THE PROSPECTS OF RAINWATER HARVESTING IN THE HO CHI MINH CITY

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Abstract

Wisely using natural water resources to serve human needs plays a decisive role in ensuring water and food security. In the natural water cycle, rainwater is considered as a valuable renewable resource. Rainwater harvesting (RWH) for daily life and production is a simple but effective and also environmentally sound measure. It is also a positive solution in a climate change adaptation strategy. However, this resource is being wasted in our country in general and in the HCM City in particular. This paper provides an overview of the status of rainwater use in the world; the general situation, the potential of rainwater collection and a number of issues related to the potential of rainwater harvesting in the city. Some solutions to enhance the use of rainwater and improve water supply for city residents are also suggested in this discussion.

1 USE OF RAINWATER - WORLDWIDE SOLUTON

Clean water is facing deep changes due to the global climate change. The "Report on water resources development" of the United Nations, 2006, indicated that the combination of two phenomena of low rainfall and high evaporation in many regions has reduced water levels in rivers, lakes and groundwater levels. In this situation, rainwater is considered a valuable renewable resource. Rainwater harvesting for everyday life and production is now commonly used in most countries at different levels for thousands of families. This can be considered as a simple but effective and also environmentally sound measure. The purpose and basis of the utilization of rainwater vary in each country [1].

In Europe, rainwater is used as a supplementary source. For example, in Germany, the use of rainwater is encouraged to conserve groundwater. Denmark and the Netherlands also encourage the efforts to utilize rainwater in the same way as in Germany [3]. In the United Kingdom, the UK Rainwater Harvesting Association has been formed with the goals of promoting and encouraging the development of rainwater harvesting industry, ensuring the best warranty service for customers of raw materials, spare parts for rainwater harvesting systems, and increasing public awareness on the benefits of using rainwater.

In Africa, they are also trying to enhance the project to collect rainwater for improving the living conditions of people. As reported by the UN Environment Programme (UNEP), Africa has an abundant potential of rainwater; the rainwater can even meet from 6 to 7 times the current water demand of Ethiopia and Kenya, if the countries have right storage measures. It is estimated that the rainfall over the entire territory of Africa can meet the needs of 9 billion people. However, rainwater harvesting for water supply has not been widely adopted due to many factors including the impact of economic factors [4]. Some statistics show that women (sometimes children) have to walk an average of about 6 km to carry 20 kg of water by putting on their heads or carrying on their backs. To alleviate this burden for women and children, many projects of installation of rainwater tanks have been supported by non-governmental organizations in Kenya.

In the U.S., surface runoff is collected and stored in large reservoirs, then pre-treated and finally recharged to the aquifer. In the Andes of South America, rainfall is often very low, but fog is often hovering close to the ground. People use black shields to collect its condensate. By this method, with the shield of 3600 m^2, the amount of water of about 11 m^3 per day can be obtained.

In Asia, rainwater becomes an important source in both rural and urban areas. Examples are as follows: In Tokyo (Japan), the utilization of rainwater or seeping rainwater into the soil is promoted by the active participation of citizens in order to prevent flooding and restore streamsp [5]. Box 1 presents an example of the mitigation of water reservoir exploitation by utilizing rainwater for sanitary purposes in Tokyo.

Box 1 - The plan for using rainwater for the city of Tokyo

If all households in Tokyo collect rainwater, the total capacity would be an impressive number. The number of houses in Tokyo is about 1.5 million; the average roof size is 60 m^2. With an average annual rainfall of 1,500 mm, water reserves are: 60 m^2 × 1.5 m (1500 mm) × 1.5 million = 135 million m^3. Notably, this number is higher than the amount of water taken from the Yagisawa Dam in Gunma Prefecture for Tokyo (126 million m^3). In short, the combination of many "small-tanks" will be a large water reservoir. If each individual house has 4 people and often uses about 790 litres of water per day, the rainfall that would be lost can be recovered for use against the total amount of water per day: (60 m^2 × 1.5 m): (790 litres × 365 days) × 100 = 31 %. The amount of water used for sanitation accounts for 22 % of total water consumption of a family, so it is possible to use rainwater collected for this demand [7].

In the agricultural areas of north-eastern Thailand where no large rivers flow through, ground water is saline; therefore, people have been using rainwater for a long time. Singapore is a typical example of rainwater utilization. Previously, there were 3 traditional water supplies in the island including local water resources (mainly water in small streams), water imported from Malaysia and filtered seawater. Only in 1992, the country began to use rainwater at the Changi Airport. Currently, 80 % of the water of the Changi International Airport activity is from stormwater. The rainwater is taken from the airport runway and used for sanitation. In Yogyakarta, Indonesia, the infiltration of rainwater into the ground is a mandatory duty to conserve the city's groundwater water sources [2].

