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ADEQUACY OF RAINWATER HARVESTING SYSTEM IN HUMID TROPICAL MALAYSIA

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ABSTRACT

Even in humid tropical Malaysia where rainfall is abundant, water fluctuations due to a lack of rainfall do happened as in the 1998 and 2014 drought which brought unpleasant water supply disruptions in many parts of the country. Following this water crisis, the Government has expressed interest in designing houses to collect rainwater and produced a Guideline on Installing a Rainwater Collection and Utilization System. Rainwater harvesting system becomes popular in domestic usages for schools and households. Recently, this concept has spread to shopping malls, terrace houses, and community housing areas. Rainwater harvesting has been proven beneficial to the users, the environment and the governments. Rainwater harvesting is also included as one of the requirement to obtain the Green Building Index in Malaysia. This encourages installation of this system in new buildings and to combat future potable water supply shortage and to act as a buffer in times of water crisis.

INTRODUCTION

Malaysia is located in South-East Asia. It belongs to the tropical climate regime. Throughout the year, the average temperature ranges from 20°C to 30°C. The main rainy season in the east runs between November and March (Northeast Monsoon season), while May to December is the wettest period in the west coast (Southwest Monsoon Season). Peninsular Malaysia receives on the average annual rainfall of 2,500 mm while East Malaysia receives about 5,080 mm (Malaysian Meteorological Department, 2015). In tropical country like Malaysia, rain is plentiful throughout the year. However, since the first El Nino phenomenon in 1997, the climate has unexpectedly changed. The situation worsens in 2014 when Malaysia experienced an unprecedented drought. Rationing and water-use bans were in place in many parts of the country. Malaysia, among other countries, is living in a "water bubble" – their current rates of water usage are unsustainable. Over the past 50 years, cheap energy and technology have made it possible to move huge amounts of water without regard to natural limits or the sustainable yield of water sources.

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These water bubbles are beginning to burst, pushed by increasing temperatures and changes in precipitation patterns resulting from climate change. Water shortage is expected to happen more frequently and often without early warning. It may end up in higher cost of clean water supply to home. The good news is the problem can be avoided and solution can be done at home or business premises with wide spread of rainwater harvesting system use.

Traditional Rainwater Harvesting Practices

Rainwater harvesting (RWH) system can be as simple as has been applied in the traditional way. For example, the *tembaga*, a traditional container (Fig. 1) is used for rain water collecting. Then, the water is used for feet-washing before entering the house. The idea and implementation is simple. Rainwater harvesting system is also popular for domestic used such as for schools and households (Fig. 2). Developers had successfully installed rainwater harvesting features to meet the water needs of residents at three residential areas in Sandakan, Sabah such as Taman Utama, Taman Megah and Taman Mawar. When the towns encountered severe water shortage due to global warming, the Sandakan Municipal Council had made rainwater harvesting system compulsory for new housing and other projects in the early 2000's (Adi Irfan *et al.*, 2009).

Fig. 1. Tembaga is used to collect rainwater

Fig. 2. Rainwater collection for household use

Besides the projects in Sandakan, there are other housing projects that implement rainwater harvesting system. For example, in Kuala Langat District and Seberang Perai's houses are equipped with rainwater harvesting system. Meanwhile, Segamat also has five housing estates with rainwater harvesting system. There are a lot of other current projects implementing rainwater harvesting system now. Adi Irfan *et al.* (2009) also noted that rainwater harvesting is not something new in Malaysia. The Ministry of Housing and Local Governments has introduced a guideline on RWH after the 1998 water crisis, in order to combat future potable water supply shortage and to act as a buffer in times of water crisis (Sehgal, 2005).

The components of RWH system includes the collections/catchments area that includes roof and surface area; conveyance system that includes gutters and downpipes; filtering system that includes first flush; storage facility that includes tanks, and the distribution system that includes plumbing (to toilets, washing machine and general use). There are two common rainwater harvesting systems which are attached to the houses in Malaysia such as above ground rainwater harvesting system (Fig. 3) and underground rainwater harvesting system.

