IDENTIFICATION OF POTENTIAL EFFECT OF ILLEGAL RESIDENCE IN FLOODPLAIN AND SOCIO-ECONOMIC EFFORTS FOR SOLUTION ~a case study of ciliwung river basin~

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ABSTRACT

As a consequent of urbanization, Ciliwung floodplain has become the favorite place for disadvantaged people. The occupation of floodplain obviously narrowing river section and as the result Ciliwung River became unable to accommodate the water from its drainage area.
In order to set the Ciliwung floodplain free from illegal residence, it is necessary to relocate people to appropriate places. Nevertheless, this effort is still facing some problems. Many obstacles and protests come from the residents. Moreover, many residences that live in floodplains are reluctant to move to the apartment with a variety of reasons that eventually make them going back to the floodplain.
In order to give contribution and to promote solution about floodplain occupation by illegal residence, this study identified scientifically the potential effects of illegal residence in floodplain by using hydrological data comparison. Furthermore, to promote the socio-economic solutions, the efforts for reducing illegal residence that area related to socio-economic conditions are analyzed based on literature review.

Keywords: Floodplain, Ciliwung River Basin, Illegal Residence

INTRODUCTION

Objectives

1. Scientific identification of potential effects of illegal residence on flood by using hydrological data comparison; such as rainfall intensity, discharge and water level in Ciliwung Basin together with population, land use and occupied floodplain area data.
2. Systematic analysis of illegal residence reduction efforts related to socio-economic conditions based on a review of related literature in order to find the way of promoting solution in reducing the growth of illegal residence.

Background

In regard to land use change, common occupation of floodplain is considered having contribution to the potential increase of floods. As the impact of urbanization, Ciliwung floodplain becomes favorite place for disadvantaged people. The occupation of floodplain obviously narrowing river section and as the result Ciliwung River became unable to accommodate water drainages to this river. Analysis on the effect of floodplain occupation is still very limited. But it is considered important since it is usually closely related to settlement of people with poverty. Solution to this problem will be related to technical as well as socio-economic matters. From the point of view of disaster management, understanding on the qualitative and quantitative effects of floodplain occupation on the increase of flood events is indispensable to give appropriate direction on the proposal of solution. As a contribution to draw the knowledge about the above matters, this thesis would like to identify the effects of illegal residence in the floodplain to the flood potential.

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In order to set the Ciliwung floodplain free from illegal residence, it is necessary to relocate people to appropriate places. Relocating the people living in floodplains along the Ciliwung River is not an easy task and even brings other problems. Problems such as facilities, price, or flats allocation are accompanying regarding to this effort. Moreover, many residents that live in floodplains are reluctant to move to the apartment with a variety of reasons that eventually make them going back to the floodplain. Along with this, cause of fast growth of illegal residence will be discussed to find the way of promoting solution in reducing that problem.

STUDY AREA IDENTIFICATION

Ciliwung River is one of the rivers that crossing the provincial administrative region through the Province of West Java and Jakarta. This river comes from Telaga Warna Pangrango at the foot of Mount Pangrango in Puncak, Bogor, and flows northwards through the cities Bogor, Depok, Jakarta and the Jakarta Bay in the estuary. The Ciliwung river basin form is long and narrow. Ciliwung river length is approximately 119 km, with basin area of approximately 476.2 km^2 and is inhabited by approximately 3.5 million people. The upstream part is dominated by hilly and mountainous topography with slope gradient 16%. Upstream elevation is located between 370 meters to 3,010 meters above sea level. The elevation in the midstream is located between 51 meters to 370 meters above the sea surface water. While for downstream area is generally dominated by flat topography with a slope gradient from 0-2%. The elevation of downstream is located between 0 meters to 51 meters above sea level.

Fig. 1 Ciliwung Basin

According to the Manual Control of Space Utilization in Disaster Flood Prone Area, Directorate General of Spatial Planning Republic of Indonesia, the floodplains is land on the both side of river section along the riverbank which is measured from the river bank up to the inside of embankment toe.

Based on the Regulation of Public Works Minister No. 63 of 1993 concerning on Floodplain Line, River Utilizing Area, River Controlling Area, and Former River, function of flood plains is an area where some of river discharge can flow during the flood/high water/overflow. Accordingly, it is prohibit in the floodplains to throw trash/garbage and construct any buildings. Floodplain line of river that has embankment inside city area at least 3 m outside the embankment counted from the lower part of the embankment. This area is regulated zone. It is prohibit in this area to throw any waste; solid or liquid, and to construct permanent building for housing or business area.

