

**INTEGRATING CLIMATE CHANGE ADAPTATION ON WATER SECTOR
INTO DEVELOPMENT PLAN BY MAKING USE OF
ECOSYSTEM SERVICES APPROACH
CASE STUDY: UPPER BRANTAS RIVER BASIN, INDONESIA**

MASTER THESIS

**A thesis submitted in partial fulfilment of the requirements for
The Master Degree from University of Groningen and
The Master Degree from Institut Teknologi Bandung**

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Double Master Degree Program

**Department of Regional and City Planning
School of Architecture, Planning and Policy Development
Bandung Institute of Technology**



and



**Environmental and Infrastructure Planning
Faculty of Spatial Sciences
University of Groningen
2013**

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ABSTRACT

Integrating Climate Change Adaptation on Water Sector Into Development Plan by Making Use of Ecosystem Services Approach Case Study: Upper Brantas River Basin, Indonesia

by

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The impact of climate change is tangible and it threatens the sustainability of water resources and its dependent human. Hence, adaptation strategies is important to counter this risk and it should be embedded within policy to establish a climate resilient development. Adaptation strategies should be directed to enhance natural system to ensure the continuity of supply goods and services delivered for human. This so called ecosystem-based adaptation is essential to secure both nature and human system in the face of climate change. Ecosystem services is significant as the foundation in determining adaptation strategies. This concept is important notion to link nature and human system. Within Indonesia's policy, specifically the case study in upper Brantas River Basin, ecosystem services and climate change adaptation might not actualize in specific projects so called ecosystem services and/or climate change adaptation assessment. However the consideration of services ecosystem generated for human up to the effect emerge due to disruption of biophysical system is well addressed within development plans. This is particularly concerning regulating services in terms of water regulation, water supply, erosion regulation and natural hazard regulation to dampen the risk of floods, landslide and erosion which are the main threats within area under study. Strategies to adapt with climate change impacts mainly focus on land and forest rehabilitation and rehabilitation on water resources and its catchment area. Apart from these, there is little indication on ecosystem trade-offs. How the preference over particular services affects the continuity of other services is not highlight within development plans. Therefore, this issue should be carefully assess in defining adaptation strategies in the future.

Keywords: ecosystem services, water resources, climate change impact, adaptation, resilience, development plan, ecosystem-based adaptation

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Natural resources has been the object of human interference ever since the history of human begin. Undoubtedly, the nature has change into the critical point where it cannot support human needs any longer. Instead, exploitation of natural resources lead to disaster and loss for both nature and human. This writing is part of my thoughts to give something valuable in favour environmental protection. As I work in the Ministry of Forestry, specifically in River Basin Management Agency, it is my desire to explore this matter through the framework of river basin ecosystem. Ecosystem services and adaptation to climate change is quite new issues in my country, thus I want to give my share to contribute in the improvement of Integrated River Basin Management Plan.

First of all, I would like to express my gratitude for Allah Almighty who give me this opportunity to experience different education systems that beneficial to enrich my personal quality and knowledge, and also for the faith and strength therefore I am able to finish my study. I would like to address my special thanks to my supervisors, Prof. Johan Woltjer (RuG) and Dr. Djoko Santoso Abi Suroso (ITB), for the guidance in completing my thesis. I would express my thanks as well for all of the lecturers in RuG and ITB, the staff members for helping me with administration matters, my colleagues in Brantas River Basin Management Agency and my fellows Double Degree Program ITB-RuG 2011-2013 for every support and precious moments we have shared. Last but not least, I would like to show my appreciation for Bappenas and NESO for giving me this scholarship.

I dedicate this writing for my late father for always being my anchor, my mother for her devotion and love, and for all of my family for their remarkably support. My greatest thanks for always keeping their faith in me.

Groningen, August 2013
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ABBREVIATION

Bappeda	:	<i>Badan Perencanaan Pembangunan Daerah</i> (Local Development Planning Agency)
BPDAS	:	<i>Balai Pengelolaan Daerah Aliran Sungai</i> (River Basin Management Agency)
DAK	:	<i>Dana Alokasi Khusus</i> (Special Allocation Fund)
IPB	:	<i>Institut Pertanian Bogor</i> (Bogor Institute of Agriculture)
IPCC	:	Intergovernmental Panel on Climate Change
MA	:	Millennium Assessment
Renja	:	<i>Rencana Kerja</i> (Work Plan)
Renstra	:	<i>Rencana Strategis</i> (Strategic Plan)
RDTR	:	<i>Rencan Detail Tata Ruang</i> (Detailed Spatial Plan)
RKPD	:	<i>Rencana Kerja Pembangunan Daerah</i> (Short-term Development Plan)
RPJMD	:	<i>Rencana Pembangunan Jangka Menengah Daerah</i> (Long-term Development Plan)
RTRW	:	<i>Rencana Tata Ruang Wilayah</i> (Spatial Plan)

Chapter 1

INTRODUCTION

1.1. Background

Human dependency on nature is inevitable. Nature provides abundant resources to be harnessed in order to improve human living. One of the benefits that nature provides is water resources. Drinking water, irrigation, energy power, transportation and recreation are some of advantages from the existence of water resources. In line with the rapid growth of population, the need of water resources increase too. Indeed, many regions undergo crisis of clean water that further affect human health and welfare. Hence, being the most critical aspect in human life, water resources states at critical point as well if it is utilized in unsustainable manner. This risk is aggravated by the change in global climate leading to extreme pattern of rainfall and temperature that affect human habitation.

*Climate change*¹ is hardly a new term in environmental perspective. Since the declaration of Earth Summit in 1992, there is a rising awareness about this issue within global world. Despite the debates on climate change, evidences on natural disaster caused by the change in global climate such as flood and drought are apparent. Changes in rainfall and temperature as well as population and land use change affects run off and water availability. It is believed that the drawback of climate change on freshwater system is greater than the benefits. It was projected that by 2050s the availability of freshwater will be undermined especially in large river basins in Central, South, East and South-East Asia (IPCC, 2007). Apparently, the effect of this event is manifold. Not only does climate change bring impact to hydrological, biological and ecological system, it also affects economy which in turn could threat the sustainable development of regional, national and even the global world (Yang, 2011).

¹ A change in the state on the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity (IPCC, 2007)

Nowadays, there is growing concern on the vulnerability of the environment. Therefore, there are more attempts to establish a so called adaptation strategy to preserve the natural resources to maintain its sustainability. Dealing with water resources, adaptation to changing conditions, increasing water demand and climate variability are being the main focus (Krysanova, et al., 2010). Adaptation strategy should be done through integrated water resources management and define river basin as unit analysis (Timmerman, et al., 2010). This adaptation strategy should be embedded into policy regarding water resources. This integration will establish a climate resilient development which has capacity to absorb and release immediately from climate shocks and stresses (Mitchell & Maxwell, 2010).

*Ecosystem Services*² can be used as the appropriate approach to analyse the adaptation strategy within river basin ecosystem. This concept is considered as important notion to connect ecosystem function and human welfare (Fisher, et al., 2009). The use of ecosystem services was begin with the utilitarian framing of beneficial ecosystem functions as services to attract public interest in biodiversity conservation in the late 1970s (Westman, 1977 in Gomez-Baggethun, et al., 2010). However, it was the Millennium Ecosystem Assessment that put ecosystem services on policy agenda and become the starting point of ecosystem services development (Fisher, et al., 2009). Figure 1.1 clearly describe the connection between policy and legal framework (indirect driver) and climate change (direct driver) and how they affect ecosystem services and further, human well-being.

² *The benefits human population derive, directly or indirectly, from ecosystem function* (Constanza, et al., 1997)

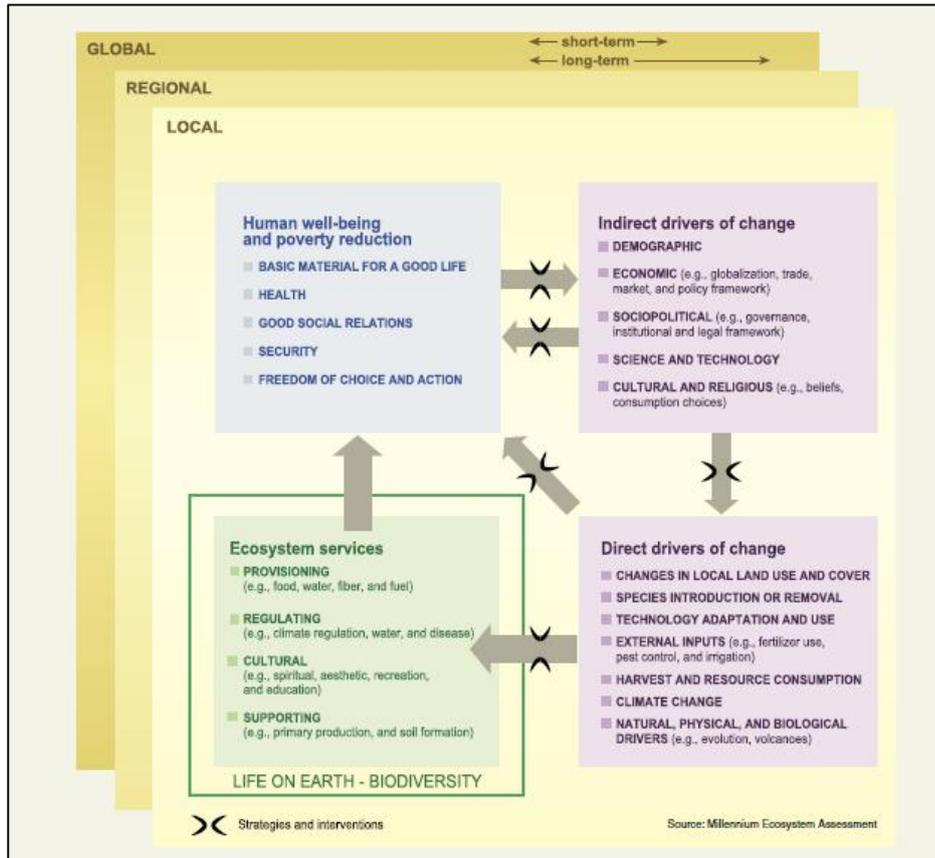


Figure 1.1. Millennium Ecosystem Assessment Conceptual Framework
 Source: Millennium Ecosystem Assessment (2005)

1.2. Problem Statement

Planning river basin, there are economic, social and environmental benefits that have to be taken into consideration (Mageded, 1985). These three elements; ecological, socio-cultural and economic value of ecosystem, are well captured in ecosystem services approach. These values closely related to ecosystem functions which contribute to enhance human well-being namely; regulation functions, habitat functions, production functions and information functions (De Groot, et al., 2002). Regarding climate change, adaptation strategy should cover ecosystem services to reduce the risk caused by climate change and create a climate resilience. The impact of climate change on altering quantity and distribution of water resources is obvious. Extreme changes in the frequency and intensity of precipitation has direct effects on the magnitude and timing of run off. Thus, the

risks of floods and droughts as well as water shortage become tangible. That is way, this research attempts to analyse how policies within river basin management implement adaptation strategies for reducing these risks.

There might considerable publication regarding ecosystem services within policy however pertaining developing countries there is still lack of scientific document (Ferraro, et al., 2011). As for Indonesia, its geographical position causing the country vulnerable to climatic hazard. Changing in global climate has led to extreme rainfall within rainy season and vice versa. Land use change and deforestation increase the risk of flood, landslide, water shortages and soil erosion. The importance of environment and natural resources management is widely acknowledged within Indonesian legislation, however the enforcement of such policy is still difficult. The main constraint is how to rectify the current regulations and policies to be more applicable as well as increase budget allocation for environmental protection (Wingqvist & Dahlberg, 2008).

