"COWAR" (CONSERVATION OF WATER RESOURCES): THE EFFORT OF DROUGHT AND WATER CRISIS PREVENTION IN BRANTAS RIVER BASIN

Anggun Sugiarti[1] and Donny Harisuseno[2]
[1]Water Resources Engineering, Brawijaya University
[2]Graduate Student, Water Resources Engineering, Brawijaya University,
Jalan Danau Paniai Utara III C7/B13 Malang 65138, Jawa Timur-Indonesia
Email: *anggun.sugiarti@yahoo.com*

ABSTRACT

The water is still leaves the thorny issues in Indonesia. Whereas with an average rainfall reaches 2779 mm per year, Indonesia should be able to be the water- rich country. However, 66% of the rain water is actually turned into a disaster (floods and landslides). When the drought comes, the water-rich country is also lack of water. High rainfall potential should be valuable capital in water endurance and prevent drought in Indonesia. In fact only 34% of the total rain water that can be stored by the soil into the groundwater (Data Agriculture, Agricultural Statistics, 2001). The remainder becomes surface runoff water disastrous floods every rainy season. When the dry season comes, the water reserves are not depleted and bring drought disaster.

Conservation of water resources is one of water resource management aspect (water resources conservation and utilization of water resources, and control of the destructive force of water). The conservation of water resources starting from the identification of the problem, identification of alternative treatment, plan for recommended activities, and the implementation of action plans. With the "COWAR" (Conservation of Water Resources), is expected to prevent drought that hit Indonesia annually, especially in Brantas River Basin. It is an effort to manage water that can be harvested water during the rainy season (rain water plant) so we have a store of water that can be used during the dry season.

KEY WORDS: Conservation, Water Resources, Drought, Water Crisis, and Brantas River Basin

1. INTRODUCTION

1.1 Overview

According to Maude Barlow and Tony Clarke (Blue Gold, 2005), the amount of water on planet Earth approximately 1.4 billion cubic kilometers. Of that amount, fresh water is available only 2.6 percent, or 36 million cubic kilometers. Not much volume of fresh water that can be enjoyed by people from the water cycle that goes fast, which is only about 0.77 percent of the total freshwater available in nature, or just 11 million cubic kilometers.

Indonesia is an archipelago country with six percent of the world's water supply, or about 21% of the water supply in Asia Pacific. Indonesia also has more than 500 lakes and has Toba Lake which is the largest lake with an area of more than 110 thousand hectares. Basin water in Indonesia is estimated to have a total volume of 308 million cubic meters. From these data it is indisputable that Indonesia as rich country in water availability.

Water availability has related to how much water can be used compared to its needs. Every year Indonesia hits by water crisis. Indications clean water crisis can be seen from the water conditions that described by their quality and the availability of water (volume) in Indonesia. This is due to the destruction of water catchment areas and environmental pollution are estimated

at 15-35% per capita per year. Whereas on the other hand water consumption trend actually goes up exponentially.
Almost every year, drought has always occurred in Indonesia. Though Indonesia is a country that should be rich in water. Although it is not the same every year, but rainfall in Indonesia is still relatively high. Rainfall average annual in Indonesia reaches 2779 mm/year.

Water quality relates to the feasibility of water use for various needs. Water quality is also related to the volume and recovery of water (self purification) to accept a certain amount of pollution load. Beside that the feasibility of water, especially for drinking in Indonesia has reached a certain threshold that is very alarming.

Global threat is in sight. Indonesia is one country that is very vulnerable to the negative impacts of climate change. Climate change has changed the pattern of precipitation (rain) and evaporation, thereby potentially causing flooding in some locations and drought in another location. This fact is particularly threatening livelihoods of many areas in Indonesia country, especially the agriculture and fisheries.

In recent years, Indonesia has increased concerned intensity and frequency of climate change. The issue of global warming and climate change shows that a variety of development activities undertaken little or no attention to ecological sustainability, which is an essential factor for sustainable development.