Many of permanent building and simple rookery have filled floodplain along the left-right edge on Ciliwung River. Ironically, people got the permission and legal certificate to utilize Ciliwung floodplain (Pusdiklat PAP, 2007). Illegal residence occupation has reduced river effective capacity.

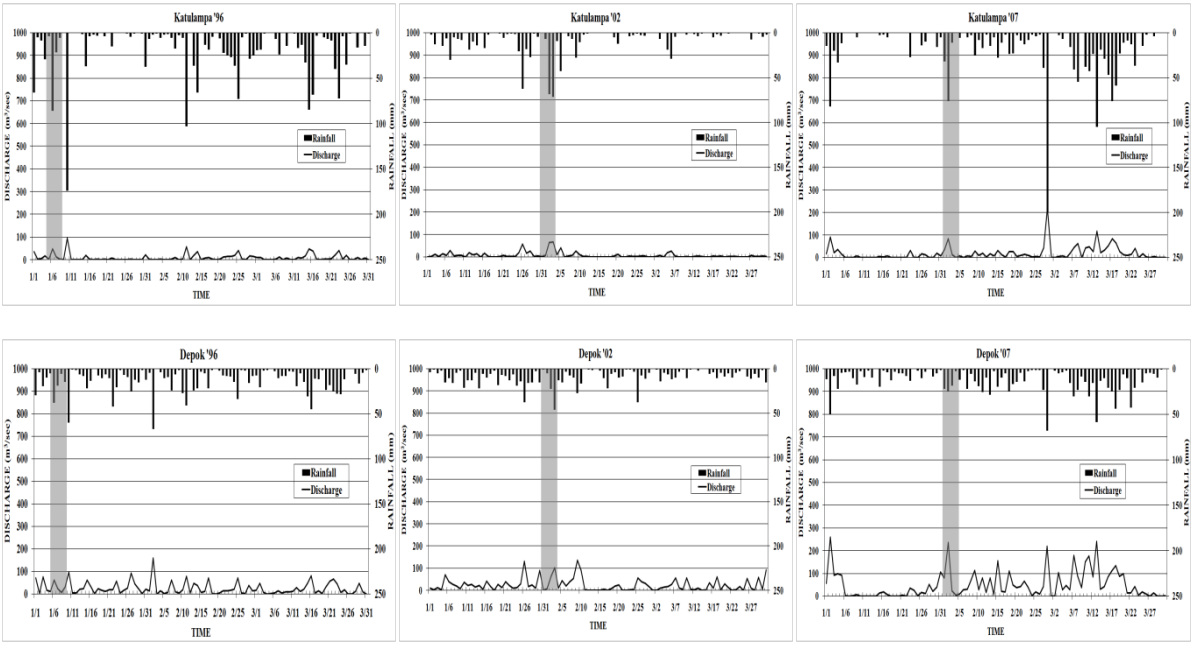
Ministry of Public Works together with Provincial Government of DKI Jakarta has carried out socio-economic efforts to solve the illegal residence in floodplain. One effort is people relocation to subsidized apartment. However, implementation of people relocation is not a simple effort. Illegal residents are reluctant to move to the new apartment due to reasonable objection. Economic factor become the basic issue.

DATA ANALYSIS

Based on census data, in the past decades the human population in Ciliwung Basin exploded from 6.4 million in 1971, 9.2 million in 1980 up to 12.3 million in 1990 and reached 13.8 million in 2000 (BPS, 2008). The city's need for additional residential space resulted in rampant housing and commercial developments as well in Bogor and Depok areas. Forests and paddy fields were quickly replaced by asphalt pavements and concrete buildings, herewith reducing the water retention capacity of the area. More rainwater is now diverted faster and directly to the nearest stream or river, thereby it may increase river peak flows and discharges.

Floods in Ciliwung basin usually occurred during January to March. The tendency of annual mean rainfall (mean catchment) from 1980 until 2007 in all sub-basin is not decreasing. Many discuss that Ciliwung floods are caused by the 'given flood' from upstream. However, the annual mean rainfalls in the upstream to downstream were actually decreasing. The tendency in those sub-basins represents that in fact there was no increasing rainfall of 'given flood' from the upstream although the highest monthly average rainfalls have occurred in the upstream.