The need to mainstream those issues within planning is of great importance. Policy enforcement is equally important as well. All these matters are requirement towards a more resilient system for both nature and human system. As the risks of climate change expose both system, the need to increase invulnerability against such disturbance is notable. This is not only because of the need to protect natural resources but also aiming to secure human welfare especially poor communities as they eventually suffer the most from such impacts. Wingqvist & Dahlberg (2008) stress that poor communities depend on natural resources for their living therefore they are the most vulnerable group affected from the changing in natural resources. In Indonesia, around 40 million people disadvantaged due to biodiversity loss and ecosystem services degradation because of their dependency on natural resources. Mainstreaming adaptation strategies within development plan might be the effective way to ban activities that could harm the sustainability of water resources thus increase the vulnerability from climate change impacts. This approach also significant in encouraging climate resilience (Burton, et al., 2006).

Consequently, how planning considers ecosystem services as the foundation for managing natural resources, particularly water resources, should be examined. Further, how these services are considered in defining adaptation strategies in the face of climate change is necessary as well. This is significant to understand the extent to which policy in Indonesia concerns about this issue. This might be actualized in terms of specific programs, funding or mere in the form of directive plan. This has to be investigated to discover planning attempts this far.

1.3. Research Objectives

This research is expected to give clear picture on climate change impact on water resources. Furthermore, it is hoped that through this research there will be more understanding on climate change impact, the need to adapt as well as implementation of such adaptation. The main idea is to analyse the integration of climate change adaptation strategy into development plan. It is important for knowing to what extent climate change is understood as a threat for human-being and environment and how adaptation strategy considered as an important factor in policy making. This adaptation strategy will be explored by using the concept of ecosystem services (ecosystem-based adaptation).

First of all, this research attempts to explore ecosystem services (services, processes, components and benefits), particularly upon water resources, within the framework of river basin ecosystem. This is connected to climate change as this phenomenon brings significant impact on water resources. Then, it will go further to analyse how decision maker addresses the issue and consider it in the development plan. This research will take case study in Indonesia to explore how the current practices consider ecosystem services in the development plan.

1.4. Research Questions

The main concern of this research is to investigate the integration of climate change adaptation on water sector into development plan. Ecosystem services is used as the tool for exploring this adaptation strategy. Research question emerge in this study based on problem stated is *to what extent ecosystem services is*

captured in the development plan on water sector within Brantas River Basin, Indonesia, as the mean to perform adaptation strategy to climate change.

In order to answer this question, there are sub questions as follows:

Theoretical perspective:

1. What is the link of ecosystem services and climate change adaptation?
2. What is the importance of these two concepts within development plan?

Theoretical and empirical study:

What are changes in ecosystem services related to water resources due to climate change?

1. What services (ecosystem processes and components) are changing?
2. What are the consequences of these changing (what benefits might change)?
3. What are the responses in development plan regarding the changes?

Empirical study:

1. How are ecosystem services integrated within planning practice?
2. What lesson can be drawn from the practices to improve the climate change adaptation in Indonesia's policy?

1.5. Research Methodology

1.5.1. Research Area

This research will be done through case study in Indonesia. Research area is in Brantas River Basin particularly the upper part of the river basin. Being the second largest river system in East Java Province, Brantas River Basin holds significant role for the whole population within this area. It provides abundant natural resources beneficial for human. Surface water has been utilized for hydropower plant, irrigation and industrial purposes for a long time. Forest and conservation areas provide catchment area to store groundwater as the main source of drinking water. In addition, it also serves as habitat for biota that supports the sustainability of this river basin.

For the past few years this river basin has been suffered from natural hazard such as flood, drought, landslide, erosion and sedimentation which threatening not only human well-being but also the sustainability of the natural ecosystem. River basin system can be divided into three parts; upstream, middle-stream and downstream. Upstream area stands as recharge area that has to be protected and conserved. Downstream area is considered as utilization area while transport zone of water resources occurred in middle part. Thus, upstream area is important part for the whole river basin ecosystem as this area is functioned as recharge area to catch precipitation and store it as groundwater retention and also manage water balances within the river basin system. It is also essential in controlling erosion and sedimentation, therefore this area should be managed to keep its health and functions to support the whole river basin. Hu et al. (2005) emphasize the impact of landcover change on stream discharge in which exacerbate by the change in precipitation which endanger water resource availability.

Therefore, the selected river basin is considered as appropriate to represent the dynamic process within river basin ecosystem and how planning should be done regarding this complex system encountering climate change events.

1.5.2. Data Required

Data required to support this research mainly come from secondary resources. It consists of development plans from institutions involved in the management of Brantas River Basin. The development plan can be divided into three different documents as follows:

1. Spatial plan

Spatial plan (*RTRW/Rencana Tata Ruang Wilayah*) acts as the foundation for every development in Indonesia. The document used in this research is local spatial plan established by the Local Development Planning Agency (*Bappeda/Badan Perencanaan Pembangunan Daerah*). As the legal basis for development, it regulates space utilization within city and regency thus each development plan should be in lined with this.

2. Mid-term development plan and short-term development plan

Mid-term development plan (*RPJMD/Rencana Pembangunan Jangka Menengah Daerah*) and short-term development plan (*RKPD/Rencana Kerja Pembangunan Daerah*) are assigned as the reference for every stakeholder in composing its strategic plan and work plan. Mid-term development plan is a five-year planning drawn from the long-term development plan (20 years) and is described further in an annual short-term development plan.

3. Strategic plan and work plan

Strategic plan (*Renstra/Rencana Strategis*) and work plan (*Renja/Rencana Kerja*) are the main basis for development which is assigned by each government agency as the guidance for establish programs per development sector. Regarding this research, strategic plan and work plan being used are from the agency involved within Brantas River Basin management which responsible for agriculture and irrigation sector, forestry sector and environmental sector.

1.5.3. Data Analysis

Prior to analysis of acquired data, literature review on the theoretical perspective on climate change, water resources and ecosystem services will be done. The aim is to study on the impact of climate change as well as adaptation strategies to encounter the risks. It also will assess the ecosystem services, its processes and components, and the benefits human obtained from it. Furthermore, it will review on changing services in river basin ecosystem and the consequences of those changes regarding water resources. This information will be collected from articles, books, documents, reports related to the points stated above. This will be presented in table as the reference for analysing the document plans and assessing ecosystem services within.

The second step involves analysis of the development plans within the study area. Data analysis will be conducted through descriptive-qualitative analysis. Analysis of the document plans will be done using software Atlas.ti as the tool for content

analysis. First, the obtained-data are classified into categories as stated in the previous part. Thus, coding is made to categorize services, benefits and its changing, and responses needed to anticipate the risk in order to make reference for content analysis of the development plans. This analysis is not merely depend on the use of keywords or phrase in the document but involving detailed analysis on the context of paragraph/phrase related to certain issue. The aim is to avoid repetition of the same object thus lead to misguide on the result. Table below describe the supporting data as well as source of data and analysis required in this research.

Table 1.1. Method and data analysis

Research Questions	Data required	Source of data	Analysis
<i>Theoretical perspective</i>			
1. What is the link of ecosystem services and climate change adaptation?	Concept of: <ul style="list-style-type: none"> ▪ Climate change (and risk) ▪ Adaptation strategy ▪ Ecosystem services 	Articles, books, reports, newspaper	Literature review
2. What is the importance of these two concepts within development plan?	<ul style="list-style-type: none"> ▪ Climate resilient development 		
<i>Theoretical perspective and empirical study</i>			
What are changes in ecosystem services related to water resources due to climate change:	<ul style="list-style-type: none"> ▪ Climatic event and risk on water resources ▪ Ecosystem processes and components affected by climate change related to water resources 	Theoretical: Articles, books, reports	Qualitative analysis (content analysis)
a. What services (ecosystem processes and components) are changing?		Empirical (case study): Development Plans	
b. What are the consequences of these changing (what benefits might change)?	<ul style="list-style-type: none"> ▪ Benefit human obtain from the services and the changes regarding to climate change 		
c. What are the responses in development plan regarding the changes?	<ul style="list-style-type: none"> ▪ Adaptation strategy related to the changes captured in development plan 		

1.6. Thesis structure

The overview of the structure of this thesis is as follows;

Chapter 1: Introduction

To begin with, this chapter provides background of this research on how climate change has become threat for human life therefore human needs to adapt with these changes in order to maintain their life. Hereafter, the urgency to mainstream adaptation strategies into development is discussed. To acknowledge these adaptation strategies, the use of ecosystem services approach is significant as with this approach the changing in ecological process and also in ecosystem services flows can be recognized. Therefore, what benefits changing or missing for human can be detected as well. This chapter also describe the methodology of this research including the explanation of the case study, the reason behind the choice of the case study and how to conduct the research.

Chapter 2: Literature review

This chapter provides literature review to form conceptual framework of this research. Specifically, it will address research sub-questions on the link of ecosystem services and adaptation strategies and the importance of these concepts within policy. First of all, it discusses the concept of climate resilient development as the umbrella of this research. It describes how integration of adaptation strategies, to be precisely, ecosystem-based adaptation (involving the role of ecosystem services) and development plan become important. It also discuss the concept of ecosystem services in depth way. In the end, this chapter addresses research sub questions on the changes in ecosystem services on water resources from the theoretical review. It delivers list of ecosystem services, ecological changes due to climate change and how policy should respond these circumstances. This table stands as conceptual framework in assessing ecosystem services and adaptation strategies within the case study.

Chapter 3: Case Study: Upper Brantas River Basin, Indonesia

This chapter focuses on the case study, Brantas River Basin to provide overview about research area. Characteristics of research area in terms of physical and

socio-economic aspects will be discussed to give insight about the river basin. It also discusses on the new approach in the management of this river basin as there is attempts to perform integrated river basin management by involving various stakeholders. Furthermore, climate change and its impacts on this river basin system will be explored to illustrate the risks and to address what benefits changes as the impact of such events. This part also points out the main of services generated within area under study.

Chapter 4: Ecosystem Services and Adaptation Strategies in Upper Brantas River Basin

This section concerns on the changes in ecosystem services related to water resources based on empirical study. It will discuss the context of policy documents in regard with the objective of the research. It will analyse the development plans from the institutions related to water management in this area namely spatial plan, mid-term and short-term development plan, and strategic plan and work plan. This part will analyse what changes in ecosystem captured in the policies and how the decision makers address with those changes by applied adaptation strategies in their policy. It also discusses to what extent the development plans discuss about this matter. Whether it applies the concept of ecosystem services explicitly or just imply on this matter, whether it actualize it in concrete programs, funding support or just a directive plan, or whether it considers specifically in term of benefit trade-offs or it just touch upon general issues will be discussed in here. As the concluding remark, this chapter will reflect the findings in practice based on theoretical perspective.

Chapter 5: Conclusion and recommendation

This chapter draws up on findings in the previous chapters to answer the objective of this research. It also develops recommendation to figure out from the theories and practices to deal with climate change impact, how to adapt and how to translate it into policy.

Chapter 2

LITERATURE REVIEW

This chapter explores the literatures to develop conceptual framework of this research. It will address research sub questions on link between ecosystem services and climate change adaptation and how importance these two concepts within policy. First, it will discuss on the integration of climate change adaptation strategy into development plant as the umbrella of this research. Specifically, this part focuses on the concept of climate resilient development that accommodates strategy for adaptation. It will discuss as well the concept of ecosystem-based adaptation which integrating adaptation strategies and ecosystem services. This will lead further to the concept of ecosystem services to identify the dynamic in ecosystem (functions, services and benefits) and to address questions on changes in ecosystem services regarding water resources at once. The last part will describe the importance of ecosystem services approach in decision-making and how policy captures this concept as a mean to perform a so called adaptation strategies. Finally this chapter will come up with framework to assess ecosystem services and adaptation strategies performed within policy being examined.

2.1. Climate Resilient Development

Dealing with climate change, there is urgency to apply strategies to adapt with the bad impact. Adaptation strategies attempt to improve measures to reduce, moderate and take advantage of climate impacts at all scales and seek forward to reduce dependency on ecosystem services and ensure decision-making processes at multiple levels are connected. This adaptation strategies should be mainstreamed into development strategies in which perform so called a climate resilient development (Figure 2.1) (Mitchell & Maxwell, 2010). Resilience refers to the ability of a system to maintain stresses without disturb the system itself. The more definite term is given by the Resilience Alliance that is “the amount of disturbance a system can absorb, remaining within the same state or domain of attraction; the degree to which a system is capable of self-organization; and the degree to which a system can build and increase the capacity for learning and

adaptation” (Galderisi, et al., 2010). This definition refers to the term resilience within complex system of social ecological system that involving social (human) system in understanding the complex problem within natural system. Thus resilience of the system is compulsory to preserve both system to counter risk from climate events.