Although Indonesia has many rivers, lakes, reservoirs, and swamps as a potential water resources other than groundwater, but not all of them can be used for the benefit of clean water. Moreover, if the forest and land is severely damaged, which amounts to 77 million hectares, of course, the potential of water resources will reduced.

Degradation of land, degraded land and environmental damage are the main problems faced by Indonesia. Poor condition will continue to increased if doesn't solved. Based on research Mulyadi (1975), there are 20 million hectares of degraded land in Indonesia, and every year is increase of 1-2% or 200000-400000 ha area. Meanwhile, according to the Directorate General of Forestry survey period of 1974-1980 there were 8.5 million hectares of degraded land in the seventy-five watersheds (DAS), both inside and outside of state forests and critical land areas every year is increasing, and now estimated at 16 million ha.

In addition to critical land, land degradation is also a very serious problem, especially in area of dry and slope (tilt) land agriculture, so productivity of land become lower, 90% upland plateau in Indonesia has a slope> 8%. Therefore, the potential degradation in dry and sloping land is very high, it is also supported by the high rainfall.

Clean water crisis makes the most of Indonesia's population should consume water that should not be worth drinking. United States Agency for International Development (USAID) in its report (2007), said the research in various cities in Indonesia showed nearly 100 percent of drinking water sources contaminated by the bacteria *E Coli* and *Coliform*.

To overcome the water crisis and saving the environment, including water resources rescue, should be done in an integrated and sustainable manner. Rescue efforts in order to overcome the water crisis can be done through:
- Promote the efficient water movement.
- Promote tree planting movement as one man one tree (tree during its life cycle can produce 250 gallons of water).
- Conservation of land, forest conservation and watershed areas.
- Construction of water reservoirs from rains, such as ponds and reservoirs so that water can be used during the dry season.
- Prevent minimum wastage of rain water into the sea to create water catchment wells or infiltration pit (biopori).
- Reduce water pollution by household, industrial, agricultural and mining waste.
- Development of process technology for desalination of salt water (sea) into fresh water.

The efforts to save the environment, including saving water resources, should be done in an integrated and sustainable manner. This is done to avoid land degradation, ecosystem damage (mainly agro-ecosystem), water quality and water quantity reduction (siltation of river), and

the water destruction in the soil. Thus "COWAR" (Conservation of Water Resources): The Effort of Drought and Water Crisis Prevention in Indonesia is needed to realize the benefits of clean, efficient, and effective water, and sustainable prosperity for all people.

1.2 Scope of Study

The scope of topics presented include:

a) The balance of water resources in Indonesia in general
b) Reservoir conditions in Indonesia are experiencing drought, and Brantas Watershed Condition.
c) The Effort of Water Resources Conservation.

1.3 Objectives and Research Targets

Objective discussion of this study include:

a) Describe the equilibrium water resources of Indonesia in general.
b) Discuss about the state of water resources in Indonesia, which is the state reservoirs are experiencing drought, and Brantas watershed condition.
c) Review the strategic role and position of Water Resources conservation, which includes scope for conservation of Water Resources, approaches and strategies, some examples of implementation and benefits, and challenges of conservation efforts in the future.

The research target is embedded a comprehensive understanding of water resources condition and the management of water resources in Indonesia and its prospects to next years, so it moved an awareness of each individual to the slightest action started conserving water resources in order the life of the current generation and the future.

2. METHOD

The method used in this study is exploratory research when viewed from the goal by digging extensively about causation or matters that affect the occurrence of something. This study also used the descriptive research method when viewed from the nature of the problem with finding information on the symptoms of existing systematic, factual, and accurate information about the facts and the properties of the population. Hopefully, by the "COWAR" (Conservation of Water Resources), it can prevent drought and water crisis in Indonesia.

3. RESULTS AND DISCUSSION

3.1 Balance Water Resources in Indonesia in General

In order to describe the condition of the water resources balance in Indonesia, Ministry of Public Works in Kodoatie (2005), performing calculations in units of the island. Specified nine major islands, namely the island of Java, Sumatra, Kalimantan, Sulawesi, Bali, West Nusa Tenggara (NTB), East Nusa Tenggara (NTT), Maluku and Irian Jaya. On each island the water balance is calculated based on rainfall data, spacious island, the amount of surface runoff, the amount of steady flow, and water use. Steady flow is a water being stored in reservoirs, lakes, rivers, and the water being stored in groundwater. The results of calculations are shown in Table 1 and Figure 1.