As well as rainfall intensity, the highest discharges also occur during January-March in each stations and the lowest occur during June- August. Annually, the discharge has a tendency of increasing from 1980 to 2007. Rainfall and discharge have parallel associations, as the hydrological effect, when the rainfall intensity increases; the runoff discharge also tends to increase too. From this phenomenon it can be concluded that the floods in Ciliwung basin is not caused either by the increasing of annual rainfall and increasing discharge.



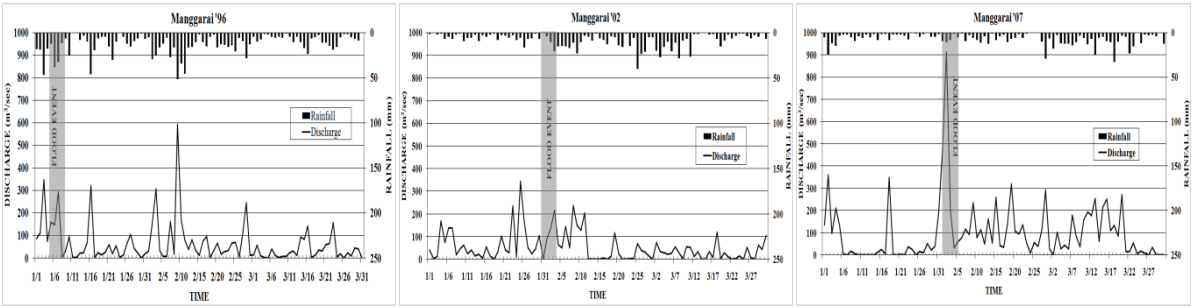


Fig. 2 Hydrograph in January - March 1996, 2002, 2007

Fig. 2 shows the change of mean catchment rainfall in Ciliwung Basin and discharge during the major flood events in 1996, 2002, and 2007. Simply analyze the hydrograph in Fig. 2 briefly shown that rainfall was decreased. The discharge in each station is increasing. The highest discharge was occurred in 2007 in each station. According to the flood history, the most severe flood was occurred in 2007. Fig. 2 shows that equivalent intensity of rainfalls sometimes cause floodings but sometimes not. In some cases higher discharges thatn those in flood events did not cause flooding. The factors that can be assumed are the possible effects of sea tide and effect of garbage accumulation at the trash rack in Manggarai Barrage. Here it is assumed that the sea tide were in normal level; there was no back water effect so that water could be drained to the sea during the high discharge. Also it is assumed that there was not high garbage accumulated in the thrash rack; when the high discharge occured garbage did not clog the water flow. Another phenomenon that found from the Fig. 2 is that after the flood events sometimes discharge was raised but there is no flood event recorded. It can be assumed that the floods washed away most of the illegal residences which occupied the floodplain. Then the river capacity returned to normal condition and during the following high discharge the floodplain could accommodate the flood water excess. To verify all the assumptions, it is necessary to collect all the data required such as sea level and garbage volume record in the next study.

Furthermore, analyses of changes of rainfall and discharge changes are explained in Fig. 3 about annual runoff ratio. The trend of runoff ratio is increasing from 1980 to 2007. The highest runoff ratio increment was found in Manggarai Barrage. Runoff ratio is comparison between discharge and rainfall. The increment of runoff ratio indicates the increase of discharge volume by rainfall. As mentioned before, the change of rainfall and discharge should be shown in a parallel relation. Increase of rainfall is in line with increase of discharge.

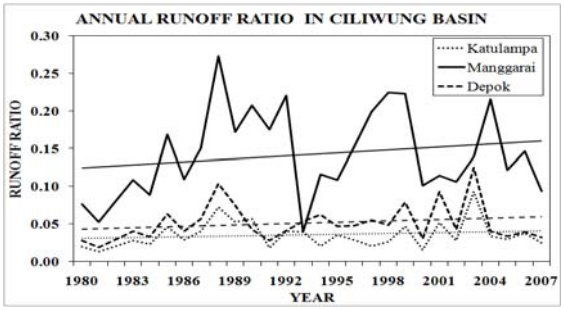


Fig. 3 Annual Runoff Ration in Ciliwung Basin

The left side of Fig. 4 shows the changes of land use (paved area) from 1990 to 2007. It is found that during the period of 10 years, from 1990 to 2000, the paved area increased from 27% (12,834 ha) to 40% (18,722 ha) of total Ciliwung Basin area (47,620 ha). Furthermore, by 2007, the paved area has increased rapidly to 92% of total basin area which means only 8% (3,338 ha) remaining open area in this basin. Right side of Fig. 4 shows the ratio of paved area in Ciliwung Basin in 1996, 2002 and 2007. To express the ratio of paved area in each sub-basin it is assumed that urbanization starts from the

