can be seen in Table 4.12 below.

Table 4.12 Potential Flood Risk Area of Greater Malang

Risk Level	Batu City		Malang City		Malang District	
	Baseline (km^2)	Projection (km^2)	Baseline (km^2)	Projection (km^2)	Baseline (km^2)	Projection (km^2)
Very Low	179.38	160.68	57.22	6.88	3,059.36	2,494.50
Low	11.68	7.75	3.14	3.80	177.58	347.08
Moderate	1.59	2.71	4.03	1.30	97.15	104.59
High	3.32	0.70	25.55	9.00	66.90	228.36
Very High	0.001	24.14	20.53	89.48	7.71	233.21

Flood hazard model analysis has been done for each watershed. Based on the detailed analysis for each watershed in the baseline and projection conditions, the very high potential flood risk area is located in the Bango watershed as seen in Figure 4.11.

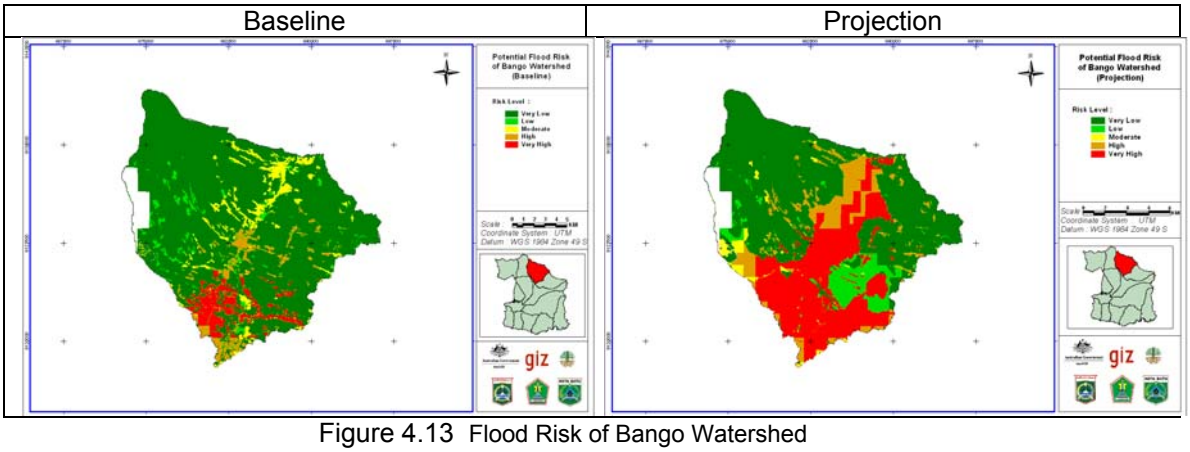


Figure 4.13 Flood Risk of Bango Watershed

In baseline conditions, the risk areas mostly cover residential areas. Meanwhile in the projection conditions, very low level would cover most dry-land agricultures, plantation, paddy field and protected forest. Meanwhile other levels would mostly cover the military area, the industry areas and the residential areas. The highest risk is the airport because it is the main transportation infrastructure in Greater Malang.

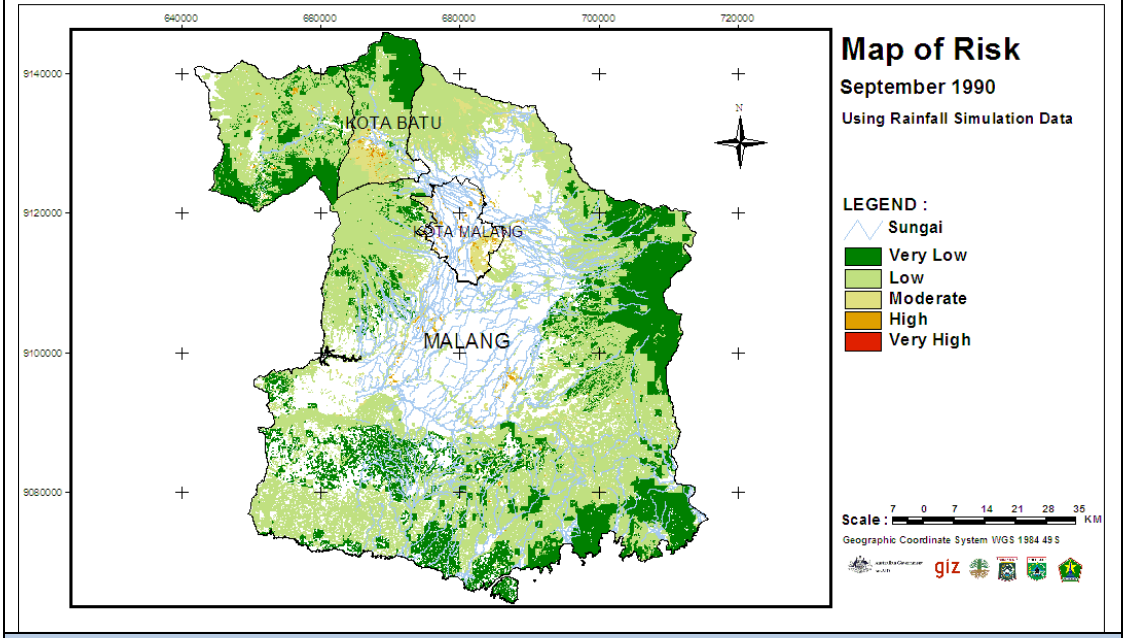
Table 4.13 Potential Flood Risk Area of Bango Watershed

Risk Level	Baseline		Projection	
	Area (km2)	Land Use	Area (km2)	Land Use
Very Low	252.17	Paddy Field Dry-land agricultures	164.80	Protected Forest Plantation Paddy Field Dry-land agricultures
Low	11.76	Residential Paddy Field	22.21	Dry-land agricultures Residential Industry Area
Moderate	18.36	Residential	6.95	Military Area Industry Area Residential
High	13.12	Residential	30.20	Military Area Industry Area Residential
Very High	17.48	Residential	89.41	Airport Public Facility Industry Area Residential

4.3.2 Risk Analysis of Landslide

The landslide risk modeling has been done through the simulation of ground water table fluctuation and estimation of the soil strength. The spatial distribution of risk areas for the baseline (2011) and projection (2030) years in September is shown in Figure 4.14.

Baseline condition



Projection condition

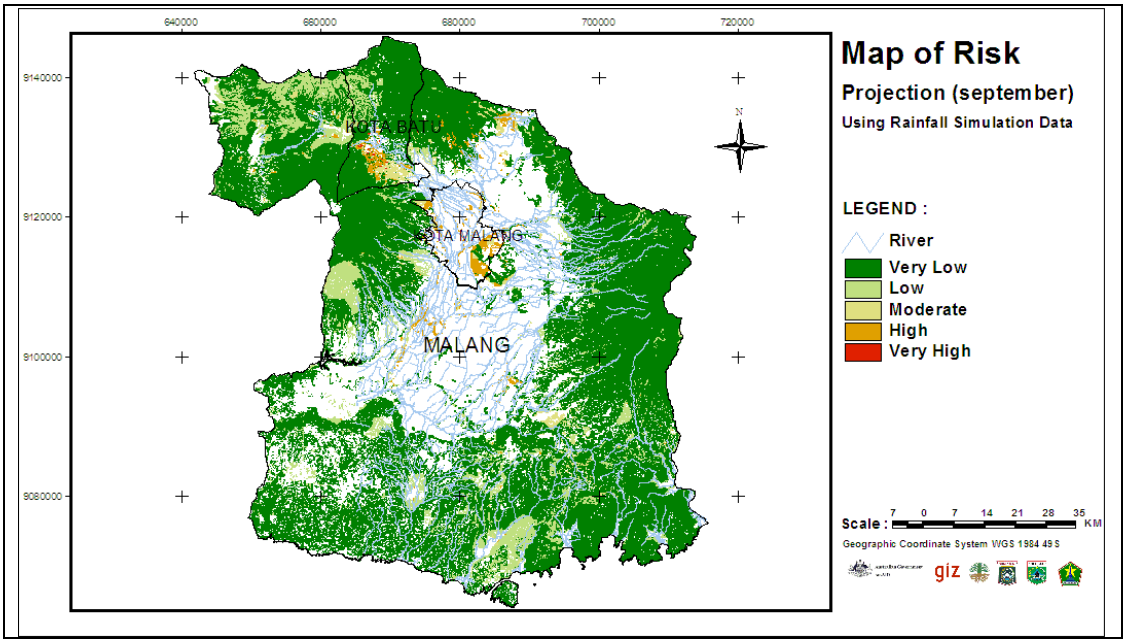
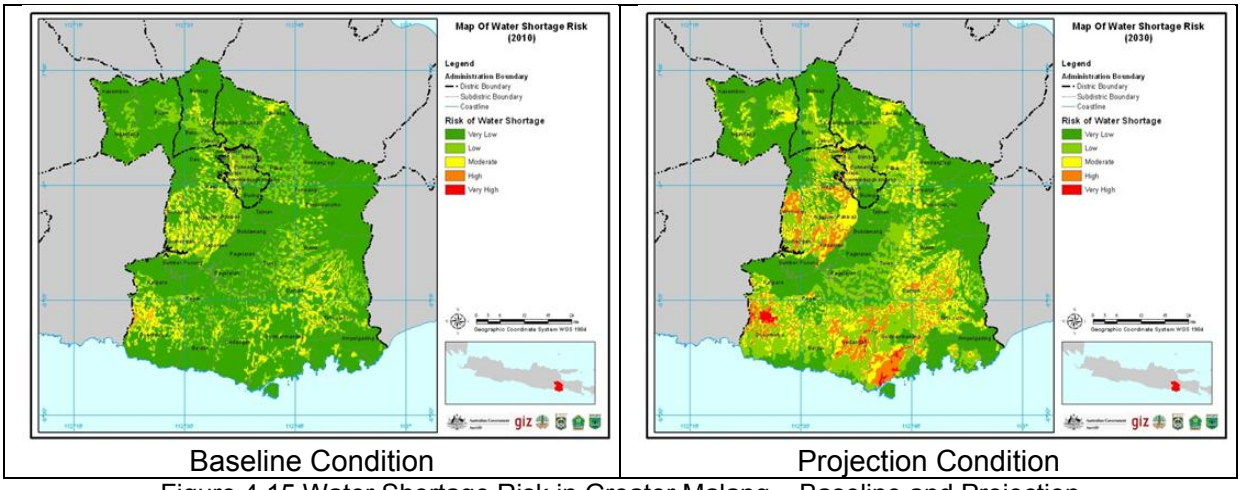


Figure 4.14 Landslide risk map for baseline condition and for projection condition

In detail, for the baseline conditions, a very high level occurs in built-up areas (3.352,39 m^2), Plantation (45.934,96 m^2), residential (111.493,88 m^2), and irrigation paddy (27.890,22 m^2). As for the projection conditions, a very high level would occur in Social and Public facilities (15.634,89 m^2), Protected Forest (60,78 m^2), industrial and warehouse areas (2,908.91 m^2), tourist areas (41.603,05 m^2), Plantation areas (3.673,96 m^2), Trade and service areas (70.600,75 m^2), Residential areas (624.679,50 m^2), green open space (19.507,86 m^2), and river borders (13.654,42 m^2).

4.3.3 Risk Analysis of Water Shortage

The risk map of water shortage, for both baseline and projection years, can be seen in Figure 4.15 below. As can be understood from these figures, the water shortage risk in Greater Malang is relatively low during the baseline period and is projected to experience a slight increase by 2030.



Baseline Condition | Projection Condition

Figure 4.15 Water Shortage Risk in Greater Malang – Baseline and Projection

In the baseline conditiona, the decreased water availability in the Greater Malang Region is only found at very low to high level of risk. However, it is projected that by 2030, some areas in southern part of Malang District will experience a very high level of risk in water availability.

The characteristics of risk level and its distribution can be seen in Table 4.13 below, for baseline conditions, while Table 4.14 describes the projection.

Table 4.14 Water Shortage (WS) Risk and Distribution in Baseline Period (2010)

Level of WS[1)] Risk	Watershed	City / District : Subdistrict	Description of the Risk
Very High		-	-
High	IIA, IIIA	Malang City: Donomulyo, Wonosari, Tirtoyudo	Decrease of water availability as a cause of climate factors Increase in water availability as a cause of concentration of settlement.
Moderate	IIA, IIC, IIIA, IIIB	Malang City: all subdistricts except Pagak, Pagelaran, Bululawang, Tajinan, Gondanglegi, Pakis, Singosari, Karangploso, Pujon, Ngantang, and Kasembon	Decrease of water availability as a cause of climate factors Increase in domestic water demand and change in land use.
	IA	Batu City: Bumiaji	
	IIC	Malang City: Dinoyo, Mulyorejo, Sukun	
Low	IB, IC, IIA, IIB, IIC, IIIA, IIIB, VA, VC	Malang City: all subdistricts except Bululawang and Tajinan	There's no significant risk
	IA	Batu City: Bumiaji, Jabung, &Batu	
	IB, IC, IIA	Malang City: dominantly in Lowokwaru, Blimbing, Purwantoro, Klojen, and Kedungkandang subdistricts	
Very Low	IB, IC, IIA, IIB, IIC, IIIA, IIIB, IV	Malang City: Bululawang, Tajinan	There's no significant risk
	IA	Batu City: Bumiaji, Jabung, Batu	
	IIB	Malang City: Buring	

Table 4.15 Water Shortage (WS) Risks and Distribution in Projection Period (2030)

Level of WS[1)] Risk	Watershed	City/ District : Subdistrict	Description of the Risk
Very High	IIIA, IIIB	Malang City: Donomulyo, Gedangan, Sumbermanjing	Decrease of water availability caused by climate factors Increase in water availability as a cause of concentration of settlement.
High	IIA, IIC, IIIA, IIIB	Malang City: Donomulyo, Kalipare, Pagak, Bantur, Gedangan, Sumbermanjing, Dampit, TirtoYudo, Dampit, Poncokusumo, Kromengan, Wonosari, Ngajum, Kepanjen, Dau, Wagir	Decrease of water availability caused by climate factos Increase in domestic water demand and change in land use.
Moderate	IB, IC, IIA, IIC, IIIA, IIIB	Malang City: all subdistricts except Singosari, Bululawang, Tajinan, Pagelaran,	Decrease of water availability caused by climate factors
	IA	Batu City: Bumiaji, Jabung	
	IIC	Malang City: Dinoyo, Oro-oroDowo, Sukun, Mulyorejo, Klojen	
Low	IB, IC, IIA, IIB,	Malang Muncipal : all subdistricts except	There's no significant risk

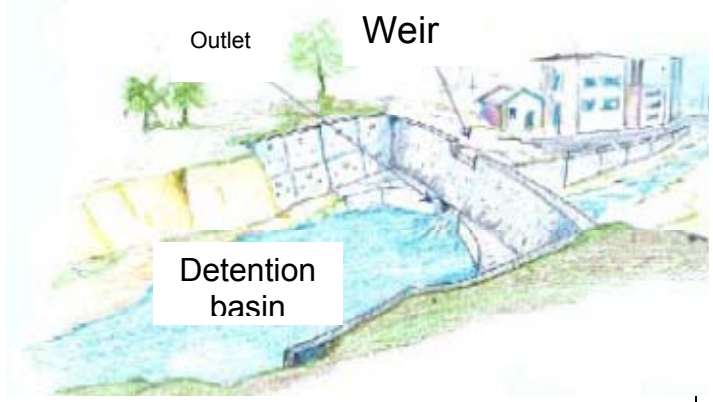
Level of WS[1)] Risk	Watershed	City/ District : Subdistrict	Description of the Risk
	IIC, IIIA, IIIB, V	Bululawang	
	IA	Batu City: Bumiaji, Jabung, Batu	
	IB, IC, IIB	Malang City: Kedungkandang, Lowokwaru, Blimbing, Purwantoro	
Very Low	IB, IC, IIA, IIB, IIC, IIIA, IIIB, IV	Malang Municpal: all subdistricts except Kromengan, Wonosari	There's no significant risk
	IA	Batu City: Bumiaji, Jabung, Batu	
	IIB	Malang City: Buring	

4.4 Adaptation Options

4.4.1 Adaptation Options for Flood

The adaptation options for Greater Malang will be addressed for each area based on the risk level. In general, the adaptation options for flood include reforestation, detention basins, ponds, retention ponds, and infiltration measures. Explanation for each adaptation area is seen in Table 4.16.

Table 4.16 Adaptation Option in Greater Malang Base on Location

Adaptation Option	Explanation	Sub-Districts	Ilustration
Reforestation	The process of replacing plants in the encroached forest area due to unplanned urban growth, irregular land-use or other motives; e.g. for economic use of trees. Therefore, it is a very important measure to recover natural patterns. Reforestation prevents soil erosion, retains topsoil and favours infiltration. Runoff volumes are reduced and drainage structures keep working efficiently, once a minor quantity of sediments arrives at the system. Reforestation can be done by the artificial planting of seeds or young trees.	Pujon Batu BumiAji Jabung Dau Wagir Ngajum Poncokusumo	
Detention Basin	Flood damping is an effective measure to redistribute discharges over time. In this measurement, increasing volumes of runoff, as a result of urbanization, are not diminished; however the flood peaks are reduced. Damping process works storing water and controlling outflow with a limited discharge structure. There are several possibilities in applying this measure. For instance, detention ponds may be placed in line with rivers, thus controls great portions of the basin. As for urban areas located at the upstream level, larger reservoirs can be built. On the other hand, at the downstream, public parks and squares, as well as riverine areas, should be constructed; i.e. will give multifunctional landscapes and can act as detention ponds during flood events.	Pujon Bumiaji Singosari Gondanglegi Wajak Tumpang	

Ponds (Embung)	The pond provides two primary services; i.e. first, the to catch runoff water from higher elevation areas and retains the water before releasing it into streams, and second, to be used as water storage that can also serve as a water source. Afterwards, the pond should be built near the middle stream area.	Pujon Batu Bumiaji Jabung Dau Wagir Wajak Dampit Turen	
Retention Pond	A retention pond is designed to control storm water runoff on a site and also possibly to remove pollutants from the retained water. Storm water control strategies include ditches, swales, ponds, tanks, and vaults. These generally function by capturing, storing, treating, and slowly releasing storm water downstream or allowing infiltration into the ground. A retention (or infiltration) pond collects water as a final storage destination, where water is held until it either evaporates or infiltrates the soil.	Kedung Kandang Pakisaji Kepanjen Tajinan	

Infiltration Measures	Infiltration measures allow to partially recover the natural catchment hydrologic behaviour. Infiltration measures may be divided into some different categories; i.e. infiltration trenches, vegetated surfaces, rain gardens, porous or permeable pavements.	Lowokwaru Blimbing Kedung Kandang Dinoyo Sukun Buring Klojen Purwantoro Mulyorejo Oro Oro Dowo Pakisaji Bululawang Kepanjen	  

4.4.2 Adaptation Options for Landslide

Based on landslide risk evaluation, experts suggested priorities for adaptation based on the likelihood of loss and occurence as well as identified acceptable risk. Prioritisation of the adaptation options in the Greater Malang area is influenced by some vulnerability factors such as building, public facilities, protected forest, industrial areas, tourism areas, commercial areas, plantation areas, settlement areas, green open field, and watershed. Adaptation work or activity is chosen based on the compatibility of four practical groups on every landslide land-use risk. Adaptation should be implemented by using several combinations of adaptation works or activities.Table 4. 17 below shows the adaptation options for each subdistricts.

Table 4.17 Adaptation Option for Landslide in Greater Malang

Adaptation Option	Explanation	Subdistricts	Ilustration
Riverbank Protection	Stabilisations work to protect the riverbank with a combination of vegetation and man-made structure that integrates working in preventing slide. This concept of slope stabilisation is generally cost effective as compared to hard structural elements. Beside, it is more compatible to the environmental, as it allows the use of local material. The fences bind the compaction of soil, while the riprap vegetation and structural elements, give double benefitsas they keep the stability by roots anchoring to the soil and gives a hydrological effect that causes slope stabilisation.	Kasembon Ngantang Pujon Pakisaji Kepanjen Sumberpucung	
Forestation	The process of replacing plants in the encroached forest area due to unplanned urban growth, irregular land-use or other motives; e.g. for economic use of trees. Therefore, it is a very important measure to recover natural patterns. Reforestation prevents soil erosion, retains topsoil and favours infiltration. Runoff volumes are reduced and drainage structures keep working efficiently, once a minor quantity of sediments arrives at the system. Reforestation can be done by the artificial planting of seeds or young trees.	Kasembon, Ngantang, Pujon, Bumiaji, Batu, Jabung, Dau, Wagir, Ngajum, wonosari, Donomulyo, Bantur, Pagak, Gedangan, Sumbermanjing, Dampit Tirtoyudo, Ampel Gading, Poncokusumo, Gondang Legi, Lawang, Singosari, Karang Ploso	

Engineering Works	Structural element serving this purpose are check dam (open type), and soft-engineering that uses interaction between biovegetation and hard structural elements. The purpose is basically to give simple prevention on rockfall by binding rocks when its fractured. Meanwhile, rock blocks that are made from metallic material nets, being tied to its anchor as a handle of nets, and elongation of nets itself, serve to catch the fractured rocks and prevent them falling to the ground. The last are boulder fences that have the same materials as rocks blocks, but different in construction, it can stand up to both rockfall and debris flow landslide.	Kasembon, Pujon, Ngantang, Bumiaji, Batu, Jabung, Kedung Kandang, Buring, Blimbing, Klojen, Sukun, Mulyorejo, Pakisaji, Turen	 

4.4.3 Adaptation Options for Water Shortage

Based on the distribution pattern and the level of the water shortage hazard, the land elevation and the existing watershed classification from the Agency of Brantas Watershed Management or *Balai Pengelolaan DAS Brantas* (*BP DAS Brantas*), the Greater Malang area is divided into 5 (five) zones for adaptation strategies. Further, these zones are also divided into several sub zones, except for Zone III Therefore, we have 12 (twelve) zones for the adaptation in Greater Malang as follows: Zone IA, Zone IB, Zone IC, Zone IIA, Zone IIB, Zone IIC, Zone III, Zone IVA, Zone IVB, Zone VA, Zone VB, and Zone VC. The division of the zones can be seen in Figure 4.15 below. In addition, the summary of adaptation for each zone is provided in Table 4.18.

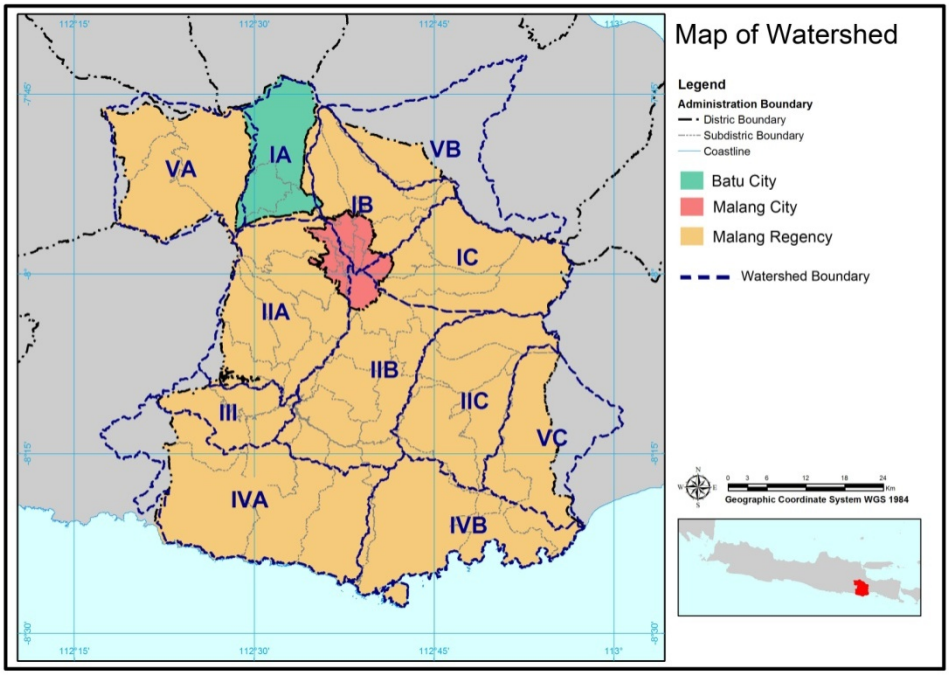


Figure 4.16 Zoning for Adaptation to Water Shortage in Greater Malang

Table 4.18 Main Condition, Risk in Projection Period, and Adaptation Option for Water Shortage

ZONE	City / District Area	Characteristics → MAIN REASONS/ CONDITIONS	HAZARD (H), VULNERABILITY (V) & RISK I IN PROJECTION PERIOD	Adaptation Option For Strategy
IA, Sumber Brantas sub watershed	Batu, Jabung, Bumiaji (Batu City)	Mostly green areas as recharge areas for downstream region, separated by spring. Relatively unchanged of Land use Spring as main water sources	The hazard is increasing one level to high in 2030 DoWA is relatively unchanged arround 652,999.25 m^3/month. The vulnerability is increasing to high In the centre part of Batu,several areas risk are increasing up two level from very low to moderate affected by increasing of water demand	Reforestation/Afforestation Implementation of water resource conservation (supply side) Implementation of low impact development (LID), i.e.: maximise recharge area, increase water infiltration with special vegetation and land structuring, decreasing impermeable layer of land, conserve land function in holding and recharging water;

ZONE	City / District Area	Characteristics → MAIN REASONS/ CONDITIONS	HAZARD (H), VULNERABILITY (V) & RISK I IN PROJECTION PERIOD	Adaptation Option For Strategy
IB, Bango watershed, part of Amprong-Bango (Ambang) sub watershed	Karangploso, Singasari, north Pakis, south Lawang (Malang District); east Lowokwaru, Blimbing, Purwantoro, east Klojen, and northern part of Kedungkandang (Malang City)	Mostly urban area Recharge & discharge area (groundwater) Mostly built-up area Higher Water demand but reltively fulfilled by the PDAM and groundwater	The hazard is moderate. DoWA is relatively unchanged arround 3,226,867.05 m^3/month The vulnerability is very low to high and it is increasing from 2010 to 2030. The causes of the increasing risk are increasing water demand (the vulnerabilty)	Lower region or urban area (Malang city and its surrounding area) through implementation of water resource conservation (supply side) Hard adaptation in the upper region or rural region to upper area or highland area.
IC, Amprong, part of Amprong-Bango (Ambang) sub watershed	Gondanglegi, centre to south of Pakis, northern part of Poncokusumo, Tumpang (Malang District); Buring and Kedungkandang (Malang city)	Dry land are dominant which impacts are increasing runoff & sediment transport Water sources: PDAM's water in urban area, hand pump or electric pump (groundwater) in north part; and rivers (direct use) or limited springs in south and east part of the zone	The hazard is increasing one level to high in 2030 DoWA is relatively unchanged arround 567,153.88 m^3/month. The vulnerability is very low to high, mostly very low. The risks are very low to moderate, mostly very low. The causes of the increasing risk are increasing the hazard & water demand (the vulnerabilty)	Lower region or urban area (west part of the zone or Malang city and its surrounding area) by implementation of water resource conservation. Hard adaptation in the middle region to upper region or rural region.
IIA, West part of Metro –Lahor-Lemon sub watershed	Dao, Wagir, Pakisaji, Kapanjen, Ngajum, Kromengan, Wonosari(Malang District); Dinoyo, west Lowokwaru, west Klojen, Sukun, west Buring (Malang City)	Recharge area in upper part. Rice field and irrigation area in middle to lower part Water demand is high mainly for irrigation of rice field and domestic use The irrigation are using only river water (not using water from Soetami dam)	The hazard is increasing one level to high in 2030 DoWA in 1950 to 2010 reach 3,277,247.63 m^3/month and DoWa 1950 to 2030 reach 2,693,738.53 m^3/month. The vulnerability becoming very high in lower area, caused by water demand. The risks is increasing from 2010 to 2030	Hard adaptation by implementation of water resource in lower region or urban area (Malang city and capital city of Malang municipal and its surrounding area). Hard adaptation in the middle to upper region or rural region
IIB, East part of Metro –Lahor-Lemon sub watershed	most part Buring (Malang City), Tajinan, Bululawang, Turen, Pagelaran Selatan, Pagelaran Utara	Lowland region in greater Malang Mostly as discharge area. The main water problem is likely flood	The hazard is low. DoWA is relatively unchanged arround 10,424,687.55 m^3/month. The vulnerability is increasing.	Collaboration with upper sub watershed in flood adaptation and water shortage adaptation; Developing agro-forestry as natural recharge for water resource conservation and

ZONE	City / District Area	Characteristics → MAIN REASONS/ CONDITIONS	HAZARD (H), VULNERABILITY (V) & RISK I IN PROJECTION PERIOD	Adaptation Option For Strategy
	(Malang District)	Water resources: PDAM's water, groundwater with electric pump or hand pump, groundwater with dug well and river water or springs	The risks is increasing, still very low. The causes of the increasing risk are increasing the vulnerability (water demand)	developing artificial recharges in plantations area (trench or ditch); Developing artificial recharge by: (a) developing recharge well, especially in north part of the zone; (b) developing retardation basin or polder (*embung* or *urung-urung*); Drainage and river maintenance.
IIC, Lesti	Southern part of Poncokusumo, Wajak, Dampit Northwest Titoyudo (Malang District)	Recharge area in upper part. Rice field and irrigation area in middle to lower part Dry land dominated by loosing increase of runoff and sediment transport Recharge area in upper land & recharge area in low land Low water demand	The hazard is high. DoWA is increasing up to 100,000 m^3/month. The vulnerability is increasing, mostly high. The risks are very low-high, mostly moderate. The causes are increasing the vulnerability (water demand) .	Upper to middle region: (1) forestation/ vegetation of dry-land agriculture or wasteland area, (2) agro-forestry as natural recharge for water resource conservation; (3) artificial recharges by developing trench or ditch in plantations area; (4) developing small dam/ check dam; (5) minimize land erosion; Lower region / urban area: (1) developing artificial recharge by developing recharge well; (2) drainage maintenance.
III, South part of Metro –Lahor-Lemon sub watershed	Sumberpucung, upper part of Kalipare	Region is down stream of upper Brantas, Amprong, Bango and Lesti watersheds Location of Soetami dam Water demand is high caused by water demand for the dam Place of high important of water infrastructure	The hazard is very low. DoWAis increasing reach 9 million.m^3/month. The vulnerability is increasing by the condition of water infrastructure. The risk is very low.	Collaboration with upper sub watershed in water shortage adaptation as well as flood adaptation; Upper region : (1) forestation, especially on dry-land agriculture; (2) land erosion prevention Lower region/dam region: (1) engineering on dam, (2) spillway evaluation, (3) emergency spillway, (4) evaluation of dam ass, etc; (5) preventing water supply for the dam; (3) decreasing sedimentation and dredging sedimentation
IVA, Western south coast watershed, outside of Brantas watershed	Kalipare, Pagak, GedanganBatur, Donomulyo (Malang District)	Dominated by limestone Water demand is high caused by high cultivation actvities	The hazards are increasing one level to very high in western and eastern area. DoWA is increasing up to 800 thousand m^3/month. The vulnerability and the risk increasing one level by increasing water	Agro- forestry as natural recharge for water resource conservation; and artificial recharges by developing trench or ditch in plantations area; Developing surface water resource in region that drained abundantly by short rivers; Developing groundwater or subsurface water resource

ZONE	City / District Area	Characteristics → MAIN REASONS/ CONDITIONS	HAZARD (H), VULNERABILITY (V) & RISK I IN PROJECTION PERIOD	Adaptation Option For Strategy
			demand.	in karst regions or limestone region Rain water harvesting in centre region which has no potency of both surface water and groundwater.
IVB, Eastern south coast watershed, outside of Brantas watershed	Sumbermanjing, southern part of Tirtoyudo, southern part of AmpelGading (Malang District)	Dominated by limestone Water demand is high caused by high cultivation actvities	The hazard is increasing one level to high in the western part DoWA is increasing that up to 200 thousand m^3/month. The vulnerability is increasing to high in the western part. The risk is increasing one level in the western part to high-very high.	Agro- forestry as natural recharge for water resource conservation; and artificial recharges by developing trench or ditch in plantations area; Developing surface water resource in region that drained abundantly by short rivers; Developing groundwater or subsurface water resource in karst regions or limestone region Rain water harvesting in centre region which has no potency of both surface water or groundwater. Desalination of sea water if necessary
VA, Konto watershed, outside of Brantas watershed	Pujon, Ngantang and Kasambon (Malang District)	Region is belong to Konto watershed	The hazard is moderate. DoWA is increasing about 500 thousand m3/month. The vulnerability is low and increasing caused by water demand. The risks are low and increasing.	Hard adaptation by implementation of water resource conservation (supply side) and low impact development.
VB, Lawang watershed, outsideBrantas watershed	Northern part of Lawang (Malang District)	Region in southeast Malang District	The hazard is high and it is relatively unchanged compared to 2010. DoWAis decreasing about 400 thousand m^3/month. The vulnerability is very high in northern part of Malang. The risks are moderate and increasing by the vulnerability (water demand)	Hard adaptation by implementation of water resource conservation (supply side) and low Developing water piping system by establishing PDAM in Lawang subdistrict. Water resource as raw water for this water piping system can be taken from groundwater; Developing agro forestry as natural recharge for water resource conservation and generating new springs using artificial recharge such as ditch or trench in plantation.
VC, Ampelgading watershed,	Northern to eastern part of Ampelgading	Region in eastern Malang District	The hazard is increasing one level to high.	Hard adaptation by implementation of water resource conservation

ZONE	City / District Area	Characteristics → MAIN REASONS/ CONDITIONS	HAZARD (H), VULNERABILITY (V) & RISK I IN PROJECTION PERIOD	Adaptation Option For Strategy
outside of Brantas watershed	(Malang District)		DoWA is relatively unchanged arround 900,572.74 m^3/month. The vulnerability is increasing one level. The risk is increasing to moderate by the hazard and water demand (the vulnerabilty)	(supply side) and low impact development.

Based on the description of adaptation options that fit each zone's characteristics above, the implementation criteria is arranged this way (Table 4.19):

Table 4.19 Table Implementation Rank of Climate Change Adaptation in Greater Malang (Priority scale 1-3)

No	Criteria	Malang City	Malang District	Batu City	Adaptation Strategy Priority
1	Large area factor that has a high risk only	2	1	3	Hard Adaptation + Soft Adaptation
2	Large area factor that has a high to very high risk + water needs factor	1	2	3	Focus on Hard Adaptation, accompanied with Soft Adaptation
3	Large area factor that has a high to very high risk + water supply factor supply factor	3	2	1	Focus on Hard Adaptation,accompanied with Soft Adaptation

5. Risk Assessment Results and Adaptation Options of Agriculture Sector

5.1 Hazard Analysis

Climate change impact that is analysed here in relation to the agricultural sector in Greater Malang are the potential decrease in productivity, potential reduction in harvested area, potential reduction in land area, and potential decline of crop production. The analyses are based on the assumption that the decrease in plant productivity and harvested area has a strong relationship with changes in air temperature and rainfall.

The hazard analysis is conducted for two main crop commodities in Greater Malang, i.e. paddy and corn. The level of hazard is divided into five; i.e. very low, low, moderate, high, and very high. Hazard level is represented by the green, blue, yellow, orange, and red colours, respectively. The classification and weighting factors are shown in Table 5.1, which applies to all types of hazard.

Table 5.1 The Hazard Level in Agricultural Sector

No	Level of Hazard	Index of Hazard	Colours
1	Weighting 1, Very Low Hazard	< 0.200	Green
2	Weighting 2, Low Hazard	0.200-0.400	Blue
3	Weighting 3, Moderate Hazard	0.400- 0.600	Yellow
4	Weighting 4, High Hazard	0.600 - 0.800	Orange
5	Weighting 1, Very High Hazard	>0.800	Red

5.1.1 Hazard Analysis of Crop Productivity Decrease

The analysis for decrease in crop productivity works under the assumption that the increase in temperature is from climatic stimuli which will increase respiration rate and shorten crop growing season, thus causing decline in the crop yield. Therefore, as the temperature gets higher, the crop growing period wil be shorter, thus resulting in smaller accumulated crop biomass and lower crop yield. The relationship between these variables was used to estimate the decrease in crop yield caused by increasing air temperature (Handoko et al, 1998). In addition, rainfall determines the water availability to support crop growth especially on rain-fed fields. Therefore, changes in rainfall that may lead to droughts or floods will cause a decreased crop yield.

An estimation of a decrease in crop productivity in Greater Malang for the year 2030 is made for two types crops, i.e. rice and corn. The estimation is presented in Table 5.2. In addition, the projection of productivity and wetland rice field, dryland rice field, and corn until year 2030 is shown in Figure 5.1.

Table 5.2 Analysis Results of Decrease in Productivity (∆Ya) of Staple Food Crops in Greater Malang Year 2030

Subdistrict	Decreasing Wetland Paddy Productivity		Decreasing Dryland Paddy Productivity		Decreasing Corn Productivity	
	(Ton/Ha)	%	(Ton/Ha)	%	(Ton/Ha)	%
01. Donomulyo	-0.715	-12	-0.498	-11	-0.379	-9
02. Kalipare	-0.764	-12	-0.481	-10	-0.395	-9
03. Pagak	-0.728	-12	-0.507	-11	-0.435	-10
04. Bantur	-0.747	-12	-0.587	-13	-0.457	-11
05. Gedangan	-0.747	-12	-0.579	-13	-0.454	-11
06. Sumbermanjing	-0.782	-12	-0.569	-13	-0.460	-11

Subdistrict	Decreasing Wetland Paddy Productivity		Decreasing Dryland Paddy Productivity		Decreasing Corn Productivity	
	(Ton/Ha)	%	(Ton/Ha)	%	(Ton/Ha)	%
07. Dampit	-0.792	-12	-0.605	-12	-0.457	-11
08. Tirtoyudo	-0.748	-12	-0.610	-12	-0.468	-11
09. Ampelgading	-0.697	-12			-0.446	-11
10. Poncokusumo	-0.786	-13	-0.548	-13	-0.583	-11
11. Wajak	-0.982	-13	-0.624	-12	-0.530	-11
12. Turen	-0.987	-12	-0.560	-12	-0.599	-10
13. Bululawang	-0.783	-13	-0.551	-12	-0.501	-10
14. Gondanglegi	-1.051	-12			-0.622	-10
15. Pagelaran	-1.054	-12			-0.580	-9
16. Kepanjen	-0.988	-12			-0.544	-10
17. Sumberpucung	-0.915	-12			-0.625	-9
18. Kromengan	-0.743	-12			-0.427	-10
19. Ngajum	-0.810	-13	-0.484	-11	-0.528	-10
20. Wonosari	-0.760	-12	-0.454	-11	-0.475	-10
21. Wagir	-0.792	-13	-0.485	-12	-0.435	-10
22. Pakisaji	-0.821	-13			-0.488	-10
23. Tajinan	-0.753	-13	-0.485	-13	-0.504	-10
24. Tumpang	-0.819	-13			-0.511	-11
25. Pakis	-1.038	-13			-0.634	-10
26. Jabung	-0.838	-14	-0.529	-13	-0.543	-11
27. Lawang	-1.053	-14			-0.503	-11
28. Singosari	-1.147	-14	-0.718	-11	-0.559	-11
29. Karangploso	-0.852	-13	-0.568	-12	-0.478	-11
30. Dau	-0.803	-13	-0.482	-12	-0.492	-10
31. Pujon	-0.726	-13			-0.527	-10
32. Ngantang	-0.770	-13			-0.509	-10
33. Kasembon	-0.761	-13	-0.464	-11	-0.485	-10
34. Kedungkandang	-0.880	-13			-0.392	-11
35. Sukun	-1.001	-13			-0.384	-11
36. Klojen	0.000	0				-3
37. Blimbing	-0.934	-13				-3
38. Lowokwaru	-0.901	-13			-0.392	-11
39. Batu	-0.839	-13			-0.420	-11
40. Junrejo	-0.844	-13			-0.423	-11
41. Bumiaji	-0.869	-13			-0.440	-11

As a result of the impacts of climate change, the productivity of agricultural crops in all areas of Greater Malang is estimated to fall by 12.4% for wetland paddy, 10.4% for dryland paddy, and 10.0% for corn in 2030. Annually, the average reductions in productivity are 0.62%, 0.52%, and 0.50% per year for wetland paddy, dryland paddy, and corn, respectively.

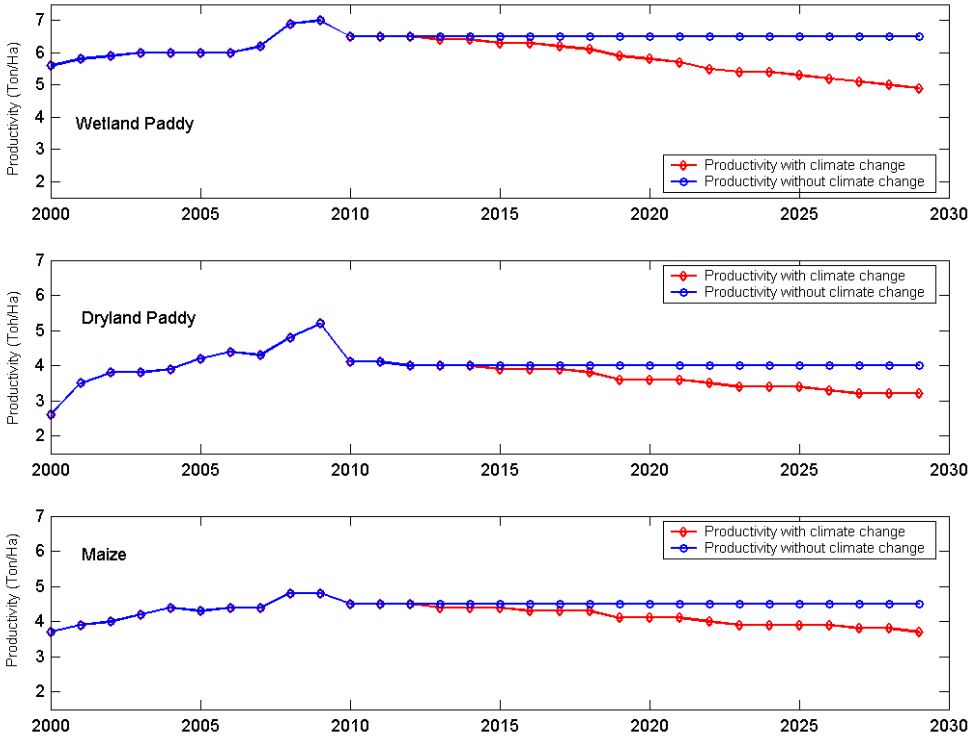


Figure 5.1 Projections of productivity of wetland paddy, dryland paddy, and corn (maize) in Greater Malang until 2030

Based on the analysis, the accumulated decrease in productivity of wetland paddy in Greater Malang will be 0.829 ton/ha in 2030. Meanwhile, the majority of irrigated paddy areas will experience a potential productivity decline by up to 0.982 ton/ha (very high hazard level), except for Wajak, Turen, Gondanglegi, Pagelaran, Kepanjen, Pakis, Lawang, Singosari, Sukun, and Blimbing Subdistricts. On the other hand, the accumulated productivity decrease of dryland paddy in 2030 is on average 0.542 ton/ha and the maximum fall in productivity of dryland paddy is about 0.587 ton/ha (very high hazard level); except for Bantur, Gedangan, Dampit, Tirtoyudo, Wajak, and Singosari Subdistricts. In the case of corn, its accumulated decrease in productivity will be 0.471 ton/ha on average in 2030. In addition, the corn's productivity decrease is estimated as much as 0.509 ton/ha (very high hazard level); except for Poncokusumo, Wajak, Turen, Gondanglegi, Pagelaran, Kepanjen, Sumberpucung, Tumpang, Pakis, Jabung, Singosari, Pujon, and Ngantang Subdistricts.

5.1.2 Hazard Analysis of Decreased Harvested Area in Rainfed Fields

The reduction in harvested area of food crops is greatly affected by the changes in air temperature and rainfall, due to climate change. Besides its effect on crop productivity, low rainfall also causes drought which thus results in harvest failure. Conversely, excessive rainfall will cause floods that also lead to harvest failure. In this analysis, a decline in harvested area due to drought and flood is derived from the relationship between harvested areas with rainfall changes. The results of the analysis of the reduction in harvested area of paddy and corn in Greater Malang in 2030 is shown in Table 5.3.

Table 5.3 Results of Reduction in Harvested Area of Staple Crops on Rainfed Fields in Greater Malang in 2030

Subdistrict	Type of Crops		
	Rainfed Paddy (Ha)	Dryland Paddy (Ha)	Corn (Ha)
01. Donomulyo	-944	-232	-947
02. Kalipare	-972	-600	-2860
03. Pagak	-114	-356	-575
04. Bantur	-689	-248	-1395
05. Gedangan	-363	-62	-1430
06. Sumbermanjing	-354	-8	-904
07. Dampit	-1437	-814	-2868
08. Tirtoyudo	-292	-218	-732
09. Ampelgading	-173	0	-169
10. Poncokusumo	-238	0	-1318
11. Wajak	-202	-90	-5065
12. Turen	-218	-11	-1007
13. Bululawang	0	-2	-103
14. Gondanglegi	-49	0	-111
15. Pagelaran	-92	0	-245
16. Kepanjen	-6	0	-27
17. Sumberpucung	0	0	-701
18. Kromengan	0	0	-73
19. Ngajum	-524	-47	-249
20. Wonosari	-407	-2	-219
21. Wagir	-95	-34	-827
22. Pakisaji	0	0	-21
23. Tajinan	-397	-1	-1112
24. Tumpang	-91	0	-1091
25. Pakis	-55	0	-222
26. Jabung	-49	-63	-728
27. Lawang	-271	0	-530
28. Singosari	-214	-148	-354
29. Karangploso	-174	-17	-345
30. Dau	-44	-10	-559
31. Pujon	-42	0	-867
32. Ngantang	-301	0	-813
33. Kasembon	-454	-7	-819
34. Kedungkandang	0	0	-151
35. Sukun	0	0	-10
36. Klojen	0	0	0
37. Blimbing	0	0	0
38. Lowokwaru	0	0	-14
39. Batu	-2	0	-384
40. Junrejo	-3	0	-234
41. Bumiaji	-3	0	-620

The potential reduction of harvested area in Greater Malang in 2030 for rainfed paddy is about 9,269 ha, 2,970 ha for dryland paddy field, and 30,669 ha for corn field. Therefore, in general, climate change impact around Greater Malang in 2030 potentially does not create a severe threat in the reduced harvested area of each crop. Although the air temperature will increase, the rainfall in the region is projected to experience only a slight decline, thus the possible occurrence of harvest failure is relatively small. However, it should be noted that in Donomulyo, Kalipare, Dampit, and Wajak Subdistricts major potential reduction in harvested area might occur.

5.1.3 Hazard Analysis of Decreased Harvested Area in Irrigated Fields

As one of the impacts of air temperature rise is the increased crop evapotranspiration rate, its also increases the demand for water provision. Therefore the level of service from the irrigation system might be reduced and cause a decline in the harvest area. The potential evapotranspiration (ETp) is used as the basis for calculating the water irrigation change respective to the air temperature. In this hazard analysis, it is assumed that irrigated land area is linearly proportional to the ETp and the water supply for irrigation does not change. Table 5.4 below shows the reduction of wetland paddy harvested area in Greater Malang in 2030.

Table 5.4 Analysis Results of decreases in harvested areas of irrigated paddy in Greater Malang in 2030

Sub-Dstrict	Irrigated Paddy (Ha)	Sub-Dstrict	Irrigated Paddy (Ha)
01. Donomulyo	-178	22. Pakisaji	-171
02. Kalipare	0	23. Tajinan	-137
03. Pagak	0	24. Tumpang	-122
04. Bantur	-124	25. Pakis	-178
05. Gedangan	0	26. Jabung	-185
06. Sumbermanjing	-67	27. Lawang	-135
07. Dampit	-300	28. Singosari	-257
08. Tirtoyudo	-63	29. Karangploso	-219
09. Ampelgading	-42	30. Dau	-21
10. Poncokusumo	-104	31. Pujon	-14
11. Wajak	-75	32. Ngantang	-113
12. Turen	-230	33. Kasembon	-129
13. Bululawang	-99	34. Kedungkandang	-49
14. Gondanglegi	-86	35. Sukun	-55
15. Pagelaran	-163	36. Klojen	0
16. Kepanjen	-277	37. Blimbing	-18
17. Sumberpucung	-181	38. Lowokwaru	-54
18. Kromengan	-206	39. Batu	-28
19. Ngajum	-149	40. Junrejo	-39
20. Wonosari	-52	41. Bumiaji	-55
21. Wagir	-72		

The total potential decrease of harvest area for irigated paddy fields in Greater Malang is about 4,447 ha in 2030 (222 ha/year on average). In general, the decrease of irrigated paddy field is less than 181 ha (high hazard level); except for Dampit, Kepanjen, Singosari, Turen, Sumberpucung, Kromengan, Jabung, and Karangploso Subdistricts. Therefore, the possible reduction in harvest area due to climate change impact is not as threatening as the decrease caused by land conversion (0.77% or 284 ha per year).

5.1.4 Hazard Analysis of Reduction in Crop Production

The total volume of crop production is derived from the rate of crop productivity and harvest area size. The results of the analysis into the decreased production of paddy and corn is given in Table 5.5 below. Based on the analysis, the fall in production changes dynamically each year until 2030. The projection analysis of decreased production is thus compared with the condition in 2010. The projection results of productivity and production of wetland paddy, dryland paddy, and corn until 2030 are shown in Figure 5.2 and 5.3.

