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Fourth International Conference on Sustainable Built Environment

PROCEEDING

The 4th International Conference on Sustainable Built Environment

"Sustainable Bulding and Environment for Sophisticated Life"

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The 4th International Conference on Sustainable Built and Environment

Sustainable Building and Environment for Sophisticated Life

October 12-14, 2016

Yogyakarta

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Welcome Speech

The Dean - Faculty of Civil Engineering and Planning, Universitas Islam Indonesia

Assalamu'alaikum warrahmatullahi wabarakatuh
The honorable:

- Rector of UII, Dr. Harsoyo,
- Conference Partners: University of Hawai'i at Manoa – USA, Univesity of Rhode Island – USA, Hokkaido University – Japan, University of Rhode Island (URI), - USA, National Cheng Kung University – Taiwan, PT. Waskita Sangir Energi, Persatuan Insinyur Indonesia (PII) and Intakindo
- Keynote speakers: Prof. Dolores Foley, Prof. Thomas Boving, Prof. Masahiko Fujii, Prof. Tsair Fuh Lin, Mr. Ibnu Sina and Mr. Surahman
- Participants of the 4th ICSBE 2016
- Distinguished Guests, ladies and gentlemen,

First of all, praise be to Allah, the Cherisher and Sustainer of the world, for His blessing for all of us. He who has provided us a chance so that we could be here to share knowledge, ideas, solutions and experiences in the Fourth International Conference on Sustainable Built Environment (ICSBE) 2016. To the academicians, our colleagues from overseas universities, guests, participants, students and so on, please accept our gratitude, warm welcome and appreciation.

The sustainability of green infrastructure and environment is a common thing to be realized without compromising the ability of future generation. It must be done to prevent any adverseimpacts on our lives such as air and water pollution, land use and contamination, material depletion, impacts on human health, and climate change. Therefore, it is expected that the incorporation of sustainable development concept in terms of research, product, and values will enhance the energy performance of environment development and bring about building sustainability as well as disaster management. The needs should merge with the improvement of global development to create a sophisticated life.

The Fourth International Conference on Sustainable Built Environment (ICSBE) 2014 takes issues in this urgent agenda of **Sustainable Building and Environment for Sophisticated Life**". The conference plays role as the media to share wisdom and experiences, and develop knowledge as well as skill and recent technologies on the applicationof built environmental sciences and technologies.

Let me deeply express a special appreciation to the speakers: Prof. Dolores - University of Hawai'i at Manoa, USA, Prof. Thomas Boving – University of Rhode Island (URI), USA, Prof. Masahiko Fujii - Hokkaido University, Japan, Prof. Lin – Cheng Kung University, Taiwan, Mr. Surachman-PT. WaskitaSangir Energy, Mr. IbnuSina- Major of Banjarmasin. Our appreciation is also for all the participants who have actively written excellent research papers.

Finally, my special thanks go to the Rector of UII, all the steering and organizing committees for making this conference possible. It is desired to have a sustainable conference to be continuously held in the future times, as we are challenged to make a sustainable building and environment for a sophisticated life.

Wassalamu'alaikum warrahmatullahi wabarakatuh

Yogyakarta, October 12, 2016
Faculty of Civil Engineering and Planning (FCEP), Universitas Islam Indonesia
Dr.-Ing. WidodoBrontowiyono.
The Dean

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Welcome Speech

The Rector - Universitas Islam Indonesia

The Honorable:

- Dean of Faculty of Civil Engineering and Planning Universitas Islam Indonesia, Dr. –Ing. Ir. Widodo, M.Sc
- All the keynote speakers of this conference: Prof. Dolores Foley (from University of Hawaii at Manoa, USA), Prof. Thomas Boving (from University of Rhode Island, USA), Prof. Tsair Fuh Lin (from National Cheng Kung, Taiwan), Ibnu Sina S.Pi., M.Si., (as a Mayor of Banjarmasin), Prof. Masahiko Fujii (from Hokkaido University), Ir. Surachman, M.Tech. (Director of PT. Waskita Sangir Energi)
- Distinguished participants, ladies, and gentlemen

Assalamu'alaikum Warahmatullahi Wabarakatuh,

On this special occasion, let me invite you to praise Allah SWT for His mercy and grace that we are able to attend the 4th International Conference on Sustainable Built Environment (ICSBE) today.

On behalf of the university, I warmly welcome you, all the impressive keynote speakers and participants. Welcome to Universitas Islam Indonesia, the oldest national university in the country.

Distinguished guests, ladies, and gentlemen,

In September 2015, The United Nations (UN) held The UN Development Summit that formally adopted the agreement "Transforming our World: The 2030 Agenda for Sustainable Development". The summit embraced the three dimensions of sustainability, such us economic, social and environment. The summit also aimed at ending global poverty and building a life of dignity for all. That was a generally accepted concept of Sustainable Development Goals (SDGs) in the world. The report of the 1987 World Environment and Development Committee argues that "Sustainable development is development that meets the needs of prevention without compromising the ability of future generations to meet their own needs".

Three dimensions of sustainable development which consist of society, economy and environment should exist together. Economic development should not depend on excessive resource consumption; meanwhile, environmental sustainable development should be considered more important. This 4th ICSBE 2016 is conducted to provide the opportunity for government officials, researchers, academicians, industry practitioners, non-governmental and multinational organization staffs and other stakeholders to share their views and experiences to build international collaborative networks on managing sustainable development.

Some important issues that will be presented on this seminar are about how to manage sustainable development through Green Infrastructure, Sustainable Resources Management, and Sustainable City. I do hope that this conference will inspire us to enhance our awareness to explore any possibilities in involving sustainable development. Also, I look forward to hearing discussions (on these topics) and I hope we can be inspired by the best practices we will hear from our distinguished speakers.

