Ecohydrology (EH) for Enhancement of Kuala Lumpur Urban Storm Water Management System

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ABSTRACT

The urban design characteristic and environment of Malaysia capital city, Kuala Lumpur has changed dramatically. Spatial urban expansion caused by economic demands and an increasing urban population has created a new built environment that has increased an impervious urban surface. The alteration of the urban characteristic, such as clearing of vegetated land, disturbed on urban hydrology cycle and increasing co efficient runoff during short high peak precipitation. Kuala Lumpur have to find a holistic solution for sustainably storm water management by using urban resources. The study focusing on the qualitative characteristic of operational potential Ecohydrology (Eh) for urban storm water. This paper analyses potential Ecohydrology (EH) from its theories that appropriate to be adapted for enhancing Kuala Lumpur urban storm water. It will cover on the characteristic of EH concept and the criteria establishment of integrated operation environment. The study will reveal a potential of Ecohydrology (EH) as a new paradigm shift for enhancement storm urban water system for Kuala Lumpur.

INTRODUCTION

Malaysia has transformed from an agricultural to an industrial base. The improvement of Malaysia’s economy is changing its urban Landscape characteristic, enhancing people’s life style, providing better infrastructure and amenities, increasing new township and housing developments as well as creating job opportunities in the urbanized area. The rapid urbanization and high growth of Malaysia’s economy during the 70s and 80s has altered the existing zoning of land use activities (mining area, agricultural land) to the potential of urban activities due to socio-economic demands.

The rapid urbanization process and uncontrolled development defined on cities health factors and environment integrity’s, and became main polluted resources (air pollution, water noise and increasing urban heat island effect) to the environment and losing the ‘good look’ of the city [1,2,3]. Thus, impacted on the deterioration of resilient and good urban design characteristic of Kuala Lumpur, as to accommodate sustainable urban planning in term of urban resource (water crisis – deterioration of water qualities and fresh water, depletion of urban ecology, social problem, and economic losses) and creating better living environment for city dweller.

Malaysia has high annual rainfall and is rich with water resources, receiving an average of 3000mm of rain per year [4]. Malaysia’s main fresh water source (97%) is from the river, and the remaining fresh water is from underground water sources. Ironically, in 2012 and 2013 Kuala Lumpur was already facing stress on its water supply due to a water shortage and uneven distribution of precipitation causing drought and also creating conflict and economic losses. The invariabilities in the climate most likely exacerbate the risk of Storm Water Management (SWM). Water issues such as flooding in 2000 and the deterioration of Klang Valley river system water qualities. Malaysian Environmental Quality Reports of 2000 recorded that the Water Quality Index (WQI) showed both rivers were still polluted (WQI Class III, IV, V 51.9 - 76.5) and required extensive treatment and sufficient SWM qualities and quantities [5].
Therefore, Kuala Lumpur Storm Water Management (KLSWM) will experience further difficulties in efficient management if the reliable water resource is threatened. Malaysia’s drainage system design was based on the Department of Irrigation and Drainage, Malaysia Manual 1970. Conventional SWM drainage is still present for most of Kuala Lumpur area. The design approach was to channel surface runoff during precipitation into main conveyance system and then into the main river by concrete drains. This approach should be able to reduce flooding in the city, however increasing flood events downstream especially during the period from October until January (Kuala Lumpur Structural Plan 2020) results in these systems struggling to hold the storm water. This design approach was focusing on the quantity aspect such as discharge, retention and detention. This process has impacts on the stream biodiversity, decreasing biota process and biological cycles, erosion on the river embankment and increasing sedimentation on Klang River system [6]. Significant changes to Malaysia SWM in protecting natural ecosystem have been made through construction of biological system such as pond, wet land and mechanical infiltrations system.

Kuala Lumpur Structural Plan 2020 (KLSP) is aiming to be a World Class City that provide a high standard of quality of life through the protection and enhancement on urban ecologies and ecosystems. The water quality improvement of Kelang River System (Sungai Kelang and Sungai Gombak), became one of the main agendas in KLSP in creating a resilient city’s that be able to attract visitors, investors, and looks good to users. The biological aspect, ecological cycle and interrelation of aesthetic value are characteristics needed to be incorporated into Kuala Lumpur’s SWM for it to achieve World Class City status [6,7].

Methodology:

The study analysis some theories of Ecohydrology (EH) related to be contributed potential for enhancement urban storm water management in response to urban storm water issues in Kuala Lumpur. The potential of Ecohydrology on how the ecological aspect and biota process has effect on the hydrological cycle and is also able to identify and eliminate the human impact cycle through hydrological processes is analysed using a content analysis. The theories of Ecohydrology (EH) is analysed in response to the storm water accentuation through the process of natural systems and engineering treatment techniques would meet the characteristic and EH principal frameworks in increasing the ecosystem carrying capacity. The content analysis examine how EH can be adopted into ecological engineering approach that can be harmonised the urban storm water management.