Table 5.5 Analysis Results of Decreasing Staple Crops Production in Greater Malang in 2030

Subdistrict	Decreasing Wetland Paddy Production		Decreasing Dryland Paddy Production		Decreasing Corn Production	
	(Ton)	%	(Ton)	%	(Ton)	%
01. Donomulyo	-1691	-11	-309	-14	-731	-9
02. Kalipare	-1381	-11	-652	-12	-2261	-9
03. Pagak	-187	-13	-434	-13	-515	-10
04. Bantur	-1247	-12	-387	-17	-1294	-11
05. Gedangan	-553	-12	-164	-28	-1317	-11
06. Sumbermanjing	-722	-12	-44	-50	-852	-11
07. Dampit	-3080	-12	-1091	-14	-2633	-11
08. Tirtoyudo	-658	-12	-350	-16	-707	-11
09. Ampelgading	-419	-12	0	0	-173	-12
10. Poncokusumo	-940	-12	-7	-51	-1539	-11
11. Wajak	-912	-12	-203	-21	-5327	-10
12. Turen	-2858	-12	-62	-50	-1216	-10
13. Bululawang	-939	-12	-19	-51	-124	-12
14. Gondanglegi	-1147	-12	0	0	0	0
15. Pagelaran	-2210	-11	0	0	-307	-10
16. Kepanjen	-3351	-11	0	0	-53	-17
17. Sumberpucung	-2083	-11	0	0	0	0
18. Kromengan	-1886	-11	0	0	-79	-12
19. Ngajum	-1424	-11	-105	-25	-280	-10
20. Wonosari	-646	-12	-18	-50	-224	-10
21. Wagir	-664	-12	-76	-25	-730	-10
22. Pakisaji	-1633	-11	0	0	-40	-19
23. Tajinan	-1195	-12	-12	-50	-1129	-10
24. Tumpang	-1109	-12	0	0	-1123	-11
25. Pakis	-2000	-12	0	0	-301	-11
26. Jabung	-1651	-13	-115	-22	-800	-11
27. Lawang	-1445	-13	0	0	-544	-12
28. Singosari	-3035	-12	-292	-16	-409	-11
29. Karangploso	-1957	-12	-83	-44	-343	-11
30. Dau	-211	-13	-50	-50	-561	-10
31. Pujon	-130	-13	0	0	-921	-10
32. Ngantang	-985	-11	0	0	-836	-10
33. Kasembon	-1083	-11	-37	-50	-804	-10
34. Kedungkandang	-504	-12	0	0	-132	-12
35. Sukun	-632	-12	0	0	-22	-29
36. Klojen	0	0	0	0	0	0
37. Blimbing	-205	-14	0	0	0	0
38. Lowokwaru	-543	-12	0	0	-25	-24
39. Batu	-276	-12	0	0	-336	-11
40. Junrejo	-374	-12	0	0	-211	-11
41. Bumiaji	-510	-12	0	0	-558	-11

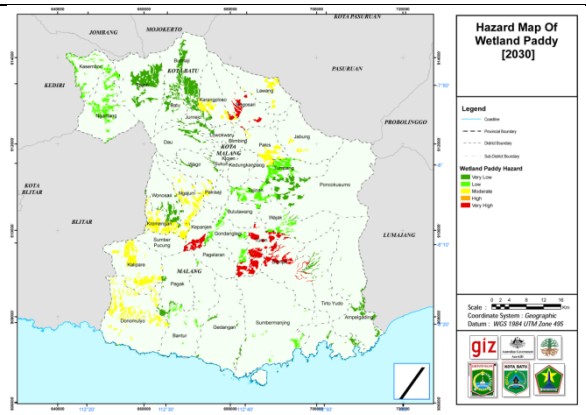


Figure 5.2 Map of 2030 Wetland Paddy Hazard

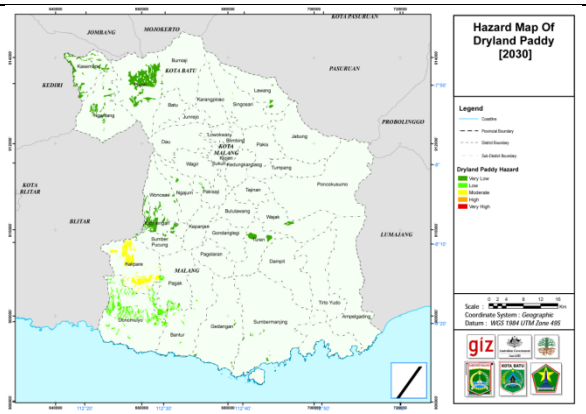


Figure 5.3 Map of 2030 Dryland Paddy Hazard

Due to the impacts of climate change, agricultural crops experience accumulated decrease production in of 11.9%, 31.8%, and 11.6% for wetland paddy, dryland paddy, dan corn in 2030, respectively. The average production decreases are 0.59%, 1.59%, and 0.58% per year for wetland paddy, dryland paddy, and corn, respectively.

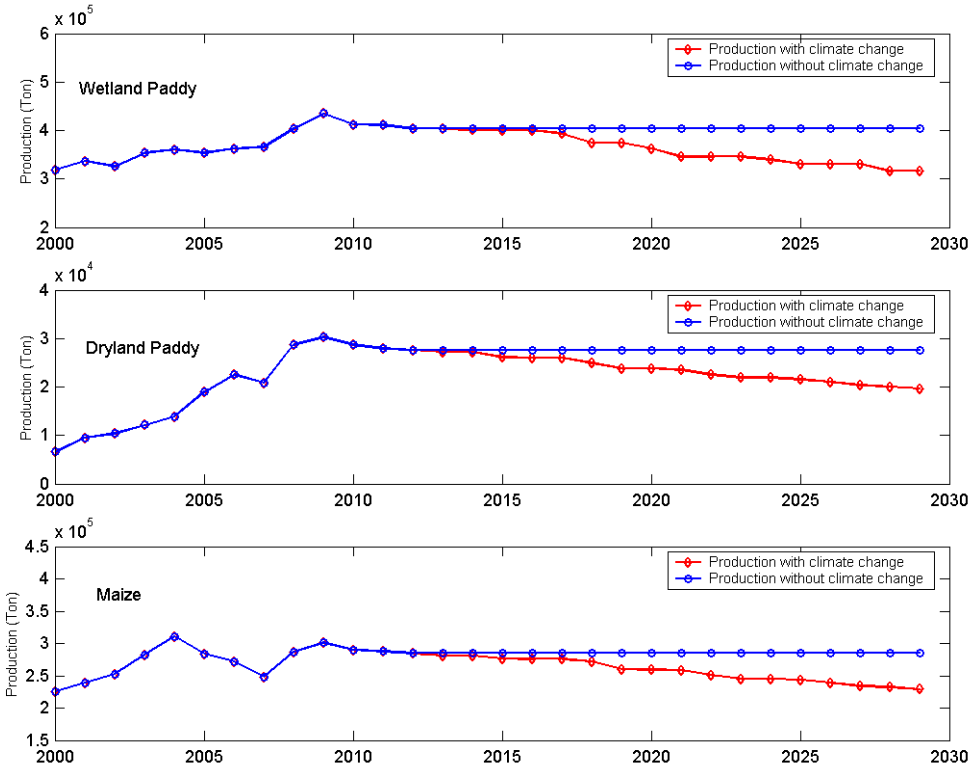


Figure 5.4 Productivity projections of production of wetland paddy, dryland paddy, and corn in Greater Malang up to 2030

The potential reduction in wetland paddy production in Greater Malang is about 4.8476 tons of dry milled grain (DMG); i.e. accumulation from 2012 to 2030. By 2030, most parts of Greater Malang will experience this hazard up to 2,083 tons DMG (high hazard level); except in Dampit, Turen, Kepanjen, Singosari, Pagelaran, and Sumberpucung Subdistricts. Meanwhile, the potential drop in dryland paddy production is about 4,510 tons of DMG in 2030. Therefore, almost all parts of Greater Malang region will experience the hazard potential of decreasing dryland paddy production up to 1,091 tons of DMG; except for Dampit Subdistrict. As for the reduction in corn production, in 2030 it is estimated at 29457 tons, i.e. almost the entire region will experience a decline in corn production up to 5,327 tons; except Wajak Subdistrict.

In general, climate change impacts in Greater Malang by 2030 will lead to decreased production in paddy and corn, i.e. due to the potential decrease in productivity and harvest area, as the impact of increased air temperature and rainfall decrease. Areas which have high potential for decreasing crop production are Dampit, Turen, Kepanjen, and Singosari Subdistricts for wetland paddy; Dampit Subdistricts for dryland paddy and Wajak Subdistrict for corn.

5.2 Vulnerability Analysis

Vulnerability analysis for the agriculture sector is assessed through three components; i.e. exposure (E), sensitivity (S), and adaptive capacity (AC). Exposure can be defined as the major elements of the agriculture sector that are exposed to the impacts of climate change. Sensitivity represents the condition of people and their environment which are vulnerable to hazards, triggering hazards, or on the other hand can reduce the hazards. Indicators for each vulnerability component are as follows:

1. Indicators of exposure: agricultural land area and number of farmers.
2. Indicators of sensitivity: agricultural land types (non-irrigated), topography (elevation), and farmers' income.
3. Indicators of adaptive capacity: Irrigation infrastructures, level of education, and agriculture sector's income contribution to GDP.

For each calculation, i.e. total vulnerability and its component, the results are classified into five levels of vulnerability. Table 5.6 below provides the information about its level and the range of vulnerability indices.

Table 5.6 Level and Vulnerability Indices on Agriculture Sector in Greater Malang

No	Level of Vulnerability	Vulnerability Indices
1	Weighting 1, Very Low Vulnerability	0.00 - 0.20
2	Weighting 2, Low Vulnerability	0.21 – 0.40
3	Weighting 3, Moderate Vulnerability	0.41 - 0.60
4	Weighting 4, High Vulnerability	0.61 - 0.80
5	Weighting 5, Very High Vulnerability	0.81 – 1.00

5.2.1 Exposure

The first calculation to be addressed is the component of exposure which is determined by agricultural land area and the number of farmers. Based on the calculation results, Table 5.7 below provides vulnerability results of exposure both for the baseline (2010) and projection (2030) years. The level of exposure is classified into five groups; i.e. very high, high, moderate, low, and very low.

Table 5.7 Climate change Exposure to Agriculture Sector in Greater Malang in 2010 and 2030

Subdistricts	Exposure in 2010					Exposure in 2030				
	Indicators		Total E	Index of E	Level of Exposure	Indicators		Total E	Index of E	Level of Exposure
	AAL	NF				AAL	NF			
01. Donomulyo	1.0000	0.4896	0.265	1.000	Very High	1.0000	0.5606	0.265	1.000	Very High
02. Kalipare	0.5431	0.4456	0.159	0.601	High	0.5431	0.4658	0.159	0.594	Moderate
03. Pagak	0.5377	0.3326	0.149	0.560	Moderate	0.5377	0.3470	0.149	0.552	Moderate
04. Bantur	0.9076	0.4721	0.243	0.917	Very High	0.9076	0.4933	0.243	0.903	Very High
05. Gedangan	0.6803	0.3652	0.183	0.691	High	0.6803	0.3525	0.183	0.671	High
06. Sumbermanjing	0.8474	0.6413	0.244	0.921	Very High	0.8474	0.6551	0.244	0.905	Very High
07. Dampit	0.3493	0.7733	0.144	0.545	Moderate	0.3493	0.8123	0.144	0.545	Moderate
08. Tirtoyudo	0.3883	0.4149	0.122	0.461	Moderate	0.3883	0.4376	0.122	0.458	Moderate
09. Ampelgading	0.5213	0.3774	0.149	0.561	Moderate	0.5213	0.3923	0.149	0.553	Moderate
10. Poncokusumo	0.7777	0.6094	0.226	0.852	Very High	0.7777	0.5880	0.226	0.826	Very High

Subdistricts	Exposure in 2010					Exposure in 2030				
	Indicators		Total E	Index of E	Level of Exposure	Indicators		Total E	Index of E	Level of Exposure
	AAL	NF				AAL	NF			
11. Wajak	0.5025	0.5324	0.158	0.595	Moderate	0.5025	0.5791	0.158	0.597	Moderate
12. Turen	0.4097	0.7386	0.155	0.584	Moderate	0.4097	0.7517	0.155	0.575	Moderate
13. Bululawang	0.3661	0.4063	0.117	0.440	Moderate	0.3661	0.4214	0.117	0.435	Moderate
14. Gondanglegi	0.4650	0.5123	0.148	0.557	Moderate	0.4650	0.3674	0.148	0.499	Moderate
15. Pagelaran	0.3077	0.4315	0.106	0.399	Low	0.3077	0.4540	0.106	0.397	Low
16. Kepanjen	0.3291	0.6122	0.126	0.475	Moderate	0.3291	0.8380	0.126	0.536	Moderate
17. Sumberpucung	0.2103	0.3593	0.078	0.293	Low	0.2103	0.1835	0.078	0.231	Low
18. Kromengan	0.2750	0.2603	0.084	0.316	Low	0.2750	0.2717	0.084	0.312	Low
19. Ngajum	0.4153	0.3304	0.121	0.457	Moderate	0.4153	0.3396	0.121	0.449	Moderate
20. Wonosari	0.1616	0.2939	0.061	0.231	Low	0.1616	0.3207	0.061	0.235	Low
21. Wagir	0.4303	0.5017	0.139	0.525	Moderate	0.4303	0.5007	0.139	0.513	Moderate
22. Pakisaji	0.2563	0.4908	0.099	0.375	Low	0.2563	0.5103	0.099	0.373	Low
23. Tajinan	0.2990	0.3266	0.095	0.357	Low	0.2990	0.3321	0.095	0.351	Low
24. Tumpang	0.4119	0.4903	0.134	0.506	Moderate	0.4119	0.5093	0.134	0.500	Moderate
25. Pakis	0.3706	0.8023	0.152	0.572	Moderate	0.3706	0.7796	0.152	0.552	Moderate
26. Jabung	0.4558	0.4566	0.141	0.532	Moderate	0.4558	0.4707	0.141	0.524	Moderate
27. Lawang	0.3701	0.5963	0.134	0.505	Moderate	0.3701	0.6346	0.134	0.506	Moderate
28. Singosari	0.4281	1.0000	0.181	0.684	High	0.4281	1.0000	0.181	0.669	High
29. Karangploso	0.3230	0.3574	0.103	0.388	Low	0.3230	0.3829	0.103	0.387	Low
30. Dau	0.2680	0.3758	0.092	0.347	Low	0.2680	0.3991	0.092	0.347	Low
31. Pujon	0.3232	0.4002	0.107	0.402	Moderate	0.3232	0.4266	0.107	0.401	Moderate
32. Ngantang	0.3469	0.3827	0.110	0.416	Moderate	0.3469	0.3879	0.110	0.408	Moderate
33. Kasembon	0.2455	0.2037	0.072	0.273	Low	0.2455	0.2070	0.072	0.267	Low
34. Kedungkandang	0.1698	0.2036	0.055	0.209	Low	0.1698	0.1952	0.055	0.201	Low
35. Sukun	0.0703	0.2196	0.035	0.130	Very Low	0.0703	0.1777	0.035	0.114	Very Low
36. Klojen	0.0000	0.1592	0.014	0.052	Very Low	0.0000	0.1102	0.014	0.035	Very Low
37. Blimbing	0.0144	0.2148	0.022	0.082	Very Low	0.0144	0.1740	0.022	0.067	Very Low
38. Lowokwaru	0.0386	0.2284	0.028	0.107	Very Low	0.0386	0.2033	0.028	0.096	Very Low
39. Batu	0.1343	0.4141	0.066	0.247	Low	0.1343	0.3548	0.066	0.223	Low
40. Junrejo	0.1260	0.1724	0.043	0.162	Very Low	0.1260	0.1472	0.043	0.150	Very Low
41. Bumiaji	0.2313	0.7529	0.116	0.439	Moderate	0.2313	0.6634	0.116	0.401	Moderate

Note : AAL : Area of Agriculture Land (expressed as indices range 0-1)
NF : Number of Farmers (expressed as indices range 0-1)
E : Exposure (expressed as indices range 0-1)

As can be seen from Table 5.7 above, basically the level of exposure in Greater Malang will be the same in year 2030 as it is in 2010; except for Kalipare whose exposure will actually decrease from a high-level in 2010 to a moderate-level in 2030. While it is true that most of the subdistricts are only exposed at very low (5 subdistricts), low (11 subdistricts), and moderate-level (18 subdistricts), focus should be given to the five subdistricts which will be exposed at very high and high-level both in 2010 and 2030; i.e. Donomulyo, Bantur, Sumbermanjing, Poncokusumo, and Singosari. In general, urban areas have low level of exposure due to less agricultural area and fewer farmers. Distribution of the exposure can be seen in Figure 5.5 below.

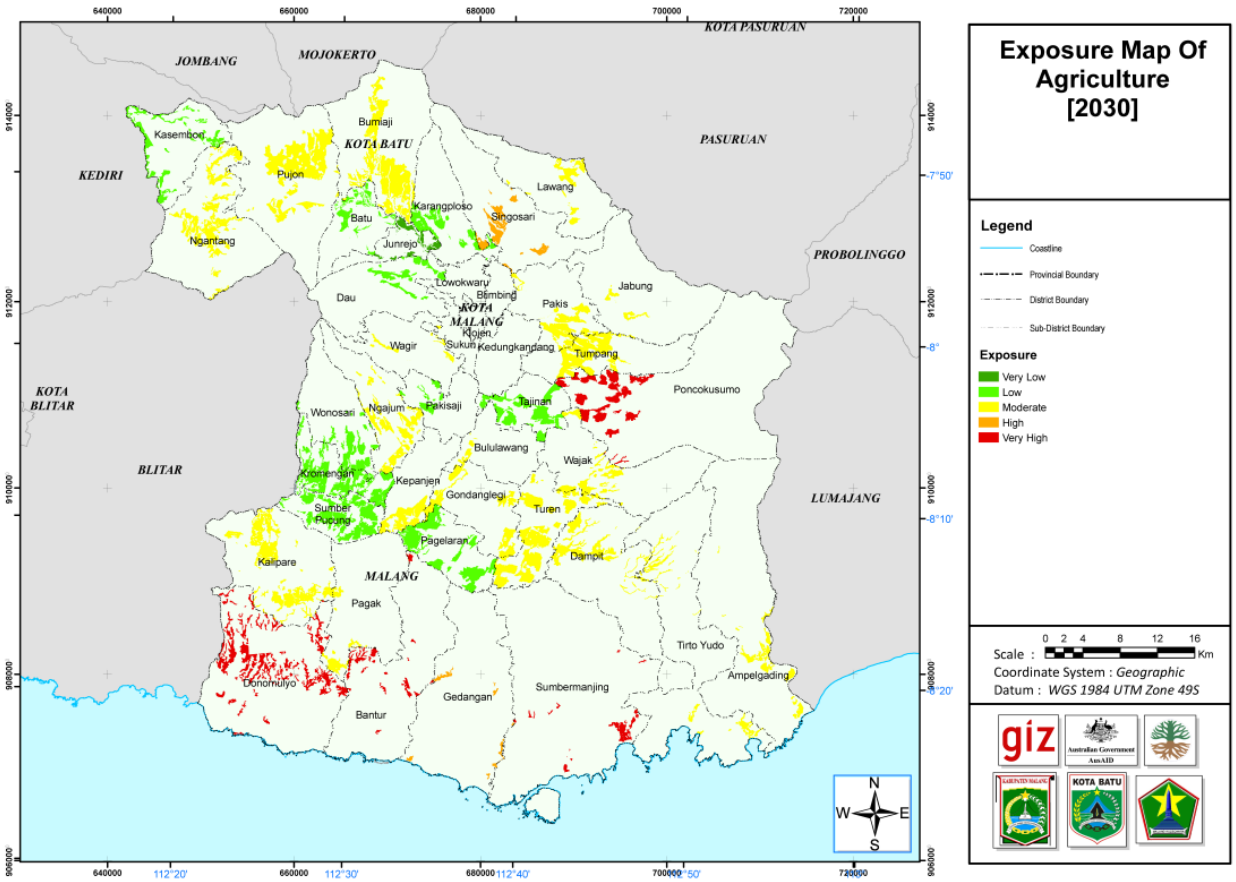


Figure 5.5 Climate Change Exposure in Agriculture Sector of Gretaer Malang Map

5.2.2 Sensitivity

As is previously mentioned, climate change sensitivity assessment of the agriculture sector in Greater Malang uses three indicators; agricultural land types (non-irrigated lands), topography (elevation), and farmers' income. Table 5.8 below provides the results of the sensitivity analysis in Greater Malang for both 2010 and the projection year in 2030.

Table 5.8 Climate Change Sensitivity to Agriculture Sector in Greater Malang, 2010 and 2030

Subdistrict	Sensitivity in 2010						Sensitivity in 2030					
	Indicators			Total S	Index of S	Level of Sensitivity	Indicators			Total S	Index of S	Level of Sensitivity
	NIF	A	FI				NIF	A	FI			
01. Donomulyo	0.950	0.654	0.570	0.295	0.861	Very High	0.009	0.654	0.600	0.109	0.333	Low
02. Kalipare	1.000	0.761	0.917	0.343	1.000	Very High	0.050	0.761	0.881	0.150	0.457	Moderate
03. Pagak	1.000	0.569	0.282	0.274	0.799	High	0.003	0.569	0.270	0.074	0.225	Low
04. Bantur	0.970	0.790	0.529	0.308	0.898	Very High	0.317	0.790	0.508	0.176	0.535	Moderate
05. Gedangan	1.000	0.580	0.440	0.288	0.840	Very High	0.680	0.580	0.391	0.220	0.670	High
06. Sumber-manjing	0.980	0.567	0.216	0.264	0.771	High	0.774	0.567	0.202	0.222	0.677	High
07. Dampit	0.880	0.550	0.786	0.289	0.843	Very High	1.000	0.550	0.759	0.311	0.947	Very High
08. Tirtoyudo	0.960	0.536	0.338	0.268	0.781	High	1.000	0.536	0.327	0.275	0.837	Very High
09. Ampel-gading	0.970	0.583	0.148	0.258	0.754	High	0.994	0.583	0.141	0.263	0.800	Very High
10. Poncoku-sumo	0.880	0.352	0.361	0.237	0.691	High	1.000	0.352	0.320	0.258	0.785	High
11. Wajak	0.830	0.574	1.000	0.299	0.871	Very High	0.825	0.574	1.000	0.298	0.907	Very High
12. Turen	0.500	0.657	0.552	0.204	0.595	Moderate	0.827	0.657	0.517	0.266	0.812	Very High
13. Bululawang	0.480	0.673	0.261	0.178	0.518	Moderate	1.000	0.673	0.248	0.281	0.855	Very High

Subdistrict	Sensitivity in 2010						Sensitivity in 2030					
	Indicators			Total S	Index of S	Level of Sensitivity	Indicators			Total S	Index of S	Level of Sensitivity
	NIF	A	FI				NIF	A	FI			
14. Gondang-legi	0.380	0.659	0.260	0.156	0.456	Moderate	1.000	0.659	0.172	0.273	0.832	Very High
15. Pagelaran	0.230	0.664	0.615	0.156	0.454	Moderate	1.000	0.664	0.595	0.308	0.938	Very High
16. Kepanjen	0.290	0.742	0.603	0.174	0.506	Moderate	1.000	0.742	0.758	0.328	1.000	Very High
17. Sumber-pucung	0.130	0.776	0.875	0.167	0.486	Moderate	0.967	0.776	0.411	0.296	0.903	Very High
18. Kromengan	0.390	0.753	0.816	0.212	0.618	High	0.469	0.753	0.783	0.225	0.685	High
19. Ngajum	0.820	0.705	0.549	0.272	0.793	High	0.952	0.705	0.518	0.296	0.902	Very High
20. Wonosari	0.940	0.376	0.298	0.246	0.718	High	0.771	0.376	0.299	0.212	0.647	High
21. Wagir	0.760	0.635	0.262	0.230	0.672	High	1.000	0.635	0.240	0.277	0.843	Very High
22. Pakisaji	0.310	0.703	0.373	0.155	0.453	Moderate	0.868	0.703	0.356	0.266	0.810	Very High
23. Tajinan	0.690	0.626	0.654	0.247	0.721	High	1.000	0.626	0.611	0.306	0.932	Very High
24. Tumpang	0.690	0.556	0.401	0.221	0.643	High	1.000	0.556	0.383	0.281	0.856	Very High
25. Pakis	0.520	0.635	0.277	0.184	0.536	Moderate	1.000	0.635	0.247	0.277	0.844	Very High
26. Jabung	0.750	0.520	0.499	0.237	0.692	High	1.000	0.520	0.473	0.285	0.869	Very High
27. Lawang	0.880	0.594	0.298	0.254	0.740	High	0.786	0.594	0.291	0.234	0.714	High
28. Singosari	0.700	0.621	0.349	0.224	0.654	High	0.990	0.621	0.321	0.280	0.852	Very High
29. Karang-ploso	0.650	0.568	0.634	0.232	0.678	High	1.000	0.568	0.624	0.302	0.919	Very High
30. Dau	0.880	0.567	0.178	0.242	0.705	High	1.000	0.567	0.174	0.265	0.808	Very High
31. Pujon	0.770	0.000	0.220	0.172	0.501	Moderate	0.004	0.000	0.216	0.018	0.056	Very Low
32. Ngantang	0.810	0.330	0.479	0.231	0.672	High	0.736	0.330	0.446	0.213	0.649	High
33. Kasembon	0.870	0.815	0.948	0.324	0.946	Very High	0.037	0.815	0.885	0.153	0.465	Moderate
34. Kedung-kandang	0.643	0.578	0.290	0.204	0.595	Moderate	0.643	0.578	0.255	0.201	0.613	High
35. Sukun	0.556	0.578	0.296	0.186	0.544	Moderate	0.551	0.578	0.220	0.180	0.549	Moderate
36. Klojen	0.000	0.578	0.000	0.052	0.152	Very Low	0.000	0.578	0.000	0.052	0.159	Very Low
37. Blimbing	0.034	0.637	0.085	0.071	0.207	Low	0.034	0.637	0.063	0.069	0.211	Low
38. Lowokwaru	0.208	0.646	0.241	0.119	0.348	Low	0.208	0.646	0.197	0.116	0.353	Low
39. Batu	0.572	0.368	0.128	0.158	0.461	Moderate	0.572	0.368	0.101	0.156	0.474	Moderate
40. Junrejo	0.377	0.470	0.308	0.143	0.416	Moderate	0.377	0.470	0.242	0.137	0.418	Moderate
41. Bumiaji	0.535	0.182	0.123	0.133	0.389	Low	0.535	0.182	0.099	0.132	0.401	Moderate

Notes : NIF : Non-irrigated Fields (expressed as indices range 0-1)
A : Elevation (expressed as indices range 0-1)
FI : Farmers' Income (expressed as indices range 0-1)
S : Sensitivity (expressed as indices range 0-1)

Based on the Table 5.8 above, it can be clearly seen that most of the subdistricts will be very sensitive to climate change impact; i.e. 20 subdistricts with very high and 8 with high level of sensitivity in 2030. By 2030, it is projected that there will only be 2 subdistricts with very low sensitivity to climate change (Pujon and Klojen), 4 subdistricts with low sensitivity, while the rest are moderate. This estimation result is actually worse than conditions in 2010 which is dominated by high (17 subdistricts) and moderate-level (13 subdistricts) of sensitivity. In addition, the worsening projection is also confirmed by the estimation result that 22 subdistricts will have higher sensitivity in 2030 compared to 12 subdistricts with the same level of sensitivity and 7 subdistricts will have lower sensitivty level. However, remarks should be added to several subdistricts, i.e. Donomulyo, Kalipare, Pagak, Bantur, Gedangan, Pujon, and Kasemon, whose sensitivity will be reduced due to the reduction in non-irrigated fields.

By looking at the estimation for 2010, in subdistricts with many non-irrigated agriculture fields, flat lowland areas, and low farmers' income; the sensitivity potential is very high. On the other hand, projection in 2030 shows that subdistricts with large area of non-irrigated lands,

low plains, and low farmers' income have a very high sensitivity potential. In general, Greater Malang has a very high sensitivity potential due to its large area of non-irrigated agricultural fields, flat lowland areas, and low farmers' income.

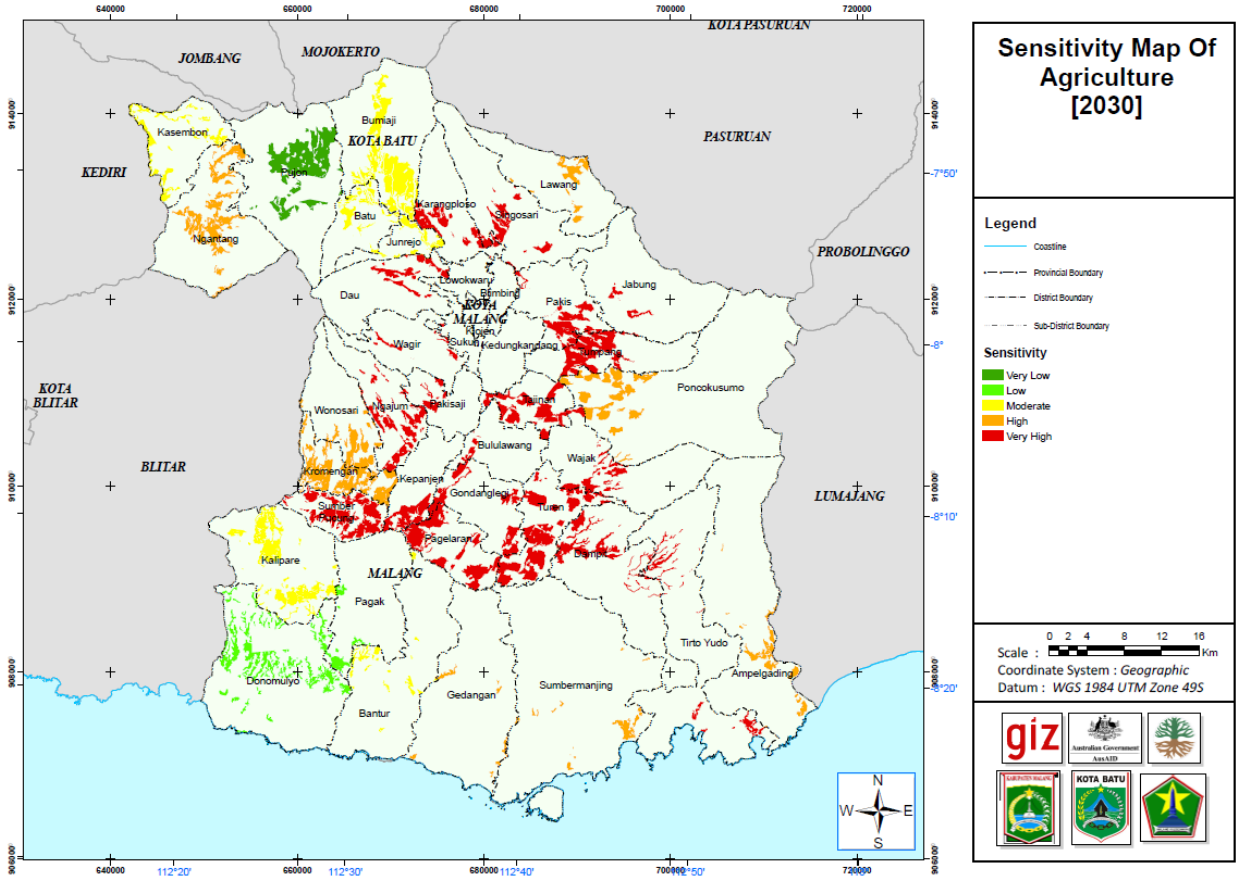


Figure 5.6 Map of Sensitivity in 2030

5.2.3 Adaptive Capacity

Assessment of adaptive capacity in the agriculture sector in Greater Malang uses three indicators; i.e. irrigation infrastructure, education level, and access to the capital. Analysis has been done for both baseline conditions (2010) and for the projection time (2030) and the results are provided in Table 5.9 below.

Table 5.9 Adaptive Capacity of Agriculture Sector in Greater Malang, 2010 and 2030

Subdistrict	Adaptive Capacity in 2010						Adaptive Capacity in 2030					
	Indicators			Total AC	Index of AC	Adaptive Capacity Level	Indicators			Total AC	Index of AC	Adaptive Capacity Level
	II	EL	ATC				II	EL	ATC			
01. Dono-mulyo	0.052	0.706	0.062	0.063	0.195	Very Low	0.994	0.837	0.074	0.270	0.902	Very High
02. Kalipare	0.000	0.706	0.056	0.052	0.161	Very Low	0.953	0.764	0.061	0.255	0.855	Very High
03. Pagak	0.000	0.706	0.056	0.052	0.161	Very Low	1.000	0.762	0.061	0.265	0.887	Very High
04. Bantur	0.031	0.706	0.056	0.058	0.181	Very Low	0.685	0.764	0.061	0.199	0.667	High
05. Gedang-an	0.000	0.707	0.045	0.051	0.159	Very Low	0.321	0.706	0.045	0.119	0.397	Low
06. Sumber-manjing	0.021	0.706	0.090	0.058	0.179	Very Low	0.227	0.747	0.096	0.104	0.348	Low
07. Dampit	0.124	0.706	0.287	0.088	0.273	Low	0.000	0.768	0.314	0.068	0.227	Low
08. Tirto-yudo	0.041	0.706	0.034	0.060	0.184	Very Low	0.000	0.771	0.037	0.056	0.186	Very Low
09. Ampel-gading	0.031	0.706	0.034	0.057	0.178	Very Low	0.006	0.760	0.037	0.056	0.188	Very Low

Subdistrict	Adaptive Capacity in 2010						Adaptive Capacity in 2030					
	Indicators			Total AC	Index of AC	Adaptive Capacity Level	Indicators			Total AC	Index of AC	Adaptive Capacity Level
	II	EL	ATC				II	EL	ATC			
10. Ponco-kusumo	0.124	0.706	0.101	0.080	0.247	Low	0.000	0.706	0.102	0.054	0.181	Very Low
11. Wajak	0.176	0.706	0.096	0.091	0.280	Low	0.176	0.795	0.108	0.097	0.325	Low
12. Turen	0.518	0.706	0.219	0.167	0.518	Moderate	0.173	0.744	0.233	0.099	0.330	Low
13. Bulu-lawang	0.538	0.706	0.202	0.171	0.529	Moderate	0.000	0.758	0.219	0.063	0.211	Low
14. Gon-danglegi	0.642	0.706	0.242	0.194	0.601	High	0.000	0.524	0.181	0.045	0.150	Very Low
15. Pagelaran	0.797	0.706	0.067	0.219	0.677	High	0.000	0.769	0.074	0.057	0.191	Very Low
16. Kepan-jen	0.735	0.706	0.635	0.232	0.716	High	0.000	1.000	0.906	0.111	0.371	Low
17. Sumber-pucung	0.901	0.706	0.180	0.246	0.760	High	0.033	0.373	0.096	0.037	0.125	Very Low
18.Kromeng-an	0.632	0.706	0.045	0.183	0.567	Moderate	0.533	0.763	0.049	0.167	0.559	Moderate
19. Ngajum	0.186	0.706	0.023	0.089	0.276	Low	0.048	0.751	0.024	0.064	0.213	Low
20. Wono-sari	0.062	0.706	0.056	0.065	0.201	Low	0.230	0.798	0.064	0.107	0.357	Low
21. Wagir	0.249	0.707	0.079	0.105	0.324	Low	0.000	0.730	0.082	0.055	0.183	Very Low
22. Pakisaji	0.714	0.706	0.214	0.208	0.644	High	0.132	0.760	0.232	0.091	0.305	Low
23. Tajinan	0.321	0.706	0.084	0.120	0.372	Low	0.000	0.743	0.089	0.056	0.188	Very Low
24. Tumpang	0.321	0.706	0.253	0.128	0.395	Low	0.000	0.759	0.274	0.065	0.219	Low
25. Pakis	0.497	0.706	0.264	0.165	0.511	Moderate	0.000	0.710	0.267	0.062	0.207	Low
26. Jabung	0.259	0.706	0.051	0.106	0.327	Low	0.000	0.754	0.054	0.055	0.185	Very Low
27. Lawang	0.124	0.706	0.376	0.092	0.285	Low	0.215	0.778	0.418	0.118	0.395	Low
28. Singo-sari	0.310	0.706	0.517	0.138	0.425	Moderate	0.010	0.731	0.539	0.078	0.260	Low
29. Karang-ploso	0.362	0.706	0.230	0.136	0.419	Moderate	0.000	0.783	0.257	0.066	0.222	Low
30. Dau	0.124	0.706	0.185	0.084	0.259	Low	0.000	0.776	0.205	0.064	0.213	Low
31. Pujon	0.238	0.707	0.096	0.104	0.320	Low	0.999	0.780	0.106	0.268	0.897	Very High
32. Ngan-tang	0.197	0.707	0.062	0.093	0.289	Low	0.265	0.741	0.065	0.110	0.369	Low
33. Kasem-bon	0.135	0.707	0.056	0.080	0.248	Low	0.966	0.743	0.0560	0.257	0.859	Very High
34. Kedung-kandang	0.370	0.993	1.000	0.192	0.593	Moderate	0.358	0.986	1.000	0.189	0.632	High
35. Sukun	0.464	0.993	1.000	0.212	0.654	High	0.450	0.832	0.844	0.190	0.637	High
36. Klojen	0.000	0.993	1.000	0.115	0.354	Low	0.000	0.712	0.722	0.082	0.275	Low
37. Blimbing	1.000	0.993	1.000	0.324	1.000	Very High	0.969	0.833	0.845	0.299	1.000	Very High
38. Lowok-waru	0.821	0.993	1.000	0.286	0.884	Very High	0.795	0.915	0.928	0.272	0.910	Very High
39. Batu	0.443	1.000	0.685	0.194	0.598	Moderate	0.430	0.887	0.613	0.179	0.600	High
40. Junrejo	0.645	1.000	0.191	0.213	0.659	High	0.625	0.884	0.170	0.200	0.670	High
41. Bumiaji	0.481	1.000	0.140	0.177	0.547	Moderate	0.466	0.912	0.129	0.167	0.559	Moderate

Notes : II : Irrigation Infrastructure (expressed as indices indices range 0-1)
EL : Education Level (expressed as indices indices range 0-1)
ATC : Access to The Capital (expressed as indices indices range 0-1)
AC : Adaptive Capasity (expressed as indices indices range 0-1)

As can be seen in Table 5.9, adaptive capacity in 2010 was generally low with 8 subdistricts classified as having very low level and 15 with low-level adaptive capacity, followed by 9 subdistricts having moderate-level of adaptive capacity. It is only Blimbing and Lowokwaru that have very high adaptive capacity; followed by 7 other subdistricts with high adaptive capacity. In subdistricts which have low irrigation infrastructure, farmers' education level, and access to the capital, the adaptive capacity potential is very low.

Projection for adaptive capacity in 2030 is less convenient, since it can be seen that more subdistricts will have less capacity; i.e. 9 having very low and 18 having low-level of adaptive

capacity. However, some developments could be found since more subdistricts will enhance their capacity extensively, i.e. 5 subdistricts will have high-level and 7 at very high level capacity. For instance, Donomulyo, Kalipare, and Pagak are projected to have very high level adaptive capacity from previously being classified as very low. Figure 5.7 below provides the distribution map of adaptive capacity in Greater Malang by 2030.

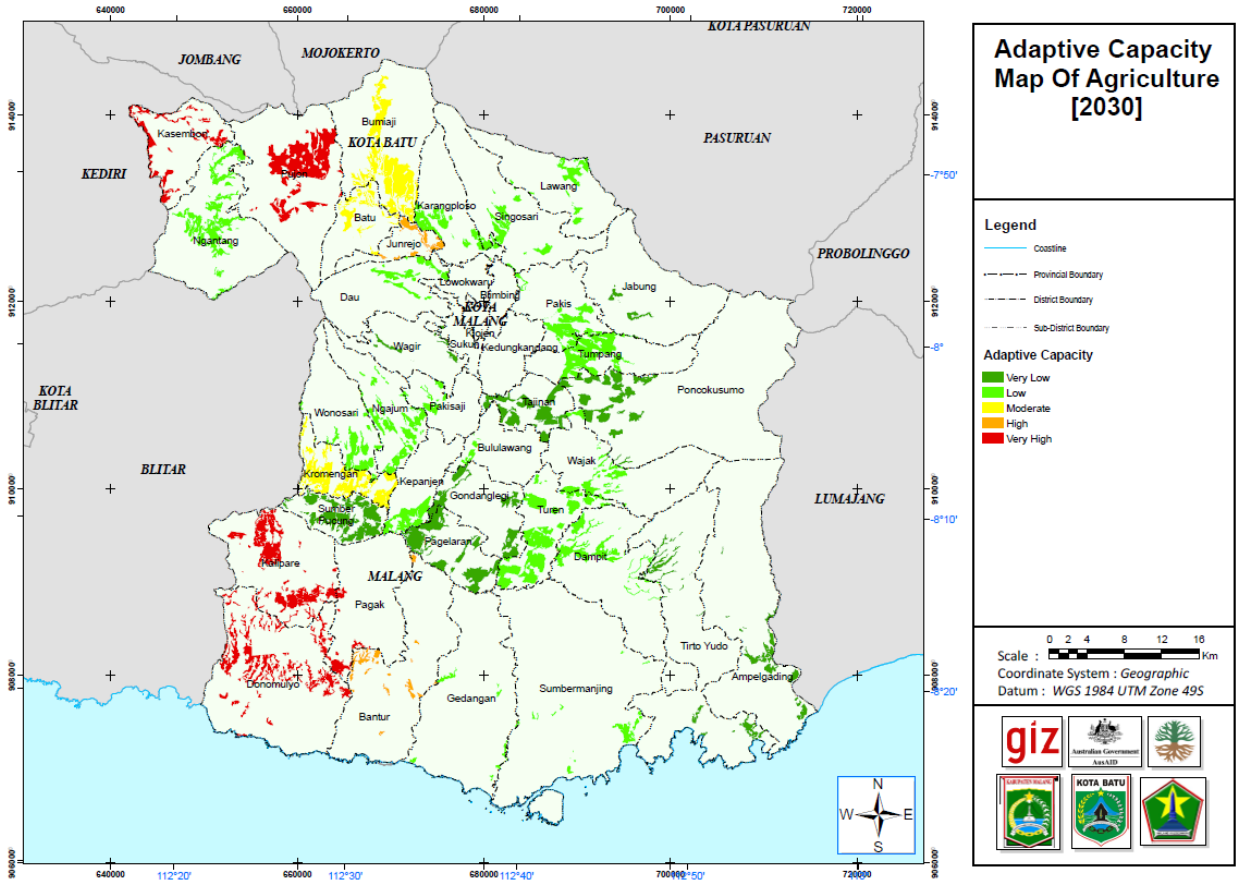


Figure 5.7 Projection Map of Adaptive Capacity in Agriculture Sector, 2030

5.2.4 Total Vulnerability Components

Having completed the assessment of each vulnerability component, the total vulnerability can be aggregated using weighting based on pairwise comparison from an expert's judgement. The result of vulnerability for both 2010 and 2030 can be seen in Table 5.10 below.

Table 5.10 Vulnerability of Agriculture Sector in Greater Malang, 2010 and 2030

Subdistrict	Vulnerability in 2010						Vulnerability in 2030					
	Component			Total V	Index of V	Level of Vulnerability	Component			Total V	Index of V	Level of Vulnerability
	E	S	AC				E	S	AC			
01. Dono-mulyo	0.265	0.295	0.063	2.065	1.000	Very High	0.271	0.109	0.270	1.711	0.822	Very High
02. Kalipare	0.159	0.343	0.052	1.914	0.927	Very High	0.161	0.150	0.255	1.627	0.782	High
03. Pagak	0.149	0.274	0.052	1.786	0.865	Very High	0.150	0.074	0.265	1.283	0.617	High
04. Bantur	0.243	0.308	0.058	2.048	0.992	Very High	0.245	0.176	0.199	1.897	0.912	Very High
05. Gedangan	0.183	0.288	0.051	1.899	0.919	Very High	0.182	0.220	0.119	1.896	0.911	Very High
06. Sumber-manjing	0.244	0.264	0.058	1.984	0.961	Very High	0.245	0.222	0.104	2.036	0.978	Very High
07. Dampit	0.144	0.289	0.088	1.783	0.863	Very High	0.148	0.311	0.068	1.976	0.950	Very High
08. Tirtoyudo	0.122	0.268	0.060	1.688	0.817	Very High	0.124	0.275	0.056	1.852	0.890	Very High

Subdistrict	Vulnerability in 2010						Vulnerability in 2030					
	Component			Total V	Index of V	Level of Vulnerability	Component			Total V	Index of V	Level of Vulnerability
	E	S	AC				E	S	AC			
09. Ampel-gading	0.149	0.258	0.057	1.759	0.852	Very High	0.150	0.263	0.056	1.914	0.920	Very High
10. Ponco-kusumo	0.226	0.237	0.080	1.894	0.917	Very High	0.224	0.258	0.054	2.081	1.000	Very High
11. Wajak	0.158	0.299	0.091	1.834	0.888	Very High	0.162	0.298	0.097	1.985	0.954	Very High
12. Turen	0.155	0.204	0.167	1.631	0.790	High	0.156	0.266	0.099	1.920	0.923	Very High
13. Bulu-lawang	0.117	0.178	0.171	1.446	0.700	High	0.118	0.281	0.063	1.836	0.882	Very High
14. Gondang-legi	0.148	0.156	0.194	1.485	0.719	High	0.135	0.273	0.045	1.891	0.909	Very High
15. Pagelar-an	0.106	0.156	0.219	1.329	0.643	High	0.108	0.308	0.057	1.839	0.884	Very High
16. Kepanjen	0.126	0.174	0.232	1.448	0.701	High	0.145	0.328	0.111	1.976	0.949	Very High
17. Sumber-pucung	0.078	0.167	0.246	1.216	0.589	Moderate	0.063	0.296	0.037	1.596	0.767	High
18. Kromeng-an	0.084	0.212	0.183	1.374	0.665	High	0.085	0.225	0.167	1.555	0.747	High
19. Ngajum	0.121	0.272	0.089	1.679	0.813	Very High	0.122	0.296	0.064	1.873	0.900	Very High
20. Wonosari	0.061	0.246	0.065	1.350	0.653	High	0.064	0.212	0.107	1.429	0.687	High
21. Wagir	0.139	0.230	0.105	1.661	0.804	Very High	0.139	0.277	0.055	1.904	0.915	Very High
22. Pakisaji	0.099	0.155	0.208	1.305	0.632	High	0.101	0.266	0.091	1.733	0.833	Very High
23. Tajinan	0.095	0.247	0.120	1.519	0.736	High	0.095	0.306	0.056	1.783	0.857	Very High
24. Tumpang	0.134	0.221	0.128	1.617	0.783	High	0.136	0.281	0.065	1.896	0.911	Very High
25. Pakis	0.152	0.184	0.165	1.577	0.763	High	0.150	0.277	0.062	1.934	0.930	Very High
26. Jabung	0.141	0.237	0.106	1.679	0.813	Very High	0.142	0.285	0.055	1.927	0.926	Very High
27. Lawang	0.134	0.254	0.092	1.691	0.819	Very High	0.137	0.234	0.118	1.801	0.865	Very High
28. Singosari	0.181	0.224	0.138	1.752	0.848	Very High	0.181	0.280	0.078	2.016	0.969	Very High
29. Karang-ploso	0.103	0.232	0.136	1.522	0.737	High	0.105	0.302	0.066	1.815	0.872	Very High
30. Dau	0.092	0.242	0.084	1.511	0.731	High	0.094	0.265	0.064	1.713	0.823	Very High
31. Pujon	0.107	0.172	0.104	1.418	0.687	High	0.109	0.018	0.268	0.537	0.258	Low
32. Ngantang	0.110	0.231	0.093	1.565	0.758	High	0.111	0.213	0.110	1.670	0.802	Very High
33. Kasem-bon	0.072	0.324	0.080	1.535	0.743	High	0.073	0.153	0.257	1.287	0.619	High
34. Kedung-kandang	0.055	0.204	0.192	1.175	0.569	Moderate	0.055	0.201	0.189	1.309	0.629	High
35. Sukun	0.035	0.186	0.212	0.924	0.447	Moderate	0.031	0.180	0.190	1.013	0.487	Moderate
36. Klojen	0.014	0.052	0.115	0.004	0.002	Very Low	0.009	0.052	0.082	0.001	0.000	Very Low
37. Blimbing	0.022	0.071	0.324	0.265	0.128	Very Low	0.018	0.069	0.299	0.329	0.158	Very Low
38. Lowok-waru	0.028	0.119	0.286	0.617	0.299	Low	0.026	0.116	0.272	0.718	0.345	Low
39. Batu	0.066	0.158	0.194	1.137	0.550	Moderate	0.060	0.156	0.179	1.244	0.598	Moderate
40. Junrejo	0.043	0.143	0.213	0.902	0.437	Moderate	0.041	0.137	0.200	1.011	0.486	Moderate
41. Bumiaji	0.116	0.133	0.177	1.319	0.639	High	0.109	0.132	0.167	1.430	0.687	High

Notes: E : Exposure (expressed as indices indices range 0-1)
S : Sensitivity (expressed as indices indices range 0-1)
AC : Adaptive Capacity (expressed as indices indices range 0-1)

From 5.10 above, it can be seen that actually even from the baseline conditions, year 2010, basically the agriculture sector of Greater Malang is vulnerable from the impact of climate change. More than half of the subdistricts are either classified as highly (17 sub district) or very highly vulnerable (16 subdistricts) to climate change impact. It has been seen that only two subdistricts, i.e. Klojen and Blimbing, have a very low vulnerability, followed by Lowokwaru with low vulnerability level, and Sumberpucung, Kedungkandang, Sukun, Batu, as well as Junrejo which are classified as having a moderate level of vulnerability.

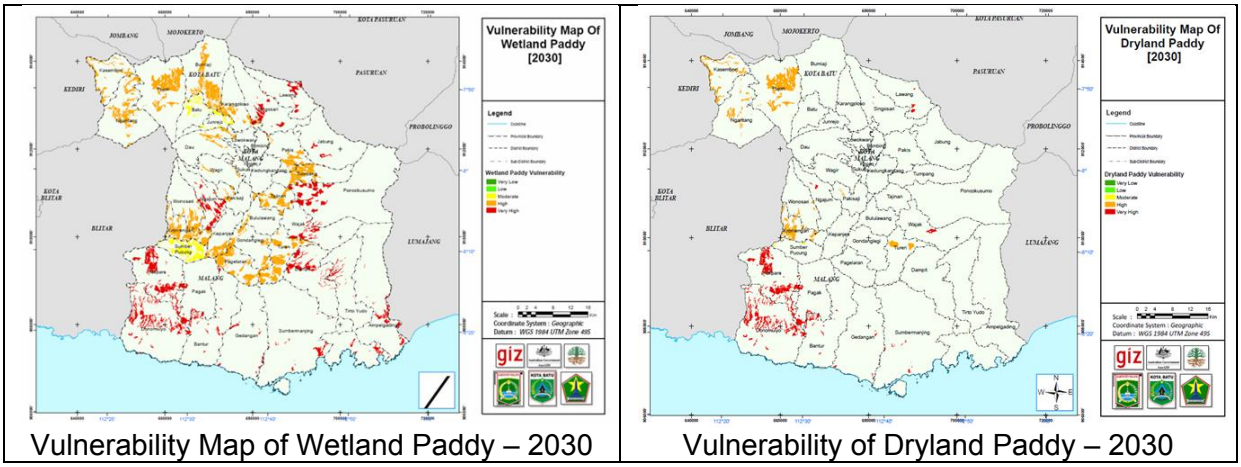
At the baseline time, the highly and very highly vulnerable conditions of Greater Malang are due to a high level of exposure and sensitivity and low adaptive capacity. Most of the

subdistricts have large agricultural areas but low irrigation infrastructure. On the other hand, urban areas have low exposure and sensitivity, and high adaptive capacity, making urban areas less vulnerable to climate change impact.

The projected conditions will also be less encouraging, i.e. still more than half of the subdistricts are either highly or very highly vulnerable to climate change impact and also the moderate group of subdistrict will also reduce. The situation will be worse since the number of very highly vulnerable subdistricts will increase (26 subdistricts), leaving 8 subdistricts still at high level of vulnerability. Some subdistricts will face worse vulnerable situations moving from either moderate or high-level vulnerability into the very highly vulnerable; i.e. Turen, Bululawang, Gondanglegi, Pagelaran, Kepanjen, Pakisaji, Tajinan, Tumpang, Pakis, Karangploso, Dau, and Ngantang. High or very high vulnerability indicates that the climate change impact on crop production in Greater Malang would be very damaging. Therefore, the adaptation strategy needs to be improved, so that the vulnerability will not suppress the agricultural production, food availability, and food sufficiency in Greater Malang.

However, there will be one case of decreased vulnerability level, i.e. in Pujon from a baseline highly vulnerable into a project low state of vulnerability; this is due to the fact that the subdistrict will be less sensitive to climate change because of a reduction in terms of agricultural fields. Changes in 2030 are mainly related to the dynamic change in non-irrigated regions and irrigation infrsstructures.

Figure 5.8 below provides the vulnerability map of wetland paddy and dryland paddy in Greater Malang by 2030. In addition, Table 5.11 presents the summary of vulnerability changes from 2010 to 2030, especially enlisted subdistricts with moderate, high, and very high level of vulnerability.