The International Conference on Rainwater Use hosted by Japan was held in Sumida City, Tokyo from 1st to 6th August 1994. The message of the conference is "Using rainwater to save the Earth – Developing close relationships with rainwater in the city." At this conference, members offered ideas on the use of rainwater and together were finding ways to save rainwater. This conference also launched the policy and technology related to the use of rainwater, changing people's thinking about rainwater. Results of the conference have formed an information network on the global use of rainwater. There are 5 key points summarized by the Conference as follows:

1. Population in Asia, Africa and Latin America will continue to reside mainly in large cities, so these cities face the problems of "Drought and floods in city".
2. Profound lessons learned from wasting and discharging rainwater into the sewers of Tokyo; and recently, the people of Tokyo have created technologies for the efficient use of rainwater to help solve the problem "Droughts and Floods in city".
3. Utilization of rainwater is responsibility of the entire world, associated with the "Sustainable Development of Cities".
4. The problem with using rainwater directly relates to acid rain and air pollution.
5. Build the habits of using rainwater in the cities with abundant rainfall.

2 RAIN WATER RESOURCES IN THE HO CHI MINH CITY

2.1 Annual Rainfall

The Ho Chi Minh City has relatively abundant rainfall. The average rainfall in the period of 1995-2007 reached about 1962 mm. In many years, the annual rainfall has passed the level of 2000 mm. Particularly, in the year 2000 up to 2730 mm (see Fig. 1). In general, the rainfall in the HCM city is much larger than the rainfall in Tokyo (about 1500 mm/year).

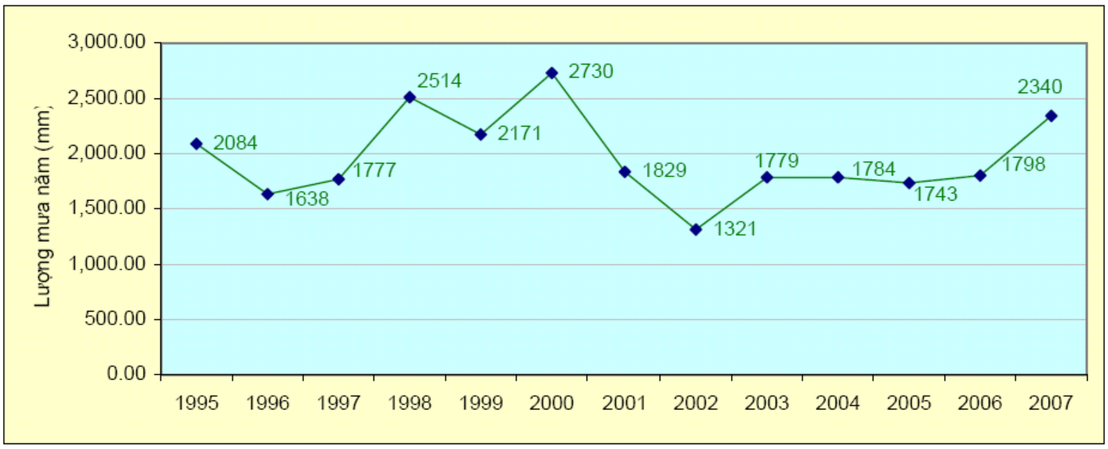

Fig. 1 Annual rainfall in the period of 1995-2007 in Tan Son Hoa

An important feature consists in that the rainy season is relatively long in the city; the rainfall is relatively evenly distributed during the rainy period (from April to November). The maximum monthly rainfall reached 281-495 mm in the period from 1995 to 2007. The average monthly rainfall during the rainy season was from 153-302 mm. The rainfall during the rainy months occupied 87-99 % (see Tab. 1, Fig. 2)

Tab. 1 Distribution characteristics of monthly rainfall in HCMC (mm)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Month Max	493 (VIII)	281 (VII)	475.3 (VII)	466.6 (VI)	417.3 (XI)	478 (VI)	364.1 (VI)	292.1 (X)	347.1 (X)	355.9 (VII)	388.6 (X)	349 (VIII)	495.4 (IX)
Month Average	251.1	199.7	219.8	298.9	237.0	302.4	208.8	153.1	221.7	221.4	204.7	211.0	284.2
Rainfall 4-11	2009	1598	1758	2391	1896	2419	1671	1225	1774	1771	1637	1688	2273
% years	96	98	99	95	87	89	91	93	100	99	94	94	97

Source: Compiled from statistics of the Ho Chi Minh City

Rainfall patterns are fairly distributed as described above, which is very convenient for the design of tanks with an appropriate storage capacity. They not only capture much rain, but also use less expensive containers. It can be found that the rainfall is abundant and fairly evenly distributed throughout the rainy months. The system designed to collect and store rainwater in the Ho Chi Minh City is quite favourable.

