Title	Preparedness Effort toward Climate Change Adaptation in Upper Citarum River Basin, West Java, Indonesia
Author(s)	KUSUMA, M.Syahril Badri, KUNTORO, Arno Adi, SILASARI, Rasmiaditya
Citation	Society for Social Management Systems Internet Journal
Date of issue	2011-09
URL	http://hdl.handle.net/10173/855
Rights	
Text version	publisher

Preparedness Effort toward Climate Change Adaptation in Upper Citarum River Basin, West Java, Indonesia

M.Syahril Badri KUSUMA* Arno Adi KUNTORO*, Rasmiaditya SILASARI*
Bandung Institute of Technology*

***ABSTRACT*:**
Citarum River Basin is one of the strategic Basins in West Java. Citarum River flows from the mountainous area in Bandung, through the three cascade dams: Saguling, Cirata, and Jatiluhur, before finally flows to Java Sea. Surface water from Upper Citarum River Basin is a plateau area surrounded by mountain range which forms a basin which flows into Saguling Dam. This geographical condition causes the rainfall runoff on the mountain range tend to flow into the basin area, resulting in high discharge surface flow during wet season. The high discharge unfortunately is not accommodated with adequate channel capacity, which in this case is the Citarum River of Upstream Citarum River Basin. Consequently, during the rainy season, flood disaster often occurs around the Citarum River which flows through Bandung Regency. Heavy flood disaster in particular occurred in Dayeuh Kolot Subdistrict which brought great damages, due to the area is located adjacent to the Bandung City, the capital city where many important activities occur. As the main catchment area of Saguling Dam, this basin also holds an important role for water supply in the downstream area. Lack of water supply from Upper Citarum River Basin during dry season might disturb water supply for irrigation area in Karawang and Indramayu. Climate Change Mitigation which in Indonesia mainly associated with flood in wet season and drought in dry season has to deals with common problems, for example: 1) lack of hydrological data; 2) high discrepancy in hydrology/drainage computation result using the common computation method; 3) unreliable design of drainage facilities, etc., and his study emphasizes the importance of solving those kinds of problems for Climate Change Mitigation in the future, especially in Citarum River Basin

KEYWORDS: climate change adaptation, Citarum River Basin

1. INTRODUCTION

Upper part of upper Citarum River consist of 13 rivers such as Citarum Hulu, Citarik, Cikeruh, Cikapundung, Cisangkuy, Cipamokolan, Cidurian, Cicadas, Citepus, Cisangkuy, Cibolerang, Ciwidey and Cibereum River, which flows from mountaineaus and hilly area to flat area. Each of these tributaries has sub-basin which forms the entire Upper Citarum River Basin, covering total area of 1.771 km^2. Study location is shown in Figure 1**.**The meeting point of these tributaries and its main river form bottle neck for its flow as it is located in its flat area. That is why its flat area generate natural flood plain area for its river basin. This natural flood plain cover Bandung City and Bandung Regency where Rancaekek, Sapan, Baleendah and Dayeuh Kolot Subdistrict are located. The downstream of upper

citarum river consist of hilly area which provide a very potential area for reservoir development. It is in this part three multy purpose cascade reservoir such as Saguling, Cirata and Jatiluhur have been constructed to optimize the use of Upper Citarum River discherge. The purposes of thes three cascade reservoir are irrigation, fresh water, hydropower and flood control.

