Design principles of water sensitive in settlement area on the river banks

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Abstract. This research will formulate the principle of designing settlement area of Kapuas River Pontianak with the approach of water sensitive concept of urban design (WSUD) the densely populated settlement area. By using a case study the approach that is a dense settlement area located on the banks of the river with literature study techniques to formulate the aspects considered and components that are set in the design, descriptive analysis with the rationalistic paradigm for identification characteristics of the settlement in the river banks areas with consideration of WSUD elements and formulate the principles of designing water-sensitive settlement areas. This research is important to do because the problems related to the water management system in the existing riverside settlement in Pontianak has not been maximal to do. So the primary of this research contains several objectives that will be achieved that is identifying the characteristics of riverside settlement area based on consideration of design aspects of the area that are sensitive to water and the principle of designing the area so that the existing problem structure will be formulated in relation to the community's need for infrastructure in settlement environment and formulate and develop appropriate technology guidelines for integrated water management systems in riverside settlement areas and design techniques for water-sensitive settlements (WSUD).

1. Introduction

Newman (1) said the ‘big pipes in, big pipes out’ approach to urban water management were developed in the 19th century for a particular linear urban form. Large, sprawling car-dependent cities are pushing this approach to new limits in rich cities and it has never worked in poor cities. An alternative which uses new small-scale technology and is more community-based, is suggested for both rich and poor countries. The settlement is a complex problem that is related to social, economic, cultural, ecological, and so on. The complexity that occurs in the settlement is a natural thing considering the nature and function of the settlement is so widespread in human life, although not by itself means always cared for and taken into account. The focus of sustainability research is no longer merely a matter of natural environment in the understanding of global ecology (air quality, water, biodiversity, land, minerals and energy), but also to the human built environment, such as buildings, infrastructure, open spaces and historic heritage). Riparian settlements have diverse potentials and problems. Its potential that directly relates to the banks of the river provides benefits for the
surrounding community to utilize river water as a source of water fulfillment for activities and daily needs. Peter (2) said in their research that the site uses rainwater tanks, infiltration trenches and a central basin where cleansed stormwater enters the unconfined aquifer for water retention and retrieval. A two-year monitoring program for roof water, rain tanks, hot water systems and first flush pits has commenced with samples taken from these sources tested for compliance with the Australian Drinking Water Guidelines (1996). Total water saving of around 60% has been shown to be feasible as well as almost complete storm runoff retention.

Based on the background of the above problems is how to identify the characteristics of the river settlement area based on consideration of the design aspects of the area that are sensitive to water and the elements of the design of the area so that it will formulated the existing problem structure related to the needs of the community infrastructure infrastructure infrastructure . This research is important to do because the problems related to the water management system in the existing river riverside settlement in Pontianak has not been maximally done. So the urgency (importance) of this research contains several objectives to be achieved which will be divided into 2 (two) research stages. In the first year will be formulated identification of the characteristics of the study area with the consideration of the design of water sensitive settlement areas and formulate the principles of designing residential areas, especially on the banks of water sensitive rivers. It is expected that in the first year it will produce guidelines for the principles of rural settlement design with the WSUD concept approach that will be used as the appropriate technology that can be directly used by the community in the settlement of the riverbank. In the second year, it is expected to formulate an integrated water management system in the settlement area of riverbanks and design techniques for settlements divided into 4 components, namely open space design, housing design, road design and streetscape design of the area which will be integrated with rainwater management Namely the principle of local drainage system with Low Impact Development (LID).

The concept of Water Sensitive Urban Design is an urban design approach that can reduce the issue of availability and flooding. The results showed that physical environmental characteristics that influence water management based on Water Sensitive Urban Design in Tambak Sarioso Village are water problems such as inundation/flood due to rob and rain and lack of water service (3). The concept of Water Sensitive Urban Design (WSUD) is an urban design approach and is part of the concept of identified green infrastructure that can reduce the flood problem (3). Lokita (4) said that in implementing WSUD, urban design components should be considered including internal and external plot, the physical condition of the area covering land capability, land use and the provisions and regulations related to preservation of Semarang Old City. The main principle for the old city of Semarang is that the application of the WSUD concept should not damage the building facade, integrate internal and external components of the plot to retain water, increase the un-hardened area, reduce the use of pavement materials, redesign the open space to accommodate water and use containers of water reservoir (4).

