

An Innovative Approach on Urban Drainage Engineering and Management in A Coastal City – A Conceptual Design for The City of Manado, North Sulawesi.

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SIBCE-2009

The 1st International Conference
on Sustainable Infrastructure
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SABUGA ITB, Bandung - Indonesia
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- Volume C : Water Engineering and Management
- Volume D : Waste Engineering and Management
- Volume E : Ocean Engineering
- Volume F : Construction Management
- Volume G : Geotechnical Engineering
- Volume H : Environmental Protection and Management

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PREFACE

¹⁴ The 1st International Conference on Sustainable Infrastructure and Built Environment in Developing Countries (SIBE) 2009 is aimed to provide a forum to discuss and disseminate recent advance in scientific research, technology, and management approach to obtain better environment quality.

² Infrastructure that provides the basic need of a society and sustainable infrastructure system are essential for the survival, health and well-being of a society. In developing countries, civil and environmental engineers are at the epicenter in seeking means to enhance the quality of human life through modernization of infrastructure as evidenced by provision of shelters, water, and transport, amongst others. The current rate of urbanization and industrialization raises a number of environmental issues, often resulting in environmental mismanagement, especially in developing countries. The problems are further aggravated by environmental degradation such as soil erosion, depletion of water resources, etc. In order to meet these multifaceted challenges, proper planning followed by implementation and verification must be exercised, via an integrated, multi disciplinary and holistic approach.

¹⁰ The conference will provide an opportunity for professionals and researchers to learn, share and exchange about the latest development and research in civil and environmental engineering. The scope of the conference covers all aspect of civil and environmental engineering practices.

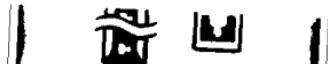
Participants of the conference include researchers, academic staffs, students, industries, public and local governments. The keynote presentations during the conference are as follows:

Keynote speakers:

- **Indonesian Government Representative**
Minister of Public Works, Indonesia
- **Dr. Puti Farida Marzuki**
Dean of the Faculty of Civil and Environmental Engineering, Institut Teknologi Bandung, Indonesia
- **Dr. Tony Liu**
National Taiwan University, Taiwan
- **Prof. Shunji Kanie**
Hokkaido University, Japan
- **Prof. Syunsuke Ikeda**
Tokyo Institute of Technology (AUN/SEED-Net), Japan.

Invited speakers:

- **Dr. Setiawan Wangsaatmaja**
Environmental Protection Agency of West Java Province, Indonesia
- **Dr. Edwan Kardena**
Faculty of Civil and Environmental Engineering, Institut Teknologi Bandung, Indonesia
- **Prof. Harianto Rahardjo, Ph.D.**
School of Civil and Environmental Engineering, Nanyang Technological University, Singapore
- **Prof. Ikuo Towhata**
School of Engineering, University of Tokyo, Japan
- **Prof. Dr. Seiichi Kagaya**
School of Engineering, Hokkaido University, Japan
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Faculty of Civil and Environmental Engineering, Institut Teknologi Bandung, Indonesia
- **Prof. Nakasaki Kiyohiko**
Tokyo Institute of Technology, Japan.

³ The objectives of this conference are:

1. To provide a platform for exchange of ideas, information and experiences among academics, researchers, consultants, engineers, manufacturers and post graduate scholars in civil and environmental engineering.
2. To discuss and evaluate the latest approaches, innovative technologies, policies and new directions in infrastructure development, pollution prevention and eco-friendly technologies adapted to developing countries.
3. To promote cooperation and networking amongst practitioners and researchers involved in addressing infrastructure and built environment issues.

The oral and poster presentations are subdivided into 8 major sections, as following:

- A. Structure and material
- B. Transportation system and engineering
- C. Water engineering and management
- D. Waste engineering and management
- E. Ocean engineering
- F. Construction management
- G. Geotechnical engineering
- H. Environmental protection and management.

There are 176 contributors in oral presentation and 36 contributors for poster presentation.

⁴ Finally, the Organizing Committee wishes that this conference is able to provide beneficial scientific information to the participants and other concerned readers.

Bandung, November 2009
Organizing Committee



An Innovative Approach on Urban Drainage Engineering and Management in A Coastal City – A Conceptual Design for The City of Manado, North Sulawesi.

