
Green Infrastructure Implementation Case Study in Asia Monsoon Climate- In case of ABC Water Design Guideline in Singapore with Sustainable Stormwater Management Concept

Développement d'une infrastructure verte dans un climat de moussons en Asie. Recommandations pour la conception d'ouvrages à Singapour intégrant le concept de gestion durable des eaux pluviales

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RÉSUMÉ

L'objectif de cette étude est d'analyser des stratégies pour une gestion durable des eaux pluviales et d'analyser les lignes directrices en matière de conception d'ouvrages d'eau ABC (ABC-WDG) à Singapour. Depuis très longtemps, Singapour est confrontée à de sérieux problèmes hydrologiques, tels que des pénuries d'eau, des inondations et des questions liées à la qualité de l'eau. Les lignes directrices nationales en matière de conception des ouvrages d'eau, soit ABC-WDG, donnent un aperçu global pour promouvoir l'aménagement de l'eau urbaine et la mise en œuvre d'infrastructures vertes. De plus, ABC-WDG a créé un système de certification pour améliorer la gestion durable des eaux pluviales. Le système professionnel ABC est unique, et sert aussi de système éducationnel qui promeut des concepts d'aménagement des eaux urbaines. Par le biais de cette étude de cas de l'ABC-WDG, et avec la présentation de la conjoncture actuelle, nous explorons les problèmes à Singapour et les stratégies pour la mise en œuvre d'infrastructures vertes dans les climats de mousson en Asie, et de la gestion durable des eaux pluviales en milieu urbain.

ABSTRACT

This case study research aims to analyze urban to nation scale sustainable stormwater management strategies, ABC Water Design Guideline (ABC-WDG) in Singapore. Historically, Singapore faced many water issues such as lack of water, flood, and water quality issues. ABC-WDG, nation-wide water design guideline provides overall vision to promote water sensitive urban design, and to implement Green Infrastructure at various scale and site typologies. In addition, ABC-WDG created certification system to enhance value of sustainable stormwater management and created very unique ABC professional system which function as educational system to promote water sensitive urban design concept. Through case study research of selected ABC WDG, current background, problems in Singapore and Green Infrastructure implementation strategies in Asia Monsoon climate revealed towards creation of water sensitive city with sustainable stormwater management.

KEYWORDS

Green Infrastructure; Sustainable Stormwater Management, Water Sensitive Urban Design

1 INTRODUCTION

1.1 Research Background and Purpose

This research aims to analyze Water Design guideline, which challenges to promote implementation of Green Infrastructure (GI) projects with sustainable stormwater management concept in order to reduce water disaster risk and to seek more sustainable stormwater management. Specifically, how site-scale GI projects can contribute to larger, city scale GI implementation by setting up active design guidelines.

The effects of rapid urbanization on global climate change have resulted in the mutation of natural water cycle such as infiltration and evapotranspiration. Dense urban environment set with high rises and multi complex buildings have increased levels of solar radiation which in turn exacerbates the urban heat island effect. Combined with large areas of monolithic impervious surfaces and a conventional, underground piped linear stormwater management system face potential risk of flood. From now on, as part of climate change adaptation strategies in highly urbanized area, Water Sensitive Urban Design (WSUD) may become essential approaches to reduce further water related disaster. In other words, GI implementation with sustainable stormwater management potentially have very important role. Sustainable stormwater management in this article can be defined as an alternative way of managing stormwater runoff by using combination of various stormwater tools such as green roof, pervious surfaces, vegetated swale in order to reduce stormwater runoff and speed, promote onsite retention and infiltration, and increase evapotranspiration which all contribute to recover fragmented natural water cycle in urban area.

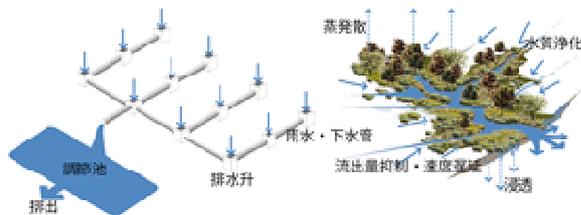


Figure-1: Gray Infrastructure (left) and Green Infrastructure with sustainable stormwater management (right) (LID Low Impact Development Design Manual by University of Arkansas, edited by author)

This research targets GI implementation in Asia monsoon climate areas with significant precipitation. The purpose of this research is to analyze methods and to obtain knowledge of promoting GI implementation at broader city scale through studying Water Design Guideline in Singapore. Current trend in stormwater management is limited to site scale stormwater harvesting and infiltration methods, and more holistic and diverse GI implementation methods need to be applied in much broader scale. GI implementation methods are technically available, but there are disconnection how to implement such methods into actual projects. To breakthrough this limited GI with sustainable stormwater management, communication media with citizen or architects are essential to explain how GI can be implemented and what the impacts are. As one of GI promoting communication media, water design guideline can function as effective tools. Towards applying broader scale GI implementation with sustainable stormwater management, water design guideline needs to be studied in order to reveal what required elements are as well as how GI concept is communicated with diverse readers.