The principles in the WSUD according to Australia’s national guidance on WSUD (5) are: 1. To protect and improve (strengthen) rivers, creeks and wetlands in an urban environment. 2. Protect and improve the quality of water flowing from urban environments to small rivers, Greater river flow, and wetlands. 3. Restore urban water environments by maximizing reuse of rainwater, recycled water, and grey water. 4. Protect (conserve) water resources through reuse by recycling and system efficiency. 5. Integrate handling Rain water into the landscape thus offering several useful uses such as water quality treatment, natural habitat, recreation and open public space. 6. Reducing peak flow and water runoff from urban environments and simultaneously providing infiltration (water flow into the soil through the soil surface itself ) and refueling water groundwater recharge. 7. Integrate water into the landscape to improve urban deserts and also enhance social, visual, cultural, and ecological values: and 8. The effectiveness of effective implementation and use of costs enables widespread application and adoption. The objectives of the WSUD are: 1. Adjust the water balance (groundwater, current flow, and damage by flood water and erosion. 2. Maintain and where possible improve water quality (including sediment, riparian vegetation protection and minimize transfer of pollutants to surface and
groundwater. 3. Encourage water conservation (minimize imports of drinking water supplies through rainwater harvesting and wastewater recycling and reduction of irrigation requirements) and Maintain water-related environments and recreational opportunities. In the planning process the researchers used the technical elements that occurred within the Guideline Water Sensitive Urban Design for Western Sydney (5) as a reference in the recommendation which will be supported by various other sources such as vegetated swales, vegetated filters Strips / buffer strips, Sand filters, bioretention systems, permeable pavements, infiltration trenches, infiltration basins, and rainwater collection tanks (CSIRO).

2. Method
The research method used is by doing field observation to get a description of the condition, characteristic and problem formulation related to water issue at Kapuas river settlement area especially Kelurahan Benua Melayu Laut. The analytical method used is qualitative descriptive analysis with a rationalistic paradigm to describe the concept approach of WSUD on river bank settlement, so that later can be formulated the principles of designing the settlement area. In this study the data used consisted of primary data and secondary data. Primary data, among others, related to the condition of settlements on the banks of rivers and infrastructure facilities that exist in the observation location. The application of qualitative method with rationalistic approach in this research is by exploring theories about urban design theory, river bank theory and the theory about water-sensitive city element (WSUD). Data presentation techniques used in this study include narrative data, table data, data diagrams and map data. The WSUD guidelines for residential areas according to CSIRO (6), include public and private open space networks, the layout of residential layouts, road layout forms and streetscape layout forms (visual elements and roadside landscaping). Mikovits said that population data alone are not sufficient to describe the effects of city development on urban water infrastructure. For a comparison of the simulated urban development scenarios SWMM simulations are performed to show differences in runoff and flooding according to the developed areas (7).

3. Results and Discussions
The results will be discussed in 5 indicators (5) (8), they are Water availability indicators in settlements, water demand indicators in residential areas, infrastructure indicators, land use indicators, circulation indicators and parking, open space indicators, building and streetscape indicators. The map of the study location is as follows. Administratively, the research area is Subdistrict of Melayu Melayu Laut Sub-district of South Pontianak. The following figure 1, where the location of the research area is RW 1 to RW 11 and has a land area of 56 hectares. The boundaries of the territory are to the north bordering the Kapuas River in the south, Subdistrict Melayu Darat Subdistrict, West side bordering Central Market, and East side bordering with Bansir Laut Village.