RESULTS AND DISCUSSION

i) Ecohydrology Principles for Sustainable Urban Storm Water Management (USSM):

EH principles as systematic solution that can be applied to solve Kuala Lumpur’s USWM problem and reuse storm water as a resource in developing a resilient city. Ecohydrology is a new scientific theory on how the interrelationship of hydrology and biota at a catchment basin regulate water management related issues. This creates sustainable management water resources such as enhancing the resilience of the ecosystem and its functionalities, controlling anthropogenic activities and protecting water cycle [8]. Accordingly, water and temperature are determined factors of biogoshpere evolution. Water is the main ingredient for carbon accumulation in ecosystems, which stimulate biological processes and the nutrient cycle [8]. The Ecohydrology approach is able to restore and increase carbon/biomass through climate and hydrological patterns by increasing urban water retention. Hydrosphere is used to regulate biota and biota regulates the hydrosphere in a ‘dual regulation’ concept that complements the hydrological cycle. Therefore enabling a synchronization of different EH biotechnologies (phytoremediation, denitrification wall, biofiltration, biogeochemical barriers and vegetated ecotones) to enforce and enhance the sustainability process.

Ecohydrology is a low-cost advanced technology in which ecosystem properties are used as management tools in solving complex issues. Ecosystems are disturbed and altered due to anthropogenic pressure. The integration and reflection of the ecological and hydrological process in the enhancement of ecosystem integrity is formulated into holistic frameworks and determined by Ecohydrological (hydrological, ecological and ecotechnological) principles. Firstly the hydrological Principle is the establishment of the hydrological process and nutrient cycle and kinetic flows at a catchment scale. The second principle is the Ecological Principle Enhancement tool for ecosystem carrying capacity in controlling anthropogenic impacts on societies in terms of robustness, resilience, biodiversity and ecosystem services. The third principle is ecological engineering which is a combination of the first and second principles. This third principle results in ‘dual regulation’ where hydrological regulate biota as water management tools through an ecological engineering approach.

ii) Ecohydrology as to Increase Ecosystem and Biomass:

Ecohydrology is a new scientific research area on water problems involving the integration of environmental potential in achieving societal needs. It addresses the issues in two aspects, firstly on knowledge contribution of freshwater ecosystem protection through providing empirical knowledge of ecosystem properties as management tools to engineering and hydro technical solutions. Secondly the enhancement of a ecosystems
carrying capacity through a trans disciplinary science approach based on a formulated system to define integrated urban water management (IUWM).

The potential of the new paradigm concept as an urban pollutant abatement and to eliminate water threat via best management practise in development of wetlands, ecotone, control at the source as well on the bio manipulation process, be able to increase biomass production, bioenergy and local socio economic income. The Ecohydrology approach can complement conventional technological tools such as bio filtration technologies for polluted drain treatment and also reduce operational cost, increase ecosystem efficiency as well as creating a good perspective to people.

The deterioration of urban health has impacted freshwater availability. New solutions of ‘Green technologies’ such as Pyhtotechnologies are helping the EH concept to increase plant biomass and improve urban biodiversity. These approaches are helping Kuala Lumpur become a resilient city flexible enough to face future global climate change and urban pollution. Ecohydrology will be a driving force in solving Kuala Lumpur’s water problems and urban biodegradation, and it will also help to determine a sustainable management approach for a reliable fresh water resource. In terms of Kuala Lumpur USWM, the potential of EH will improve on 1.Prevention of property damage, flash floods, water pollution, and reducing the Urban Heat Island effect. 2. Utilization of urban Storm water recycling programme to overcome water sacrifices in the Kuala Lumpur area through the collection, storage, distribution, and treatment of surface runoff. 3. Application of a holistic EH concept and its principle approach in optimizing cost-efficiency for a low level operation cost. 4. Increasing the Green building design concept, urban green spatial, and selection of previous materials, water bodies that provide benefits to urban biodiversity, aesthetic value and public awareness through an education programme. Therefore the protection and improvement of ecosystem services a habitat for biota, improves environmental integrity, and improves the image of Kuala Lumpur as World Class City.

Summary:

The USWH has formulated a new paradigm approach for sustainable water management in Kuala Lumpur’s. SWM. There will be a new level of integration for ecosystem properties used as solving tools for water related issues by using urban resource (storm water) as a water supply. The knowledge transfer through multi-disciplinary collaboration will push green technologies to the edge and improve non-portable water availability for Kuala Lumpur. The study will be link a bridge between ecology and hydrology through participation of the Landscape Architect to strengthen the urban ecological design in creating resilience city of Kuala Lumpur.

The results of this study show the number of foreign labourers in Malaysia’s construction industry to be unpredictable. In certain years, the amount of foreign labour increased and then declined in the following years. However, the number of foreign labourers in 2013 (March) showed a huge increase compared with the previous years’ reported fluctuations. The fact that this trend is occurring suggests that, even though IBS systems have been implemented for a considerable period of time, the demand for foreign labour in the construction sector still remains high. Although the number of foreign labourers decreased in certain years, the overall trend shows that numbers have been growing over the past 13 years, highlighting the fact that the Malaysian construction industry is still heavily dependent on foreign labour for construction-related work.

REFERENCES