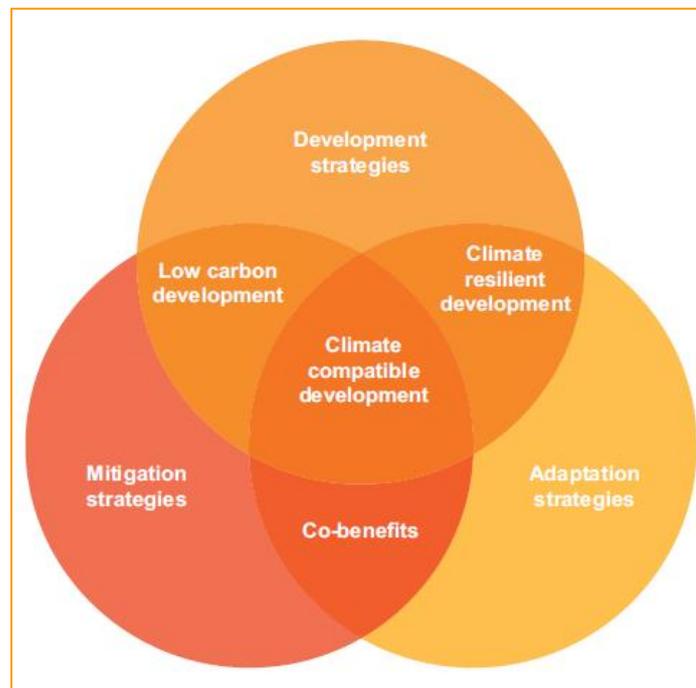


Figure 2.1. Climate Compatible Development

Source: Mitchell and Maxwell (2010) adapted from Zadek (2009)

Climate resilient development is significant to bridging adaptation strategies and policy aiming for a resilience system. There are four stages needed to secure climate resilient development: (1) asses climate risks and uncertainties (2) develop and evaluate measures to address the risks and uncertainties (3) prioritise the most effective measures, and (4) integrate them into development strategies (Mitchell & Maxwell, 2010). Indeed, dealing with uncertainty in climate events, there should be actions to cope with this circumstance to reduce the impacts both on ecosystem and human-being. However, how this actions can do much to anticipate climate change impact is still questionable. There are lot of research on adaptation to climate change as well as building its practice but how this matter being implemented is still become a challenge. That is way bridging the concept

of adaptation and development plan is important task to provide framework on how to deal with risk triggered by climate change. Further, the kind of adaptation strategies appropriate for addressing this challenge will be discussed in the following section.

2.2. Ecosystem-based Adaptation

Inter-governmental Panel on Climate Change (IPCC) defines adaptation to climate change as “adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities” (IPCC, 2007). It is clear that adaptation is needed to ensure the natural and human systems are prepared with the impact of climate events. Moreover, adaptation means to reduce the risk due to uncertainties in climate events by perform strategies to develop and improve the system’s resilience. IPCC (2001) determines several types of adaptation; autonomous and planned adaptation, proactive and reactive, and public and private adaptation. The term adaptation in this research refers to planned adaptation which is “the result of a deliberately policy decision which concern on the changing in environment and the need to maintain those changing” (IPCC, 2001). This planned adaptation should be done in sustainable manner, not only overcoming the present climate change but also anticipating the future changes. Feenstra et al. (1998) also stress the importance of adaptation measure to anticipate future climate change and to cope with present climate both in natural system and socio-economic system. In addition, Smith & Lenhart (1996) emphasize two fundamental adaptations; reactive, that is after the impacts of climate change being observed, and anticipatory (proactive) before the impacts are observed. Both have to be incorporated in the long-term planning and also existing practices. This is the great importance as policy should considering every uncertainty involved for minimising the risk, especially with the unpredictable of climate events.

This lead us further to the question on what framework this panned adaptation should be determined. The concept of ecosystem-based adaptation is the suitable approach for this challenge. Perez et al. (2010) argue the significant of this

concept as it underlines on ecosystem services as the foundation in performing adaptation strategies. Ecosystem-based adaptation takes into account the role of ecosystem services in lessening the vulnerability to climate change both in multi-sector and multi-scale approach. This includes harness the natural processes and functions of ecosystem to adapt to climate change (Vignola, et al., 2009). As the change in climate event affects both natural system and human, the natural processes and services provided by the ecosystem become the most important part as its alteration can affects human life. The MA (2005) in its framework clearly describes that change in climate is one of direct drivers to the change in ecosystem and its services and to human well-being (figure 1.1). Therefore changing in climate event should be counted as threat that needs to be anticipated. That is way it is important to take a look from the perspective of ecosystem services to assess the changing in both natural and human system related to changes in climate events. Mooney et al. (2009) argue the substantial point to appraise those changes through the lens of ecosystem services as they represent the final point of complex system within the natural processes. This final point that is the services and benefits, affects directly to human system.

Furthermore, in performing adaptation strategies, the necessity of ecosystem and its services become apparent. This adaptation should aim to improve the ecosystem and maintain its services and further, its benefits for human. Through maintenance of ecosystem to guarantee the continuity of supply goods and services, ecosystem-based adaptation approach attempts to foster the resilience of the ecosystem itself and human that depends on it (Perez, et al., 2010). United States Department of State (2006) also emphasizes the urgency to enhance the ecosystem resilience by “changing in processes, practices or structures to reduce anticipated damages as well as enhance beneficial responses associated with climate variability and change”.

2.3. Ecosystem Services

As already stated in the previous chapter, nature has been the object of human exploration to fulfil their needs. What is the nature giving to human is what it is

called ecosystem services. To be precisely, there are many interpretations about this term. Fisher et al. (2009) define ecosystem services as “the aspects of ecosystem utilized (actively or passively) to produce human well-being”. Constanza et al. (1997) view ecosystem services from the benefits human obtained, directly or indirectly, from ecosystem function. The most common use is the concept from Daily (1997) which refers to “the condition and processes through which natural ecosystem sustain and fulfil human life”. From these definitions, it can be concluded that ecosystem services involving products of nature which benefit human either in direct or indirect way.

Despite its diverse understanding of this concept, ecosystem services has been an important notion to connect ecosystem function and human welfare (Fisher, et al., 2009). The application of this concept in various policy fields including climate change mitigation and sustainable land water use has been increasing recently in order to reduce degradation within natural system (Hauck, et al., 2013). Reid et al. (2006) also underline the significant role of ecosystem services approach in conveying the importance of ecosystem conservation to different stakeholders thus implemented in their policy.

Within the concept of ecosystem services, there are main issues that have to be considered in this research; ecosystem services and benefits. The Millennium Ecosystem Assessment (2005) classifies ecosystem services into four categories: provisioning services, regulating services, cultural services and supporting services. Provisioning services related to the ability of ecosystem in providing goods such as water, food and timber. Regulating services reflect on how nature can control climate, flood, diseases and water quality. Cultural services related to the function of nature to give recreational, aesthetic and spiritual benefits. In the meantime, supporting services related to the process such as photosynthesis, soil formation and nutrient cycling in which important to produce the other services. Its impact tends to be gained indirect way or in the long-term. This classification indeed illustrates the complex system within ecosystem which advantage human.

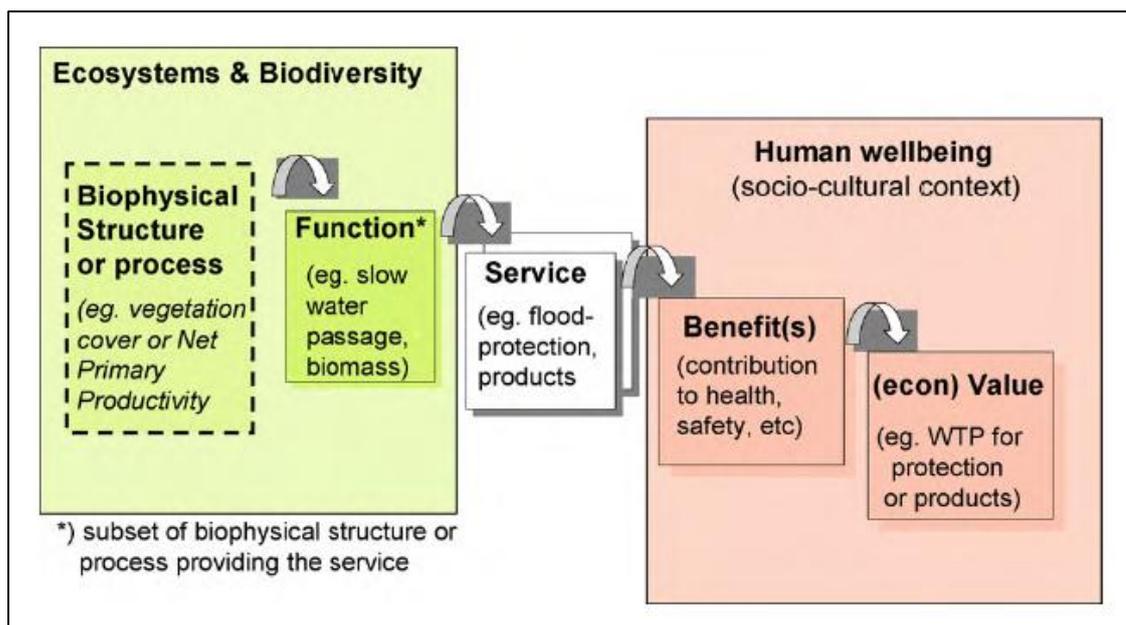


Figure 2.2. Framework for linking ecosystem to human well-being
 Source: de Groot et al. (2010) adapted from Haines-Young & Postchin

De Groot et al. (2010) provide a more detail scheme to describe the connection between ecosystem and human well-being (Figure 2.2). From this framework, it is clear how ecosystems components and its functions provide services that brings benefits for human well-being. While ecosystem services and its classification are clearly elaborated in some articles (see De Groot et al., 2002; Millennium Ecosystem Assessment, 2005) there seems difficulties to assess benefits. Fisher et al. (2009) argue that benefit is the point where human welfare is affected directly from the ecosystem services. He also emphasize on the existence of other forms of capital as a requirement to realize this benefit. To simplify the connection of ecosystem services and benefits gained and also its valuation, he divides the services as intermediate services and final services while benefits become the product of this final services that support human life (Figure 2.3).

These two frameworks elaborate the complex processes within natural ecosystem on how these processes produce materials and deliver them into human in term of such benefits. Meanwhile, concerning the classification of ecosystem services, it is important to underline that some of services might overlapping each other.

Obviously, ecosystem processes connect each other in such a way that the existence of particular component and process essential in performing other services. Therefore it is not unusual as each service delivered the same benefits instead.