Vulnerability Map of Wetland Paddy – 2030 | Vulnerability of Dryland Paddy – 2030

Figure 5.8 Map of 2030 Wetland and Dry Land Paddy Vulnerability

Table 5.11 The Distribution of Vulnerability on Agriculture Sector in Greater Malang (2010 and 2030)

Year	Subdistrict		
	Moderate Vulnerability	High Vulnerability	Very High Vulnerability
2010	Sumberpucung, Kedungkandang, Sukun, Batu,and Junrejo. Total: 5 Subdistricts	Bumiaji, Bululawang, Gondanglegi, Pagelaran, Kepanjen, Kromengan, Wonosari, Pakisaji, Tajinan, Tumpang, Pakis, Dau, Pujon,Karangploso, Turen, Ngantang, and Kasembon.	Donomulyo, Kalipare, Pagak, Bantur, Gedangan, Sumbermanjing, Dampit, Tirtoyudo, Ampelgading, Poncokusumo, Wajak, Ngajum, Wagir, Jabung, Lawang, and Singosari.

		Total: 17 Subdistricts	Total: 16 Subdistricts
2030	Sukun, Batu,and Junrejo Total: 3 Subdistricts	Kalipare, Pagak, Sumberpucung, Kromengan, Wonosari, Kasembon, Kedungkandang, and Bumiaji Total: 8 Subdistricts	Donomulyo, Bantur, Gedangan, Sumbermanjing, Dampit, Tirtoyudo, Ampelgading, Poncokusumo, Wajak, Turen, Bululawang, Gondanglegi, Pagelaran, Kepanjen, Ngajum, Wagir, Pakisaji, Tajinan, Tumpang, Pakis, Jabung, Lawang, Singosari, Karangploso, Dau, and Ngantang Total: 26 Subdistricts

5.3 Risk Analysis

In the agricultural sector, risk is defined as those negative impacts that may hamper food security; thus it is composed of the risk of decreased food crop productivity, decreased rainfed harvested area, decreased irrigated harvested area, and decreased food crop production. The risk analysis above is being assessed for two food crops, i.e. paddy and corn, in Greater Malang by 2030. The risk is basically influenced by the result of hazard and vulnerability analysis presented beforehand.

5.3.1 Risk of Decreased Food Crop Productivity

The results of the risk analysis of decreasing productivity of staple food crops, paddy and corn, in Greater Malang is shown in Table 5.12 below.

Table 5.12 Risk of Decreased Food Crops Productivity in Greater Malang

Sub-Districs	Level of Risk (for each Crop)		
	Wetland Paddy	Dryland Paddy	Corn
01. Donomulyo	0.529 / moderate	0.588 / moderate	0.529 / moderate
02. Kalipare	0.538 / moderate	0.541 / moderate	0.524 / moderate
03. Pagak	0.404 / moderate	0.449 / moderate	0.455 / moderate
04. Bantur	0.613 / high	0.769 / high	0.708 / high
05. Gedangan	0.613 / high	0.759 / high	0.703 / high
06. Sumbermanjing	0.689 / high	0.800 / very high	0.763 / high
07. Dampit	0.677 / high	0.826 / very high	0.737 / high
08. Tirtoyudo	0.599 / moderate	0.780 / high	0.707 / high
09. Ampelgading	0.577 / moderate	0.000 / low	0.696 / high
10. Poncokusumo	0.707 / high	0.788 / high	0.990 / very high
11. Wajak	0.843 / very high	0.855 / very high	0.857 / very high
12. Turen	0.820 / very high	0.743/ high	0.938 / very high
13. Bululawang	0.622 / high	0.699 / high	0.751 / high
14. Gondanglegi	0.860 / very high	0.000 / very low	0.959 / very high
15. Pagelaran	0.839 / very high	0.000 / very low	0.869 / very high
16. Kepanjen	0.844/ very high	0.000 / very low	0.877 / very high
17. Sumberpucung	0.632 / high	0.000 / very low	0.813 / very high
18. Kromengan	0.500 / moderate	0.000 / very low	0.542 / moderate
19. Ngajum	0.656 / high	0.626 / high	0.806 / very high
20. Wonosari	0.470 / moderate	0.448 / moderate	0.553 / moderate
21. Wagir	0.652 / high	0.638 / high	0.676 / high
22. Pakisaji	0.616 / high	0.000 / very low	0.690 / high
23. Tajinan	0.581 / moderate	0.597 / moderate	0.733 / high
24. Tumpang	0.672 / high	0.000 / very low	0.790 / high
25. Pakis	0.869 / very high	0.000 / very low	1.000 / very high
26. Jabung	0.699 / high	0.703 / high	0.853 / very high
27. Lawang	0.820 / very high	0.000 / very low	0.739 / high
28. Singosari	1.000 / very high	1.000 / very high	0.919 / very high
29. Karangploso	0.669 / high	0.712 / high	0.707 / high
30. Dau	0.595 / moderate	0.570 / moderate	0.687 / high

Sub-Districs	Level of Risk (for each Crop)		
	Wetland Paddy	Dryland Paddy	Corn
31. Pujon	0.169 / very low	0.000 / very low	0.231 / low
32. Ngantang	0.556 / moderate	0.000 / very low	0.693 / high
33. Kasembon	0.424 / moderate	0.412 / moderate	0.510 / moderate
34. Kedungkandang	0.498 / moderate	0.000 / very low	0.418 / moderate
35. Sukun	0.439 / moderate	0.000 / very low	0.317 / low
36. Klojen	0.000 / very low	0.000 / very low	0.000 / very low
37. Blimbing	0.133 / very low	0.000 / very low	0.030 / very low
38. Lowokwaru	0.280 / low	0.000 / very low	0.230 / low
39. Batu	0.452 / moderate	0.000 / very low	0.427 / moderate
40. Junrejo	0.369 / low	0.000 / very low	0.349 / low
41. Bumiaji	0.538 / moderate	0.000 / very low	0.514 / moderate

From the table above, it can be seen that for wetland paddy, basically the projected risk of decreased productivity is discouraging because only 5 subdistricts have a very low (3) and low level (2) of risk, while on the other hand 15 subdistrricts are considered to have moderate risk, 13 with high-level of risk, and 8 having a very high risk of losing food crop productivity. Those eight subdistricts with areas with a very high-level of risk are Wajak, Turen, Gondanglegi, Pagelaran, Kepanjen, Pakis, Lawang, and Singosari.

On the other hand, the risk profile for dryland paddy is generally lower compared to the previous crop; i.e. almost half of the subdistricts (19) are projected to have a very low level of risk in decreased productivity and one will have low-level of risk. However, the projected risk still needs to be taken into consideration adequately because 10 subdistricts are projected to have a high-level of risk and 4 subdistricts will have a very high level of risk; i.e. Sumbermanjing, Dampit, Wajak, and Singosari. Meanwhile, 7 subdistricts will have a moderate risk in decreased wetland paddy productivity.

Though it is not as bad as wetland paddy, the risk in decreased productivity of corn is also discouraging. From the table, it can be seen that 15 subdistricts will have a high-level of risk and 11 are classified as very highly at risk by 2030. Those subdistricts with very high level of risk are Poncokusumo, Wajak, Turen, Gondanglegi, Pagelaran, Kepanjen, Sumberpucung, Nganjum, Pakis, Jabung, and Singosari. In addition, there will be 9 subdistricts with moderate risk, 4 with low-risk, and 2 with very low level of risk in decreased productivity.

Another important finding is that by 2030, Wajak, Turen, Gondanglegi, Pagelaran, Kepanjen, Pakis, Lawang, Sumbermanjing, Dampit, Poncokusumo, Sumberpucung, Nganjum, Jabung, and Singosari will be at a high or very high level of risk of decreased productivity of both paddy (either wetland or dryland) and corn. Therefore, priority should be given to these fourteen subdistricts that are facing high and very high level of risk in decreased food crop productivity due to the impact of climate change. An adequate adaptation strategy is needed to maintain the production of the three crops, otherwise there will be a threat of decreasing production of staple food crops in those regions that will disrupt the food self-sufficiency in Greater Malang.

5.3.2 Risk of Decreased Rainfed Harvested Area

Another possible impact of climate change in the agricultural sector is the reduction of rainfed harvest area for two crops, paddy and corn. The result of this risk analysis is presented in Table 4.13 below.

Table 5.13 The Risk of Decreasing Rainfed Harvested Area in Greater Malang by 2030

Subdistricts	Level of Risk		
	Rainfed Paddy	Dryland Paddy	Corn
01. Donomulyo	0.569 / moderate	0.247 / low	0.161 / very low
02. Kalipare	0.557 / moderate	0.607 / high	0.463 / moderate
03. Pagak	0.052/ very low	0.284 / low	0.073 / very low
04. Bantur	0.460 / moderate	0.292 / low	0.263 / low
05. Gedangan	0.242 / low	0.073 / very low	0.270 / low
06. Sumbermanjing	0.253 / low	0.010 / very low	0.183 / very low
07. Dampit	1.000 / very high	1.000 / very high	0.564 / moderate
08. Tirtoyudo	0.191 / very low	0.251 / low	0.135 / very low
09. Ampelgading	0.117 / very low	0.000 / very low	0.032 / very low
10. Poncokusumo	0.174 / very low	0.000 / very low	0.273 / low
11. Wajak	0.141 / very low	0.111 / very low	1.000 / very high
12. Turen	0.147 / very low	0.014 / very low	0.192 / very low
13. Bululawang	0.000 / very low	0.002 / very low	0.019 / very low
14. Gondanglegi	0.033 / very low	0.000 / very low	0.021 / very low
15. Pagelaran	0.059 / very low	0.000 / very low	0.045 / very low
16. Kepanjen	0.004 / very low	0.000 / very low	0.005 / very low
17. Sumberpucung	0.000 / very low	0.000 / very low	0.111 / very low
18. Kromengan	0.000 / very low	0.000 / very low	0.011 / very low
19. Ngajum	0.346 / low	0.055 / very low	0.046 / very low
20. Wonosari	0.205 / low	0.002 / very low	0.031 / very low
21. Wagir	0.064 / very low	0.041 / very low	0.157 / very low
22. Pakisaji	0.000 / very low	0.000 / very low	0.004 / very low
23. Tajinan	0.249 / low	0.001 / very low	0.197 / very low
24. Tumpang	0.061 / very low	0.000 / very low	0.206 / low
25. Pakis	0.037 / very low	0.000 / very low	0.043 / very low
26. Jabung	0.033 / very low	0.075 / very low	0.139 / very low
27. Lawang	0.172 / very low	0.000 / very low	0.095 / very low
28. Singosari	0.152 / very low	0.185 / very low	0.071 / very low
29. Karangploso	0.111 / very low	0.020 / very low	0.062 / very low
30. Dau	0.027 / very low	0.011 / very low	0.095 / very low
31. Pujon	0.008 / very low	0.000 / very low	0.046 / very low
32. Ngantang	0.177 / very low	0.000 / very low	0.135 / very low
33. Kasembon	0.206 / low	0.006 / very low	0.105 / very low
34. Kedungkandang	0.000 / very low	0.000 / very low	0.020 / very low
35. Sukun	0.000 / very low	0.000 / very low	0.001 / very low
36. Klojen	0.000 / very low	0.000 / very low	0.000 / very low
37. Blimbing	0.000 / very low	0.000 / very low	0.000 / very low
38. Lowokwaru	0.000 / very low	0.000 / very low	0.001 / very low
39. Batu	0.001 / very low	0.000 / very low	0.048 / very low
40. Junrejo	0.001 / very low	0.000 / very low	0.023 / very low
41. Bumiaji	0.001 / very low	0.000 / very low	0.088 / very low

From the table above, it can be seen that basically Greater Malang has a comforting projection about the risk of decreased rainfed harvest area. For all types of crops, more than half of the subdistricts will have either a very low or a low-level of risk of decreased rainfed harvest area; i.e. 31 subdistricts with a very low level of risk and 6 subdistricts with a low-level of risk of decreased harvest area for rainfed paddy; 35 subdistricts with a very low level of risk and 4 subdistricts with low-level of risk of decreased harvest area for dryland paddy; and 34 subdistricts with a very low level of risk and 4 subdistricts with a low-level of risk of decreased harvest area for corn.

In this sense, consideration shoud be addressed to subdistricts that are projected to experience moderate, high, and very high levels of risk in decreased rainfed harvest area. For rainfed paddy, it is projected that Donomulyo, Kalipare, and Bantur will face a moderate

level of risk; while, Dampit will experience a very high risk of decreased rainfed harvest area. As for the dryland paddy, Kalipare will be highly at risk, and Dampit will be very highly at risk of decreased rainfed harvest area. Meanwhile, for corn, Kalipare and Dampit will experience a high risk of decreased rainfed harvest area, while Wajak will be very highly risky. Thus, it can be said that, only Dampit, Donomulyo, Kalipare, Bantur , and Wajak have a risk of decreasing rainfed harvested area due to climate change.

Given the projection results above, in terms of the risk in decreased rainfed harvest area, priority for adaptation should be given as follows: 1) for Dampit, since it will experience a very high risk both for rainfed and dryland paddy as well as a moderate risk for corn, 2) Kalipare since it will experience a high-risk for dryland paddy and moderate risk for both rainfed paddy and corn, 3) Wajak, which will experience a very high risk of decreased rainfed harvest area for corn, and 4) Donomulyo and Bantur which will experience a moderate risk of decreased rainfed harvest area for rainfed paddy.

5.3.3 Risk of Decreased Irrigated Harvested Area

The result of the risk analysis of decreasing harvested area for irrigated paddy in Greater Malang by 2030 is presented in Table 5.14 below.

Table 5.14 Risk of Decreasing Irrigated Harvest of Irrigated Paddy in Greater Malang by 2030

Subdistricts	Level of Risk Irrigated Paddy	Subdistrict	Level of Risk Irrigated Paddy
01. Donomulyo	0.515 / moderate	21. Wagir	0.233 / low
02. Kalipare	0.000 / very low	22. Pakisaji	0.499 / moderate
03. Pagak	0.000 / very low	23. Tajinan	0.411 / moderate
04. Bantur	0.397 / low	24. Tumpang	0.389 / low
05. Gedangan	0.000 / very low	25. Pakis	0.581 / moderate
06. Sumbermanjing	0.229 / low	26. Jabung	0.603 / high
07. Dampit	1.000 / very high	27. Lawang	0.412 / moderate
08. Tirtoyudo	0.198 / very low	28. Singosari	0.874 / very high
09. Ampelgading	0.137 / very low	29. Karangploso	0.673 / high
10. Poncokusumo	0.367 / low	30. Dau	0.062 / very low
11. Wajak	0.252 / low	31. Pujon	0.013 / very low
12. Turen	0.747 / high	32. Ngantang	0.319 / low
13. Bululawang	0.306 / low	33. Kasembon	0.280 / low
14. Gondanglegi	0.275 / low	34. Kedungkandang	0.108 / very low
15. Pagelaran	0.506 / moderate	35. Sukun	0.094 / very low
16. Kepanjen	0.923 / very high	36. Klojen	0.000 / very low
17. Sumberpucung	0.487 / moderate	37. Blimbing	0.010 / very low
18. Kromengan	0.542 / moderate	38. Lowokwaru	0.065 / very low
19. Ngajum	0.471 / moderate	39. Batu	0.059 / very low
20. Wonosari	0.125 / very low	40. Junrejo	0.067 / very low
		41. Bumiaji	0.134 / very low

From the table above, it can be seen that, in general, Greater Malang has a less risk in terms of decreased irrigated harvest area; i.e. can be reflected from the result that 16 subdistricts will have a very low risk and 10 subdistricts defined as having a low-level of risk. Therefore, consideration for adaptation should be address for subdistricts with moderate (9 subdistricts), high-level (3 subdistricts), and very high level of risk (3 sub districts). Those which are projected to have a very high level of risk in decreased irrigated harvest area are Dampit, Kepanjen, and Singosari. While, subdistricts with a high-level of risk in 2030 are Turen, Jabung, and Karangploso. As a remark, some parts of Greater Malang experience the risk of decreasing irrigated harvest area due to increased evapotranspiration and rainfall variation.

5.3.4 Risk of Decreased Food Crop Production

The final risk analysis is that of decreased food crop production for both paddy and corn in Greater Malang by 2030; the result is presented in Table 5.15 below.

Table 5.15 The Risk of Decreased Production of Food Crops Production in Greater Malang, 2030

Subdistricts	Level of Risk		
	Wetland Paddy	Dryland Paddy	Corn
01. Donomulyo	0.437 / moderate	0.245 / low	0.118 / very low
02. Kalipare	0.339 / low	0.492 / moderate	0.348 / low
03. Pagak	0.036 / very low	0.258 / low	0.062 / very low
04. Bantur	0.357 / low	0.341 / low	0.232 / low
05. Gedangan	0.158 / very low	0.144 / very low	0.236 / low
06. Sumbermanjing	0.222 / low	0.041 / very low	0.164 / very low
07. Dampit	0.919 / very high	1.000 / very high	0.492/ moderate
08. Tirtoyudo	0.184 / very low	0.301 / low	0.124 / very low
09. Ampelgading	0.121 / very low	0.000 / very low	0.031 / very low
10. Poncokusumo	0.295 / low	0.006 / very low	0.303 / low
11. Wajak	0.273 / low	0.187 / very low	1.000 / very high
12. Turen	0.829 / very high	0.055 / very low	0.221 / low
13. Bululawang	0.260 / low	0.016 / very low	0.022 / very low
14. Gondanglegi	0.327 / low	0.000 / very low	0.030 / very low
15. Pagelaran	0.614 / high	0.000 / very low	0.053 / very low
16. Kepanjen	1.000 / very high	0.000 / very low	0.010 / very low
17. Sumberpucung	0.502 / moderate	0.000 / very low	0.134 / very low
18. Kromengan	0.443 / moderate	0.000 / very low	0.012 / very low
19. Ngajum	0.403 / moderate	0.091 / very low	0.050 / very low
20. Wonosari	0.139 / very low	0.012 / very low	0.030 / very low
21. Wagir	0.191 / very low	0.067 / very low	0.132 / very low
22. Pakisaji	0.427 / moderate	0.000 / very low	0.007 / very low
23. Tajinan	0.322 / low	0.010 / very low	0.190 / very low
24. Tumpang	0.318 / low	0.000 / very low	0.201 / low
25. Pakis	0.584 / moderate	0.000 / very low	0.055 / very low
26. Jabung	0.481 / moderate	0.103 / very low	0.146 / very low
27. Lawang	0.393 / low	0.000 / very low	0.093 / very low
28. Singosari	0.924/ very high	0.273 / low	0.078 / very low
29. Karangploso	0.536 / moderate	0.070 / very low	0.059 / very low
30. Dau	0.055 / very low	0.039 / very low	0.091 / very low
31. Pujon	0.010 / very low	0.000 / very low	0.047 / very low
32. Ngantang	0.248 / low	0.000 / very low	0.132 / very low
33. Kasembon	0.210 / low	0.022 / very low	0.098 / very low
34. Kedungkandang	0.100 / very low	0.000 / very low	0.016 / very low
35. Sukun	0.097 / very low	0.000 / very low	0.002 / very low
36. Klojen	0.000 / very low	0.000 / very low	0.000 / very low
37. Blimbing	0.010 / very low	0.000 / very low	0.000 / very low
38. Lowokwaru	0.059 / very low	0.000 / very low	0.002/ very low
39. Batu	0.052 / very low	0.000 / very low	0.040 / very low
40. Junrejo	0.057 / very low	0.000 / very low	0.020 / very low
41. Bumiaji	0.110 / very low	0.000 / very low	0.075 / very low

From Table 5.15 above, it can be seen that Greater Malang has a less concerning projection about the risk of decreased food crop production. For all types of crops, more than half of the subdistricts either has or will have a very low or a low-level of risk in decreased food crop production; i.e. 16 subdistrict with very low level of risk and 12 subdistrict with low-level of risk of decreased production in wetland paddy; 34 subdistrict with very low level of risk and 5 subdistrict with low-level of risk of decreased production for dryland paddy; and 33 subdistrict with very low level of risk and 6 subdistrict with low-level of risk of decreased production for corn.

However, consideration still needs to be addressed for wetland paddy because a quarter of the subdistricts are still classified as having moderate (8 subdistricts), high (1 subdistrict), and very high level of risk (4 subdistricts) of decreased production. While for dryland paddy

production, concerns of decreased production should only be addressed for Kalipare (moderate risk) and Dampit (very high risk). The same applies to the risk in corn production for which only Dampit (moderate risk) and Wajak (very high risk) have projection results that are cause for concern. In addition, Dampit, can be identified as a subdistrict which has a concerning risk level by 2030; i.e. very high risk in wetland and dryland paddy as well as moderate risk in corn production.

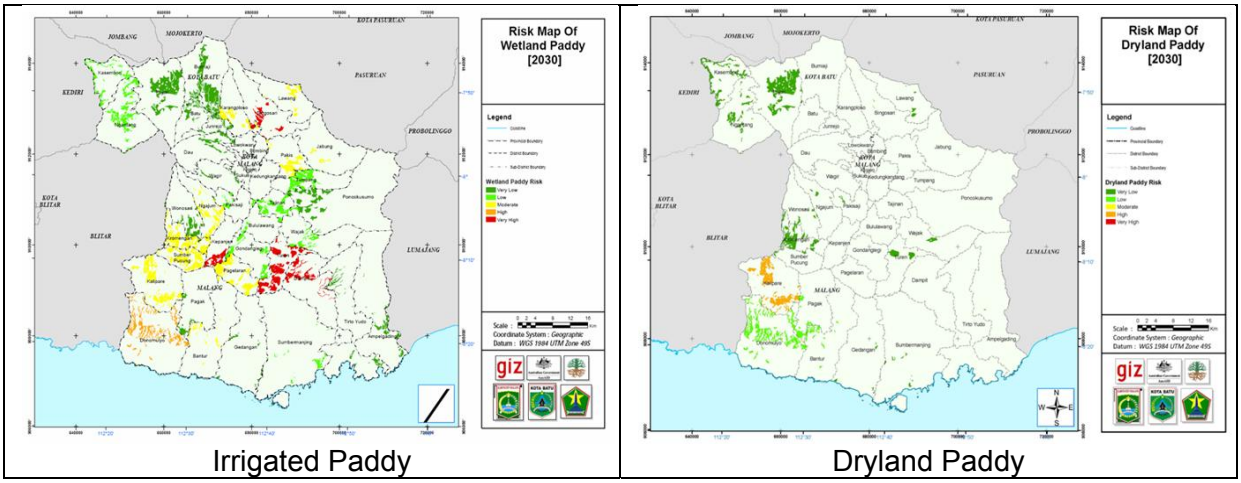


Figure 5.9 Risk Map of Decreasing Production for Irrigated Paddy and Dryland Paddy in Greater Malang, by 2030

In addition, although climate change has caused negative impacts to food crop production, decreasing apple production of Batu City, as a special case in this assessment, was the result of confounding factors particularly of climate variables and its production inputs. Indeed, the available limited data cannot distinguish the impacts between the two and, hence, this study cannot portray the impact of climate change on apple production over a wide range of temperature and rainfall. Decreasing apple production in Malang Raya is more caused by socio-economic aspects related to the price of agricultural inputs and the crop yield. The remaining apple production areas are in the subdistricts of Bumiaji, Sidomulyo and Punten.

5.4 Adaptation Options

There are several adaptation strategies to address the risk of decreasing crop production due to climate change in Greater Malang; i.e. 1) increasing crop productivity through superior variety/seed, cultivation technology, fertilizer, and equipment; 2) increasing agricultural field areas to increase crop and harvest areas through field reclamation, field optimisation, and extension of new fields; 3) food diversification through plantation of potential crops which are resilient to climate change, such as early ripening crops, drought resistant crops, and inundation resistant crops; 4) revitalisation of planting patterns according to changes in distribution and frequency of precipitation; 5) prevent the land conversion from agriculture to non-agriculture use using laws and regulations; and 6) strengthen coordination between institutions related to agricultural activities in the climate change adaptation strategy.

Further development of each adaptation strategy is thus being carried out based on the level of hazard, vulnerability, risk, and priority districts; i.e. creation of programmes and activities for each type of hazard that can refer to the sectoral report. A summary of the adaptation strategy in the agriculture sector for Greater Malang is given below:

Table 5.16 Summary of Adaptation Strategy in Greater Malang

Hazard (H)	Priority Districts	Adaptation Strategy
Decreasing Crop Productivity	)Wajak, Turen, Gondanglegi, Pagelaran, Kepanjen, Pakis, Lawang, and Singosari (wetland Paddy))Sumbermanjing, Dampit, Wajak, and Singosari (dryland Paddy))Poncokusumo, Wajak, Turen, Gondanglegi, Pagelaran, Kepanjen, Sumberpucung, Nganjum, Pakis, Jabung, and Singosari (Corn)	Using superior seeds with high productivity, short life, and resistance to drought or floods. Increasing the technique of agricultural cultivation, such as through PTT and cultivational intensification (SRI and Legowo system)
Decreasing Harvest Area of Rainfed Field	)Dampit, Turen, Kepanjen, Singosari, and Pagelaran (wetland paddy))Kapipare and Dampit (dryland paddy))Wajak (Corn)	Increasing capacity of rain water reservoirs on wet season Revitalisation of irrigation network Use of superior seeds of paddy and corn seeds with higher quality and early ripening.
Decreasing Harvest Area of Irrigated Field	)Dampit, Kepanjen, Singosari, Turen, Jabung, and Karangploso (wetland paddy)	Increasing capacity of rain water reservoirs on wet season. Revitalisation of irrigation network Conservation of soil and water on agricultural field.
Decreasing Crop Production	)Dampit, Turen, Kepanjen, Singosari, and Pagelaran (Wetland paddy))Dampit (Dryland paddy) 0)Wajak (Corn)	Use of superior seeds of paddy and corn seeds with higher quality and early ripening. Increasing the technique of agricultural cultivation, such as through PTT and cultivational intensification (SRI and Legowo system) Development of raised bed cultivation system to conserve land soil and water on rainfed fields. Optimisation of use of rainfed fields by reforestation. Optimisation of use of abandoned land reclamation, and opening of new fields.

Source: Handoko and Ruminta, 2011

In addition, in the case of apple production in Batu City, some recommendations provided to maintain the production are to rehabilitate apple plantations by changing old apple crops with young ones, to prevent the conversion of apple plantation areas to non apple ones, and to provide incentives for apple farmers so that they would still have a passion to plant apple and would not change their occupation.

6. Risk Assessment and Adaptation Options for the Health Sector

6.1 Hazard Analysis

Changes in climatic factors, i.e. temperature and rainfall, are believed to trigger negative impacts in the health sector, especially in DHF, malaria and diarrhea incidences. This sub-chapter will describe the hazards of climate change impact to the health sector in Greater Malang as triggered for these diseases. Greater Malang has difference characteristics among subdistricts, even among villages, particularly in terms of geographic and social patterns; thus, subdistrict-scale study approach is actually most appropriate to be conducted. However, data availability at the subdistrict-scale is a major concern and becomes a limitation to conduct a comprehensive review; thus the analysis is limited to the meso-level. In this analysis, incidence of the diseases in the past and present are used as the hazard baseline, and mathematical modeling is used to perform projections of future trends for the hazards.

6.1.1 Hazard Analysis of DHF

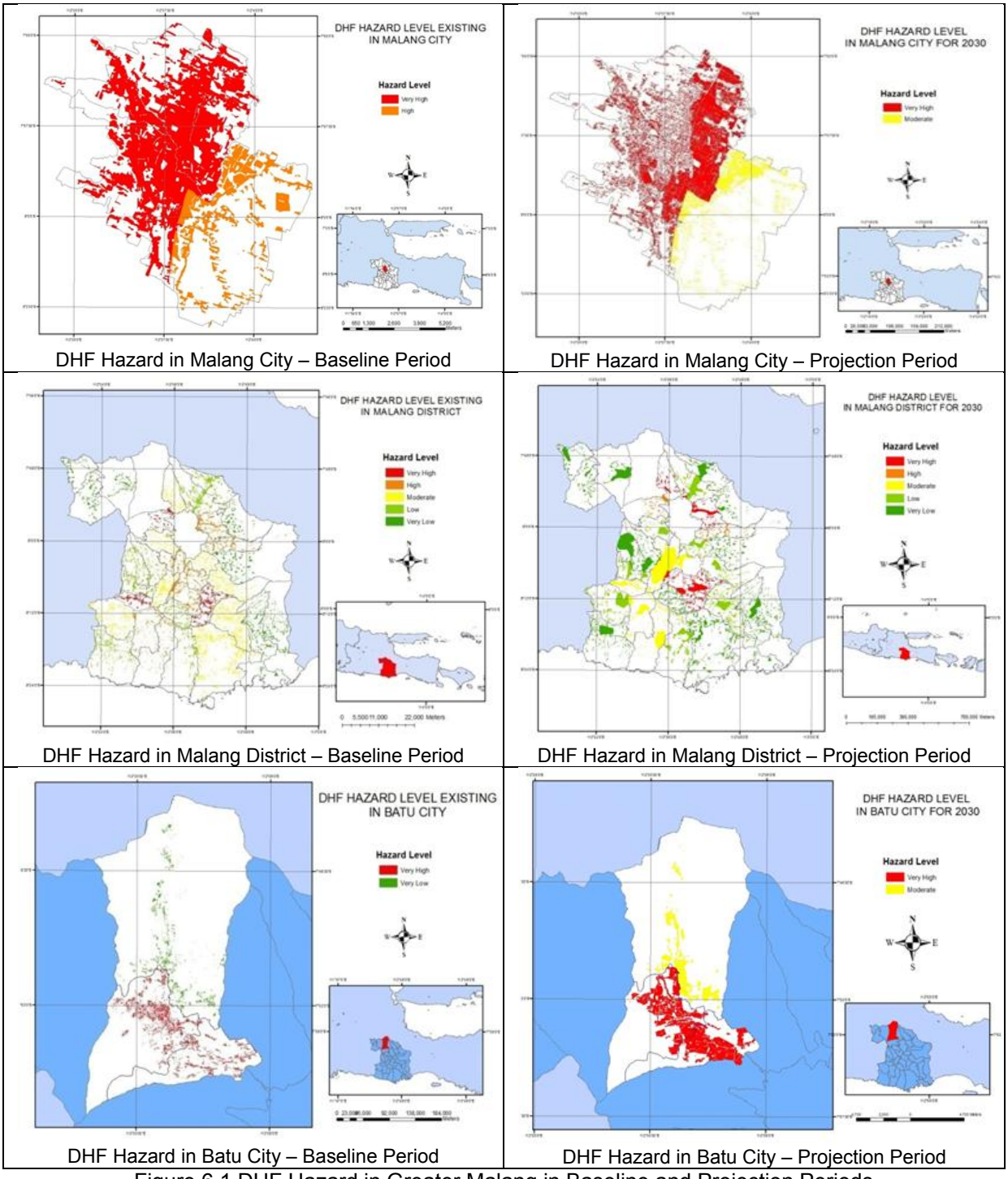
In general, the incidence of DHF tends to increase prior to an increment in rainfall. Hazard analysis is calculated based on a percentile rank positioning. The percentile 0-5 becomes the border of each of the categories of hazard. The percentile is obtained from the summary of prevalence (incidence) rate of DHF in all regions of Greater Malang between 2007-2010 as a baseline. The regression constants b and μ are fitted to the actual data and are be used to estimate the future projection of DHF in Greater Malang. Other data required are the projection of population number and climatic variables, such as rainfall and temperature. Table 6.1 below presents the result of the hazard analysis in Greater Malang for the baseline and projection periods.

Table 6.1 DHF Hazard Analysis in Greater Malang in Baseline and Projection Period

No.	Sub Districts	Hazard in Baseline Period			Hazard in Projection Period		
		Population (2008)	Average Prevalence /1,000 Population	Level	Population (2030)	Average Prevalence / 1,000 Population	Level
Malang City							
1	Kedung Kandang	162,104	0.532	High	291,410	0.4	Moderate
2	Sukun	174,868	0.707	Very High	206,420	1.0	Very High
3	Klojen	126,760	1.125	Very High	108,790	2.4	Very High
4	Blimbing	171,051	0.601	Very High	197,010	0.9	Very High
5	Lowok Waru	181,854	0.696	Very High	287,130	0.9	Very High
Malang District							
6	Tumpang	73,651	0.453	High	110,484	0.5	High
7	Poncokusumo	89,701	0.089	Very Low	127,702	0.1	Very Low
8	Jabung	74,572	0.107	Very Low	103,319	0.2	Very Low
9	Pakis	132,502	0.561	High	169,905	1.0	Very High
10	Lawang	111,125	0.185	Low	138,176	0.2	Very Low
11	Singosari	160,620	0.185	Low	217,268	0.2	Low
12	Karangploso	70,702	0.325	Moderate	83,014	0.6	Very High
13	Dau	52,045	0.803	Very High	84,696	0.5	High
14	Pujon	63,724	0.026	Very Low	93,352	0.0	Very Low
15	Ngantang	53,501	0.075	Very Low	83,567	0.1	Very Low
16	Kasembon	31,543	0.032	Very Low	44,879	0.1	Very Low
17	Kepanjen	105,969	0.358	Moderate	138,788	0.4	Moderate
18	Sumber Pucung	49,825	0.690	Very High	82,257	0.4	Moderate
19	Kromengan	37,019	0.270	Low	58,195	0.2	Low
20	Pakisaji	81,891	0.572	High	110,763	0.4	Moderate
21	Ngajum	48,209	0.180	Low	73,402	0.1	Very Low
22	Wonosari	43,746	0.167	Low	68,230	0.1	Very Low

No.	Sub Districts	Hazard in Baseline Period			Hazard in Projection Period		
		Population (2008)	Average Prevalence /1,000 Population	Level	Population (2030)	Average Prevalence / 1,000 Population	Level
23	Wagir	76,041	0.276	Moderate	108,633	0.2	Low
24	Pagak	46,239	0.550	High	75,122	0.4	Moderate
25	Donomulyo	66,683	0.245	Low	118,855	0.2	Very Low
26	Kalipare	57,998	0.317	Moderate	99,617	0.2	Low
27	Bantur	71,397	0.569	High	105,872	0.3	Moderate
28	Gedangan	50,200	0.266	Low	75,560	0.2	Low
29	Gondanglegi	81,316	0.477	High	80,121	0.9	Very High
30	Bululawang	65,249	0.571	High	90,470	0.4	Moderate
31	Wajak	76,985	0.384	Moderate	125,670	0.2	Low
32	Tajinan	47,560	0.308	Moderate	72,188	0.2	Low
33	Turen	110,157	0.705	Very High	162,295	0.7	Very High
34	Dampit	125,762	0.277	Moderate	175,207	0.2	Low
35	Sumbermanjing Wetan	98,591	0.289	Moderate	140,892	0.2	Very Low
36	Ampelgading	55,380	0.096	Very Low	85,014	0.1	Very Low
37	Tirtoyudo	66,935	0.080	Very Low	94,308	0.1	Very Low
38	Pagelaran	62,181	0.175	Low	98,889	0.1	Very Low
Batu City							
39	Batu	89,843	0.592	Very High	142,103	2.4	Very High
40	Junrejo	45,340	0.692	Very High	77,748	1.3	Very High
41	Bumiaji	56,876	0.109	Very Low	89,794	0.4	Moderate

From the table above, it can be seen that basically the DHF hazard for both baseline and projection conditions threaten Malang City and Batu City. Until 2030, four subdistricts in Malang City and two subdistricts in Batu City are projected to experience a very high level of DHF hazard. On the other hand, for Malang District, while it is true that the numbers of subdistricts which experience lower DHF hazard level at projection condition will increase (13 subdistricts with very low level, 8 with low level, and 5 with medium level of hazard), cautions should be addressed to six subdistricts with high and very high level of DHF hazard; i.e. Turen, Gondanglegi, Karangploso, and Pakis (very high level of hazard) as well as Tumpang and Dau (high-level of hazard). The distribution of DHF hazard in Greater Malang for both baseline and projection periods can be seen in Figure 6.1 below.



DHF Hazard in Malang City – Baseline Period | DHF Hazard in Malang City – Projection Period

DHF Hazard in Malang District – Baseline Period | DHF Hazard in Malang District – Projection Period

DHF Hazard in Batu City – Baseline Period | DHF Hazard in Batu City – Projection Period

Figure 6.1 DHF Hazard in Greater Malang in Baseline and Projection Periods

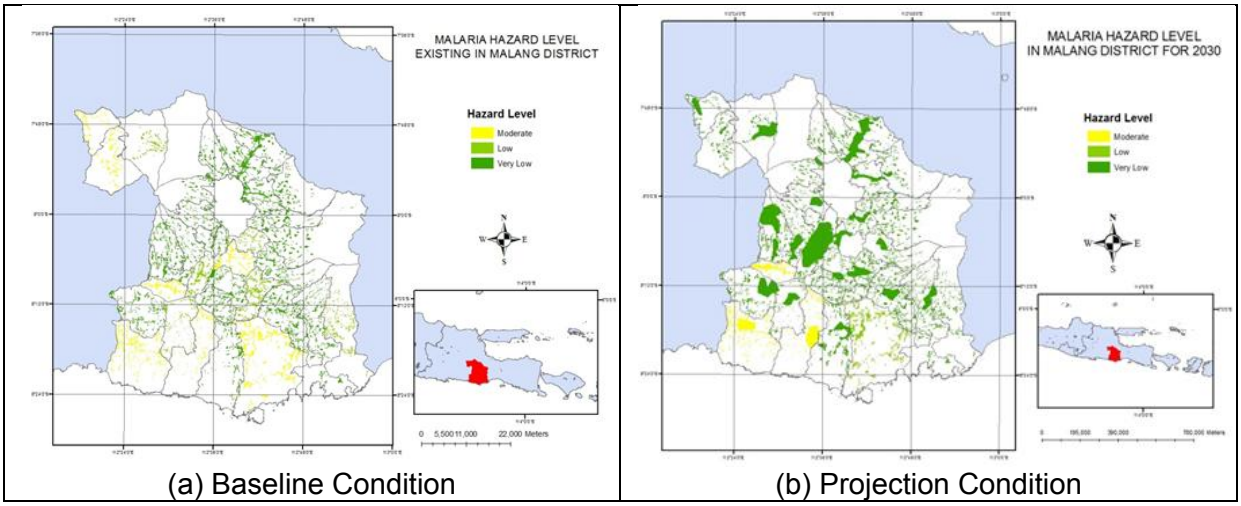
6.1.2 Hazard Analysis of Malaria

This sub-chapter presents the results of the hazard analysis for malaria, for which the hazard is only found in Malang District. The hazard analysis is calculated based on a percentile rank positioning. The percentile of 0-5 becomes the border of each level of hazard. The percentile was obtained from the summary of prevalence rate of Malaria in all regions of Malang for the period 2007-2010 as baseline conditions. The result of the hazard analysis for malaria, in both baseline and projection conditions, is given in Table 6.2 below.

Table 6.2 Results of Existing Malaria Hazard Analysis in Malang District

No	Sub District	Hazard in Baseline			Hazard in Projection		
		Population (2008)	Average Prevalence / 1,000 Population	Level	Population (2030)	Average Prevalence / 1,000 populations	Level
1	Tumpang	73,651	0.0	Very Low	110,484	0	Very Low
2	Poncokusumo	89,701	0.0	Very Low	127,702	0	Very Low
3	Jabung	74,572	0.0	Very Low	103,319	0	Very Low
4	Pakis	132,502	0.0	Very Low	169,905	0	Very Low
5	Lawang	111,125	0.0	Very Low	138,176	0	Very Low
6	Singosari	160,620	0.0	Very Low	217,268	0	Very Low
7	Karangploso	70,702	0.0	Very Low	83,014	0	Very Low
8	Dau	52,045	0.0	Very Low	84,696	0	Very Low
9	Pujon	63,724	0.0	Low	93,352	0	Very Low
10	Ngantang	53,501	0.0	Moderate	83,567	0	Very Low
11	Kasembon	31,543	0.1	Moderate	44,879	0	Very Low
12	Kepanjen	105,969	0.0	Low	138,788	0	Very Low
13	Sumber Pucung	49,825	0.2	Moderate	82,257	0.03647	Moderate
14	Kromengan	37,019	0.0	Very Low	58,195	0	Very Low
15	Pakisaji	81,891	0.0	Very Low	110,763	0	Very Low
16	Ngajum	48,209	0.0	Very Low	73,402	0	Very Low
17	Wonosari	43,746	0.0	Very Low	68,230	0	Very Low
18	Wagir	76,041	0.0	Very Low	108,633	0	Very Low
19	Pagak	46,239	0.0	Low	75,122	0	Very Low
20	Donomulyo	66,683	0.1	Moderate	118,855	0.06731	Moderate
21	Kalipare	57,998	0.0	Very Low	99,617	0	Very Low
22	Bantur	71,397	0.1	Moderate	105,872	0.08501	Moderate
23	Gedangan	50,200	0.0	Very Low	75,560	0	Very Low
24	Gondanglegi	81,316	0.0	Very Low	80,121	0	Very Low
25	Bululawang	65,249	0.0	Moderate	90,470	0.01105	Very Low
26	Wajak	76,985	0.0	Very Low	125,670	0	Very Low
27	Tajinan	47,560	0.0	Low	72,188	0	Very Low
28	Turen	110,157	0.0	Low	162,295	0.00616	Very Low
29	Dampit	125,762	0.0	Very Low	175,207	0	Very Low
30	Sumbermanjing Wetan	98,591	0.1	Moderate	140,892	0.02129	Low
31	Ampelgading	55,380	0.0	Low	85,014	0	Very Low
32	Tirtoyudo	66,935	0.0	Very Low	94,308	0	Very Low
33	Pagelaran	62,181	0.0	Very Low	98,889	0	Very Low

From the table above, it can be seen that in the baseline situation, levels of malaria hazard in Malang District only vary from very low to moderate level, without any subdistricts experiencing high or very high levels of hazard. In detail, the baseline conditions are 20 subdistricts with very low level of hazard, six with low-level of hazard, and seven with moderate level of hazard. Afterwards, projection results show that the situation will be less threatening; i.e. 29 subdistricts are projected to have only very low level of hazard, one subdistrict would have low-level of hazard, and three subdistricts would have a moderate level of hazard. From the map of hazard analysis in Figure 6.2 below, it can be seen that even though the level of hazards are less threatening the area of hazard is projected to be more agglomerated.



(a) Baseline Condition (b) Projection Condition

Figure 6.2 Hazard Map of Malaria in Malang District

6.1.3 Hazard Analysis of Diarrhea

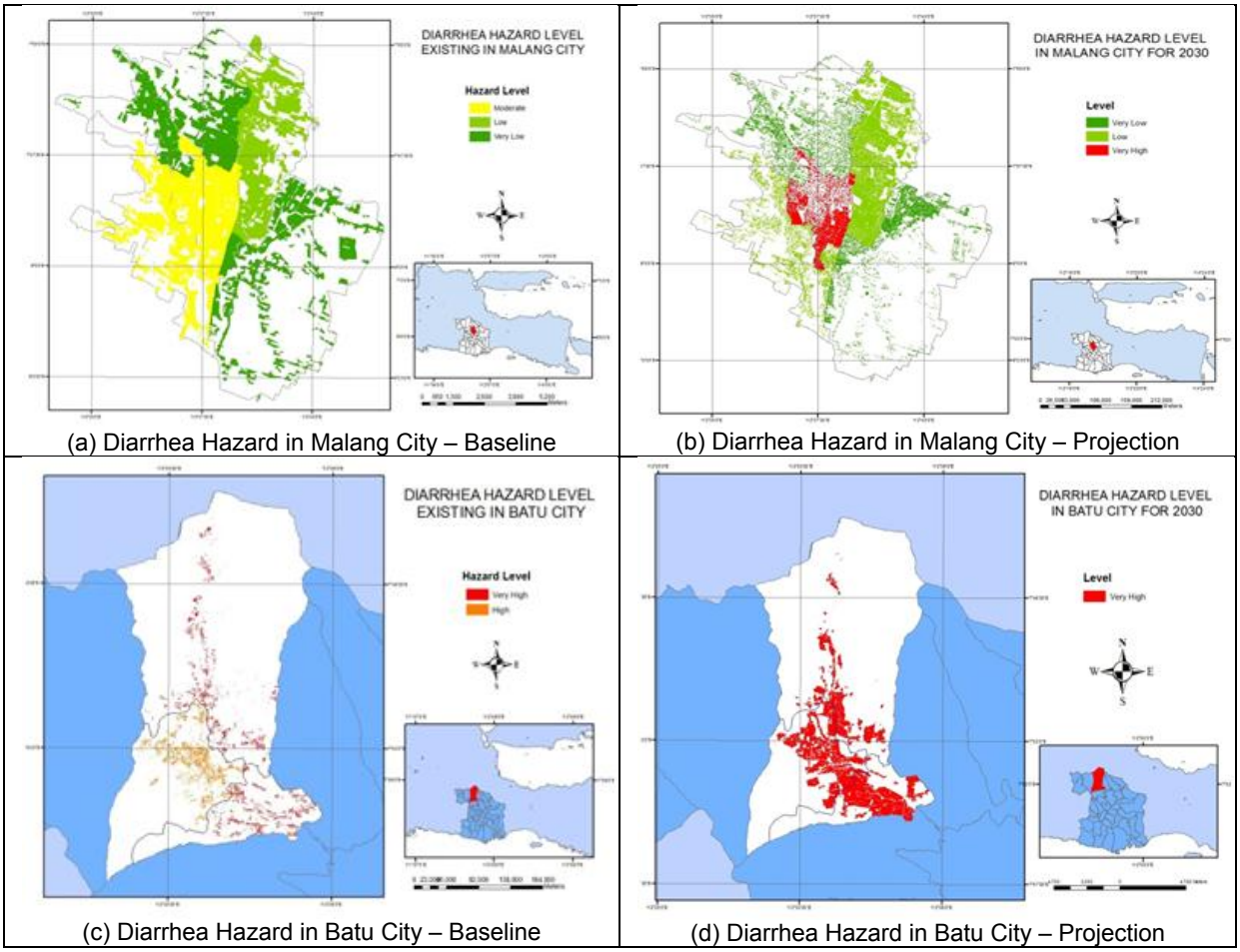
As with the previous hazard, the hazard of diarrhea is only being analysed for Malang City and Batu City. For baseline conditions, three years average of prevalence (2007-2009) is used to categorise the hazard at the subdistrict level. Then, given the projection of population and average of prevalence, the projection analysis is conducted. The result of the hazard analysis for diarrhea in Malang and Batu City for both baseline and projection conditions is given in Table 6.3 below.

Table 6.3 Existing Hazard Categories of Diarrhea in Malang City and Batu City

Sub Districts	Hazard in Baseline Condition			Hazard in Projection Condition		
	Population (2008)	Average Prevalence / 1,000 Population	Level (2008)	Population (2030)	Average Prevalence / 1,000 Population	Level
Malang City						
Kedung Kandang	162,104	12.3	Very Low	291,410	7.18	Very Low
Sukun	174,868	22.2	Moderate	206,420	19.73	Low
Klojen	126,760	20.3	Moderate	108,790	35.10	Very High
Blimbing	171,051	17.6	Low	197,010	18.16	Low
Lowok Waru	181,854	13.9	Very Low	287,130	9.18	Very Low
Batu City						
Batu	89,843	22.6	High	142,103	66.35	Very High
Junrejo	45,340	50.8	Very High	77,748	101.83	Very High
Bumiaji	56,876	40.3	Very High	89,794	69.19	Very High

As can be seen from the table above, in the baseline conditions the levels of hazard in Malang City vary from very low (two subdistricts), low (one subdistrict), and moderate (two subdistricts). Later on, while subdistricts with very low level of hazard remain and there will be two subdistricts that are projected to have low-level of hazard, another one subdistrict, Klojen, is projected to experience a very high level of diarrhea hazard.

Meanwile, analysis shows that the hazard of diarrhea threatens Batu City. In the baseline conditions, Batu subdistrict is considered to have a high-level of hazard while the rest experiences a very high level of hazard. Then, the projection result indicates that all of the subdistricts in Batu City are projected to experience a very high level of hazard of diarrhea cases. The distribution of diarrhea hazard in both cities both in baseline and projection conditions can be seen in Figure 6.3 below.



(a) Diarrhea Hazard in Malang City – Baseline

(b) Diarrhea Hazard in Malang City – Projection

(c) Diarrhea Hazard in Batu City – Baseline

(d) Diarrhea Hazard in Batu City – Projection

Figure 6.3 Hazard Map of Diarrhea in Malang City and Batu City

6.2 Vulnerability Analysis

Vulnerability is defined as the extent to which a natural or social system is susceptible to sustaining damage from climate change. It is a function of the magnitude of climate change, sensitivity of the system to changes in climate, and ability of the system to adapt to changes in climate. Different socio-geographic characteristics allow variations of vulnerability conditions between districts.

6.2.1 Vulnerability Assessment of DHF

Vulnerability to DHF is calculated from four variables, namely total population, population density, source of water supply, and provision of health facilities. The results of vulnerability to DHF hazard for both baseline and projection conditions are given in Table 6.4.

