Policy evaluation of runoff, erosion and flooding to drainage system in Property Depok City, Indonesia

W Wihaji$^{1,2}$, R Achmad$^1$ and N Nadiroh$^1$

$^1$Universitas Negeri Jakarta, Jakarta, 13220, Indonesia

E-mail: wihaji2018@gmail.com

Abstract. Depok City is one of the capital cities in Jakarta and has a very large population. This resulted in the lack of green open spaces due to the transfer of the function of land use into settlements. This eventually results in excess surface water runoff during the rainy season and reduction on groundwater reserves during the dry season. At present, it still applies the conventional drainage system, so the potential flood becomes high because dimension of drainage channel is too small to manage rain water well and avoid flood disaster. The aim of this research is to study policy evaluation of runoff, erosion and flooding to drainage system in property Depok City, Indonesia. The result of the research shows that the public perception about the runoff, erosion and flooding policy evaluation property in the framework of green property which is passably with 42.4% is good. The research on the evaluation of the property policy obtained information that the runoff process on the property construction is stated quite influential on the change of structure of the soil and flooding.

1. Introduction

The current decade, rapid human development causes the population in a region to become uncontrolled resulting in a lack of green open space due to the large number of residential, office, and property and housing areas [1-3]. The high level of property development in Depok City caused disruption of ecosystem and land use in the residential area. It can be seen that the existing housing used a lot of land in the form of swamps. But by the marsh property developers in the dungeon get into a property building site, the swamp ecosystem and land use are directly or indirectly being destroyed. Land use should consider the environment. Environment is to maintain the overall quality of life; to maintain continuing access to natural resources; to avoid lasting environmental damage; to consider as sustainable a development that meets the needs of the present [2]. Similarly, space, especially cities in Indonesia is still seen only limitation to meet development growth and tends to make efforts to achieve economic growth targets, or to meet the needs of the development of a particular region. The orientation of such a Town arrangement does not take into consideration the purpose of the arrangement and the use of the space in accordance with its designation. It should be conceptually that the spatial plan is conceptualized as an integrated plan integrated with analysing all aspects and factors of development and development of the City in an integrated sequence in the form of policy descriptions and steps that are fundamental in complete with data and use space map.

One of the spatial map functions of land use for properties previously only used to know rainwater catchment areas is now evolving to describe groundwater reserves. Water contamination by human behaviour that discharges waste into waterways such as streams causes water flow in the channel to become blocked and during rainfall the channel will overflow to the lower area. As a result, the area is
flooded because the existing drainage cannot accommodate the water discharge. Urban areas that do not have enough green open space as it will be affected by floods if no action is followed, plus an property of Indonesian residential property which on average has an average increase of 9 % / year [4].

Flood is a very popular word in Indonesia, especially in Depok City in the rainy season, considering almost all cities in Indonesia are experiencing flooding. The problem of urban flooding is caused by land use that is inconsistent with the prevailing rules and small drainage measures. In the discussion of further property drainage will be focused on prevention of flooding of a city that is always a question of everyone. Therefore, knowing the characteristics of a city is necessary. Geographically Sawangan District, Depok City, West Java, Indonesia located at latitude LS 6° 22’21 BT 106° 49’39 makes it become one of the flood subscriptions due to the number of property development, so a good drainage system is needed. The need for research on public has an influence on runoff and flooding control.

The good drainage system can prevent flooding in an urban area during the rainy season and keep the groundwater reserves in the dry season. Proper management of good overflow rainfall can turn that into something more useful like water resources for the city. It is one of the largest metropolitan cities in West Java and also the city capital of Jakarta. Depok City has an area of 200.29 km² with a population of 1.87 million and population density 13,522 / km². This, of course, increases land change, as evidenced by the widespread use of land for urban activities (housing, and property). Reduced open land used for the property certainly raises the potential for high runoff, now most of the drainage system used is still conventional. This is reflected from the existence of 60 points of flood [5].