Finally, by reciting "Bismillahirrahmanirrahim" hereby I officially open the event of the 4th International Conference on Sustainable Built Environment (ICSBE). May Allah always guide us and lighten our step.

Thank you.

Wassalamu'alaikum*Warahmatullahi Wabarakatuh.*

Yogyakarta, October 12-14, 2016

Dr. Harsoyo

Rector

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Preface

Dear Readers and Participants,

The 4th International Conference on Sustainable Built Environment (ICSBE), held in Yogyakarta on October 12-14, 2016, is biannual international conference organized by the Faculty of Civil Engineering and Planning, Islamic University of Indonesia (UII), Yogyakarta since 2010. The conference is aimed at nurturing the study, comprehension, and appreciation of the built environment.

The conference is intended to provide a forum for exchanging of ideas, sharing of knowledge, and dissemination of information on the study of the built environment from different parts of the world. It seeks to further develop regional and international network of academicians, professionals, and policy makers on the management of the built environment.

The first ICSBE was held in May 2010 in Yogyakarta, with the theme 'Enhancing Disaster Prevention and Mitigation', which attracted participants from 8 countries, who presented 74 selected papers. In response to the interests of the participants, the second was held in July 2012 with the theme "Livable Cities in Fast Growing Cities" and the third was held in October 2014 by theme "Resilience and Risk Reduction towards Well-being Society." There were more than 150 abstracts submitted and presented in the conference from several countries such as Indonesia, Malaysia, Philippine, Turkey, Thailand, USA, etc. Since the 4th ICSBE, ISSN (International Standard of Serial Number) is used instead of ISBN because the conference is organized regularly once in two years. In order to improve the quality of ICSBE, we select excellent papers and submit to international journal indexed by scopus (selected papers only).

The fourth ICSBE is supported by Hokkaido University, Japan, University of Hawaii at Manoa, USA, University of Rhode Island, USA, National Cheng Kung University, Taiwan, Government of Banjarmasin, PT. Waskita Sangir Energy, PII and Intakindo.

The theme of 4th ICSBE 2016 is **Sustainable Building and Environment for Sophisticated Life** and the sub-themes are: **Green Infrastructure, Sustainable Resources Management, Sustainable City and Special Issues on Disaster management.**

The 4th ICSBE is attended by worldwide participants such as Indonesia, Malaysia, Philippines, Thailand, India, Bangladesh, Australia, USA, Japan, Taiwan, etc. More than 140 abstracts and full papers were submitted and about 95 papers were selected to be presented during the conference.

Finally, on behalf of the organizing committee and organizing institution, we would like to deliver our gratitude to the participants and various parties for their financial support, especially to the Ministry of Research, Technology and Higher Education (RISTEK DIKTI).

Eko Siswoyo, Ph.D
Chairman of 4th ICSBE

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Conference Organization

Organizing institutions
Universitas Islam Indonesia, Indonesia
Hokkaido University, Japan
University of Rhode Island (URI), USA
National Cheng Kung University, Taiwan
University Hawaii at Manoa, USA

Supporting Organization
Ministry of Research, Technology and Higher Education, the Republic of Indonesia
Persatuan Insinyur Indonesia (PII)
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EDITORIAL

Nowadays, green infrastructure has been flourishing extensively worldwide so as to improve the quality of life. As what is seen from the conference, there are countless number of presented papers focused on this issue.. The widely studied green material to develop construction by covering the variation of filler on the building and pavement, the usage of wood, fiber usage, GGBS and slag in concrete, etc is one of the examples of such studies on green infrastructure. In addition, some studies also address the aspect of methodology, by aiming to shed light on design and assessments of green infrastructure.

Besides green infrastructure, the management of sustainable resources also has considerable significance to preserve the wellness of the earth. There were 35 papers written about the result of the optimization of some management methods for environmentally friendly surroundings with few papers aimed to focus on the aspect of assessment. Some of the papers presented the result of the management of waste, reservoir, raw water, and standard operating procedure. Hence, the material to support the management was also discussed from several types of chemicals particularly.

Those researches were expected to create sustainable city in some parts of the world extending from Some issues such as sustainable housing development and the activities that support sustainable city have been presented in this conference. Moreover, some breakthrough concepts to create a green city have also been developed such as sustainable transport system, climate change mitigation, and sustainable city planning. Altogether were expected to succeed the sustainable building and environment for sophisticated life.

Furthermore, there was also a theme of disaster management since Indonesia is renowned as prone to disaster areas and that many other parts of the world are also experiencing the same thing. These researches extend from disaster preparedness and the application of some tools for disaster resilience, and the disaster simulation to find the worst possible effect which may take place. These researches proposed people sense of belonging of the disaster and mitigation in areas of disaster. Lastly, the evaluations for all of which were conducted to know the best strategy to manage the disaster.

During discussion in the plenary session, some questions such as how to prevent and minimize the impact of disaster, what should be done to deal with crisis of energy, what is the most suitable water treatment technology in Indonesia and what will Kalimantan do to protect rivers were addresed to the keynote speakers. Answering these questions, Professor Dolores mentioned that people in Indonesia should get an insight and understanding on the potency of natural hazard in their area. Professor Fujii said that Indonesia should consider about microhydro energy for power plant. Furthermore, Mr. Surachman suggested that biomass energy will provide us with huge benefit because the sources were abundant in this country. Prof. Boving from Rhode Island University who was totally familiar with the condtion in Indonesia proposed the filtration system for water supply. In the parallel session, the discusion was well organized by each moderator in four different rooms based on each topic. The participant from Thailand was interested on the development of bioadsorbent prepared from tofu waste in Indonesia. Questions such as what was the recent condition about green infrastructure in Indonesia, the impact of rapid land use change, the potencial energy sources, etc were discussed extensively.