Table 1. Balance Of Water Resources In Indonesia

No	Island	Rain	Million m^3/year	
			Req	Balance
		(mm/year)	Total	
1	Java	2,680	59,838	12,570
2	Sumatera	2,820	22,985	149,990
3	Borneo	2,990	5,265	180,993
4	Sulawesi	2,340	6,995	128,655
5	Bali	2,120	1,515	97
6	NTB	1,410	2,864	846
7	NTT	1,200	1,745	648
8	Moluccas	2,370	1,051	20,742
9	Irian Jaya	3,190	804	188,031
	Total		103,062	655,546

This condition is only seen from one aspect, the availability of water in terms of number (quantity). If seen further aspect of the quality and continuity of water availability collectively, mkaa water availability will worry not just happen on three islands at the top of Java, Bali and West Nusa Tenggara (NTB), but also occur on other islands.

Empirical facts prove that in Java, there is excess water (flooding) in rainy season, while the other seasons (drought) the water deficit is incredible. It can be seen from the graph below.

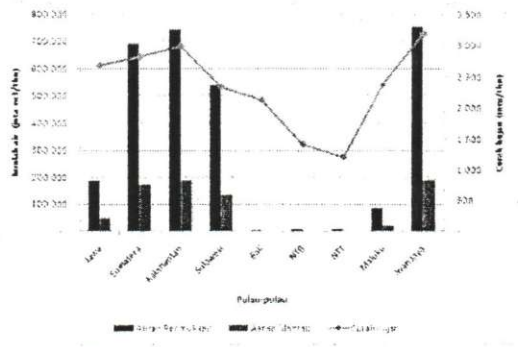

Figure 1. Comparison between surface flow with steady flow in some Island in Indonesia

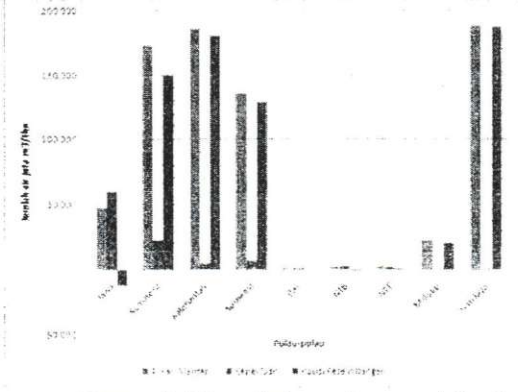

Figure 2. Water balance in some island in Indonesia

3.2. Reservoir Conditions in Indonesia

The reservoir is a source of fresh water that supports life of all living things and economic social human activities. Availability of water resources, has a fundamental role to support regional economic development. Limited water resources in the region have implications for development activities. If the economic activity is limited, the prosperity will not achieved. The water reservoir is used for multiple uses such as drinking water, sources of raw water, irrigation, power generation, flushing, fisheries, and others. So fresh water from the reservoir is very important for the life.

In Indonesia there are approximately categories lakes> 50 ha of 500 pieces. The lake is spread evenly on each major island (Sumatra, Java, Kalimantan, Sulawesi, Papua) except for the island of Bali. Rather large reservoirs, mostly located in Java. In addition to large lakes category, there is also a thousands of small lakes and small reservoirs called ponds. The reservoir is often called a large artificial lake. According to the World Dams Commission, Reservoir or large dam is a dam that has height of more than 15 m. While ponds is a small reservoir that has approximately 15 m high dam. Ponds were built in East Nusa Tenggara and West Nusa Tenggara. Construction of large dams in Indonesia to 1995 approximately 100 dams. Most of the 80% are located in Java. Since the monetary crisis in 1998, the construction of large dams in Indonesia has not been done again exept Jatigede Reservoir Planning in Sumedang district of West Java Province. Reservoir water system is different from a natural lake. In general, the water reservoir system components have been planned in such a way that the volume, depth, breadth, presepitasi, inflow and outflow discharge. So the residence time of water is known certainty.