Both of the systems share similar components. While, the obvious different is the location of the water tanks.

Benefits of Rainwater Harvesting

Table 1 shows the amount of water usage in domestic daily activities. According to the table, about 30% of the daily domestic water demand can be supplied by non-potable water sources.

Table 1. Usage of water in household daily activities

No.	Purpose	Usage of Water
1.	Toilet Flushing	7 L/flush
2.	Floor mopping and washing	20 L/room
3.	Bathing	10 L/minute shower
4.	Washbasin Usage (brush teeth, etc)	5-10 L/minute
5.	Clothes washing	100-150 L/wash cycle
6.	Machine dishwashing	50 L/dishwater cycle
7.	Hand dishwashing	5-10 L/minute
8.	Cooking	Potable
9.	Drinking	Potable
10.	Other Peripheral Uses	Potable

This portion of water use may be substituted by water collected by rainwater harvesting system. The benefits of RWH system are comprehensive in the respects of users, environment and governments. For the users, they can enjoy the independent water supply and it is free of costs. But, the users have to invest in the RWH system. For the environment, it is both water conserving and energy conserving, reducing reliance on water storage dam and reducing soil erosion and flooding. Besides, the secondary use of grey water reduces the need to processing effluent water in treatment plants before discharge into waterways. As for the governments, they can reduce the burden for new investment to build, operate and maintain additional water supply systems such as reservoirs, water treatment plants and distribution systems and save land area such as building artificial lakes to store water.

Shortcomings of Rainwater Harvesting

Relatively, RWH system also has limitation during or before its application. For instance, the initial cost (mainly of storage tank) may prevent a family from installing RWH system. The water availability is limited by the rainfall intensity and availability of roof area. The mineral-free rainwater has a flat taste, which may not be preferable by many people. Besides, the poorer segment of the population may not have a suitable roof for rainwater harvesting. The domestic RWH will always remain a supplement and not a complete replacement for public piped supply or supply from more 'reliable' sources. There are also other limitation such as the space for water tank in urban housing.

Modern Rainwater Harvesting System

One Utama Shopping Center

The roof area of One Utama Shopping Mall is 30,000 m^2 (Fig. 4). The shopping mall demands high consumption of water especially during weekends. Water is used for toilet flushing, air-conditioning water cooling tower, car park washing and landscape irrigation. The rainwater storage reservoir should be sized to contain 10 days of usage. There are diverter valves which are used for discharging excessive rainwater. The water storage tank is located at the basement of the building.