1

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Abstract

This research exposes the existing condition, the current and potential problems of Manado urban drainage system. Using qualitative descriptive methods which make use of in depth interviews to several experienced and resourceful informants, a comprehensive review of the engineering, management and environmental aspects of the current system is carried out. It covers all implementation stages of the system, starts from the planning and design, construction, operation and maintenance and end with the monitoring and evaluation. It further identifies the actors or agencies which are deemed responsible for the execution of each of the implementation stages. A quick estimate on the hydraulic capacity and efficiency of the present main drainage culvert is also carried out to portray any technical problems occurring within the system. Identification of present and upcoming demands of an integrated sustainable urban drainage engineering and management of the city is considered. The process takes into account any master plans available for the city's drainage system, the strategic plan of the city itself, projection and trend on the city's economic development, the prediction of population pressure as well as the trends in people's lifestyles which might effect the management of drainage system in the future.

Several engineering and environmental approaches are evaluated to come up with an innovative scheme specifically designed for the unique coastal city of Manado. This includes the presentation of modified frameworks for each of the implementation stages of the urban drainage system. It also outlines the roles and interests interaction among the responsible actors or agencies in the implementation of the drainage system and all the stakeholders who are genuinely interested in the existence of an integrated sustainable and maintainable urban drainage system.

Keywords: innovative approach, strategic plan, urban drainage system.

1. Introduction

Manado city is one of the many coastal cities in Indonesia which shares a rather distinctive terrain. It has a relatively narrow flat coastal plain by the beach and at the background mostly consists of moderate to steep slope of medium height hilly landscapes. This resulted in a high velocity surface water from a high incidence and intensity rainfall which flow from the hinterland to the low laying areas of the city. Historically, the city was once a fishermen village. Then growth brought fast development on its coastline. The city center has been on the coast for more than 30 decades. It was marked by busy economic and public service activities such as market, banking, harbor and central public building and offices. The rest of the coastal land uses are of dense populated residential areas. At present as the city grows bigger, the development near the coastline has increased even faster. Since 1993 Manado has a 60 ha of reclaimed area by the beach. The length of the reclamation area covered about 4 km of Manado coastline.

Its fast development activities is quite in contradiction to the particular conservation efforts of the Bunaken marine national park located half an hour boat-driving from it. The city has been an unusual attractive place partly due to its close distance to this world class diving spot and the center of highly treasured marine biodiversity area. The sustainability and harmonic linkage between the developments of the two areas will significantly depend on several factors. One of them is on how Manado's waste water is discharged into Manado bay.

According to Manado city spatial plan (RUTRK), the rivers which flow through the city of Manado have sufficient capacity to function as urban drainage outlets. The relatively high intensity rainfall would flow through these rivers towards Manado bay. For almost the last 10 years with the current urban drainage system, the city has been subjected to sporadic inundation problems. Contrary to what was predicted in Manado RUTRK, floods have been recently occurred at various places in the city. Especially along Manado bay, drainage is still a serious problem. Storm water frequently inundates the city boulevard and provides negative impacts on road users and on the condition of the road itself.

The relatively more frequent incidences of inundation may be the effect of urban development which has not matched the available supporting infrastructures, hence fail to provide comfortable public places and healthy residential environment. To solve the city's problems well-designed plans of an appropriate urban drainage system are urgently needed.

2. Research Methodology

The case study is based on descriptive observations of the real/actual conditions on the field. Primary data also obtained were those captured from interviews with competent persons and surrounding communities. While secondary data collected were in the form of topographical maps, rainfall data, etc. These included an inventory of existing drainage scheme problems and evaluation on storm water flows entering the city. The procedure used to carry out hydrology and hydraulic reviews included: analysis of rainfall data outlier, selection of rainfall data distribution type based on data skewness, variability and kurtosis, application of Smirnov-Kolmogorov test to check the suitability of data distribution, calculation of rainfall intensity and flood discharge, and evaluation of the existing hydraulic dimensions of channels, culverts and all other related structures within the drainage scheme.

Studies relating to non technical problems such as inadequate management tools as well as managerial discrepancy were compiled and analyze collectively to produce a complete comprehension of the urban drainage system present condition and problems, future demands and plans.