The expansion of an area can reduce the amount of rainwater that can be absorbed into the soil [6] and it should be immediately followed up to prevent flooding. At present, surface water runoff from hardened areas such as parking lots, industrial estates, office areas and highways is simply discharged into ditches before finally flowing into the river. If very heavy rainfall drainage cannot accommodate runoff and cause flooding [7,8]. The drainage system regulates rainwater that falls in a watershed area by resembling what happens naturally and environmentally friendly. This system prevents many problems from surface water runoff by reducing the impact of excess water flow quantities. Other benefits of this system are: (1) Provide environmental stability by maintaining water quantity and quality [9]. (2) Reduce erosion by controlling the frequency and volume of surface runoff [6]. (3) A good drainage system is able to control pollutant waste so that pollutants waste does not absorb the soil k directly. (4) Increase the reserve capacity of water resources.

However, there has been no research on the drainage system in terms of the green property. So it is necessary to do research about policy evaluation of runoff, erosion and flooding to drainage system in property Depok City, Indonesia.

2. Policy evaluation of runoff, erosion and flooding to drainage system

In general, to control surface runoff, flood control agencies have constructed large centralized facilities, such as culverts, detention basins and sometimes re-engineered natural hydrologic features, including the paving of city river channels to quickly convey runoff to receiving water bodies. These large-scale facilities are required to handle the massive amounts of runoff generated by the largest storm events, as it would be impractical to handle this runoff on a decentralized parcel-by-parcel basis with small-scale infiltration devices. The current trend is toward a more overall integrated approach to manage runoff as an integrated system of preventive and control practices to accomplish runoff and flooding management goals [10].

The management environmental aspect is not independent but closely related to the other two aspects. In industrial estates (property), the opportunity to integrate two aspects of the environment and economic aspects is enormous. It depends on how to manage the environment wisely and profitably. Social factors that mostly concern the community around or outside are closely related to Environmental Impact Assessment (EIA) [11]. The problem of environmental degradation over the years has been increasing in all areas, marked by climate change, an increase in airspace, and disruption of ecosystems due to the declining biodiversity of flora and fauna, including various social
problems inflicted.

The adaptive strategies are needed to manage the uncertainty of future development that is primarily shaped by climate change [12] or rapid urbanization. The strategies Drainage Systems (DS) are increasingly considered as the right strategy for managing storm water in cities because of their adaptive or multifunctional nature [13]. These measures drain water in a natural way using infiltration, retention and storage devices in urban areas [1]. They consist of source control structures (mostly vegetated) such as swales, underground storage, permeable sidewalks or green roofs, with limited capacity and certain design thresholds. Particular attention is the control of overflow currents in case of a hurricane that goes beyond DS capacity. Excess flow from the drainage system can be diverted to the surface or road to multipurpose areas (e.g. parks or green open spaces). So there is no wasted water flow [1, 13].

Surface water runoff management should be done from the smallest scale such as residential or so called source control and then proceed to larger scale such as area or so-called site control and regional control. This runoff management can reduce the potential for flood disaster in the upstream area because the downstream water runoff has been managed previously and multiply the ground water reserves [14]. Determining the scale of this runoff system can also facilitate the maintenance of each method.

Continuous drainage system methods that have been applied in countries can be grouped into two types of rainwater retention facilities, namely storage type and impregnation type. Both of these runoff water retention facilities also serve as a provider of water reserves for an environment. Both types of water retaining facilities must be interconnected with each other, so that falling rainwater can be managed and utilized properly so as not to be wasted and become surface runoff.

![Figure 1](https://www3.epa.gov/caddis/ssr_urb_is1.html)

**Figure 1.** The difference between the natural ground cover and various types of impervious surfaces in property. The impervious surfaces increase surface water runoff (https://www3.epa.gov/caddis/ssr_urb_is1.html).