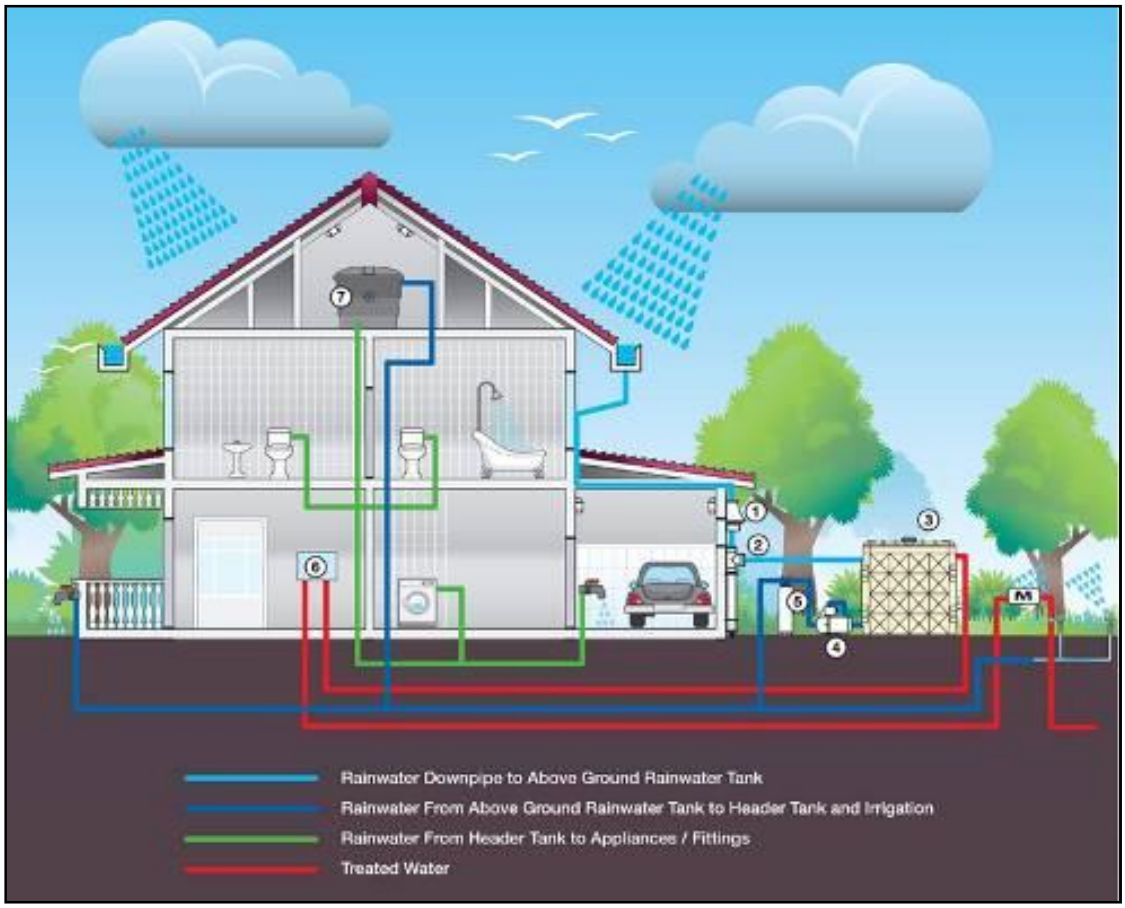

Fig. 3. Above ground rainwater harvesting system: 1. Lift filter, 2. Downpipe first flush diverter, 3. Above ground rainwater tank, 4. Automatic booster pump, 5. Sand bedding filter, 6. Rain backup in a box, 7. Header tank. (Aura-Lite, 2015)

Table 2. Principal features of the Putrajaya wetlands and lake

Principal Features of the Putrajaya Wetlands (Area in ha)						
Total Area	Planted Area	Open Water	Water and Islands	Zone of Intermittent Inundation		Maintenance Tracks
197.2	77.70	76.80	9.60	23.70		9.40
Principal Features of Putrajaya Lake						
Catchment Area	Water Length	Surface Area	Storage Volume	Average Depth	Average Catchment Inflow	Average Retention Time
51.90 km^2	21.00 m	400 ha (4 km^2)	24.5 mil. m^3	6.60 m	200 mil. L/day	132 days

The rainwater is collected from many points of the rooftop. The collected water is distributed for various usages. Besides rainwater collecting system, there are other sustainability features also. For example, the application of high performance, building integrated technologies such as chilled water irrigation sourced from One Utama air conditioning system. There is a building automation system with sensors that automatically adjust lighting and temperature. The company got back their initial investment of more than RM 1 million from the savings in their water bills in 4 years (UKM News Portals, 2009)

Bandar Utama Terrace House

Fig. 5 shows the rainwater harvesting system in the 2 1/2 storey terrace house. To avoid any pumping system for extracting rainwater from storage as well as limiting the storage tank to small size, rainwater is collected from the upper roof and flows to the water tank located below the secondary lower roof. Stored rainwater is tapped and passes through a centrifuge filtration device to remove solids and sediments. The collected water is distributed for various usages that include toilet flushing, car-washing, and landscape irrigation. A saving of about 30% has been recorded (Ab. Rahman *et al*., 2013).

