The Flood between the Balance of Natural Systems and the Challenges of The Future

Ahmad Mashadi

Department Civil Engineering, Faculty of Engineering, Sarjanawiyata Tamansiswa University, Yogyakarta
**Corresponding author:ahmadmashadi48@gmail.com*

ABSTRACT

The Water is a gift from God Almighty that is needed by all living things. The availability of water for human and other commercial purposes includes the quality and continuity of social, environmental and economic functions. Water as a natural resource can be renewed even though it is influenced by various interests and goals. Population growth, development of settlements related to water is still ongoing. The development of settlements is one of the causes of the reduced water catchment area in the rainy season which increases the volume of runoff that causes flooding. Floods are often associated with the rainy season causing damage in various places. On the other hand, the availability of water tends to decrease, but the demand for water increases and drought can occur in the dry season. Changes in water quantity and quality can cause problems, so it needs to be managed with an integrated approach. Management with efforts to reduce damage due to flooding and minimize drought in the dry season. A rational approach to flood problems is carried out in an area that synergizes between regions with an eco-drainage system. This system can control excess surface water and the opportunity for a lot of water to seep into the ground. This is intended so that groundwater conservation can take place properly and the dimensions of the drainage building structure are more efficient. Other efforts that can be done in several areas are by building retention ponds, infiltration and so on.

Keywords*: water, flood, eco-drainage system, retention pond, infiltration*

1. INTRODUCTION

Water potential in the world, according to Chow VT, 1988 in Triatmojo [1]; Kodoati RJ and Sharif R [2]; that water on earth is 1.386 billion m^3, 96.54% in the sea, 1.73% at the poles, groundwater is 1.69% (0.76% fresh water and 0.93% salt water), water on the surface and water in the air is 0.04%. Water is needed in domestic and industrial life as human intervention in various other interests. Table 1 shows the condition of the population in Java and the population growth of Indonesia in 2020. Population growth and population numbers have had a significant impact on many people's lives; new settlements have increased, as has the use of water resources.

Table 1. Population Of Java Province (thousands)

Province	2016	2017	2018	2019	2020
DIY	372090	37620	380290	384290	366872
DKI Jakarta	1027760	1037420	1046760	1055780	1056209
Jawa Barat	4737940	4803760	4868370	4931670	4827416
Jawa Tengah	3401910	3425790	3449080	3471820	3651604
Jawa Timur	3907530	3929300	3950090	3869890	4066570
Indonesia	25870500	26189090	26501530	26807460	27020392

Source: BPS Indonesian Population Projection 2010-2035

Globalization has influenced a variety of issues, including weather and a slightly altered climate, which have impacted other parts of the globe. The rainy season with floods in various parts of the earth and droughts in the dry season has also hit Indonesia. In Indonesia, the rainy season and the dry season shift each other, which results in several problems in various lives.

Indonesia is part of the maritime continent in the tropics dominated by convective and orographic clouds, causing very high rain intensity. Heavy rainfall is a major factor causing flooding and can be caused by:

a. Dynamic natural conditions, namely high precipitation, shallow rivers, the influence of tides, land subsidence,
b. Static natural conditions, geography, topography, river geometry (slope, sedimentation, bottleneck)

c. Dynamic human activities: the spatial layout of floodplains is not yet appropriate, development in flooded areas, settlements on riverbanks, drainage that has not been maximized, garbage, and others.

In Jakarta, the flood phenomenon occurs according to M. Pramono, stating that the main cause of this flood is evenly distributed rain, which is a large amount, and the storage on the surface of the land is saturated with water. (Kompas.com, Wednesday, January 1, 2020). Other data shows that rain and the extent of waterlogging and receding time in Jakarta are shown in Table 2.