Based on figure 1, developer’s property and housing must build a self-contained waste management site early on. The difference between the natural ground cover and various types of impervious surfaces is in property and housing. The rising waterproof surfaces alter the hydrological cycle and create conditions that can no longer support the diversity of life. The problems faced by the drainage system are flooding, river bank erosion and export of pollutants. Improving the quality of runoff water entering the receiving water and reducing the pressure on the existing water supply system is thus the main objective of water management in property.

The impervious surfaces increase surface water runoff. Green property has the following criteria is the first is obedient to the pro-environment policy. The second criterion is that settlement building must implement waste management system and minimum zero waste so that waste disposed to landfills is very small. The third criterion is that settlements have a system of control and water management that allows 30 percent of the rain water to be absorbed into the soil. The fourth criterion is green infrastructure [2]. The construction of infrastructure networks supports the development of
green settlements, such as the use of water-absorbing materials, the provision of pedestrian paths, shade, safe, and safe for children or the elderly. The fifth is the green transport criteria. Thus, Developers must provide a parking lot, carpooling and a convenient and strategic stop that invites people to travel without using private vehicles. The criterion is a green building property is (1) Building volume is maintained so that the cost of development, (2) Operation and maintenance is kept under control and more efficient [3].

The maintenance for control and more efficiency for work are urgent in environmental assessment. The characteristic environmental Depok city has an area of 200.29 km² or 20000 ha. The climate of the city is influenced by the humid and cool climate of the mountains. By 2017 the average temperature is 32.4°C, the monthly average rainfall is 209.23 mm and the average number of rain days is 16 days per month. Depok City currently still uses conventional drainage system, which delivers surface water runoff as soon as possible to the drainage channel. But this system is not supported by the dimension and capacity of the drainage channel, so that when there is heavy rain for 1 to 2 hours, the drainage channel in the city is unable to accommodate the amount of discharge and finally break down, especially it have applied a method of drainage system that is bio Pori and absorption well. Both of these methods are considered to be quite successful in managing surface water runoff so as not to be directly channelled to the main drainage channel. Selection of drainage system method is needed in order to realize the green property. With reference to the method of drainage system that has been widely applied in developed countries, it is suggested it can implement the drainage system in order to reduce the potential flood disaster.

3. Method

While the evaluation model of policy is implemented on the framework of Grindle Model [4,6], that policy implement is influenced by content variable and contexts of policy which consist of strategy Planning, Organizing, Actuating, and Controlling in order to achieve Green Property. In accordance with the research objectives and evaluation model of the selected program, the research design is set within the framework of thinking as follows:

4. Results and discussion

Land clearing, cutting and confinement of the soil at the construction stage will lead to changes in the structure and nature of the soil, for example, the soil surface becomes open, the soil great is destroyed and makes the soil sensitive to erosion. The soil compaction activity at the construction stage also causes water to not penetrate into the soil, thus increasing the volume of runoff. This will continue until the operational phase, so when the initiator does not have careful planning on the drainage channel network and good local flood prevention efforts then the flood disaster will occur. After knowing what methods of drainage systems in developed countries and methods developed in Indonesia, especially in Depok City, it can be compared in terms of area, shelter volume, pollution, workmanship, maintenance and cost of the method of drainage system as presented in table 1.

| Comparison          | Developed countries                  | Indonesia                                      |
|---------------------|--------------------------------------|------------------------------------------------|
| Area                | Requires a large place               | The dimensions of the cross-section are small so they are not requires a large place |
| Volume of Shelter   | Can accommodate a large volume of surface water runoff | Can only accommodate small surface water runoff volumes |
|Filtering pollutant | Can filter pollutants in surface water runoff | Unable to filter pollutants in surface water runoff |
| How to work         | Workmanship is quite difficult       | Easy workmanship                               |
| Maintenance         | Requires regular maintenance         | Requires regular maintenance                   |
The cost of manufacture is quite expensive. The cost of manufacture is economical.

