POTENTIAL OF RAINWATER HARVESTING IMPLEMENTATION IN MALAYSIA FROM MULTIPLE ECONOMIC IMPACTS MEASURES

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Abstract: Rapid urbanization induced by population growth will face water shortages due to increase demand of water and it is expected to be more severe in the future. According to the National Water Resources Report 2000-2050 by the Economic Planning Unit, the demand for treated water would grow between 2% and 3.5% annually for Selangor, Kuala Lumpur and Putrajaya, thus the major cities in Malaysia possibly will face a water crisis situation. It was also mentioned that in 2014, these cities will face an expected water deficit of 476 m/l/d when demand exceeds supply. Rainwater harvesting (RHW) is one of the promising, but challenging system and its approach into a building as an effective way to minimize the use of treated water can help to cope with water deficit. Due to limited knowledge and promotion on this system, the RWH practice is unpopular in this country despite the high total rainfall amount in Malaysia. A proper design with economic impact characteristic will significantly give good effect not only to a project, but also the opportunity it represents. This paper is to identify the importance of RWH system in sustainable development and its potential of utilization benefits for new development. The significant of RWH on environmental and economic impacts are also discussed.

Keywords: Economic impact, Rainwater harvesting system, Sustainable development, Water shortages.

INTRODUCTION

Half of the world's population lives in urban areas today with additional urban dwellers coming in the world every day. According to study done by the United Nations, 1997 stated that two third of the world's population is likely to live in countries with moderate or severe water shortages by 2025.Water has become critical values as it covers approximately three quarter of the earth's surface and has changed from one of the relative abundance to one of the relative scarcity since there are increasing of water demand as well as a risk of water pollution (United Nation, 2002).

Malaysia is on it way reaching the status of developed nation by the year 2020 following the swift socio-economic growth in several years before. It is estimated that between 65 to 75 percent of the 28 million population live in the urban areas and water stress is fast developing due to high demands both for domestic and non-domestic uses (Bernama, 2011). This country is blessed with plentiful water resources with an average annual rainfall of 3000 mm or 990 billion m^3 over the Malaysian land mass amounts, of which 566 billion m^3 becomes surface runoff, 64 billion m^3 recharges the aquifer and 360 billion m^3 returns to atmosphere (Abdullah & Mohamed, 1998). With a present estimated total of 28 million people, the Malaysian population is expected to exceed higher number in 2020 and, cities and towns may reach 55-60% of the total population.

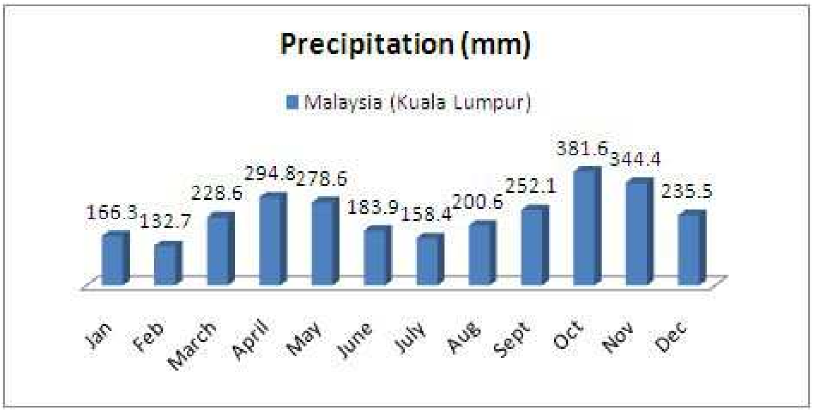

Figure 1: Annual Precipitation of Malaysia *(Source:RainwaterTechnology.org*)

Table 1: Water supply- demand and projection for Selangor and Kuala Lumpur (*Subramaniam, 2004*)

Year	Demand (Mld)	Supply (Mld)
2002	3,326	3,628
2003	3,519	4,028
2004	3,723	4,028
2005	3,940	4,428
2006	4,170	4,428
2007	4,413	4,553
2008	4,671	4,553