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KEYNOTE SPEAKERS' ABSTRACT

THE RESILIENCE IMPERATIVE: STRENGTHENING COMMUNITY RESILIENCE THROUGH TRAINING

Dolores Foley
University of Hawaii at Manoa, USA

Abstract: Earthquakes, hurricanes, tsunamis etc. have all caused enormous damage and suffering over the last century. As we consider climate change, sea level rise but also the movement of populations to coastal areas and hazard zones the combination of factors – geologic, climatic, environmental, social and economic- threatens an unprecedented risk of the loss of lives, homes, jobs, and businesses. In this time of great environmental and economic uncertainty, resilience has emerged as a key aspiration in long-range development and planning. The argument is, if communities are to become resilient and minimize the cost of disasters in terms of lives and economic losses they will first need to develop a culture of preparedness and adaptation. Communities need to have access to the planning tools, data, and resources to learn and adapt to changing climate and environments.

Keywords: Adaptability; Disaster risk reduction; Planning tools

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STORMWATER RUN-OFF AND NONPOINT SOURCE POLLUTION MANAGEMENT WITH TREE FILTERS INRHODE ISLAND, USA

Thomas Boving
Dept. of Geosciences, Dept. of Civil and Environmental Engineering, University of Rhode Island, USA

Laura Schifman
Dept. of Civil and Environmental Engineering, University of Rhode Island, USA

Abstract: Stormwater runoff is one of the main contributors of non-point source pollution in many countries, introducing high loads of contaminants into surface water bodies and posing a threat to the ecosystem and human health. In the United States, stormwater treatment standards have not yet been introduced on a federal level, however increasingly more states require at least primary treatment of stormwater runoff to prevent water quality degradation of surface waters. Rhode Island, located in the Northeastern part of the U.S., has set contaminant reduction standards for stormwater runoff that has been treated by structural best management practices (BMP). Those standards require nutrients (nitrate and phosphate) to be reduced by 30%, pathogens by 60%, and total suspended solids by 85%. As BMP performance depends on geographical location and climate, and the Northeastern United States experiences broad ranges of temperatures throughout the year along with long intermittent periods between precipitation events, stormwater treatment can be challenging. At the University of Rhode Island, a Stormwater Technology Demonstration facility is used for testing BMP practices under real world conditions. Besides permeable pavement, bioswales and retention BMPs, the demonstration facility also features tree filter (TF) technology.
In a year-long field study, two tree filters were evaluated: a conventional unit (CTF) with sand/shale mix as filter media, and a modified tree filter (ITF) with an added layer of red cedar wood chips amended with 3-(trihydroxysilyl)propyldimethyloctadecyl ammonium chloride. Based on laboratory tests, the addition of amended wood enhances the removal of bacteria, dissolved heavy metals and petroleum hydrocarbons. Twelve constituents were analyzed (pH, specific conductance, chloride, nitrate, phosphate, total suspended solids, copper, nickel, lead, zinc, and a special focus on Escherichia coli and polycyclic aromatic hydrocarbons). Both tree filters met or outperformed RI's standards for bacteria removal (60%) and TSS (85%), making them a good choice for BMP use in this climate. Total suspended solids, E. coli, PAHs, nitrate, and phosphate removal is higher in ITF. A controlled field scale tracer test using E. coli confirmed these results. The results suggest that Tree Filter BMPs are a robust stormwater treatment technology that can be easily integrated into stormwater management plans inside and outside the study area.

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EXPLORING AND DEVELOPING THE POTENTIAL OF RIVERS IN BANJARMASIN CITY

Ibnu Sina
Mayor of Banjarmasin, Indonesia

Abstarct: Since several years ago, the existence of rivers in Banjarmasin is well retained in order to support the social cultural and economic of public in the city. River transportation for daily life and activities along the river in Banjarmasin makes this city become very unique and gives benefit for tourism. In the other hand, the presence of the rivers is also urgent and most effective for flood control. Therefore, as a city for trading and service, in the future Banjarmasin is expected to become a comfortable city which is free of flood. In addition, the development of the tourism sector is expected to contribute significantly for the economy of the city.

Exploring the potencial and uniqueness of Banjarmasin city is important for the growth and development of the city. Having called as "River City", it is necessary that the rivers in Banjarmasin to have an added value and become a strategic thing for Banjarmasin. Thus, this is unseparable from the socio cultural as well as the economic life of the residents of Banjarmasin city as the character and identity of Banjarmasin.

At the present time, approximately 75% of the area in Banjarmasin city is covered by the residential buildings, office, service trade buliding, etc. This makes many of the rivers become not functioning as they should. The surface of the rivers is affected by the tide with the height difference of 2 meter and this is worsen by the flood coming from Barito and Martapura rivers as well as the intense rainfall which is 300 milimeter. The location of the city, which is in the down stream area of the rivers, makes the city become prone to flooding when those 3 above phenomena occur simultaneously.

Due to the rapid development and the characteristic of the city area, flood becomes a latent threat that must be wary of. The programs for disaster mitigation must be arranged and well prepared to face this.

However, until today, there are 102 rivers which are still functioning well and can be used as the water sources for the residents. So, the role and function of rivers as the basis for the development of the city is of importance. The arrangement of the riverbanks and the management of the rivers must be conducted by the city organizer and the residents of the city because the rivers have an important role and function to support the life of the city residents.