2.2 Rainwater quality

Results of stormwater quality monitoring in 2011 are shown in Tab. 2. In comparison with the Vietnam's standards TCVN 5502-2003, it can be seen that the concentration of main parameters of the city's rainwater such as hardness, NH_4-N, N-NO_3, Cl are much smaller than the thresholds for drinking water. The value of pH in the areas of high traffic density such as Hang Xanh, Phu Lam is less than 6. It can be determined that it is the impact of air pollution in urban central area. The rainwater in the area of Tan Son Hoa has good quality.

Tab. 2 Results of rainwater quality monitoring in 2011

	TAN SON HOA			HANG XANH			PHU LAM		
At the start of rainy season									
pH	6.48	5.63	6.5	4.92	4.83	5.10	5.14	5.31	5.03
EC	54.9	13.0	78.0	30.2	52.2	34.6	27.2	38.2	34.0
N-NH_4	1.1	0.19	1.01	0.49	0.42	0.52	0.48	0.51	0.35
N-NO_3	1.856	0.09	3.369	2.286	0.524	1.518	1.867	0.506	2.232
SO^{2-}_4	2.7	4.1	2.7	3.5	4.3	3.3	3.2	3.1	3.5
Cl	3.1	3.0	3.0	1.9	2.3	2.3	2.0	2.3	2.3
Hardness	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alkalinity	0.09	0.07		0.0	0.0	0.04	0.0	0.04	0.0
At the end of rainy season									
PH	6.4	6.02	6.11	6.02	5.64	5.61	5.91	5.83	5.72
EC	10.7	8.2	14.9	36.3	42.2	32.6	20.2	31.8	41.7
N-NH_4	0.00	0.19	0.07	0.34	0.25	0.22	0.43	0.29	0.25
N-NO_3	0.129	0.221	1.927	0.335	0.568	1.988	0.386	0.436	1.889
SO^{2-}_4	4.2	2.7	2.4	2.7	2.9	3.0	2.7	2.7	2.8
Cl	3.1	3.9	3.9	1.9	3.0	3.0	1.6	1.6	3.3
Hardness	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alkalinity	0.12	0.1	0.1	0.1	0.05	0.04	0.08	0.08	0.06

Source: Sub-Institute of Hydrology and Environment, 2011

3 CURRENT SITUATION IN RAINWATER USE

3.1 Popularity

According to preliminary investigation results on the use of rainwater in some districts of the Ho Chi Minh City. The practices of rainwater harvesting in the city is very limited. The results of the random survey of 400 households showed that only 80 of those (20 %) carry out collecting, storage and use of rainwater for a number of different purposes [8]. The highest percentage of households using rainwater is in the Can Gio district (about 57.50 %). This comprises about 20 % in the areas such as Binh Chanh, Binh Tan, District No7, No 8, and Nha Be. In other areas, including Thu Duc, Districts No12, No2, No9, the percentage varies from 8 % to 10 %.

3.2 Forms of rain water collection and storage

The survey showed that the forms of rainwater collection and storage in the city are very diverse with different sizes from small ceramic jars to large-scale models of tanks. The tanks have a capacity of 2-5 m^3 and are made of plastic or composite. The form and scale are applied depending on economic conditions of each family. Some typical forms of rainwater collection are described below.

- The first form can be found in poor households. For these ones, roofings are made of water coconut leaves. Gutters are made of aluminium, steel or even of wood. Containers usually are ceramic jars. Depending on their economic situation, these families can buy a greater or lesser number of the jars. In general, the containing volume is very little, only about 300-600 litres (about 50-10 of small ceramic jars). Rainwater is used mainly in the rainy season to save money to pay for water purchased from the water satellite station.
- The second one represents an average scale in households residing in long time. This scale is common for households with medium income levels, relatively long settlement time, and the experience in collecting and storing rainwater. Their roofings are made of iron sheets or even of coconut leaves, but with a large area, and are designed with the intention to collect rainwater. Storage instruments may be ceramic jars or cement tanks or cylinders, but of much larger capacity. The storage of rainwater serves as the main source for all activities of the family: eating, bathing, washing and even used to irrigate crops and livestock.
- The third form constitutes a large scale in high-income households. In wealthier families, houses are built of brick, tile roof or flat roof. The rainwater collection system has been relatively built in a large scale. The storage capacity in these households is large with high volume cement tanks (1.5 to 2 m^3). Through interviews, the households reported that rainwater is the main source of their water supply. With a capacity of up to 10 m^3, these households can be provided an adequate water amount during the rainy season and for about 2-3 months in the dry season.
- The fourth one can be seen in the industrial enterprises. This form is popular in the water shortage areas such as Can Gio and Binh Chanh. The practical survey found that many industrial facilities have rainwater collection systems of a large scale. The collecting roof is usually made of steel sheets and has a large area. Composite or plastic tanks with a capacity of about 10 m^3 or larger are the most common.