Table 6.4 Vulnerability to DHF in Greater Malang both in baseline and projection conditions

No	Sub Districts	Vulnerability in Baseline						Vulnerability in Projection					
		Vp	Vpd	Vnp	Vhf	Vtotal	Level	Vp	Vpd	Vnp	Vhf	Vtotal	Level
Malang City													
1	Kedung Kandang	0.07	0.125	0.038	0.03	0.21	Very High	0.10	0.281	0.076	0.01	0.44	Very High
2	Sukun	0.08	0.250	0.070	0.03	0.37	Very High	0.07	0.281	0.050	0.03	0.37	Very High
3	Klojen	0.06	0.125	0.054	0.08	0.16	High	0.04	0.250	0.047	0.09	0.24	Very High
4	Blimbing	0.08	0.125	0.064	0.04	0.22	Very High	0.07	0.125	0.081	0.04	0.24	Very High
5	Lowok Waru	0.08	0.125	0.064	0.03	0.24	Very High	0.10	0.281	0.062	0.02	0.42	Very High

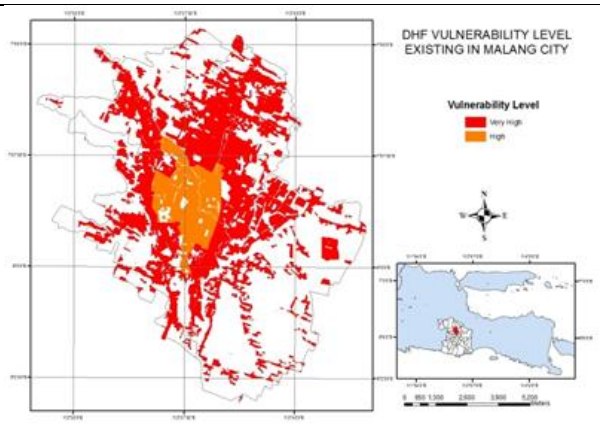
No	Sub Districts	Vulnerability in Baseline						Vulnerability in Projection					
		Vp	Vpd	Vnp	Vhf	Vtotal	Level	Vp	Vpd	Vnp	Vhf	Vtotal	Level
Malang District													
6	Tumpang	0.01	0.062	0.088	0.04	0.12	Low	0.032	0.062	0.082	0.03	0.13	Low
7	Poncokusumo	0.01	0.062	0.106	0.04	0.15	Moderate	0.037	0.062	0.105	0.03	0.16	High
8	Jabung	0.01	0.062	0.109	0.03	0.15	High	0.030	0.125	0.109	0.02	0.22	Very High
9	Pakis	0.02	0.062	0.055	0.03	0.11	Very Low	0.049	0.062	0.055	0.02	0.11	Very Low
10	Lawang	0.02	0.062	0.041	0.05	0.07	Very Low	0.040	0.062	0.000	0.04	0.04	Very Low
11	Singosari	0.02	0.062	0.096	0.03	0.15	High	0.062	0.062	0.041	0.02	0.10	Very Low
12	Karangploso	0.01	0.062	0.042	0.04	0.08	Very Low	0.024	0.062	0.042	0.03	0.08	Very Low
13	Dau	0.01	0.062	0.102	0.04	0.13	Moderate	0.024	0.062	0.080	0.02	0.13	Low
14	Pujon	0.01	0.062	0.102	0.05	0.13	Low	0.027	0.062	0.000	0.03	0.04	Very Low
15	Ngantang	0.01	0.062	0.110	0.04	0.14	Moderate	0.024	0.062	0.099	0.03	0.14	Moderate
16	Kasembon	0.00	0.062	0.116	0.06	0.12	Low	0.013	0.062	0.012	0.04	0.04	Very Low
17	Kepanjen	0.02	0.062	0.072	0.05	0.10	Very Low	0.040	0.062	0.000	0.03	0.04	Very Low
18	Sumber Pucung	0.01	0.062	0.118	0.04	0.15	High	0.024	0.062	0.067	0.02	0.11	Low
19	Kromengan	0.01	0.062	0.118	0.04	0.15	Moderate	0.017	0.062	0.051	0.03	0.09	Very Low
20	Pakisaji	0.01	0.062	0.076	0.03	0.12	Low	0.032	0.062	0.000	0.03	0.05	Very Low
21	Ngajum	0.01	0.062	0.101	0.04	0.13	Low	0.021	0.062	0.000	0.03	0.04	Very Low
22	Wonosari	0.01	0.062	0.006	0.05	0.03	Very Low	0.020	0.062	0.000	0.03	0.04	Very Low
23	Wagir	0.01	0.062	0.118	0.03	0.16	Very High	0.031	0.062	0.049	0.02	0.10	Very Low
24	Pagak	0.01	0.062	0.037	0.05	0.06	Very Low	0.021	0.062	0.000	0.03	0.04	Very Low
25	Donomulyo	0.01	0.062	0.106	0.04	0.14	Moderate	0.034	0.062	0.050	0.02	0.10	Very Low
26	Kalipare	0.01	0.062	0.107	0.05	0.13	Moderate	0.028	0.062	0.012	0.03	0.06	Very Low
27	Bantur	0.01	0.062	0.118	0.04	0.15	High	0.030	0.062	0.000	0.03	0.04	Very Low
28	Gedangan	0.01	0.062	0.118	0.04	0.15	High	0.022	0.062	0.000	0.02	0.05	Very Low
29	Gondanglegi	0.01	0.062	0.051	0.05	0.08	Very Low	0.023	0.062	0.008	0.05	0.03	Very Low
30	Bululawang	0.01	0.062	0.085	0.04	0.12	Low	0.026	0.062	0.056	0.03	0.10	Very Low
31	Wajak	0.01	0.062	0.063	0.04	0.10	Very Low	0.036	0.062	0.063	0.02	0.12	Low
32	Tajinan	0.01	0.062	0.084	0.04	0.11	Low	0.021	0.062	0.000	0.03	0.04	Very Low
33	Turen	0.02	0.062	0.107	0.05	0.14	Moderate	0.046	0.062	0.068	0.03	0.12	Low
34	Dampit	0.02	0.062	0.118	0.03	0.17	Very High	0.050	0.062	0.084	0.02	0.14	Moderate
35	Sumbermanjing Wetan	0.02	0.062	0.074	0.04	0.12	Low	0.040	0.062	0.056	0.03	0.11	Very Low
36	Ampelgading	0.01	0.062	0.106	0.04	0.14	Moderate	0.024	0.062	0.070	0.02	0.12	Low
37	Tirtoyudo	0.01	0.062	0.118	0.04	0.15	High	0.027	0.062	0.077	0.03	0.12	Low
38	Pagelaran	0.01	0.062	0.118	0.04	0.15	High	0.028	0.062	0.110	0.02	0.16	High
Batu City													
39	Batu	0.17	0.250	0.025	0.05	0.39	Very High	0.17	0.062	0.035	0.03	0.23	Very High
40	Junrejo	0.09	0.250	0.020	0.05	0.31	Very High	0.09	0.062	0.035	0.03	0.16	Very High
41	Bumiaji	0.11	0.250	0.000	0.03	0.33	Very High	0.11	0.062	0.035	0.02	0.19	Very High

Note: Vp = Vulnerability based on Population Number
Vpd = Vulnerability based on Population Density
Vnp = Vulnerability based on Non-Piped Water Facility
Vhf = Vulnerability based on Health Facility
Vtotal = Summation of vulnerability to DHF in corresponding area

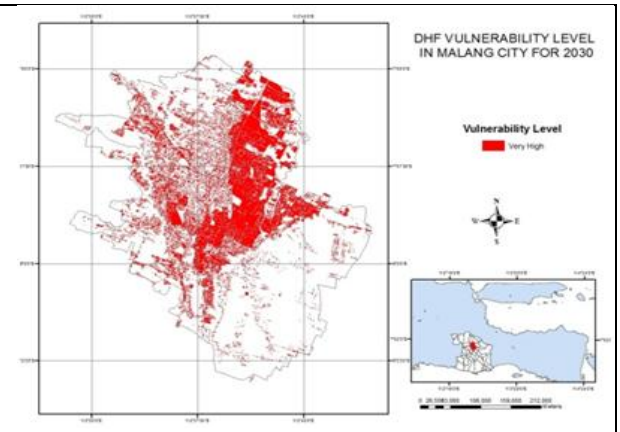
As can be seen from the table above, Malang City and Batu City are basically very vulnerable with regard to DHF incidence, i.e. varying with high and very high levels of vulnerability in baseline conditions and very high levels of vulnerability in projection conditions in all subdistricts. On the other hand, for Malang District, analysis for baseline condition shows that the levels of vulnerability vary quite significantly; i.e. eight subdistricts are classified at a very low level, seven subdistricts are classified at a low level, eight subdistricts are classified at a moderate level, seven subdistricts are classified at a high level, and only two subdistricts are classified as having a very high level of vulnerability to DHF. On the other hand, the projection suggests that Malang District will be less vulnerable; it has 21 subdistricts with a very low level of vulnerability and seven subdistricts with low-level. Concern should be addressed to subdistricts with high and very high levels of

vulnerability; i.e. Jabung (very high level) as well as Poncokusumo and Pagelaran (high level).

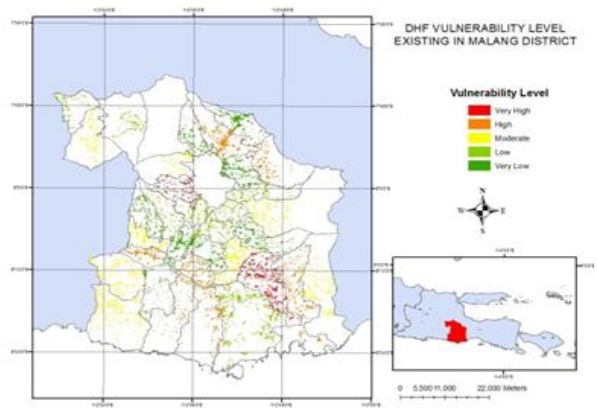
Figure 6.4 illustrates the result of the vulnerability analysis to DHF in Greater Malang for both baseline and projection conditions.



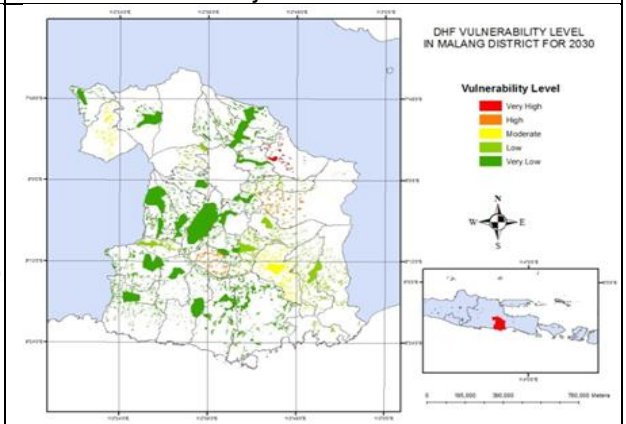
Vulnerability to DHF in Malang City – Baseline Period



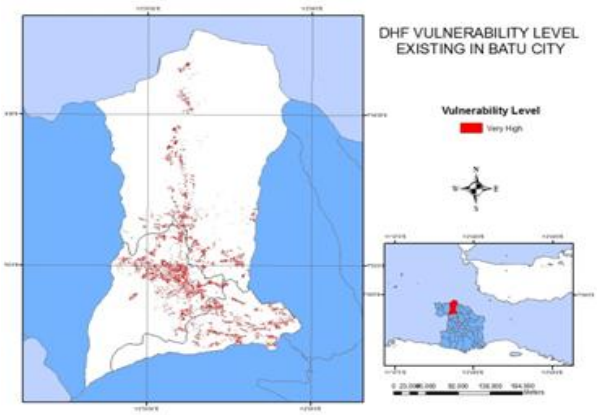
Vulnerability to DHF in Malang City – Projection Period



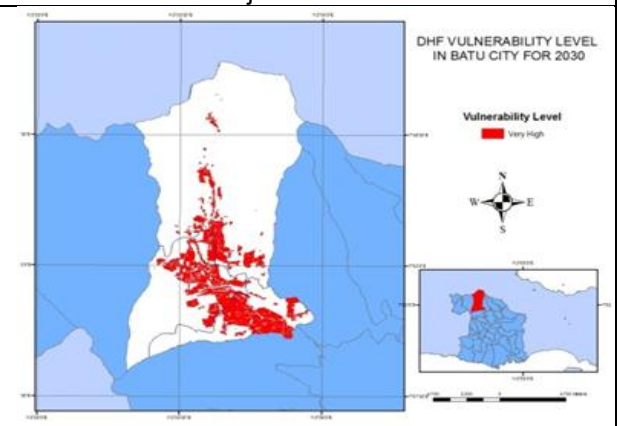
Vulnerability to DHF in Malang District – Baseline Period



Vulnerability to DHF in Malang District – Projection Period



Vulnerability to DHF in Batu City – Baseline Period



Vulnerability to DHF in Batu City – Projection Period

Figure 6.4 Map of Vulnerability to DHF in Greater Malang

6.2.2 Vulnerability Assessment of Malaria

Vulnerability analysis of malaria hazard is conducted in the subdistricts in Malang District which are vulnerable to incidence of malaria; i.e. considering population living near breeding sitea, numbers of housea near breeding sitea, numbers of non-permanent housing, and provision of health facilities. Table 6.5 below presents the result of the assessment of vulnerability to malaria in Malang District for both baseline and projection conditions.

Table 6.5 Vulnerability to Malaria in Malang District for both baseline and projection conditions

No	Sub Districts	Vulnerability in Baseline						Vulnerability in Projection					
		Vpb	Vhb	Vnp	Vhf	Vtotal	Level	Vpb	Vhb	Vnp	Vhf	Vtotal	Level
1	Tumpang	0.39	0.192	0.012	0.02	0.57	Moderate	0.38	0.286	0.005	0.02	0.66	High
2	Poncokusumo	0.42	0.215	0.028	0.02	0.64	Moderate	0.42	0.306	0.027	0.02	0.74	Very High
3	Jabung	0.29	0.128	0.050	0.02	0.45	Very Low	0.30	0.185	0.050	0.02	0.52	Low
4	Pakis	0.25	0.147	0.141	0.02	0.52	Low	0.26	0.193	0.141	0.02	0.58	Moderate
5	Lawang	0.28	0.146	0.141	0.03	0.54	Moderate	0.24	0.155	0.080	0.02	0.45	Very Low
6	Singosari	0.19	0.128	0.071	0.02	0.38	Very Low	0.16	0.144	0.006	0.02	0.30	Very Low
7	Karangploso	0.42	0.218	0.141	0.02	0.76	Very High	0.42	0.255	0.141	0.02	0.80	Very High
8	Dau	0.36	0.153	0.039	0.02	0.53	Low	0.38	0.260	0.013	0.02	0.63	Moderate
9	Pujon	0.34	0.150	0.000	0.03	0.46	Very Low	0.11	0.071	0.000	0.02	0.16	Very Low
10	Ngantang	0.47	0.222	0.000	0.02	0.67	High	0.47	0.346	0.000	0.02	0.80	Very High
11	Kasembon	0.42	0.198	0.141	0.03	0.73	High	0.34	0.225	0.016	0.03	0.55	Moderate
12	Kepanjen	0.11	0.059	0.141	0.03	0.29	Very Low	0.07	0.050	0.000	0.02	0.10	Very Low
13	Sumber Pucung	0.45	0.191	0.043	0.02	0.66	High	0.45	0.314	0.000	0.02	0.75	Very High
14	Kromengan	0.44	0.183	0.141	0.02	0.74	Very High	0.41	0.266	0.061	0.02	0.72	High
15	Pakisaji	0.18	0.088	0.093	0.02	0.34	Very Low	0.09	0.064	0.000	0.02	0.14	Very Low
16	Ngajum	0.43	0.194	0.107	0.02	0.71	High	0.38	0.260	0.000	0.02	0.62	Moderate
17	Wonosari	0.31	0.132	0.071	0.03	0.48	Low	0.23	0.156	0.000	0.02	0.37	Very Low
18	Wagir	0.25	0.151	0.141	0.02	0.53	Low	0.17	0.144	0.059	0.01	0.36	Very Low
19	Pagak	0.31	0.132	0.077	0.03	0.49	Low	0.22	0.149	0.000	0.02	0.35	Very Low
20	Donomulyo	0.43	0.168	0.141	0.02	0.71	High	0.38	0.263	0.074	0.02	0.70	High
21	Kalipare	0.39	0.176	0.054	0.03	0.60	Moderate	0.28	0.215	0.000	0.02	0.48	Low
22	Bantur	0.38	0.159	0.141	0.02	0.65	High	0.25	0.158	0.000	0.02	0.39	Very Low
23	Gedangan	0.44	0.214	0.141	0.02	0.77	Very High	0.41	0.301	0.000	0.02	0.69	High
24	Gondanglegi	0.37	0.181	0.064	0.03	0.58	Moderate	0.35	0.170	0.013	0.03	0.50	Low
25	Bululawang	0.14	0.067	0.067	0.02	0.26	Very Low	0.20	0.130	0.033	0.02	0.35	Very Low
26	Wajak	0.29	0.132	0.046	0.02	0.45	Very Low	0.29	0.213	0.045	0.02	0.53	Low
27	Tajinan	0.37	0.149	0.027	0.02	0.52	Low	0.33	0.202	0.000	0.02	0.51	Low
28	Turen	0.42	0.198	0.007	0.03	0.59	Moderate	0.39	0.275	0.000	0.02	0.65	High
29	Dampit	0.41	0.205	0.141	0.02	0.74	Very High	0.38	0.268	0.101	0.02	0.74	Very High
30	Sumbermanjing Wetan	0.40	0.194	0.025	0.02	0.60	Moderate	0.39	0.271	0.004	0.02	0.65	High
31	Ampelgading	0.45	0.189	0.141	0.02	0.76	Very High	0.42	0.270	0.098	0.02	0.77	Very High
32	Tirtoyudo	0.45	0.217	0.141	0.02	0.79	Very High	0.41	0.279	0.092	0.02	0.77	Very High
33	Pagelaran	0.47	0.240	0.141	0.02	0.83	Very High	0.47	0.380	0.132	0.02	0.96	Very High

Vpb = Vulnerability based on Population Near Breeding Site
Vhb = Vulnerability based on House Near Breeding Site
Vnp = Vulnerability based on Non Permanent Housing
Vhf = Vulnerability based on Health Facility
Vtotal = Summation of vulnerability to Malaria in corresponding area

From the table above, it can be seen that vulnerabilities to malaria hazard in Malang District vary both in baseline and projection conditions. In baseline conditions, seven subdistricts are considered to have a very low level of vulnerability, six subdistricts are considered as low level of vulnerability, seven subdistricts are considered as having a moderate level vulnerability, five subdistricts are considered as a high level of vulnerability, and seven subdistricts are considered to have a very high level of vulnerability.

On the other hand, in projection conditions, while numbers of subdistricts with a very low level of vulnerability increase into ten, the numbers of those with levels of vulnerability that are cause for concern also increase; i.e. six subdistricts with high-level of vulnerability and eight subdistricts with very high-level of vulnerability. The increase of vulnerability in the latter group is basically influenced by the factors of increased population as well as human settlements located near the breeding site.

The distribution of vulnerability for projection conditions (2030) in Malang District is given in Figure 6.5 below.

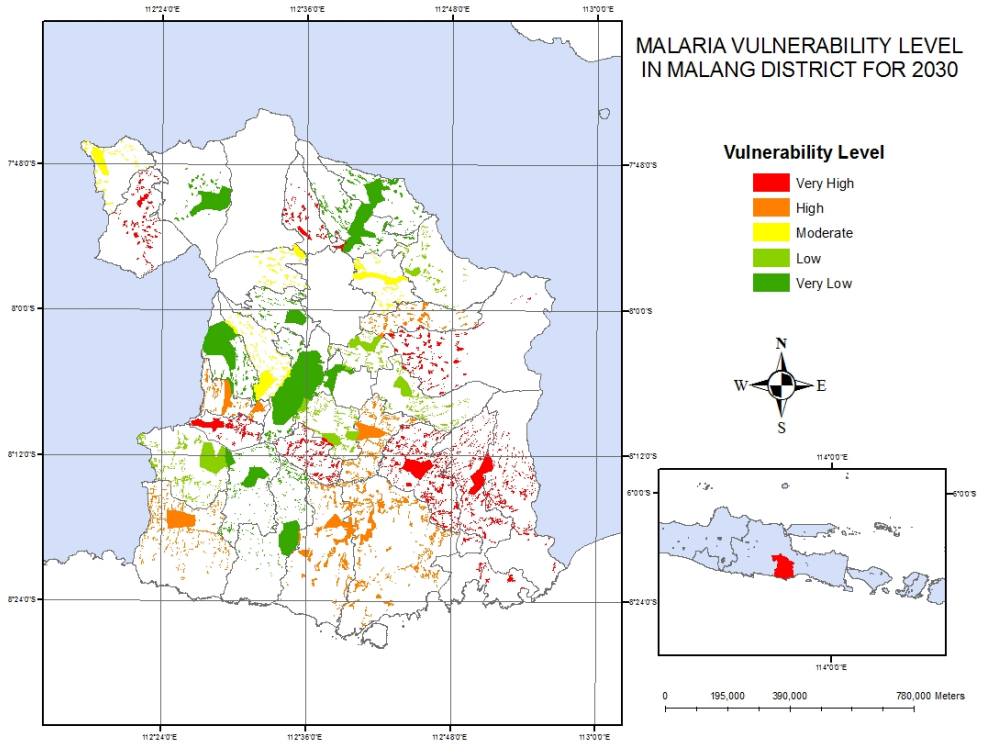


Figure 6.5 Projection of Vulnerability to Malaria in Malang District

6.2.3 Vulnerability Assessment of Diarrhea

Vulnerability to diarrhea hazard is analysed through consideration of factors as follows: total population, houses which are not equipped with a lavatory, piped water coverage, and existence of health facilities. Table 6.6 below presents the results of the vulnerability assessment for diarrhea in Malang City and Batu City both in baseline and projection conditionss.

Table 6.6 Vulnerability to Diarrhea in Malang City and Batu City

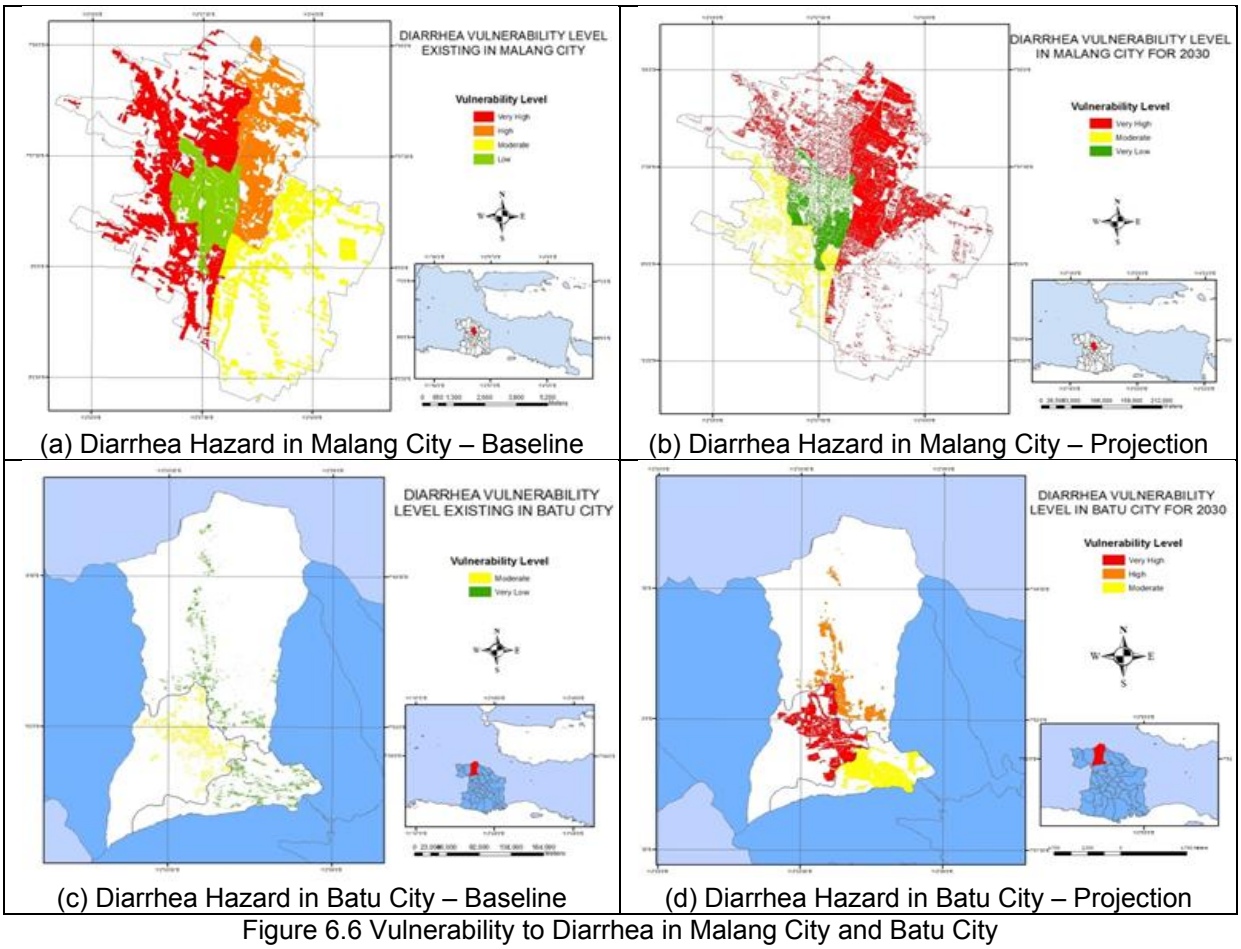
No	Sub Districts	Vulnerability in Baseline						Vulnerability in Projection					
		Vp	Vht	Vpw	Vhf	Vtotal	Level	Vp	Vht	Vpw	Vhf	Vtotal	Level
Malang City													
1	Kedung Kandang	0.056	0.006	0.070	0.03	0.10	Moderate	0.075	0.120	0.140	0.03	0.31	Very High
2	Sukun	0.060	0.006	0.130	0.04	0.15	Very High	0.053	0	0.093	0.04	0.11	Moderate
3	Klojen	0.043	0.005	0.098	0.10	0.04	Low	0.028	0	0.086	0.12	0.00	Very Low
4	Blimbing	0.059	0.005	0.117	0.06	0.12	High	0.051	0.083	0.150	0.05	0.23	Very High
5	Lowok Waru	0.062	0.005	0.117	0.04	0.14	Very High	0.074	0	0.114	0.03	0.15	Very High
Batu City													
6	Batu	0.131	0.000	0.046	0.07	0.11	Moderate	0.128	0	0.065	0.05	0.14	Very High

No	Sub Districts	Vulnerability in Baseline						Vulnerability in Projection					
		Vp	Vht	Vpw	Vhf	Vtotal	Level	Vp	Vht	Vpw	Vhf	Vtotal	Level
7	Junrejo	0.066	0.000	0.036	0.06	0.04	Very Low	0.070	0	0.065	0.04	0.09	Moderate
9	Bumiaji	0.083	0.000	0.001	0.04	0.04	Very Low	0.081	0	0.065	0.03	0.11	High

Vp = Vulnerability based on Population Number
Vht = Vulnerability based on House without Toilet
Vpw = Vulnerability based on Piped Water Coverage
Vhf = Vulnerability based on Health Facility
Vtotal = Summation of vulnerability to Diarrhea in corresponding area

For Malang City, it can be seen that more subdistricts will have worse vulnerability to diarrhea; i.e. for Kedungkandang, Blimbing, and Lowok Waru, which are classified as very high level in the future. Basically, the vulnerability level in these subdistricts is greatly affected by the projection of higher population and lack of piped water coverage in the respective subdistricts. Furthermore, subdistricts in Batu City will have even higher vulnerability to diarrhea in the future; i.e. Batu subdistrict with very high level of vulnerability, Junrejo with moderate level, and Bumiaji with high-level.

Figure 6.6 below presents the distribution of vulnerability to diarrhea in Malang and Batu City.



(a) Diarrhea Hazard in Malang City – Baseline
(b) Diarrhea Hazard in Malang City – Projection
(c) Diarrhea Hazard in Batu City – Baseline
(d) Diarrhea Hazard in Batu City – Projection

Figure 6.6 Vulnerability to Diarrhea in Malang City and Batu City

6.3 Risk Analysis

6.3.1 Risk Assessment of DHF

Based on the results of hazard and vulnerability, risk levels can be assessed for DHF in Greater Malang. Table 6.7 below presents the results of the risk analysis for DHF both in baseline and projection conditions. Attention should be given to the risk level in each area in the projection timeframe.

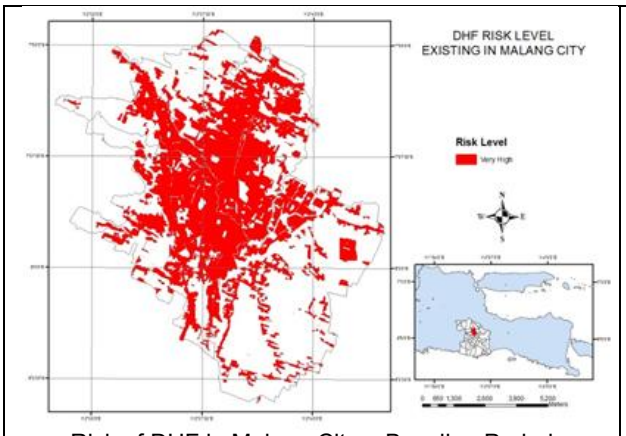
Table 6.7 Risk Level of DHF in Greater Malang

No	Sub Districts	Baseline Condition					Projection Condition				
		Hazard		Vulnerability		Risk Level	Hazard		Vulnerability		Risk Level
		Average Prevalence	Level	Score	Level		Average Prevalence	Level	Score	Level	
Malang City											
1	Kedung Kandang	0.532	High	0.21	Very High	High	0.4	Moderate	0.44	Very High	High
2	Sukun	0.707	Very High	0.37	Very High	Very High	1.0	Very High	0.37	Very High	Very High
3	Klojen	1.125	Very High	0.16	High	Very High	2.4	Very High	0.24	Very High	Very High
4	Blimbing	0.601	Very High	0.22	Very High	Very High	0.9	Very High	0.24	Very High	Very High
5	Lowok Waru	0.696	Very High	0.24	Very High	Very High	0.9	Very High	0.42	Very High	Very High
Malang District											
6	Tumpang	0.453	High	0.12	Low	High	0.5	High	0.13	Low	Moderate
7	Poncokusumo	0.089	Very Low	0.15	Moderate	Very Low	0.1	Very Low	0.16	High	Low
8	Jabung	0.107	Very Low	0.15	High	Very Low	0.2	Very Low	0.22	Very High	Moderate
9	Pakis	0.561	High	0.11	Very Low	High	1.0	Very High	0.11	Very Low	Moderate
10	Lawang	0.185	Low	0.07	Very Low	Low	0.2	Very Low	0.04	Very Low	Very Low
11	Singosari	0.185	Low	0.15	High	Low	0.2	Low	0.10	Very Low	Very Low
12	Karangploso	0.325	Moderate	0.08	Very Low	Moderate	0.6	Very High	0.08	Very Low	Moderate
13	Dau	0.803	Very High	0.13	Moderate	Very High	0.5	High	0.13	Low	Moderate
14	Pujon	0.026	Very Low	0.13	Low	Very Low	0.0	Very Low	0.04	Very Low	Very Low
15	Ngantang	0.075	Very Low	0.14	Moderate	Very Low	0.1	Very Low	0.14	Moderate	Low
16	Kasembon	0.032	Very Low	0.12	Low	Very Low	0.1	Very Low	0.04	Very Low	Very Low
17	Kepanjen	0.358	Moderate	0.10	Very Low	Moderate	0.4	Moderate	0.04	Very Low	Low
18	Sumber Pucung	0.690	Very High	0.15	High	Very High	0.4	Moderate	0.11	Low	Low
19	Kromengan	0.270	Low	0.15	Moderate	Low	0.2	Low	0.09	Very Low	Very Low
20	Pakisaji	0.572	High	0.12	Low	High	0.4	Moderate	0.05	Very Low	Low
21	Ngajum	0.180	Low	0.13	Low	Low	0.1	Very Low	0.04	Very Low	Very Low
22	Wonosari	0.167	Low	0.03	Very Low	Low	0.1	Very Low	0.04	Very Low	Very Low
23	Wagir	0.276	Moderate	0.16	Very High	Moderate	0.2	Low	0.10	Very Low	Very Low
24	Pagak	0.550	High	0.06	Very Low	High	0.4	Moderate	0.04	Very Low	Low
25	Donomulyo	0.245	Low	0.14	Moderate	Low	0.2	Very Low	0.10	Very Low	Very Low
26	Kalipare	0.317	Moderate	0.13	Moderate	Moderate	0.2	Low	0.06	Very Low	Very Low
27	Bantur	0.569	High	0.15	High	High	0.3	Moderate	0.04	Very Low	Low
28	Gedangan	0.266	Low	0.15	High	Low	0.2	Low	0.05	Very Low	Very Low
29	Gondanglegi	0.477	High	0.08	Very Low	High	0.9	Very High	0.03	Very Low	Moderate
30	Bululawang	0.571	High	0.12	Low	High	0.4	Moderate	0.10	Very Low	Low
31	Wajak	0.384	Moderate	0.10	Very Low	Moderate	0.2	Low	0.12	Low	Low
32	Tajinan	0.308	Moderate	0.11	Low	Moderate	0.2	Low	0.04	Very Low	Very Low
33	Turen	0.705	Very	0.14	Moderate	Very	0.7	Very	0.12	Low	High

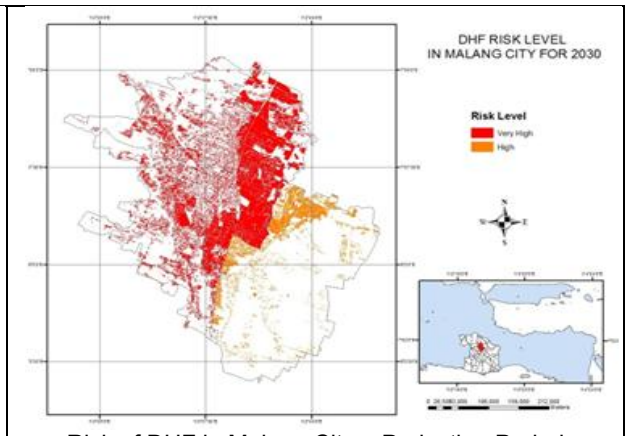
No	Sub Districts	Baseline Condition					Projection Condition				
		Hazard		Vulnerability		Risk Level	Hazard		Vulnerability		Risk Level
		Average Prevalence	Level	Score	Level		Average Prevalence	Level	Score	Level	
			High			High		High			
34	Dampit	0.277	Moderate	0.17	Very High	Moderate	0.2	Low	0.14	Moderate	Low
35	Sumbermanjing Wetan	0.289	Moderate	0.12	Low	Moderate	0.2	Very Low	0.11	Very Low	Very Low
36	Ampelgading	0.096	Very Low	0.14	Moderate	Very Low	0.1	Very Low	0.12	Low	Very Low
37	Tirtoyudo	0.080	Very Low	0.15	High	Very Low	0.1	Very Low	0.12	Low	Very Low
38	Pagelaran	0.175	Low	0.15	High	Low	0.1	Very Low	0.16	High	Low
Batu City											
39	Batu	0.592	Very High	0.39	Very High	Very High	2.4	Very High	0.23	Very High	Very High
40	Junrejo	0.692	Very High	0.31	Very High	Very High	1.3	Very High	0.16	Very High	Very High
41	Bumiaji	0.109	Very Low	0.33	Very High	Very Low	0.4	Moderate	0.19	Very High	High

Note: Average prevalance indicated for each 1,000 population.

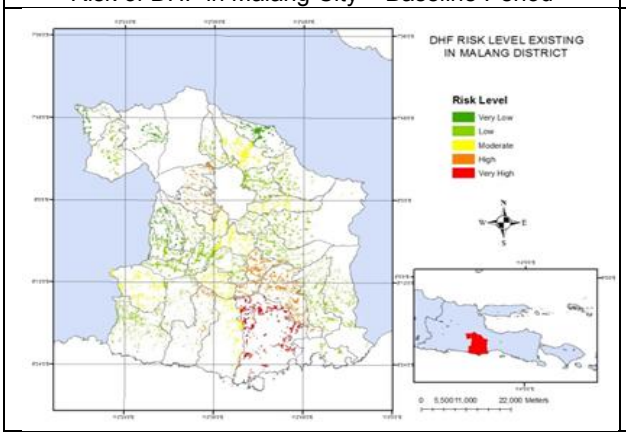
From the table above, it can be seen that, in general, Malang City and Batu City anticipate a greater risk of DHF in comparison to that of Malang District. All subdistricts in Malang City and Batu City are classifed to have a very high level of DHF risk in the future, except for Kedungkandang in Malang City (high level of risk), due to the high prevalence of DHF and high level of population density in those subdistricts. Meanwhile, the risk in Malang District is basically less cause for concern; i.e. 15 subdistricts are classifed to have a very low level of risk to DHF incidences, 11 with low-level of risk, six subdistricts a have moderate level of risk, and only one subdistrict has a high-level of risk of DHF. Distribution of DHF risk in each area can be seen in the figure below.

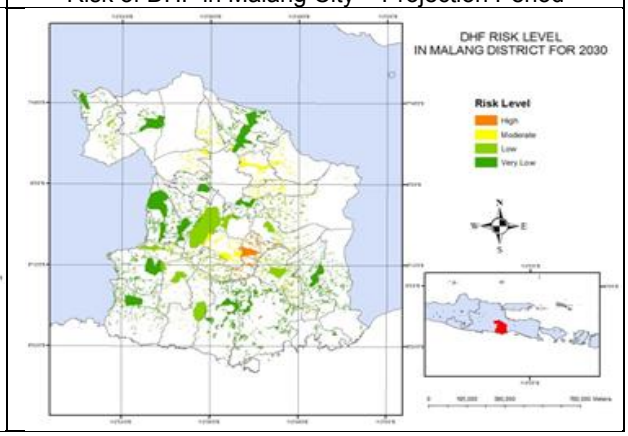


Risk of DHF in Malang City – Baseline Period



Risk of DHF in Malang City – Projection Period





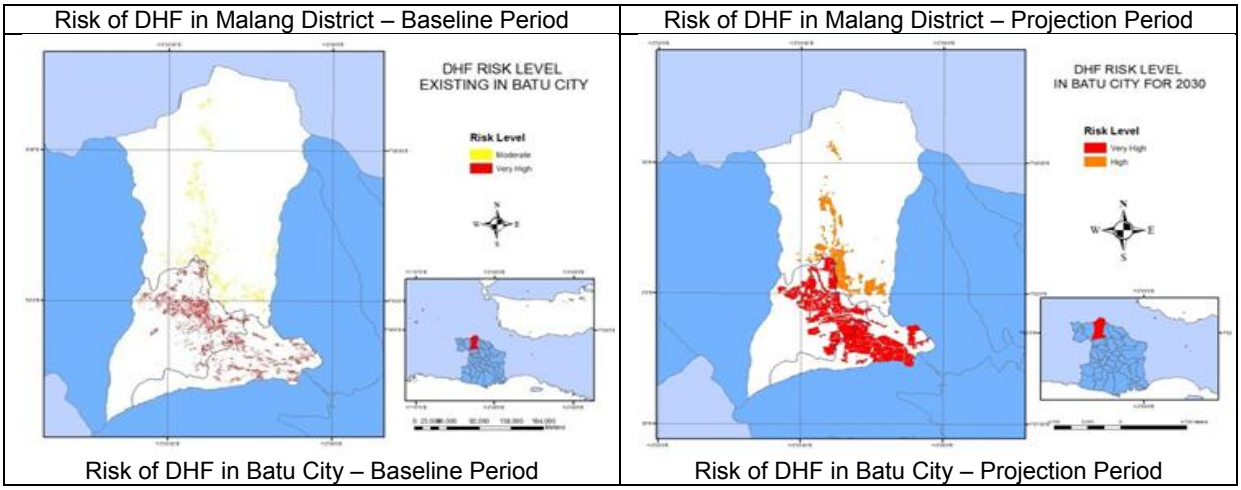


Figure 6.7 DHF Risk in Greater Malang

6.3.2 Risk Assessment of Malaria

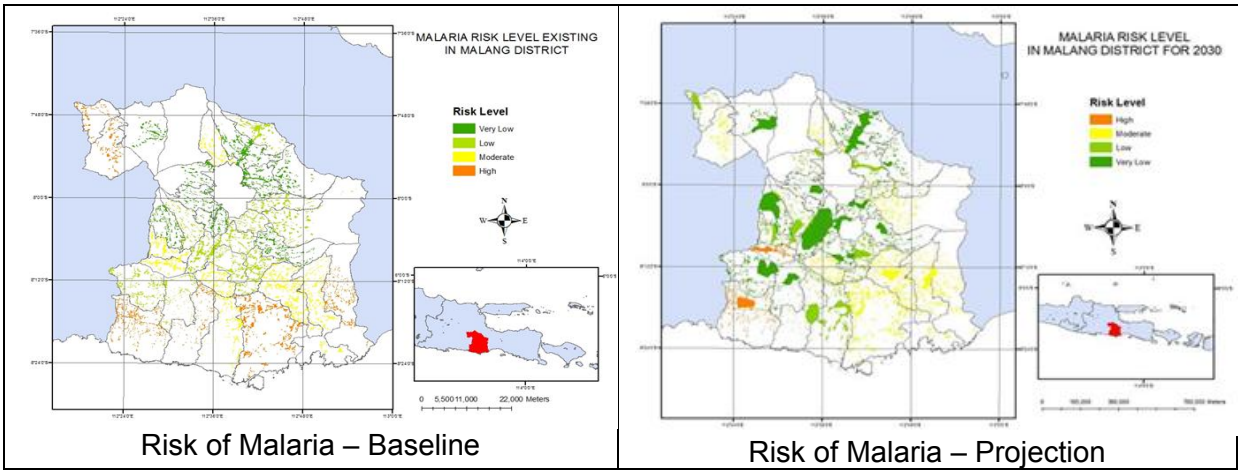
The risk of malaria is only analysed for Malang District in accordance with the results of the hazard and vulnerability assessments. Table 6.8 below presents the results of the risk assessment for malaria in Malang District for both baseline and projection conditions.

Table 6.8 Risk Level of Malaria in Malang District

No	Sub Districts	Baseline Condition					Projection Condition				
		Hazard		Vulnerability		Risk Level	Hazard		Vulnerability		Risk Level
		Average prevalence / 1,000 Population	Level	Score	Level		Average prevalence / 1,000 Population	Level	Score	Level	
1	Tumpang	0.000	Very Low	0.57	Moderate	Low	0.00	Very Low	0.66	High	Low
2	Poncokusumo	0.011	Very Low	0.64	Moderate	Low	0.00	Very Low	0.74	Very High	Moderate
3	Jabung	0.000	Very Low	0.45	Very Low	Very Low	0.00	Very Low	0.52	Low	Very Low
4	Pakis	0.015	Very Low	0.52	Low	Very Low	0.00	Very Low	0.58	Moderate	Low
5	Lawang	0.000	Very Low	0.54	Moderate	Low	0.00	Very Low	0.45	Very Low	Very Low
6	Singosari	0.000	Very Low	0.38	Very Low	Very Low	0.00	Very Low	0.30	Very Low	Very Low
7	Karangploso	0.000	Very Low	0.76	Very High	Moderate	0.00	Very Low	0.80	Very High	Moderate
8	Dau	0.000	Very Low	0.53	Low	Very Low	0.00	Very Low	0.63	Moderate	Low
9	Pujon	0.021	Low	0.46	Very Low	Very Low	0.00	Very Low	0.16	Very Low	Very Low
10	Ngantang	0.038	Moderate	0.67	High	High	0.00	Very Low	0.80	Very High	Moderate
11	Kasembon	0.095	Moderate	0.73	High	High	0.00	Very Low	0.55	Moderate	Low
12	Kepanjen	0.022	Low	0.29	Very Low	Low	0.00	Very Low	0.10	Very Low	Very Low
13	Sumber Pucung	0.214	Moderate	0.66	High	High	0.04	Moderate	0.75	Very High	High
14	Kromengan	0.000	Very Low	0.74	Very High	Moderate	0.00	Very Low	0.72	High	Low
15	Pakisaji	0.000	Very Low	0.34	Very Low	Very Low	0.00	Very Low	0.14	Very Low	Very Low
16	Ngajum	0.000	Very Low	0.71	High	Low	0.00	Very Low	0.62	Moderate	Low
17	Wonosari	0.000	Very Low	0.48	Low	Very Low	0.00	Very Low	0.37	Very Low	Very Low
18	Wagir	0.000	Very Low	0.53	Low	Very Low	0.00	Very Low	0.36	Very Low	Very Low
19	Pagak	0.029	Low	0.49	Low	Low	0.00	Very Low	0.35	Very Low	Very Low
20	Donomulyo	0.070	Moderate	0.71	High	High	0.07	Moderate	0.70	High	High
21	Kalipare	0.000	Very Low	0.60	Moderate	Low	0.00	Very Low	0.48	Low	Very Low
22	Bantur	0.074	Moderate	0.65	High	High	0.09	Moderate	0.39	Very Low	Low
23	Gedangan	0.000	Very Low	0.77	Very High	Moderate	0.00	Very Low	0.69	High	Low
24	Gondanglegi	0.011	Very Low	0.58	Moderate	Low	0.00	Very Low	0.50	Low	Very Low

No	Sub Districts	Baseline Condition					Projection Condition				
		Hazard		Vulnerability		Risk Level	Hazard		Vulnerability		Risk Level
		Average prevalence / 1,000 Population	Level	Score	Level		Average prevalence / 1,000 Population	Level	Score	Level	
25	Bululawang	0.046	Moderate	0.26	Very Low	Low	0.01	Very Low	0.35	Very Low	Very Low
26	Wajak	0.000	Very Low	0.45	Very Low	Very Low	0.00	Very Low	0.53	Low	Very Low
27	Tajinan	0.028	Low	0.52	Low	Low	0.00	Very Low	0.51	Low	Very Low
28	Turen	0.030	Low	0.59	Moderate	Low	0.01	Very Low	0.65	High	Low
29	Dampit	0.011	Very Low	0.74	Very High	Moderate	0.00	Very Low	0.74	Very High	Moderate
30	Sumbermanjing Wetan	0.081	Moderate	0.60	Moderate	Moderate	0.02	Low	0.65	High	Moderate
31	Ampelgading	0.024	Low	0.76	Very High	High	0.00	Very Low	0.77	Very High	Moderate
32	Tirtoyudo	0.015	Very Low	0.79	Very High	Moderate	0.00	Very Low	0.77	Very High	Moderate
33	Pagelaran	0.000	Very Low	0.83	Very High	Moderate	0.00	Very Low	0.96	Very High	Moderate

In general, the risks of malaria in Malang District is less cause for concern both in the baseline and projection conditions, which are indicated by either very low or low levels of risk experienced by two-thirds of the subdistricts; i.e. 9 subdistricts with a very low level of risk and 11 with low-level of risk in the baseline conditions, as well as 14 subdistricts with very low level of risk and 9 with low-level of risk in the projection situation. In addition, numbers of subdistricts having a high-level of risk also decrease, from six subdistricts in the baseline conditions to only two subdistricts in the projection conditions (Sumberpucung and Donomulyo). Some vulnerability components greatly affect the risk level for the two subdistricts: low health facility coverage in Sumberpucung and a large proportion of non-permanent housing in Donomulyo. These factors are insight that can be addressed in adaptation responses. Figure 6.8 below describes the distribution of risk of malaria in Malang District.



Risk of Malaria – Baseline | Risk of Malaria – Projection

Figure 6.8 Risk of Malaria in Malang District

6.3.3 Risk Assessment of Diarrhea

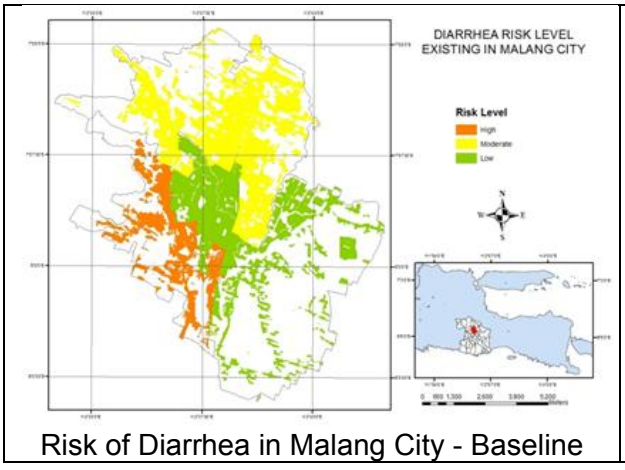
Based on the results of hazard and vulnerability assessments, risk levels of diarrhea in Malang City and Batu City are assessed. Table 6.9 below presents the result of risk to DHF both in baseline and projection conditions. Consideration should be addressed to risk level in each area the in projection condition.

As it can be seen, the risk of diarrhea in Malang City is relatively moderate, which one subdistrict has low level of risk, three subdistricts are classified in moderate level of risk, and only one subdistrict is projected to have high level of risk in diarrhea, i.e. Blimbing subdistrict. Risk level in Blimbing turns out to be high due to vulnerability factor of low coverage of piped water.

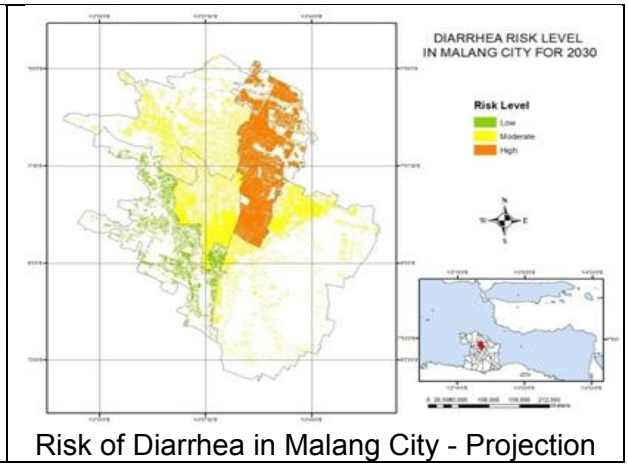
Table 6.9 Risk Level of Diarrhea in Malang City and Batu City

No	Sub District	Hazard		Vulnerability		Risk Level	Hazard		Vulnerability		Risk Level
		Average Prevalence / 1,000 Population	Level	Score	Level		Average Prevalence / 1,000 Population	Level	Score	Level	
Malang City											
1	Kedung Kandang	12.312	Very Low	0.10	Moderate	Low	7.18	Very Low	0.31	Very High	Moderate
2	Sukun	22.153	Moderate	0.15	Very High	High	19.73	Low	0.11	Moderate	Low
3	Klojen	20.267	Moderate	0.04	Low	Low	35.10	Very High	0.00	Very Low	Moderate
4	Blimbing	17.572	Low	0.12	High	Moderate	18.16	Low	0.23	Very High	High
5	Lowok Waru	13.921	Very Low	0.14	Very High	Moderate	9.18	Very Low	0.15	Very High	Moderate
Batu City											
6	Batu	22.580	High	0.11	Moderate	High	66.35	Very High	0.14	Very High	Very High
7	Junrejo	50.796	Very High	0.04	Very Low	Moderate	101.83	Very High	0.09	Moderate	High
8	Bumiaji	40.276	Very High	0.04	Very Low	Moderate	69.19	Very High	0.11	High	Very High

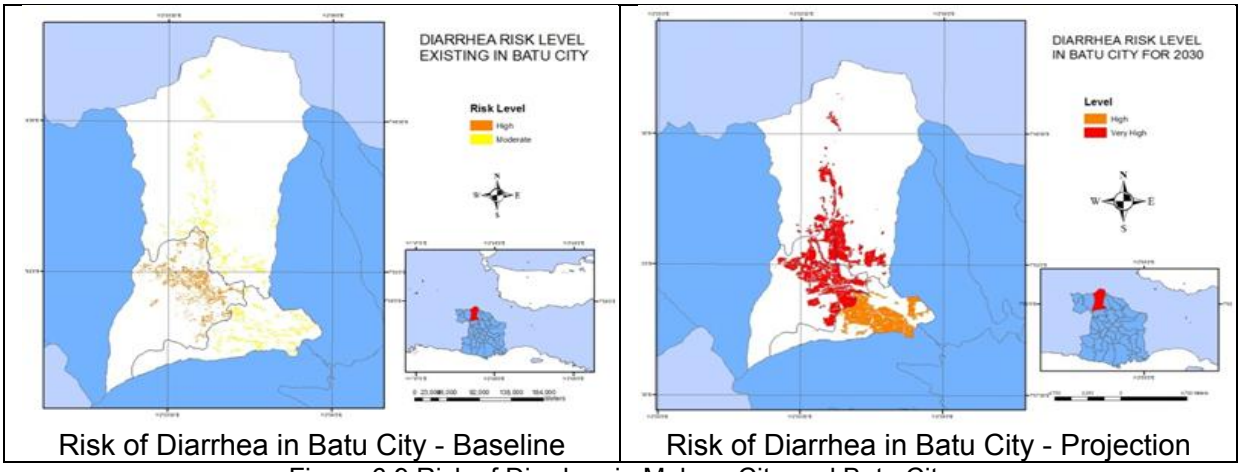
On the other hand, risk of diarrhea in Batu City is more concerning in comparison to one in Malang City. In projection condition, Batu and Bumiaji subdistricts will have very high risks of diarrhea and Junrejo subdistrict will have high level of risk. Different with the case of Malang City, the risk in Batu City is basically caused by combination of very high level of hazard (diarrhea prevalence) and very high level of vulnerability in projection condition.
Figure 6.9 below provides the risk map of diarrhea in Malang City and Batu City, for both baseline and projection conditions.



Risk of Diarrhea in Malang City - Baseline



Risk of Diarrhea in Malang City - Projection



Risk of Diarrhea in Batu City - Baseline | Risk of Diarrhea in Batu City - Projection

Figure 6.9 Risk of Diarrhea in Malang City and Batu City

6.4 Adaptation Option

Adaptation option for Greater Malang in health sector is being formulated under three main principles; i.e. 1) Adaptation in health sector requires a policy switches from curative dominance to preventive and promotive activity in the long run, 2) Health sector should not be working alone in tackling the situation especially those related to or affected by climate changes, and 3) Policy shift in the future may see effort for less short-term (2010-2020) mitigation type of activity and more of a long term (2030-2050) adaptation approach.

In general those diseases that are exacerbated by climate change, i.e. DHF, malaria, and diarrhea, can be effectively prevented with adequate financial and human resources, includes training, surveillance and emergency response, prevention, and control programmes. Adaptation enhances population's coping ability and provides protection against current and future climatic variabilities. In general, adaptation strategy consists of two major components, which are proactive strategy that deals with the reduction of climate change effect and reactive strategy that deals with enhancement of community strength toward disease incidences. In addition, the adaptation programme is adjusted according to the risk level and the onset of action of each programme.