downstream area to upstream area. The result shows that in 2007 almost whole area of downstream, Manggarai sub-basin, has been changed into paved area (0.9). As well as downstream, midstream and upstream area have also been changed into paved area, 0.8 and 0.7 respectively.

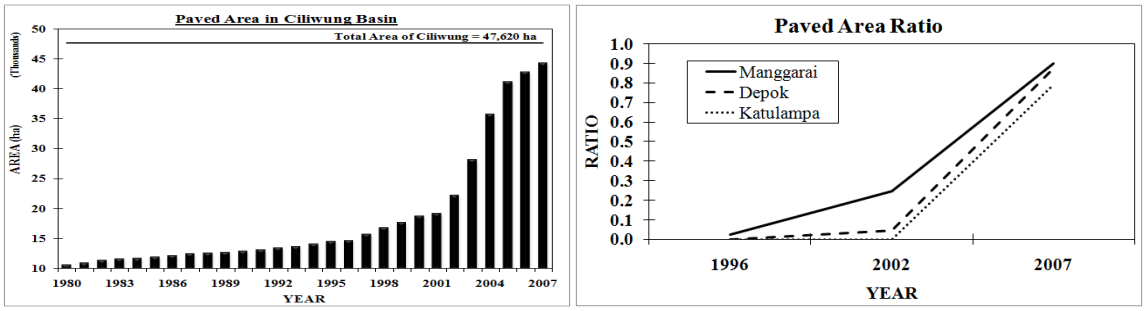


Fig. 4 Paved Area Changes and Paved Area Ratio in Ciliwung Basin

Land use change is a serious matter in Ciliwung Basin. The development of residential and business area has driven the farming and forest area in whole area of basin changed into paved area. The upstream areas, being the water absorbing areas, experienced a great deal of land use change, marked by a lot of constructions of housings. The change has enhanced the surface runoff instead of rain infiltration into the ground water as reflected in increasing of annual runoff ratio in Fig 3.

Water level data is the most important aspect to be considered in analyzing the potential effect of illegal residence to floods in this basin. Water level data can show the physical condition of river channel. The highest water level is in Manggarai Barrage. From 1996, 2002 and 2007, the water level in Manggarai Barrage is increasing from 970 cm, 1050 cm and 1061 cm. Meanwhile, either in Katulampa and Depok Weir, the water level in 2002 was lower than 1996, but in 2007 it showed considerable increase. From 1996 to 2007, the water level in each AWLR station has increased 16.8 cm in Katulampa, 56.9 cm in depok, and 91 cm in Manggarai. Accumulation of water from upstream and midstream together with narrowed river by illegal residences and also solid waste that piled up and clogged the gates in Manggarai Barrage may cause the water level in this section drastically higher than other barrage/weir.

The growth of floodplain occupation in Ciliwung Basin from 1983 to 2008 is fluctuating. In some years, like in 1996 and 2004, it is shown decreasing number due to river control works by local government. However these works are usually executed for short period of times, after that floodplain are fulfilled again by the illegal residences. In 2008 the Ciliwung floodplain area which are occupied by illegal residences reached 13.77 ha or 8% of total floodplain area. Moreover, about 9.317 ha of floodplain in Manggarai sub-basin is occupied.

Data Correlation

From Pearson Correlation calculation, land use and discharge have positive association, 13%. It means any changes of land use to paved area will affect to the changing of discharge.

Increase of occupied area in floodplain is associated with increase of water level. Pearson Method shown that the correlation between those data is 96.29 % associated. From this analysis, the flooplain occupation gives strong correlation to the increasing of water level in Manggarai Barrage. Floodplain occupation in Ciliwung River followed by other factors such as garbage accumulation, land subsidence,

sea tidal rising, etc, have given severe potential effect of flood in Ciliwung Basin, particularly in downstream area, Jakarta City. Thus the correlation result does not fully reflect the actual effect or relation between floodplain occupation and water level. The water level in Manggarai Barrage is not only influenced by illegal residence but probably by garbage accumulation in trash rack that installed in Manggarai Barrage. Therefore, for further investigation, the data of water level in upstream area of illegal residence and also the garbage volume and characteristic in the barrage are required.