A conceptual design based on the descriptions above is then developed using exploratory and explanatory methods. The concept focuses on the quality planning and quality control of the urban drainage system's engineering and management.

3. Result and Discussion

The study location covered the drainage area at the coastline to the Southern part of Manado city. Administratively it is located within the jurisdiction of Sario and Wanea sub districts. This was taken as a sample together with two other studies located at different parts of the city. The first study was located by the coastline area, started at the boundary of this study and stretched to the Northern part of Manado city. The second one covered a location from the highest position of the city sloping down to the flatter area closed to the coastline.

From data analysis it was found that there were 70 segments within the study area. Of this figure 54 were considered in good condition while the other 16 segments could not meet the capacity requirement (that is 20% of the segments were undersized). There were 25 culverts in total with only 2 of them could not meet the capacity standard and were badly in need of repair. A plan of improvement consisted of 7 new segments would be incorporated into the current system in anticipation of solving the existing inundation problem in the study area. All the outlets (5 outlets) discharge untreated waste water into Manado bay. The total discharge from these outlets was 2.73 m³/sec. Figure 1 shows the modified design of drainage system

for the study area. Due to the frequently occurred inundation problems caused by the increase in water discharge since 2005, an additional segment is proposed to be incorporated with the old system.

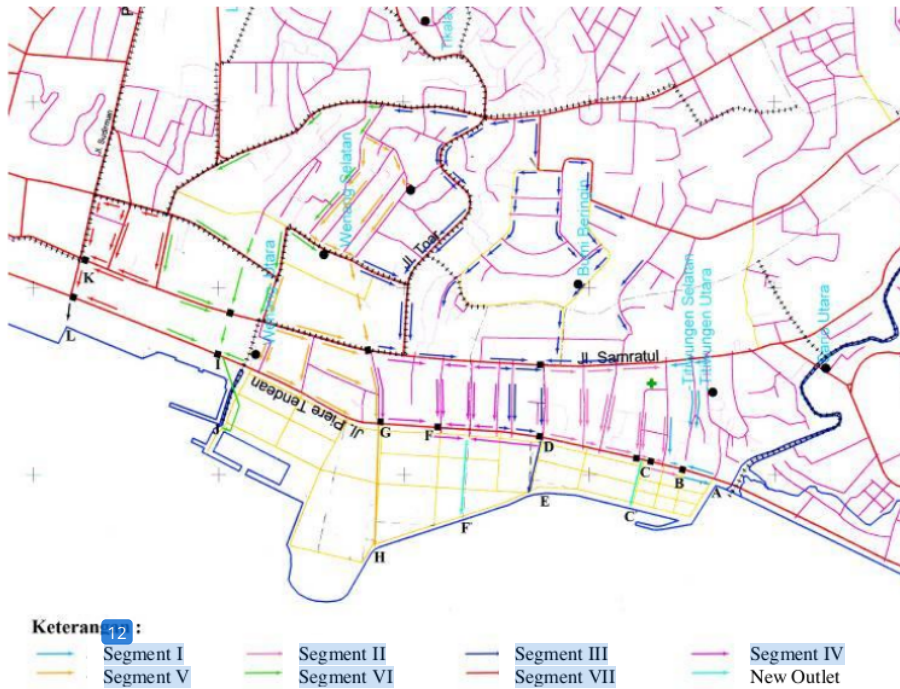


Figure 1 Modified Segments planned to technical problems in the studied area.

Several similar problems regarding the performance of the drainage system were identified at the study area as well as at the other 2 sites. They ranged from technical to managerial problems. Technical problems mainly associated with hydraulically not feasible channel's designs and parameters, such as: insufficient or over steep long cross section slope, undersized channel, high rate cross section sedimentation, constructed channels alignment with building margins instead of following the vale of land contour.

The lack of commitment among responsible government agencies to provide adequate drainage system and the lack of awareness of a number of stakeholders to maintain or support the continued existence of a problem-free drainage scheme or drainage channel were 2 major factors accounted for the variety of managerial problems occurred. Some of the identified problems were: (1) the indistinctness tasks and responsibilities among government agencies responsible for the planning, design, construction, maintenance, monitoring and evaluation of urban drainage system of the city, (2) the absence of a comprehensive and up to date master plan on the city's urban drainage system, (3) the ill-defined scope of work of technical agencies dealing with the planning and management of the city urban drainage system, (4) the absence of sufficient technical guidelines to assist construction, monitoring and evaluation work, (5) the weak law enforcement mechanism regarding permit or restriction on the newly constructed and the close-off of certain channel segments, (6) public misconception on their roles and the governments' regarding the management of an urban drainage system, and (7) the insufficient fund available to regularly carry out drainage channel segments' maintenance, rehabilitation and up-grading (R&U).