Adaptation strategies in health sector are divided to four categories, which are developed according to its priority. Those categories are as follows:

a) First priority: Areas with high risk due to high level of hazard and vulnerability
   For areas with such criteria, the first attention should be given is the management of hazard against dengue, malaria and diarrhea. Afterwards, the next step is to provide improve environmental quality, provision of save water supply, sanitation, and health facility.
b) Second priority: Areas with high risk due to high level of hazard
   Second priority is for areas with high level of hazard but has low level of vulnerability. For areas with such conditions, management of hazard for each disease should be implemented through prevention and treatment. Afterwards, programme should be continued through environmental management such as improvement of clean water supply, sanitation, and clean-healthy environment.
c) Third priority: Areas with high risk due to high level of vulnerability
   For areas with this character, management of vulnerability is the main consideration, such as development of healthier environment, save water supply, and environmental sanitation, thus management of slum areas and deurbanization should be integrated. The improvement of quality and access to health facilities should also be prioritized and adjusted to the real necessity of the community. For rural areas, improvement to the access to health facilities may be tackled by either reducing the cost of health services cost or by providing public transport facility for better access.

d) Fourth priority: Areas with low risk due to low level of hazard and vulnerability
For areas with condition suits this category, the main task is to preserve the environment in healthy condition. Campaign and community education to prevent dengue, malaria, and diarrhea are also important.

6.4.1 Adaptation Option of DHF

Adaptation option for combating DHF threat is developed for each type of priority area. The priority level thus is assigned for each subdistrict in Greater Malang by considering level of hazard, vulnerability, and risk. Table 6.10 below presents the classification of priority for each subdistrict.

Table 6.10 Categorization of Adaptation Strategy Priority of DHF in Greater Malang

No	Sub Districts	Hazard			Vulnerability			Risk			Category for Adaptation Strategy
		2008	2030	Comp.	2008	2030	Comp.	2008	2030	Comp.	
Malang City											
1	Kedung Kandang	H	M	-1	VH	VH	0	VH	H	-1	A
2	Sukun	VH	VH	0	VH	VH	0	VH	VH	0	A
3	Klojen	VH	VH	0	H	VH	+1	VH	VH	0	A
4	Blimbing	VH	VH	0	VH	VH	0	VH	VH	0	A
5	Lowok Waru	VH	VH	0	VH	VH	0	VH	VH	0	A
Malang District											
6	Tumpang	H	H	0	L	L	0	H	M	-1	B
7	Poncokusumo	VL	VL	0	M	H	+1	VL	L	+1	C
8	Jabung	VL	VL	0	H	VH	+1	VL	M	+2	C
9	Pakis	H	VH	+1	VL	VL	0	H	M	-1	B
10	Lawang	L	VL	-1	VL	VL	0	L	VL	-1	D
11	Singosari	L	L	0	H	VL	-3	L	VL	-1	C
12	Karangploso	M	VH	+2	VL	VL	0	M	M	0	B
13	Dau	VH	H	-1	M	L	-1	VH	M	-2	B
14	Pujon	VL	VL	0	L	VL	-1	VL	VL	0	D
15	Ngantang	VL	VL	0	M	M	0	VL	L	+1	D
16	Kasembon	VL	VL	0	L	VL	-1	VL	VL	0	D
17	Kepanjen	M	M	0	VL	VL	0	M	L	-1	D
18	Sumber Pucung	VH	M	-2	H	L	-2	VH	L	-3	A
19	Kromengan	L	L	0	M	VL	-2	L	VL	-1	C
20	Pakisaji	H	M	-1	L	VL	-1	H	L	-2	B
21	Ngajum	L	VL	-1	L	VL	-1	L	VL	-1	D
22	Wonosari	L	VL	-1	VL	VL	0	L	VL	-1	D
23	Wagir	M	L	-1	VH	VL	-4	M	VL	-2	C
24	Pagak	H	M	-1	VL	VL	0	H	L	-2	B
25	Donomulyo	L	VL	-1	M	VL	-2	L	VL	-1	D
26	Kalipare	M	L	-1	M	VL	-2	M	VL	-2	D
27	Bantur	H	M	-1	H	VL	-3	H	L	-2	A
28	Gedangan	L	L	0	H	VL	-3	L	VL	-1	C
29	Gondanglegi	H	VH	+1	VL	VL	0	H	M	-1	B
30	Bululawang	H	M	-1	L	VL	-1	H	L	-2	B
31	Wajak	M	L	-1	VL	L	+1	M	L	-1	D
32	Tajinan	M	L	-1	L	VL	-1	M	VL	-2	D
33	Turen	VH	VH	0	M	L	-1	VH	H	-1	B
34	Dampit	M	L	-1	VH	M	-2	M	L	-1	C
35	Sumbermanjing Wetan	M	VL	-2	L	VL	-1	M	VL	-2	D
36	Ampelgading	VL	VL	0	M	L	-1	VL	VL	0	D
37	Tirtoyudo	VL	VL	0	H	L	-2	VL	VL	0	C
38	Pagelaran	L	VL	-1	H	H	0	L	L	0	C
Batu City											
39	Batu	VH	VH	0	VH	VH	0	VH	VH	0	A
40	Junrejo	VH	VH	0	VH	VH	0	VH	VH	0	A

No	Sub Districts	Hazard			Vulnerability			Risk			Category for Adaptation Strategy
		2008	2030	Comp.	2008	2030	Comp.	2008	2030	Comp.	
41	Bumiaji	VL	M	+2	VH	VH	0	VL	H	+3	C

Note: Comp.= comparison

Afterwads, the specific adaptation strategy for DHF in each category thus is formulated with the summary as follows:

Table 6.11 Adaptation Strategy for DHF for Each Category in Greater Malang

Category / Location (Subdistrict)	**Adaptation Strategy**
(A) First priority area: high risk due to it high level hazard and vulnerability. Location All subdistricts in Malang City Batu City: Batu and Junrejo Malang District: Sumber Pucung and Bantur	Mosquito source reduction Community and village level of vector management (pesticide fogging programme at high incidence and specific locations) Vaccination on vulnerable population (still on trial) Whole hospital and Puskesmas emergency alert Increased Routine surveillance of DHF Improvement of housing condition Better piped-water supply and covered water storage Control of population density Development of early warning method based on meteorogical surveillance
(B) Second priority area: area with high level of hazard but low level of vulnerability Location Malang District: Tumpang, Pakis, Karangploso, Dau, Pakisaji, Pagak, Gondanglegi, Bululawang, and Turen	Mosquito source reduction Community and village level of vector management (pesticide fogging programme at high incidence and specific locations) Vaccination on vulnerable population (still on trial) Whole hospital and Puskesmas emergency alert Increased Routine surveillance of DHF
(C) Third priority area: area with high level of vulnerability but low level of hazard Location Batu City: Bumiaji Malang District: Poncokusumo, Jabung, Singosari, Kromengan, Wagir, Gedangan, Dampit, Tirtoyudo, Pagelaran	Improvement of housing condition Better water supply and covered water storage Control of population density Development of early warning method based on meteorogical surveillance
(D) Last priority area: area with low level of hazard and vulnerability Location Malang District: Lawang, Pujon, Ngantang, Kasembon, Kepanjen, Ngajum, Wonosari, Donomulyo, Kalipare, Wajak, Tajinan, Sumbermanjing Wetan, and Ampelgading	Household level of vector management (Abate, spray cans, mosquito coils, repellents etc.) Routine yearly seasonal spraying Community awareness programme Routine implementation of 3M Plus programme Non-Routine, sentinel surveillance of DHF Individual patient treatment

6.4.2 Adaptation Option of Malaria

Similar with DHF, adaptation option for combating malaria threat is developed for each type of priority area. The priority level is thus assigned for each subdistrict in Malang District by considering level of hazard, vulnerability, and risk. Table 6.12 below presents the classification of priority for each subdistrict.

Table 6.12 Categorization of Adaptation Strategy Priority of Malaria in Malang District

No	Sub Districts	Hazard			Vulnerability			Risk			Category for Adaptation Strategy
		2008	2030	Comp.	2008	2030	Comp.	2008	2030	Comp.	
1	Tumpang	VL	VL	0	M	H	+1	L	L	0	C
2	Poncokusumo	VL	VL	0	M	VH	+2	L	M	+1	C
3	Jabung	VL	VL	0	VL	L	+1	VL	VL	0	D
4	Pakis	VL	VL	0	L	M	+1	VL	L	+1	D
5	Lawang	VL	VL	0	M	VL	-2	L	VL	-1	D
6	Singosari	VL	VL	0	VL	VL	0	VL	VL	0	C
7	Karangploso	VL	VL	0	VH	VH	0	M	M	0	C
8	Dau	VL	VL	0	L	M	+1	VL	L	+1	D
9	Pujon	L	VL	-1	VL	VL	0	VL	VL	0	D
10	Ngantang	M	VL	-2	H	VH	+1	H	M	-1	C
11	Kasembon	M	VL	-2	H	M	-1	H	L	-2	C
12	Kepanjen	L	VL	-1	VL	VL	0	L	VL	-1	D
13	Sumber Pucung	M	M	0	H	VH	+1	H	H	0	C
14	Kromengan	VL	VL	0	VH	H	-1	M	L	-1	C
15	Pakisaji	VL	VL	0	VL	VL	0	VL	VL	0	D
16	Ngajum	VL	VL	0	H	M	-1	L	L	0	C
17	Wonosari	VL	VL	0	L	VL	-1	VL	VL	0	D
18	Wagir	VL	VL	0	L	VL	-1	VL	VL	0	D
19	Pagak	L	VL	-1	L	VL	-1	L	VL	-1	D
20	Donomulyo	M	M	0	H	H	0	H	H	0	C
21	Kalipare	VL	VL	0	M	L	-1	L	VL	-1	D
22	Bantur	M	M	0	H	VL	-3	H	L	-2	C
23	Gedangan	VL	VL	0	VH	H	-1	M	L	-1	C
24	Gondanglegi	VL	VL	0	M	L	-1	L	VL	-1	D
25	Bululawang	M	VL	-2	VL	VL	0	L	VL	-1	D
26	Wajak	VL	VL	0	VL	L	+1	VL	VL	0	D
27	Tajinan	L	VL	-1	L	L	0	L	VL	-1	D
28	Turen	L	VL	-1	M	H	+1	L	L	0	C
29	Dampit	VL	VL	0	VH	VH	0	M	M	0	C
30	Sumbermanjing Wetan	M	L	-1	M	H	+1	M	M	0	C
31	Ampelgading	L	VL	-1	VH	VH	0	H	M	-1	C
32	Tirtoyudo	VL	VL	0	VH	VH	0	M	M	0	C
33	Pagelaran	VL	VL	0	VH	VH	0	M	M	0	C

Note: Comp = comparison, Adap Str. = adaptation strategy category

From the classification in Table 6.12 above, it can be seen that, for malaria case, subdistricts are basically only classified into Category C and D. Therefore, the formulation of adaptation strategies for combating malaria in Malang District are as follows:

Table 6.13 Adaptation Strategy for Malaria for Each Category in Malang District

Category / Location	**Adaptation Strategy**
(C) Third priority area: area that has high vulnerability but low hazard Location Malang District: Tumpang, Poncokusumo, Singosari, Karangploso, Ngantang, Kasembon, Sumer Pucung, Kromengan, Ngajum, Donomulyo, Bantur, Gedangan, Turen, Dampit, Sumbermanjing Wetan, Ampelgading, Tirtoyudo, and Pagelaran.	Improvement of housing condition Meteorological surveillance (rainfall, temperature) Coastal reclamation (drying of swamps and lagoons) Mangrove re-forestation Legislative measures (enforcement of existing regulation on environment and health)
(D) Last priority area: area that has low both hazard and vulnerability Location,	Household level of mosquito bites prevention (Abate, spray cans, mosquito coils, repellents etc.) Routine annual or twice per year seasonal spraying Community malaria awareness programme

Category / Location	Adaptation Strategy
Malang District: Jabung, Pakis, Lawang, Dau, Pujon, Kepanjen, Pakisaji, Wonosari, Wagir, Pagak, Kalipare, Gondanglegi, Bululawang, Wajak, and Tajinan.	Depend on cases, non-routine (sentinel surveillance of Malaria species) or routine mosquito quarterly surveillance (measurement of mosquito density index) Availability and provision of prophylactic anti malaria tablets Individual patient treatment

6.4.3 Adaptation Option of Diarrhea

Adaptation option for combating diarrhea threat is developed for each type of priority area. The priority levels are thus assigned for each subdistrict in Malang City and Batu City by considering level of hazard, vulnerability, and risk. Table 6.14 below presents the classification of priority for each subdistrict.

Table 6.14 Adaptation Strategy of Diarrhea in Greater Malang

No	Sub Districts	Hazard			Vulnerability			Risk			Category for Adaptation Strategy
		2008	2030	Comp.	2008	2030	Comp.	2008	2030	Comp.	
Malang City											
1	Kedung Kandang	VL	VL	0	M	VH	+2	L	M	+1	C
2	Sukun	M	L	-1	VH	M	_2	H	L	-2	C
3	Klojen	M	VH	+2	L	VL	-1	L	M	+1	B
4	Blimbing	L	L	0	H	VH	+1	M	H	+1	C
5	Lowok Waru	VL	VL	0	VH	VH	0	M	M	0	C
Batu City											
6	Batu	H	VH	+1	M	VH	+2	H	VH	+1	A
7	Junrejo	VH	VH	0	VL	M	+2	M	H	+1	B
8	Bumiaji	VH	VH	0	VL	H	+3	M	VH	+2	A

Note: Comp = comparison, Adap Str. = adaptation strategy category

Based on the Table 6.14 above it can be seen that, in terms of diarrhea, subdistricts are distributed in Category A, B, and C. Therefore the detail of adaptation strategies for diarrhea are as follows:

Table 6.15 Adaptation Strategy Category of Diarrhea for Each Sub District in Malang

Category	Adaptation Strategy
(A) First priority area: high risk area because it has high both hazard and vulnerability. Location, Malang City: N/A Batu City: Batu and Bumiaji	Whole hospital emergency alert and increased access to emergency treatment. If epidemic warning (KLB) occurs do citywide hospital alert and decrease in morbidity and mortality Availability of drugs and antibiotic against diarrhea and develop rapid diarrheal diagnostic agents Better training of hospital personnel during emergency diarrheal outbreak and increased routine surveillance of diarrhea agents Meteorological surveillance (rainfall, temperature) and development of early warning method based on meteorogical surveillance Increased community participation If flood occur do better sanitation system in flood refugee camps Development of drainage infrastructure in flood prone areas Widening and deepening of existing drains and canals Improvement of household sewer system and adaptation of greywater usage Legislative measures (enforcement of existing regulation on environment and health) Kampung(villages) improvement sanitation programme Extensive use of piped-water (PDAM) and increased of household piped-water

Category	Adaptation Strategy
(B) Second priority area: area that has high hazard but low vulnerability Location, Malang City: Klojen Batu City: Junrejo	Whole hospital emergency alert and increased access to emergency treatment. If epidemic warning (KLB) occurs do citywide hospital alert and decrease in morbidity and mortality Availability of drugs and antibiotic against diarrhea and develop rapid diarrheal diagnostic agents Better training of hospital personnel during emergency diarrheal outbreak and increased routine surveillance of diarrhea agents Meteorological surveillance (rainfall, temperature) and development of early warning method based on meteorogical surveillance Increased community participation If flood occur do better sanitation system in flood refugee camps
(C) Third priority area: area that has high vulnerability but low hazard Location, Malang City: Kedung kandang, Sukun, Blimbing, and Lowok Waru Batu City: N/A	Development of drainage infrastructure in flood prone areas Widening and deepening of existing drains and canals Improvement of household sewer system and adaptation of greywater usage Legislative measures (enforcement of existing regulation on environment and health) Kampung(villages) improvement sanitation programme Extensive use of piped-water (PDAM) and increased of household piped-water Improvement of health facility

7 Mainstreaming into Development and Spatial Plans in Greater Malang

The results of the Climate Change Risk and Adaptation Assessment (CRAA) should be mainstreamed into local development planning and policy in order to give better direction in development.

The process in mainstreaming CCRAA results involves several steps, including the identification of themes in national, provincial, or local plans that are related to CCRAA. For the Greater Malang context, these documents include the Long-Term Development Plan (RPJP) of Malang City (2005-2025), Batu City (2005-2025), and Malang District (2005-2025); the Medium-Term Development Plan (RPJM) of Malang City (2010-2014), Batu City (2007-2012), and Malang District (2010-2015); and the General Spatial Plan (RTRW) of of Malang City (2008-2028), Batu City (2010-2030), and Malang District (2010-2030). The purpose of identifying those themes in the Greater Malang area's documents is to find the entry points for discussion with stakeholders on issues addressed by CCRAA so that they have "hooks" in the existing documents.

Ideally, the CCRAA should be mainstreamed into all development plans. However, at the time of this assessment, the Governments in Greater Malang have already established Local Regulations (Peraturan Daerah) on the RPJP, RPJM, and RTRW. Hence, the current mainstreaming process is only conducted into the RKP. The other development plans are only reviewed and expected to be mainstreamed in the near future.
In line with the above process, preferred adaptation options are also identified by stake-holders consultation. In this process, factors are identified that determine the likelihood of executing the adaptation options proposed by experts.

A further step is working with government officials, especially from the Regional Development Planning Agency (Bappeda), on a compatibility analysis between the preferred adaptation options and the existing programmes or activities stipulated in the RKP. The purpose of this step is to make recommendations on which adaptation options need to be mainstreamed further in the next annual development plan of the local government.

Following these recommendations, Focus Group Discussions are conducted involving local and central government officials from the respective sectors with the purpose of synchronising programmes or activities recommended by local governments with those of central government. At this stage we identify which central government office manages a programme or activity similar to the one recommended by the previous step, as well as to identify the possible funding mechanisms that could be used implement the programme or activity.

The final step in mainstreaming CCRAA into development planning is formulating the champion programmes for each region, based on the recommendations from the earlier process, which is the adaptation prioritisation. These champion programmes are submitted to central government in order to obtain funding commitment either from state budget or non-state budget, including international funds.

A diagram below captures the mainstreaming process elaborated above.

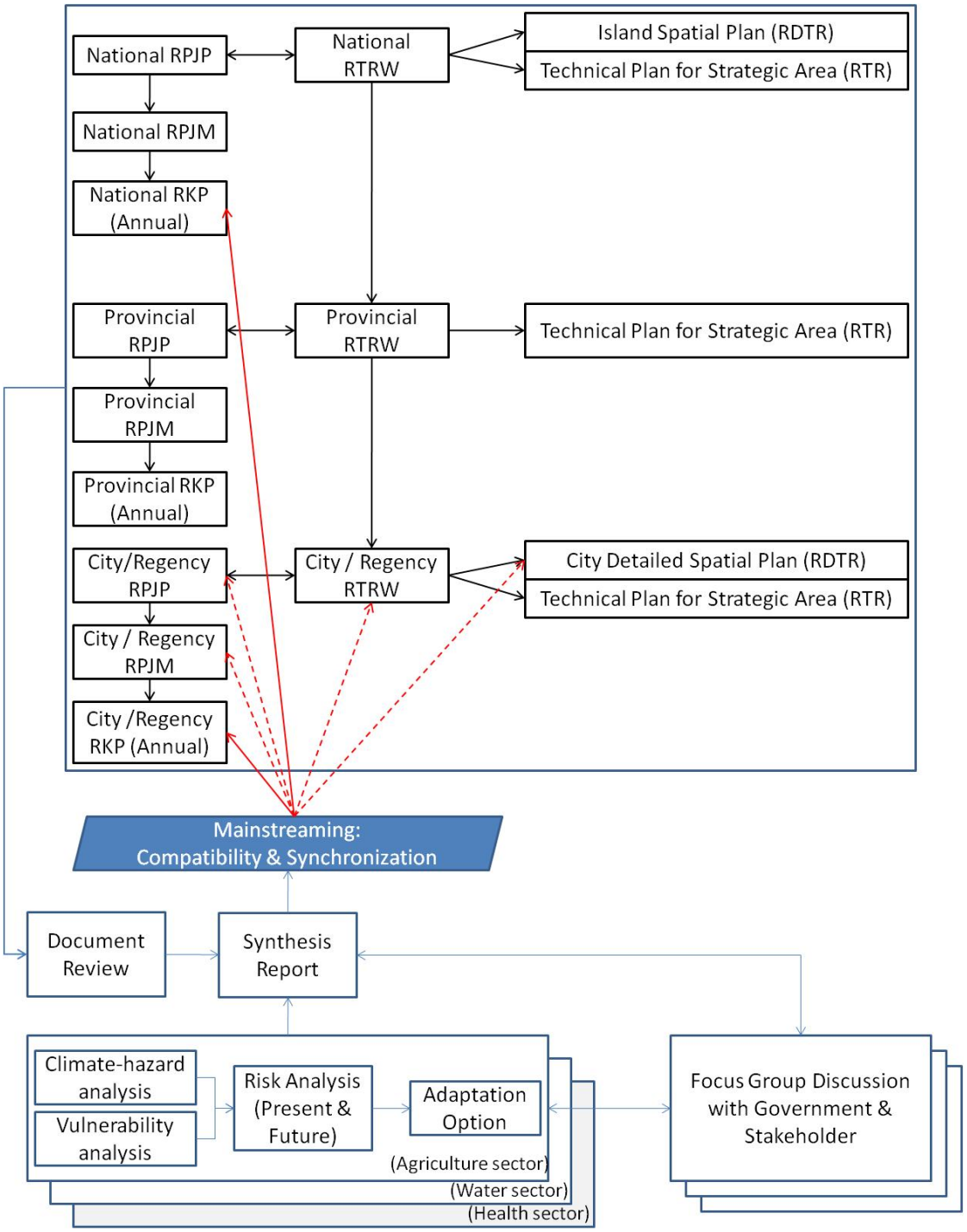


Figure 7. 1 CCRAA Process and Mainstreaming into Development Planning in Greater Malang

7.1 Review of Local Long-Term and Medium-Term Development Plans

This chapter will briefly show the current status and substance of spatial and non spatial plan documents in Greater Malang as previously explained. Strategic substances which have relation to Climate Change Risk and Adaptation Assessment will be highlighted for further consideration in mainstreaming the adaptation proposed by the various sectors into the spatial and non spatial development plans, with a summary as follows:

Table 7.1 Climate Risk Consideration within Document

City / District	RPJP / LTDP (Long-Term Development Plan)	RJPM / MTDP (Medium-Term Development Plan)	RTRW (General Spatial Planning)
Malang City	Period: 2005-2025 Mentioned climate risk as major threat without further assessment and has several points to be enriched by CCRAA.	Period: 2010-2014 No consideration related to climate risk, but has several points to be enriched by CCRAA.	Period: 2008-2028 No consideration related to climate risk and has not referred to Law 32/2009, but has several points to be enriched by CCRAA.
Batu City	Period: 2005-2025 Mentioned specific concern on climate risk and the necessity of climate change adaptation.	Period: 2007-2012 Mentioned specific concern on global warming and its climate change impact in agricultural sector.	Period: 2010-2030 Only mentioned global warming. Already refer to Law 32/2009
Malang District	Period: 2005-2025 No consideration related to climate risk, but has several points to be enriched by CCRAA.	Period: 2010-2015 Mentioned that climate risk is one of the threats without further assessment and has several points to be enriched by CCRAA.	Period: 2010-2030 No consideration related to climate risk even though already refer to Law 32/2009

Source: Analysis, 2011

From the table above, it should be noted as well that none of the development plans has referred to Law 32/2009 which mandates assessment on climate risk and adaptation within the Strategic Environmental Assessment (KLHS) to be introduced to the RTRW. While the summary of specific climate risk related issues based on sector mentioned in those documents above can be seen in Table 7.2 below.

Table 7.2 Climate Risk Related Issues

Sector	**Malang City**	**Batu City**	**Malang District**
Water	More concern on flood risk due to 5 watersheds and regional system. Urban drainage and clean water network.	More concern on landslide and flood risk Forest conservation important for landslide prevention, catchment area, and water source of Brantas River. Urban drainage and clean water network.	Concerns and risk on flood, landslide, and water shortage. Water resource management affects its surrounding. Water provision very important to support agriculture sector. Rural and urban drainage and clean water network.
	Degradation of water springs from 800 to 450. (Information source: from Public Consultation on April 18th 2011 in Batu City). Water conservation should consider capacity of the Brantas watershed Development should place Brantas Watershed as main consideration.		
Health	Concern, slum area along watershed. Location of sufficient health facility.	Concern, slum area along watershed. Location of sufficient health facility.	Health facilities provision both in rural and urban areas.
	Minimum consideration on DHF, Malaria, and Diarrhea in relation to climate risk, even though the incidence rate were high.		
Agriculture	Agricultural land conservation (admitted and legalized by RTRW), as it was not the main sector	Designated as agriculture centre in East Java. Agropolitan approach. Face land conversion	Designated as agriculture centre in East Java. Rural based agriculture and agribusiness development

Sector	Malang City	Batu City	Malang District
	anymore.	competition with tourism activity. Apple as its main commodity is declining.	(Agropolitan). Climate risk was being acknowledged in relation with fisheries, not with inland agriculture.
		Demand further assessment on climate change impact to paddy field and cornfield.	

Source: Analysis, 2011

7.1.1 CCRAA Mainstreaming into Malang City Long-Term Development Plan (RPJP / LTDP)

The current Malang City RPJP serves to become a guideline for long term development activities until 2025. In general, its current and future analysis, conducted as consideration for deciding the long term development vision, mission, and development policies, have not consistently mentioned climate change as a main threat for development. At first, Malang City LTPD only mentioned that, due to the eradication of the ozone layer and global warming, within the next twenty years there will be seasonal, weather, and ecosystem changes[10]. It goes on to affirm that climate change impact is a major threat, and that consequently there is a need to formulate adaptation strategies for development in health, agriculture, settlement, and spatial planning sector[11]. In addition, several considerations in environmental, population, and infrastructure issues in Malang City can actually be linked with the climate change impacts context in more detailed ways, i.e. with water, health, and agriculture sectors. As follows, here is the table that indicates probable climate change impact considerations in Malang City:

Table 7.3 Related Context of Climate Change Impact in RPJP of Malang City

SECTOR	RELATED CONTEXT OF CLIMATE CHANGE IMPACT
Water	Flood and landslide risk confirmed as two plausible disastrous events that could occur in Malang City. Distribution of slum areas was mostly along river basins (i.e. Brantas, Metro, Sukun, Bango, and Amprong Rivers) in Malang City thus very vulnerable to flood. Malang City geographically confirmed to serve as a catchment area with 3 main areas; i.e. northern catchment area consists of Bango and Amprong watershed, western catchment area consists of Brantas watershed, and southern catchment area consists of Brantas, Metro, Sukun, and Amprong watershed. Flood risk cannot be fully controlled by City Government; e.g. environmental degradation in upstream side of river basin (outside the city) can cause flood in Malang City. Waterfront development concept many times mentioned in the RPJP, with one of its priorities being to allocate open space along the river basin. Existing drainage system has not been able to exempt the city from flood incidences. Clean water provision rate approximately serves 64% of total population, RPJP roughly aims to increase it's service to serve up to 80% of total population.

[10] See Malang City Long Term Development Plan 2005 – 2025, p.II-27
[11] See Malang City Long Term Development Plan 2005 – 2025, p.II-79 – II-80

SECTOR	RELATED CONTEXT OF CLIMATE CHANGE IMPACT
Health	There was a specialised section concerns the health sector, i.e. stated as averagely better than National situation. However there was no consideration for diseases that are related to climate change impact; i.e. DHF, diarrhea, and malaria. Increased rate of slum area development and environmental degradation, which is mostly distributed along river basins, leads to decrease of people's health quality. Unhealthy behaviour and unsustainable provision of clean water may increase diarrhea incidences. There are several concerns on environmental quality improvement that may relate to diseases affected by climate change impact; i.e. improvement of settlement quality, clean water quality, and public spaces.
Agriculture	Limited resources and land competition (conversion of paddy field into other utilisation) have been confirmed may triggered food security crisis.

Source: Analyzed from Malang City RPJP 2005 – 2025

The RPJP of Malang City thus mentions that the long term development vision is Malang City as a Qualified and Cultured Educational City based on Environmental Value towards Prosperous Society. From the vision, the term "based on Environmental Value" means that development activities do not only aim to achieve physical and economic targets, but also has a conservation orientation. Based on this vision, the RPJP equipped the city with long-term development missions; i.e. 1) to develop Malang as an educational city with global orientation with local knowledge; 2) to have qualified human resources which master and are able to utilize science, technology, and culture; 3) to create an urban environment that is conducive to supporting its educational activities; 4) to develop environmentally based infrastructure; 5) to develop good governance and professional government apparatus; 6) to develop Malang as a city based on religious values; 7) to create efficient, productive, and sustainable economic growth; and 8) to create a prosperous Malang City. In relation to the CCRAA context, there are only a few missions and development agenda that are closely linked with climate change adaptation as follows:

Table 7.4 Related Malang City's RPJP with CCRAA Process and Output

RELATEDDEVELOPMENT MISSIONS	RELATED DEVELOPMENT AGENDA
Mission Number 4: to develop environmentally based infrastructure	Development Agenda Number 4 – "Development of sustainable infrastructure", with several focuses on: Enhancement of quantity and quality of green open space to preserve city's micro climate. Utilisation of river bank to enhance quantity and quality of green open space. Development and utilization of river based resources. Enhancement of clean water quality and quantity through: sustainable water resources management, utilisation of river as a water source, decrease of pollution in water sources, recycling, enhancement of clean water quality to comply with national and international standards. Enhancement of quality and quantity of clean water to achieve service rate around 80%
Mission Number 7: to create efficient, productive, and sustainable economic growth	Development Agenda Number 9 – "Enhancement of natural resources utilisation optimally and sustainably", with several focuses on: Introduction of natural resources management and utilisation strategy through education and training for environmental rehabilitation and environmental pollution. Development of natural resources and environmental management system through an increase in the community involvement in its management and address the importance of healthy life and eco-friendly behaviour

RELATEDDEVELOPMENT MISSIONS	RELATED DEVELOPMENT AGENDA
Mission Number 8 to create a prosperous Malang City	Development Agenda Number 10 – "Creating a prosperous Malang City", with several focuses on: Development on health sector through enhancement of healthy environment, healthy behaviour of people, development of qualified health centres, and improve health services for infants, etc.

Source: Summary from the brief of development missions and agenda on Malang City RPJP 2005 – 2025

The Malang City RPJP vision, mission, strategies, and development agenda are then equipped with long term development scenarios and stages. In terms of development stages, the Long-Term Development Plan is further elaborated through four Medium-Term Development Plans (Malang City RPJMD / MTDP). The stages are divided as follows:

1. 1st Malang City RPJMD (2005 – 2009)
2. 2nd Malang City RPJMD (2010 – 2014)
3. 3rd Malang City RPJMD (2015 – 2019)
4. 4th Malang City RPJMD (2020 – 2025)

The current Climate Risk and Adaptation Assessment is being conducted during the 2nd term of The Malang City RPJM; i.e. for the period 2010 – 2014 which has a focus on the stabilisation of infrastructure development which will be supported by an adequate management system.

7.1.2 CCRAA Mainstreaming into Malang City Medium-Term Development Plan (RPJMD / MTDP)

Malang's RPJM is an obligatory document plan that is developed by City Government to elaborate vision, missions, and development agenda into strategies, policy, programmes, and development activities which are consistent with the guidance provided by the RPJP Malang City 2005 – 2025. In addition the RPJM document will also be referred to by city agencies in formulating their annual development activities.

The RPJM outlines 14 strategic issues for the period, of which, based on preliminary identification, there are 3 that relate to the CCRAA context[12]. The first is the in-optimum disaster management within the city, in which one of the focuses is the high probability of flood occurrence. Secondly, is about the lack of environmental conservation which leads to low quality of people's health. Lastly, the lack of health services for the population, both for preventive (healthy life style) and curative.

The medium-term development vision mentioned in the RPJM is Malang as a Qualified Educational City, Health and Environmentally Friendly City, Cultured Tourism City, towards an Advanced and Independent Society. Healthy and environmentally friendly city is being defined as a state in which the city has a good quality of physical and social environment thus providing safety, comfort, and health to the population. In addition it can also be inferred as a city whose development considers environment conservation and supportive capacity. Then, the RPJM defines six development missions; i.e. 1) to develop and enhance qualified education; 2) to enhance people's health quality; 3) to implement environmentally friendly development; 4) to create economic equity with its surrounding area; 5) to create and develop culture based tourism; and 6) to create excellent public services. By proposing more detailed development activities, the RPJM is thus equipped with the appropriate formulation of goals, strategies, and policy guidance for each of the development missions. As follows,

[12] See Chapter 4, Malang City Medium-Term Development Plan 2009 – 2014

here are the related features in the RPJM with the context of the CCRAA process and output:

Table 7.5 Related Development Missions, Goals, Strategies, Policy Guidance in Malang City RPJM with CCRAA Process and Output

GOALS	STRATEGIES	POLICY GUIDANCE
Development Mission Number 2: to enhance people's health quality		
Goal Number 1 Improvement of quality and quantity of health facilities.	Improvement of quantity and quality of health services	Quality improvement for Public Health Centre Equitable distribution of health services Quality and quantity improvement of medical human resources
	Improvement of easy, cheap, and equitable health access	Development of medical insurance system, especially for poor people
Goal Number 2 Improvement people's health quality level and environment	Improvement of health level of mother and infant	Equitable distribution on health services for mother and infant
	Improvement of people's participation in increasing the level of health quality	Socialisation on Perilaku Hidup Bersih dan Sehat – healthy life style
	Improvement of disease prevention and eradication	Improving diseases prevention and eradication, especially for poor people
	Improvement of local sanitation	Endorse sanitation improvement in community level
	Improvement of people's nutrient	Counseling and nutrient services for people
Development Mission Number 3: to implement environmentally friendly development		
Goal Number 3 Improved environmental quality	Improvement of quality of water, land, and air	Improving efforts on environmental impact monitoring Developing community awareness towards environmental issues and endorsed them to conduct social control towards environmental quality
Development Number 6: to create excellent public services		
Goal Number 1: Well implemented governmental affairs	Improvement of agriculture production and productivity	Developing agricultural sector with a regionalist approach and integrated business Developing steps to enhance competitiveness of agricultural and fisheries products Facilitating marketing and risk management on agricultural business.
Goal Number 4: Improved public facilities	Improvement of quantity and quality of public facilities and utilities	Constructing, maintaining, and preserving the condition of roads and bridges Constructing and maintaining city drainage
	Improvement of settlement's facilities and utilities	Constructing, improving, and preserving settlement facilities.
Goal Number 5: Improved basic services for the people	Improvement and development of clean water, cemetery, and waste facilities and utilities	Provisioning of clean water to met people's demand Provisioning of waste management facilities
Goal Number 9: People welfare	Improvement of disaster prevention and management	Improving services for disaster and social casualties

Source: Summary from Chapter 5 Malang City RPJM 2009 - 2013

From the table above, it can be seen that the RPJM has not specialised in the concern of climate change impact being hinted at in the RPJP. However, there are already several

policy guidance areas that potentially can be enriched by the concern of climate change impact on a particular sector, i.e. introduction of adaptation activities into the annual government agenda under those related policies. Therefore, the adaptation strategies proposed by each sector can be used to sharpen the annual government activities within this RPJM period. In addition, it can also be used to specify concern for climate change impact in the next period of Malang City RPJM, which will be more constructive with the RPJP.

7.1.3 CCRAA Mainstreaming into Malang City General Spatial Plan

Malang City General Spatial Plan (RTRW) for the period 2008 – 2028 is the baseline for all spatial development activities in Malang City. It serves as the main consideration for more detailed plans, and complies with the Malang City RPJP 2005 – 2025, and it evaluates the previous RTRW of Malang City 2001 – 2011. In relation to the CCRAA context, this part identifies the recognition of climate risk and affecting impacts within the RTRW of Malang City 2008 – 2028. In the earliest part, the document mentions six issues to be faced, though there is only one having a relation to climate change impact[13]; i.e. the problem of flood risk in the city that demands for synergetic efforts in providing the drainage system, retention system, sanitation, and green open space. It should be noted that the Malang City RTRW was enacted and legalized in 2008, before the Law 32/2009 on Environmental Management and Protection was enacted, thus the plan has not considered the law which mandates for Strategic Environmental Assessment (KLHS), with climate change adaptation as one of the pre-requisites.

Malang City RTRW thus mentions that the development vision accommodated by the plan is Malang City as a Qualified and Cultured Educational City based on Environmental Value towards Prosperous Society; i.e. it complies with the Malang City RPJP. The vision is thus being detailed with eight spatial planning missions; i.e. 1) to develop Malang as an educational city with global orientation with local knowledge; 2) to have qualified human resource which master and are able to utilize science, technology, and culture; 3) to create an urban environment conducive to supporting its educational activities; 4) to develop environmentally based infrastructure; 5) to develop good governance and professional government apparatus; 6) to develop Malang as a city based on religious values; 7) to create efficient, productive, and sustainable economic growth; and 8) to create prosperous Malang City.

To realise the vision and mission, the Malang City RTRW 2008 – 2028 consists of a spatial structure, spatial pattern, strategic area, and spatial monitoring plan. The plan then further examines the problems, prospects, and spatial strategies of the city, in which some of them have further relation to the sectors discussed in the CCRAA as follows:

Table 7.6 Plausible Context of Climate Change Impact in RTRW (General Spatial Plan) of Malang City

SECTOR	PLAUSIBLE CONTEXT OF CLIMATE CHANGE IMPACT
Water	The city is being served by 5 natural springs and 4 in-depth wells; however there are still some areas in the city do not have access to the water network provided by the PDAM. The city consists of 5 main drainage systems; i.e. Bango, Brantas, Sukun, Metro, and Amprong Watersheds, however inundated areas during the rainy period still occur due to the low quality of secondary and tertiary drainage and waste. River bank has been stated to be provided with adequate dimensions to reduce the risk of flood events; however the space is facing competition with land conversion and utilisation or slums. RTRW aims to increase PDAM level of service up to 80%, maintaintaining the balance of water demand and supply, and increasing the number of water sources.

[13] See more on Chapter 1 Malang City RTRW 2008 – 2028

SECTOR	PLAUSIBLE CONTEXT OF CLIMATE CHANGE IMPACT
	In relation to the drainage system, the RTRW defines the following strategies: improvement of pre-existing drainage, redevelopment of drainage based on land use zone, provision of green open space along river banks (included as conservation area, thereby having a legal basis). The RTRW aims to increase water tank system capacity to 6200 m^3 to fulfill the demand from 31.100 households, with the development of a pipe network for villages that haven't yet been accessed by PDAM, e.g. Kelurahan Tlogomas, Merjosari, Karang Besuki, Bandulan, Mulyorejo, Bandung Rejosari, Bakalan Krajan, Bumiayu, Arjowinangun, Tlogowaru, Wonokoyo, Buring, Kedung Kandang, Lesanpuro, Madyopuro, Cemoro Kandang.
Health	The city has several important health facilities; i.e. RSUD, many private hospitals, doctors, etc. Under-utilisation of Public Health Center (Puskesmas), thus it can be optimised to enhance distribution of health facilities. RTRW aims to optimise a wastewater centre within the city and endorse people in highly-dense housing and settlement along the river to use the communal wastewater system. The RTRW plans (by 2028) to improve health facilities as follows: 5 hospitals from 3 units previously, 36 Puskesmas from 27 units previously, 73 Supporting Puskesmas from 55 units previously, 545 Posyandu from 412 units previously, 109 drugstores from 82 units previously.
Agriculture	Agriculture land is facing competition with other land uses, e.g. settlement. The RTRW aims to limit the agriculture land conversion especially in Bakalan Krajan for organic paddy fields. Within the spatial structure, there was no part of the city (BWK or subdistrict) defined to have specific agriculture land; for instance BWK Malang Tenggara which currently consists of paddy field was planned to consist of green open space, Malang Hall Convention Centre, offices, and social facilities.

Source: Analyzed from Malang City RTRW 2008 – 2028

7.1.4 CCRAA Mainstreaming into Batu City Long-Term Development Plan (RPJP)

The current Long-Term Development Plan (RPJP) that is active in Batu City runs from 2005 – 2025. The vision that is stated in the RPJP of Batu City is "Batu City as Toursim Center supported by Competitive Agriculture towards Civic Society". The vision has four main variables; they are tourism centred, agricultural based, competitive, and civic society. The vision is thus prepared to be achieved through five development missions; i.e. 1) implementation of religious values and local wisdom, 2) creation of qualified human resources, 3) implementation of good governance, 4) ensure social peace and order, and 5) development of Batu City as an agricultural and environmentally based centre for tourism.

From its description, the context of the CCRAA basically fits with the considerations within the mission numbers 2, 4, and 5. Within the second development mission, it is stated that qualified human resources will be attained through a triple track strategy, i.e. fulfillment of education, fufillment of health services, and improve economic welfare, in this sense the second strategy fits with the CCRAA context[14]. Meanwhile, the fourth development mission fits with the CCRAA context because one of its core substances is the consideration of natural disaster, which to some extent includes climate-related disaster, as a source of threat towards society[15]. Finally, the description of the fifth development mission heavily mentions the importance of agricultural activities as a backbone of economic activities in Batu City and that, in general, economic activities should be practiced within a sustainable development

[14] See Batu City Long-Term Development Plan 2005 – 2025, p. IV – 5.
[15] See Batu City Long-Term Development Plan 2005 – 2025, p. IV – 6.

framework to avoid environmental degradation through various sources of pollution in the air, water, and land[16].

Batu City RPJP thus formulates it's main development strategies based on a SWOT analysis and determines the key factors for its success and fundamental stages. From the total of 22 strategic programmes, seven of them fit with the CCRAA context[17]; i.e. a) derived from strength-opportunity: revitalisation of the agricultural sector; b) derived from strength-threat: environmentally friendly agricultural activities; c) derived from weakness-opportunity: improvement in health service quality, infrastructure development and spatial planning, improvement of social protection and insurance; and d) derived from weakness-threat: development of manufacturing and creative industries based on agriculture, land and forest rehabilitation.

There are three fundamental stages of long-term development in Batu City; i.e. an internal and external consolidation stage, welfare improvement stage, and self-sufficency stage[18]. The triumph of these stages lies within five key factors as follows: 1) agriculture revitalisation and development of agricultural-based industry, 2) tourism development, 3) improvement in access and quality of education and health, 4) availability of hard-infrastructure (e.g. roads, dams, irrigation, etc.) and soft-infrastructure (e.g. regulations to attract investment), and 5) improvement in the capacity and quality of bureaucracy and public services[19].

To ensure the conformity of the RPJP towards further detailed development plans, the RPJP is equipped with targets and policy guidance for each mission. Those which are related to the CCRAA context are as follows:

Table 7.7 Related Batu City RPJP and CCRAA Context

Related Development Target	**Related Policy Guidance**
Development Mission Number 2: Creation of qualified human resources – sub aspect: health	
Improved health service quality which is practiced in fair, equitable, and accessible ways. Realisation of qualified health facilities Access of health services for poor people Decreased number of communicable diseases incidences. Improved quality of clean and healthy environment Improved health awareness in society.	Improvement of health service - equitable access to reduce gaps among areas and among groups. Improvement of private sector and community participation in health development, particularly in health service provision. Improvement in production, distribution, and consumption of qualified, effective, and safe medicindes for the people with affordable price. Provision of support and opportunity for private-hospital development. Sustainable improvement of health services and quality for poor people.
Development Mission Number 4: Ensure social peace and order	
Improved ability in managing risk of natural disaster	Endorsement of responsive community with spirit of voluntarism in countering multiple threats Improvement of security and social protection from multiple threats.
Development Mission Number 5: Development of Batu City as agricultural and environmentally based tourism centre – sub aspect economic development	
Society-based economy, especially in tourism and agribusiness, which competitive and self-sufficient and able to penetrate national and global market through strategic partnership. Increased utilization of local economic	Revitalisation and modernisation of agriculture, including husbandry and fisheries. Improvement of quantity and quality of agricultural production to ensure its continuity in achieving food security and market demand. Improvement and strengthening of agricultural and rural

[16] See further in Batu City Long-Term Development Plan 2005 – 2025, p. IV – 6 until IV – 11
[17] See Batu City Long-Term Development Plan 2005 – 2025, p. IV – 13.
[18] See Batu City Long-Term Development Plan 2005 – 2025, p. IV – 15.
[19] See Batu City Long-Term Development Plan 2005 – 2025, p. IV – 16.

Related Development Target	Related Policy Guidance
	facilities. 16. Sustainable economic development
Development Mission Number 5: Development of Batu City as an agricultural and environmentally based tourism centre – sub aspect regional infrastructure development	
Optimum spatial utilisation for economic activities which is supported by adequate infrastructure. Acceleration of vital infrastructure development in strategic sectors. 5. Fulfilment of housing necessity along with its supporting facilities and utilities	Improvement of access to clean water through increased capacity. Development of water resources capacity through demand and supply management. Improvement in housing provision and its facilities and utilities (including clean water, drainage, etc.) to attain healthy settlement. Improvement in waste and drainage system in settlement area. 12. Sustainable spatial utilisation
Development Mission Number 5: Development of Batu City as an agricultural and environmentally based tourism centre – sub aspect environmental development	
Balanced between population number and environmental carrying capacity. Improved environmental quality, particularly forest resources preservation. Improved environmental awareness within society. Controlled natural resources utilization in effective, efficient, and value added oriented. Provision of law and regulation for environmental management.	Mitigation and monitoring of environmental degradation and pollution. Improvement in natural resource management, conservation, and rehabilitation effectiveness, particularly forestry. Improvement in access to natural resources and environmental information. Improvement in community participation in managing natural resources and environment. Improvement in coordination, monitoring, and control of natural resources and environment. Improvement in the role of spatial planning for supporting environmental based development. Insitutional arrangement and law enforcement for natural resources and environmental preservation.

Source: Analyzed from Batu City Long-Term Development Plan (RPJP), 2005 – 2025

It should be noted that following the description of development targets and policy guidance of mission number 5 (sub aspect environmental development), Batu City RPJP mentions specific concern about natural disaster and climate change[20]. The location of the city in the highland area was believed to be prone towards disaster and climate change risk. Thus the focus in the future will be addressed towards disaster risk reduction and climate change adaptation. Disaster risk reduction focus will be given towards disaster prevention, mitigation, and preparedness, for reducing damages, economic loss, and victims. In its implementation, disaster risk reduction will be mainstreamed within development planning. Furthermore, spatial planning must be undertaken by considering the risk of disaster, linked to information about disaster and vulnerability to climate, early warning systems, contingency, as well as socialisation and training for the community to be better prepared and resilient in the face of disaster.

The Batu City RPJP vision, mission, strategies, and development agenda is then equipped with long term development scenarios and stages. In terms of development stages, the RPJP is further elaborated through four Medium-Term Development Plans (Batu City RPJMD). The stages are divided as follows:

1. 1st Batu City RPJMD (2005 – 2009)
2. 2nd Batu City RPJMD (2010 – 2014)
3. 3rd Batu City RPJMD (2015 – 2019)
4. 4th Batu City RPJMD (2020 – 2025)

[20] See further in Batu City Long Term Development Plan 2005 – 2025, p. V – 17

At the time of this CCRAA, the second stage is effective with its focus on Batu City development as an agriculturally-based tourism centre by concentrating efforts on several tourism locations and agricultural product and industry, in spite of market expansion. Focus of each related development mission to the CCRAA in this stage are as follows[21]:

a) Development mission Number 2, point b: health sector development aimed at increasing life expectancy, reduction of mother and infant death. Efforts that will be tackled are improvements in the health system, prevention and control of communicable disease, improvement in medical human resources, and improvement of the health service especially for mothers and children.
b) Development mission Number 4: *no specific priority for development focus to tackle natural disaster threat.*
c) Development mission Number 5, point c: improvement of farmer's livelihood, agricultural infrastructure, human resources thorugh agricultural education, management of land and controlling land conversion, and agricultural productivity.
d) Development mission Number 5, point g: infrastructure development, including development of water resources and irrigation facilities, management of water resources degradation, flood and drought control, and improvement in irrigation and drainage network.
e) Development mission Number 5, point h: environmental development, including implementation of disaster risk reduction especially in the aspect of climate change adaptation and disaster mitigation.

7.1.5 CCRAA Mainstreaming into Batu City Medium-Term Development Plan (RPJMD)

At the moment, the active Batu City Medium-Term Development Plan (RPJM) is the one running from 2007 – 2012. This means that soon the city will elect a new City Mayor and there will be a revision to the Batu City RPJM. However, even though the current RPJM will soon be inactive, a review process still be conducted to capture how deep is the understanding of the Batu City Government in addressing climate risk within the development agenda. In general, the review process will look at how deep is the climate risk being included as a development problem and which parts of the CCRAA process and output can be mainstreamed into the medium term development vision, mission, policy, and development agenda.

In the introduction to the Batu City RPJM 2007 – 2012, it is stated that sustainable environmental consideration is one of the principles in medium-term development[22] as well as to assure its compliance with other development planning documents. Later in the document, environmental issues are the first to be introduced as problems[23] for Batu City; i.e. it covers as follows: 1) environment development in conservation areas and also forest encroachment which leads to a decreas in agricultural land and an increase in vulnerability to disaster, 2) increased rate of destruction of forest land, critical-land, and water resources, and 3) deterioration of water, air temperature, and soil quality. On the other hand, the problem of weakness and limitation in health facilities are listed under social-cultural issues. Under infrastructure issues, it is noted that the pace of development will increase demands for clean water provision. Those matters relate directly to the CCRAA context of development problems being documented in Batu City RPJM 2007 – 2012.

Based on the problems above, several strategic issues are defined in the Batu City RPJM 2007 – 2012. Among five strategic issues, only two main issues are explained as being related to the CCRAA context[24]. The first is the community-welfare issue, where, among

[21] See further in Batu City Long Term Development Plan 2005 – 2025, p. V-23 – V-28.
[22] See Batu City Medium-Term Development Plan 2007 – 2012, p. 2.
[23] See Batu City Medium-Term Development Plan 2007 – 2012, p. 56.
[24] See Batu City Medium-Term Development Plan 2007 – 2012, p. 58 – 60

seven sub-issues, only two are directly related to the CCRAA context; i.e. population growth that needs to be balanced by food security measurement and lacks in the agricultural sector to support tourism in Batu City. Meanwhile, the second is the issue of infrastructure development and spatial planning where three out of four sub-issues are related to the CCRAA context; i.e. 1) global warming which leads to climate change and affects agriculture production, and so climate consideration should be integrated in Batu City spatial planning, 2) population, industrial and service growth require extension of settlement areas which are affected by uncontrolled development, and 3) limitations in spatial monitoring leads to conversion of agricultural land into settlement and industrial areas which is causing deterioration of the ecosystem.

Considering all the conditions and problems faced by Batu City, the medium-term development vision stated at that time was “Batu City as an Agriculturally-based Tourism Centre which is supported by human, natural, and cultural resources as well as creative, innovative, and clean government for the benefit of the people with faith and devotion towards the Only God”. The vision is actually composed of four axes; i.e. 1) religious faith, 2) towards tourism centre, 3) agricultural based, and 4) creative, innovative, and clean government[25].

The medium-term development vision is supported by eight missions, whose main themes are as follows[26]: 1) ensuring the implementation of religious life and tolerance among religions, 2) optimisation and sustainable utilisation of human, natural, and cultural resources in supporting Batu City development, 3) optimisation of inward investments to Batu City from multiple parties, 4) revitalisation of government officials and implementation of clean government, 5) enhance the role of Batu City as an agro-city, strengthening of agriculture-based products and industry in the regional and national market, 6) enhance the position of Batu City from a “tourism city” into a “tourism centre” at the regional and national level, 7) physical development and comprehensive spatial planning in supporting economic activities and public services, and 8) implement a democratic political environment in Batu City with adequate community participation. In this sense, development missions number 2, 5, 6, and 7 have a relation, directly and indirectly, to the CCRAA context.

