## INITIATIVE URBAN WATER STUDIES AT DEPOK, PERI-URBAN CITY - TOWARD THE IMPLEMENTATION OF WATER SENSITIVE CITY CONCEPT

\*Firdaus Ali<sup>1</sup>, Tito Latif Indra<sup>2</sup>, Irene Sondang<sup>3</sup>, Esty Suyanti<sup>3</sup> and Ahmad Zubair<sup>4</sup>

<sup>1</sup> Engineering Faculty, Universitas Indonesia, <sup>2</sup> Mathematics and Natural Sciences Faculty, Universitas Indonesia, <sup>3</sup>School of Strategic and Global, Universitas Indonesia, Indonesia, <sup>4</sup>Center for Urban and Regional Research, Indonesia

\*Corresponding Author, Received: 1 July 2017, Revised: 16 Oct. 2017, Accepted: 10 Dec. 2017

**ABSTRACT**: The city has increasingly been burdened with the increase of urbanization. The effect of this dynamic is the pressure to the urban environment, specifically on the supply of water and the number of water space. The city of Depok as a peri-urban city continuously experience infrastructure development as the consequences of the capital city, Jakarta's spill over. It resulted in the diminishing amount and quality of water supply and space. Water Sensitive Cities is an innovative approach that is based on similar experience in similar surroundings within Australian cities. The approach integrates the concept of the water cycle with urban development dynamics that consider to ecological equilibrium. To what extent the concept is implemented in one of the middle cities in Indonesia will therefore then be significant for the study of urban developments and water studies in Indonesia. Specifically for the case of Depok, Water Sensitive City studies will provide a guideline as to what will be required to be done with regards to the current condition of water supply and space in the middle city context. The research takes advantage of mix-method approach; content analysis as a lesson learned for Water Sensitive City in several cities and combined with GIS mapping to identify land-use condition comparing with the management of water supply. The research will also highlight the extent of which Water Sensitive City as an approach can be applicable in Depok and Indonesia in general.

Keywords: Water Sensitive City, Water Supply, Middle City, Peri-Urban

#### 1. INTRODUCTION

Since the world's urban population has increased rapidly in the past few years, approximately 54% of the world's populations now live in urban areas, limitless of resources become urban issues. Water is one of the most important natural resources and plays an irreplaceable role in human survival and in the ecosystem [1]. In urban areas, many water resources are now facing threats from nutrient enrichment, organic, and inorganic pollution [2]. Besides, with the rapid urban expansion and population growth, water resources in urban areas are also gradually decreasing. With some of the main issues of urbanization in mind, urban entities will need to take further consideration to maintain a balance between the different spaces in the land, air, and water. The numerous dimension that is involved within urban water management portrays the complexities of managing issues in the urban area. The changing of water management is important not only because of the manmade shifting but also climate reason. Since global warming had impacted to the volume and distribution of rainfall, it affected to increase the potential hazard like the flood risk [3]. Water dimension becomes multilayer aspects in an urban area that covers two main issues water consumption and water risk disaster.

This complexity carries with it a multidimensional issue that involves a large area of solution that includes the need for technological, urban planning and design, empowerment of urban communities as well as social and institutional development solution [4]. Urban dynamics will have to be able to provide a balance between economic and physical development with the availability of sources, management, and freshwater space.

Moreover, water studies had been implemented with derived from several models of studies that cannot integrate one to another. It implemented partially or sometimes do not have to synchronize with one program and another program until it cannot optimize the water management at city particularly middle city at a peri-urban area that has limited resources management. Therefore, water management at middle city scale emphasizes the linking between one programs to another program and conducted integrally.

In Indonesia 's city cases, we need to know the sustainability of water management after more than