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ASSESSMENT OF THE POTENTIAL FOR DEVELOPING MINI/MICRO HYDROPOWER: A CASE STUDY IN BEPPU CITY, JAPAN

Masahiko Fujii
Soichiro Tanabe
Makoto Yamada
Taketoshi Mishima
Takahiro Sawadate
Shinji Ohsawa
Faculty of Environmental Earth Science, Hokkaido University, Japan

Abstract: This study aims to provide quantitative guidelines necessary for capacity building among various stakeholders to minimize water-energy conflicts in developing mini/micro hydropower (MHP), a baseload renewable energy that is socially necessary, not only to reduce greenhouse gas emissions but also to vitalize local economies by creating jobs related to MHP operations. Using three different methods to calculate river water levels and discharges, the potential power generation by MHP was estimated for six rivers in Beppu City, Japan. Our results show that installation of MHP facilities can provide stable electricity for tens to hundreds of residents in local communities along the rivers. However, the results are based on the existing infrastructure, such as roads and electric lines. This means that greater potential is expected if additional infrastructures are built to develop further MHP facilities. On the other hand, in Japan, river laws and irrigation right regulations currently restrict new entry by actors to rivers. Therefore, to further develop MHP, deregulation of the existing laws relevant to rivers and further incentives for business owners of MHP facilities, along with the current feed-in tariffs, are required. Meanwhile, possible influences to riverine ecosystems when installing new MHP facilities should also be taken into account.

Keywords: Generated power; Hot spring water; Mini/micro hydropower (MHP); Riverine ecosystem

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BIOMASS AS A MODEL OF SUSTAINABLE RENEWABLE ENERGY AS A SUBSTITUTE FOR COAL-BASED THE COMMUNITY ECONOMY

Surahman
Waskita Sangir Energy, Indonesia

Abstract: According EBTKE (2015) Program of the National Electricity 35,000 MW is a government project to build power plants reached 35,000 Mega Watt up to 35 thousand MW 2019. The program aims to meet the demand of Indonesia electricity needs from *Sabang* to *Merauke*. This will certainly have a significant impact on economic growth outside Java, which was previously a shortage of electricity supply.
The Government has committed to realize the supply of electricity of 35,000 Megawatts (MW) within a period of 5 years (2014-2019). Throughout the next 5 years, the government and private together with PLN will build 109 plants; each comprising 35 projects by PLN with a total capacity of 10 681 MW and 74 projects by private / Independent Power Producer (IPP) with a total capacity of 25 904 MW. And in 2015 the company will sign a contract of 10 thousand MW power plants as the first phase of the total 35 thousand MW.
With a projected economic growth of *6% up to 7% per year*, additional electricity capacity in the country needs at least 7,000 megawatts (MW) per year. That is, in the next five years, 35,000 MW additional capacities becomes a necessity. The need for 35 thousand MW has been confirmed in the document of the National Medium Term Development Plan (RPJMN) 2015-2019.
The average energy consumption of 199 TWh, while production of 228 TWh of electrical power (only *PLN* and *IPP*). National electrification ratio stood at 84.35%. The electricity consumption for household categories, *namely by 43%, followed by industry at 33%, 18% and last business 6% public.*
As for the energy mix to procure electricity mix are as follows: *coal 52%,gas 24%, fuel oil 11.7%, water 6.4%, geothermal 4.4% and other energy amounted to 0.4%* , thus the use of coal in Indonesia is still very large although Coal belongs to the group of renewable energy instead of (*Non renewable energy*).
The use of coal for electricity demand in Indonesia is still very large, while the power plant using coal is not included in a group of environmentally friendly energy due to the impact of burning coal is likely to cause environmental pollution such as *air pollution, resulting in acid rain and can damage marine life due to damage coral reef ecosystems.*
Based on the above conditions it is necessary to find a replacement for environmentally friendly fuels to be used as a substitute for coal which has a heat rate (heat content) is nearly equal to coal, which is about *4800 up to 6500 kilo calories.*
One of the natural resources which are environmentally friendly and renewable is an organic fuel that contains carbon, so that the resulting combustion only emit *CO2* that can be neutralized and absorbed by plants and vegetation in the vicinity.
One of the plants that have the potential of biomass energy has a heat rate is high and can be used for other needs is *Calliandra red flower* (*Calliandra colothyrsus*), because in addition to the stem used for biomass energy, the leaves can be used as animal feed (goat / cow) because has a high protein and interest to the needs of beekeeping (*calliandra honey*).
When all the land as "idle" throughout Indonesia Calliandra planted by the people, the people will benefit a lot for planting only once until the age of 25-30 next years .Thus it can be said *Calliandra Colothyrsus* Investment based democratic economy, because then it is the people who will be as owners of "mine" coal substitutes, during which only are owned by the large investors.

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HARMFUL CYANOBACTERIA AND THEIR METABOLITES IN DRINKING WATER SYSTEMS: BIOMOLECULAR MONITORING AND OXIDATION TREATMENT

Tsair-Fuh Lin
Yi-Ting Chiu
Yi-Ting Chen
Che-Wei Chang
Yi-Hsuan Chen
Hsiu-Lien Lin
Department of Environmental Engineering, National Cheng Kung University, Taiwan

Abstract: Presence of cyanobacteria in lake and reservoirs has become an important issue to public water supply in many countries. Many cyanobacteria may produce harmful cyanotoxins and/or taste and odor compounds, posing potential risk to human and diminishing the aesthetic value of the water. Therefore, monitoring and treatment of cyanobacteria and their metabolites are important for safeguard the quality of drinking water. In this presentation, two topics will be covered: (1) biomelcular monitoring of toxin and taste and odor producing cyanobacteria in reservoirs, and (2) modeling the oxidation treatment of harmful cyanobacteria and their metabolites in water.