GI need be mainly studied in two categories, which are policy (planning, incentives) and implementation (planning and design through project implementation). The purpose of this is research is to study Water Design Guidelines in Singapore as case study for GI implementation in Asia monsoon climate, and to analyze important structure and methods towards promotion of GI implementation with sustainable stormwater management in broader scale.

1.2 Previous Research Review

Previous sustainable stormwater management related research in Japan mainly focus in the area of stormwater harvesting and infiltration methods and concept, methods and techniques as hard facilities, and described in various book and manuals such as Rainwater Architecture (AIJ ed. 2005), Stormwater harvesting manuals (AIJ ed.2011, SHASEJ ed.2011) GI related research in Japan are relatively new field. Stormwater Infiltration Road Model Study through GIS (Inoue 2011), Green open space and stormwater management relationship (Kato 2012), several research case studies in GI policy in Philadelphia (Endo 2011), Green Street implementation in Portland (Hanai 2011), and GI implementation in Portland(Fukuoka 2014). As listed, previous research can be categorized into quantitative based stormwater management and techniques, and GI policy or case studies. However, methodologies for GI implementation at broader scale, and guideline case study have novelty and original approach to seek GI implementation for diverse target.

1-3. Methods of Research

Author conducted multiple interviews with Public Utility Board (PUB) and Urban Redevelopment Agency (URA) government officers regarding innovative ABC Water Design Guidelines (ABC-WDG) from March 25 through 26 in 2015. This research is based on interviews above. Firstly, at URA, author conducted an interview with Mr. Teck Leong Lim (director), Ms. Dixi Mengnote, Ms. You Ling Lim. URA explained ABC-WDG from city planning point of view, gave presentation and conducted questions and answers session. Secondly, author conducted another interview with Ms. Geok Ling Chen (sustainability team director), Ms. Suat Ong, and Ms. Enid Chen at PUB. At an interview, PUB provided ABC-WDG overview, framework, and project implementation and its problems, and conducted questions and answers session. After interviews above conducted in Singapore, ABC-WDG framework, promotion methods of GI implementation and certification system analyzed.

2 ABC-WATER DESIGN GUIDELINES IN SINGAPORE

2.1 Background of ABC-WDG

Singapore is located in the center of Southeast Asia, and consists of 63 islands. Population is 5.3 million, and population density is the second in the world. Singapore island is 42km long to east to west, and 23km to south to north. Island's highest point is 163m, and several major rivers run through on relatively flat land. Historically, Singapore has been relying on 40% of drinking water resource from Malaysia through Pipe Lines. However, due to uncertain future with water issues, government made decision to be self sufficient for water by applying watershed based management system. Especially, 2,400mm annual rainfall was targeted as major water resource to be wisely used together with other gray water and dam solution. In this paper, overall structure of ABC Water Design Guidelines (ABC-WDG) by Public Utility Board (PUB) and how WBC-WDG function to change nation wide water resource management to create Garden Cities with water.

2.2 Summary of ABC-WDG

First edition of ABC-WDG was published in 2009 as holistic water design guidelines. In 2011, second edition was published with additional implemented case studies and regional characters. Then third edition is published in 2014. ABC stands for Active (Places for recreation), Beautiful (Holistic water management and amenity), Clean (enhance water quality), and designed to provide water for all. ABC-WDG has three strategic approaches, which are 1) Creation of ABC Water Master Plan and Green Infrastructure project implementation 2) Promotion of ABC water concept and application 3) 3P (People, Public, Private) partnership. First, ABC Water Master Plan created which are based on water shed based, and plotted important existing water resources such as rivers, canals, reservoirs and wetlands as well as potential project locations for future GI project implementation. Towards 2030, over 100 projects to be implemented based on this master plan. So far, 23 projects completed by June in 2014. Second, PUB functions as main agency to promote ABC water concept to all related governmental agencies as well as private developer. Third, ABC-WDG targets 3P. For diverse users various methods such as water education program and ABC water related activities held to promote at all different levels. ABC-WDG promotes watershed base, holistic water management. As shown in figure 2 and 3, surface flow of all stormwater from roof and buildings, roads and green open spaces, and water bodies are designed to apply various GI projects in order to reduce stormwater runoff volume, and its speed. It is central to integrate sustainable stormwater management with GI projects. In other words, ABC-WDG seeks to enhance Blue and Green Infrastructure by maximizing performance of land.