Tabel 2. Comparison of the impact of floods in Jakarta 2007-2013-2015-2020

Year	The highest rainfall during the flood (day)	Affected Area		Refugees	
		Flooded area (km^2)	Strategic Area	Number of Refugees	Number of Location
2007	340	955	yes	276333	NA
2013	100	599	yes	90913	1250
2015	277	702	yes	45813	409
2020	377	390	no	31232	209

Source: https://www.merdeka.com/jakarta/membandingkan-data-banjir-jakarta-pada-2013-2015-dan-2020.html

From a catastrophic perspective, drought is defined as a lack of rainfall in a certain period (generally in one or more seasons) that causes a water shortage for various needs. The lack of water affects the amount of surface flow in a watershed. In parts of Indonesia, many droughts also need attention to reduce the impacts they cause. Drought hazards occurred in several regions in 2017, according to data from: https://bpbd.bogorkab.go.id/lebih-dari-2-726-desa-kekeringan-jutaan-masyarakat- terdampak-di-jawa-dan-nusa-tenggara/

a. West Nusa Tenggara, 318 villages from 71 sub-districts spread across 9 districts, as many as 640,048 people, or 127,940 households.
b. East Java, there are 588 villages in 171 sub-districts and 23 districts
c. Central Java has 1,254 villages from 275 sub-districts and 30 districts with 1.4 million people from 404,212 households.
d. West Java, there are 496 villages in 176 sub-districts and 27 districts covering 936,328 people. Drought emergency status in Ciamis, Cianjur, Indramayu, Karawang, Kuningan, Sukabumi, Banjar and Tasikmalaya
e. Yogyakarta, there are 10 sub-districts in Kulon Progo. There are 32 villages totaling 12,721 people from 7,621 households.

2. METHOD

a. Reducing Flood

Flooding is a condition of non-storage of water in the river trough or obstruction of water flow in the disposing of the disbursement, so that overflowing inundates the surrounding area (floodplain) [3]. Flooding is a temporary condition of the land surface, generally dry under normal conditions but can be inundated due to oversupply due to the very rapid accumulation of surface runoff. Flooding occurs when the discharge of the river flows becomes high, thus exceeding the river's capacity. As a result, the part of the water that overflows beyond the riverbanks inundates the lower surrounding area. The causes of flooding include climate, watershed characteristics, and the influence of human activities (anthropogenic).

The behavior of river discharge is determined by the biophysical characteristics of the Watershed, namely the shape, size, and density of the river network; topography; soil type; and geology; hence:

1) Watersheds that are round, small, and have high river network density, steep slopes, and low soil permeability will have a very fast hydrological response when receiving rain input. Therefore, the risk of flooding will be easier to occur in the case of round-shaped watersheds.

2) Watersheds of elongated shape, large size, low hydrographic tissue density, gentle slopes, and high soil permeability will have a very slow hydrological response.

Indonesia is an archipelagic country, where the type of Watershed is mostly small with steep slopes. The elongated Watershed is found only on large islands, such as the Musi and Batanghari rivers in Sumatra, Kapuas, Barito, and Mahakam in Kalimantan. Rivers in northern Sumatra, Java, and Sulawesi are generally short and often flooded. During the rainy season, a balance of water can be depicted so that the water coming out of the Watershed shows the condition of the Watershed, illustrated in figure 1.

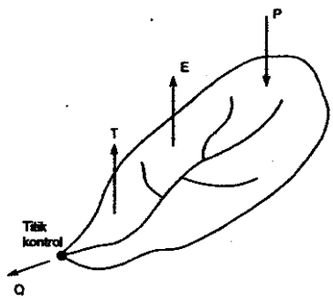

Fig 1. Water balance in Watershed

$$P - E - T - Q = 0$$

Description: P = Precipitation in watershed,
E = Evaporation
T = Transpiration
Q = Debit out let

This water balance is a tool for approaching the hydrological values of the processes occurring in the field. In short, the water balance explains the relationship between inflow and outflow in an area for a certain period of the water circulation process. The water balance can also be defined as the difference between the amount of water received by the plant and the loss of water from the plant and the soil through the evapotranspiration process. The large outflow from this Watershed will burden the downstream area with discharges that are not accommodated by the dimensions of the overflow channel as flooding.