A qPCR based biomolecular monitoring approach was developed for monitoring the producers of five cyanotoxins and T&O compounds, including microcystin, cylindrospermopsin, saxitoxin, geosmin, and 2-MIB in reservoirs. The approach has been applied in *on-site* monitoring of 38 reservoirs in Taiwan for more than 4 years. Field results suggested that the abundance of the producing genes correlates with corresponding metabolites reasonably well. Since the developed method is able to be conducted *on-site* and the results can be obtained within three hours, the biomolecular monitoring scheme may provide timely and useful information for water utilities and reservoir managers to justify the risk of the cyanotoxin and T&O compounds in their source waters and to trigger appropriate response actions.

Two typical oxidants used in water treatment plants and/or reservoirs for the control of cyanobacteria, including hydrogen peroxide and chlorine, are studied and modelled for their effect of on cell integrity and destruction of metabolites during the oxidation processes. Sequential kinetic models were successfully developed to simulate the concentrations change of chorine decay, radical production, and cell rupture during chlorination and hydrogen peroxide oxidation. The model also successfully predicts the degradation of microcystin during the oxidation processes. The developed models may provide a simple means to estimate the dose and contact time required when oxidants are used for the control of cyanobacteria in water treatment plants and reservoirs.

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RESTORATION OF URBAN RIVER AREA BASED ON THE *M3K* CONCEPT

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Abstract: Urban problems have become more complex as time goes by. Urbanization rate seems uncontrolled, and population growth is augmenting. It implies that the need for land and living space is growing. On the other hand, land availability has remained static or even declined. It means there has been a deficit or crisis of environmental carrying capacity. One of the areas that become the object of urban problem complexity is the riverbank. This area should ideally function as green open space, but it has in fact been covered by settlements that go run-down. As a data sample, the area of slums in Yogyakarta City has reached 278.7 hectare or 8.17% of the city extent. Approximately 90% of the slums are located along riverbanks. Therefore, riverbank area requires a restoration effort to revitalize its function and condition in accordance with the principles of conservation as well as humanity. The proposed concept was then *M3K* (*Mundur, Munggah, Madhep Kali*)or retreating settlements from the riverbank, building vertical settlements, and facing towards the river. The implementation of M3K should be integrated and sustainable. The harmony among related aspects and sectors is performed through systematic and participative phasing. The affected community ought to be involved from the start during the identification and stocktaking, economic study of the land, as well as area planning. This program can be optimized, for example, through a Community-Based Environmental Planning (*PLBK*) that is preceded by the establishment of Action Plan for Settlement Environmental Planning (*RTLP*). In addition, the leaders' political commitment is required in order to optimize the implementation of this M3K-based program.

Keywords: *M3K*;Restoration; River; Slum

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WASTE MANAGEMENT OF TOLL ROADS TOWARDS GREEN INFRASTRUCTURE IN INDONESIA

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ABSTRACT

Waste management is a complex problem in Indonesia. There are waste and waste disposal heaps at many locations, for examples in residential areas, traditional markets, sightseeing locations, unused-land, drains and road sides in the city, and also on toll road side. The aim of this study is to find out how to manage waste and reduce the illegal waste disposal along toll road side in Indonesia. Based on the monitoring data on all 29 toll roads in Indonesia i.e. toll roads in Java island, Sumatra island, Bali island, and Sulawesi island, there are many illegal waste disposal sites found at many locations along toll road sides, especially on the inter-city toll roads. Therefore, waste management of toll road in order to develop green infrastructure in Indonesia is crucial. Waste management could begin with periodic monitoring along the toll road, availability of waste/trash disposal receptacles at each rest-area, cooperation between road authority and the local government to manage waste and educate the society, develop holistic and integrated waste disposal management, regular campaign regarding 3R (reduce-reuse-recycle) until the adherence to public orderliness regulation. Results of this study are beneficial to manage waste and reduce illegal waste disposal locations along toll road side towards green infrastructure, not only in Indonesia but also in other developing countries with similar conditions.

Keywords: Developing countries, Green infrastructure, Indonesia, Toll road, Waste management

1. INTRODUCTION

Waste management is a crucial problem in many countries especially in developing country like Indonesia. In Indonesia, waste and illegal waste disposal are in residential areas, traditional markets, sightseeing locations, unused-land, drains and road sides in the city, and also on toll road side. Periodic monitoring data of toll road to fulfill minimum service standard also indicated that there are many illegal waste disposal sites found at many locations along the toll road side.

The aim of this study is to find out how to manage waste and reduce illegal waste disposal along toll road side in Indonesia. Data used and presented in this study is from all 29 toll roads in Indonesia. Results of this study are beneficial to manage waste and reduce illegal waste disposal locations along toll road side towards green infrastructure, in Indonesia and in other developing countries with similar conditions.

2. WASTE AND WASTE DISPOSAL IN INDONESIA

Waste and waste disposal in Indonesia is a complex, crucial, and not a new problem. The problem is more complicated due to high number of population, limited number of

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waste bin in the public areas, limited number of waste-truck, limited number and location of waste disposal, and poor waste disposal integrated management. If most of 2.461.931 million people (Indonesia Statistics Central Bureau, 2012) in Indonesia do not have a good habit to put the waste in a bin and furthermore have no awareness about the importance of sanitary and the aesthethic of the living space environment, therefore it is a huge problem and crucial to be solved.