No	Location	Background	Challenge	Obstacle	Findings
1	Sidney <u>Major Role:</u> New South Wales Government and Local Communities	<ul> <li>Severe water crisis</li> <li>City water sources is far from the city and suffering water shortages</li> </ul>	<ul> <li>Collaboration amongst all levels of government &amp; different types of water professionals</li> <li>Full community participation in planning and implementation</li> </ul>	Government and local communities had to negotiate to get people involved at the municipal level	• Fostering enthusiasm for local initiatives in managing and maintaining neighborhood infrastructure
2	Melbourne Major Role: Victoria Government and Local Communities	<ul> <li>Phillip Bay and the Yarra River are natural water systems in the city</li> <li>Drought broke</li> </ul>	<ul> <li>Political commitment to achieve water sensitive outcomes</li> <li>Water sector collaboration</li> <li>Community knowledge and attitude</li> </ul>	Future uncertainty with possibilities for failure, loss, and damage to resilient water system	<ul> <li>Developing water sensitive citizen</li> <li>Breaking down the institutional and geographical barriers</li> <li>Decentralized water supply systems</li> </ul>
3	Brisbane <u>Major Role:</u> Brisbane City Council	<ul> <li>City connected by a large network of waterway corridors including Brisbane River and Moreton Bay</li> <li>Waterway corridors are a critical element for the city</li> </ul>	<ul> <li>In creating new urban paradigms related to water used</li> <li>New creative approach of water used and waterways More comprehensive and sustainability</li> </ul>	Too many negotiable aspects deal with legislative, meanwhile, In fact, there are some aspects that are not applied properly	<ul> <li>Create city that embedding and mainstreaming water as main issues in citizen's mindset and activities</li> <li>Waterways as a key part of Brisbane connected and livable city</li> </ul>
4	England <u>Major Role:</u> Municipalities Government, Water service providers, Property Developers, communities	<ul> <li>Various water management between the constituent countries</li> <li>Organizations that manage water are separate from those responsible for urban design and planning</li> </ul>	<ul> <li>Linking main river flood risk management and coastal erosion with protection treatment at once time appropriately</li> <li>Application of multi- value land use and multiple and societal benefits</li> </ul>	Missing of water management and wider land use planning linkage	<ul> <li>Placing water more centrally in the land-use planning</li> <li>Placing water much higher on the development agenda development agenda than it has traditionally been located</li> </ul>
5	South Africa <u>Major Role</u> : Legislator, Institutional champions (individuals)	<ul> <li>Complex water management challenges</li> <li>Water security is major concern</li> <li>The growing burden of wastewater</li> </ul>	Developing an understanding of the potential for transforming socially- divided (Apartheid-style) settlements in which the integration of water resources Integrating rainwater/drainage into the urban water cycle	Unfamiliar concepts to most South Africans	<ul> <li>Demonstrating the positive influence of coordinating bodies of institution</li> <li>Generating strategic evidence that creates new efficiencies</li> </ul>

30 years of rapidly changing in middle city at periurban area called Depok City. Simple question like: "How the water management to fulfill the needs of the Depok's residents?" becoming our aim in doing this research. By asking this question the research tries to examine the extent of which the concept of Water Sensitive City (WSC) as has been implemented in Australia, is applicable in the context of Indonesian urban environment in Indonesian cities. This investigation is conducted as another effort to achieve an integrated and sustainable urban water management in Indonesia.

Along with this line, this study tries to find out the urban water characteristic at Depok City since this city located at a peri-urban area that impacted directly with the growth activities of Jakarta, the capital city of Indonesia. Hence it has potential risk constraints in dealing with water management. Within this paper also, it describes the possibility water management concept like the implementation water sensitive city concept could be a solute action for middle scale city in Indonesia context.

# 2. WATER SENSITIVE CITY AND ITS IMPLEMENTATION

An urban expansion such as population growth and settlement occupancy needs to consume water. Even inappropriate utilization gray water or wastewater decreasing the environment that affects the increase the disaster risks. It was exacerbated by a climate-changing effect like flood or sea level rise risk [5]. So then, water is very closely related to human cycle life even more in an urban area.

To comprehensively examine and provide effective solutions for the issue of sustainable water management within a certain urban context, a concept of an ideal system of urban water management will be used. One of this concepts is Water Sensitive City, a concept that presents an integrative approach of urban water management that does not only provide sufficient supply for urban water requirements but equally provide numerous other benefits to increase the urban livability and resilience of the city [6]. Water Sensitive City itself appeared at 2004 by Australian consist of three pillars: Cities as Water Supply Catchments Cities Providing Ecosystem Services, Cities Comprising Water Sensitive Communities [7].

Water Sensitive city itself is a new comprehensive approach for water management at an urban scale that integrates not only the engineering side of water treatment but also considerate with social institution aspects. It is an effort to meet the societal needs to the efficient use of physical infrastructure, water urban design and urban water management integrally that enhances the quality of life.