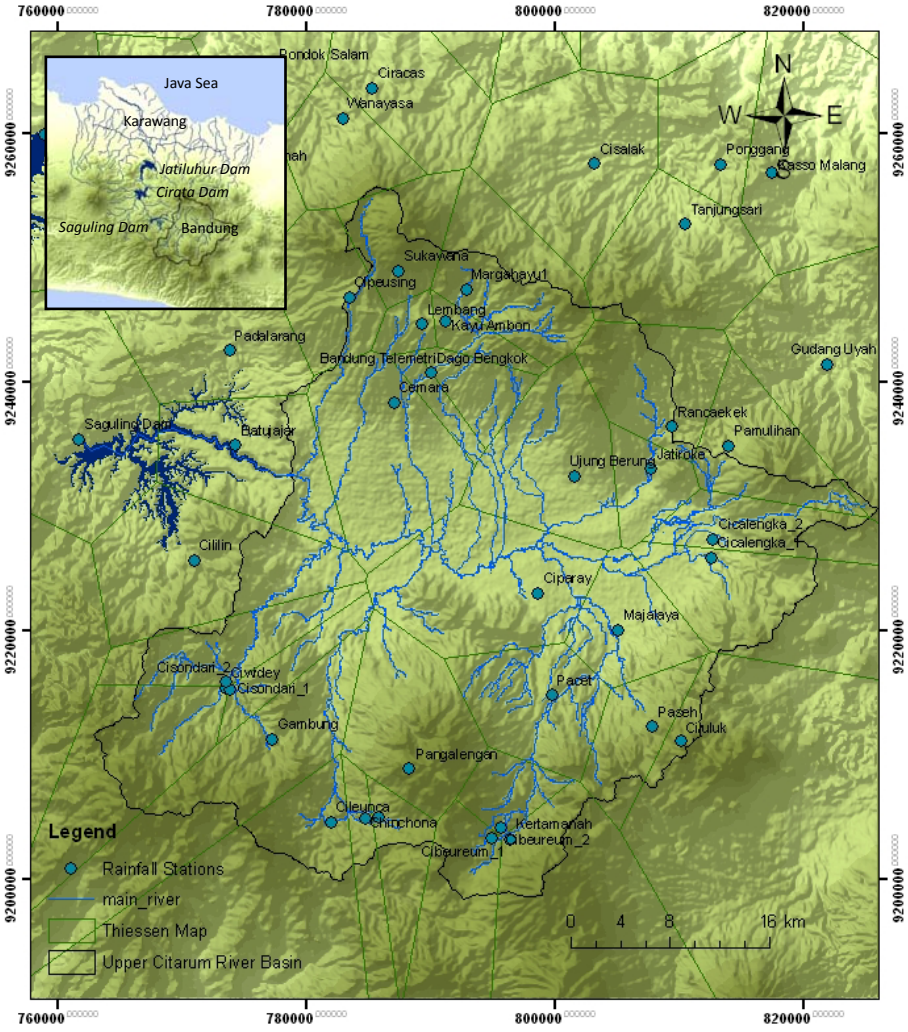

Figure 1 Citarum River Basin

Flood usually occurs in the meeting point of main Upper Citarum River and its tributary. The river path in these meeting point are perpendicular due to its flow regime which is at least critical flow. This critical flow regime generated by steep topography of Bandung Regency which ranges from 0.5% - 1.5% (Institut Teknologi Bandung, 2009). This perpendicular meeting point will delay the rainfall runoff flow from tributary, increasing the flow water level which leads to overflow.

Overflow of the Citarum River in Dayeuh Kolot Subdistrict is caused by the discharge load which cannot be accommodated by channel capacity. This high discharge comes from rainfall runoff of various sub-basins of Upstream Citarum River Basin which enter the Citarum River. Inundation in Dayeuh Kolot Subdistrict is hard to be drained because of its lowland condition. This inundation would bring mud and damage properties which bring great losses to the citizen.

Upper Citarum River Basin provides large amount of water for the three cascade dams. Data from Perum Jasa Tirta II as the operator of Jatuluhur Dam shows that the average inflow to Saguling

Reservoir in 2010 was 85.6m^3/s, while inflow to Cirata and Jatiluhur Reservoirs were 161.2m^3/s and 174.1m^3/s, respectively. With total contribution nearly 49% of the total water inflow to Jatiluhur, Upper Citarum River Basin plays an important role in maintaining water supply for drinking water of the Capital City of Indonesia (Jakarta) and the most developed industrial area of Indonesia (Bekasi, Kerawang and Cikarang). Prolonged drought in Upper Citarum River Basin will decreasing water supply to those area that might potentially suffering national economic activities in Indonesia.

One of the dominant land cover in Upper Citarum River Basin is plantation area. Due to the effect of climate change, a long dry years usually followed by a more intense wet years with intense heavy rainfall. This condition might result in increase of land erosion in the upstream of the catchment which later transported into the downstream, resulted in decrease the capacity of the river and drainage channel.