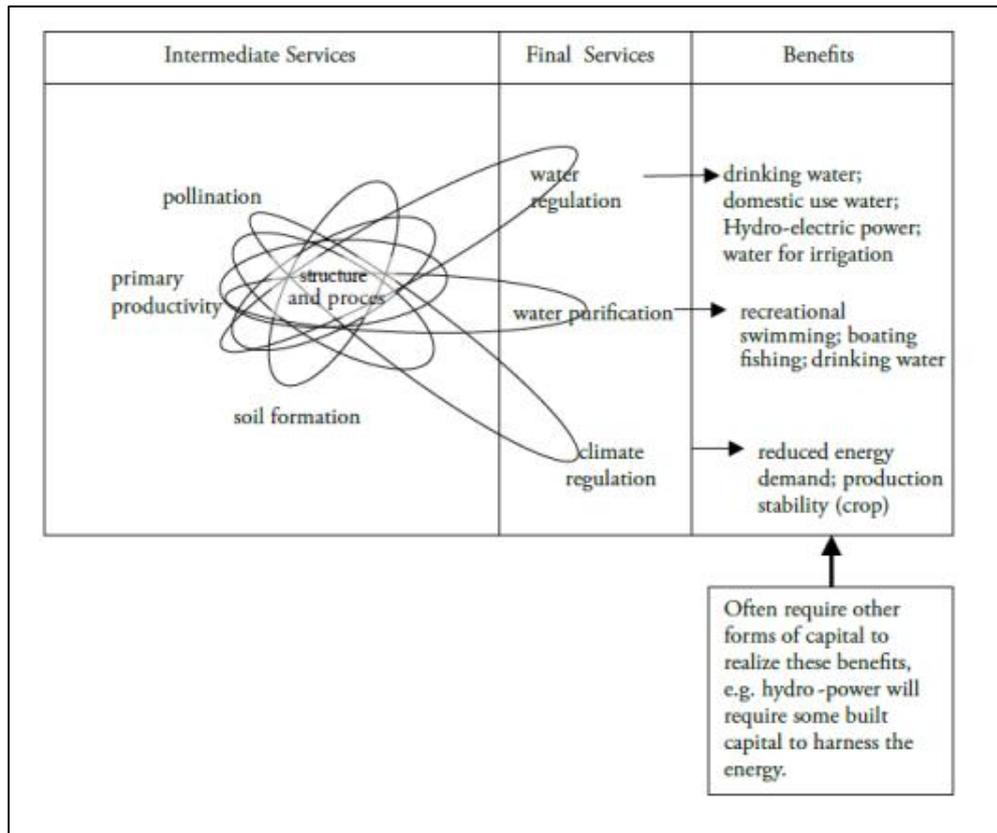


Figure 2.3. Conceptual delineation between ecosystem services and the benefits derived from them. *Source: Fisher, et al. (2009)*

Classification of ecosystem services in order to simplify the complex processes within ecosystem has been made by many scholars. Within this research, classification of ecosystem services constructed by the Millennium Ecosystem Assessment is used as the foundation of classification of ecosystem services in Brantas River Basin. These services are categorized into four types as stated in the previous part. However, in order to determine each services, wide array of literatures and concepts are employed to generate a complete list of ecosystem services. The classification of ecosystem services identified pertaining water resources is elaborated in the following part.

2.3.1. Provisioning Services

Provisioning services mostly related to tangible product of natural resources which is easily recognize. In terms of water resources, fresh water is fall under this category. It refers to the presence of water reservoirs which can be measured in terms of quantity and quality. This can be in the form of surface water, groundwater and also springs. The existence of water reservoirs bring benefits for human to be utilized as drinking water and domestic use, irrigation purposes for agriculture areas, fisheries and aquaculture, and also source of energy. Changing pattern of global climate has significant impact to the presence of water reservoirs. During rainy season, high precipitation gives advantage as to increase supply of water. However, due to incapacity of land to infiltrate precipitation it might lead to increasing runoff and floods. Land degradation causes malfunction of the catchment area to store water and lead to water imbalances and drought in the dry seasons.

2.3.2. Regulating Services

Regulating services refers to ecosystem function to control natural processes which benefit human. This involves the ability of ecosystem through its processes and components to regulate climate, water and also hazard protection. Climate regulation relate to the capability to maintain favourable climate through land cover and biologic mediated process. This is also involving regulating water redistribution and regional rainfall pattern. Water regulation encompasses the ability to maintain river discharge, water storage as well as water quality while hazard protection represents the capability to alleviate and prevent hazard. Within regulating services, there are 6 (six) different ecosystem function identified related to water resources; (1) climate regulation, (2) water regulation, (3) water supply, (4) water purification and waste treatment, (5) erosion regulation, and (6) natural hazard regulation.

Climate regulation provided by ecosystem generates temperature and precipitation essential for human habitation and cultivation. Change in global climate event might lead to nuisance on natural and human habitat such as disturbance on

planting period and increasing green gas houses. Meanwhile, water regulation implies the role of land cover in regulating runoff and river discharge. The presence of vegetative coverage brings significant role in water storage process and in controlling surface runoff. Advantages derived through these services are the presence of river body as a natural irrigation and drainage system, for fisheries and aquaculture, as a medium of transport, for water storage either surface or groundwater and maintenance of water balance.

Water supply services is generated from the function of ecosystem in filtering, retention and storage of fresh water (aquifer). This service depends on the land coverage and the characteristic of soil and geological formation. Through this process, fresh water is stored which can be utilized for drinking water or other domestic use, irrigation and also industrial use. Meanwhile, water purification and waste treatment are the result of activities of vegetation and biota in decompose organic waste. This process neutralizes waste and pollutant thus maintains the quality of water resources. In the meantime, erosion regulation and natural hazard regulation are associated with natural processes useful in restraining natural hazard such as flood, landslides, erosion, and sedimentation. Once again, characteristic of land cover and soil formation affects the capacity of ecosystem to provide these services.

2.3.3. Cultural Services

Cultural services closely related to the value of nature that beneficial for human to satisfy their spiritual needs and/or to strengthen social relationship between them. Aesthetic value, social relations, and recreation and ecotourism are some services identified in this category. Aesthetic value, recreation and ecotourism portray the presence of natural landscape contributing to enrich human spiritual. Parks and water recreation are manifestation of this services in which their existence beneficial for leisure activities. Besides creating venue to comply human's spiritual need, this services also necessary as media for social interaction. This interaction has forming common interest group such as fisheries communities and agriculture communities.

2.3.4. Supporting Services

Supporting services is considered as the most difficult services to be assessed. It acts as support for other services thus its effect on human sometimes cannot be observed directly. It can be measured only by tracing other services (provision, regulating and cultural services). Regarding water resources, there are two kind of services recognize; water cycling and soil formation. Water cycling explains the process within ecosystem that important in favour water supply and water purification. Meanwhile, soil formation important to support regulating services such as water regulation, erosion regulation and natural hazard regulation as these services depends on the role of vegetation, soil and geologic formation.

2.4. Ecosystem services in decision making: linking ecosystem services, adaptation to climate change and development plan

Based on the framework developed by de Groot, et al. (2010), it is obvious how important ecosystem for human is. It is clear how the flows of ecosystem components and processes in the end give something valuable to be utilized by human to improve their life. This is come in the form of basic material for a good life, health, social relations, security and freedom to choice and action like what so called human well-being components (Millennium Ecosystem Assessment, 2005). This benefits gained by human should be directed for the long run. Hence, it is important to maintain the sustainability of the ecosystem to support human welfare.

In the meantime, development plan attempts to enhance human life as well through increasing economic growth, health and poverty reduction. To support these goals, it is important to take into account ecosystem services as these services are the crucial aspect for human welfare. The alteration within ecosystem and its services is likely affecting the benefits human gained, in turn influence human welfare. Regarding with climate change impact, ecosystem services can be used as important notion to perform adaptation strategies. As stated earlier, the change in climate events have been aggravating the vulnerability of the ecosystem from natural disaster that lead to degradation of the ecosystem. To what extent

this climate change affects the ecosystem depends on the level of climate change and the ability to adapt with those changes in which relied on the condition of the ecosystem itself. Hence, adaptation strategy should be directed at enhancing ecosystem processes and components in order to maintain ecosystem's resilience to confront with the impact of climate change.

Here, the role of policy framework to promote an adaptation strategy focusing on ecosystem services is crucial. By increasing the capacity to deal with extreme change in climate pattern, it can bring significant impact in reducing the magnitude of economic, social and human damage, and cost needed for recovery action. Therefore, it is important to put vulnerability to extreme weather events, disaster management and adaptation strategies as the part of sustainable development in the long-term planning (Mirza, 2003). Berman et al. (2012) state the important role of institution to transform coping capacity at present into longer adaptive capacity aiming for sustainability through its adaptive planning.

How policy frames these adaptation strategies can be assessed by investigate ecosystem processes and components that deliver benefits for human. Based on this framework, the changes on ecosystem processes and components due to changes in climate events can be elaborated. Thereafter, what kind of adaptation strategies implemented within policy in responses to those circumstances can be evaluated. This conceptual framework is built to give guidance in assessing how policy performs adaptation strategies based on ecosystem services approach. Table 2.1 explains the assessment based on theoretical review as the means to assess the policy within the case study.

The table appoints the link among ecosystem services, the processes and components, the benefits delivered, the changes occur due to disturbance and what should be done dealing with such changes to secure the services conveyed to human. Each part will be given a code to simplify in assessing the document plans (see Appendix for detail). Coding is not differentiated according to the type of services as some services might overlap and generate the same benefits. The whole parts are related to each other, thus in conducting content analysis this matter should be considered thoroughly. For example, irrigation might represent

the presence of fresh water (provisioning services) and/or as the result of water regulation (regulating services) through the characteristic of land coverage in regulate runoff and river discharge. Therefore, in doing analysis the whole content regarding this matter should be carefully analysed to trace what kind of services involved within particular issue.

Table 2.1. Conceptual framework for assessing adaptation strategies based on ecosystem services approach

Types of services	Processes and components	Benefits	Consequences (benefits change)	Responses
1	2	3	4	5
Provisioning				
1. Fresh water	Presence of water reservoir	Drinking water, irrigation, fisheries, hydro-power plant (supply of fresh water)	Deficit water source for all purposes (drinking water, agriculture, fisheries, etc)	Forest and wetlands rehabilitation for water catchment, rehabilitation water sources and area surroundings (riparian), improvement on reservoir (technical maintenance) to reduce water loss
Regulating				
1. Climate regulation	- Maintenance of favourable climate by land cover and biologic mediated process - Altering water redistribution and regional rainfall pattern	Temperature and precipitation essential for human habitation and cultivation	Disturbance on human and cultivation (increasing temperature, change in season period affected crop, drought in dry season and flood in rainy season, increasing risks of landslide, erosion, sedimentation)	Change in planting period and crop technology (choosing drought resistant crop), management of irrigation system
2. Water regulation	Role of land cover in regulating runoff and river discharge	- Drainage and natural irrigation - Fisheries - Water storage (groundwater and surface water) - Water balance - Medium of transport	Deficit water supply in dry season, increasing run off in rainy season Decrease fish productivity in dry season Declining the quantity and quality of groundwater and surface water Imbalances of water storage between dry and rainy season Reduce the use of water transport	Rehabilitation to improve land cover in order to maintain water storage

1	2	3	4	5
3. Water supply	Filtering, retention and storage of fresh water (aquifer)	Water provision: - Drinking water - Domestic use - Irrigation - Industrial use	 Reduce supply for drinking water, declining the quality of drinking water, higher water cost Reduce supply for domestic use Reduce supply for irrigation lead to crop failure Reduce supply for industrial use affected economic and also increase attempt to exploit other source of water supply	Land and forest rehabilitation (creating green space) to improve catchment area and maintain water storage Collaboration on water supply system for domestic/drinking water Improvement of clean water distribution system Integrated water management
4. Water purification and waste treatment	Role of vegetation and biota in removal/decompose organic waste	Pollution control (water quality)	Decrease water quality, higher water cost	Forest and wetlands rehabilitation as a habitat for vegetation and other biota
5. Erosion regulation	Role of vegetative coverage in soil retention	Prevention of landslides, erosion, sedimentation	Increase the risk of landslide and erosion, sedimentation reducing the capacity of river channel	Technical construction (retaining dam, gully construction, retention wells); forest and land rehabilitation
6. Natural hazard regulation (disturbance provision)	Influence of ecosystem structure on dampening environmental disturbances	Flood prevention and landslide	Increase the risk of flood and landslide	Technical construction (retaining dam, gully construction, retention wells); forest and land rehabilitation

	1	2	3	4	5
Cultural					
1. Aesthetic value	Aesthetic value in various aspects of ecosystem	Parks and water recreation	Limit area for recreation, sport and other amusement activities, reduce aesthetic value of the nature	Create venue for aesthetic purposes: parks (green space) and water recreation	
2. Social relations	Ecosystem influence the types of social relations	Agriculture societies, fisheries societies	Limit forums/venue to form common interest group	Strengthen services for agriculture and fisheries to provide forum for social interaction	
3. Recreation and ecotourism	Characteristics of natural or cultivated landscape as venue for leisure time	Water recreation	Limit area for recreation, sport and leisure activities	Rehabilitation of natural landscape and its aesthetic value (parks, green space, water recreation)	
Supporting					
1. Water cycling	Importance of ecosystem to support water cycle	Support water supply, water purification	Hamper services for water supply & water purification	Forest and wetlands rehabilitation to improve catchment area and provide habitat for vegetation and other biota	
2. Soil formation	Role of natural process in soil formation and regeneration	Support water regulation, erosion regulation and natural hazard regulation	Hamper water regulation, erosion regulation & increase natural hazard	Forest and wetlands rehabilitation, technical construction (retaining dam, gully construction, retention wells)	

Sources: (De Groot, et al., 2010; Fisher, et al., 2009; Millennium Ecosystem Assessment, 2005; Wallace, 2007; Yung, 2004)

Chapter 3

CASE STUDY: UPPER BRANTAS RIVER BASIN, INDONESIA

This chapter focuses on the case study which is Brantas River Basin to give insight and understanding about the research area. This chapter will start with general overview about the research area to inform about characteristic of selected area. Hereafter, the issue of climate change and its impact on Brantas River Basin will be discussed to describe the risks emerge that might disturb the sustainability of this river basin.