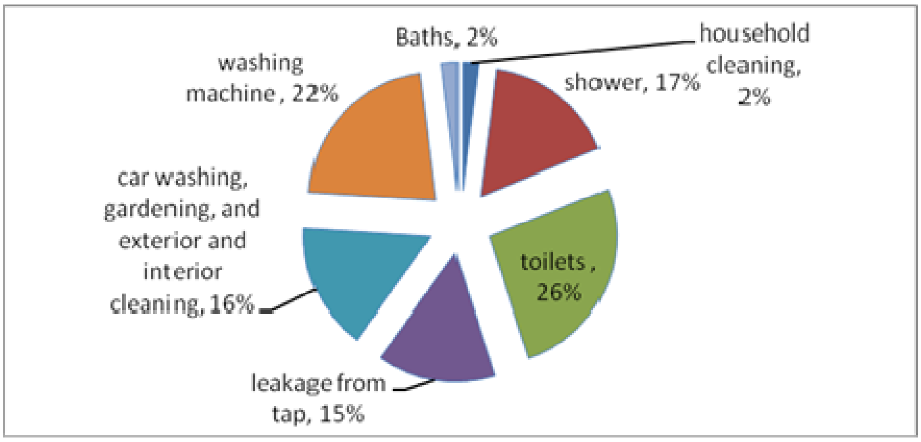

Figure 2: Water usage by household

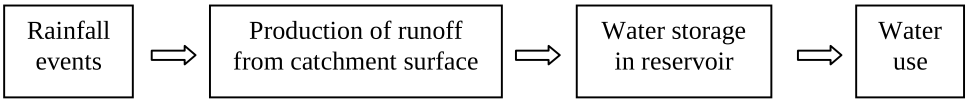

Figure 3: Fundamental process of demonstrating rainwater harvesting

Table 1 outlined the water supply and demand study on water resources for Selangor and Kuala Lumpur (Subramaniam, 2004)

Even though Malaysia received abundant of rain annually, it is not excepted to be expected to encounter acute water crisis such as flooding and water shortage. Year 1998 in history has seen that the hub of Malaysia, the Klang Valley has faced the water scarcity culminating the water crisis. The current variation of rainfall in time and space as well as the sustainable resources failed to meet the urbanization request are the factors that seemed to cause water deficit to happen. On the other hand, due to the abundance of rainfall are not fully utilized, this country experiencing frequent flood which is grown with the development. Also, due to rapid population growth, it has lead to increasing of demand on clean water thus caused insufficient to supply.

There are various techniques to be applied in order to overcome urban water crisis such desalination, reuse water or water recycling, channel reservoirs, on-farm reservoirs, infiltration ditches, infiltration wells, dams and many more.

However, among all the techniques existed, one of the economical solutions to the urban water crisis is also rainwater harvesting. This approach can help capturing the runoff and reduce flooding. It also capable to store water for future use thus reduces the reliance on treated water from main supply. In order to avoid water crisis in 1998 to happen again, a proactive step must be taken to evade acute water shortage in future.

This paper aims to identify the potential of rainwater harvesting implementation in Malaysia especially to the urban area with multiple economic impacts in both monetary and environmental saving taking into account.

With no rivers or lakes to tap for freshwater, Singapore relies on rainfall collected in its fourteen reservoirs and on imports from Malaysia; in the future it will increasingly depend on desalination. Because of this dependence on outside sources, the Public Utilities Board has made an effort in recent years to improve efficiency and reduce waste, especially in the area of Unaccounted-for-Water (UfW).

UfW is the difference between the water delivered to the distribution system and the water sold. It has two basic components: physical losses, such as water lost from pipes and overflows from tanks, and commercial losses, which include water used but not paid for. Through a consistent monitoring programme, Singapore has achieved the UfW rate of an impressive 6 percent. Singapore's UfW reduction programme is based on metering, audits of commercial water use and leak detection. The metering programme aims to achieve universal metering with high accuracy on all meters by replacing domestic meters every seven years and industrial meters every four years, and by measuring and billing for water used for firefighting. Singapore has implemented programmes to identify consumption patterns and notify customers of excessive consumption, identify inconsistent meter readings, replace faulty meters and set average water rates close to the marginal cost of water to encourage careful inspection and evaluation of unaccounted-for and inefficient use of water. There are also substantial efforts to detect and stop leaks: the systems are tested annually and the surface pipes quarterly, and these are replaced if more than three breaks a year are reported.

As a result of this programme, the number of pipe breaks has decreased from twelve per 100 km/year in 1985 to less than four per 100 km/year in 1992 (Yepes, 1995). Although the annual cost of these investments over a thirty-year period works out to US$5.8 million, the programme has proven to be cost-effective when considering the current and long-term marginal cost of water to Singapore.