Cities that implemented the first stage of Water Sensitive City since 2004 in Australia in Melbourne. This city threatened various elements not only growth pressure but also climate changing risk. Drought and flood happened at Melbourne. 40% reduction in livestock production, 80% reduction in grain production, 10-20% reduction in rainfall in autumn/winter and Melbourne's largest reservoir got down to 16%. Floods made most region at Melbourne had inundated. Hence city government deals it with a short-term plan like disaster response unit. They also doing long-term plan to implement 10,000 rain gardens, planning scheme amendment and maintaining sports grounds [8]. Evolving the water sensitive city concept in dealing with water crisis becoming an integrated solution with the pace of Melbourne development. In Melbourne case, WSC needs to emphasize by the collaborative action of institution-level even local participation.

The implementation of Water Sensitive City Concept at Melbourne city that stated before, become best practice to another city. As a concept, water sensitive city has challenge broader area adhere to a regional and national program of each country.

The recapitulation table 1 above likes to explain about the initial condition how the concept had been implemented in each region. Sidney and Melbourne have a severe disaster as a background of their journey turn into water sensitive concept.

Sidney and Melbourne have a severe disaster as a background of their journey turn into water sensitive concept. Yet Brisbane comes up with water issues as part of the city connected by a large network of waterway corridors (Brisbane River) as a critical element. Even Sydney, Melbourne and Brisbane have to challenge from a local citizen in order to mainstream the water sensitive concept [9].

Not only at Australian cities, but also at England and South Africa having difficulties in coordinate with many institutions to get involved with. The implementation in England had missing linkage at one critical aspect which is land use planning meanwhile South Africa, the unfamiliar concepts make a double burden for generating strategic evidence that creates new efficiencies at water issues.[10] [11]

#### 3. WATER AVAILABILITY AND MANAGEMENT AT DEPOK CITY

There are 24 rivers cross Depok City with the longest river are Kali Grogol and Kali Psanggrahan. Length of Kali Grogol crossed Depok City is 35.2 kilometers and Kali Psanggrahan is 20.75 kilometers. But the most important river in Depok City is Ci liwung, the river has 14-kilometer length throughout Depok City. Ci liwung is the main river of Depok which Bogor at the South become upstream and flow to the north to Jakarta Bay as its downstream. It usually has flooded at Ci liwung watershed at Depok area, and some area occupies by settlements.

Moreover, describing water, the most intersect with the public is the availability of clean water supply throughout the city. Water supply in Depok City provided by PDAM Tirta Asasta, a company owned by the city. PDAM Tirta Asasta established in 2013, before 2013 the needs of clean water provided by PDAM Tirta Kahuripan that owned by Bogor Municipality. In 2015, PDAM Tirta Asasta has 52,255 customers with the clean water supply of 1,172,883 cubic meters. The biggest customer of PDAM Tirta Asasta is residential. The middle residentials are the biggest with total 26,759 customers and low residential with 18,120 customers [12].

Needs of clean water in Depok City is not only provided by PDAM Tirta Asasta but also from other sources. Surprisingly, sources of clean water in Depok City mainly from groundwater pumps with a total of 51.31%. Water meter from PDAM Tirta Asasta only supplied 2.96% needs of drinking water.



Fig.1 Graphic Source of Drinking Water 2016

Groundwater used to meet needs of drinking water in Depok. Local companies such as PDAM Tirta Asasta was not able to meet the needs of clean water, especially drinking water for residents of Depok city. Excessive use of groundwater can lead to rapid groundwater degradation resulting in an imbalance in the groundwater flow system.

#### 4. GAP OF WATER ISSUES AT DEPOK CITY

The issues of water in Depok City are dominated by 1)flood and 2)clean water issues. Floods in many areas of Depok City became major issues especially in the rainy season where rainfall is rising. This flooding issue is usually accompanied by information of clogged waterways caused by garbage and mud sediment. Siltation and constriction of water bodies are also the cause of floods in the city of Depok. The flooded districts spread throughout Depok City and are dominated in the east of the city. Some areas prone to flooding tend to be passed by large streams such as Ciliwung and Psangerahan River. Not only close to the river but also the presence of lake is one of the factors that make the region prone to flooding.

Based on the previous identification. Depok City has potential disaster threat variables and historical data related flood as a disaster risk. Rapidly land-use change make the city riskier.