In Indonesia, waste is usually piled up at many places including along the toll road side. Waste can be an organic and inorganic waste for example vegetation waste, food waste, plastic bottles, paper, animal carcasses, litter, sediment, and soil material. The condition leads to the overflow and flood in the city if rain occurs. Furthermore, the traffic congestion usually happened and traffic accident can be happened because of the flood.

The environmental issues specific to the construction and operation of roads include the habitat alteration and fragmentation, stormwater, waste, noise, air emissions, and wastewater. Solid waste generation during operation and maintenance may include road resurfacing waste, road litter, illegally dumped waste or general solid waste from the rest areas, animal carcasses, vegetation waste, paint waste, and sediment and sludge from stormwater drainage system maintenance (University of New Hampshire, 2001; World Bank Group, 2007; Austroads, Inc. 2003).

On the toll roads in Indonesia, many bus, trucks, and passenger car drivers throw the waste directly to the road. Waste can be cigarette ash, cigarette stub, tissue paper, and plastic bottle. Awareness of every people for not throwing the waste directly to the road is needed. In this poor condition, waste management problem cannot be ony dependent on the government waste employee. All level of societies are needed to contribute to the efficient and effective process to produce sanitary and pleasant environment, in their own responsibility.

2.1. Waste and waste disposal regulation

In general, it is government's responsibility to solve the problems regarding waste and waste disposal. There is a regulation regarding public orderliness and waste disposal at national and district level. At national level, there is Republic of Indonesia law number 18 year 2008 regarding waste disposal. It states about the kind of waste, location of waste disposal, responsibility and authority of government to assure a good waste disposal management based on the environment concept, society role, and prohibited actions to pollute the environment.

At the district level, there is the governor of special district of Jakarta province regulation number 8 year 2007 regarding public orderliness. Article 21 of the regulation said that each people or corporation is prohibited to: a. scratch, write, draw, attach advertisement on wall, bridge, pedestrian-bridge, bus stop, electric pole, tree, public transportation, and other public means; b. throw away and pile up waste on the street, plant stripe, river, and other places that can impair aesthetics and sanitation of environment; c. throw feces and litter on the road, garden, river, and drain.

2.2. Previous studies

Keep America Beautiful in 2009 indicated that the personal factor (behavior and poor knowledge regarding waste), social factor (daily life to keep living space clean by moving waste into the nearest place), and material factor (availability of trash bin and poor waste management) are factors that influence the availability of waste.

A study on one toll road in West Java, Indonesia, i.e. Purbaleunyi toll road (Utami, Gerienta Putu and Santosa, Wimpy, 2015) indicated that based on the questionnaire results givent to the society living near to the toll road, factors that influence the society behavior for throwing the waste away to toll road site is because the toll road side location is close to the society's living place, usual behavior to throw away waste to toll road site, dirty condition of toll road site, and unavailablity of the trash bin around their living place. On the other hand, the age, education level, and occupation are not related to such behavior.

3. CASE STUDY AND FIELD DATA

Case study id carried out on all 29 toll roads in Indonesia. They located in Sumatra island, Java island, Bali island, Sulawesi island, and connected to Madura island. Routine monitoring regarding the toll road condition to fulfill the minimum service standard also indicated that there are many illegal waste disposal sites found at many locations along the toll road sides.

Figure 1 presented the photos of the illegal waste disposal on toll road side in Indonesia. Table 1 presented the detail location of illegal waste disposal along the 29 toll road sides in both directions in Indonesia and Table 2 presented the number of locations of waste disposal along the 29 toll road sides in both directions.

In more detail, the number of waste disposal is not related to the length of the toll road but related to the location of housing or residential areas along the toll road side. Table 2 also shows that there are no illegal waste disposal locations on 14 out of 29 toll roads, whereas there are illegal waste disposal locations on 15 out of 29 toll roads. In more detail 10 out of the 15 toll roads lie at inter-city.

Figure 1 Illegal waste disposal on toll road side in Indonesia (BPJT, 2014)

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Table 1 Detail location of waste disposal along toll road side in Indonesia (BPJT, 2014)