To achieve wider benefits, the concept of water resource management can be carried out at several levels, including:

1) The river's sub-area level includes a relatively small portion or sub-area of the river that is part of the river area. The management is partial, not fused, and simple, with suboptimal results.
2) The unit level of the river area is called one river of management. Management is integrated so that it is more complex in its implementation and can be optimized to meet various interests in water problems.
3) Between river areas, namely management to improve water utilization and overcome problems in each area passed by the river in terms of floods, water needs, and so on [4]

At the level of river flood management between administrative areas, the manager must study recognizing the phenomenon of flooding, efforts to isolate floods, and efforts to reduce river flow discharge and water levels during floods. By recognizing the flood phenomenon, Kodoatie, J.R. [5] stated that flood control includes upstream and downstream, namely:

1) The upstream part can be in the form of a control dam to flood, reduce flood discharge, field reservoirs, or greening.

2) For the downstream part, repairs can be carried out on river flows, embankments, waterway diversion on critical lines, and utilization of low areas as retarding basins.

Control dams to inhibit flooding and reduce flood discharge can take the form of field reservoirs, retention ponds, or Embung, as shown in Figure 2.

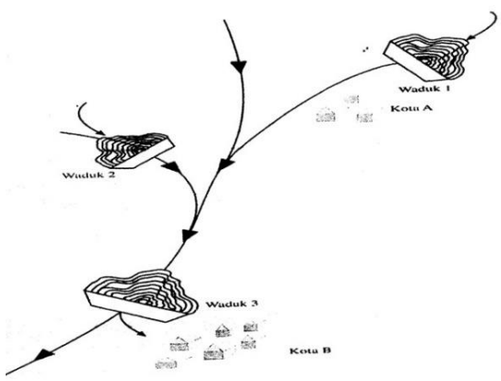

Fig. 2. Flood Control Reservoirs

b. Eco drainage consept

Eco drainage concept is managing the excess water by way it is naturally permeated or drain it into the river without exceeding the river capacity. Water seeps into this soil so that groundwater conservation takes place properly. As a result, it will reduce water runoff on the soil surface. In addition, the volume of surface water runoff is reduced so that the dimensions of the building structure of the drainage infrastructure are obtained more efficiently.

Eco drainage concept is an effort to prevent groundwater shortages in the future. In addition, this system can optimize the balance of natural systems in the form of groundwater conservation by raising groundwater reserves. This environmentally sound form of drainage can take the form of retesi ponds, infiltration buildings, infiltration wells, or on a medium scale, called Embung. This environmentally sound drainage system has many benefits [4], including:

1) suppress the intrusion of seawater in coastal areas,
2) reduce the dimensions of the drainage channel,
3) reduce flooding downstream,
4) lower the concentration of groundwater pollution,
5) maintain a high groundwater level
6) prevent land subsidence,
7) increasing the role of society in the development
8) preserving traditional technology

This Embung has been built around Yogyakarta with various uses, namely:

1) Embung Nglanggeran, Patuk Gunungkidul
2) Emnung Kleco, Girimulyo Kulon Progo
3) Embung Langensari, Gondokusuman Yogyakarta
4) Embung Kaliaji, Turi Sleman
5) Embung Banjaroya, Kalibawang, Kulon Progo
6) Embung Lampeyan, Cebongan Sleman
7) Embung Tegaltirto, Berbah Sleman,
8) Embung Tambakboyo, Condong Catur Sleman
9) Embung Batara Sriten, Gunungkidul
10) Embung Serut Sukunan, Gamping, Sleman

3. CONCLUSION

Flooding is a disaster that must be solved to reduce its wider impact. The wedge load is reduced by improving integrated inter-and intra-regional management to reduce problems in each region. It is necessary to increase development on a large scale, such as reservoirs dams, retention ponds, and Embung, eco drainage and build infiltration wells. These efforts aim to increase water infiltration into the soil, reduce surface water runoff, and increase groundwater reserves to conserve groundwater and increase groundwater reserves.

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