3.1. Indicator of water availability in the settlement
In Kelurahan Benua Melayu Laut, it is dominated by densely populated settlements that live to meet most of the banks of the Kapuas River. For the people in this village, they use surface water, rainfall,
infiltration, water runoff and topographic condition of the dominant area to take river water to meet daily water needs. The condition of surface water in this village is mostly used by the public for MCK because it is easier and cheaper. The rainfall in Pontianak is very dependent on weather conditions and frequent changes in rainfall so that it will affect the condition of surface water availability in the Kapuas River. The amount of rainfall in Pontianak City ranges between 3000mm - 4000 mm per year the largest (wet month) occurred in May and October, while the smallest rainfall fell in July. The following description of surface water conditions at the study site. With a land height of 0.1 -0.5m to sea level and the slope of the land 0-2%, so that in the rainy season often experience ups and downs.

Figure 2. The condition of surface water type in Kelurahan Benua Melayu Laut

Topographic conditions which are shown figure 2 that are on the banks of the river, susceptible to tides of river water. The rapid growth of population so that will affect the availability of water and the community will more use of existing river water. The tidal water conditions of the river, especially at high tides sometimes cause water to rise up to the surface of the soil and cause tidal flooding in residential neighborhoods in Sub-District of Benua Laut due to the overflow of river water. The dominant soil type condition in Pontianak is peat swamp land, which has high resilience to excess surface water. This allows if the occurrence of pairs in this area will experience a rapid retreat also to the height of the tide that can reach 1 meter above the water surface of the river.

3.2. Indicator of water demand in the region

The society in the sub-district of Benua Melayu Laut is still uses river water for their daily needs. In addition to cheap, river water is easily available and access to the river was not far from their homes. River water used to meet the needs of bathing and washing. The government has also provided clean water infrastructure by creating a network of PDAMs for the community in the Subdistrict of Benua Melayu Laut. In addition, the community also accommodates rainwater in reservoirs that are used for cooking and drinking water.

Figure 3. People use river water and collect rain water for activities for shower and wash

Figure 3 shown the existence of rain bar, well, green belt, green space which is a means of water availability in this district become an important indicator in serving the availability of water. However, its availability is not entirely present in all the sub-districts of Benua Melayu Laut (BML) especially for retention wells, infiltration trenches, paving permeable, and green roof spaces. So that the
application of WSUD elements is needed to meet the demand of clean water in this area. Several steps are taken in WSUD to maintain water availability by reducing water use (water use effectively and efficiently) and harvesting rainwater or recycling water (filtration). Thus, there will be an increase in water reserves and improved water quality. In addition, WSUD keeps the environmental conditions around the banks of the Kapuas River remain good. So the surrounding habitat is maintained.

3.3. Indicator of Infrastructure

Infrastructure in the research area is still inadequate thus disrupting the activity of water management for the local community. In figure 4 that shown the drainage condition is not good and sometimes filled with garbage so that it clogs the flow of water. There are also some conditions drainage channels are cut off so the water does not flow smoothly.

![Figure 4. Conditions of drainage and garbage in the research area](image)

3.4. Indicator of Land Use

Land use in BML urban areas is dominated by trade/service located along the main road corridor of Jalan Tanjungpuran and settlement functions along the banks of the Kapuas River.

![Figure 5. Analysis of land use](image)

Land use conditions that are shown in figure 5 are dominated by residential buildings, especially those located along the banks of the river, thus causing the availability of open space as water storage space does not exist. Sometimes split open spaces at some point are simply left unprocessed as providers and water stores for the surrounding community. So that the need for water management in unused spaces as water space based on the concept of WSUD is the principle of infiltration (water flow into the ground through the surface of the soil itself).
3.5. Indicator of circulation and parking

The research area lies in a strategic location. Where access to the location can be achieved through land and river transportation. Tread can be reached through Tanjungpura Road access and Perintis Kemerdekaan Street which is the main route not far from Kapuas I Bridge. From the side of river transportation, the pier located in the planning area can be reached from the direction of Kapuas Square Park and SengHie Pier.