2. METHODOLOGY

This study describes the current condition of Upper Citarum River Basin from rainfall-runoff point of view, followed by the analysis on the progress of preparedness effort toward Climate Change Adaptation in Upper Citarum River Basin from two main factors: 1) hydrological data availability, 2) high discrepancy in hydrology/drainage computation result using the common computation method; and 3) inadequate of water infrastructure

3. CURRENT CONDITION OF CITARUM RIVER BASIN

3.1 Rainfall runoff characteristic in Citarum River Basin

Rivers in upper Citarum River Basin flow into Saguling Dam. To analyze rainfall and discharge variability in Upper Citarum River Basin, discharge stations in Nanjung which is located near the inlet of Saguling Dam is compared with rainfall area in upper CRB computed based on the generated thiessen map as shown in Figure 1. Monthly data comparison between rainfall and discharge from 1997, 1999, 2001, 2003, 2005, 2007 and 2009 are shown in **Figure 2**

Figure 2 show that in general, monthly rainfall seems to have a strong correlation with monthly discharge which indicates the typical of runoff in developed area with high variation between wet and dry season and relatively low base flow. Further analysis also shows that the average rainfall and discharge during wet season tends to increase, while the average of rainfall and discharge during dry season tends to decrease. Trend of rainfall and discharge in Upper Citarum River Basin is shown in Figure 3.

3.2 Hydrological data availability

The needs for hydrological data are highly affected by the development stage and typical activities in the region. In a highly populated urban area hydrology measurements mostly focused to support design of drainage facilities and flood prevention. In rural area, hydrology measurement might be focused to another aspect such as for irrigation water management. Before 1990s, most hydrological measurements in Indonesia were managed by Central Government under the Geophysics and Meteorological Agency and Department of Public Works.

After reformation area in 1998, the policy for decentralization was implemented so that the authority for hydrology measurements was distributed into several different agencies with different purposes and requirements. In Citarum River Basin, rainfall measurement mainly conducted by BBWSC (Balai Besar Wilayah Sungai Citarum), DPSDA (Dinas Pengembangan Sumber Daya Air),

BMKG (Badan Meteorologi, Klimatologi dan Geofisika), Perum Jasa Tirta II (PJT-II) as the operator of Jatiluhur Dam, PJB as the operator of Cirata Dam, and Indonesia Power as the operator of Saguling Dam.