Compound Channel Equation/Ida Method (Ida, 1960), briefly explained the correlation between floodplain area and water level. Ida explained that the peak discharge in one section of channel is equal to the accumulation of discharge in main channel (mc) with discharge in both sides of floodplain. The Ida's Method can be expressed as:

$$Q = 2\frac{A_{fp}}{n_{fp}}\left(\frac{A_{fp}}{S_{fp}}\right)^{2/3} \cdot {I_b}^{1/2} + \frac{A_{mc}}{n_{mc}}\left(\frac{A_{mc}}{S_{mc}}\right)^{2/3} \cdot {I_b}^{1/2}$$

Where: Q is discharge, A_{fp} is floodplain area, n_{fp} is floodplain roughness coefficient, S_{fp} is wetted perimeter floodplain, I_b is slope of bed channel, A_{mc} is main channel area, n_{mc} is main channel roughness coefficient, and S_{mc} is main channel wetted perimeter. Ida's equation can be derived as:

$$h_{fp} = \left[\frac{1}{2} \cdot \left(\frac{n_{fp} \cdot Q_t}{B_{fp} \cdot {I_b}^{1/2}} - \frac{n_{fp} \cdot B_{mc} \cdot {h_{mc}}^{5/3}}{B_{fp} \cdot n_{mc}}\right)\right]^{3/5}$$

By using the last formula, water level in floodplain (h_{fp}) can be identified. The water level changes will be explained by two different scenarios, by changing the floodplain width and by changing the roughness coefficient. There are some assuming parameters data, such as type of channel will be considered as lined or built-up channels. The wall made from concrete bottom float finished with sides of cement rubble masonry has roughness coefficient (n_{mc}) 0.03 in maximum condition. Floodplain is considered as the one with heavy timber, a few down trees, little undergrowth, flood stage below branches and its roughness coefficient (n_{fp}) is 0.120 in maximum condition. The slope of bed channel (I_b) is 0.01. Main channel depth (h_{mc}) is considered as 50 cm. Main channel width (B_{mc}) is assumed to be 30 m and floodplain width (B_{fp}) 15 m. The peak discharge is considered to be the one at Manggarai Barrage in 2002, namely 655 m^3/sec. From those scenarios can be identified that the changing of floodplain width by construct the concrete wall in the floodplain give big effect to the changing of water level in floodplain.

According to literature review from many sources, some problem of illegal resident relocation can be analyzed. The first matter is land price compensation. Illegal resident rejected to move from floodplain due to unequal compensation from the government so that they unable to construct a new housing in the new appropriate places. Other problem is rent fee system. Most of illegal residents who live in Ciliwung floodplain, particularly in Manggarai sub-basin, have no permanent jobs. Sometimes they have money but sometimes not. They cannot purchase or rent an appropriate house in a safe area. Further issues in management of apartment are human and healthy aspect and apartments facilities. The issue has been raised is one flat of apartment are allocated for two or three households. Considering humanity and healthy aspect, this situation is reprehensible. The basic facility such as electricity and clean water on the apartment becomes another problem that has arisen from the residents in apartment. Those facilities are not working properly.

CONCLUSIONS

1. The main cause of flood problem in Ciliwung River Basin is not because the increasing of rainfall.
2. The unusual phenomenon of decreasing rainfall and increasing discharge has indicated that land use in Ciliwung Basin has been changed significantly to the paved area that reduce the land infiltration.
3. From 1980 until 2007, land use in Ciliwung Basin has been changed significantly. The correlation analysis between the land use change into paved area and the increase of discharge gives 13% association. The paved area ratio has explained that the land use changed into paved area in whole sub-basin changed rapidly.
4. Water levels in the major flood events in 1996 to 2007 have been rising.
5. The correlation analysis of illegal residence to water level gives 96.29 % association.
6. From literatures review it can be concluded that the socio-economic problems of illegal relocation are the unequal compensation and the apartment management problems, such as the rental fee system and inadequate facilities. The recommendations for illegal residence relocation problem related to socio-economic efforts are law enforcement, periodic river control and monitoring, proper compensation, daily rental fee system, appropriate facilities installation.

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