Fig.2 Landuse Distribution of Depok City 2011

The number of settlements increased, causing an increase in the need for clean water for the people of Depok City (see Fig 2). The total area of Depok City is 20,029 hectares. Residential areas dominating land use in Depok City that reach 58% areas of Depok City. Mixed agricultural is the second largest land use in Depok only have 8.95% of total area. Water bodies such as rivers, lakes, and ponds only reach 3% of total area.

Water bodies such as rivers, ponds, lakes, and others in Depok City can't work well to receive rainwater or runoff due to the insufficient area. This can cause floods in many locations in Depok City. Massive housing development can be a contributing factor to the decreased area of water catchment area. Increased housing area causes the change of others land uses to a residential area.



Fig.2 Total Area of Land use in Depok City 2016

The issue of clean water became the second biggest issue after the flood, where the need of clean water supplied by PDAM Tirta Asasta has not been able to meet all the needs of the people of Depok City. This causes the use of other sources, especially groundwater pumps become the main source of Depok City residents to get clean water.

#### 5. THE POSSIBILITY OF WATER SENSITIVE CITY CONCEPT WOULD IMPLEMENT AT DEPOK

The implementation of Water Sensitive City in the urban areas of Indonesia becomes a challenge in itself due to specific characteristics that tropical urban context in the case of Indonesia. The developmental nature of the urban areas, the everincreasing population and the rise of land and water use issues as well as continuous development of its governance system provides Indonesian cities an interesting case for the implementation of Water Sensitive City concept. As the concept itself has mainly been implemented in Australian cities, it serves a valid reference from which Indonesian cities may be able to consult from.

Depok is one of the middle city in Indonesia that have changing urbanize rapidly. Since earlier 1970 until now there are massive developments since many campuses move from Jakarta to the periphery area. The land use changing made the changing of water usage too. It impacted not only by the availability of fresh water but also the services of fresh water per households at Depok.

Depok city, in this sense, serves as a perfect example of a middle city that also serves as waterway through Ci Liwung main river and buffers city connecting the capital Jakarta and water catchment area Bogor city.



Fig.3 Population of Depok City in 2015

The population of Depok City is 2,106, 100 people with a population growth of 3.57 in 2015 [13]. Cimanggis sub-district is the region with the highest population, about 292,132 people live in the region. But the densest sub-district in Depok City is Sukmajaya sub-district with a population density of 15,600 people per kilometer square.

Despite their importance in water management, land use between Jakarta, Depok and Bogor city also vary with both urban and rural characteristics developments constantly providing alterations. As many of the developments occurred within the past 5 years, urban management of the city neglected water management from being integrated into the development plan. As a result, water supply demands increased, while water space decreased. If Depok city government had fully understood and implemented Water Sensitive city concept, this may effectively. averted In addition, such be developments have subsequent effects to water catchment areas in Depok, and particularly Jakarta. Despite its status as the center of economic activity in Indonesia, sustaining close to 10 million residents of different nationalities, cultural backgrounds, and social economic power, Jakarta may suffer diminishing supply of water in the next few years to come.

The concepts of Water Sensitive Cities are emerging in response to a general consensus that existing water services and planning processes have been poorly equipped to support the discussed urban challenges (projected population growth, and climate and economic challenges) [14]. Integrated solutions to deliver services for supply, sewerage, and flood protection, as well as green and liveable urban environments, are a requirement for future cities and towns. In a Water Sensitive City, this will be achieved by:

- 1. Using the city as water supply catchments: diversity of sources and diversity of centralized and decentralized solutions.
- 2. Assuring its healthy environments: clean rivers and groundwater, with cool, green and beautiful urban landscapes.

3. Developing resilient, water-conscious citizens: communities that accept and support new water solutions.

While Australian cities are on their (rather slow) path to transform to water sensitive futures the possibility exists in Indonesian developing cities to leapfrog certain traditional stages in building the urban water infrastructure. For example, rather than investing in a massive centralized sewerage system, it may be more practical in some areas to implement decentralized, efficient and cost-effective treatment and recycling systems at the neighborhood scale, leading to direct development of a water sensitive city. In this way developing Indonesian cities will avoid repeating the mistakes that westernized cities made on sustainability.

Since the water sensitive city was a staging concept, it possible to take one stage to strengthen first rather than working with quick assessment with whole stages but the result not optimize. So, the Water Sensitive City approach provides a "Leapfrogging" mechanism that indicates the different stages that a city needs to fulfill in order to achieve Sensitive Water Management in the urban context [15].