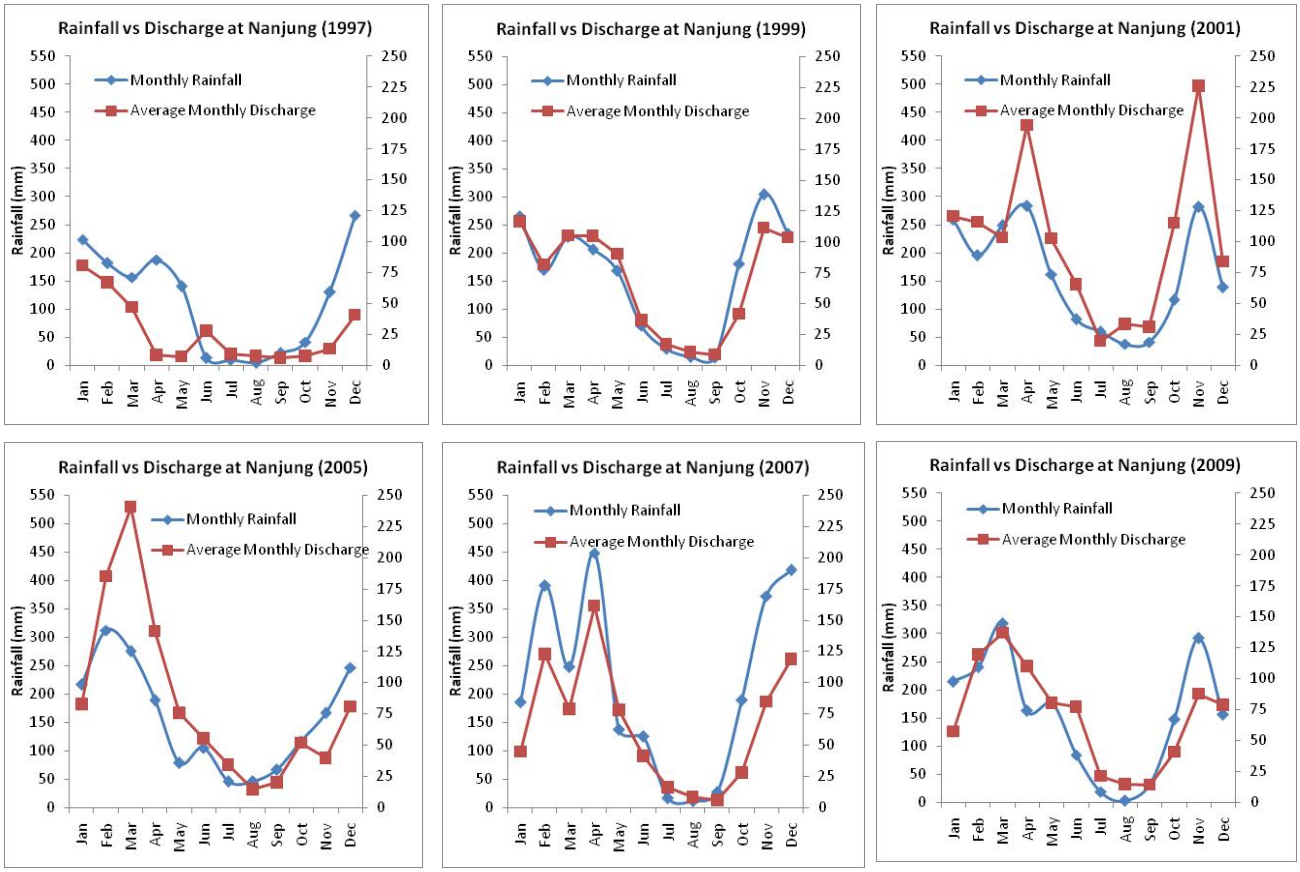

Figure 2 Rainfall runoff characteristic in Upper Citarum River Basin

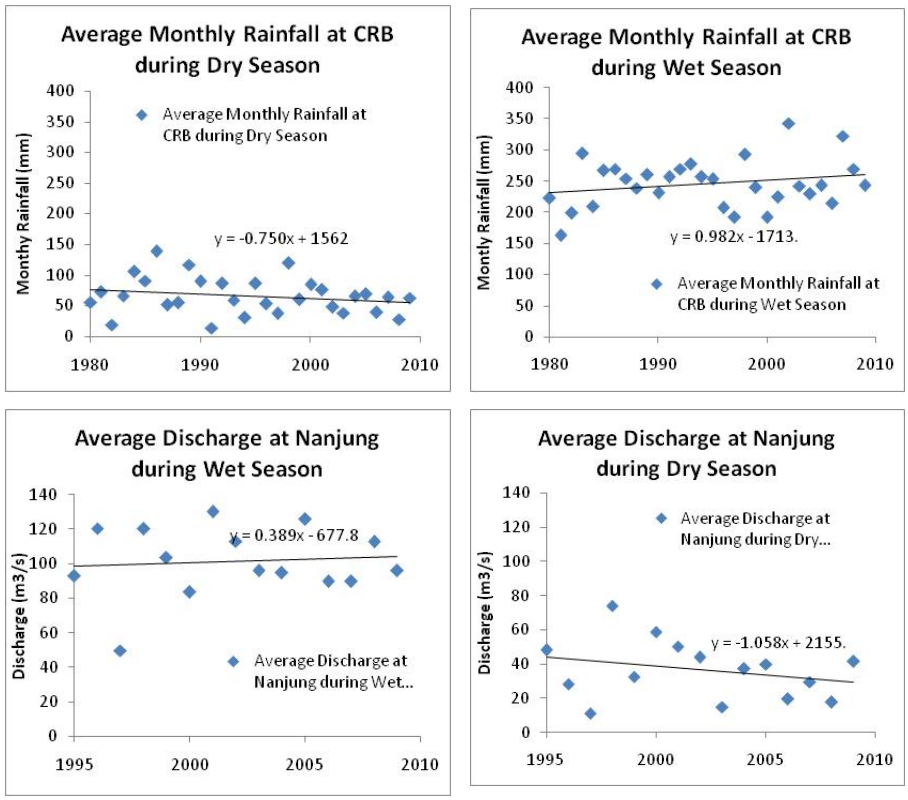

Figure 3 Trend of rainfall and discharge in Upper Citarum River Basin

Analysis from 376 rainfall stations in Citarum River Basin from different data sources for the period of 1980-2008 shows that: 1) Only 26 stations (6.9% of the total rainfall stations) consist of very good data record with data availability more than 90%; 2) 142 stations (37.8% of the total rainfall stations) consist of relatively good data records with data availability more 70%; 3) 192 stations (51.2% of the total rainfall stations) consist of data records with data availability less than 50%. Histogram of rainfall data availability in Citarum River Basin is shown in **Figure 2.**