Based on the vision, missions, and strategic issues, there are five groups of development agenda in 2007 – 2012; i.e. 1) agenda in quality improvement of religious life, 2) agenda in improvement on community welfare, 3) agenda in human resources development, 4) agenda in infrastructure and spatial planning development, 5) agenda in just and democratic political system development. Development missions and agendas are detailed with in the sequence of development goal, strategy, policy, target, and programme. Table 7.8 below presents a summary of the sequences which have a close link with the CCRAA context.

[25] See Batu City Medium-Term Development Plan 2007 – 2012, p. 63 – 66
[26] See Batu City Medium-Term Development Plan 2007 – 2012, p. 66 – 68

Table 7.8 Related Development Goals, Strategies, Policies, Targets, and Programmes in Batu City RPJM to CCRAA

Development Goals	Strategies	Policies	Targets	Programmes
Development Mission: Enhance the role of Batu City as agro-city, strengthening of agriculture-based product and industry in regional and national market Development Agenda No.2: Improvement on community welfare				
2. Enhancing the role of Batu City as agropolitan city, especially for horticulture, vegetables, and flowers; optimation in market development, competitivenes strengthening, and devleopment in entrepreneurhip within society in industrialising natural resources, supported by qualified society in order to have strong economic structure	7. Increase and maintain agricultural production to push income gaining of farmer. 8. Provision of food barn to keep agricultural product in order to maintain its quality. 9. Development of agricultural zone to maintain balance with other sectors (service, industry, commerce) 10. Development of quality and quantitiy of agricultural infrastructure and to nurture off-farm activities 11. Improvement of human resources quality to support development of agricultural products. 12. Development of comprehensive marketing system to eliminate debt bondage.	3. Promote new investment in export oriented industry, especially agro-industry 4. Development of marketing facilities for agriculture-related activities	Ensure stability of agricultural inputs Increase agricultural productivity Increase income of farmers Agricultural zone which linked with service and industry. Improved quality and quantity of agricultural infrastructure and off-farm activities Developed human resources Developed agricultural institutions Market infromation support Development of agricultural knowledge Support for agricultural tools, seeds, and capital Ensure availability of food stock Labelisation of agricultural products Development of new agricultural product Environmentally friendly agriculture Enhance agricultural partnership Revitalisation in agricultural officials.	10. Countermeasure to assure price stability 11. Increase agricultural productivity 12. Implementation of income increase for farmers 15. Improve human resource quality 16. Development of agricultural institution 18. Improvement of agricultural knowledge for farmer 19. Provision of agricultural tools, seeds, and capital 20. Ensure food-stock availability 21. Development of primary agricultural products 22. Socialisation of new agricultural product 23. Organic agricultural system 24. Organic agricultural training 25. Socialisation of partnership in agriculture 26. Training for field officer 27. Enhancment program for partnership 28. Provision of facilities for field officer.
Development Mission: Optimation and sustainable utilization of human, natural, and cultural resources in supporting Batu City development Development Agenda No. 3: Human Resource Development				
. Optimalization of human, natural, and cultural resources for Batu City development	6. Community empowerment and improvement of healthy life 7. Improvement of people's capacity in accessing qualified health services 8. Improvement on surveillance, monitoring, and health information. 9. Health insurance for the poor 10. Conservation of natural resources and rehabilitation of	Community empowerment and improvement of healthy life Improvement of people's capacity in accessing qualified health services Improvement on surveillance, monitoring, and health information. Health insurance for the poor Conservation of natural resources and rehabilitation of critical land.	For Policy No. 1 a. Realisation of healthy life style within community b. Increase awareness in nutrition fulfillment. For Policy No. 2 a. Health service for all poor people b. Protection for infant, child, maternal Terlindunginya bayi, anak, expectant woman and vulnerable	Health logistic improvement program 2 Medicine and food control program 3 Standardization in health services 1. Community and local health improvement program 2. Health infrastructure imporvement program 3. Health service imporvement program 4. Free health services for poor people

Development Goals	Strategies	Policies	Targets	Programmes
	critical land. 11. Optimaliation in natural resources and ensure ecosystem balance.	Optimaliation in natural resources and ensure ecosystem balance.	groups c. Availability of qualified human resources in health services d. Equitable access to Health Centre e. Implementation of health service according to the standard For Policy No. 3 a. Implementation of rapid reporting system from Head of Village to respective health agencies b. Rapid response for communicable and outbreak diseases c. Availability of pharmaneutical logistics, foods, and standard health support d. Controled environmental pollution accordance to the standard e. Functioned evidence based health information system Policy No. 4 a. Availability of funding from central and local government b. Utilisation of health financial resources for prevention and health promotion c. Availability of health insurance, especially for poor people	5.Healthy environment program
Development Mission: . physical development and comprehensive spatial planning in supporting economic activities and public services Development Agenda No. 4: instrastructure and spatial planning development				
2. Optimization of spatial monitoring to ensure its compliance with Batu City spatial plan	3. Enactment of spatial plan and zoning regulation , supported by license mechanism 4. Mapping for disaster prone area in order to create mitigation plan 5. Addition of green open space area with multiple functions	7. Clean water and energy provision for household and industry 9. Drainage maintenance	6. Periodical review on Spatial Plan in order for adjustment with environmental changes 9. Improved roads, bridges, irrigation, and other facilities 10. Disaster prone area map 11. Realisation of a clean environment	10. Slum area improvement program for Brantas watershed 12. Road, bridge, utilities, and drainage management 13. Infrastructure planning, monitoring, and evaluation program 14. Rural infrastructure development program 15. Water resource management program 16. Natural resources rehabilitation

Development Goals	Strategies	Policies	Targets	Programmes
				and conservation program 17. Development and implementation of environmental friendly technology 20. Development and preservation of natural resources program 21. Emergency warning and disaster management program

Note : Numbering being made accordance to the format within the Batu City Medium-Term Development Plan 2007 – 2012

7.1.6 CCRAA Mainstreaming into Batu City General Spatial Plan

Batu City General Spatial Plan (RTRW) for the period 2010 – 2030 is the baseline for all spatial development activities in Batu City. It serves as the main consideration for more detailed plans, and complies with the Batu City RPJP. In relation to the CCRAA context, the preface of the document literally mentions that it aims to contribute to solving global problems, i.e. global warming, even though it does not mention the impact of climate change. Therefore it can be inferred that the understanding was more related to the mitigation side of climate change, i.e. reducing GHG emissions. The first problem defined in the document and maybe related with climate risk is the recognition of landslide as one of the threats to the city. On the other hand, climate risk may also affect the agriculture sector as Batu City's economic base is agriculture, i.e. crops, fruits, horticulture.

Batu City RTRW thus mentions that the development vision accommodated by the plan is Batu City as a Tourism and Agropolitan City in East Java. The vision is then detailed through five spatial planning missions; i.e. 1) optimally use city resources, including natural sources and human resources, 2) enhance its role as an agriculture based city especially through vegetable plantations, fruits, and flowers, and thus enhance the agro-based product commercialisation at a regional level, 3) enhance its position as a tourist destination city, 4) development of physical infrastructure, e.g. governmental, public facilities, transportation, and spatial plan, and 5) balanced development of the ecosystem.

To realise the vision and mission, the Malang City RTRW 2008 – 2028 consists of spatial structure, spatial pattern, strategic area, and spatial monitoring plans. The plan then further examines the problems, prospects, and spatial strategies of the city, of which several among them have further links with the sectors discussed in the CCRAA as follows:

Table 7.9 Plausible Context of Climate Change Impact in Batu City RTRW 2010 – 2030

SECTOR	PLAUSIBLE CONTEXT OF CLIMATE CHANGE IMPACT
Water	Related spatial structure strategy Water resources development, consists of regional water resources system, watershed management within Batu City, irrigation development network for supporting agriculture activities, clean water network, and flood control. Drainage system: land-based drainage system, primary-secondary-tertiary network redesign, preservation of river as primary network, river normalization, conservation of river bank. Evacuation route (includes landslide), Related spatial pattern strategy Natural conservation to support Batu City's role as Brantas watershed upstream. Monitoring on utilised area to avoid environmental degradation and mitigate further disaster's risk. Prohibit development on location with high level of landslide risk Identification of disaster's prone area, especially landslide, and prevent further erosion or environmental degradation within.
Health	Related spatial pattern strategy Rehabilitation of highly dense settlement areas for better healthy environment Related spatial structure strategy Equitable distribution of health facility, at least in each BWK centres. Development of international health facility, located in Tlengkung Village, Junrejo Sub District
Agriculture	Related spatial pattern strategy Development of horticulture area by optimizing appropriate land with support from irrigation network. Distribution of settlement area nearby agricultural activities. Monitoring of agricultural area located near disaster's prone area. Related spatial structure strategy Development of agropolitan centres, concentrated in Bumiaji and Junrejo Subdistrict

Source: Analyzed from Batu City RTRW 2010 – 2030

7.1.7 CCRAA Mainstreaming into Malang District Long-Term Development Plan (RPJP / LTDP)

The Current Malang District Long-Term Development Plan 2005 – 2025 (RPJP) serves to become a guideline for long term development activities until year 2025, that is as a main consideration for the General Spatial Plan of the district, RPJM, as well as the annual government plans. In general, in its RPJP there is no specific concern for climate change as one of the main factor that may affect the course of development. However, there are several main considerations for current and future conditions of Malang District that very closely linked to the context of the CCRAA; i.e. the watersheds in Malang, its reliance on the agriculture sector, and the relationship between agriculture and water management within the area.

Table 7.10 Plausible Context of Climate Change Impact in Malang District RPJP

SECTOR	PLAUSIBLE CONTEXT OF CLIMATE CHANGE IMPACT
Water	Malang District is the location of Brantas River upstream, thus its management may affect its watershed in more than 14 cities/districts. The RPJP of Malang District has confirmed several issues regarding its degradation that may lead to disastrous events such as landslide, flood, and drought as well as lack of water resources for both domestic usage and agriculture activities (agriculture rank the most sector demands for water) as one of the main challenges for the next twenty years. The document also mentions the importance and role of spatial planning to be the tool to manage and lessen the risk of such disastrous events and preserve the ecosystem services provided by the environment.
Health	On the other hand, concern for the health sector has been expressed in several indicators / indices. However, none of them indicate additional concerns regarding diseases related to climate change impact. RPJP initial findings also confirm the lack of clean water sources for subdistricts (10 out of 33, given only 57% of urban population being served and 17% of rural population)[27], which may lead to poor health quality of the population.
Agriculture	In relation to the development of agricultural activities, the intention was very strong and can be seen from the assignment of agriculture in all 8 Sub Satuan Wilayah Pengembangan (SSWP/development area) in Malang District. Agriculture is also known as the highest contributor to the GDP. As such, it is the economic base of the District, even though the data from 2001 – 2005 shows that there was a shift from primary to tertiary economic activities. The agriculture sector demands the highest services of water provision through irrigation systems

Source: Analyzed from Malang District RPJP 2005 – 2025

The Malang District RPJP 2005 – 2025 states that the long term development vision is a Secured, Advance, Just, and Prosperous Malang District. Afterwards, there are six development missions as follows: 1) Increasing understanding and to ensure religious values as a bonding factor and driver towards an empowered civil society, 2) Increasing the supreme position of law and human rights as well as endorse the development of non governmental organisation and political groups, 3) Increasing the quality of education and health services as well as achievement in sport and culture, 4) Increasing the management of natural and other resources based on its potencies and prospects, 5) Increasing the development equity based on social justice and its environmental sustainability, and 6) Increasing the professionalism of civil servanta for public services. To conceptualise the long term development vision and mission, the RPJP defines 4 development agenda, of which two may have links with the CCRAA context. As follows, here is the explanation of each related development orientation:

[27] Malang District LTDP 2005 – 2025, p.26

Table 7.11 Related Development Agenda and Policy Guidance in Malang District RPJP to CCRAA Process and Output

Related Development Agenda	Related Policy Guidance
Development Orientation Number 3: To establish resilient, competitive Malang District towards prosperity	Improvement of health services through enhancement of health facilities, medical power, public health centre, and community awareness on healthy environment. Improvement on economic activities in each SSWP through industrial area, agropolitan area, education, and commerce. Development of vital infrastructure; e.g. roads, bridges irrigation system, clean water provision, natural conservation, and spatial planning. Utilisation of science and technology, with a priority on environmental preservation, food security, and energy.
Development Orientation Number 4: To establish equitable and environmental friendly development in Malang District	General Spatial Plan (RTRW) as a reference on spatial policy for development in each sector and cross sectors, towards synergetic, proper, and sustainable development. Improving and expansion of basic infrastructure service areas especially for the southern part of Malang District; e.g. infrastructure related to the CCRAA context are water resources, road and bridges, healthy housing and settlement environment, clean water and sewerage utilities. Arrangement of areas as follows: annual utilised area, seasonal utilised area, buffer area, water spring protected area, river protected area, and disaster's prone area, which empowered with sustainable natural resources utilisation. Enhancing the capacity of the environmental agency, coordination on control and management of water resources, protection of river banks, and improvement on drainage system. Preservation and development of clean water sources Enhancing clean water provision and sanitation for settlement area Disaster mitigation Natural environment control will be focused on recovery and rehabilitation of pre-degradated area

Source: Summarised from Malang District RPJP 2005 – 2025

The Malang District RPJP vision, mission, and development agenda is equipped with long term development scenarios and stages. In terms of the development stages, the Long-Term Development Plan will be elaborated further through four Medium-Term Development Plans (Malang District Province / RPJM). The stages are divided as follows:

1. 1st Malang District RPJMD (2006 – 2010)
2. 2nd Malang District RPJMD (2011 – 2015)
3. 3rd Malang District RPJMD (2016 – 2020)
4. 4th Malang District RPJMD (2021 – 2025)

The current Climate Risk and Adaptation Assessment is conducted during the 2nd term of The Malang District RPJM; i.e. for the period 2011 – 2015 and focuses on the following areas: 1) enhancement of civil awareness and compliance to law and regulations, 2) Increase government officers' professionalism towards better public services, 3) Develop adequate infrastructure to support economic base activities in agriculture, mining, marine, industrial, trade and tourism, 4) Develop a natural environmental preservation and monitoring system, 5) reduce poverty, unemployment, and provide a better situation for the labour force, 6) Improve the quality of health and education, and 7) Control population growth, family welfare, and gender mainstreaming in development.

7.1.8 CCRAA Mainstreaming into Malang District Medium-Term Development Plan (RPJMP)

Malang District RPJM is the obligatory planning document that is developed by the Local Government to elaborate a vision, missions, and development agenda into strategies, policy, programmes, and development activities which are consistent with the guidance provided by Malang District RPJP 2005 – 2025. In addition, the RPJM document is also referred to by district agencies in formulating their annual development activities.

At the earliest stage, the RPJM outlines 7 strategic problems for the period, of which, based on a preliminary identification, there are 3 that relate to the CCRAA context[28]. The first is the lack of health services for poor people and those is remote areas, the second is the concern regarding demands for agriculture production and food insecurity, and the last is about the provision of basic services including health services and clean water provision.

Then the RPJM provides a special section with regard to environmental challenges through a SWOT analysis[29]. In relation to the CCRAA, the RPJM has defined that the potential of natural resources is one of the main strengths to be utilized, especially for theagriculture sector. However, from the weaknesses perspective, it has been inferred that the district is still lacking in utilizing resources for agriculture productivity. In addition, this part also mentions the threat of several disasters such as volcanic eruption, landslide, floods, and tsunamis as their weakness. From the opportunity side, the existence of political will to have a more sustainable development and policy and to position Malang District as one of the development centres in East Java in the agriculture sector has been affirmed as opportunities. The RPJM thus literally expresses the fact that environmental degradation, global warming, and extreme climate change are some of the biggest threats towards development for this period.

The RPJM then mentions 11 strategic issues, of which 3 might have relation to the CCRAA context; i.e. 1) access to health services for the population, 2) economic growth and revitalisation of the agriculture sector, and 3) optimisation of natural resource utilisation and natural conservation. In advance, development of the agriculture sector towards food security and health services is being placed as second out of 6 focus development sectors.

The medium-term development vision mentioned in the RPJM is Malang District as an Empowered, Religious, Democratic, Productive, Advanced, Secured, Ordered, and Competitive Society. The RPJM goes on to define eight development missions; i.e. 1) establish values based on religion and custom, 2) establish good, clean, just, and democratic governance, 3) establish supreme law and human rights, 4) establish a secure, ordered, and peaceful environment, 5) enhancement quality and provision of infrastructure, 6) establish productive and competitive human resources, 7) establish an agriculture and rural based economic growth, and enhancement of quality and services as well as sustainable utilisation of the natural environment. In providing more detailed development activities, the RPJM is equipped with appropriate formulation of goals, objectives, general policy, and key programmes for each development mission.

Table 7.12 below provides related features in the RPJM in the context of the CCRAA process and output. In general, it can be seen that even though the document has mentioned climate change impact as one of the major threats, there are no specific programmes that have been addressed, especially in relation to the sectors discussed in the CCRAA. Still, there is one key programme mentioned, which is the importance of climate

[28] See Chapter 4, Malang District Medium-Term Development Plan 2011 – 2015
[29] See Chapter 4, Malang District Medium-Term Development Plan 2011 – 2015

prediction; however it was only dedicated to seashore fisheries activity[30]. Neverthelss, selected key programmes below can be defined as probable entry points for further adaptation action that consider climate change impact measurement.

[30] See for more in key programs of fisheries sector in Malang District MTDP 2010 – 2015, the fishery sector itself was out of CCRAA context.

Table 7.12 Related Development Goals, Objectives, General Policy, and Key Programmes in RPJM with CCRAA Process and Output

GOALS / OBJECTIVES	GENERAL POLICY	RELATED KEY PROGRAMMES
Goal Number 5: Increased numbers and qualified public works, water resources, settlement, and energy infrastructure in order to support economic, social, and cultural activity. Objective Number 5: Constructed and well maintained public works, water resources, settlement, and energy infrastructure for economy, tourism, and poverty alleviation.	Providing and maintaining the condition of transportation, public works, water resources, settlement, and energy infrastructure with priority to support economic activities, tourism, and poverty alleviation.	Construction of drainage system Construction of river bank Construction, rehabilitation, inspection, and emergency preparation for roads and bridges Provision of water treatment installation Flood control Management on river, lake, and other water resources Clean and drinking water treatment Introduction of healthy settlement environment
Goal Number 6: Increased quality and productivity of human resources Objective Number 6: Better access to education and health services for society	Increasing accessibility to qualified education and health services, developing competence based education facility, developing local health centre (Puskesmas), and free of charge on education and health services.	Medicine and health support facilities Health promotion and community empowerment Nutrient betterment programme Development of healthy environment Prevention of contagious diseases Health services standardization Construction, improvement, and maintenance of hospital, local health centre (Puskesmas), and other facilities
Goal Number 7: Increased and equitable prosperity Objective Number 7: Increased economic growth on agriculture sector through comprehensive agribusiness as base for industry, commerce, and services as well as tourism through the mainstreaming of small medium enterprises and cooperative unit.	Endorse economic growth on agriculture (crops, horticulture, farming, and fisheries), industry, commerce, and tourism; through the mainstreaming of SMEs, cooperative unit, and poverty alleviation.	Counseling and empowerment on farmer Increased on agricultural product promotion Application of technology on agricultural activity Forest land rehabilitation conservation
Goal Number 8: Increase functions and quality of natural environment and its utilization Objective Number 8: Well monitored spatial planning and land utilization, thus leads to a more responsible permit for industrial activities and reduce contamination	Monitoring of spatial planning, permit publication for industrial activities, rehabilitation of forest and critical area, and disaster mitigation plan	Spatial planning arrangement in general and detailed level Monitoring for environmental degradation Conservation of natural resources Improvement on natural environment and resources monitoring and information system.

Source: Summary from Chapter 5 Malang District RPJM 2010 – 2015

7.1.9 CCRAA Mainstreaming into Malang District General Spatial Plan

Malang District General Spatial Plan (RTRW) for the period 2010 – 2030 is the baseline for all spatial development activities in Malang District. It serves as the main consideration for more detailed plans, and complies with the Malang District RPJP 2005 – 2025. In relation to the CCRAA context, this part will identify the recognition of climate risk and affecting impacts within the RTRW of Malang City 2008 – 2028. In the earliest part, the document mentions that one of the threats of the district is flood occurrence influenced by the Brantas, Metro, and Lesti watersheds, which may become an entry point for the climate risk assessment.

The Malang District RTRW does not mention any specific spatial planning vision, and hence quotes the general goals of spatial planning in Indonesia that serve to address secured, comfortable, productive, and sustainable areas. Afterwards, there are several goals to be achieved by the RTRW; i.e. 1) enhancement of infrastructure to support economic development, 2) economic growth through agriculture, commerce, tourism, and industrial sector, 3) natural resources management that comply with the conservation function, 4) ordered development based on the spatial plan, and 5) a religious, democratic, and prosperous society.

To implement the vision and mission, the Malang District RTRW 2010 – 2030 consists of spatial structure, spatial pattern, strategic area, and spatial monitoring plans. Then the plan further examines the problems, prospects, and spatial strategies of the district, amongst which there are several that have further links with the sectors discussed in the CCRAA as follows:

Table 7.13 Plausible Context of Climate Change Impact in Malang City RTRW

SECTOR	PLAUSIBLE CONTEXT OF CLIMATE CHANGE IMPACT
Water	Related spatial structure strategy Enhancement of water resources network; e.g. development of irrigation network Optimisation of function and services of the water resources network; e.g. water spring protection, dam development, normalisation of irrigation network, and sluice maintenance. Related spatial pattern strategy Protection for conservation areas, including conservation forest, river banks, water springs. Avoidance of development in flood and landslide prone areas Ground water protection
Health	Related spatial pattern strategy Equitable distribution of health facilities both in rural and urban settlement area. Related spatial structure strategy Healthy environment for settlement development in urban areas; e.g. one septic tank per household, communal wastewater management, and sanitation improvement.
Agriculture	Related spatial pattern strategy Policy to preserve eternal and sustainable agricultural land, indicated with no prohibition on agricultural land decreased. In urban areas, where land conversion is unavoidable, it should be followed by half-technical irrigation development. In eternal agriculture area, crops cultivation will have incentives and there's no compliance for land conversion. Modernisation of village food-barn. Related spatial structure strategy Rural based structure to endorse agropolitan area/cluster throughout the district, with each village have agricultural product, both upstream and downstream, to introduce into international market.

Source: Analyzed from Malang District RTRW 2010 – 2030

7.2 Compatibility Process

One of the methods for mainstreaming is by measuring the compatibility between the preferred adaptation options and the local government programmes. The idea is to see whether the adaptation options fit into programmes that the local government has planned. The tool for this method is the compatibility matrix. It compares the adaptation options side by side with the government programme along with its location and risk level. The compatibility assessment recommends which adaptation options can be mainstreamed and where to mainstream them into the appropriate plans.

Complete results of the compatibility process of all sectors are attached in the Appendix, while examples of them are shown in the following sections.

7.2.1 Example in Water Sector

Examples below come from the water sector, covering examples of water shortage in Malang and Batu City, flood in Malang District and Batu City, as well as landslide in Malang City, Malang District, and Batu City. In terms of the water shortage risk, for Malang District, the Expert provides two adaptations actions for Zone II-C and III. Thus, as it can be seen in part A of Table 7.14, these options find compatibility in RKP 2012 of Malang District, i.e. Land Rehabilitation Programme, and Water Resource Development Programme. On the other hand, for Batu City as it can be seen in Part B of Table 7.14, the Expert suggests that conservation must be implemented for preserved forest, water springs, and groundwater. However, even though there are five similar programmes, it was found to be not fully compatible since the recommendation does not seem to solve environmental degradation in Batu City directly. Therefore, the recommendation is to conduct a further assessment of environmental degradation and its losses for Batu City.

As an example of flood hazards, Part C of Table 7.14 shows that the Expert recommends two types of adaptation for the Kondo Watershed in Malang District, which was found to be compatible with two programmes from the government. However, the location of the programme itself is not compatible with the preference according to the risk level. Therefore, the recommendation is to conduct a feasibility study of both adaptations. The compatibility measurement for Batu City with regard to flood hazard is similar to the description for Malang District. Preferred adaptations from the Expert are reforestation and construction of a check-dam, which is compatible with the natural and water development programme as well as the rural infrastructure development programme. However, the locations decided by the programme are again incompatible. This leads to recommendations to have a comprehensive environmental planning and feasibility study for the preferred adaptations.

On the other hand, Part E and F of Table 7.14, suggest different compatibility results for landslide risk in all areas. In Malang District and Malang City, reforestation and engineering construction suggested by the Expert are incompatible with the land rehabilitation programme from the government. Therefore, the recommendation is to proceed to draw the detailed engineering design for the adaptations. Similarly, adaptations suggested for Batu City are engineering construction and reforestation. TThese were incompatible with the urban infrastructure development, green open-space, and water management programme; i.e. since it is planned to support tourism and the trade sector which contribute to the economic development of the city. Therefore, the recommendation is to conduct a green-GDP initiatives or environmental valuation to solve this incompatibility.

Table 7.14 Example of Compatibility in Water Sector of Greater Malang

A. Water Shortage in Malang District

Zone	Location with High and Very high Level of Risk	Adaptation Preferred by Expert	Planned Programme 2012 (RKP, APBD)	Programme Compatibility	Programme Location	Location Compatibility Level	Importance	Recommendation	Mainstreaming
II C. Lesti		• Highland to midland: (1) Reforestation in moor area, (2) agro- forestry (3) artificial recharge with levee in agricultural land,; (4)construction of small- dam; (5) reduce land erosion; • Low-land/rural area: (1) artificial recharge with wells; (2) drainage maintenance	Land Rehabilitation Programme	Compatible			1 - 5		
III. Bag. Selatan Sub DAS Metro – Lahor-Melamon		Highland: (1) Reforestation, in moor area; (2) land erosion prevention. Low-land/dam area: (1) dam-engineering; (2) spillway evaluation; (3) emergency spillway; (4) dam evaluation; (5) reduce water supply for dam; (6) dredging of sediment.	Water Resource Development Programme	Compatible			4 - 5		

B. Water Shortage in Batu City

Zone	Location with High and Very high Level of Risk	Adaptation Preferred by Expert	Planned Programme 2012 (RKP, APBD)	Programme Compatibility	Programme Location	Location Compatibility Level	Importance	Recommendation	Mainstreaming
• Surface water (water spring and Brantas River) • Groundwater below acquifer	138 water spring and catchment area of groundwater (Batu and Beji Subdistrict) - Preservation Forest and	• Conservation forest • Conservation of water spring • Conservation of groundwater	Conservation Programme of Water spring and groundwater	Incompatible, because not directly related to environmental degradation.	Batu City area	Compatible	5	-Environmental degradation calculation, by: a. Willingness to pay b. Market value replacement c.Productivity value d. Cost Production e. Travel cost f. Hedonic Pricing -Estimation of economic value from water exploitation towards environmental degradation.	Ministry of Environment
			Conservation of catchment area		-		4-5		
			Reforestation and land rehabilitation		-				
			Environmental		-	Compatible			

			preservation and natural resource development					- Assessment for catchment area in batu City	
	Slope of Arjuno, Raung, Panderman, Anjasmoro, Pusung-Kutu, Kerumbung, G. Banyak, Punuk Sapi, G.Bokong, Srandil, G.Kembar		Utilization of geo-thermal source in Cagar Water spring		- 13 mountains mountains o		3-4	- Geo-thermal feasibility study Note: Batu City supplies water to Malang City and District, but there's no environmental compensation aside of tax. Kab/Kota Malang)	Ministry of Energy and Mineral Resources (ESDM)

C. Flood Hazard in Malang District

Zone	Location with High and Very high Level of Risk	Adaptation Preferred by Expert	Planned Programme 2012 (RKP, APBD)	Programme Compatibility	Programme Location	Location Compatibility Level	Importance	Recommendation	Mainstreaming
Konto Watershed	Hulu Brantas (Batu, Junrejo, Karangploso, Dau, Lowok Waru, Klo-jen, Blimbing, Kedung Kandang, Sukun, Pakis Haji, Tumpang, Ponco-kusumo, Tajinan, Bulu-lawang, Wajak, Kepanjen, Gondang Legi, Pagak, Kalipare)	• Greenery • Pond • Infiltration technology, e.g. biopori, green open space provision, etc.	• Agro-forestry, community-forest, and land rehabilitation. • Pond construction	Compatible	Karangplos, Tumpang, Poncokusu-mo, Wajak, Gondang Legi	Incompatible: Batu, Junrejo, Dau, Lowok Waru, Klojen, Blimbing, Ke-dung kandang, Sukun, Pakis Haji, Tajinan, Bulu-lawang, Kepanjen, Pagak, Kalipare	3 – 5	Environmental Planning : reactive, proactive and intregative Pond feasibility study Micro-hydro feasibility study	
	Kondang Merak (Pagak, Bantur, Donomulyo, Kalipare)	• Greenery • Pond	Water resource development programme (pond construction planning)	Compatible	Kalipare, Pagak, Bantur, Donomuly o	Incompatiblei: Kalipare	3 – 5		

D. Flood Hazard Batu City

Zone	Location with High and Very high Level of Risk	Adaptation Preferred by Expert	Planned Programme 2012 (RKP, APBD)	Programme Compatibility	Programme Location	Location Compatibility Level	Importance	Recommendation	Mainstreaming
Sumber Brantas, in Batu area	Sumberbrantas, Tulungrejo, Gunungsari, Mojorejo Torongrejo villages	• Greenery	Natural resource management, conservation, and rehabilitation	Compatible	Along Brantas river	Compatible	5	Environmental Planning : reactive, proactive and intregative	Ministry of Environment
	Temas, Torongrejo, Mojorejo	• Check dam construction (runoff control)	• Rural infrastructure development programme • Water Resource development programme	Compatible	Junrejo Sub-District		3	• Check dam feasibility study • Micro-hydro feasibility study	Kementrian PU Kementrian ESDM

E. Landslide Hazard in Malang District and Malang City

Zone	Location with High and Very high Level of Risk	Adaptation Preferred by Expert	Planned Programme 2012 (RKP, APBD)	Programme Compatibility	Programme Location	Location Compatibility Level	Importance	Recommendation	Mainstreaming
Malang District	Gondang Legi	Engineering construction	• Land Rehabilitation programme	Incompatible	---	Incompatible	4 - 5	Detailed engineering design	
Malang City	Blimbing	Engineering construction Reforestation		Incompatible	---	Incompatible	3 - 5	Detailed engineering design	
Malang City	Kedung Kandang			Incompatible	---	Incompatible	3 - 5	Detailed engineering design	

F. Landslide Hazard in Batu City

Zone	Location with High and Very high Level of Risk	Adaptation Preferred by Expert	Planned Programme 2012 (RKP, APBD)	Programme Compatibility	Programme Location	Location Compatibility Level	Importance	Recommendation	Mainstreaming
Batu City	Temas and Beji due to highest risk to major landslide from Brantas watershed.	Engineering construction Reforestation	Urban Infrastructure Programme; (1) Bio-retention along drainage and pavement in urban area, (2) Socialization and workshop regarding community behavior and decreased environmental carrying capacity., (3) Natural resource rehabilitation programme Green open-space programme: increase the area of green open	Incompatible, because the programme is only effective for short-term; less rational and comprehensive.	Oro oro Ombo, Temas, Pesanggrahan, Gunungsari, Sumberbrantas, Sumberejo, Beji villages	Compatible	3-4	Green GDP (value assessment on natural resource reserve, economic valuation, environmental charges, and BCR) GDP contribution from tourism and trade tend to	Ministry of Environment

Zone	Location with High and Very high Level of Risk	Adaptation Preferred by Expert	Planned Programme 2012 (RKP, APBD)	Programme Compatibility	Programme Location	Location Compatibility Level	Importance	Recommendation	Mainstreaming
			space, measurement and control of green open-space size. Water resource management; (1) infiltration and runoff rate measurement, (2) runoff control construction along Brantas Watershed					increase, however these sectors also the highest contributing factor to landslide, runoff, and infiltration capacity.	

7.2.2 Example in the Agriculture Sector

Table 7.16 provides the example of the compatibility process for the agriculture sector. As it can be seen, there are three preferred adaptations, i.e. 1) enhancement of the capacity of rainwater reservoirs , 2) revitalisation of the irrigation network and water gate, and 3) conservation of land and groundwater in agricultural land. Each of them has its own prospective-compatible programme. The first one saw itself compatible with the water resource development programme, even though it is partially incompatible in terms of location and the number of reservoirs to be developedt. Then, the second one is also compatible even though the estimation within the programme is less intensive than is needed; therefore the recommendation is to continue the installment and maintenance of a water gate. While, the third was found to be partially compatible with the protection and conservation of natural resources programme, and incomplete in terms of location. Thus, the recommendation is for having cultivation of perennials and sediment monitoring and strategic reservoirs in the upstream of the Brantas watershed.

Table 7.15 Example of Compatibility in the Agriculture Sector of Greater Malang

No	Adaptation Preffered by Expert	Hazard being anticipated	Programme for 2012 (RKP, APBD)	Programme Compatibility	Programme Location	Location with High and Very high Level of Risk	Hazard, Vulnerability Factor	Location Compatibility Level	Importance	Recommendation	Mainstreaming
3	Rainwater reservoirs capacity enhancement	Decrease of rain-fed agricultural area	Water resource development programme: • Preservation of water spring • Construction of Pond (Dinhut, BPLHD, BBWS, BP DAS, PJT)	Compatible, but lacking in numbers.	Metro-Lahor-Mela-mon (Dao, Wagir, Pakisaji, Kapanjen, Ngajum, Kromengan, Wonosari) Watershed	. Dampit . Wajak . Turen . Pagelaran . Kepanjen Singosari	Vas area-size of non-irrigated land Low level of income of farmer Low and plain topography	Compatible: Kepanjen. Incompatible: Dampit, Wajak, Turen, Pagelaran, Singosari	. 3 . 5 . 2 . 5 . 2 5	Requires synchronization between Pemkab, PJT, Forestry Agency, and community The minimum demands of 34 ponds can be fulfilled 11 units through rehabilitation in 2011.	• Programme 2012 (?) • Ministry of Public Work for pond's material (?)
4	Revitalization of irrigation network and water gate	Decrease of agricultural land	Irrigation Network, Swamp, and other water network development (Dinhut, BPLHD, BBWS, BP DAS, PJT)	Compatible, but needs to be more intensive	Brantas Watershed (not specific)			Partially compatible	. 5 . 5 . 5 . 5 . 4 5	Installment and maintenance of water gate at intake (17 secondary network has been rehabilitated by 2011)	Programme 2012 (?)
5	Conservation of land and groundwater in agricultural land.	Decrease of agricultural land	Protection and conservation of natural resources Programme • Water resource conservation and control of water spring • Community advocacy • Land rehabilitation • Securing water spring from desctruction. (Dinhut, BPLHD, BBWS, BP DAS, PJT)	Partially compatible	---			Incompatible	All: 5	Cultivation of perennials (e.g. sengon, jabon, teak), productive plantation in economic valuable area Sediment monitoring in strategic reservoirs in upstream side of Brantas.	Program 2012 (?)

7.2.3 Example in the Health Sector

Table 7.16 presents the compatibility examples for the health sector in Greater Malang, which consists of compatibility adaptations for three diseases, i.e. DHF, malaria, and diarrhea. For DHF, the preferred adaptation from the Expert is the type of environmental rehabilitation, which comprises a set of measures: socialisation, drainage retrofitting, enhancement of clean water service, and vector (mosquito) control in housing area. All of the adaptations found compatibility, two with full compatibility and the rest are partially compatible, with the health promotion programme, drainage development programme, irrigation-swamp-water network development programme, and healthy-environmental programme. However, it was found out that the location is incompatible due to the absence of specific designation in the government programme. Therefore, the recommendation is to have regulations on this matters and to prioritise areas with high-level of risk.

Compatibility for adaptation to counter-measures for malaria are also similar with the previous case. In general, three adaptations proposed under the control of domestic wastewater in flood-risk, coastal inundated, and slum areas are compatible with five programmes from local government; even though the degree of compatibility varies. The locations are incompatible, thus the recommendation is focused on improving sanitation facilities, i.e. to include community-based sanitation programme.

Preferred adaptations for counter-measuring diarrhea are also focused on the control of domestic wastewater in flood-risk, coastal inundated, and slum areas, i.e. consisting of socialisation and provision of toilets and septic tanks in houses, as well as socialisation and the provision of urban drainage and wastewater facilities. Both find compatibility even though not yet integrated. Thus, the recommendation puts the emphasis on the improvement of sanitation including community-based sanitation. In addition, the priority of adaptation will also be given for locations with higher flood-risk.

Table 7.16 Example of Compatibility in Health Sector of Greater Malang

A. DHF Disease Hazard

No	Hazard and Vulnerability Factor	Adaptation Type	Adaptation Preffered by Expert	Programme 2012 (RKP, APBD)	Level of Compatibility	Location with High and Very High Level of Risk	Programme Location	Location Compatibility Level	Importance	Recommendation	Main-streaming
8	• Climate hazard (increased temperature, percipitation) • Population number and density • Potential mosquito breeding site due to the absence of water pipe system.	2. Environ-mental Rehabi-litation	Socialization: to reduce water inundation and/or to introduce prey for wiggler in water-tank.	Health promotion programme and community empowerment	Compatible activities, but unoptimum	• Malang City (All subdistrict) • Malang District (Dau, Sumber Pucung, Turen), • Batu City (Batu dan Junrejo).	---	Incompatible	KoM: 3 KaM: 2 KoB: 2	Regulations regarding Healthy-environment: • Circular Letter (SE) by Major/Bupati, • Regulation by Major/ Bupati • Local Regulation (Perda) • Joint Decision Letters (SK Bersama) Menkes, MenLH, Mendagri • Priority of actions in locations with high and very high level of risk.	Ministry of Environment coordinates the Joint Decision Letters (SKB) with Health Ministry and Ministry of Home Affairs about the Healthy Environment Regulation
9			Drainage retrofitting	Drainage development programme (DPU)	Compatible		---	Incompatible	KoM: - KaM: - KoB: -		
10			Enhancement of clean water service (PDAM)	Irrigation-swamp-water network development programme (DPUCK)	Compatible		---	Incompatible	KoM: 4 KaM: 4 KoB: 3		
11			Vector (mosquito) control in housing area and public building.	healthy-environmental programme	Compatible activities; but not-integrated substances		---	Incompatible	KoM: - KaM: - KoB: -		

B. Malaria Disease Hazard

No	Hazard and Vulnerability Factor	Adaptation Type	Adaptation Preffered by Expert	Programme 2012 (RKP, APBD)	Level of Compatibility	Location with High and Very High Level of Risk	Programme Location	Location Compatibility Level	Importance	Recommendation	Main-streaming
5	• climate hazard (temperature,	2. Control of domestic wastewater in flood-	Socialization and provision of toilet and septic tank in houses.	• Community Based Sanitation Programme (STBM) (Kemenkes)	Compatible activities; but not-integrated	• Kota Malang (Sukun, Blimbing) Kota Batu:	---	Incompatible	KoM: 5 KaM: - KoB: 4	Sanitation Rehabilitation • Healthy House Program	• Ministry of Social • Corporate Social Responsibility • Community Housing

6	percipitation) • Population • Sanitation and clean water facility in housing area	risk, coastal inundated, and slum area	Socialization and provision of urban drainage and wastewater facility	• Programme Pembangunan saluran drainase/ gorong-gorong (DPU) • Programme Upaya Kesehatan Masyarakat Program pengembangan lingkungan sehat	Compatible activities; but not-integrated	(Batu, Bumiaji, Junrejo)	---	Incompatible	KoM: - KaM: - KoB: -	• Healthy Lavatory Program Sehat Optimalisasi Program Sanitasi Total Berbasis Masyarakat (STBM) →Terutama pada daerah rawan bencana banjir (lokasi risiko tinggi)	Ministry • Ministry of Public Work (Cipta karya) Ministry of Health (STBM)
7			Provision of chlorine in wells	Program Upaya Kesehatan Masyarakat	Compatible, but demands continuity		---	Incompatible	KoM: 5 KaM: - KoB: 3		

C. Diarrhea Disease Hazard

No	Hazard and Vulnerability Factor	Adaptation Type	Adaptation Preffered by Expert	Program 2012 (RKP, APBD)	Level of Compatibility	Location with High and Very High Level of Risk	Program Location	Location Compatibility Level	Importance	Recommendation	Main-streaming
5	• Climate hazard (temperature, percipitation)	2. Control of domestic wastewater in flood-risk, coastal inundated, and slum area	Socialization and provision of toilet and septic tank in houses.	• Community Based Sanitation Program (STBM) (Kemenkes) • Drainage construction program (DPU) • Community Health effort program • Healthy environment development program	Compatible activities; but not-integrated	• Kota Malang (Sukun, Blimbing) • Kota Batu: (Batu, Bumiaji, Junrejo)	---	Incompatible	KoM: 5 KaM: - KoB: 4	Sanitation Rehabilitation • Healthy House Program • Healthy Lavatory Program Optimalization of the Community Based Sanitation Program (STBM) →Especially in highly flood risk areas	• Ministry of Social • Corporate Social Responsibility • Community Housing Ministry • Ministry of Public Work (Cipta karya) • Ministry of Health (STBM)
6	• Population • Sanitation and clean water facility in housing area		Socialization and provision of urban drainage and wastewater facility		Compatible activities; but not-integrated		---	Incompatible	KoM: - KaM: - KoB: -		

7.3 Synchronisation Process

The purpose of the synchronisation of recommended programmes or activities by local government and programmes or activities that central government agencies have is to identify potential funding mechanisms for those recommended programmes or activities, either available from the sectoral ministries or other sources. The appropriate central government office that manages a similar programme or activity is also identified during the synchronisation process. The result of this synchronisation process for each sector is in a form of a policy matrix as illustrated below.

Complete results of the synchronisation process for all sectors are attached in the Appendix, while examples of them are shown in the following sections.

7.3.1 Example in Water Sector

In Part A of Table 7.17 it can be seen that the adaptation of water resource conservation to counter-measure the decreased water availability is being synchronised into two programmes and nine activities in Malang District. Then, two different types of adaptations for flood-risk are being synchronised into two programmes. Finally, one adaptation for landslide in Malang District, the reforestation action, is being synchronised to land rehabilitation programme. In Malang District, the responsible agencies are the Forestry Agency, Water-source, part of the Public Works Agency, and Bappeda.

On the other hand, synchronisation in Batu City is being done for adaptation to the risk of decreased water availability. The adaptation is water resource conservation and is synchronised to the natural resources preservation programme and water resource management programmes. The responsible agencies are the Forestry Agency, Public Works Agency, and Bappeda.

Synchronisation in Malang City sees the adaptation to decreased water availability, flood, and landslide risk is similar, i.e. conservation of water resource and reforestation. It is then synchronised to the surface and groundwater conservation and forest planning development programmes. The responsible agencies are the Forestry Agency and Landscape-Park Agency.

Table 7.17 Example of Synchronisation in the Water Sector of Greater Malang

A. Malang District

Risk	Expert's Option	No	Local Programme related with Climate Change	Responsible Agency	*Stakeholders*		
					Central Govt'	Private/BUMN	Others
1. Decreased Water Availability	Related to the Water Resource Conservation Option	6	Land Rehabilitation Programme	Forestry Agency	Ministry of Public Work DJ-BPDAS-PS; Forestry Ministry DJPLA		
		6.1	Aforestration in rainfed field and waste areas				
		6.2	Agro- forestry				
		6.3	Tertiary canalls construction in plantation field for infiltration uses				
		8	Water resource Management and Development Programme	Public Work Agency for Water; Local Planning Office (Bappeda)	Ministry of Public Work DJSDA		
		8.1	Construction of infiltration wells for biopori enhancement				
		8.2	Construction of retardation basin or polder (ponds)				
		8.5	Development of surface water resources in areas containing many small rivers				
		8.6	Development of ground water and sub-surface water in karst areas				
		8.7	Rain water collection container in areas with small potencies of surface and ground waters				
2. Flood	Related to the Conservation/ Reforestation Option	1	Land Rehabilitation Programme	Forestry Agency	Ministry of Public Work DJ-BPDAS-PS; Forestry Ministry DJPLA		
		1.1	Agro-forestry				
		1.2	Community Forest				
		1.3	Reforestration				
	Related to the Development of Drainage/ Flood Control	8	Water Resource Development Programme	Public Work Agency for Warer	Ministry of Public Work DJSDA		
		8.1	Spring sustainability				
		8.2	Pond construction				
		8.3	Infiltration technology enhancement (biopori, infiltraton wells, , utilization of green open field)				

Risk	Expert's Option	No	Local Programme related with Climate Change		Responsible Agency	*Stakeholders*		
						Central Govt'	Private/BUMN	Others
3. Landslide	Related to the Conservation/ Reforestration Option	2	Land Rehabilitation Programme		Forestry Agency	Ministry of Public Work DJ-BPDAS-PS; Forestry Ministry DJPLA		
			2.1	Community Forest				
			2.2	Reforestration				

B. Batu City

Risk	Expert's Option	No	Local Programme related with Climate Change		Responsible Agency	*Stakeholders*		
						Central Govt'	Private/BUMN	Others
1. Decreased Water Availability	Water resource conservation	7	Development and Sustainability Programme for Environment and Water Resources		Forestry Agency	Forestry Ministry DJPHKA; Ministry of Environment		
			7.1	Reforestation and land rehabilitation				
		8	Water Resource Management and Development Programme		Public Work Agency for Water; Local Development Planning (Bappeda)	Public Work Ministry DJSDA		
			8.11	Establishment of Local Regulation of Water Resource Conservation Areas				
			8.12	Forecasting the Water Balance for 5 years forward				
			8.13	Technical computation of infiltration and run-off rates along road				
			8.14	Construction of run-off barrier along roads toward rivers				
			8.15	Construction of Sabo DAM				

C. Malang City

Risk	Expert's Option	No	Local Programme related with Climate Change	Responsible Agency	*Stakeholders*		
					Central Govt'	Private/BUMN	Others

1. Decreased Water Availability	Water resource conservation programme	5	Surface and Groundwater conservation programme	Forestry Agency	Public Work Ministry DJSDA; Ministry of Energy and Mineral Resources		
2. Flood	Conservation and Reforestation	2.b	Forest Planning Programme Malang City: community forest	Landscape-Park Agency	Forestry Ministry DJPL		PT Perhutani
3. Landslide	Conservation and Reforestation	1	Greenery Programme	Landscape-Park Agency	Ministry of Environment		
			1.1 Reforestation				

7.3.2 Example in the Agriculture Sector

An example of synchronisation in the agriculture sector is given in Table 7.18. It can be seen that for the adaptation to the risk of decreased production, the adaptation recommendations consist of the land and groundwater conservation in agricultural area as well as the opening of new agricultural plots. The first adaptation is being synchronised to the water resource management programme and the natural resources conservation and protection programme. In addition, the latter is synchronised to the land rehabilitation programme. Further coordination will be needed since the list of responsible agencies is quite long, comprising the Forestry Agency, BPLHD, BBWS, BP DAS Brantas, and Perum Jasa Tirta.

Table 7.18 Example of Synchronization in Agriculture Sector of Greater Malang

Risk	Expert's Option	No	Local Programme related with Climate Change		Responsible Agency	*Stakeholders*		
						Central Govt'	Private/BUMN	Others
Decreased Production	Land and Groundwater conservation in Agricultural area	3	Water resource development programme		DinHut, BPLHD, BBWS, BP DAS Brantas, Perum Jasa Tirta			
			3.1	Water spring preservation				
			3.2	Construction of Pond				
			3.3	Rainwater reservoirs capacity enhancement				
		6	Natural resource protection and conservation programme		DinHut, BPLHD, BBWS, BP DAS, Perum Jasa Tirta	Kemen-Hut; Kemen PU DJ-BPDAS-PS; Kemen-PU DJSDA		
			6.1	Water resource conservation and control on water resource destruction				
			6.2	Land rehabilitation advocacy group				
			6.3	Refinement of destructed water spring				
			6.4	Cultivation of perennials (e.g. sengon, jabon, teak), productive plantation in economic valuable area				
			6.5	Sediment monitoring in strategic reservoirs at the upstream of watershed				
	Opening of new agricultural plot and optimization in rain-fed field with reforestation	8	Land Rehabilitation Programme		DinHut, BPLHD, BBWS, BP DAS, Perum Jasa Tirta	Kemen-Hut; Kemen PU DJ-BPDAS-PS		
			8.1	Agro-forestry				
			8.2	Community forest				
			8.3	Land Optimization in rain-fed field with reforestation				

7.3.3 Example in the Health Sector

Table 7.19 below provides an example of synchronisation in the health sector for all three diseases, DHF (dengue fever), malaria, and diarrhea, which generally will be approached by environmental improvements. For DHF, it is synchronised into three programmes; i.e. irrigation-swamp-other water networks development, provision of basic clean water, and development of healthy environment. The responsible agencies for the three programmes are shared between the Public Works Agency and Health Agency.

On the other hand, an environmental improvement for adapting to malaria risk is only synchronised through the healthy-environment development programme. The activity specifically for this purpose is the effort to reduce inundation in coastal areas and fields, as well as by combining it with introduction of prey of the mosquito. The responsible agency for this programme is the Health Agency.

In the case of diarrhea, the environmental improvement is being synchronised to the Irrigation-swamp-other water networks development programme and healthy-housing environment development programme. The first is basically related to the effort for improving health-community and the activities consist of construction of a clean water network, utilisation of chlorine, and improvement of water quality. As for the second programme, it is more focused on socialisation and theprovision of toilets and septic-tanks in housing areas.

Table 7.19 Example of Synchronisation in the Health Sector of Greater Malang

Risk	Expert's Option	No	Local Programme related with Climate Change	Responsible Agency	*Stakeholders*		
					Central Govt'	Private/BUMN	Others
DHF	Environmental Improvements	3	Irrigation-swamp-other water networks development Programme (Construction of clean and drinking water network)	Dinas PU Cipta Karya	Kemen-PU DJCK		
			Related with: Drainage network construction programme				
			3.1 Retrofitting of drainage				
			3.2 Improvement on piped water network				
		4	Provision and management of basic clean water programme	Dinas PU Cipta Karya; PDAM; BLH Prov. Jatim	Kemen-PU DJCK		
			4.1 Improvement on piped and non-piped clean water (PDAM)				
		5	Healthy-Environment Development Programme	Dinas Kesehatan	Kemenkes Peny. Lingkungan, Kemen-PU DJCK		
			5.1 Vector (mosquito) control in housing and public building.				
Malaria	Environmental Improvements	3	Healthy-Environment Development Programme	Dinas Kesehatan			
			3.1 reduce of inundation in coastal area, field, as well as by combines with introduction of prey to mosquito, and dessalinzation effort.				
Diarrhea	Environmental Improvements	2	Irrigation-swamp-other water networks development Programme	DinasPU Cipta Karya	Kemen-PU SDA		
			Related with: Community-health improvement		Kemenkes DJ-P2PL		
			2.1 Clean/drinking water network development		Kemen PU DJCK	HIPAM	
			2.2 Usage of chlorine for wells and water tank	Dinas Kesehatan			
			2.3 Improvement of drinking water quality.	Dinas PU Cipta Karya; PDAM			
		4	Healthy- Housing Environment Development Programme	Bappeda	Pokja Perum. Bappenas; Kemen-pera + Kemen PU DJCK; Kemenkes; Kemen-KP		
			4.3 socialization and provision of toilet and septic-tank in housing area	Bappeda			

7.4 Champion Programme

Finally, the champion programme is formulated based on the recommendations from an adaptation prioritisation process as well as the synchronisation in order to get funding commitment either from state budget, through respective central government agencies, or from non-state budget, including international funds. This champion programme is actually multi-sectoral, but the associated sectoral programmes and activities are identified, as illustrated in the table below. The leading agency from central government is also identified for every programme being proposed. The table also lists which risk to be anticipated by the programme or activities, as well as the dominant vulnerability factor, in order to sustain the flow that all programmes or activities are addressing climate change impacts as the results of the CCRAA.