3.1. General Overview

3.1.1. Physical Characteristic

Brantas River Basin is located at East Java Province in Indonesia and is considered as the second largest river basin in Java Island. It lies between $7^{\circ}15'30''$ - $8^{\circ}15'07''$ south latitude and $111^{\circ}35'58''$ - $112^{\circ}56'03''$ east longitude (Figure 3.1). Geographically, this river basin is surrounded by mountainous area as its boundaries. In the northern and southern part, it is bordered with karst topographic namely Kendeng Ridges and Southern Ridges respectively. Meanwhile, in the western part lies Mount Wilis and in the eastern part lies Mount Bromo and Mount Semeru which are categorized as active volcanoes. Brantas River is sourced from the spring in Sumber Brantas village in Batu City which come from Arjuno Mountains in the northern part of this area (BPDAS Brantas, 2010).

Characteristic of precipitation within this river basin is determined by monsoonal season in which causing high precipitation within rainy season especially between November and April. The average annual precipitation in the upstream area is regarded as high with 2000-3000 mm/year therefore provides favourable climate for human and cultivation (BPDAS Brantas, 2007). Physiography of Brantas River Basin is characterised by four major zones; volcanic quaternary ranging from Mount Wilis in the west to Mount Semeru in the east, alluvial plain as interconnecting zone between the volcanoes, Kendeng Ridge Zone and Southern

this matter. However this provisioning services also depends on the characteristic of land cover. Vegetative coverage helps to maintain supply of water thus regulating services becomes essential. The sustainability of fresh water provision in a certain way is determined by the ability of ecosystem to regulating its biophysical processes. Therefore, these two services altogether hold the key for maintaining the delivery on such benefits.

3.1.2. Socio-economic Characteristic

The upper part or upstream area consists of three sub-basin; Ambang, Lesti and Melamon which administratively fall under the authority of Batu City, Malang City and Malang Regency (Greater Malang). This river basin covers area of 1,118,559 ha encompasses 9 (nine) regencies and 6 (six) cities. It is inhabited by 20,401,749 populations with population growth 1.18 % per year. Upstream area has the highest population compared to others thus affects the carrying capacity of the land. In line with the increasing population, land use change increase as well undermining the main function of this area as water catchment area (BPDAS Brantas & IPB, 2011).

The development of this area has been increasing rapidly characterized by many growth centres in the urban area within Greater Malang. This has cause the development of settlement become uncontrollable and bring serious problems. Within rural area, although the development relatively slow compared to urban area, land use change as the consequences of population growth is unavoidable also. Decreasing in vegetative coverage lead to land degradation thus increase the vulnerability of the river basin system (BPDAS Brantas, 2007).

3.1.3. Integrated River Basin Management

Management of Brantas River Basin has been done to reduce the vulnerability of the river basin system. However, optimum results have not been achieved yet. Instead, evaluation indicates that this river basin is stated at critical condition. Floods, landslides, sedimentation of reservoir and river channel and drought are some indicators that denote the unhealthy state of the river basin. Within this river

basin, various interests involved in its management effort. Each stakeholder, public and private parties, attempts to utilize and manage the potential natural resources within this river basin ecosystem. In terms of water resources, stakeholders involved within its management are:

1. Local Development Planning Agency

This agency responsible for plan making and policy implementation for each regency/city. Apart from strategic plan and work plan as the legal basis for its activities, this agency also compose long-term development plan, mid-term development plan and short-term development as the guidance for every development sector involved. It also responsible in establishing Spatial Plan (*RTRW*) and Detailed Spatial Plan (*RDTR*) which regulate space utilization as well as control this utilization. The aim is to establish an environmentally sound and sustainable development towards society welfare.

2. Agriculture Agency (Ministry of Agriculture)

Agriculture agency has significant role in composing strategic plan within agriculture sector particularly in terms of development of crop technology, improvement of supporting infrastructure and increasing food productivity. The goal is to create competitive agriculture society which is oriented not only on increasing productivity but also the sustainability of natural resources involved.

3. Irrigation Agency (Ministry of Public Works)

Compose regulation on irrigation sector based on the principle of decentralization is the main purpose of this government agency. This is involving planning, monitoring, controlling and evaluation on policy implementation within this sector. It strives for integrated and sustainable management of water resources in order to secure its expediency for human welfare. It encompasses conservation on water resources, optimization of water resources utilization, control floods and water resources degradation in integrated way.

4. Environmental Agency

The main responsibility of this agency is to assign and evaluate policy on environmental issues and also to carry out coordination among stakeholders within local level regarding those matter. It attempts to prevent and control degradation of environment in order to maintain the sustainability of natural resources.

5. Brantas River Basin Management Agency (Ministry of Forestry)

Establish plan in regards to management of river basin as well as evaluation and development of institutional capacity are the main concern of this stakeholder. It involves development of watershed management modelling as pilot project for integrated watershed management and partnership programs with both public and private sector. River basin management is one of priorities of forestry development therefore the attempt to sustaining natural resources is directed through forest and land rehabilitation, and social forestry within river basin ecosystem framework to increase human welfare.

Land degradation within this river basin is exacerbated by poor regulation that unable to control the development. Therefore in 2011 Integrated Brantas River Basin Management Plan was established facilitated by the Ministry of Forestry through its Brantas River Basin Management Agency. This document plan elaborates strategies in managing Brantas River Basin in holistic and integrated way involving many stakeholders starting from problem structuring until defining the objectives of this river basin management. The objectives of this plan are to provide guidance for every development sector in order to maintain, increase and rehabilitate natural resources. Mechanism and indicator for monitoring and evaluation are formulated as well to appraise the implementation of this plan. However, this plan needs a more detailed action plan with distinct targets and priority within certain time frame and budget allocation. Therefore, an action plan was established to follow up this management plan encompasses detailed strategies concerning those aspects (BPDAS Brantas & IPB, 2011).

3.2. Risk of Hazard due to Climate Change

Research on hazard analysis on water sector within Greater Malang area (Batu City, Malang City and Malang Regency) found that there has been changing in climate event within this area. From the analysis of data series from 1951 to 2008, there is huge distinction on the monthly rainfall pattern within ten-year span. This condition affects the timing of rainy season period and further the length of the season not only rainy season but also the dry season (Figure 3.2). The temperature also indicates an increasing pattern for the last 25 years within regional scale (Figure 3.3) (Suroso, et al., 2011).

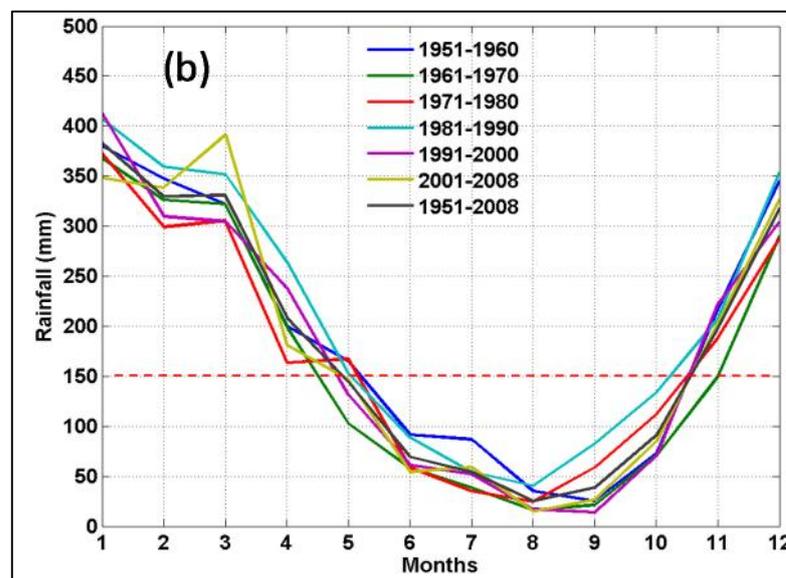


Figure 3.2. Mean decadal pattern of monthly rainfall in Malang during 1981-2008. Red dashed line indicates the rainfall of 150 mm, which can be used as a threshold for defining dry season (Source: Suroso et al., 2011)

The negative trend of rainfall as well as the monsoonal strength and dominance generate significant changes on the annual pattern that characterized by the high intensity of rainfall during the rainy season and increase the dry state during the dry season (Aldrian & Djamil, 2008). These circumstances led to the risk of floods in rainy season and drought in the dry season which affects the balances of water resources within the river basin ecosystem.

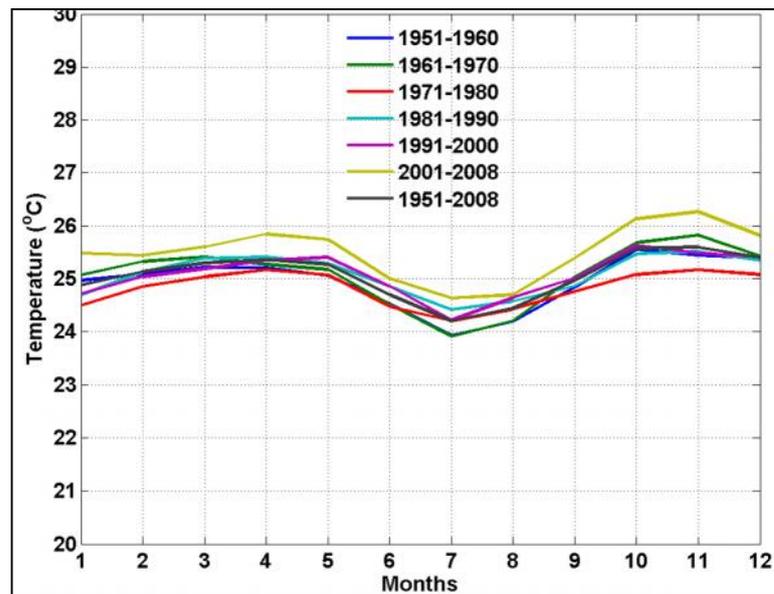


Figure 3.3. Mean annual variation of monthly mean temperature in Malang analysed from globally gridded temperature data provided by the University of Delaware (UDEL) (Source: Suroso et al., 2011)

From the analysis of flood hazard based on the extreme runoff for baseline condition, Malang City is considered as undergo a very high potential on flood hazard while in the projection condition Malang regency has the same risk as well. As the indicators for defining the vulnerability from floods and landslides are similar, the distribution of these two hazards within area under study is quite similar as well. In the meantime, the availability of water resources experience a declining pattern with moderate until high risk level particularly at the upstream area (Upper Brantas). There is significant increase in vulnerability of water shortage in the entire Malang City, southern part of Batu City, and the vast majority of Malang Regency (Suroso, et al., 2011).