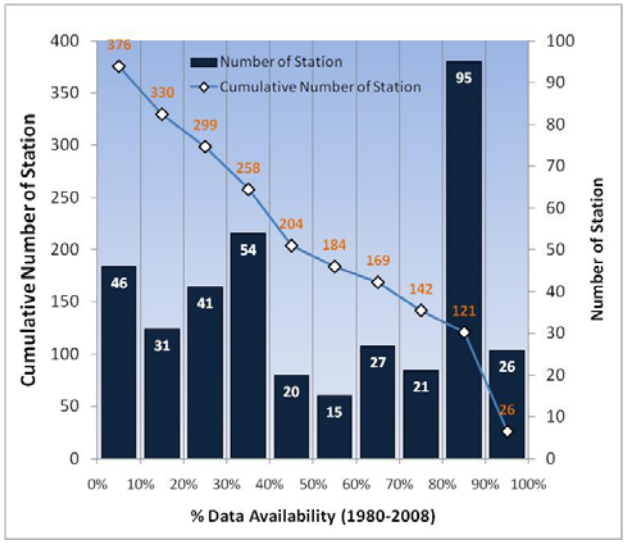

Figure 4 Rainfall data availability in Citarum River Basin

At Upper Citarum River Basin, there are only about 30 stations with relatively good data records are found. The location of rainfall stations in Upper Citarum River Basin is already shown in Figure 1.

From technical point of view, a good rainfall station network is needed to construct a series of high accuracy hydrology data. A good and long time series of rainfall from sufficient number of stations to cover rainfall variability in the region is needed to obtain a reliable result for drainage design, flood mitigation, and also for future climate change mitigation. However, the current condition shows that rainfall data availability in Citarum River Basin is still far from the ideal conditions.

3.3 Hydrology computation method

Most of hydrological computation/method for drainage/flood analysis used in Indonesia was derived in other countries, such as United States (e.g.: SCS Unit Hydrograph) and Japan (e.g.: Nakayasu Hydrograph). Only few method were derived based on the actual local/regional conditions in Indonesia. This condition might result in discrepancy between computation result and the actual field condition. Example of data plot of flood hydrograph based on case study of Nanjung is shown in Figure 5.

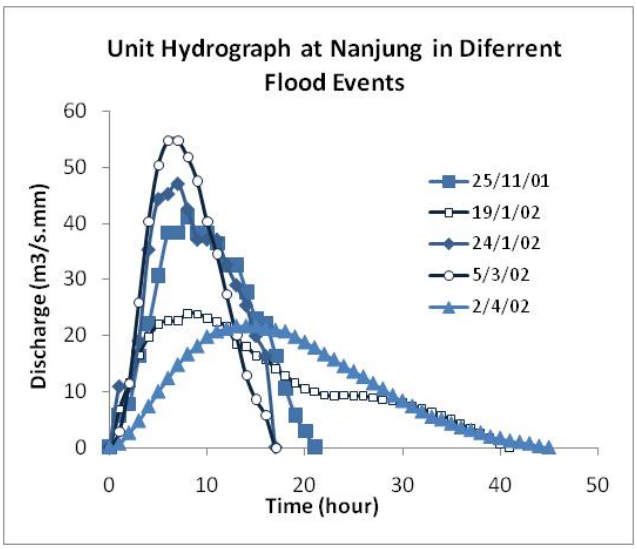

Figure 5 Computation Result of Flood Hydrograph at Nanjung by using Unit Hydrograph Method

Figure 5 shows that different flood event have different shape of hydrograph. Therefore, hydrology computation should be able to represent discharge variability in terms of peak discharge and time. However, the use of common hydrology computation method sometimes shows a high discrepancy with the data as shown in the example case in Figure 6.

3.4 Inadequate of water infrastructure

In previous time, water infrastructure in the

downstream of Jatiluhur mainly developed to support irrigation system.