Source: Prepared for the World Water Assessment Programme (WWAP) by V. Srinivasan, P.-H. Gleick and C. Hunt at the Pacific Institute, 2002.

Box 1: Singapore Public Utilities Board: reducing Unaccounted-for-Water

RAINWATER HARVESTING

Although climate change is expected to have a major effect on the global environment in its broadest sense, one of its earliest and most direct impacts will be on earth's freshwater system. Although 70% of the earth is covered with water, only 3% of this water is fresh water and out of this, 2% is locked in the form of ice that makes the balance left 1%. This percentage is the only amount of water that recycles through the evaporation, condensation cycle that flow into rivers and lakes, to be used mankind (Jitender Dev Sehgal, 2005). Along with rapid growth in global population, there is challenge for countries all around the world of how to acquire an adequate supply of potable water. For those areas having plentiful rainfall, the rainwater harvesting system can be adopted as a wise solution.

In Malaysia, the only economically viable solution to have treated and non-treated supplies of water is to collect rainwater. This collection of rainwater to be used as untreated water for flushing toilets can only be viably applied to new housing projects and commercial developments as it involved having the necessary changes to the infrastructure to collect, store and distribute this second source of untreated water. Figure 2 shows the percentage of water consumption by household in Malaysia generally. As referred to the chart, Those activities such cleaning, outdoor activities and gardening, toilet flush as well as leakage from taps that happens to for sure wasting the clean water are unnecessarily needed treated water for the implementation, thus supplied portable water for the purpose activities are truly wasting. Rainwater harvesting can best be substitutes as its water quality level were already ensured safe for such uses.

The rainwater harvesting is the simple collection of storing water through scientific techniques from the areas where the rain falls. It is refers to the captures of precipitation to meet human needs. It involves utilization of rainwater for the domestic or the agricultural purpose. The method of rainwater harvesting has been into practice since ancient of time. In order to effectively harvest rainwater, a simple collection system can be used. The simple system consists of a tank, the first flush diverter, a rough mesh that functions as a leaf screen and a fine mesh to strain particles from entering the tank, downspouts, gutters and a catchment surface.

All rainwater harvesting systems share a number of common components (Gould & Nissen-Peterson, 1999): (a) A catchment surface from which runoff is collected (b) A system for transporting water from the catchment surface to reservoir (c) A reservoir where water is stored until needed. (d) A device for extracting water from reservoir

Fewkes (2006) identifies beside the main uses for harvested rainwater as the main and supplementary source of potable (drinking) water, it can also be a supplementary source of non-potable water (e.g for WC flushing).

The use of RWH systems to supply non-potable water to building in urban area has increased in popularity in the last 15-20 years (Fewkes, 2006). Example of non-potable end uses include WC flushing, urinal flushing, laundry cleaning (washing machine), hot water systems, garden/landscape irrigation, car washing and fire fighting.

Systems have been installed in a wide range of building types including domestic properties, high rise building, schools, offices, sports stadiums, garden centres, airports and exhibition centers such as the Millennium Dome in Londons. In urban location, rainwater catchment surfaces tend to be restricted to roofs although runoff can also be collected from other impermeable area such as pavements, road and car parks.

INTERNATIONAL EXPERIENCE WITH RAINWATER HARVESTING IN URBAN AREAS

The international experience with rainwater harvesting in urban area is on the learning curve but growing at a rapid pace. Singapore, the island nation in the Indian Ocean, is a case in point. Appan and Seng (2001) reported "about 48% of the land area of Singapore is being utilized as water catchment. The water abstracted is not sufficient for the increasing demands in a rapidly growing industry society. Consequently, about 60% of the water imported. Hence ways and means are being are being locked into to harness more water from the rest of the land area in which 86% of the urban population live in high rise buildings. The potential catchments being looked into are the high rise buildings wherein the water collected on the roofs is of a high order".

According to Che Wu, Wang Huizhen, Li Junqi, Liu Hong, Meng Guanghui report, Beijing is faced with dual pressure brought on by the shortage of water resources and water environment pollution. In order to cope with the situation, it was important to study the quality of the average annual runoff of about 200 million cubic metres in the urban area.