Based on this finding, the major risks within this area are floods, drought (water shortage, and landslide. Due to extreme pattern of rainfall in rainy season, the soil does not able to hold the water and the absence of vegetative coverage has worsening this circumstance. Deforestation and the conversion of agriculture land into utilized area has corrupted the capacity of the land to absorb precipitation therefore reducing the capacity of groundwater. Wingqvist & Dahlberg (2008)

also stress how deforestation in Indonesia contributes to floods, landslides and water shortage and also triggers soil erosion leading to land degradation. On the other hand, inability to preserve groundwater leads to water imbalances and drought in the dry season. These risks should be anticipated to reduce damage on the natural resources and the ecosystem as a whole. The most important is to avoid more loss for the inhabitants. Therefore, there should be a comprehensive plan to cope with this circumstance.

Those risks indicate how changing climate complemented by land use change affects the processes within river basin ecosystems thus disrupting the services generated. Provisioning services and regulating services are likely to be the most vulnerable against climate change impacts. Obviously, the existence of fresh water is disturbed by the uncertainty in climatic events. Further, the ability of ecosystems to regulate its biophysical processes is hampered as well reflected from the inability to withstand the excessive rainfall thus leading to such risks.

Chapter 4

ECOSYSTEM SERVICES AND ADAPTATION STRATEGIES IN UPPER BRANTAS RIVER BASIN

This chapter focuses on the empirical study on the ecosystem services and climate change adaptation within development plans. It will elaborate the findings on analysis of policy documents related to water resources within research area. Ecosystem services, benefits and policy's responses regarding climate change will be discussed. It will also explain the analysis on the documents referred. Lastly, it will assess the extent to which those development plans considering ecosystem services in performing adaptation strategies on climate change.

4.1. Identification of Ecosystem Services

Ecosystem provides natural resources essential for human life. These so called ecosystem services can be either in distinct form that can be recognized easily or in a complex process that can be recognized through its final services. Indicator for provisioning services, regulating services and cultural services are discussed explicitly within document plans. On the other hand, supporting services does not discuss explicitly as it is difficult to capture. One document discusses on the importance of ecosystem components in soil formation that support other process such as water retention. Provisioning services mentioned is related to the presence of water sources, reservoirs and springs and how to maintain these natural resources to strengthen its services. Regulating services surprisingly is discussed more compared to provisioning services. Indeed, this services is quite difficult to capture. However, within document plans, it is examined from the loss of natural resources due to disruption of ecosystem. As stated in the previous chapter, hazard identified within research area has rising the awareness of stakeholders within area under study. Therefore, they seek to manage these circumstances by mainstreaming these into their policy. The role of ecosystem through its vegetative coverage in supporting the process of water retention and dampening natural hazard has become the main concern of policy in every sector. In the meantime, cultural services is also emphasized within document plans specifically

on the aesthetic value of environment to provide venue to satisfy human's spiritual needs. Figure 4.1 below illustrates ecosystem services captured in the documents.

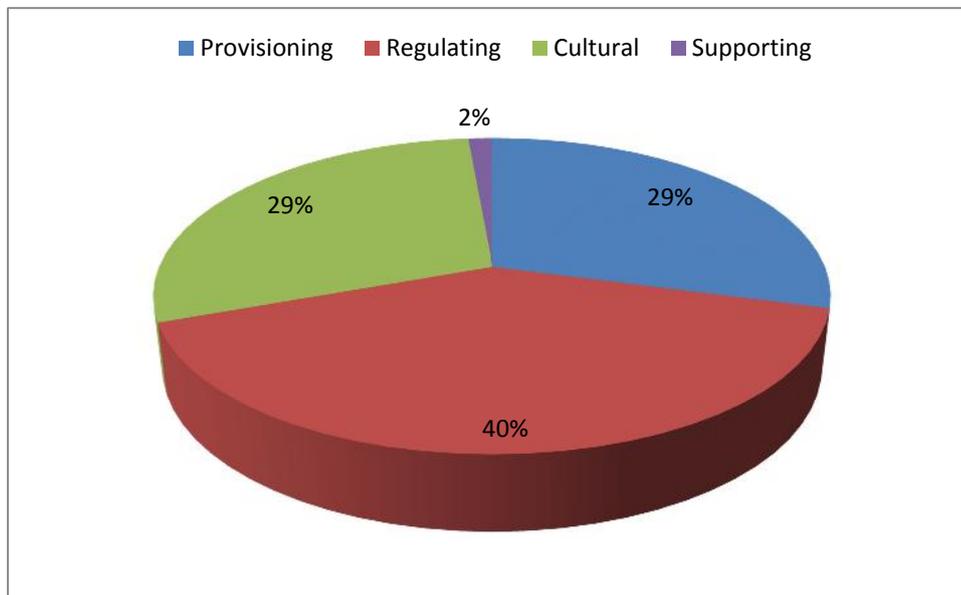


Figure 4.1. Types of services captured in the development plan

4.2. Document Analysis

As explained in the first chapter, the main focus of this analysis is development plans concerning management of Brantas River Basin particularly related to water resources. Analysis of the documents is done by using software Atlas.ti. This tool useful in analysis on the content of document plans being assessed. It works with large amount of text within the documents to assign the specific content related to the objective of this research. In doing so, coding is needed as the guidance to conduct content analysis. The code involves four aspects being evaluated within this research; ecosystem services, benefits, changing in benefits and responses of policy (for detail see appendix). Further, the analysis does not merely assigning the documents based on the code but focuses on the context of the topic being discussed.

Development plans being assessed including spatial plan, mid-term development plan, short-term development plan, strategic plan and work plan. Spatial plan is

important as it regulates every development in such a way to improve human welfare as well as create a harmonious space. It covers policies and strategies related to space utilization. Not only control development, it is also aiming to prevent conflict between sectors concerning space utilization. This is also destined to prevent inappropriate use of space that might lead to hazards affecting human. This plan should be in line with mid-term development plan which determines the direction and objectives of the development for the whole region. This mid-term plan is translated into short-term plan in which stands as reference for every stakeholders in establishing strategic plan and work plan. All these documents are linked each other as the foundation and reference for development in each government sector. Finding on document plans will be explained further in the next section.

4.2.1. Spatial Plan

Spatial plan comprises three scopes of policy namely plan-making process (*perencanaan/penataan ruang*), space utilization (*pemanfaatan ruang*) and space utilization control (*pengendalian pemanfaatan ruang*). Development in every sector is discussed thoroughly. Zoning regulation is determined to maintain specific zone to be utilized accordingly. Thus, each development should refer to this regulation. This document acknowledges how ecosystem deliver advantages for human therefore should be managed in sustainable way. It covers the management of water resources as well as its utilization based on conservation principles to maintain its sustainability. It also considers on risks on water resources including the strategies applied to deal with those risks. The development of water resources infrastructure such as maintenance of irrigation system, protection of water sources, improvement of reservoirs and dams, and other technical maintenance to deal with sedimentation are carefully discussed. It also regulates utilization of protected area such as recharge area, upstream area, riparian, spring and reservoirs that should be directed to conserve water resources.

Within spatial plans, the type of services discussed are regulating, cultural and provisioning respectively. Regulating services cover five elements (1) water

regulation, (2) water supply, (3) climate regulation, (4) erosion regulation, and (5) natural hazard regulation. Water regulation and water supply involves the importance of green space such as protected forest, urban forest and parks as recharge area to improve and maintain water retention and regulate water system. In addition, this process also ensure the availability of water (groundwater and surface water). Here, the link and overlapping between regulating and provisioning services is obvious. Process in water regulation and water supply lead to the presence of fresh water essential for human and other biota.

In the meantime, climate regulation is discussed within these documents although not in the depth way. It acknowledges the significance of forest and green space to regulate micro climate beneficial for human and cultivation. On the other hand, erosion regulation and natural hazard regulation are discussed in detailed way. The documents stress the importance of ecosystem in preventing natural disaster (flood, erosion, sedimentation) and in deterring the declining of soil hydraulic function essential for maintaining nutrient, groundwater and surface water.

4.2.2 Mid-term development plan and short-term development plan

As directive plans, mid-term development plan and short-term development plan do not discuss the policy on water resources in specific way. Indeed, it touch upon the issue being discussed within this research. It clearly regulates the role of each stakeholder (government agency) and covers the agendas and programs recommended to cope with hazard in order to preserve water resources, however it does not examine the policy in detail. Mainly, the documents concern on the provisioning of clean water. They focus on the improvement of clean water distribution system especially for area with lack of water supply. They also emphasize on the importance of conservation of water sources and area surrounding in terms of vegetative management.

4.2.3. Strategic plan and work plan

A more detailed plan is conceptualized within strategic plan and work plan composed by each stakeholder. Obviously, these plans focus on the development

of each sector nevertheless there is indication to apply a more integrated approach to address problem in water resources. Strategic plan and work plan being assessed within this research involving policy in three sectors that is environmental, forestry and agriculture. Environmental policy concerns on the improvement of environment coping with the issue of climate change and degradation of water resources. Forestry policy refers to the management of land use within this research area related to water resources, while agriculture is from the point of water user in anticipating the uncertainty in supply of water.

▪ ***Environmental sector***

Within environmental sector, the main consideration is control utilization of natural resources that is protection, conservation and rehabilitation of natural reserve in sustainable way. There is shifting in policy from utilization of natural resources to monitoring and control to maintain the natural resources including water resources. The issue of climate change is explicitly discussed within environmental policy sector. Indeed, the impacts of climate change particularly declining in quality and quantity of water resources and also degradation in river basin quality due to erosion and sedimentation become the main priority of policy within this sector.

Provisioning services in terms of availability of water sources and regulating services in terms of erosion and natural hazard regulation are the main objective of environmental policy sector. Programs for conservation of natural resources including water resources are elaborated within specific work plans. Those programs not only focusing on management of water body but also on water catchment area. As for adaptation strategies, the documents emphasize on the rehabilitation of natural resources such as protected area, water sources, river basin and groundwater to ensure the availability fresh water. These strategies are also directed to dampen natural hazard i.e. erosion and floods. In addition, coordination, collaboration and participation across stakeholders in actualizing those adaptation strategies is underscored within the documents.

- ***Forestry sector***

One of strategic issues in forestry sector is the degradation of natural resources including water and soil that lead to expanding of critical land within Brantas River Basin. Indeed, the lessening of forest area and the disturbance of water catchment area due to land conversion has become critical issue within forestry sector. This is related to the function of these vegetative coverage in supporting the provision of fresh water as well as regulating services in dampening natural hazard. Provisioning services discussed within document plans mostly related to the importance of water sources and how to maintain its existence through management of land use. This kind of adaptation overcoming the degradation of water sources indeed become the main objective of forestry policy. Forest and land rehabilitation, rehabilitation of springs, urban forest and green space are some project proposed by forestry agencies to improve water catchment within area under study.

In the meantime, regulating services mentioned within document plans is related to the importance of ecosystem through its vegetative coverage in water regulation, water supply, erosion regulation and natural hazard regulation. Vegetative coverage significant in water storage process and in buffering extreme discharge of surface water flow that beneficial to provide fresh water for various purposes. Another issue is related to the risk of erosion and natural hazard (flood and landslide) within area of study. Therefore, management of land use should be directed to minimise these risks through maintenance of the ecosystem itself. This is not only in terms of rehabilitation of vegetative coverage and creating green space but also in terms of soil conservation through construction of technical structure such as retaining dam, gully construction and retention well.

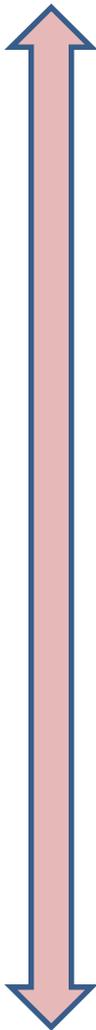
Apart from these strategies, there is effort to improve the management of the whole river basin through an integrated river basin management plan. This project attempts to create synergy within river basin plan involving every stakeholder in its management. The objective is to establish a more integrated plan across sectors to improve the quality of river basin ecosystem to ensure the continuity of the services it is provided.