Putrajaya

Putrajaya Corporation implements the rainwater harvesting concept as recommended in the guidelines on "Installing a Rainwater Collection and Utilizing System" introduced by the Housing and Local Government Ministry in 1999 for residential houses as well as commercial and government offices in Putrajaya (Ab. Rahman *et al*., 2010). The application of rainwater harvesting in Putrajaya serves its purpose in terms of the water quality improvement aspects such as the prevention of wastes, debris, chemical agents and other pollutants entering the Putrajaya Lake (Fig. 6 and Table 2).

Fig. 4. One Utama Shopping Mall

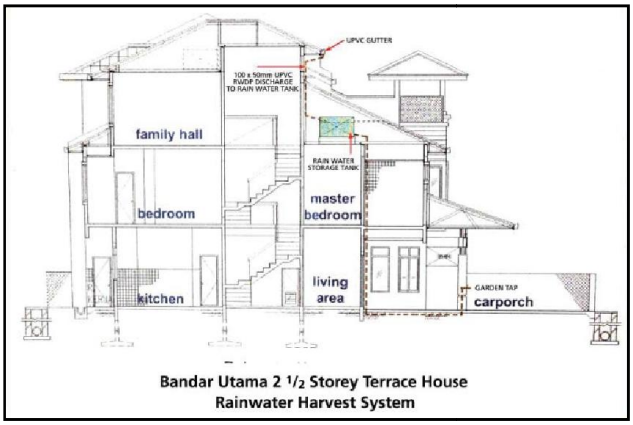

Fig. 5. Rainwater Harvesting System in Bandar Utama

Fig. 6. Putrajaya planning with manmade lake in the middle of the zoning

The development strategies of Putrajaya also focus on the implementation of the rainwater harvesting system in the housing area, for example, the development of 19 units of type C private bungalows in Precinct 16.

In the first phase of construction, 4 bungalow units have already been fitted with the RWH system while in the second phase, only 1 unit has been fitted with the RWH system and the remaining 14 units of bungalows are still under construction. Basically, every bungalow unit is fitted with a 300 L capacity underground rainwater storage tank equipped with a suction pump, located near the back portion of the house. The water tanks are concealed underground near to the drying yard. The pump control valves are located near to the rainwater storage tank. The water tanks are connected to a poly storage round water tank of 1.776 m (D) x 1.524 m (H) situated at the roof level with a storage capacity of 2,250 L via the 25 mm Acrylonitrile Butadiene Styrene (ABS) system of incoming flow and 32 mm diameter ABS outgoing flow pipeline. The storage tank at the roof floor is separated from the domestic cold water plumbing provision tanks.

Conclusion and Suggestions

Even in humid tropical Malaysia where rainfall is abundant, water fluctuations due to a lack of rainfall do happened as in the 1998 and 2014 drought which brought unpleasant water supply disruptions in many parts of Malaysia. Following this Water Crisis, the Minister of Housing and Local Government on 7 May 1998 has expressed the Government's interest for houses to be designed for collecting rainwater. In 1999, the Ministry of Housing and Local Government has produced a Guideline on Installing a Rainwater Collection and Utilization System. Rainwater harvesting system is an environmentally friendly solution for collecting rainwater effectively. It is suitable for both residential and commercial buildings.

In support of the Government's interest in rainwater harvesting, the National Hydraulic Research Institute of Malaysia (NAHRIM) through collaboration with other government agencies such as Department of Irrigation and Drainage, Department of Local Government, Universiti Teknologi Malaysia, Universiti Sains Malaysia and Universiti Malaya has pursued R&D (research and development) on rainwater harvesting focusing on hydrologic and hydraulic design, system design and performance, installation and operational costs and water quality aspects.

In April 2009, Malaysian Building and Construction Industry also has introduced the Green Building index (GBI) as an environmental rating system for Malaysian building. Rainwater harvesting is one of the criteria in GBI index for residential building construction. GBI index is a rating tool for green building requirement in Malaysia. As the rainwater facility would add points to the GBI and this would encourage developers and architects to incorporate rainwater harvesting systems in the buildings. Besides the architects and developers, the residents also need to be aware with the essential of rain water harvesting facility as it is a cost-effective installation.

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