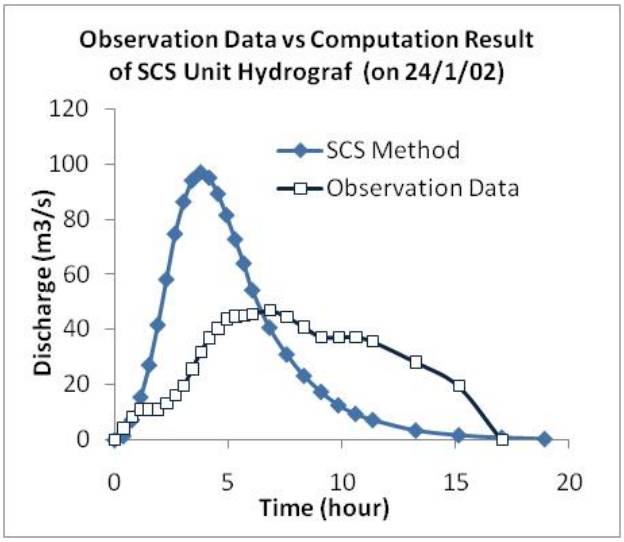

Figure 6 Example comparison between observation data and computation result (Ariani, 2010)

However, rapid land use change during the last decades has resulted in decrease of irrigation area and increase of urban/developed area. Although water demand for irrigation area tends to decrease as affected by land use change, irrigation infrastructures are still in the same dimension. This aspect might result in decrease of water supply efficiency especially during dry season.

4. CONCLUSION

Upper Citarum River Basin tend to have higher discharge in wet season and lower discharge in dry season in recent year compared to 10 to 15 years ago. However, this condition is not only affected by anthropogenic factor such as land cover change and other type of urban area development, but also affected by changes in climate conditions. Plot of rainfall data also shows that average monthly rainfall data in wet season tends to increase, while average monthly rainfall data in dry season tends to decrease.

Based on current condition of hydrological data availability and commonly used hydrological computational method in Indonesia, it seems that preparedness of Upper Citarum River Basin on Climate Change Mitigation still far from ideal conditions. For future Climate Change Mitigation in Upper Citarum River Basin which might be caused by natural, anthropogenic, and combination between the two causes, further improvement in data acquisition, data sharing, management, together with development of more reliable hydrological method still need to be conducted.

REFERENCES

Ariani, 2010, *Evaluation Study of Unit Hydrograph Method in Three River of Java Island, Indonesia*, Desertation of PhD, ITB

BBWS Citarum, 2009, *Flood Management in Bandung Basin*, Kompas Seminar, Bandung, 19 Februari.

Institut Teknologi Bandung, et. al., 2009, *Flood Control Concept in Upper Citarum Area*, Kompas Seminar, Bandung, 19 Feb.

Dance k, M. Syahril B.K., M. Farid and M. Bagus, 2007, *Two Dimension Mathematical model of Rainfall-Runoff Based on Finite Diffirent Method*, Proc. ITB Sains & Tek. Vol.39A No.1 & 2, p 97-123.

Koike T., 2010, *White paper of Climate Change Adaptation Scenario*, University of Tokyo, AWCI.

Kusuma, MS Badri and and Karhana, Hadi, 2009, *The Development of A Distributed Runoff Model for Flood Warning*, Report of Research Grant of Asahi Glass Fondation.

Kusuma, M.S Badri, M. Bagus, M. Farid, Iwan K and M. Cahyono, 2008, *Mathematical Model of Over Land Flow Due to The Flood Propagation*, Report of

Graduate Program Grant from Directorate of Higher Education.

Kusuma, M.S Badri, 2008, *The Development of Flood Control System in Jakarta*, International Conferences on Social Management System (SMS) 2008, Kochi University, Kochi, Japan.

Kusuma, M.S Badri, 2007, *Water Resources Infrastructure Management in Indonesia*, Proceeding of National Conferences on Infrastructur, Organized by UI-ITB-UGM, Jakarta.

Kusuma, M.S Badri, Iwan dan Rommy, 2007, *Evaluation Study of the Reservoir performance for flood control in Central Jakarta based on Mathematical Model*, JTS ITB, Vol 14 No 4.

Rahayu H, Kusuma, M.S Badri, M. Bagus and M. Farid, 2008, *The development of Flood Risk Assessment Map in Sub-sub District of Bukit Duri and Kebon Baru of Jakarta City*, Report of PROMISE (Program for Hydro-Meteorological Risk Mitigation in Secondary Cities in Asia), LPPM-ADPC-USAID.

Silasari, R., et. al., 2009. *Development of A Flood Hazard Map for Jakarta Case Study: Kelurahan Kebon Baru, Tebet Sub District*, Final Project, Institut Teknologi Bandung.