Construction of dams designed for variety purposes such as power generation, irrigation, flood control, source of raw drinking water, industrial water, flushing, water fishery, and tourism. The amount of electricity generated from hydropower from water reservoirs is 3.4% of the national total of reqiurement.

Although BMKG estimating the dry on September 2012 considered normal drought, but in many areas getting drought and puso. Recorded 127.788 ha of rice field are drought. Drought place between them in West Java, Banten, Central Java, East Java, and so on.

The drought also reduced the water supply reservoir. Based on the monitoring of the Ministry of Public Works, 71 reservoirs scattered in Indonesia, until the end of August 2012 there are 19 normal reservoirs, 42 alert, and 10 dry. It is called normal reservoir water conditions if the actual elevation greater than normal. Be wary if the actual volume is less than normal but greater than idle drought. While dry if the actual elevation lower than the elevation of drought alert.

Three major reservoirs in West Java which is include alert condition are Saguling, Cirata and

Jatiluhur. There is a difference of 187.66 million cubic meters of normal. The same thing happened in Central Java, such as Wonogiri, Cacaban, Rawapening, Kingpin, and Sudirman reservoirs. In Central Java, there are 9 normal reservoirs, 20 alert, and 8 dry. The wary reservoirs are Sermo Reservoir in DIY, Lahor, Sutami, and Bening. There are 7 normal, 13 alert, 1 dry in East Java. 10 dry reservoirs are Krisak, Plumbon, kedungguling, Nawangan, Ngancar, Delingan, Gebyar, Botok, Prijelan, and Gerogak. While in Bali from five reservoirs, there are 4 alert reservoirs and 1 dry reservoir. These conditions lead to reduced water supply. Many factors that causes droughts occur every year. There are damage watersheds, water pollution, lack of forest, reservoir sedimentation, and others.

3.3 Conditions of Brantas River Basin

Brantas is one of the most critical watershed of about 29 watersheds in East Java. Almost half of the basin is included in the category of degraded land (BKPH XI, 2006). The most prominent environmental issue in this region are (a) land use change from forest to plant vegetables, (b) reduction in the quantity and quality of water, and (c) land degradation.

Batu city is one of the areas in the upper of Brantas River Basin that has many springs. Inventory of springs in Batu city showed that there were 107 springs with varies discharge from less than 1 liter / sec to more than 300 liters / second (PJT, 2003). It was reported that the springs condition in Batu City start worrying, because the water flow has decreased. In Bumiaji districts, it found 3 of 57 springs in the dry season is dry. Geographically, the area of Bumiaji, Batu is located in the middle of mountains slopes Arjuna. So that this area is one of the catchment area. Land use in the Bumiaji, Batu is dominated by farmlands. Based on research in the area of Bumiaji, Batu has slope> 8%. So that the region of Bumiaji will have very high potential land degradation if converted to be farmland. In addition to causing erosion to landslides during the rainy season. When the dry season comes, it can threaten the water resources to be drought in downslope areas or low-lying, like Malang City.

Based on water condition (quality and availability) in Indonesia, the potential as water rich country is not able to prevent Indonesia from clean water crisis. When dry season comes many areas gets drought. Even when the rainy season, it is still lurking clean water crisis due to surplus water. It often lead flooding so water can not be utilized.

The development result produces a large number of irrigation infrastructure. The benefits of development are: 50 years of flood control on major rivers that reduce overflowing as large as 80,000 ha; irrigation to an area of 345,000 ha of rice fields where 83,000 ha of technical irrigation directly from the main stream (2.5 billion m^3 per year), electrical energy 1000 giga-W-hours per year, the supply of raw water for industrial 130 million m^3 per year domestic and 240 million m^3 per year.

Residents in the Brantas river area reached 15.2 million people (1999) or 43% of the population of East Java. It has an average density 1.2 times higher than average Java. The Brantas River has a significant role in supporting the East Java as a national food. In the years 1994-1997, East Java province have contributed an average of 470,000 MT of rice / year or 25% of the national food stocks.