![Figure 6. Circulation and pocket parking in research area](image)

Figure 6 shown the streets of Benua Melayu Laut sub-district are the main access to the Kapuas River. Most road conditions are already in a concrete cast and in a good condition. The availability of sidewalks for pedestrians still does not have a clear linkage. The condition of the sidewalks has not yet shown pedestrian friendly, which provides comfort and safety for pedestrians. At some points the pavements have a very little width and completeness of the sidewalks have not been met, such as the height of the pavement up and down, the lack of vegetation, has not paid attention to the disabled and the signposts of incomplete sidewalk markers. The existing roads and parking spaces can be utilized as open spaces that can drain runoff water with great intensity.

3.6. Indicator of open space

Green open space facilities are very much in the Village of Benua Melayu Laut. The location was scattered on the banks of the river but some are on land. Existing open space is expected to be utilized as public spaces to support eco-tourism area on the banks of the Kapuas River Benua Melayu Laut Village. In addition, for the area of impregnation of water and green areas so as not to become a dead space. Open space under the bridge can also be developed as a passive open space and active open space for the development of Kapuas river eco-tourism area are shown in figure 7 below.

![Figure 7. Open space in settlement area at Benua Melayu Laut](image)
In the area of RW VII, VIII and IX Kelurahan Benua Melayu Laut, the green open space condition is analyzed based on 2 (two) divisions of RTH Private and Public RTH. In the area of RW VII, VIII and IX, the green open space problem is dominant because the land for settlements is very dense and some of the lands is also located in tidal areas. Private open space in the area of planning is just a community effort by planting crops using pots on the terrace of the house. With private and public open spaces in the region, it is possible to provide water needs through a retention basin that integrates groundwater with open public spaces, preparing green corridors on drainage to direct run-off water to open spaces to keep water sources uncontaminated.

In addition, utilizing open spaces both private space and public space as water treatment and storage space of water in residential buildings that can be a water tank, green space roof of the building and on the yard space in the form of retention ponds, open spaces that use paving which can absorb water.

3.7. Indicator of building dan streetscape (visual landscape)

With regard to population density in the area of planning, the area in Sub-District Melayu Laut Sea classified a dense residential area. This is indicated by the distance between buildings is very narrow. Land use is generally done as optimally as possible without leaving space for pages. It is also linked to the typology of most of the riverbanks. The area is created following the channel flow formed either natural or artificial.

In figure 8 show that the condition of buildings density in settlements and trade in BML urban area is more dominated by building 1 - 2 floors on river banks and buildings 2 floors on the main road corridor (Jalan Tanjungpura). In buildings 2 floors can take advantage of roof space in the form of flat roof/concrete as a green space roof as a landscape element in the building. While in the settlement through WSUD elements can utilize the area of pavement (concrete gang) as the water absorption area.

Water-sensitive urban designs often incorporate drainage corridors with growing settlements. So there is an opportunity open space becomes more can be used as a buffer and water storage for various activities in residential areas in BML Village. In addition, the green drainage corridor can provide a natural buffer strip and provide recreation space for the public as a public space. Here are some visual illustrations as design directives based on the WSUD principles used and discussed above, that shown in figure 9 below.
The concept of land use and building layout is based on analysis of building density, fracture, building distance, building type and solid void typology of building mass. This allows open spaces in residential areas in Benua Melayu Laut Sub-District to be utilized as water catchment areas as a conservation space and water provider.

4. Conclusion

Based on the result of preliminary survey in the research area, it is found that some important elements of urban design greatly affect the design principles of WSUD such as public and private space network elements that can be used as storage space and water catchment area (retention pool). The lay out of the riverside settlement building, the lay out of the road that is equipped with green drainage, and the visual layout of the road space in the form of landscape on the walkway on the circulation area within the settlement area. In the area of research can be enabled and indicated also used as eco-tourism area as a supporter of the concept of WSUD in preparing the abundant green spaces of water. So that later design directives will also be influenced by the function of the area as an ecotourism area. Therefore, further studies are required.

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