Based on table 1 the information selection of drainage system methods to be applied in it, the method was selected based on the needs and the surface runoff water in it and the suitability of the technical criteria of the method with the field conditions [1]. The cornerstone of method selection in addition to review from the aspect of technical criteria, also viewed from the aspects of care that is not too difficult.

The Depok city, formerly known for its cool and cool atmosphere, today has undergone a tremendous shift. The large tree that grows in the area of it now the space has become a concrete tree. Green open space that used to be a lot in the city now has become a concrete open space because the plants turned into housing. This is due to the development activities of the property that only think about economic benefits rather than the environment. It is therefore necessary to have control by the Depok Environment Office (DEO) where the environmental permit depends on the laws issued by the local Government. The purpose of the environmental permit is to control the development activities undertaken within by the property due to its impact on the environment. It initiated the concept of vertical dwelling trends also helped meet this city of Belimbing land. Call it like Margonda Residence, Park View Condominium, Taman Melati Margonda, Green Lake view, Saladin mansion, Grand Depok city, and Grand Zamzam Tower. Based on data from Cushman Wakefield, property sales in Jakarta, Bogor, Depok and Bekasi are above 90 percent within 5 years. Reminding about the importance of environmental management in the property is the most important thing of a business activity undertaken to keep the runoff and flooding. The development of the property includes 3 aspects of the Environment, Economy, and Equity, so researchers do research about public perception about drainage system in the framework of green property. Research on policy evaluation in property is shown in table 2.

| No. | Rated Aspect                                                                 | Criteria         |
|-----|------------------------------------------------------------------------------|------------------|
|     |                                                                              | Very good | Good | Neutral | Rather good | Not good |
| 1.  | Communities get explanation from developers about land clearing, cutting and  | 3.2       | 42.4 | 49.3     | 3.8          | 1.3       |
|     | confinement of land at construction stage will lead to potential changes in   |            |     |          |              |           |
|     | structure and soil properties and drainage system                            |            |     |          |              |           |
| 2.  | Communities get explanation from developers due to the construction and      | 1.7       | 4.6  | 50.6     | 42.1         | 1         |
|     | operational activities of the property (housing) will make the land potential |            |     |          |              |           |
|     | for erosion drainage system                                                  |            |     |          |              |           |
| 3.  | People get explanation from the developer due to the development and         | 30.4      | 54.6 | 14       | 0            | 1.0       |
|     | operational activities of the property (housing) will be the potential flood  |            |     |          |              |           |
|     | and drainage system                                                          |            |     |          |              |           |

Based on table 2 it is found that 42.4% of the community stated Good and 49.3% Neutral in the statement of the public perception get explanation from developers about land clearing, cutting and confinement of land at construction stage will lead to potential changes in structure and soil properties. 50.6% of the public declared Neutral and 42.1% Poorly stated in the statement People get explanation from the developers due to the construction and the operational activities of the property (housing) will make the land has the potential for erosion. 54.6% Community stated Poor and 30.4% stated Not
Good for statements People get explanation from the developers due to the construction and operational activities of the property will be the potential flood.

The results of the data show that the runoff on the property construction is stated quite influential on changes in structure and soil properties. This also resulted in the construction and operational activities of the property area making the soil potentially eroding. Runoff and erosion factors are still in the medium category due to housing development. Meanwhile, a significant factor influencing the development of housing that is the occurrence of floods. The impact is environmental pollution and the spread of various diseases.

Some efforts that need to be overcome in flood prevention in housing development are (1) property design; (2) availability of adequate sanitation channels; (3) availability of green land. First, property construction requires detailed planning. Development based on environment is not only to build a house but to pay attention to the prevention of environmental pollution. Second, the built housing should pay proper attention to sanitation. Each house has proper sewer for sewerage. In addition, the guarding of channels with the cleaning of the channel cleaning work is very helpful to reduce environmental pollution. Third, the development of the beautiful needs adequate green land. The design of the house is an area to plant the plants to make the house look beautiful and comfortable to live in. In addition, green land is also provided in the corners of housing and in children's play areas. Thus, property construction can cope with flooding.