Table 7.20 Champion Programme of Greater Malang

Champion Programme	Related Sector	Related Governmental Programme	Related Activities	Related Ministry / Agency	Climate Change Risk Anticipation	Dominant Vulnerability Factor
Water Resource Conservation in Upstream Part of Catchment Area of Brantas River	• Water • Agriculture	Land Rehabilitation Programme	• Aforestration (*Reboisasi*), especially in moor and waste areas • Agro-forestry • Community forest	Forestry Ministry; Public Work Ministry-DJBPDAS-PS; Ministry of Environment	• Water shortage • Flood • Landslide • Decreased food production due to decreased agriculture land	So many land conversions of forest into human settlements, tourism, and agriculture in upstream part of the Brantas catchment areas
		Water Resources Development Programme	Pond construction	Public Work Ministry-DJSDA		
	Health	Land Rehabilitation Programme (additional)	Enrichment mammals (monkeys, etc.) into forests	Forestry Ministry	Malaria disease	Lack of mammals as target diversion of malaria mosquitoes
		Drainage development programme, integrated with: Healthy environmental development programme	Rehabilitation of drainage canals, rain drain, and clean water reservoirs air bersih	Public Work Ministry-DJCK and Health Ministry-DJP2PL; Ministry of Environment	• DHF disease • Malaria disease • Diarrhea disease	Many drainage canals, rain drain, and clean water reservoirs that do not fulfill environmental health standard
Climate-related Inventory and standardisation Programme.	Supporting Scientific Data	Climate-related Inventory and standardisation Programme.	Climate-data standardization Ocean climate-data standardization Climate-data inventory Ocean-climate-data inventory	BMKG; Badan Informasi Geospasial; Kemen-Ristek LIPI LAPAN	All sectors risks	Low level of accuracy in climate change and its projection analysis might lead to inappropriate adaptation recommendation; i.e. due to the lack and bad quality data.

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Appendix

A.1 Compatibility Matrices
A.1.1 Water Sector - Flood Hazard

1. Malang District

Zona	Lokasi resiko tinggi dan sangat tinggi	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi Program	Tingkat Kesesuaian lokasi	Tingkat Kepen-tingan	Rekomendasi	Main-streaming
DAS Konto	Konto (Kasembon, Pujon, Ngantang)	Penghijauan	---	Belum sesuai	---	Tidak sesuai	3	Environmental Planning : reactive, proactive and intregative (perwujudan dari perlindungan dan pemecahan masalah lingkungan)	
	Hulu Brantas (Kec Batu, Junrejo, Karangploso, Dau, Lowok Waru, Klo-jen, Blimbing, Kedung Kandang, Sukun, Pakis Haji, Tumpang, Ponco-kusumo, Tajinan, Bulu-lawang, Wajak, Kepanjen, Gondang Legi, Pagak, Kalipare)	• Penghijauan • Embung • Teknologi infiltrasi seperti sumur resapan, bio pori, pemanfaatan RTH dan sebagainya	• Program Pemulihan/ Rehabilitasi lahan (argoforestry, Hutan Rakyat Murni) • Pembuatan Embung	Sesuai	Karangploso, Tumpang, Poncokusumo, Wajak, Gondang Legi	Tidak sesuai: Batu, Junrejo, Dau, Lowok Waru, Klojen, Blimbing, Ke-dung kandang, Sukun, Pakis Haji, Tajinan, Bulu-lawang, Kepanjen, Pagak, Kalipare	3 – 5	Environmental Planning : reactive, proactive and intregative (perwujudan dari perlindungan dan pemecahan masalah lingkungan) Studi kelayakan embung Studi Kelayakan Potensi Mikrohidro	
	Bango (Karang Ploso, Lawang, Singosari, Blimbing, Pakis, Lowok Waru, Kedung	• Penghijauan • Embung • Teknologi infiltrasi seperti sumur resapan, bio pori,	• Program Pemulihan/ Rehabilitasi lahan (argoforestry) • Pembuatan Embung	Sesuai	Karangploso, Singasari, Pakis, Lawang	Tidak sesuai: Blimbing, Lowok Waru, Kedung Kandang	3 – 5	Environmental Planning : reactive, proactive and intregative (perwujudan dari perlindungan dan pemecahan masalah lingkungan) Studi kelayakan embung	

Zona	Lokasi resiko tinggi dan sangat tinggi	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi Program	Tingkat Kesesuaian lokasi	Tingkat Kepen-tingan	Rekomendasi	Main-streaming
	Kandang)	pemanfaatan RTH dan sebagainya							
	Amprong (Kedung-kandang, Pakis, Tumpang, Jabung)	• Penghijauan • Embung	• Program Pemulihan/ Rehabilitasi lahan (Hutan Rakyat Murni) • Pembuatan Embung	Sesuai	Pakis, Tumpang	Tidak sesuai: Kedungkandang, Jabung	3 – 5		
	Lesti (Poncokusumo, Tirtoyudo, Wajak, Turen, Dampit, Gondang Legi, Pagak, Bantur, Gedangan, Sumber manjing wetan)	Penghijauan	Program Pemulihan/ Rehabilitasi lahan (Hutan Rakyat Murni)	Sesuai	Poncokusumo, Wajak, Gondang Legi	Tidak sesuai: Tirtoyudo, Turen, Dampit, Pagak, Bantur, Gedangan, Sumber manjing wetan	3	Environmental Planning : reactive, proactive and intregative (perwujudan dari perlindungan dan pemecahan masalah lingkungan)	
	Glidik (Ampelgading, Tirtoyudo, Dampit)	Penghijauan	--	Belum sesuai	--	Belum sesuai	3		
	Panguluran (Gedangan, Sumbermanjing wetan, Dampit)		--	Belum sesuai	--	Belum sesuai	3		
	Barek (Bantur, Pagak, Gedangan)		--	Belum sesuai	--	Belum sesuai	3		
	Kondang Merak (Pagak, Bantur, Donomulyo,	• Penghijauan • Embung	Program Pengembangan Sumber Daya Air (Penyusunan	Sesuai	Kalipare, Pagak, Bantur, Donomulyo	Tidak sesuai: Kalipare	3 – 5		

Zona	Lokasi resiko tinggi dan sangat tinggi	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi Program	Tingkat Kesesuaian lokasi	Tingkat Kepen-tingan	Rekomendasi	Main-streaming
	Kalipare)		Rancangan Embung)						
	Donowari (Kalipare, Donomulyo)			Sesuai	Kalipare, Donomulyo	Sesuai	3 – 5		
	Lahor (Ngajum, Wonosari, Kromengan)			Belum sesuai		Belum sesuai	3 – 5		
	Metro (Lowok waru, Klojen, Sukun, Wagir, Pakis Haji, Ngajum, Kepanjen, Kromengan)	• Kolam penahan air (embung) • Teknologi infiltrasi seperti sumur resapan, bio pori, pemanfaatan RTH dan sebagainyaKolam retensi		Belum sesuai		Belum sesuai	3 – 5	Studi kelayakan DAM	

2. Batu City

Zona	Lokasi resiko tinggi dan sangat tinggi	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi Program	Tingkat Kesesuaian lokasi	Tingkat Kepen-tingan	Rekomendasi	Mainstreaming
Sumber Brantas wil Batu	Sepanjang aliran sungai Brantas di Kota Batu(Ds. Tulungrejo, Mojorejo, Pendem)	• Penataan guna lahan	- Program Monitoring dan evaluasi pembangunan kegiatan Kajian Pelaksanaan Tata guna lahan dan pola ruang dalam implementasinya thd RTRW dan Perda tata ruang	Sesuai	Seluruh Kota Batu	sesuai	3-4	• Monev perubahan guna lahan dan analisa kesesuaian lahan sepanjang DAS Brantas di wil kota Batu sbg dasar arahan kebijakan • Green spatial planning program (perhitungan benefit cost akibat environmental development dg green economy)	Kementrian PU
	Seluruh kota Batu		- Program perencanaan, monitoring dan evaluasi infrastruktur daerah						Kementrian LH
	Kel.Temas, Sisir, Songgokerto, Pesanggrahan, Ngaglik	• Manajemen Limpasan perkotaan	- Program pencegahan dini dan penanggulangan bencana alam	Sesuai	Daerah perkotaan padat permukiman dan perdagangan		4-5	• Floods zones • Site plans tangkapan hujan sepanjang drainase perkotaan (siteplan bioretensi kota)	Kementrian PU
	Ds. Sumberbrantas, Tulungrejo, Gunungsari, Torongrejo, Mojorejo	• Penghijauan	Pengelolaan, rehabilitasi dan konservasi sumber daya alam	Sesuai	Sepanjang aliran sungai Brantas		5	• Environmental Planning : reactive, proactive and intregative (perwujudan dari perlindungan dan pemecahan masalah lingkungan)	Kementrian LH
	Temas, Torongrejo, Mojorejo	• Pembangunan check dam (bangunan pengendali limpasan air)	• Program pembangunan infrastruktur perdesaan • Program pengelolaan sumber daya air	Sesuai	Kec.Junrejo		3	• Studi kelayakan check dam • Studi Kelayakan Potensi Mikrohidro	Kementrian PU Kementrian ESDM

Zona	Lokasi resiko tinggi dan sangat tinggi	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi Program	Tingkat Kesesuaian lokasi	Tingkat Kepen-tingan	Rekomendasi	Mainstreaming
	Sepanjang aliran DAS Brantas di wilayah Batu	• Penghitungan erosi sedimentasi	• Program Pengembangan pelestarian lingkungan dan sumber daya alam	Sesuai	Sepanjang aliran DAS Brantas di wilayah Batu		4	• Perhitungan degradasi dan daya tampung daerah aliran sungai Brantas di Wilayah Batu	Kementrian LH
		• Penataan perbaikan kawasan permukiman	- Penataan dan perbaikan kawasan permukiman kumuh, terutama di daerah pinggir DAS Brantas - Penertiban sempadan sungai	Sesuai			4	• Rencana pengelolaan Integrasi lintas sektoral dan lintas daerah sepanjang DAS Brantas di Malang raya	Kementrian LH

A.1.2 Water Sector - Landslide Hazard

1. Malang District dan Malang City

Zona	Lokasi resiko tinggi dan sangat tinggi	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi Program	Tingkat Kesesuaian lokasi	Tingkat Kepen-tingan	Rekomendasi	Mainstreaming
Kab. Malang	Ampelgading	Pekerjaan rekayasa Reboisasi	Program Pembangunan saluran Drainase/ Gorong - Gorong	sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	
Kab. Malang	Bantur	Pekerjaan rekayasa	Program Pengendalian Erosi dan Sedimentasi (Pembuatan Dam Penahan)	sesuai	---	Belum sesuai	4 - 5	Detail desain untuk pekerjaan rekayasa	
Kab. Malang	Bulu Lawang	Pekerjaan rekayasa Reboisasi	• Program Pengendalian Erosi dan Sedimentasi (Pembuatan Dam	sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	

Zona	Lokasi resiko tinggi dan sangat tinggi	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi Program	Tingkat Kesesuaian lokasi	Tingkat Kepen-tingan	Rekomendasi	Mainstreaming
			Penahan) • Program Pemulihan / Rehabilitasi Lahan						
Kab. Malang	Dampit		• Program Pengendalian Erosi dan Sedimentasi (Pembuatan Perlindung-an Kanan Kiri Sungai) • Program Pemulihan / Rehabilitasi Lahan	sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	
Kab. Malang	Dau		• Program Pengendalian Erosi dan Sedimentasi (Pembuatan Dam Penahan, Pembuatan Gully Plug) • Program Pemulihan / Rehabilitasi Lahan	sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	
Kab. Malang	Gondang Legi	Pekerjaan rekayasa	• Program Pemulihan / Rehabilitasi Lahan (Hutan Rakyat Murni)	tidak sesuai	---	Belum sesuai	4 - 5	Detail desain untuk pekerjaan rekayasa	
Kab. Malang	Kalipare		Program Pengendalian Erosi dan Sedimentasi (Pembuatan Dam Penahan)	sesuai	---	Belum sesuai	4 - 5	Detail desain untuk pekerjaan rekayasa	
Kab. Malang	Karangploso	Pekerjaan rekayasa Reboisasi	• Program Pemulihan / Rehabilitasi Lahan • Program Pengendalian Erosi dan Sedimentasi (Pembuatan Dam Penahan)	sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	

Zona	Lokasi resiko tinggi dan sangat tinggi	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi Program	Tingkat Kesesuaian lokasi	Tingkat Kepen-tingan	Rekomendasi	Mainstreaming
Kab. Malang	Kasembon	Pekerjaan rekayasa	Program Pengendalian Erosi dan Sedimentasi (Pembuatan Dam Penahan)	sesuai	---	Belum sesuai	4 - 5	Detail desain untuk pekerjaan rekayasa	
Kab. Malang	Kepanjen	Pekerjaan rekayasa Reboisasi	• Program Pengendalian Erosi dan Sedimentasi (Pembuatan Dam Penahan, Pembuatan Perlindungan Kanan Kiri Sungai) • Program Pemulihan / Rehabilitasi Lahan	sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	
Kab. Malang	Kromengan		• Program Pengendalian Erosi dan Sedimentasi (Pembuatan Dam Penahan) • Program Pemulihan / Rehabilitasi Lahan	sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	
Kab. Malang	Lawang			sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	
Kab. Malang	Ngajum			sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	
Kab. Malang	Ngantang			sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	
Kab. Malang	Pagak			sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	
Kab. Malang	Pakis		• Program Pengendalian Erosi dan Sedimentasi (Pembuatan Dam Penahan, Pembuatan Perlindungan Kanan Kiri Sungai) • Program Pemulihan / Rehabilitasi Lahan	sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	
Kab. Malang	Pakisaji			sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	
Kab. Malang	Pujon			sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	
Kab. Malang	Singosari			sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	
Kab. Malang	Sumbermanjing wetan			sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	

Zona	Lokasi resiko tinggi dan sangat tinggi	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi Program	Tingkat Kesesuaian lokasi	Tingkat Kepen-tingan	Rekomendasi	Mainstreaming
Kab. Malang	Tajinan			sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	
Kab. Malang	Tirtoyudo	Pekerjaan rekayasa	• Program Pengendalian Erosi dan Sedimentasi (Pembuatan Dam Penahan)	sesuai	---	Belum sesuai	4 - 5	Detail desain untuk pekerjaan rekayasa	
Kab. Malang	Tumpang	Pekerjaan rekayasa Reboisasi	• Program Pengendalian Erosi dan Sedimentasi (Dam Penahan) • Program Pemulihan / Rehabilitasi Lahan	sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	
Kab. Malang	Turen		• Program Pengendalian Erosi dan Sedimentasi (Pembuatan Dam Penahan, Perlindungan Kanan Kiri Sungai) • Program Pemulihan / Rehabilitasi Lahan	sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	
Kab. Malang	Wagir		• Program Pengendalian Erosi dan Sedimentasi (Pembuatan Dam Penahan) • Program Pemulihan / Rehabilitasi Lahan	sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	
Kota Malang	Blimbing	Pekerjaan rekayasa Reboisasi		Belum sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	
Kota Malang	Kedung Kandang			Belum sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	
Kota Malang	Klojen	Pekerjaan rekayasa		Belum sesuai	---	Belum sesuai	4 - 5	Detail desain untuk pekerjaan rekayasa	
Kota	Lowok Waru			Belum	---	Belum sesuai	4 - 5	Detail desain untuk	

Zona	Lokasi resiko tinggi dan sangat tinggi	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi Program	Tingkat Kesesuaian lokasi	Tingkat Kepen-tingan	Rekomendasi	Mainstreaming
Malang				sesuai				pekerjaan rekayasa	
Kota Malang	Sukun	Pekerjaan rekayasa Reboisasi		Belum sesuai	---	Belum sesuai	3 - 5	Detail desain untuk pekerjaan rekayasa	

2. Batu City

Zona	Lokasi resiko tinggi dan sangat tinggi	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi Program	Tingkat Kesesuaian lokasi	Tingkat Kepen-tingan	Rekomendasi	Mainstreaming
Kota Batu	Kel. Temas dan Beji mempunyai resiko paling besar longsor akibat aliran / lintasan DAS Brantas	Pekerjaan rekayasa Reboisasi	• Program infrastruktur perkotaan Kegiatan perencanaan bioretensi sepanjang drainase dan trotoar di kawasan perkotaan Sosialisasi dan Workshop tentang perilaku masyarakat thd penurunan daya dukung lingkungan • Program pengelolaan, rehabilitasi dan konservasi sumber daya alam • Program pengelolaan Ruang Terbuka Hijau : Kegiatan Penambahan RTH Kegiatan Perhitungan luas total RTH seluruh Batu • Pengelolaan Sumber Daya Air : Kegiatan: Perhitungan laju infiltrasi dan runoff :Rekomendasi bangunan penahan runoff sepanjang jalan menuju sungai DAS Brantas	Belum sesuai krn program hayan bersifat penangan an jangka pendek, tidak Rational Compre-hensife	Ds. Oro oro Ombo, Temas, Pesanggraha n, Gunungsari, Sumberbrant as, Sumberejo, Beji	sesuai	3-4	•PDRB hijau (menilai cadangan sumber daya alam, valuasi ekonomi, pungutan lingkungan dan BCR) •PDRB sektor pariwisata dn perdagangan di kota Batu cenderung meningkat namun justru sektor ini penyumbang terbesar degradasi lingkungan (longsor, runoff dan penurunan kemampuan infiltrasi)	Kementrian LH
Kota Batu	Sumberbranta s Ds Tulungrejo, Bulukerto Kec.Bumiaji	Pekerjaan rekayasa Reboisasi	• Program pengelolaan, rehabilitasi dan konservasi sumber daya alam : Sosialisasi dan Workshop tentang perilaku masyarakat thd penurunan daya dukung lingkungan • Program infrastruktur perdesaan	sesuai	Ds.Sumber-brantas, Bumiaji, Giripurno, Pandanrejo, Gunungsari	sesuai	4- 5	• Rancangan Perda pengelolaan, rehabilitasi dan konservasi sumber daya alam dan air	Kementrian PU

Zona	Lokasi resiko tinggi dan sangat tinggi	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi Program	Tingkat Kesesuaian lokasi	Tingkat Kepen-tingan	Rekomendasi	Mainstreaming
			• Program pengembangan dan penerapan teknologi ramah lingkungan • : Penghijauan, bantuan bibit tanaman, bantuan teknologi pengolahan limbah tanaman					Pencegahan dini penanggulangan bencana alam (banjir)	Kementrian LH
Kota Batu	Junrejo, Dadaprejo, Pendem	Pekerjaan rekayasa Reboisasi	• Program pengelolaan, rehabilitasi dan konservasi sumber daya alam : Sosialisasi dan Workshop tentang perilaku masyarakat thd penurunan daya dukung lingkungan : Penertiban penambang galian C • Program infrastruktur perdesaan • Program pengembangan dan pelestarian lingkungan dan sumber daya alam	sesuai	Ds.Junrejo, Beji, Dadaprejo, Torongrejo, Mojorejo	sesuai	3	• Pengembangan dan pelestarian SDA	Kementrian LH

A.1.3 Water Sector - Water Shortage Hazard

1. Malang District

Zona	Lokasi resiko tinggi dan sangat tinggi	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi Program	Tingkat Kesesuaian lokasi	Tingkat Kepen-tingan	Rekomendasi	Mainstreaming
I A. Sumber Brantas		• Penghijauan; • Agro forestry • Memaksimalkan luas daerah resapan, meningkatkan infiltrasi air dan penataan tanah, penurunan lapisan tanah kedap air, melestarikan fungsi lahan dalam memegang dan mengisi kembali air; • Reboisasi atau vegetasi pada daerah tegalan.	Program Pemulihan / Rehabilitasi Lahan	Sesuai			1 - 3	• Perlu pen-danaan yang memadai serta dukungan dari Pemerintah Provinsi dan	

Zona	Lokasi resiko tinggi dan sangat tinggi	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi Program	Tingkat Kesesuaian lokasi	Tingkat Kepen-tingan	Rekomendasi	Mainstreaming
I B. Bango		• Wilayah bawah atau daerah perkotaan (Kota Malang dan sekitarnya): membangun sumur resapan, mengembang-kan basin retardasi atau polder (embung atau urung-urung); permeabel paving, dan taman atap atas; mengembangkan atap hijau, pemeliharaan drainase • Wilayah atas atau pedesaan ke daerah atas atau dataran tinggi: penghijauan, agro-forestry, resapan buatan dengan membangun parit atau selokan di daerah perkebunan, mengembangkan bendungan / cek dam kecil	Program Pengembangan Sumber Daya Air, Program Pemulihan / Rehabilitasi Lahan	Sesuai			1 - 5	• Pemerintah pusat • Perlu koordinasi dengan K/L untuk program pendukung dalam bentuk dana Dekon-sentrasi/Dana Tugas Pembantuan guna mencapai sasaran yang diinginkan oleh daerah. • Perlu dilakukan penyelarasan program antara K/L dengan program daerah • Penyediaan kebutuhan air melalui sumur bor terutama di wilayah selatan Kab. Malang melalui koordinasi dengan Pusat Lingkungan Geologi, Kementrian	
I C. Amprong		• Wilayah bawah atau daerah perkotaan (Kota Malang dan sekitarnya): membangun sumur resapan, mengembangkan basin retardasi atau polder (embung atau urung-urung); permeabel paving, dan taman atap atas; mengembangkan atap hijau, pemeliharaan drainase • Wilayah atas atau pedesaan ke daerah atas atau dataran tinggi: Penghijauan atau vegetasi terutama di daerah ladang, agro-forestry, resapan buatan dengan membangun parit atau selokan di daerah perkebunan, mengembangkan bendungan / cek dam kecil		Sesuai			1 - 5		
II A. Metro dan Lahor		• Wilayah bawah atau daerah perkotaan (Kota Malang dan sekitarnya): membangun sumur resapan, mengembangkan basin retardasi atau polder (embung atau urung-urung); permeabel paving, dan taman atap atas; mengembangkan atap hijau, pemeliharaan drainase • Wilayah atas atau pedesaan ke daerah atas atau dataran tinggi: penghijauan, agro-forestry, resapan buatan dengan membangun parit atau selokan di daerah perkebunan, mengembangkan bendungan / cek dam kecil		Sesuai			1 - 5		
II C. Lesti		• Mengembangkan agro-forestry dan mengembangkan resapan buatan di daerah perkebunan (parit atau selokan) dengan: (a) mengembang-kan sumur resapan, terutama di bagian utara zona tersebut; (b) membangun basin retardasi atau polder (embung atau urung-urung); • Pemeliharaan drainase dan sungai.		Sesuai			4 - 5		
II C. Lesti		• Wilayah atas ke menengah: (1) Reboisasi, terutama pada tegalan dan daerah pembuangan,	Program Pemulihan / Rehabilitasi Lahan	Sesuai			1 - 5		

Zona	Lokasi resiko tinggi dan sangat tinggi	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi Program	Tingkat Kesesuaian lokasi	Tingkat Kepen-tingan	Rekomendasi	Mainstreaming
		(2) agro- forestry (3) resapan buatan dengan membangun parit atau selokan di daerah perkebunan; (4) membangun bendungan kecil / cek dam; (5) meminimalkan erosi tanah; • Wilayah bawah/pedesaan: (1) membangun resapan buatan dengan membangun sumur resapan; (2) pemeliharaan drainase.						ESDM	
III. Bag. Selatan Sub DAS Metro – Lahor-Melamon		Wilayah atas: (1) Reboisasi, terutama pada tegalan; (2) pencegahan erosi tanah Wilayah bawah/ wilayah dam: (1) rekayasa pada bendungan, (2) evaluasi spillway, (3) spillway darurat, (4) evaluasi dasar dam, dll; (5) mencegah pasokan air untuk dam; (3) mengurangi sedimentasi & pengerukan sedimentasi	Program Pengembangan Sumber Daya Air	Sesuai			4 - 5		
IV A. Sub DAS pantai selatan sebelah barat, di luar DAS Brantas		• Agro-forestry dan resapan buatan dengan mengembangkan parit atau selokan di daerah perkebunan; • Mengembangkan sumber daya air permukaan di wilayah yang terkuras banyak oleh sungai pendek; • Mengembangkan sumber daya air tanah dan bawah permukaan di daerah karst atau daerah kapur • Penadahan air hujan di kawasan terpusat yang tidak memiliki potensi baik air permukaan atau air tanah.	Program Pengembangan Sumber Daya Air	Sesuai			1 - 5		
IV B. Sub DAS pantai selatan sebelah timur, di luar DAS Brantas		• Agro-forestry dan resapan buatan dengan mengembangkan parit atau selokan di daerah perkebunan; • Mengembangkan sumber daya air permukaan di wilayah yang terkuras banyak oleh sungai pendek; • Mengembangkan sumber daya air tanah dan bawah permukaan di daerah karst/daerah kapur • Penadahan air hujan di kawasan terpusat yang tidak memiliki potensi baik air permukaan atau air tanah. • Desalinizes air laut jika perlu	Program Pengembangan Sumber Daya Air, Program Pemulihan / Rehabilitasi Lahan	Sesuai			1 - 5		

Zona	Lokasi resiko tinggi dan sangat tinggi	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi Program	Tingkat Kesesuaian lokasi	Tingkat Kepen-tingan	Rekomendasi	Mainstreaming
V A. DAS Konto, di luar DAS Brantas		• Dereboisasi dan lahan terdegradasi harus direhabilitasi; • Agro-forestry dan peningkatan kapasitas sumber air yang ada dan mata air baru yang dihasilkan menggunakan resapan buatan (selokan atau parit di daerah perkebunan dan sumur buatan di perkotaan); • Memaksimalkan luas daerah resapan, meningkatkan infiltrasi air dengan vegetasi khusus dan penataan lahan, penurunan lapisan tanah kedap air, melestarikan fungsi lahan dalam menahan dan mengisi air kembali; • Reboisasi atau vegetasi pada daerah tegalan.	Program Pemulihan / Rehabilitasi Lahan	Sesuai			1 - 3		
V B. DAS Lawang, di luar DAS Brantas		• Implementasi konservasi sumber daya air (sisi penawaran),yaitu membangun sumur buatan di pedesaan dan daerah industri; • Implementasi pembangunan berdampak rendah (LID), yaitu: memaksimalkan luas daerah resapan, meningkatkan infiltrasi air dengan vegetasi khusus dan penataan lahan, penuru-nan lapisan tanah kedap air, fungsi lahan kon-servasi dalam menahan dan mengisi air kembali • Reboisasi atau vegetasi pada daerah tegalan. • Mengembangkan sistem air perpipaan dengan membangun PDAM di Kec. Lawang. Sumber daya air sebagai air baku untuk sistem perpipaan air dapat diambil dari air tanah; • Mengembangkan agro-forestry sebagai daerah resapan alami untuk konservasi sumber daya air dan menghasilkan mata air baru meng-gunakan sumur resapan buatan seperti selokan/parit di perkebunan	Program Pemulihan / Rehabilitasi Lahan, Program Pengembangan Kinerja Pengelolaan Air Minum dan Air Limbah	Sesuai			1 - 5		
V C. DAS Ampel-gading, di luar DAS Brantas		• Implementasi pembangunan berdampak rendah (LID), yaitu: memaksimalkan luas daerah resapan, meningkatkan infiltrasi air dengan vegetasi khusus dan penataan lahan, penurunan lapisan kedap tanah, fungsi lahan konservasi dalam menahan dan pengisian air kembali; • Implementasi konservasi sumber daya air (sisi penawaran), yaitu: agro-forestry sebagai daerah resapan alami untuk konservasi sumber daya air dan meningkatkan kapasitas mata air yang ada dan mata air baru yang muncul menggunakan	Program Pemulihan / Rehabilitasi Lahan	Sesuai			1 - 3		

Zona	Lokasi resiko tinggi dan sangat tinggi	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi Program	Tingkat Kesesuaian lokasi	Tingkat Kepen-tingan	Rekomendasi	Mainstreaming
		resapan buatan (selokan atau parit di daerah perkebunan dan sumur buatan di perkotaan) ; • Reboisasi atau vegetasi pada daerah tegalan							

2. Batu City

Zona	Lokasi resiko tinggi dan sangat tinggi	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi Program	Tingkat Kesesuaian lokasi	Tingkat Kepen-tingan	Rekomendasi	Mainstreaming
Kota Batu • Air Permukaan (mata air dan sungai Brantas) • ABT (air dibawah aquifer)	138 titik mata air dan daerah tangkapan ABT (kec.Batu dan Beji) - Hutan Lindung dan Tahura	• Konservasi hutan lindung • Konservasi sumber mata air • Konservasi air bawah tanah	Program Konservasi Sumber Mata Air dan ABT	Belum sesuai (kurang menyentuh dan kurang mengena) karena program tidak langsung pada penanganan degradasi lingkungan	- Seluruh Kota Batu	Sesuai	5	-Program perhitungan degradasi linkungan dg metode: g. Willingness to pay h. Nilai psar pengganti . Nilai produktifitas yang hilang . Kenaikan biaya produksi k.Travel cost method . Hedonic Pricing method -Estimasi nilai ekonomi eksploitasi Air permukaan dan ABT terhadap kerusakan lingkungan -Kajian Penetapan & perlindungan kawasan resapan di kota Batu -Kajian daerah tangkapan di kota Batu - Pengembangan energi panas bumi dan studi kelayakan potensi ABT di Daerah tangkapan	Kementrian LH
		•	Konservasi daerah resapan		-		4-5		
		•	Reforestasi dan rehabilitasi lahan		-				
		•	Pengembangan dan pelestarian lingkungan dan sumber daya alam		-	sesuai			
	Lereng Arjuno, Raung, Panderman, Anjasmoro, Pusung-Kutu, Kerumbung, G. Banyak, Punuk Sapi, G.Bokong, Srandil, G.Kembar	•	Program Pengelolaan Panas Bumi mata air Cangar		- 13 lereng gunung		3-4		Kementrian ESDM

Zona	Lokasi resiko tinggi dan sangat tinggi	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi Program	Tingkat Kesesuaian lokasi	Tingkat Kepen-tingan	Rekomendasi	Mainstreaming
								Catatan: (Kota Batu sebagai daerah penyuplai air bersih Kota Malang dan Kab. Malang tidak pernah mendapat kompensasi lingkungan kecuali hanya pembanyaran pajak bulanan dari PDAM Kab/Kota Malang)	

A.1.4 Agriculture Sector

1. Paddy and Corn Comodities in Malang District

No	Opsi adaptasi expert	Bahaya yang diantisipasi	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi Program	Lokasi resiko tinggi dan sangat tinggi	Faktor bahaya, kerentanan	Tingkat Kesesuaian Lokasi	Tingkat Kepen-tingan opsi	Rekomendasi	Main-streaming
1	Penggunaan Bibit Unggul Dengan Produktivitas Tinggi, Umur Pendek dan Tahan Banjir/Kekeringan	Penurunan Produktivitas Tanaman	• Program Pening-katan Penerapan Teknologi Pertanian/ Perkebunan • Pengembangan Perbenihan (25 Kec. - 9 tahun) (Dinas Pertanian)	Sesuai namun kuantitasnya masih kurang	---	Dampit Wajak Turen Pagelaran Kepanjen Singosari	Luasnya lahan non-irigasi, Kurangnya penghasilan petani Topografi rendah/ datar	Kurang spesifik	5 5 4 4 4 5	Perlu diterapkan di semua kecamatan, menuju pertanian organik Kerjasama dengan UPT Perbenihan Provinsi Jawa Timur	Program 2012 (?)
2	Peningkatan Teknik Budidaya Pertanian dengan PTT dan Intensifi-kasi (SRI, Legowo)	Penurunan Produktivitas Tanaman	Program pening-katan Penerapan Teknologi Pertanian/ Perkebunan (Dinas Pertanian)	Sesuai namun kurang intensif	---			Kurang spesifik	Semua: 5	Perlu lebih intensif untuk seluruh wilayah kabupaten	Program 2012 (?)
3	Peningkatan Kapasitas Waduk Air Hujan	Penurunan Lahan Pertanian Tadah Hujan	Program Pengembangan Sumber Daya Air: • Pelestarian Sumber Daya Air • Pembuatan Embung (Dinhut, BPLHD, BBWS, BP DAS, PJT)	Sesuai namun kuantitasnya masih kurang	DAS Metro-Lahor-Mela-mon (Dao, Wagir, Pakisaji, Kapanjen, Ngajum, Kromengan, Wonosari)	Dampit Wajak Turen Pagelaran Kepanjen Singosari	Luasnya lahan non-irigasi, Kurangnya penghasilan petani Topografi rendah/ datar	<u>Sesuai</u>: Kepanjen. <u>Belum sesuai</u>: Dampit, Wajak, Turen, Pagelaran, Singosari	3 5 2 5 2 5	Perlu sinergi dengan Pemkab, PJT, Dinas Kehutanan, peran serta masyarakat Kebutuhan minimal 34 embung (15 embung sudah direhabilitasi pada tahun 2011)	• Program 2012 (?) • Kemen-PU untuk penam-bahan embung (?)
4	Revitalisasi jaringan irigasi dan gerbang pintu air	Penurunan Lahan Pertanian	Program Pengem-bangan dan Penge-lolaan Jaringan Irigasi, Rawa dan Jaringan Pengairan Lainnya (Dinhut, BPLHD, BBWS, BP DAS, PJT)	Sesuai namun perlu lebih intensif	DAS Brantas (tidak spesifik)			Sebagian sesuai	5 5 5 5 4 5	Pemasangan dan pemeliharaan pintu-pintu air di intake (17 lokasi jaringan sekunder telah dire-habilitasi tahun 2011)	Program 2012 (?)

No	Opsi adaptasi expert	Bahaya yang diantisipasi	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi Program	Lokasi resiko tinggi dan sangat tinggi	Faktor bahaya, kerentanan	Tingkat Kesesuaian Lokasi	Tingkat Kepen-tingan opsi	Rekomendasi	Main-streaming
5	Konservasi Tanah dan Air Tanah pada Lahan Pertanian	Penurunan Lahan Pertanian	Program perlin-dungan dan konservasi sumber daya alam • Konservasi sumber daya air dan pengendalian kerusakan sumber-sumber air • Pendampingan Kelompok Pengelolaan Rehabilitasi Lahan • Penyelamatan daya rusak sumberdaya air (Dinhut, BPLHD, BBWS, BP DAS, PJT)	Sebagian sesuai	---			Tidak sesuai	Semua: 5	Penanaman tanaman keras (sengon, jabon, jati), tanaman produktif di kawasan hortikultur dan perkebunan yang mempunyai nilai ekonomi Perlu monitoring sedimentasi pada waduk-waduk strategis di DAS Brantas bagian hulu	Program 2012 (?)
6	Optimalisasi pemanfaatan lahan yang ditinggalkan dengan reklamasi dan membuka lahan baru	Penurunan Produksi Tanaman	Program Pengembangan Kelembagaan: • Peningkatan pengetahuan dan ketrampilan • Pelatihan teknis (5 angkatan – 30 org) • Penyuluhan (190 desa – 9 tahun)	Sebagian sesuai	---	• Dampit • Wajak • Turen • Pagelaran • Kepanjen • Singosari	Luasnya lahan non-irigasi, Kurangnya penghasil-an petani Topografi rendah/ datar	Tidak sesuai	• 3 • 5 • 5 • 5 • 3 • 5	• Untuk peningkatan pengetahuan dan ketrampilan serta pelatihan teknis sebaiknya berben-tuk: <u>Sekolah Lapang</u> • Untuk penyuluhan berbentuk: <u>Diklat Fungsional untuk Penyuluh & Juru Air</u> • Peningkatan kesejahteraan penyuluh & juru air dan regenerasinya.	Program 2012 (?)
7	Optimalisasi pemanfaatan lahan tadah hujan dengan	Penurunan Produksi Tanaman	**Program Pemu-lihan/ Rehabilitasi Lahan** (agro-	Sudah sesuai	DAS Bango (Karang-ploso,	• Dampit • Wajak • Turen • Pagelaran	Luasnya lahan non-irigasi,	<u>Sudah sesuai</u>: Singosari & Wajak.	---	•	

No	Opsi adaptasi expert	Bahaya yang diantisipasi	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi Program	Lokasi resiko tinggi dan sangat tinggi	Faktor bahaya, kerentanan	Tingkat Kesesuaian Lokasi	Tingkat Kepen-tingan opsi	Rekomendasi	Main-streaming
	reboisasi		forestry, hutan rakyat murni) (Dinhut, BPLHD, BBWS, BP DAS, Jasa Tirta)		Singasari, Pakis, Lawang) DAS Am-prong (Gondang-legi, Pakis, Ponco-kusumo, Tumpang , Wajak)	Kepanjen Singosari	Kurangnya penghasil-an petani Topografi rendah/ datar	Belum sesuai: Dampit, Turen, Pagelaran, Kepanjen			

2. Apple Comodities in Batu City and Malang District

No	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat Kesesuaian program	Lokasi resiko tinggi dan sangat tinggi	Lokasi Program	Tingkat Kesesuaian Lokasi	Tingkat Kepenti-ngan opsi	Rekomendasi	Main-streaming
1	Penggunaan lahan tanaman apel berdasarkan kesesuaian tanaman apel dengan kondisi lingkungannya	PSP (Prasarana dan Sarana Pertanian) (Kota Batu)	Sesuai	• Batu • Junrejo • Bumiaji • Ponco-kusumo	---	---	Semua: 5		
2	Menanam bibit apel yang unggul yang mampu beradaptasi dengan perubahan iklim	Program Bantuan bibit Tersertifikasi (Kota Batu dan Kab. Malang)	Sesuai		---	---			
3	Meningkatkan teknik budidaya apel yang lebih intensif dan berorientasi pada pertanian tanaman apel yang berkelanjutan	Bantuan Alat Pembuatan Pupuk Organik (Kota Batu dan Kab. Malang)	Sesuai		---	---			
	Meningkatkan efisiensi penggunaan pupuk dan pestisida		Sesuai		---	---			
4	Rehabilitasi penanaman apel dan mengganti tanaman apel yang sudah tua	Program Peremajaan Tanaman Apel (Kota Batu) Perluasan Tanaman Apel (Kab. Malang)	Sesuai		---	---			
5	Mencegah konversi lahan tanaman apel menjadi lahan tanaman non apel (Melalui pemberian insentif bagi petani tanaman apel)	Bantuan pupuk dan bibit (Kota Batu dan Kab. Malang)	Sebagian sesuai		---	---		Penentuan Harga Pokok buah apel Insentif pada petani apel (beasiswa bagi anak-anak petani) Promosi secara intensif	• Pemkot Batu • Pemkab Malang • Kementerian Pariwisata utk promosi

A.1.5 Health Sector

A. DHF Disease Hazard

No	Faktor bahaya, kerentanan	Tipe opsi adaptasi expert	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat kesesuaian program	Lokasi resiko tinggi dan sangat tinggi	Lokasi Program	Tingkat kesesuaian lokasi	Tgkt. Kepen-tingan	Rekomendasi	Main-streaming
1	Faktor terkait dengan faktor bahaya perubahan iklim (peningkatan suhu, curah hujan)	**1. Pengen-dalian vektor penyakit** (berdasar-kan informasi perubahan iklim)	Pengamatan Epidemologi (sesuai laporan kasus) oleh Dinkes	• Program Upaya Kesehatan Masyarakat • Program Pencegahan dan Penanggulangan Penyakit Menular	Sudah sesuai	• Kota Malang (Semua kecamatan) • Kab. Malang (Tumpang, Pakis, Dau, Sumber Pucung, Gondang-legi, Turen), • Kota Batu (Batu dan Junrejo).	---	Tidak sesuai	KoM: - KaM: - KoB: -	---	
2			Surveillans vektor (pengamatan jentik) DBD (mengukur Indeks Kepadatan Nyamuk) rutin (bulanan, 2 mingguan, mingguan) di setiap desa/ kelurahan oleh entomologist lapangan (Jumantik Plus)		Surveillans vektor DBD belum rutin, anggaran terbatas		---	Tidak sesuai	KoM: - KaM: - KoB: -	**Peningkatan kemampuan Jumantik (Optimalisasi Pokjanal DBD)** • **Menambah jumlah dan kualitas Kader Jumantik** • **Menaikkan insentif yang berbasis kinerja** • **Peraturan pengawasan tentang validitas data**	• **Penam-bahan DAU/ DAK** • **Kemen-kes** • **Dana CSR untuk Kese-hatan & Ling-kungan**
3			Pemberantasan sumber habitat sarang nyamuk dengan program 3M Plus dan PSN secara rutin		Sudah sesuai tapi *timing*-nya belum dikaitkan dengan data historis epidemologi		---	Tidak sesuai	KoM: 4 KaM:4 KoB: 5	Kegiatan lebih digalakkan: Sesuai dengan analisis data historis	Program 2013

No	Faktor bahaya, kerentanan	Tipe opsi adaptasi expert	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat kesesuaian program	Lokasi resiko tinggi dan sangat tinggi	Lokasi Program	Tingkat kesesuaian lokasi	Tgkt. Kepen-tingan	Rekomendasi	Main-streaming
										epidemologi Sesuai dengan Sistem Peringatan Dini DBD Lokasi kegiatan terutama di wilayah risiko tinggi	
4			Abatisasi dan/atau pema-kaian IGR (misal Altosid) di lokasi sarang nyamuk		Sudah sesuai tapi dievaluasi secara berkala		---	Tidak sesuai	KoM: 3 KaM: 2 KoB: 3	Efektivitas kegiatan abatisasi perlu dievaluasi secara berkala	Mulai dari Program 2013
5			Penyemprotan hanya atas indikasi (hasil surveilans dan/atau ada kejadian penyakit/KLB)		Sudah sesuai		---	Tidak sesuai	KoM:4 KaM: 3 KoB: 4	Pengawasan terhadap pe-laksanaan penyemprotan, sesuai dengan SE Gubernur untuk permintaan fogging	Program 2013
6			Sosialisasi tentang APD (alat pelindung diri) se-perti pengusir nyamuk, jaring nyamuk, kelambu celup, semprotan nya-muk, pakaian yg sesuai	Program Promosi Kesehatan dan Pemberdayaan Masyarakat	Kegiatan sesuai; tapi hasilnya belum maksimal		---	Tidak sesuai	KoM: 5 KaM: 4 KoB: 3	Penyesuaian strategi sosialisasi agar lebih bisa mengubah perilaku masyarakat (Waktu kegiatan	Program 2013
7			Sosialisasi tentang		Kegiatan		---	Tidak	KoM: -		

No	Faktor bahaya, kerentanan	Tipe opsi adaptasi expert	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat kesesuaian program	Lokasi resiko tinggi dan sangat tinggi	Lokasi Program	Tingkat kesesuaian lokasi	Tgkt. Kepen-tingan	Rekomendasi	Main-streaming
			alat pelindung rumah misal kawat kasa anti nyamuk di pintu dan jendela)		sesuai; tapi hasilnya be-lum maksimal			sesuai	KaM: - KoB: -	sesuai dengan catatan tersebut di atas)	
8	Faktor terkait dengan faktor: • Bahaya iklim (peningkatan suhu, curah hujan) • Jumlah dan kepadatan populasi • Potensi sarang nyamuk di bak-bak akibat ketiadaan pipanisasi air minum serta di saluran buangan air hujan	**2. Perbaikan lingkungan**	Sosialisasi: Mengurangi genangan dan/atau memasukkan musuh biologis/predator (ikan nila, ikan cupang, dsb) pada tempat genangan.	Program Promosi Kesehatan dan Pemberdayaan Masyarakat	Kegiatan sesuai; tapi hasilnya belum maksimal	• Kota Malang (Semua kecamatan) • Kab. Malang (Dau, Sumber Pucung, Turen), • Kota Batu (Batu dan Junrejo).	---	Tidak sesuai	KoM: 3 KaM: 2 KoB: 2	**Peraturan tentang Penataan Lingkungan Sehat**: SE Walikota/Bupati, Peraturan Walikota/ Bupati Perda **SK Bersama Menkes, MenLH, Mendagri** • Lokasi kegiatan difokuskan pada daerah-daerah beresiko tinggi	**Kemen LH meng-koordina-sikan SKB Menkes, MenLH, Mendagri tentang Penataan Ling-kungan Sehat-**
9			Perbaikan saluran drainase/pembuangan air hujan	Program Pembangunan saluran drainase/gorong-gorong (DPU)	Sudah sesuai		---	Tidak sesuai	KoM: - KaM: - KoB: -		
10			Peningkatan pelayanan air bersih perpipaan (PDAM)	Program pengembangan dan pengelolaan jaringan irigasi, rawa dan jaringan pengairan lainnya (DPUCK)	Sudah sesuai		---	Tidak sesuai	KoM: 4 KaM: 4 KoB: 3		
11			Pengendalian nyamuk di dalam perumahan dan bangunan umum, di pekarangan dan sekitarnya	Program Pengembangan Lingkungan Sehat	Kegiatan sesuai; materi belum sesuai dan belum terintegrasi		---	Tidak sesuai	KoM: - KaM: - KoB: -		
12	Faktor terkait dengan faktor: • Bahaya iklim (peningkatan suhu, curah	**3. Peng-awasan/ peng-amatan agen penyakit**	Monitoring serologi virus DBD secara berkala oleh virologist	---	Belum sesuai	• Kota Malang (semua kec.) • Kab. Malang (Sumber Pu-cung, Dau,	---	Tidak sesuai	KoM: - KaM: 2 KoB: 3	Monitoring serologi virus DBD secara berkala 1 tahun sekali oleh virologist	Kemenkes

No	Faktor bahaya, kerentanan	Tipe opsi adaptasi expert	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat kesesuaian program	Lokasi resiko tinggi dan sangat tinggi	Lokasi Program	Tingkat kesesuaian lokasi	Tgkt. Kepen-tingan	Rekomendasi	Main-streaming
13	hujan) • Fasilitas kesehatan		Pengembangan percobaan vaksin DBD	---	Belum sesuai	Turen), • Kota Batu (Junrejo)	---	Tidak sesuai	KoM: 3 KaM: 3 KoB: 2	• Kerjasama riset vaksin dengan Fak. Kedokteran (FK) Univ. Brawijaya • Perlunya keterlibatan RS dalam riset vaksin DBD	Kemen-kes Dikti Kemen-dikbud

B. Malaria Disease Hazard

No	Faktor bahaya, kerentanan	Tipe opsi adaptasi expert	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat kesesuaian program	Lokasi resiko tinggi dan sangat tinggi	Lokasi Program	Tingkat kesesuaian lokasi	Tgkt. Kepen-tingan	Rekomendasi	Main-streaming
1	Faktor terkait dengan bahaya perubahan iklim (curah hujan, kenaikan muka laut)	**1. Pengen-dalian vektor penyakit** (ber-dasarkan informasi perubahan iklim)	Pengamatan Epidemiologi rutin (bulanan, 2 mingguan, mingguan)	• Program Upaya Kesehatan Masyarakat • Program Pencegahan dan Penanggulangan Penyakit Menular	Belum berjalan	Kab. Malang (Ngantang, Sumber Pucung, Kasembon, Donomulyo ,Bantur, Ampel-gading)	---	Tidak sesuai	KoM: - KaM: KoB: -	• Kegiatan lebih rutin dan lebih sering, khususnya: Saat terjadinya gena-ngan air laut di pesisir Saat terjadi peningkatan kasus sesuai data historis Lokasi terutama di daerah risiko tinggi • Monitoring tingkat resis-tensi nyamuk terhadap penggunaan pestisida untuk penyemprotan	Program 2013
2			Pemberantasan sumber habitat sarang nyamuk melalui Program Perbaikan Lingkungan		Belum berjalan		---	Tidak sesuai	KoM: - KaM: 4 KoB: -		
3			Penyemprotan pada dinding rumah dan bangunan secara rutin 6 bulan sekali		Belum berjalan		---	Tidak sesuai	KoM: - KaM: 3 KoB: -		
4			Sosialisasi tentang APD (alat pelindung diri; contoh: pengusir nyamuk, jaring nyamuk, kelambu celup, semprotan nyamuk, dan pakaian yang sesuai)	Program Promosi Keseha-tan dan Pemberdayaan Masyarakat	Kegiatan sesuai tapi materi belum sesuai		---	Tidak sesuai	KoM: - KaM: 5 KoB: -	Materi sosialisasi lebih disesuaikan kebutuhan (opsi-opsi adaptasi), khususnya: sosialisasi tentang kelambu celup (rekomendasi WHO) kearifan lokal	Program 2013
5			Sosialisasi tentang alat pelindung rumah (contoh: kawat kasa anti nyamuk pada		Kegiatan sesuai tapi materi		---	Tidak sesuai	KoM: - KaM: 3 KoB: -		

No	Faktor bahaya, kerentanan	Tipe opsi adaptasi expert	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat kesesuaian program	Lokasi resiko tinggi dan sangat tinggi	Lokasi Program	Tingkat kesesuaian lokasi	Tgkt. Kepen-tingan	Rekomendasi	Main-streaming
			pintu dan jendela)		belum sesuai					(Waktu kegiatan sesuai dengan catatan tersebut di atas)	
6			Sosialisasi kearifan lokal: Pengalihan sasaran vektor pada hewan mamalia (kera, sapi); Penanaman pohon anti nyamuk; Pemeliharaan ikan		Kegiatan sesuai tapi materi belum sesuai		---	Tidak sesuai	KoM: - KaM: - KoB: -		
7	Faktor terkait dengan: • Bahaya iklim (curah hujan, kenaikan muka laut) • Populasi yang dekat sarang nyamuk (rawa, mangrove) • Kebersihan lingkungan rumah	**2. Perbaikan lingkungan**	Mengurangi genangan air laut di pesisir dan/ atau memasukkan musuh biologis (ikan) atau desalinasi pada tempat genangan yang tidak bisa dikeringkan	---	Belum sesuai	Kab. Malang (Ngantang, Sumber Pucung, Kasembon, Donomulyo ,Bantur, Ampel-gading)	---	Tidak sesuai	KoM: - KaM: 2 KoB: -	**Peraturan ttg. Penataan Lingkungan Sehat**: SE Walikota/Bupati, Peraturan Walikota/ Bupati Perda **SK Bersama Menkes, MenLH, Mendagri** • Lokasi kegiatan difokuskan pada daerah-daerah beresiko tinggi	**Kemen LH: Koordinasi tentang SKB Menkes, MenLH, Mendagri tentang Penataan Lingkung-an Sehat**
8			Restorasi hutan lindung dengan menambahkan hewan mamalia (kera dsb.)	---	Belum sesuai		---	Tidak sesuai	KoM: - KaM: - KoB: -	**Mengusulkan restorasi hutan lindung dengan tambahan hewan mamalia (kera dsb.), terutama pada pembukaan jalan jalur selatan Kab. Malang**	**Lintas sektor dg. Dinas Ke-hutanan dan PU Kab. Malang**
9	Faktor terkait: • Bahaya iklim (curah hujan,	**3. Peng-awasan/ peng-**	Pengamatan rutin parasit malaria (menghitung Indeks	---	Belum sesuai	Kab. Malang (Ngantang,	---	Tidak sesuai	KoM: - KaM: 3 KoB: -	Monitoring parasit secara rutin oleh Dinkes	Program 2013