3.4 Conservation Effort of Water Resources

3.4.1Settings Templates Reservoir Operations

In principle, the basic pattern of reservoir operation planned three operation patterns. There are the pattern of reservoir operations for dry years, the pattern of reservoir operation for normal years, and the pattern of reservoir operations for the wet year. Basic operation of the reservoir is the inflow characteristics of the reservoir or the water level schedule. While as a basis for planning is used mass curve method with two criterias: the season and elevation restriction. Operation of the reservoir can not be separated from the influence of the season, there are rainy season and dry season. The difference between the two seasons are defined the rainy season as reservoir filling period and the dry season as reservoir emptying period. Arrangement of series reservoir is need to be arranged in a single unit. If it can not arranged, then the problem will arise are (Gunawan, 2005):

1) If too much water is stored in the upstream of reservoirs, then downstream of the dam will get water shortages.

2) If too much water is removed, the risk of collapse can occur in existing reservoirs downstream.

Reservoir characteristics are referred to the archetypal reservoir operation are:

1) Dead storage capacity (dead storage zone) is used to collect sediment.
2) Effective storage capacity (effective / usefull storage) is used for the conservation of water sources (raw water supply, irrigation, hydropower, etc.), so every reservoir utilization of reservoir conservation can make the effective capacity of reservoir.
3) Flood storage capacity (flood control) is reservoir capacity which aims to hold excess water in order to reduce the potential for flood damage.

When the dry season comes, the pattern of reservoir operations is using dry pattern. The reservoir is operated with dry pattern with the first priority providing raw water for the daily needs. Then, the water for agricultural irrigation and industrial people. With that pattern of operations, so the realization of planting and harvesting rending rice realized more than 95 percent.

Some anticipation to prevent drought are, implement water use efficiency, minimize water leakage in irrigation, make cropping pattern and system, drop water via car and public hydrants, etc.

3.4.2 Anticipation Handling

Anticipation of handling the drought can be done through two stages of strategies, namely short and long term planning. Short-term Planning (one-year dry season) are:

a. Prioritization of water use according to forecasts of drought;
b. Adjustment of planting plan in accordance with the drought forecasting;
c. Operation setting and water utilization in reservoir for the basin that have reservoirs;
d. Improvement of irrigation facilities and infrastructure;
e. Counseling or possibility socialization of drought and the impacts;
f. Preparation of food reserves;
g. Preparation of temporary employment (labor intensive) to mitigate the impact, and
h. Preparation of emergency measures, such as: pantek wells or boreholes to obtain water, drinking water supply by tankers, artificial rain seeding in rain catchment areas, and the provision of water pumps.

Long-term planning includes:

a. Implementation of reforestation or conservation to improve retention and catchment in the upstream;
b. Construction of irrigation infrastructure (reservoirs and ponds);
c. Management of natural retention (temporary water reservoirs) in the basin;
d. Efficient use of water;
e. The creation of water-saving sanitary equipment;
f. Construction of water recycling infrastructure, and
g. Control of water users who do not obey the rules and without permission.

One way to prevent drought and water crisis are create a water-saving and green environment in the entire community. Activity of water saving should be encouraged. Another action that needs to be implemented is to improve hydrological networks in every region of the river as detection of changes in water availability as well as the management of water and water resources.

Conducting an inventory of pollution watershed is also important. However, a very high level of water usage in Java to be given priority handling. While increasing the carrying capacity of the watershed to prevent damage and improve water catchment area through land conservation efforts.

Implementation of ponds and reservoirs development is needed to prevent drought, because that infrastructure can be used a means to save water in the rainy season so that the water can be used in the dry season. It is supported by changes of operation pattern and maintenance of dams and complementary buildings to adjust with the increased intensity of rainfall and reduced rainfall as the impact of climate change.