No.	Toll Road		Detail Location of Waste Disposal
	Name	Length (km)	
1	Jakarta-Bogor-Ciawi	59.00	A direction: km 4+200, km 7+600, km 7+800, km 8+400, km 8+800, km 9+000, km 10+900, km 11+000, km 11+200, km 11+600, km 11+800, km 12+200, km 14+900, km 16+500, km 18+400, km 20+800, km 21+800, km 22+000, km 22+200, km 22+600, km 23+200, km 23+400, km 24+000, km 25+600, km 25+800, km 26+000, km 26+400, km 26+600, km 26+800, km 27+600, km 27+750, km 28+000, km 28+400, km 28+500, km 29+000, km 29+200, km 29+400, km 29+500, km 29+600, km 30+000, km 30+200, km 30+500, km 31+000, km 31+400, km 31+800, km 37+300, km 38+400, km 42+200 B direction: km 47+200, km 46+000, km 45+400, km 44+000, km 36+000, km 31+800, km 30+800, km 30+200, km 28+800, km 28+500, km 27+850, km 27+000, km 25+300, km 25+200, km 24+600, km 23+200, km 23+000, km 21+550, km 18+000, km 12+400, km 11+000, km 10+300, km 9+200, km 8+600, km 8+200, km 6+000, km 5+400
2	Jakarta-Tangerang	33.00	A direction: km 3+650, km 6+300, km 9+800, km 8+300, km 10+200, km 10+600, km 13+100, km 13+800, km 14+800, km 23+400 B direction: km 26+250, km 23+800, km 22+900, km 18+000, km 17+400, km 14+600, km 10+200, km 8+200
3	Cawing-Tomang-Grogol-Pluit	23.55	----
4	Prof.Dr. Ir. Sedyatmo	14.30	----
5	JORR	50.42	A direction: km 2+400, km 3+800, km 4+000, km 25+400, km 39+500, km 45+000, km 45+200, km 47+900, km 48+200, km 49+000, km 56+600 B direction: km 49+200, km 18+000
6	Pondok Aren-Bintaro Viaduct-Ulujami	5.55	A direction: km 1+200, km 2+000, km 2+200, km 3+600 B direction: km 3+800
7	Jakarta-Cikampek	83.00	A direction: km 4+800, km 5+200, km 5+500, km 6+300, km 10+400, km 10+500, km 10+800, km 14+600, km 15+000, km 15+100, km 20+500, km 20+700, km 35+200, km 42+000, km 51+000, km 59+500, km 63+600, km 65+400 B direction: km 71+600, km 54+800, km 37+800, km 37+000, km 34+600, km 23+800, km 16+000
8	Padalarang-Cileunyi	64.40	A direction: on/off ramp Pasteur, km 122+400, km 131+800A, km 134A+600A, km 136+600A B direction: km 147+800, km 146+800, km 144+000, km 138+400, km 133+800, km 128+000, on/off ramp Moh. Toha, on ramp Kopo, on/off ramp Pasir Koja
9	Cikampek-Purwakarta-Padalarang	58.50	A direction: km 85+000, off ramp Padalarang, km 122+400, km 126A+600
10	Palimanan-Plumbon-Kanci	26.30	A direction: km 207+400, km 208+800, km 212+300, km 212+800, km 220+300, km 221+300, km 225+400, km 227+300, km 224+400, km 229+700 B direction: km 226+100, km 225+300, km 220+400, km 218+000, km 217+000, km 215+000, km 211+050, km 209+600, km 209+200

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Table 1. Detail location of waste disposal along toll road side in Indonesia (BPJT, 2014) continue

11	Semarang Section A, B, C	24.75	A direction: km 1+200, km 4+400, km 7+300, km 7+400 Seksi A, km 12+200 Seksi C B direction: km 11+400, km 11+200 Seksi C, km 17+400, km 11+500, km 12+200, km 11+200, km 8+200, km 7+200, km 4+200, km 2+000, km 1+200, km 0+400, km 0+200
12	Surabaya-Gempol	49.00	A direction: km 4+200, km 5+200, km 5+600, km 5+800, km 6+000, km 13+400, km 20+600, km 34+200 B direction: km 33+200, km 22+600, km 7+200, km 7+000, km 6+800, km 6+600, km 6+400, km 6+200, km 5+200, km 4+000
13	Belawan-Medan-Tanjung Morawa	42.70	A direction: km 11+400, km 11+200 Seksi C, km 17+400, km 11+500, km 12+200, km 11+200, km 8+200, km 7+200, km 4+200, km 2+000 B direction: km 11+400, km 11+200 Seksi C, km 17+400, km 11+500, km 12+200, km 11+200, km 8+200, km 7+200, km 4+200, km 2+000
14	Jembatan Surabaya-Madura	5.40	----
15	Cawing-Tj Priok-Ancol Timur-Jbt Tiga/Pluit	27.05	----
16	Tanggerang-Merak	73.00	A direction: km 27+750, km 28+500, km 40+150, km 40+400, km 40+850, km 40+900, km 41+000, km 43+000, km 69+500, km 71+150, km 73+500, km 74+200, km 81+400, km 81+800, km 90+000, km 94+500 B direction: km 98+500, km 96+000, km 94+400, km 94+250, km 94+100, km 94+000, km 83+000, km 82+200, km 82+100, km 82+000, km 81+750, km 80+000, km 76+750, km 68+750, km 65+ 250, km 57+600, km 27+650
17	Surabaya-Gresik	20.70	A direction: km 2+200, km 4+300, km 13+200, km 13+600, km 14+700, km 15+100, km 17+800, km 18+000 B direction: km 17+400, km 13+200, km 12+800, km 12+600
18	Serpong-Pondok Aren	7.25	A direction: km 7+200, km 8+400 B direction: km 10+400, km 8+400, km 8+000
19	Ujung Pandang Seksi I dan II	6.05	A direction: km 1+200, km 1+250, km 2+000, km 2+400, km 3+500, km 4+400, km 5+400
20	S S Waru-Bandara Juanda	12.80	----
21	Makassar Seksi IV	11.60	----
22	Bogor Ring Road Seksi I	3.85	----
23	Kanci-Pejagan	35.00	----
24	JORR W1(Kebon Jeruk-Penjaringan)	9.85	----
25	Surabaya-Mojokerto	1.89	----
26	Semarang-Solo Seksi I	11.00	----
27	Cinere-Jagorawi Seksi I	3.70	----
28	JORR W2 Utara	7.70	A direction: km 12+700
29	Nusa Dua-Ngurah Rai-Benoa	9.70	----

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Table 2 Number of waste disposal location along toll road side in Indonesia (BPJT, 2014)