In India, Bangalore and Chennai, both in South India developed a master plan for rainwater harvesting for its entire Comprehensive Development Plan area of 1279 square kilometers and also has made RWH compulsory for all building in the city each. Chennai claimed that 98% buildings have complied with the requirement which seeks to wither store rainwater or to recharge it to be underground aquifer. However in Bangalore, the report suggested that up to 25% of the city's requirement by 2011 cold be met through rainwater harvesting and in the optimistic scenario that 592.90 million litres per day equivalent could be harvested in the city.

In Sweden, analysis carried out on a rainwater collection system for domestic water supply revealed that a significant measure of potable water can be saved if rainwater tanks are included as part of a dual water supply solution (Villarreal and Dixon, 2005). In Brazil, a study indicated that the potential for using rainwater for saving potable water in residential sectors situated in varied geographic regions ranged from 48% to 100% (Ghisi, 2006).

In the UK, a study revealed that the average water saving efficiency because of the use of rainwater for toilet flushing was approximately 57% (Fewkes, 1999a). In Taiwan, 32% of potable water used in the residential sector could be replaced by rainwater, mostly for toilet flushing, cleaning, and gardening (Cheng *et al.*, 2006).

RWH FOR SUSTAINABLE DEVELOPMENT, ENVIRONMENTAL AND ECONOMICAL BENEFIT

Rainwater harvesting reduces pressure on groundwater supplies and results in a surprisingly large decrease in volume and rate of storm water runoff from the property. Incorporation of rainwater harvesting into "sustainable house" is consistent with the purpose of the project.

Rainwater harvesting is also considered as one of the most promising alternatives for supplying water in the face of increasing water scarcity and escalating demand. The pressure on water supplies, increased environmental impact from large projects and deteriorating water quality, constraint the ability to meet the demand for freshwater from traditional sources. Rainwater harvesting presents an opportunity for the augmentation of water supplies allowing the same time for self-reliance and sustainability.

Using rainwater can reduce the water consumption especially for irrigation. Besides, if native and dessert-adapted plants are used for landscaping, rainwater harvesting becomes an effective tool for water conservation. Usage of rainwater harvesting means the provided irrigation water is not taken from storage allocated for municipal water supply (R.Waterfall, 1998). There are many benefits of using rainwater harvesting for irrigation, and these benefits are to reduce groundwater exploitation, to reduce flooding, to control erosion and to improve water quality by holding storm runoff on the site (on site detention), and cost reduction. Rainwater is a clean source of water for plants (free from salt). As a result, rainwater harvesting can reduce salt accumulation and contribute in a good soil environment for root growth. The salt concentration in root zone of plants is reduced when collected rainwater percolates deep into the soil and diluting available salt in this zone. This will result in greater root growth and water uptake, which increases the drought tolerance of plants. Limitations of water harvesting are few and are easily met by good planning and design (A.M. Thamer et.al, 2007)

Economic impact analysis (EIA) examines the effect of a policy, program, project, activity or event on the economy of a given area. The analysis typically measures or estimates the level of economic activity occurring at a given time with the project or policy occurring, and calculating the difference from what would otherwise be expected if the project or policy did not occur (which is referred to as the counter factual case). This analysis can be done either before or after the fact (ex ante or ex post). The term economic impact can be applied to analysis of the economic contribution of a given activity or industry to the existing local economy.

EIA is one element of an environmental impact assessment, which is required to examine impacts of proposed development projects. It is also commonly conducted when there is public concern about potential economic impacts of a proposed project or policy.

CONCLUSION

To achieve a developed country for a better living, the most precious environment is scarified for urbanization and industrialization. Unfortunately, development has generated adverse impact to the environment, economy and social. People are aware of this effect and the importance of sustainability. Rainwater harvesting has the potential to be implemented in Malaysia as we have seen a high amount of rainwater sources (exceeding 2000mm per year). With the approach of this system into practice, it will help to reduce environmental loading and controlling the rainwater input in the drainage system. Not only that, rainwater harvesting can minimizing the dependence on public water supply, thus avoiding waste of natural resources.

However a systematic and structure procedural approach is required to ensure that the maximum benefits are drawn from this technique. Great care is also required to ensure that negative externalities are not generated by the adoption of this technique such as pollution of groundwater or flooding damage to structures, or weakening of foundations etcetera. Therefore, with the economic impact measure study, we can foresee the potential of this system results and determine it sustainability in various aspects.

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