It's also important to institutionalize the use of weather forecasts and climate information effectively in carrying out the operation and water reservoirs management. So it can reduce

the risk of droughts and floods more effectively. Besides geohydrology research to find puddles of water is also important, so that it can be built and maintained lakes and develop watershed and water storage, either in buildings or in the ground. There needs to be oversight of landlord liability for making water infiltration and water storage.

Indonesia green movement by planting trees should continue to be encouraged. In children, adolescents, and young people need to be embedded culture of "Young Planting, Old Harvesting". So, plant a tree is not just ceremonial activities, but sustainable. Another thing we need to do is to harvest rain. Preventing minimum wastage of rain water into the ocean to be used in the dry season by building infrastructure such as water collection reservoirs, ponds, infiltration wells, infiltration biopori hole, and the water tank. This effort is also intended to prevent flooding that always come in the rainy season.

Planning and implementing a national strategy in a sustainable peatland management is needed too. Rehabilitation of water management in the area of peatland canals open by build a system of opening and closing the channel to maintain the stability of the ground water. And inventory of peatland areas according to their characteristics and made in accordance peatland spatial characteristics.

3.4.3 Utilizing Seawater Desalination For Drinking

Desalination is becoming one of the fast growing technologies in the world water treatment. It is a process to eliminate salt content in the water consisting of Cation (positive ions) and anions (negative ions). In order to obtain high-purity water or to obtain clean water from water that has a high salt content, such as sea water. With the several cases emergence of sea water into the land or well-ground water wells intrusion is already common in Indonesia, such as Jakarta and surrounding areas. This technology is increasingly making its presence into account.

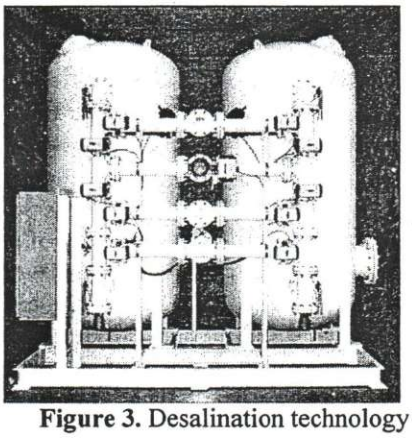

Figure 3. Desalination technology

Desalination technology is actually quite different than the "water treatment" in general. The difference lies in the level of difficulty and complexity owned, so desalination is categorized as "advanced water treatment process". Generally there are three types of commonly used desalination technology in the world, namely Ion Exchanger, Nanofiltration, and Reverse Osmosis. Ion exchangers are ion exchange process, by using the Resin. Resin shaped like fine sand, put in tube pressure (pressure tank) and skipped the water. To get the water free of salt, commonly used two types of resins are Strong Acid and Strong Base Cation Anion. Both resin was put into two different tubes.

Reverse osmosis uses semipermeable membrane in the form of spiral wound (like the shape of a tube) combined with a high-pressure pump. In contrast to the ion exchanger, reverse osmosis can not operate at 100% recovery. Reverse osmosis systems typically operate at a recovery between 20% - 90%, depending on the capacity and design. At 50% recovery, which means that to produce 1 liter of water, it takes 2 liters of water as desired. At 70% recovery, it takes 100 liters of water to produce 70 liters enter the water. The rest of water which is not be product is discarded as a reject. While Nanofiltration has the same working principle with reverse osmosis, nanofiltration membrane only have pore sizes larger than the Reverse Osmosis.

4. CONCLUSIONS

(1) The water requirement for domestic (population, industry, urban) and farm needs is a very large on the island of Java, Bali and NTB that causing three islands gets water deficit. Water deficit will be more alarming if viewed collectively from the aspect of quantity, quality, and continuity of the water availability.

(2) Potential, utilization and load in Brantas River area should be managed properly in order to bring the maximum benefit for the public.

(3) Utilization of Water Resources and controlling the destructive force of water will be done exactly if the optimum water resources have adequate quantity, quality and continuity. Conservation of water resources is carried out in order to preserve and increase the water availability, both in quantity, quality and continuity.

(4) Activity conservation of water resources is very supportive to prevent dryness and clean water crisis in Indonesia, especially the Brantas River Basin.

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