No.	Toll Road		Location	Number of Location of Waste Disposal	
	Name	Length (km)	1: urban 2: inter city	A direction	B direction
1	Jakarta-Bogor-Ciawi	59.00	2	48	27
2	Jakarta-Tangerang	33.00	2	10	8
3	Cawing-Tomang-Grogol-Pluit	23.55	1	0	0
4	Prof.Dr. Ir. Sedyatmo	14.30	1	0	0
5	JORR	50.42	1	11	2
6	Pondok Aren-Bintaro Viaduct-Ulujami	5.55	1	4	1
7	Jakarta-Cikampek	83.00	2	19	7
8	Padalarang-Cileunyi	64.40	2	5	9
9	Cikampek-Purwakarta-Padalarang	58.50	2	4	0
10	Palimanan-Plumbon-Kanci	26.30	2	10	9
11	Semarang Section A, B, C	24.75	1	5	12
12	Surabaya-Gempol	49.00	2	9	10
13	Belawan-Medan-Tanjung Morawa	42.70	2	9	10
14	Jembatan Surabaya-Madura	5.40	2	0	0
15	Cawing-Tj Priok-Ancol Timur-Jbt Tiga/Pluit	27.05	1	0	0
16	Tanggerang-Merak	73.00	2	16	17
17	Surabaya-Gresik	20.70	2	8	4
18	Serpong-Pondok Aren	7.25	1	2	3
19	Ujung Pandang Seksi I dan II	6.05	1	7	0
20	S S Waru-Bandara Juanda	12.80	1	0	0
21	Makassar Seksi IV	11.60	1	0	0
22	Bogor Ring Road Seksi I	3.85	1	0	0
23	Kanci-Pejagan	35.00	2	0	0
24	JORR W1(Kebon Jeruk-Penjaringan)	9.85	1	0	0
25	Surabaya-Mojokerto	1.89	2	0	0
26	Semarang-Solo Seksi I	11.00	2	0	0
27	Cinere-Jagorawi Seksi I	3.70	2	0	0
28	JORR W2 Utara	7.70	1	1	0
29	Nusa Dua-Ngurah Rai-Benoa	9.70	1	0	0

4. ANALYSIS AND RESULTS STUDY

Although there are public orderliness regulations as mentioned in section 3.1, the implementation of the regulation was very low and furthermore, the punishment regarding this regulation is also not consistent. If this case occurs continuously, then the waste and illegal waste disposal problems cannot be solved and can cause disturbance for the aesthetics, environment, healthy, overflow, and flood. On the other hand, good society habit of reduce, reuse, and recycle (3R) principle of waste are also important. Therefore, in order to have a good solution, a consistent implementation of the regulation as well as the implementation of 3R including using reuse things need to be done holistically.

Data of illegal waste disposal locations in Table 1 and Table 2 is an initial step to develop waste management problem along toll road side in Indonesia. The availability of the accurate, complete, and up to date recorded data of road and traffic conditions (Sutandi, A. Caroline, 2015) is needed to support implementation of green infrastructure. Based on the detaied data, further simultaneous steps of good waste management to overcome illegal waste disposal problem along toll road side are as follows:

- Periodic monitoring to collect the real accurate and continuous data of illegal waste disposal condition and location along toll road side. The application of the traffic camera as a part of intelligent transportation systems (ITS) will be beneficial. The main purpose of ITS implementation is to increase the safety aspect and to support actions and steps towards green infrastructure (Ghosh, Sumit, Lee, Tony S., 2010).

Furthermore, the availability of trained personnel, required and maintained equipment, and standard operating procedure is needed;

- Rather than do nothing, it is better that at the meantime, the societycollect all the waste/trash along toll road side using available waste-truck and take them to waste disposal. Cooperation among road authority and government at national, province, regency, and city level along toll road location is needed;
- The availability of waste/trash disposal receptacles at parking area at each rest area and residential area along toll road;
- Finding out reasons regarding the habit of the society to litter along toll road side (BPJT, 2014);
- Cooperation with mayor, regent, village chief, and neighborhood association to educate society and inform them about the importance of sanitation, healthy life habit and also bad impact of waste on environment around them;
- Enhancement of right of way esthetics especially at potential illegal waste disposal locations along toll road side (BPJT, 2014);
- Develop holistic and integrated waste disposal management. It can be started with the availability of waste dump with an adequate number and capacity at the residential areas and public areas, availability of government waste employees with adequate number and competency, periodic waste collecting schedule, last waste disposal, waste management with technology that can produce fertilizer and electrical energy as a renewable energy;
- Regular campaign to society regarding the importance of 3R (reduce, re-use, recycle) program. Society has to be involved in order to keep and remind each other about their responsibility in order to have their own sanitary and healthy living space. Continuous and consistent campaign will lead to a good result;
- Adherence to public orderliness regulation, especially regulation regarding waste disposal. For example restriction to littering along the road and river, availability of small waste bin in the car. Another important thing is a consistent implementation of punishment to the offender;
- Do the simultaneous steps continuously in order to have healthy life habit of the society. Time is needed to make society aware about the sanitary and healthy life;

Simultaneous steps of good waste management mentioned earlier can also be implemented in other road side locations beside toll road side. Furthermore, the good waste management also supports the action to decrease the number and severity of accident before, during, and after the accident occurs (Sutandi, A. Caroline, 2015).

5. CONCLUSION

Waste management is a complex, crucial, and not a new problem in Indonesia as a developing country. Waste and illegal waste disposal are not only located at the residential areas in the city but also located along toll road side. The condition leads to the poor sanitary and healthy living space. Good waste management regarding simultaneous steps to overcome illegal waste disposal problem along toll road side begins with the periodic monitoring along toll road and then continued by a number of actions involving government and society, in their own responsibilities to make an efficient and effective process. Results of this study are beneficial to manage waste and reduce illegal waste disposal locations along toll road side towards green infrastructure,

not only in Indonesia but also in other developing countries with similar conditions towards sanitary and pleasant of environment living space.

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