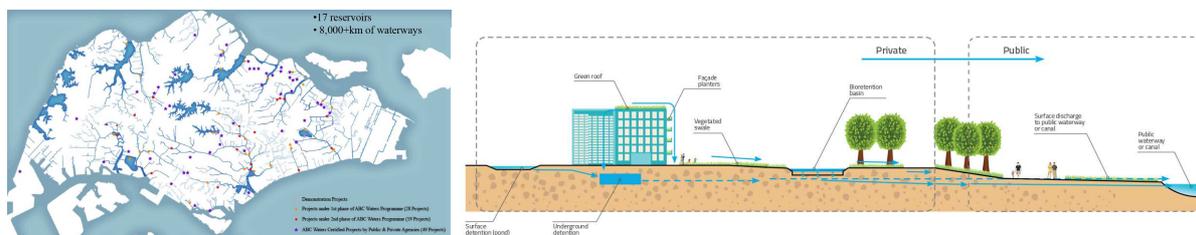


Figure-2(left) ABC-WDG function as holistic, watershed base management 3(right)ABC-WDG illustrates how stormwater is managed from roof to water river mouth, ABC WDG(2014): PUB Singapore

2.3 Structure of ABC-WDG

ABC-WDG provides actual stormwater design tools for three different stages which are applicable to

various types of GI project scale. Stormwater design tools are categorized into a) Catchment elements b) Treatment elements and c) Conveyance and storage elements. Firstly, catchment elements aim to collect water based on land use typologies such as road, canal, water bodies, pedestrian walkways, public open spaces, plazas and buildings. For different surface conditions, appropriate stormwater planning and design methodologies are shown with clear illustration. Project planning stage research and concept based on ABC water, building location and volume to meet ABC water goals, and applicable GI implementation methodologies at catchment stage. For instance, building is divided into various catchment elements such as green roofs, terraced green balconies at multi levels, and ground level elements such as planted areas and water features. ABC-WDG provides engineering and design procedures so that basic knowledge and methodologies can be easily integrated into projects. Secondly, Treatment elements such as swales, bio retention pond, detention pond, stormwater planter, rain garden and cleaning biotope methodologies and how to implement explained through visual information. Water treatment part covers wide range of methods and this provides concept, benefits, design methodologies to management issues. Thirdly, Conveyance and storage focus on large water bodies and provide methodologies such as bio engineering, erosion control and water quality control.

3 ABC-WDG DEVELOPMENT AND PROMOTION OF NAITON WIDE WSUD

3.1 ABC-WDG related Water law change and influence

Since 2009 when ABC-WDG published for the first time, there was no mandatory water regulation to force sustainable stormwater management. However, in 2013, there was revisions to COP on surface water drainage 7.1.5 to set surface runoff rate must be 0.55 for all new development sites over 0.2ha. Developer is now required to submit documents to show GI implementation model and calculation (how sustainable stormwater management is applied on site- In other words, combination of multiple stormwater design tools for various surfaces at the project). Also, there is requirement that all documents need to be reviewed by ABC professionals who are trained to give advises on ABC-WDG related issues.

3.2 ABC Certificate and ABC Water Professional Program

ABC certificate system started in 2010, July by PUB in order to recognize and further promote ABC water program. By 2015 April, 49 projects (29 public, 20 private) are certified as ABC water project. Certification system consists of 3 criteria which are Active (30 points), Beautiful (30 points), Clean (30 points), Innovative (20 points) and total of 110 points evaluated in detail. It is not only limited to sustainable stormwater treatment through GI, but also management, participation and original approaches. To support this Certificate system, ABC Professional program started which started in 2011. Currently over 200 registered ABC professionals, and they help to consult how to implement GI through ABC-WDG.

4 CONCLUSIONS

In conclusion of this case study research, following four points revealed. Firstly, ABC-WDG provides city to nation scale sustainable stormwater management vision through GI project implementation. Though stormwater design guideline is often limited to site to region scale, it is very unique to provide large scale water design guidelines with clear visions for diverse stakeholders. Secondly, Singapore finally regulated surface water runoff ration to all new development over 0.2ha. Nation wide water design guidelines and policy can provide good balance between voluntary and regulated approaches in order to create dynamic project implementation over time to meet nation wide ABC water goal. Thirdly, ABC-WDG is not limited to provide sustainable stormwater management and design methods, but also providing ABC Water Certificate and Professional system which help to develop collection of good ABC case studies and network of human resources to promote ABC further. Lastly, ABC-WDG indicate possibility of Green Infrastructure implementation strategies in Asia Monsoon climate.

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