No	Faktor bahaya, kerentanan	Tipe opsi adaptasi expert	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat kesesuaian program	Lokasi resiko tinggi dan sangat tinggi	Lokasi Program	Tingkat kesesuaian lokasi	Tgkt. Kepen-tingan	Rekomendasi	Main-streaming
	kenaikan muka laut) • Fasilitas kesehatan	**amatan agen penyakit**	Malaria dan Indeks Kepadatan Nyamuk) oleh malariologist dan entomologist			Sumber Pucung, Kasembon, Donomul-yo,Bantur, Ampel-gading)					

No	Faktor bahaya, kerentanan	Tipe opsi adaptasi expert	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat kesesuaian program	Lokasi resiko tinggi dan sangat tinggi	Lokasi Program	Tingkat kesesuaian lokasi	Tgkt. Kepen-tingan	Rekomendasi	Main-streaming
1	Faktor terkait dengan: • Bahaya iklim (suhu, curah hujan) • Tingkat populasi • Fasilitas sanitasi rumah • Fasilitas air bersih untuk minum	**1. Pengen-dalian pencem ar-an air domesti k di kawasan perumah an rawan banjir, genanga n pesisir, dan kumuh**	Sosialisasi dan penyediaan fasilitas air sumur yang bersih (air berklorin)	• Program Upaya Kesehatan Masyarakat • Program Promosi Kesehatan & Pemberdayaan Masyarakat	Sudah sesuai	• Kota Malang (Sukun, Blimbing) • Kota Batu: (Batu, Bumiaji, Junrejo)	---	Tidak sesuai	KoM: 4 KaM: - KoB: 4	Strategi penyuluhan tentang Perilaku Bersih dan Sehat dan tentang Lingkungan sedini mungkin (kurikulum TK, SD)	Kemen-dikbud
2			Sosialisasi dan penyediaan fasilitas air minum yang steril (penyaringan, direbus)		Sudah sesuai		---	Tidak sesuai	KoM: 5 KaM: - KoB: 5		
3			Sosialisasi pemanfaatan air minum dalam kemasan		Kegiatan sesuai tapi materi tidak sesuai		---	Tidak sesuai	KoM: - KaM: - KoB: -	• Sosialisasi pemanfaatan air minum dlm. kemasan • Penegakan hukum (air kemasan diuji ulang setiap 6 bulan sekali)	Program 2013
4			Penanganan air bersih dalam mitigasi kebencanaan	(Tersedia SOP mtigasi kebencanaan dari BNPB)	Kegiatan sesuai		---	Tidak sesuai	KoM: - KaM: - KoB: -	**Dinkes perlu berkoordinasi dengan BNPBD untuk penyediaan air bersih di tempat pengungsian**	**BNPB**
5	Faktor terkait dengan: • Bahaya iklim (suhu, curah hujan) • Tingkat populasi • Fasilitas sanitasi rumah • Fasilitas air bersih untuk minum	**2. Pengen-dalian air limbah domesti k di lingkung an rawan banjir, genanga n pesisir, & kumuh**	Sosialisasi dan penyediaan fasilitas toilet umum dan septik tank di perumahan	• Program Sanitasi Total Berbasis Masyarakat (STBM) (Kemenkes) • Program Pembangunan saluran drainase/ gorong-gorong (DPU) • Program Upaya Kesehatan Masyarakat • Program pengembangan lingkungan sehat	Sudah sesuai tapi belum terintegrasi	• Kota Malang (Sukun, Blimbing) • Kota Batu: (Batu, Bumiaji, Junrejo)	---	Tidak sesuai	KoM: 5 KaM: - KoB: 4	**• Perbaikan Sanitasi** **• Program Rumah Sehat** **• Program MCK Sehat** **Optimalisasi Program Sanitasi Total Berbasis Masyarakat (STBM)** **→Terutama pada daerah rawan bencana banjir (lokasi risiko tinggi)**	**• Kemen-sos** **• CSR** **• Kemen-pera** **• Kemen-PU (Cipta karya)** **• Kemen-kes (STBM)**
6			Sosialisasi dan penyediaan fasilitas drainase air limbah perkotaan		Sudah sesuai tapi belum terintegrasi		---	Tidak sesuai	KoM: - KaM: - KoB: -		
7			Pemberian kaporit pada sumur-sumur gali	Program Upaya Kesehatan Masyarakat	Sesuai; tapi perlu program kontinu		---	Tidak sesuai	KoM: 5 KaM: - KoB: 3		
8	Faktor terkait: • Bahaya iklim	**3. Peng-awasan/**	Pengamatan/pemerik saan agen penyebab	(Ada Lab Kesehatan Daerah)	Sudah sesuai,	• Kota Malang	---	Tidak sesuai	KoM: 5 KaM: -	• Perlu sistem jejaring antar lab	• Kemen-kes

	(suhu, curah hujan) • Fasilitas kesehatan	**peng-amatan agen penyakit**	di lab klinik/RS/Labkesda		tapi perlu lebih efektif	(Sukun, Blimbing) • Kota Batu: (Batu, Bumiaji, Junrejo)			KoB: 4	klinik swasta, RS, dan Labkesda yang dikoor-dinasikan oleh Dinkes • Pembebasan biaya pada rakyat kurang mampu utk pemeriksaan air ke Labkesda, terutama yang tinggal di lokasi risiko tinggi dan pada saat KLB	• Program 2013

C. Diarhea Disease Hazard

No	Faktor bahaya, kerentanan	Tipe opsi adaptasi expert	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat kesesuaian program	Lokasi resiko tinggi dan sangat tinggi	Lokasi Program	Tingkat kesesuaian lokasi	Tgkt. Kepen-tingan	Rekomendasi	Main-streaming
1	Faktor terkait dengan: • Bahaya iklim (suhu, curah hujan) • Tingkat populasi • Fasilitas sanitasi rumah • Fasilitas air bersih untuk minum	**1. Pengen-dalian pencema r-an air domestik di kawasan perumah an rawan banjir, genanga n pesisir, dan kumuh**	Sosialisasi dan penyediaan fasilitas air sumur yang bersih (air berklorin)	• Program Upaya Kesehatan Masyarakat • Program Promosi Kesehatan & Pemberdayaan Masyarakat	Sudah sesuai	• Kota Malang (Sukun, Blimbing) • Kota Batu: (Batu, Bumiaji, Junrejo)	---	Tidak sesuai	KoM: 4 KaM: - KoB: 4	Strategi penyuluhan tentang Perilaku Bersih dan Sehat dan tentang Lingkungan sedini mungkin (kurikulum TK, SD)	Kemen-dikbud
2			Sosialisasi dan penyediaan fasilitas air minum yang steril (penyaringan, direbus)		Sudah sesuai		---	Tidak sesuai	KoM: 5 KaM: - KoB: 5		
3			Sosialisasi pemanfaatan air minum dalam kemasan		Kegiatan sesuai tapi materi tidak sesuai		---	Tidak sesuai	KoM: - KaM: - KoB: -	• Sosialisasi pemanfaatan air minum dlm. kemasan • Penegakan hukum (air kemasan diuji ulang setiap 6 bulan sekali)	Program 2013
4			Penanganan air	(Tersedia SOP mtigasi	Kegiatan		---	Tidak	KoM: -	**Dinkes perlu**	**BNPB**

No	Faktor bahaya, kerentanan	Tipe opsi adaptasi expert	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat kesesuaian program	Lokasi resiko tinggi dan sangat tinggi	Lokasi Program	Tingkat kesesuaian lokasi	Tgkt. Kepen-tingan	Rekomendasi	Main-streaming
			bersih dalam mitigasi kebencanaan	kebencanaan dari BNPB)	sesuai			sesuai	KaM: - KoB: -	**berkoordinasi dengan BNPBD untuk penyediaan air bersih di tempat pengungsian**	
5	Faktor terkait dengan: • Bahaya iklim (suhu, curah hujan) • Tingkat populasi • Fasilitas sanitasi rumah • Fasilitas air bersih untuk minum	**2. Pengen-dalian air limbah domestik di lingkungan rawan banjir, genangan pesisir, & kumuh**	Sosialisasi dan penyediaan fasilitas toilet umum dan septik tank di perumahan	• Program Sanitasi Total Berbasis Masyarakat (STBM) (Kemenkes) • Program Pembangunan saluran drainase/ gorong-gorong (DPU) • Program Upaya Kesehatan Masyarakat • Program pengembangan lingkungan sehat	Sudah sesuai tapi belum terintegrasi	• Kota Malang (Sukun, Blimbing) • Kota Batu: (Batu, Bumiaji, Junrejo)	---	Tidak sesuai	KoM: 5 KaM: - KoB: 4	**Perbaikan Sanitasi** • **Program Rumah Sehat** • **Program MCK Sehat Optimalisasi Program Sanitasi Total Berbasis Masyarakat (STBM) →Terutama pada daerah rawan bencana banjir (lokasi risiko tinggi)**	• **Kemen-sos** • **CSR** • **Kemen-pera** • **Kemen-PU (Cipta karya)** • **Kemen-kes (STBM)**
6			Sosialisasi dan penyediaan fasilitas drainase air limbah perkotaan		Sudah sesuai tapi belum terintegrasi		---	Tidak sesuai	KoM: - KaM: - KoB: -		
7			Pemberian kaporit pada sumur-sumur gali	Program Upaya Kesehatan Masyarakat	Sesuai; tapi perlu program kontinu		---	Tidak sesuai	KoM: 5 KaM: - KoB: 3		
8	Faktor terkait: • Bahaya iklim (suhu, curah hujan) • Fasilitas kesehatan	**3. Peng-awasan/ peng-amatan agen penyakit**	Pengamatan/pemeriksaan agen penyebab di lab klinik/RS/Labkesda	(Ada Lab Kesehatan Daerah)	Sudah sesuai, tapi perlu lebih efektif	• Kota Malang (Sukun, Blimbing) • Kota Batu: (Batu, Bumiaji, Junrejo)	---	Tidak sesuai	KoM: 5 KaM: - KoB: 4	• Perlu sistem jejaring antar lab klinik swasta, RS, dan Labkesda yang dikoor-dinasikan oleh Dinkes • Pembebasan biaya pada rakyat kurang mampu utk pemeriksaan air ke Labkesda, terutama yang tinggal di lokasi risiko tinggi dan pada saat KLB	• Kemen-kes Program 2013

D. General (for the Three Disease Hazards)

No	Faktor bahaya, kerentanan	Tipe opsi adaptasi expert	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat kesesuaian program	Tgkt. Kepen-tingan	Rekomendasi	Main-streaming
1	Faktor terkait dengan fasilitas kesehatan: • Fasilitas operasional kesehatan • Sumber daya manusia bidang kesehatan • Kapasitas kelembagaan	**4. Mana-jemen infeksi manusia (Monitoring& Evaluasi)**	Menyusun sistem informasi dan pelaporan kasus penyakit secara online dengan penyiapan infrastruktur untuk menunjang sistem manual yang sudah ada	Program Standarisasi Pelayanan Kesehatan	Standari-sasi sudah ada tapi belum format digital	KoM: 5 KaM: 5 KoB: 5	Perbaikan sistem informasi dan pelaporan kasus: • Integrasi sistem (manual, telpon, dan komputer) • Sistem online hanya untuk kalangan terkait/terbatas • Fokus di daerah berpotensi KLB • Perlu verifikator untuk mengecek kualitas data/informasi • Analisis data statistik	Program 2013
2			Monitoring Epidemologis rutin (bulanan, 2 mingguan, mingguan, harian) yang dikaitkan dengan Sistem Peringatan Dini **DBD** (integrasi hasil surveilans vektor, laporan kasus, pengamatan serologi, dan pengamatan cuaca)		"Sistem" yang ada masih manual dan belum memperha-tikan iklim	KoM: - KaM: - KoB: -	**Penyusunan Sistem Peringatan Dini DBD (kerjasama Dinas Kesehatan, RS, dan BMKG)**	• **Kemenkes** • **BMKG** • **Dikti Kemen-dikbud**
3			Penyempurnaan sistem dan infrastruktur sehingga penanganan kasus penyakit sehingga mudah diakses/dijangkau masyarakat		Sudah sesuai	KoM: 5 KaM: 5 KoB: 4	Menambah kemudahan akses masyarakat: • Menambah Fasilitas Pelayanan Kesehatan • Menambah SDM Kesehatan • Fokus di daerah risiko tinggi	Program 2013
4			Peningkatan kesadaran dan edukasi masyarakat secara intensif untuk kesiapsiagaan pada saat peralihan musim	Program Promosi Kesehatan dan Pemberdayaan Masyarakat	Kegiatan sesuai tapi materi belum sesuai	KoM: 5 KaM: 5 KoB: 5	Program Promosi Kesehatan harus mencakup semua aspek kesehatan masyarakat, termasuk dampak perubahan iklim di sektor kesehatan	Program 2013
5			Pemberdayaan masyarakat untuk mengetahui Tata Laksana DBD, Malaria, Diare secara sederhana			KoM: - KaM: - KoB: -		

No	Faktor bahaya, kerentanan	Tipe opsi adaptasi expert	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat kesesuaian program	Tgkt. Kepen-tingan	Rekomendasi	Main-streaming
6			Penjaminan persediaan sarana penunjang diagnosis (khususnya di LabKesda)	• Program Obat dan Perbekalan Kesehatan • Program Upaya Kesehatan Masyarakat	Sudah sesuai, tapi belum memper-hatikan lokasi risiko tinggi tiap penyakit	KoM: - KaM: - KoB: -	Persediaan sarana dan prasarana serta obat-obatan difokuskan di daerah-daerah risiko tinggi setiap penyakit	Program 2013
7			Penjaminan persediaan obat: Cairan infus Transfusi darah (DBD) Obat anti-malaria Obat anti-diare			KoM: - KaM: - KoB: -		
8	Faktor terkait dengan fasilitas kesehatan: • Fasilitas operasional kesehatan • Sumber daya manusia bidang kesehatan • Kapasitas kelembagaan	**5. Penye-diaan dan pengem-bangan sumber daya manusia bidang kesehata n**	Penyediaan tenaga lapangan untuk surveillans DBD dan malaria: • Epidemiologist DBD • Entomologist (DBD, malaria) • Malarialogist	(Tersedia banyak STIKES)	Baru ada epidemio-logist	KoM: - KaM: - KoB: -	**Peningkatan kemampuan tenaga:** **Pengawasan terhadap tenaga yang sudah tersedia** **Penyegaran dengan workshop/kursus singkat** **Penambahan jumlah tenaga** **Kemampuan analisis data statistik**	• **Kemenkes** • **Kemen-dikbud**
9			Penyediaan tenaga laboratorium: Clinic analyst Virologist (DBD)	(Tersedia Poltekes)	Belum sesuai	KoM: - KaM: - KoB: -		
10			Penyediaan tenaga paramedis dan medis yang terlatih dan terampil untuk menangani penyakit DBD, Malaria, Diare	(Tersedia Akademi Perawat dan Fakultas Kedokteran dan IKM di Universitas Brawijaya)	Beum sesuai	KoM: - KaM: - KoB: -	Pelaksanaan workshop yang rutin untuk tenaga paramedis dan medis yang baru dan sebagai penyegaran untuk tenaga paramedis dan medis yang lama.	Dikti Kemen-dikbud
11			Tersedianya dokter spesialis penyakit *tropical medicine*, mikrobiologi, dan parasit sebagai rujukan	(Tersedia Program Spesialis di Fak. Kedok-teran di Univ. Brawijaya)	Sudah sesuai	KoM: - KaM: - KoB: -	Mewujudkan jejaring antara Dinkes dan Universitas dalam rangka memaksimalkan peran dokter spesialis untuk penunjang diagnosis klinik	Program 2013
12			Pengembangan LSM untuk membantu aktivitas bidang kesehatan (Jumantik, *outreach*)	---	Belum sesuai	KoM: - KaM: - KoB: -	Pengawasan pada LSM Kesehatan yang berpotensi tidak sesuai dengan program (SE atau peraturan Walikota/Bupati)	Program 2013

No	Faktor bahaya, kerentanan	Tipe opsi adaptasi expert	Opsi adaptasi expert	Rencana Program 2012 (RKP, APBD)	Tingkat kesesuaian program	Tgkt. Kepen-tingan	Rekomendasi	Main-streaming
13		**6. Pening-katan sum-ber penda-naan sektor kesehatan**	Mengusahakan peningkatan porsi anggaran kesehatan dalam APBD dan APBN sesuai dengan UU (10%)	(Tersedia porsi anggaran saat ini)	Belum fokus untuk kesehatan	KoM: - KaM: - KoB: -	**Mengusulkan penambahan porsi anggaran sektor kesehatan sehingga sesuai dengan UU (10%)**	**Program 2013 Kemenkes**
14			Peraturan tentang pemanfaatan dana CSR untuk kesehatan	(Tersedia Peraturan tentang pemanfaatan dana CSR secara umum)	Belum fokus untuk kesehatan	KoM: - KaM: - KoB: -	**Mengusulkan revisi peraturan tentang pemanfaatan dana CSR sehingga ada dana CSR untuk kesehatan dan lingkungan**	**Program 2013**
15		**Lintas Sektoral**					**Paparan hasil KRAPI (semua sektor) pada Pemangku Kebijakan dan Wakil Rakyat di Malang Raya**	**Segera**

A.2 Synchronization/Policy Matrices

A.2.1 Water Sector

1. Malang City

Risiko	Opsi Expert	No		Program Daerah Terkait Adaptasi PI	Instansi Penanggung Jawab	*Stakeholders*			Program *Stakeholders* tahun 2013 yang Terkait	Rekomendasi Lokasi
					Malang City	Pusat	Swasta/BUMN	Lain-Lain		
1. Penurunan Ketersediaan Air	Terkait dengan Opsi Konservas Sumber Daya Air	5	Program konservasi air permukaan dan air tanah		Dinas Kehutanan	Kemen-PU DJSDA; Kemen-ESDM				
	Terkait dengan Penataan Ruang (RTRW)	14	Program Penataan dan Perbaikan Kawasan Permukiman Kumuh, di sekitar Sungai Brantas		Dinas PU Cipta Karya	KemenPera; Kemen PU DJCK				
			14.1	Penataan dan perbaikan kawasan permukiman kumuh , terutama di daerah pinggir DAS Brantas						
			14.2	Penertiban Sempadan Sungai						
2. Banjir	Terkait dengan Opsi Konservasi/ Reboisasi	2.b	Program Perencanaan dan Pengembangan Hutan Tarakan: Hutan Rakyat Kemitraan; Kota Malang: Hutan Rakyat		Dinas Pertamanan	KemenHut DJPL		PT Perhutani	Kegiatan Hutan Rakyat Kemitraan (BP-DAS)	Kab Malang
	Terkait dengan Opsi Pembangunan Drainase/ Pengendalian Banjir	5	Program Pembangunan saluran drainase/ gorong-gorong		Dinas PU	Kemen PU DJCK				
		6	Program Rekayasa Pengendalian Banjir		Dinas PU Cipta Karya	Kemen PU DJSDA				
			6.5	Pembangunan reservoir pengendali banjir						
			6.6	Pemeliharaan reservoir pengendali banjir						
			6.7	Normalisasi sungai/ drainase						
		7	Program Pengendalian Erosi dan Sedimentasi		Dinas PU Cipta KaryaBP DS SPAM	Kemen PU			Bangunan Konservasi Tanah	Malang Raya

Risiko	Opsi Expert	No		Program Daerah Terkait Adaptasi PI	Instansi Penanggung Jawab	*Stakeholders*			Program *Stakeholders* tahun 2013 yang Terkait	Rekomendasi Lokasi
					Malang City	Pusat	Swasta/BUMN	Lain-Lain		
						DJSDA:KemenHut			pada DAS Prioritas (50 unit) (BP-DAS)	
			7.1	Pembuatan Dam Penahan						
			7.2	Pembuatan Gullyplug						
			7.3	Pembuatan Sumur Resapan						
3. Longsor	Terkait dengan Opsi Konservasi/ reboisasi	1	Program Penghijauan Lingkungan		Dinas Pertamanan	KLH				
			1.1	Forestasi						
	Terkait dengan Opsi Drainase/ Sungai	3	Program pembangunan saluran dranaise/ gorong-gorong		Dinas PU Cipta Karya	Kemen PU DJCK				
	Terkait dengan Opsi Rekayasa Lereng Jalan	5.b	Program Pengendalian Stabilitas Lereng Jalan		Dinas PU	Kemen PU Bina Marga; Kemen ESDM				
			5.5	Rehabilitasi/ Pemeliharaan Talud/ Bronjong						
		5.c	Program Pembangunan Talud/ Turap dan Bronjong		Dinas PU	Kemen PU DJSDA				

2. Batu City

Risiko	Opsi Expert	No		Program Daerah Terkait Adaptasi PI	Instansi Penanggung Jawab	*Stakeholders*			Program *Stakeholders* tahun 2013 yang Terkait	Rekomendasi Lokasi
					Kota Batu	Pusat	Swasta/BUMN	Lain-Lain		
1. Penurunan Ketersediaan Air	Terkait dengan Opsi Konservas Sumber Daya Air	5	Program konservasi air permukaan dan air tanah		Dinas Kehutanan	Kemen-PU DJSDA; Kemen-ESDM				
		7	Program Pengembangan dan Pelestarian Lingkungan dan Sumber Daya Alam		Dinas Kehutanan	KemenHut DJPHKA; KLH			Rehabilitasi dan konservasi untuk Taman Hutan Raya (300 Ha)	Kab Malang, Kota Batu

Risiko	Opsi Expert	No		Program Daerah Terkait Adaptasi PI	Instansi Penanggung Jawab	*Stakeholders*			Program *Stakeholders* tahun 2013 yang Terkait	Rekomendasi Lokasi
					Kota Batu	Pusat	Swasta/BUMN	Lain-Lain		
									(BP-DAS)	
			7.1	Reforestasi dan rehabilitasi lahan rusak						
			7.2	Sosialisasi dan Workshop tentang perilaku masyarakat terhadap penurunan daya dukung lingkungan						
		8	Program Pengelolaan dan Pengembangan Sumber Daya Air		Din PU Pengairan; Bappeda	Kemen-PU DJSDA			Program Pembuatan Areal Model Pemeliharaan Air (200 Ha) (BP-DAS)	Kab. Malang; Kota Malang
			8.11	Penetapan Perda zona kawasan Konservasi Sumber Daya Air						
1. Penurunan Ketersediaan Air			8.12	Perhitungan Neraca Air dalam 5 tahun kedepan						
			8.13	Perhitungan teknis laju infiltrasi dan runoff di perkerasan sepanjang jalan						
			8.14	Pembangunan penahan runoff di sepanjang jalan ke a rah sungai						
			8.15	Pembangunan Sabo DAM						
		9	Program Pengembangan dan Penerapan Teknologi Ramah Lingkungan		Din PU Pengairan	Kemen PU Puslitbang SDA			Solar cell (Puslitbang SDA)	Tarakan
			9.1	Kajian sumur resapan						
			9.2	Studi pembangunan sumur resapan						
		10	Program Pengelolaan Ruang Terbuka Hijau (RTH) Tarakan: Hutan Rakyat Kemitraan; Kota Malang: Hutan Rakyat		Bappeda BPDAS Brantas	Kemen PU DJPR			Kegiatan Hutan Rakyat Kemitraan (BP-DAS)	Kab Malang
			10.1	Pemanfaatan overlay peta dalam perhitungan prosentase						

Risiko	Opsi Expert	No		Program Daerah Terkait Adaptasi PI	Instansi Penanggung Jawab	*Stakeholders*			Program *Stakeholders* tahun 2013 yang Terkait	Rekomendasi Lokasi
					Kota Batu	Pusat	Swasta/BUMN	Lain-Lain		
				RTH						
			10.2	Pembangunan ruang terbuka						
	Terkait dengan Penataan Ruang (RTRW)	13	Program Monitoring dan Evaluasi Pembangunan		Bappeda					
			13.1	Monitoring dan evaluasi kondisi eksisting terhadap penertiban RTRW dan Perda tata ruang						
		14	Program Penataan dan Perbaikan Kawasan Permukiman Kumuh, di sekitar Sungai Brantas		Dinas PU Cipta Karya	KemenPera; Kemen PU DJCK				
			14.1	Penataan dan perbaikan kawasan permukiman kumuh , terutama di daerah pinggir DAS Brantas						
			14.2	Penertiban Sempadan Sungai						

3. Malang District

Risiko	Opsi Expert	No		Program Daerah Terkait Adaptasi PI	Instansi Penanggung Jawab	*Stakeholders*			Program *Stakeholders* tahun 2013 yang Terkait	Rekomendasi Lokasi
					Malang District	Pusat	Swasta/BUMN	Lain-Lain		
1. Penurunan Ketersediaan Air	Terkait dengan Opsi Konservas Sumber Daya Air	5	Program konservasi air permukaan dan air tanah		Dinas Kehutanan	Kemen-PU DJSDA; Kemen-ESDM				
		6	Program Pemulihan / Rehabilitasi Lahan		Dinas Kehutanan	Kemen PU DJ-BPDAS-PS; KemHut DJPLA				
			6.1	Reboisasi pada tegalan dan daerah pembuangan						

Risiko	Opsi Expert	No		Program Daerah Terkait Adaptasi PI	Instansi Penanggung Jawab	*Stakeholders*			Program *Stakeholders* tahun 2013 yang Terkait	Rekomendasi Lokasi
					Malang District	Pusat	Swasta/BUMN	Lain-Lain		
			6.2	Agro- forestry						
			6.3	Pembangunan parit/selokan di daerah perkebunan untuk resapan buatan						
		8	Program Pengelolaan dan Pengembangan Sumber Daya Air		Din PU Pengairan; Bappeda	Kemen-PU DJSDA			Program Pembuatan Areal Model Pemeliharaan Air (200 Ha) (BP-DAS)	Kab. Malang; Kota Malang
			8.1	Pembangunan sumur resapan untuk peningkatan biopori						
			8.2	Pembangunan basin retardasi atau polder (embung atau urung-urung)						
1. Penurunan Ketersediaan Air			8.3	Pengembangan permeabel paving						
			8.4	Pemeliharaan drainase						
			8.5	Pengembangan sumber daya air permukaan di wilayah yang banyak sungai pendek						
			8.6	Pengembangan sumber daya air tanah dan bawah permukaan di daerah karst/daerah kapur						
			8.7	Penadahan air hujan di kawasan yang tidak memiliki potensi air permukaan atau air tanah.						
			8.8	Mengevaluasi dasar dam dan mencegah pasokan sedimen untuk dam						
			8.9	Pembangunan Spillway darurat dan Evaluasi Spillway						
			8.10	Upaya mengurangi sedimentasi & pengerukan						

Risiko	Opsi Expert	No		Program Daerah Terkait Adaptasi PI	Instansi Penanggung Jawab	*Stakeholders*			Program *Stakeholders* tahun 2013 yang Terkait	Rekomendasi Lokasi
					Malang District	Pusat	Swasta/BUMN	Lain-Lain		
				sedimentasi dasar						
2. Banjir	Terkait dengan Opsi Konservasi/ Reboisasi	1	Program Pemulihan/ Rehabilitasi Lahan		Dinas Kehutanan	Kemen PU DJ-BPDAS-PS; KemHut DJPLA			Pembuatan Kebun bibit rakyat (BP-DAS)	Malang Raya
			1.1	Agro-forestry						
			1.2	Hutan Rakyat Murni						
			1.3	Penghijauan						
	Terkait dengan Opsi Pembangunan Drainase/ Pengendalian Banjir	7	Program Pengendalian Erosi dan Sedimentasi		Dinas PU Cipta Karya BP DS SPAM	Kemen PU DJSDA: KemenHut			Bangunan Konservasi Tanah pada DAS Prioritas (50 unit) (BP-DAS)	Malang Raya
			7.1	Pembuatan Dam Penahan						
			7.2	Pembuatan Gullyplug						
			7.3	Pembuatan Sumur Resapan						
		8	Pengembangan Sumber Daya Air		Dinas PU Pengairan	Kemen PU DJSDA				
			8.1	Pelestarian sumber mata air						
			8.2	Pembuatan embung						
			8.3	Peningkatan teknologi infiltrasi (biopori, sumur resapan, pemanfaatan RTH)						
	Terkait dengan Penataan Ruang (RTRW)	9	Program Penguatan dan Peningkatan SDM		Dinas PU Pengairan	Semua K/L			Forum DAS Brantas (BP-DAS)	Malang Raya
Longsor	Terkait dengan Opsi Konservasi/ Reboisasi	2	Program Pemulihan / Rehabilitasi Lahan		Dinas Kehutanan	Kemen PU DJ-BPDAS-PS; KemHut DJPLA				

Risiko	Opsi Expert	No		Program Daerah Terkait Adaptasi PI	Instansi Penanggung Jawab	*Stakeholders*			Program *Stakeholders* tahun 2013 yang Terkait	Rekomendasi Lokasi
					Malang District	Pusat	Swasta/BUMN	Lain-Lain		
			2.1	HUtan Rakyat Murni						
			2.2	Reboisasi						
	Terkait dengan Opsi Drainase/ Sungai	3	Program pembangunan saluran dranaise/ gorong-gorong		Dinas PU Cipta Karya	Kemen PU DJCK				
		4	Program Pengendalian Erosi dan Sedimentasi		Dinas PU Cipta Karya BPDAS	Kemen PU DJCK			Bangunan Konservasi Tanah pada DAS Prioritas (50 unit) (BP-DAS)	Malang Raya
			4.1	Pembuatan Dam Penahan						
			4.2	Pembuatan Gully Plug						

A.2.2 Agriculture Sector

Risiko	Opsi Expert	No	Program/Kegiatan Daerah yang Terkait Adaptasi Perubahan Iklim	Instansi Penanggung Jawab	*Stakeholders*			Program *Stakeholders* tahun 2013 yang Terkait	Rekomendasi Lokasi
				Malang	Pusat	Swasta/BUMN	Lain-Lain		
	a. Penggunaan Bibit Unggul yang mampu beradaptasi: - dengan perubahan iklim (Umur Pendek dan Tahan Banjir/ Kekeringan) - dengan kenaikan muka air laut (genangan air yang berkadar garam tinggi) b. Peningkatan Teknik Budidaya Pertanian Dengan PTT dan Intensifi-kasi (SRI, Legowo)		Program Peningkatan Penerapan Teknologi Pertanian/ Perkebunan						
			1.3 Penggunaan Bibit Unggul Dengan Produktivitas Tinggi, Umur Pendek dan Tahan Banjir/Kekeringan						
			1.4 Peningkatan Teknik Budidaya Pertanian dengan PTT dan Intensifi-kasi (SRI, Legowo, pupuk organik)					Pengembangan SRI (Kemen-Tan DJPSP)	Kab. Malang, Sumsel (11 Kab.)
			Terkait dengan: Program Pengembangan Perbenihan (25 Kec. - 9 tahun)						
		3	Program Pengembangan Sumber Daya Air	DinHut, BPLHD, BBWS, BP DAS Brantas, Perum Jasa Tirta					
			3.1 Pelestarian Sumber Daya Air						
			3.2 Pembuatan Embung					Pembangunan Embung (Kemen-Tan DJPSP) memakai DAK	(3 lokasi belum masuk)
			3.3 Peningkatan Kapasitas Waduk Air Hujan						
Penurunan Produksi Pertanian	Revitalisasi **jaringan irigasi dan gerbang pintu air** (mencakup saluran irigasi yang dipengaruhi oleh pasang surut laut)	4	Program Pengembangan dan Pengelolaan Jaringan Irigasi, Rawa dan Jaringan Pengairan lainnya	DinHut, BPLHD, BBWS, BP DAS, Perum Jasa Tirta	Kemen-PU; DJSDA;			Pengembangan Jaringan Irigasi (Kemen-Tan DJPSP)	Kota Malang; Sumsel (OKI)
			4.3 Peningkatan dan Rehabilitasi (Revitalisasi) jaringan irigasi serta gerbang pintu air						
	Konservasi Tanah dan Air	6	Program perlindungan dan konservasi sumber daya alam	DinHut, BPLHD,	Kemen-Hut;				

Risiko	Opsi Expert	No	Program/Kegiatan Daerah yang Terkait Adaptasi Perubahan Iklim		Instansi Penanggung Jawab Malang	*Stakeholders*			Program *Stakeholders* tahun 2013 yang Terkait	Rekomendasi Lokasi
						Pusat	Swasta/BUMN	Lain-Lain		
	Tanah pada Lahan Pertanian		6.1	Konservasi sumber daya air dan pengendalian kerusakan sumber-sumber air	BBWS, BP DAS, Perum Jasa Tirta	Kemen PU DJ-BPDAS-PS; Kemen-PU DJSDA				
			6.2	Pendampingan Kelompok Pengelolaan Rehabilitasi Lahan						
			6.3	Penyelamatan daya rusak sumberdaya air						
			6.4	Penanaman tanaman keras (sengon, jabon, jati), tanaman produktif di kawasan hortikultur & perkebunan yang mempunyai nilai ekonomi						
			6.5	Monitoring sedimentasi waduk-waduk strategis di DAS bagian hulu						
	Mencetak lahan pertanian baru untuk menggantikannya dan/atau Optimalisasi pemanfaatan lahan tadah hujan dengan reboisasi	8	Program Pemulihan/ Rehabilitasi Lahan		DinHut, BPLHD, BBWS, BP DAS, Perum Jasa Tirta	Kemen-Hut; Kemen PU DJ-BPDAS-PS				
			8.1	agro-forestry,						
			8.2	hutan rakyat murni						
			8.3	Optimalisasi pemanfaatan lahan tadah hujan dengan reboisasi						
	Optimalisasi pemanfaatan lahan yang ditinggalkan dengan reklamasi dan membuka lahan baru (melalui opsi manajemen pengetahuan)	11	Program Pengembangan Kelembagaan		Dinas Pertanian	Kemen-Tan				
			11.1	Peningkatan pengetahuan dan ketrampilan						
			11.2	Pelatihan teknis (5 angk. – 30 org)						
			11.3	Penyuluhan (190 desa – 9 tahun)						
			11.4	Sekolah Lapang Pertanian						
			11.	Diklat Fungsional untuk Penyuluh &						

Risiko	Opsi Expert	No	Program/Kegiatan Daerah yang Terkait Adaptasi Perubahan Iklim		Instansi Penanggung Jawab Malang	*Stakeholders*			Program *Stakeholders* tahun 2013 yang Terkait	Rekomendasi Lokasi
						Pusat	Swasta/BUMN	Lain-Lain		
			5	Juru Air						
			11.6	Peningkatan kesejahteraan penyuluh & juru air dan regenerasinya						
Penurunan Produksi **Apel Batu**	Menanam bibit unggul apel yang mampu beradaptasi dengan perubahan iklim	1	Program Bantuan bibit Tersertifikasi (Kota Batu dan Kab. Malang)		Dinas Pertanian (Kota Batu dan Kab. Malang)	Kemen-Pertanian				
	Rehabilitasi penanaman apel dan mengganti tanaman apel yang sudah tua	2.a	Program Peremajaan Tanaman Apel (Kota Batu)							
		2.b	Program Perluasan Tanaman Apel (Kab. Malang)							
			1.1	Rehabilitasi penanaman apel						
			1.2	Mengganti tanaman apel yang sudah tua						
	Mencegah konversi lahan tanaman apel menjadi lahan tanaman non apel	3	Pemberian insentif bagi petani apel			Kemen-Pertanian Kemen-Pariwisata & Ekonomi Kreatif				
			3.1	Penentuan Harga Pokok buah apel						
			3.2	Insentif pada keluarga petani apel (beasiswa bagi anak-anak petani)						
			3.3	Promosi secara intensif						
			3.4	Bantuan pupuk dan bibit						

A.2.3 Health Sector

Risiko	Opsi Expert	No	Program/Kegiatan Daerah yang Terkait Adaptasi Perubahan Iklim	Instansi Penanggung Jawab	*Stakeholders*			Program *Stakeholders* tahun 2013 yang Terkait	Rekomendasi Lokasi
				Malang Raya	Pusat	Swasta/BUMN	Lain-Lain		
Penyakit DBD	Pengendalian vektor penyakit	1	Program Pencegahan dan Penanggulangan Penyakit Menular	Dinas Kesehatan	Kemenkes DJ-P2PL				
			Terkait dengan: Program Upaya Kesehatan Masyarakat						
			1.1 Penyemprotan (fogging) nyamuk		1. Kemenkes Dir. PPBB Vektor; 2. Kemenkes-Kantor Kesehatan Pelabuhan			Fogging di permukiman di sekitar pelabuhan dan bandara (Tarakan)	
			1.2 Pelayanan pencegahan dan penanggulangan penyakit menular		Kemenkes Arbovirosis				
			1.3 Peningkatan surveilans epidemiologi dan penanggulangan wabah		Kemenkes Simkarkesmas				
			1.4 Surveillans vector DBD rutin di setiap desa/ kelurahan oleh entomologist lapangan		Kemenkes Arbovirosis, Simkarkesmas				
			1.5 Pemberantasan sumber habitat sarang nyamuk dengan program 3M Plus dan PSN secara rutin						
			1.6 Abatisasi dan atau pemakaian IGR (misal Altosid) di lokasi sarang nyamuk						
	Pengendalian vektor penyakit dan perbaikan lingkungan	2	Program Promosi Kesehatan dan Pemberdayaan Masyarakat	Dinas Kesehatan; Kecamatan/ Kelurahan	Kemenkes Pusat Promosi; Kemen-dagri (?)		Forum Kota Sehat Malang (swadaya masy + APBD)	Penyuluhan PHBS	
			Terkait dg: Program pengembangan media promosi dan informasi sadar hidup sehat						
			2. Penyuluhan masyarakat mengenai pola						

Risiko	Opsi Expert	No	Program/Kegiatan Daerah yang Terkait Adaptasi Perubahan Iklim		Instansi Penanggung Jawab	*Stakeholders*			Program *Stakeholders* tahun 2013 yang Terkait	Rekomendasi Lokasi
					Malang Raya	Pusat	Swasta/BUMN	Lain-Lain		
			1	hidup sehat						
			2.2	Peningkatan pendidikan tenaga penyuluh kesehatan		Kemenkes PPSDM				
			2.3	Penyuluhan masyarakat tentang APD (alat pelindung diri) seperti pengusir nyamuk, jaring nyamuk, kelambu celup, semprotan nyamuk, pakaian sesuai.		Kemenkes Pusat Promosi + Arbovirosis				
			2.4	Penyuluhan masyarakat tentang alat pelindung rumah (kawat anti nyamuk di pintu dan jendela)						
			2.5	Penyuluhan masyarakat untuk mengurangi genangan dan/atau memasukkan musuh biologis/predator (ikan nila, ikan cupang, dsb) pada tempat genangan.						
	Perbaikan Lingkungan	3	Program pengembangan dan pengelolaan jaringan irigasi, rawa dan jaringan pengairan lainnya (Pembangunan jaringan air bersih/air minum)		Dinas PU Cipta Karya	Kemen-PU DJCK			Infrastruktur drainase perkotaan (DJCK)	sesuai
			Terkait dengan: Program Pembangunan saluran drainase/gorong-gorong							
			3.1	Perbaikan saluran drainase/pembuangan air hujan						
			3.2	Peningkatan pelayanan air bersih perpipaan						
		4	Program Penyediaan dan Pengelolaan Air Baku		Dinas PU Cipta Karya; PDAM; BLH Prov. Jatim	Kemen-PU DJCK				
			4.1	Peningkatan pelayanan air bersih perpipaan (PDAM) + non-perpipaan					Penyelenggara sistem air minum yang terfasilitasi (DJCK); PAMSIMAS	
		5	Program Pengembangan Lingkungan Sehat		Dinas Kesehatan	Kemenkes Peny. Lingkungan, Kemen-PU DJCK				
			5.1	Pengendalian nyamuk di dalam perumahan dan bangunan umum, di pekarangan dan sekitarnya						

Risiko	Opsi Expert	No	Program/Kegiatan Daerah yang Terkait Adaptasi Perubahan Iklim	Instansi Penanggung Jawab	*Stakeholders*			Program *Stakeholders* tahun 2013 yang Terkait	Rekomendasi Lokasi
				Malang Raya	Pusat	Swasta/BUMN	Lain-Lain		
Penyakit Malaria	Pengendalian vektor penyakit	1	Program Pencegahan dan Penanggulangan Penyakit Menular	Dinas Kesehatan	Kemenkes DJ-P2PL				
			Terkait dengan: Program Upaya Kesehatan Masyarakat						
			1.1 Penyemprotan foging nyamuk				Global Fund	Fogging	
			1.4 Pemberantasan sumber habitat sarang nyamuk melalui Program Perbaikan Lingkungan	Dinas Kesehatan					
			1.5 Pengamatan Epidemiologi rutin (bulanan, 2 mingguan, mingguan)						
	Pengendalian vektor penyakit dan perbaikan lingkungan	2	Program Promosi Kesehatan dan Pemberdayaan Masyarakat	Dinas Kesehatan; Kecamatan/ Kelurahan	Kemenkes Pusat Promosi		Forum Kota Sehat Malang (swadaya masy + APBD)	Penyuluhan PHBS	
			Terkait dg: Program pengembangan media promosi dan informasi sadar hidup sehat						
			2.1 Penyuluhan masyarakat mengenai pola hidup sehat						
			2.2 Peningkatan pendidikan tenaga penyuluh kesehatan						
			2.3 Penyuluhan masyarakat tentang APD (alat pelindung diri) seperti pengusir nyamuk, jaring nyamuk, kelambu celup, semprotan nyamuk, pakaian sesuai.						
			2.4 Penyuluhan masyarakat tentang alat pelindung rumah (kawat anti nyamuk di pintu dan jendela)						
			2.5 Penyuluhan kearifan lokal: Pengalihan sasaran vektor pada hewan mamalia (kera, sapi); Pena-naman pohon anti nyamuk; Pemeliharaan ikan						

Risiko	Opsi Expert	No	Program/Kegiatan Daerah yang Terkait Adaptasi Perubahan Iklim	Instansi Penanggung Jawab	*Stakeholders*			Program *Stakeholders* tahun 2013 yang Terkait	Rekomendasi Lokasi
				Malang Raya	Pusat	Swasta/BUMN	Lain-Lain		
	Perbaikan Lingkungan	3	Program Pengembangan Lingkungan Sehat	Dinas Kesehatan					
			3.1 Mengurangi genangan air laut di pesisir, sawah, bekas tambang batu bara, dan/ atau memasuk-kan musuh biologis (ikan) atau desalinasi pada tempat genangan yang tidak bisa dikeringkan						
			Terkait dg: Prog. Pengembangan Perikanan Tangkap (Rehab Rumah Nelayan Sehat)						
		4	Program Pemanfaatan Potensi Sumber Daya Hutan	Dinas Kehutanan	Kemenkes Peny. Lingkungan; Kemen-Hut; Kemen-Par; Kemenkominfo; KLH				
			4.2 Restorasi hutan lindung dan mangrove dengan menambahkan hewan mamalia (kera dsb.)					Restorasi mangrove (KLH, KemenHut, Kemen-KP);	
	Pengawasan/ pengamatan agen penyakit	5	Program pengawasan / pengamatan agen penyakit	Dinas Kesehatan	Kemenkes Litbangkes				
			5.1 Pengamatan rutin parasit malaria (menghitung Indeks Malaria dan Indeks Kepadatan Nyamuk) oleh malariologist dan entomologist						
Penyakit Diare	Pengendalian vektor penyakit dan perbaikan lingkungan	1	Program Promosi Kesehatan & Pemberdayaan Masyarakat	Dinas Kesehatan; Kecamatan/ Kelurahan	Kemenkes Pusat Promosi	PT Unilever (CSR)	Forum Kota Sehat Malang (swadaya masy + APBD)	Iklan masyarakat; Penyuluhan UKS ; Penyuluhan PHBS	
			Terkait dengan: Program Upaya Kesehatan Masyarakat						
			1.1 Penyuluhan masyarakat tentang pola hidup sehat						

Risiko	Opsi Expert	No	Program/Kegiatan Daerah yang Terkait Adaptasi Perubahan Iklim	Instansi Penanggung Jawab	*Stakeholders*			Program *Stakeholders* tahun 2013 yang Terkait	Rekomendasi Lokasi
				Malang Raya	Pusat	Swasta/BUMN	Lain-Lain		
			1.2 Penyuluhan mengenai fasilitas air sumur yang bersih (air berklorin)						
			1.3 Penyuluhan mengenai fasilitas air minum yang steril (penyaringan, direbus)						
			1.4 Penyuluhan mengenai pemanfaatan air minum dalam kemasan						
	Perbaikan Lingkungan	2	Program pengembangan dan pengelolaan jaringan irigasi, rawa dan jaringan pengairan lainnya	DinasPU Cipta Karya	Kemen-PU SDA				
			Terkait dengan: Program Upaya Kesehatan Masyarakat		Kemenkes DJ-P2PL				
			2.1 Pembangunan jaringan air bersih/air minum		Kemen PU DJCK	HIPAM			
			2.2 Klorinasi terhadap sumur gali dan tempat penampungan air	Dinas Kesehatan					
			2.3 Peningkatan kualitas air menjadi air siap minum	Dinas PU Cipta Karya; PDAM					
		3	Program penambahan pada SOP mitigasi bencana	BNPB	PP Krisi, Matra, PKS Darurat				
			3.1 Mempertimbangkan penanganan air bersih dalam mitigasi kebencanaan						
		4	Program Lingkungan Sehat Perumahan:	Bappeda	Pokja Perum. Bappenas; Kemen-pera + Kemen PU DJCK; Kemenkes; Kemen-KP			Rumah sederhana dan sehat (Kemen-Pera); Program Kota Sehat (Kemenkes/Bappeda); Desa Pesisir Tangguh Bencana (Kemen-KP)	
			4.3 Penyuluhan dan penyediaan fasilitas toilet umum dan septik tank di perumahan	Bappeda					
		5	Program Pembangunan saluran drainase/ gorong-gorong	Dinas PU Tata Ruang	Kemen-PU DJCK				

Risiko	Opsi Expert	No	Program/Kegiatan Daerah yang Terkait Adaptasi Perubahan Iklim		Instansi Penanggung Jawab	*Stakeholders*			Program *Stakeholders* tahun 2013 yang Terkait	Rekomendasi Lokasi
					Malang Raya	Pusat	Swasta/BUMN	Lain-Lain		
			5.1	Penyuluhan dan penyediaan fasilitas drainase air limbah perkotaan						
		6	Program Upaya Kesehatan Masyarakat		Dinas Kesehatan					
			6.1	Pemberian kaporit pada sumur-sumur gali		Subdit Air				
	Pengawasan/ pengamatan agen penyakit	7	Program pengawasan/pengamatan agen penyakit		Dinas Kesehatan	Kemenkes Litbangkes, Surveillans				
			7.1	Pengamatan/pemeriksaan agen penyebab di lab klinik/RS/Labkesda						
Umum (DBD, Malaria, Diare)	Manajemen Infeksi Manusia	1	Program Standarisasi Pelayanan Kesehatan		Dinas Kesehatan					
			1.1	Menyusun sistem dan infrastruktur informasi dan pelaporan kasus penyakit secara online untuk menunjang sistem manual yang sudah ada						
			1.2	Monitoring Epidemologis rutin (bulanan, 2 mingguan, mingguan, harian) yang dikaitkan dengan Sistem Peringatan Dini DBD (integrasi hasil surveilans vektor, laporan kasus, pengamatan serologi, dan pengamatan cuaca)						
			1.3	Penyempurnaan sistem dan infrastruktur penanganan kasus penyakit sehingga mudah dan cepat terjangkau masyarakat						
		2	Program promosi kesehatan dan pemberdayaan masyarakat							
			2.1	Peningkatan kesadaran dan edukasi masyarakat secara intensif pada saat peralihan musim						
			2.2	Pemberdayaan masyarakat untuk Tata Laksana DBD, Malaria, Diare						
		3	Program Obat dan Perbekalan Kesehatan							
			Terkait dengan: Program Upaya Kesehatan Masyarakat							

Risiko	Opsi Expert	No	Program/Kegiatan Daerah yang Terkait Adaptasi Perubahan Iklim		Instansi Penanggung Jawab	*Stakeholders*			Program *Stakeholders* tahun 2013 yang Terkait	Rekomendasi Lokasi
					Malang Raya	Pusat	Swasta/BUMN	Lain-Lain		
			3.1	Penjaminan persediaan sarana penunjang diagnosis (khususnya di LabKesda)						
			3.2	Penjaminan persediaan obat: Cairan infus, Transfusi darah (DBD), Obat anti-malaria, Obat anti-diare						
	Penyediaan dan pengembangan sumber daya manusia bidang kesehatan	4	Pengembangan sumber daya manusia bidang kesehatan		Dinas Kesehatan					
			4.1	Penyediaan tenaga lapangan: Epidemiologist DBD, Entomologist (DBD, malaria), Malarialogist						
			4.2	Penyediaan tenaga laboratorium: Clinic analyst, Virologist (DBD)						
			4.3	Penyediaan dokter umum Plus dan tenaga perawat, khusus yang berpengalaman menangani penyakit DBD, Malaria, Diare						
			4.4	Penyediaan dokter spesialis penyakit menular, khususnya patologi klinik, mikrobiologi klinik, parasitologi klinik						
			4.5	Pengembangan LSM untuk membantu aktivitas bidang kesehatan (Jumantik, outreach)						
	Peningkatan sumber pendanaan sektor kesehatan	5	Peningkatan sumber pendanaan sektor kesehatan		Dinas Kesehatan					
			5.1	Mengusahakan peningkatan porsi anggaran kesehatan dalam APBD dan APBN						
			5.2	Peraturan tentang pemanfaatan dana CSR untuk kesehatan						

A.3 Champion Program

Program Unggulan/ Program Terpadu	Sek-tor Ter-kait	Program Sektor Terkait	Kegiatan yang Terkait	Kemen-terian/ Lembaga Terkait	Antisipasi terhadap Risiko Perubah-an Iklim	Faktor Dominan Kerentanan
Program Konservasi Sumber Daya Air Daerah Aliran Sungai (DAS) Brantas Hulu	• Air • Per-tanian	Program Pemulihan/ Rehabilitasi Lahan	• Reboisasi, terutama pada tegalan dan daerah pembuangan • Agro-forestry • Hutan rakyat murni	Kemen-Hut DJBPDAS-PS KLH	• Penu-runan Keter-sediaan Air • Banjir • Longsor • Penurunan produksi pertanian, akibat pengurangan lahan pertanian	Banyaknya konversi lahan hutan menjadi lahan permukiman, pariwisata, dan pertanian di daerah hulu DAS Brantas
		Program Pengembangan Sumber Daya Air	Pembangunan Embung	Kemen-PU DJSDA		
	Kese-hatan	Program Pemulihan/ Rehabilitasi Lahan (tambahan)	Penambahan hewan mamalia (kera, dsb) di hutan	Kemen-Hut	Penyakit malaria	Kurangnya hewan mamalia sebagai pengalih sasaran nyamuk malaria
		Program Pembangunan saluran drainase/gorong-gorong, <u>dipadukan dengan:</u> Program Pengembangan Lingkungan Sehat	Perbaikan saluran drainase, pembuangan air hujan, dan penampungan air bersih	Kemen-PU DJCK <u>dan</u> Kemen-kes DJP2PL; KLH	• Penyakit DBD • Penyakit malaria • Penyakit Diare	Banyaknya saluran drainase, pembuangan air hujan, dan penampungan air bersih yang kurang memenuhi standar kesehatan lingkungan
Program Inventarisasi dan Standarisasi Data Terkait Perubahan Iklim	Basis Sain-tifik	Program Inventarisasi dan Standarisasi Data Terkait Iklim	• Standari-sasi data iklim • Standari-sasi data kelautan • Inventari-sasi data iklim • Inventari-sasi data kelautan	BMKG; Badan Informasi Geospasial; Kemen-Ristek LIPI LAPAN	Semua risiko sektoral	Kurangnya kuantitas data yang tidak memenuhi standarisasi data iklim dapat menyebabkan kurangnya akurasi hasil analisis dan proyeksi perubahan iklim, yang pada gilirannya dapat menimbulkan kurang-tepatnya rekomendasi adaptasi perubahan iklim