- *Agriculture sector*

Policy in agriculture mainly focus on the decentralization in agriculture to support food security. The main consideration is the decreasing in agriculture land therefore leads in declining food productivity. This circumstance also as an impact of decreasing water supply for agriculture due to change in climate events. Change in climate pattern in this area causes long period of rainy season disturbing planting season. Encounter this situation, Agriculture Agency promotes the use of crop technology as the strategy to maintain food productivity. On the other hand, dealing with lack of water supply in dry season, the use of drought resistant crop become the main strategy.

Besides improvement of crop technology, there is effort in maintenance of irrigation system done by Irrigation Agency under the Ministry of Public Works. This strategy involves improvement in terms of technical work to reduce leakage of irrigation channel in order to prevent water loss and also in terms of management of water use to assure that it is distributed equally. The documents also consider on the rehabilitation of area surrounding water sources and irrigation network to improve water catchment and to lessen the risk of flood although this matters do not discuss thoroughly. Thus, provisioning services in terms of availability of water supply for irrigation is the main objectives of this sector besides its need to secure food productivity. Table below summarizes ecosystem services and its component human obtained in sequence starting from the most widely addressed within development plans.

Table 4.1. Ecosystem Services represented in Development Plans

Types of services	Ecosystem services	Description	Rank
Regulating	Water supply	Ability of vegetative coverage in water retention and storage water within soil layer (aquifer). Benefits: water provision for drinking water, irrigation	High 
	Water regulation	Ability of vegetative coverage in buffering extreme discharge of river and runoff, in regulating channel flow. Benefits: drainage and natural irrigation, water storage, water balance	
	Erosion regulation	Role of vegetative coverage in soil retention, maintenance of soil hydraulic function in preserving soil nutrient and groundwater. Benefits: prevention/ lessening erosion, sedimentation, landslide	
	Natural hazard regulation	Significance of health ecosystem structure in the face of natural hazard disturbance. Benefits: protection, damage reduction from flood and landslides	
	Climate regulation	Improvement and maintenance of micro climate, rainfall and water distribution essential for human habitation and cultivation. Benefits: temperature and rainfall	
Provisioning	Fresh water	Availability of water sources (groundwater, surface water/river/reservoir, spring) for human (various purposes). Benefits: drinking water, hydropower plant, fisheries	Low
Cultural	Aesthetic value	Aesthetic natural landscape, beautiful scenery. Benefits: fulfilment of human's spiritual needs	
	Recreation and ecotourism	Ecosystem provide venue for leisure activities (parks, water recreation, hot springs). Benefits: tourist attraction, rafting, water play, support local economy	

4.3. Benefits, Changes and Adaptation Strategies

In general, the type of services being discussed in the documents mostly are the provision of fresh water, water supply, water regulation and natural hazard regulation. The first three are linked each other as these process generate the same benefits such as drinking water, clean water for domestic use, water for irrigation

and energy sources for electricity. Brantas River Basin is characterized by its complex river system that provides abundant source of water resources. These resources have been utilized to fulfil community's demand for many purposes. Fertile land and affluent water resources support agriculture within this area in which become the livelihood for the vast majority of its inhabitant. Land use within upstream area is largely aimed for protected and conservation area. Protected forest and its buffer zone support the maintenance of water supply system within river basin ecosystem thus strengthen the capacity of aquifer to preserve fresh water. In addition, there are many springs and hot springs in this area that have been utilized by the community for their daily use and tourist attraction. In fact, water reservoirs has built and utilized as hydropower plant to supply electricity for the whole island for decades.

Other benefits important for human is the ability of ecosystem in preventing natural hazards namely floods, landslide, erosion and sedimentation. As stated in the previous chapter, these hazards are considered as the main problems in the area under study. The development plans recognize these matters and critically address the need to adapt to such events. These benefits generated depend on the characteristics of soil and vegetation coverage of site area. Besides enhancing the capacity to infiltrate and store groundwater, the existence of vegetative coverage acts as natural barrier to prevent hazards stated above. In addition, there is also recognition on the imbalance of water reserve as the impact of extreme rainfall pattern thus lead to drought in dry season and reduce supply of water. Other services recognized within document plans is the presence of natural landscape in which giving aesthetic value as well as provide venue for recreation, sport and other leisure activities. Famous with beautiful scenery and natural landscape that provide venue for leisure activities and fresh water as an added value, make this area as one of tourist attraction in East Java Province.

Encounter the changing in micro climate within research area, each government sector attempts to develop programs to lessen its impacts. The most recommended strategies are rehabilitation of water sources and its catchment area. This is involving rehabilitation of forest and conservation area as well as creating green

space within neighbourhood. Many documents propose forest and land rehabilitation to improve catchment area to increase the capability to store groundwater. Some also mention the importance of this strategy to improve forest as habitat for vegetation and other biota. Most of development plans view forest and land rehabilitation as the important strategy to conserve water resources and also to prevent natural hazard. Indeed, for the past few years, this program has been implemented by government agencies. In addition, the Ministry of Forestry of Indonesia through its River Basin Management Agency supports this activity by establish join program and providing trees to be distributed to other stakeholders and the communities.

Apart from rehabilitation strategy in terms of improvement of vegetative coverage, there is also improvement in term of physical construction such as development of retaining dam, gully construction and retention well. Retaining dam and gully construction is aimed for improving river channel in order to restrain erosion and sedimentation. Retention well is constructed to reduce surface runoff and to increase absorption of precipitation into ground layer. As sedimentation has become serious problem, there is also attempt to dredge river channel and reservoirs in order to increase the capacity of reservoirs. Among reservoirs built within this research area, most of them unable to store sufficient water for many purposes due to high rate of sedimentation. Therefore maintenance of river channel and reservoir has been the priority of the Ministry of Public Works through its Irrigation Agency.

Besides these rehabilitation program and technical maintenance, there is also attempt to address the problem concerning water resources in holistic way through integrated water management. This is involving management of Brantas River Basin in integrated way by implement integrated river basin management such as proposed by the Brantas River Basin Management Agency. Indeed, this agency already establishes an Integrated River Basin Management Plan in 2010 as the guidance for every development within Brantas River Basin. This plan is followed by action plan in 2011 in which touch upon more practical issues and implementation. However the implementation of such program is still become the

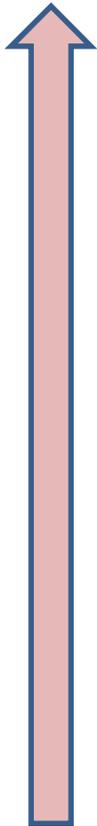
main challenge to be overcome regarding various interests involved within the management of Brantas River Basin.

Concerning strategy to reduce impact of agriculture productivity, there is a program to improve irrigation system in terms of its management to avoid conflict among users. Agriculture agencies have developed technology to deal with increasing demand of agriculture product. However, within this field, this strategy is mainly aimed to increase productivity to strengthen food security. The consideration of coping with climate change impact is not addressed explicitly within the documents. There is also emphasis on the importance of collaboration on water supply system and there is also indication to actualize this notion. The provision of drinking water and clean water for daily use within this area mostly depends on springs which are located in Batu City. However, this mechanism has to be reviewed as it does not distribute equally. Therefore, it is an important task to develop this collaboration to strengthen clean water distribution. Besides intention on preserving water resources and preventing natural hazard, rehabilitation is also directed to enrich natural landscape. By creating green space within the city, improvement of existing parks and venues for recreation, it is expected to lessen the impact of global warming as well as to enhance aesthetic value of the area.

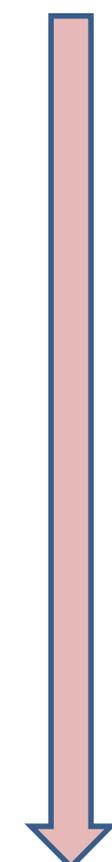
Responses of development plans in addressing risks of natural hazard are presented in table 4.2. As to directive plan such as spatial plan, mid-term development plan and short-term development plan, the consideration on ecosystem services and adaptation to climate change is as far as giving guidance on how each development sector should undertake. Although it clearly acknowledges all these environmental issues, as a directive plan it does not touch upon practical issues. On the other hand, strategic plan and work plan from each development sector focuses on the implementation of applied strategies in terms of actual programs, construction of technical infrastructure, partnership, training, monitoring and evaluation, as well as budget allocation for such programs. Although stakeholders respond in different ways, they view the need to adapt with changing natural ecosystem as the guideline in defining their policy. This integration might not be conceptualized in terms of risk assessment, however the

recognition of policy makers to accommodate this matter in policy making become an asset to establish a more detailed assessment on climate change adaptation issue in the future.

Table 4.2. Adaptation strategies: responses of Development Plans

Adaptation strategies	Description	Rank
<p>Forest and land rehabilitation</p>	<ul style="list-style-type: none"> ▪ Rehabilitate forest and land cover to enhance its function as water catchment area, as habitat for biota significant for supporting regulation function (as in soil retention). Land rehabilitation to regenerate critical land through green space programs (urban forest, community forest, city green space). ▪ Dealing with lessening water supply, inability in regulating water and maintenance of water supply due to the increase of critical land (lessening vegetative coverage) lead to disturbance of water storage. 	<p style="text-align: center;">High</p> 
<p>Rehabilitation of water sources and area surroundings</p>	<ul style="list-style-type: none"> ▪ Improvement of land coverage through rehabilitation (vegetative) of water sources (especially springs) and its catchment/recharge area to enhance the ability to preserve water. ▪ Dealing with lack of supply of water, imbalances of water system. 	

Technical construction: retaining dam, gully construction, retention well	Improvement of ecosystem structure to withstand extreme runoff, preventing floods and to increase infiltration to support groundwater preserve.	<ul style="list-style-type: none"> Brantas River Basin Management Agency and Forestry Agency: central government fund through special allocation fund (<i>DAK/Dana Alokasi Khusus</i>) for building the structures.
Management of irrigation system	Improvement of water distribution for irrigation to overcome the declining in agriculture/food productivity. Advancement of irrigation channel (physical construction) to reduce water loss.	<ul style="list-style-type: none"> Irrigation and Agriculture Agency: local government fund to maintenance irrigation system
Improvement of clean water distribution system	Improvement in clean water distribution system especially for area which water supply shortage.	Directive plan (recommendation)
Change in planting period, crop technology	Modification in planting period adjusting with the change in rainfall pattern (changing season). Recommendation on the use of crop technology dealing with deficit/surplus water supply.	<p>Agriculture Agency: actual program through local government fund, involving:</p> <ul style="list-style-type: none"> - Training for field instructor and farmers - Distribution of farming tools and superior seeds - Monitoring and evaluation
Improvement of reservoir (technical maintenance)	Technical maintenance on reservoir (weir, sluice) to reduce leakage, dredging sediment material to increase volume of reservoir.	Irrigation and Agriculture Agency: local government fund to maintenance irrigation system
Rehabilitation of natural landscape and its aesthetic value	Restore the aesthetic value of nature through creating green space (urban forest, parks) and the authenticity of natural beauty.	Local Development Planning Agency: recommendation and directive plan
Create venue for aesthetic purposes	Management of natural landscape as site for leisure activities (parks, water recreation)	Local Development Planning Agency: recommendation and directive plan
Integrated water management	Establishment of integrated planning within management of Brantas River Basin across sector.	<ul style="list-style-type: none"> Local Development Planning Agency: recommendation and directive plan Brantas River Basin Management Agency: integrated planning document
Collaboration on water supply system for domestic/drinking water	Collaboration between regions (water resources owners and users) in drinking water provision.	Local Development Planning Agency: recommendation and directive plan



Low

4.4. Reflection

The types of services acknowledged within the case study are regulating, provisioning and cultural services respectively. Interesting finding that regulating services is considered most over provisioning services. Some scholars argue that provisioning services can be recognized easily due to its tangible product therefore much more visible compared to others (Hauck, et al., 2013). De Groot et al. (2002) and Rodriguez et al. (2006) also emphasize that regulating and cultural services cannot be detected easily. However, apart from the indirect benefits they delivered in which make them difficult to be captured, they also point out how this (regulating) services being recognized through the disturbance emerge. This is occurred within the case study. Acknowledgement on the risk of climate change, not only in the future but also at present time as some hazard already occurred, lead to the increasing awareness on regulating services of the ecosystem. This services is recognizable from the disturbance on the benefits it is delivered, that threatening human well-being. Therefore, the sustainability of this services become the main concern within policies in most development sector.