#### 6. CONCLUSION

Depok city is under pressure from Jakarta's spillover and the internal development of Depok city itself. This is evidenced by the increasingly urbanized land use rather than rural area. High population density needs more residential and clean water for the citizen. This condition causes water demand to increase but water availability decreases. The issue of flooding and clean water is still emerging in many parts of Depok City. This city also has not been able to manage the water needs and the availability of water in its area. Based on the Water Sensitive City concept that had been implemented at several places, each city has their own problem. But the most issues and obstacles are how this concept will be inclusive of many stakeholders in each city. Therefore in Depok case still in a preliminary stage in preparing to be a water sensitive and sustainable city. Furthermore, if the WSC concept wants to be implemented, leapfrogging action is an important thing to cope with.

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### 8. REFERENCES

- Lei Xie Hong Zhanga, Chao Wanga, Fulong Chen, Water-Body types identification in urban areas from radarsat-2 fully polarimetric SAR data: International Journal of Applied Earth Observation and Geoinformation, Elsevier. 2016
- [2] Robby YussacTallar, Jian-Ping Suenn, Identification of water body status in Indonesia by using predictive index assessment tool: International Soil and Water Conservation Research3(224–238), Elsevier. 2015
- [3] Brown, R., Keath, N., Wong, T., Urban water management in cities: historical, current and future regimes. Water Science Technology. 2009
- [4] Johnstone, P, Adamowicz R, de Haan FJ, Ferguson B, Wong T. Liveability and the Water Sensitive City, Science-Policy Partnership for Water Sensitive Cities. Clayton: Monash University. 2012
- [5] Schucha, Gemma, Silvia Serrao-Neumanna,b,\*, Edward Morgana,b, Darryl Low Choya Neumanna, Water in the city: Green open spaces, land use planning, and flood management – An Australian case study. Landuse Policy. 2017
- [6] Brown R, Keath N, Wong T, Transitioning to Water Sensitive Cities: Historical, Current and the Future Transition States, 11th International Conference on Urban Drainage, Edinburgh, Scotland, UK, 2008, Pp 1-10.
- [7] Flyod J, Iaquinto B, Ison R, Collins, K, Managing complexity in Australian urban water governance: Transitioning Sydney to a water sensitive city, Elsevier, Vol 61, June 2014, pp. 1-12.
- [8] Wong T.H.F., Blueprint2013 Stormwater Management in Water Sensitive City, Monash University. 2013

- [9] Beardmore K, Markwell K, Chatburn C, Breen P, How do you create a 'WaterSmart Liveable City'?. Paper presented at Planning Institute of Australia 2012 National Congress, Adelaide, South Australia. 2012. Pp 1-23; Carden K, Ellis D, Armitage P, Water-sensitive cities in South Africa: developing a Community of Practice. Proceedings of the 3rd International Conference on Design, Construction, Maintenance, Monitoring and Control of Urban Water Systems, WIT Conference, 2016, pp. 51-62.
- [10] Ashley R, Lundy L, Ward S, Shaffer P, Walker AL, Morgan C, Saul A, Wong T, Moore S, Water-sensitive urban design: opportunities for the UK, in Proc. of the Institution of Civil Engineers, Municipal Engineer, Vol 166, pp 66-76;
- [11] Carden K, Ellis D, Armitage P, Water-sensitive cities in South Africa: developing a Community of Practice. Proceedings of the 3rd International Conference on Design, Construction, Maintenance, Monitoring and Control of Urban Water Systems, WIT Conference, 2016, pp. 51-62.
- [12] BPS, Kota Depok Dalam Angka 2016, Depok: Badan Pusat Statistik Kota Depok
- [13] BPS, 2016. Kota Depok Dalam Angka 2016.BPS Kota Depok
- [14] Brown, R. R., & Clarke, J. M. (2007). Transition to water sensitive urban design: The story of Melbourne, Australia (Vol. 7): Facility for Advancing Water Biofiltration, Monash University Melbourne
- [15] Ali, Firdaus et al, Laporan Kemajuan Optimalisasi Infrastruktur Sungai Terhadap Pemenuhan Kebutuhan Air Baku Kota Depok. Hibah PUPT DIKTI. 2017

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