11 Juran and Gryna (1993) suggested that quality planning efforts should consist of establishing quality goals, identifying customers' characters, determining customers' needs, developing products' features, developing process features, establishing process controls and transferring to operation. Following the steps of quality planning efforts seems relatively easy has the urban drainage system is implemented by only one government agency. In Manado, there are about 4 agencies which are held responsible for the implementation of the urban drainage system. Bappeda Tk II (Local Development Planning Board) is a government agency which is responsible for the planning and budget allocation of the whole development activities in the city. Dinas Tata Kota (the city Spatial Planning Board) has a responsibility to provide a master plan of the city's drainage system. Public Works is held responsible for most of the tasks corresponding with the performance of the drainage system. They includes executing detail design, construction and maintenance of the system, undertaking rehabilitation and upgrading of damaged channels/ segments. Badan Lingkungan Hidup kota Manado (Manado Natural Environment Planning Board) is mainly responsible for monitoring overall environmental condition of the city. Its task concerning drainage system covers monitoring of land infiltration rate, precipitation, land erosion rate. It is therefore suggested for this concept

A concept of one cell drain and flush drainage system was suggested by Lolong and Sutowo (2005). It basically focused the management of drainage system in a small region (called a cell). For a residential area, this is roughly the size of a village of approximately 1000 households. Two or more cells are then interconnected to create bigger cells that flows into secondary drain channels. Several secondary segments will flow into a primary channel which headed for an outlet. One viable benefit of this system is an inundation event for instance will be limited to problematic areas and hence prevent larger areas from experiencing unnecessary drainage problems. The concept of multilevel management system is adopted here with some modifications such as: (1) the cell will be determined based on local catchment characteristics of each of the drainage segment rather than based on administrative boundaries, (2) other than the responsible government agencies, the administration of management of drainage system will be implemented by all stakeholders involved within the considered area and according to a certain cell level which include the operation, maintenance, monitoring and evaluation activities. In the future, the planning of additional drainage scheme as well as drainage system for newly built environment should be carried out taking into consideration all the stakeholders interests and requirements.

The main environmental problem identified is the untreated waste water that flow into Manado bay. There is no communal waste water treatment plant available at present to treat waste water before it is discharged into the bay. Another socio-cultural problem that has caused a serious drainage problem is the people's habit of throwing litter and garbage into the drainage channels. The threat of waste water inflow is of the local government and some private personnels/ groups interests because of its probable deteriorating effects to Bunaken national marine park environment. According to Kenda (2006), the development of Manado city has been a real threat to the continued existence of Bunaken marine park due to some reasons i.e.: there are 12 streams outlets at Manado coastline while there is no waste treatment plant in operation ever, the coastline of Manado has been the location of 2 long-established hospitals which could not provide regular reports of the proper application of their incinerator facilities. Providing a communal sewage treatment plant appears to be an invisible option, due to the unavailability of spacious area at the coastline. Hence, the design concept presented here suggests the application of a strict quality control procedure on all the stages (covered planning, detail design, operation, maintenance, monitoring and evaluation) of the implementation of the urban drainage system. This includes: (1) the preparation of a comprehensive and comprehensible standard operation procedure for all activities within each implementation stages of the planned urban drainage system, (2) the planning of quality control aims, the unit of measure and performance criteria, (3) the measurement and evaluation of actual performance, (4) the planning of corrective measures.

4. Conclusion

This research has resulted in an insight regarding the need of implementing a sustainable urban drainage system as a proactive means to solve the recurrent urban drainage problems in Manado city. There is an increasing need to come up with sound engineering design to anticipate and hence overcome the urban drainage problems. An ideal urban drainage system would be a self-maintained system that would act not only to drain excess water from urban localities but that will also ensure long term sustainable system which will support land and water conservation.

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