In addition, preference on certain ecosystem services over another is also depend on the stakeholders involved. It is important to understand the reasons on how different stakeholders value ecosystem services differently. Particular services might be given high priority compared to others by certain stakeholder and vice versa is affected by the way those services comply their interest (Martin-Lopez, et al., 2012).

The preference over regulating services indicates the need of protection as the main focus of development. First, it attempts to preserve the ecosystem and further to secure human well-being by ensuring the sustainability of the services delivered for human. The consideration on protection is actualized in regulating utilization of space through controlling land use change and emphasis on rehabilitation to secure ecosystem and its functions. Specifically for the upper river basin as this area has significant role in maintaining the whole river basin ecosystem. The health of river basin is determined by the characteristic of

upstream area in which directed for protection. This matter also underlie the determination of adaptation strategies applied within development plans.

In the meantime, supporting services is hardly represent within the development plan as it is difficult to capture. Water cycling and soil formation involving complex processes within ecosystem significant in supporting the presence of other ecosystem services. Fisher et al. (2009) argue that supporting services underlying sustainability of other services through the interlink processes within ecosystem components. Some stress that this services is manifestation of the biophysical structures within ecosystem and its processes up to generate direct benefits delivered to human. Aside from this materialization of ecological functions and processes, it is also associated with intermediate services in which support so called final services (provisioning, regulating and cultural services) (Fisher, et al., 2009; Millennium Ecosystem Assessment, 2005; Potschin & Haines-Young, 2011).

The most applied adaptation within the case study is forest and land rehabilitation and rehabilitation of water sources. Indeed, each sector put different approach concerning adaptation strategies based on their respective goal. However, a more integrated strategy for a long term goal has been employed recently through this rehabilitation program. The capacity of ecosystem to store water resources is determined by the characteristics of geology, soil formation and land coverage. Geology and soil formation are considered as constant variable that cannot be manipulated by human. Therefore, adaptation strategies should be emphasized on management of land use to reduce the impact of climate change. The existence of vegetative coverage is essential to counter such risks. De Groot et al. (2002) pointed out on the role of vegetative structure as it has the ability to storage water resources as well as to withstand from runoff and flood. It also support the function to control natural hazard through its structure and root system that substantial in soil retention process. It has capacity to restrain sediment and preventing deposition within river body. Obviously, vegetative coverage within river basin ecosystem support its performance in maintaining runoff and water storage (Postel & Thompson, 2005).

Indeed, sustaining ecosystem functions should be directed through maintenance of ecosystem components that can be managed that is land use. Management of land use therefore important as the basis to perform adaptation strategies applied within area under study. Burton et al. (2006) argue that the characteristics of climate and how human system adjust with the variability of climate patterns determine the vulnerability of this system. Thus, they key element is in how human adapt to and cope with such changes in which actualized in management of land use, in this context is rehabilitation of water catchment area.

Chapter 5

CONCLUSION AND RECOMMENDATION

5.1. Conclusion

Obviously, climate change brings significant impacts on natural and human system. Despite all the debates on this issue, the effect is tangible. The unpredictable changes within global climate lead to disruption of micro climate as well thus interference both systems. Indeed, scientific modelling can always be performed to predict pattern in climate events, however there is always uncertainty underlie in terms of the magnitude of the risk involved. This is relied on the characteristic of the system itself. Resiliency of the system thus becomes necessity in the face of climate change in order to secure both nature and human system.

Aiming for strengthening resilience on both natural and human system, adaptation is needed encountering climate change impact. Water resources, as one of important element of human life in which the existence is in the state of crisis, has to be maintained as well. As to adaptation strategy, it should be embedded within policy as the foundation of every development. This integration thus perform a so called climate resilience development aiming for a more adaptive system in the long term. To investigate adaptation strategy regarding water resources, ecosystem services approach is important as this concept links the nature (ecosystem function) and human (welfare) system. Referring to ecosystem services, adaptation strategies are established to perform an ecosystem-based adaptation to improve human welfare through maintaining natural system. Through this framework, it can be explored whether development plan regarding ecosystem services within its policy.

This empirical study aims to investigate the integration of climate change adaptation into development plan through the lens of ecosystem services as the reference for assessment. It tries to explore the extent to which ecosystem services is captured within development as the foundation to perform adaptation strategies

by assessing the dynamic of ecosystem services affected by climate change events. Furthermore, it concerns on how these ecosystem services are integrated within planning practice. The integration within policy might not distinct in terms of specific project in terms of ecosystem services assessment and/or climate change risk assessment, however there is awareness among policy makers to put in environment recovery within their policies. The term ecosystem services might not directly stated however its components are clearly elaborated within document plans. How the consideration of benefits generated and disruption on natural system indicates how policy makers concerned about this issue. The understanding of ecosystem loss is recognized, therefore the need to secure the services its generated for the benefit of human well-being is actualized through directive plans and/or actual programs based on development sector. From this point on, it can be stated that determination of policy based on dynamic processes within natural system indicates how policy embraces ecosystem services in performing adaptation strategy.

The main concern within development plan in general is the sustainability of river basin ecosystem in regulating the biophysical process. Indeed, this types of services is prioritized within most document plans. The consideration emerge from the acknowledgement of benefits they have delivered to the disturbance affecting ecosystem structure and finally how this matter affect human well-being. These issues are assessed thoroughly within policies as the foundation in performing adaptation strategies towards a more resilience system both in natural and human system. The most considered strategy for adaptation is forest and land rehabilitation and also rehabilitation of water sources. The purpose of those programs is to secure water resources and prevent hazards which jeopardize river basin ecosystem and the livelihood of its inhabitants.

5.2. Recommendation

Despite the recognition on ecosystem services as the foundation in defining adaptation strategies, there is little indication on one of important element within ecosystem services namely trade-offs. Ecosystem trade-offs refer to condition as

the provision of specific ecosystem services causing the reduction of other services. These trade-offs are differentiated in terms of space, time and reversibility in which refer to the ability of ecosystem services returning to its initial state after disruption (Rodriguez, et al., 2006). Hauck et al. (2013) stresses that valuation of ecosystem services is the main challenge within policy formulation and implementation. This involves valuation of ecosystem services across scales and trade-offs as particular services is prioritized over another. Within the case study, these trade-offs are not implicitly discussed within development plans. Apart from adaptation strategy aiming for securing certain services, there is little explanation on how those adaptations might affect other services and how to deal with such circumstances. One indication might emerge from the attempt on sustaining water resources through rehabilitation of forest and land. Aside from securing water resources in the long term, there is attempt to minimise the consequences of such action at present times. Within forestry sector, the government agency involving the community in their rehabilitation program through community forest management. Therefore, beside conservation purposes, community still gain benefits from the land they utilized to improve their welfare. According to Hauck et al. (2013) as ecosystem services connect each other, it is difficult to value different ecosystem services individually. Indeed, due to this interconnectedness decision makers have to consider this matter carefully within their policy to prevent more ecosystem loss.

Implementation of particular adaptation strategy in favour specific ecosystem services might cause loss for other ecosystem services. Therefore, in the future this aspect should be considered thoroughly by decision makers in determining policy regarding water resources. This trade-offs issue in terms of space and time should be carefully assessed in order to strengthening the ecosystem-based adaptation to prevent mismanagement of natural resources especially water resources under study. Carpenter et al. (2006) claimed that degradation of ecosystem is more or less represent the failure of various ecosystem services. Indeed, there are many factors that responsible for this failure however through the lens of planning practice this circumstance might triggered by a mismanagement due to inappropriate policy on natural resources. Therefore this

issue should be carefully assessed as determining policy for securing the sustainability of ecosystem and further, human well-being.

The most important thing is to actualize this concept into management practice specifically aiming for ecosystem-based adaptation project through ecosystem services approach. In the future, detailed project directed to ecosystem services assessment could be done to improve the enforcement of environmental policy. This should involve valuation of ecosystem services as well in terms of economic value. In doing so, it might need further research as this issue rarely discussed within area under study. In addition, as this research is limited to some stakeholder from governmental parties due to limited access to private parties, in the future the involvement other stakeholders might necessary. This is especially for stakeholders that responsible in water provision for the community to gain more insight from water user perspective on ecosystem services and its trade-offs upon water resources. This is also as support for policy makers in defining strategies to safeguard water resources and support human welfare.

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APPENDICES

Appendix A: List of Code

1. Code of Services

Code	Types of Services
S1	Provisioning services: a. Fresh water, presence of water reservoirs
S2	Regulating services: a. Climate regulation: maintenance of favourable climate by land cover and biologic mediated process, altering water redistribution and regional rainfall pattern b. Water regulation: role of land cover in regulating runoff and river discharge c. Water supply: filtering, retention and storage of fresh water (aquifer) d. Water purification and waste treatment: role of vegetation and biota in removal/decompose organic waste e. Erosion regulation: role of vegetative coverage in soil retention f. Natural hazard regulation (disturbance provision): influence of ecosystem structure on dampening environmental disturbances
S3	Cultural services: a. Aesthetic value: aesthetic value in various aspects of ecosystem b. Social relations: ecosystem influence the types of social relations c. Recreation and ecotourism: characteristics of natural or cultivation landscape as venue for leisure time
S4	Supporting services: a. Water cycling: importance of ecosystem to support water cycle b. Soil formation: role of natural process in soil formation and regeneration

2. Code of Benefits

Code	Benefits
B1	Drinking water
B2	Domestic use
B3	Drainage and natural irrigation
B4	Fisheries
B5	Hydropower plant
B6	Temperature and precipitation essential for human habitation
B7	Water storage
B8	Water balance
B9	Medium of transport
B10	Industrial use
B11	Pollution control (water quality)
B12	Prevention of landslide, erosion and sedimentation
B13	Flood prevention
B14	Parks and water recreation
B15	Common interest group (agriculture, fisheries)
B16	Support provisioning services (fresh water)
B17	Support regulating services (water cycling, soil formation)

3. Code of Changes in Benefits

Code	Changes in Benefits
C1	Increase temperature
C2	Change in season period affecting crop
C3	Deficit in water supply (drought) in dry season, increase runoff (flood) in rainy season
C4	Decline quantity and quality of groundwater and surface water
C5	Decrease fish production in dry season
C6	Reduce the use of water transport
C7	Reduce supply for drinking water, decline quality of drinking water, higher water cost
C8	Reduce supply for domestic use
C9	Reduce supply for irrigation lead to crop failure
C10	Reduce supply for industrial use affecting production, increase exploitation of other source of water
C11	Increase the risk of landslide and erosion, sedimentation reducing the capacity of river channel
C12	Increase the risk of flood and landslide
C13	Reduce aesthetic value of nature
C14	Limit forum/venue to form common interest group
C15	Limit area for recreation, sport and leisure activities
C16	Hamper services for water supply and water purification
C17	Hamper services for regulating services (water regulation, erosion regulation and increase natural hazard)

4. Code of Responses of Development Plan

Code	Responses
R1	Forest and land rehabilitation (improve water catchment, habitat for biota)
R2	Rehabilitation of water sources and area surroundings
R3	Rehabilitation of natural landscape and aesthetic value
R4	Change in planting period; crop technology (drought resistant crop); management of agriculture system
R5	Management of irrigation system
R6	Improvement on reservoir (technical maintenance) to reduce water loss
R7	Technical construction: retaining dam, gully construction, retention well
R8	Create venue for aesthetic purposes: parks and water recreation
R9	Strengthen services for agriculture and fisheries to provide forum for social interaction
R10	Collaboration on water supply system for domestic/drinking water across municipality
R11	Improvement of clean water distribution system
R12	Integrated water management