Supervision and controlling by DLO is classified as weak, because based on the facts above has never been DLO or related offices performing a captive to the EIA that has been implemented in the property industry. This has implications for the habits of developers who are only market-oriented or market-oriented and have not tried to follow the fiber to protect the environment that affects the society. For example, the housing developers dispose of waste or rainwater runoff directly into the river in the absence of a control basin or the preparation of absorption wells.

5. Summary
The management of the drainage system should be carried out from the smallest scope of source control and continuing to site control and regional control. In rainwater management, rainwater retaining facilities are required to reduce the burden of the main drainage channels in collecting and discharging excess surface water runoff that can result in flood disaster. The drainage system chosen to be applied in Depok City and has technical criteria that match the existing condition a rain garden, retention pond. The methods are chosen based on the suitability of the size, soil type, depth of groundwater and rainfall. While the public perception of drainage system in the framework of green property, the research on the evaluation of policy in property in Depok city, Indonesia on runoff process on housing development is stated quite influential on changes in structure and nature of the land. Irrigation channel maintenance and channel cleaning greatly help reduce environmental pollution. Green fields are also provided in the housing corners and in children's play areas. Thus, housing construction can cope with flooding. The recommendation in this research formation of the EIA under Sub Section Guards field flooding control and environmental management in DEO.

References
[1] Mikovits C, et al 2017 decision support for adaptation planning of urban drainage systems J. Water Resour. Plann. Manage. 143 04017069
[2] McKendry dan N J C 2015 Greening the industrial city: equity, environment, and economic growth in Seattle and Chicago International Environmental Agreements: Politics, Law and Economics 15 1 45-60
[3] Eichholtz P, Kok N and Quigley J M 2010 Doing well by doing good? Green office buildings. American Economic Review. 100 5 2492-2509
[4] Grindle M S 1980 Politics and Policy Implementation in the Third Word (New Jersey: Princeton University Press) p 40
[5] Marfai M A, Sekaranom A B and Ward P J 2015 Community responses and adaptation
strategies toward flood hazard in Jakarta-Indonesia in review for Natural Hazards 75 1127-44

[6] Grindle, M S and Thomas J W 1989 Policy makers, policy choices, and policy outcomes: The political economy of reform in developing countries Policy Sciences 22 213-48

[7] Stovin, V R, Moore, S L, Wall, M and Ashley R M 2013 The potential to retrofit sustainable drainage systems to address combined sewer overflow discharges in the Thames Tideway catchment Water Environ. J. 27 216-28

[8] Hellmers S 2010 Hydrological Impacts of Climate Change on Flood Probability in Small Urban Catchments and Possibilities of Flood Risk Mitigation. Hamburger Wasserbau-Schriften 13. (Master’s thesis, Hamburg: Institute of River and Coastal Engineering, Hamburg University of Technology)

[9] Chui T F M and Ngai W Y 2016 Willingness to pay for sustainable drainage systems in a highly urbanised city: A contingent valuation study in Hong Kong Water Environ. J. 30 1-2 62-9

[10] Chitresh S, Pankaj K and Binaya K M 2016 Assessment of stormwater runoff management practices and governance under climate change and urbanization: An analysis of Bangkok, Hanoi and Tokyo Environ. Sci. Policy 64 101-17

[11] Atul K R, Shaktibala B and Renu P 2017 Socioeconomic environment assessment for sustainable development Environ. Pollut. 77 3-14

[12] IPCC 2012 Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation A Special Report of Working Groups I and II (Cam, UK, and NY, USA: Cambridge University Press)

[13] Wong T H F, et al 2013 Stormwater Management in A Water Sensitive City (Australia: Cooperative Research Centre for Water Sensitive Cities)

[14] Danny M and Louis L 2016 Disaster governance and the scalar politics of incomplete decentralization: Fragmented and contested responses to the 2011 floods in Central Thailand Habitat International 52 57-66