3.3 Examples of real potential

The potential use of rainwater in practice was examined in more detail in the rainwater storage system of the family of Mr. Nguyen Van Tat, An Nghia village, An Thoi Dong Commune. The information has been recorded as follows:

- Mr. Tat's family has 7 people; rainwater has been collected thoroughly from the roof tiles of the main house and from the fibro-cement roof of the side house. The rainwater is used for daily personal activities such as eating, bathing and washing, and also for raising pigs and horticulture.
- The time of the survey was November 2011. All containers were full of rainwater. The collection began in April 2011 and lasted over the rainy season. The family used the rainwater for everyday living only. The amount of collected rainwater can be utilized within 8 months.
- The total roof area for the rainwater collection is estimated to 150 m^2.
- The estimated total capacity of 34 containers (about 40 litre/jar) and 4 cement tanks (1.6 m^3 per tank) is about 10 m^3.
- If calculated according to the reserves per capita from the rainwater collection system, the potential use of rainwater per person in reality can be assessed as follows: area = 21.4 m^2 per person; cylinders: 1.4 m^3 per person; collected water used in 8 months = 240 days × 60 litres/person/day = 14,400 litres.
- The specific case of the family could confirm that the ability of rainwater harvesting for domestic purposes is highly realistic. In the context of a well-designed system such as this typical case, the other households may also be self-sufficient up to two thirds (8/12 months) of their water needs.

3.4 Comments

Surveying the actual situation of rainwater harvesting in the above districts of the Ho Chi Minh City results in several comments on this issue as follows:

- Rainwater is collected by many households for the purpose of domestic activities.
- Rainwater collection systems are simple; the materials used are cheap and locally available.
- With present housing patterns in the city, if it is invested in the containers enough, the collected rainwater could meet the basic needs of domestic activities in the rainy season, which may be extended to a certain period of the dry season as well.
- Water collection systems are rudimentary. Most systems have no coarse filter, first-flush diverter and no facility for treatment of the stored rainwater.

4 PROPOSED SOLUTIONS

4.1 Objectives

Rainwater harvesting in the districts facing water shortage is essential to improve water supply conditions and also has a great potential. To maintain practices of the utilization and development of city-wide rainwater systems has huge social and environmental meanings [2]. The objectives of implementation of the proposed measures are to achieve the following:

- Improving the water supply for communities in the suburban districts, especially for poor households in communes with difficult economic conditions.
- Reducing the increasingly demand pressure on the water supply of the Ho Chi Minh City to meet local water needs.
- Reducing the cost of price subsidies that are suffering from the HCM City every year for the water shortage areas
- Maintaining and developing the habits of sustainable water use in the suburbs.
- Reducing the environmental damage caused by exploitation, processing and transporting water from other places to remote areas.

4.2 General orientation of solutions

With the above objectives, a number of solutions to enhance the exploitation of rainwater for domestic water supply are proposed as follows:

- Implementing programs to raise awareness of the importance of exploitation and utilization of rainwater sources. Giving local communities and managers to understand the huge benefits of saving and conserving water resources through the use of rainwater [6].
- Carrying out the overall survey on the status and the ability of promoting rainwater collection systems in residential areas.
- Developing programs to encourage and support poor household's storage devices such as gutters, water tanks.
- Development of additional collection and storage networks of rainwater at agencies, offices, schools, and in public areas. Make use of rainwater for various purposes such as sanitation, irrigation to save water sources [6].
- In the planning of long-term water supply for districts, the attention should be taken on the exploitation option of large-scale rainwater harvesting projects in each locality.

4.3 Technical solutions

- Research for choosing suitable and cheap materials for rainwater collection and storage systems on the basis of materials that are locally available.
- Studying the manufacture of large-volume containers to replace the present traditional water containers (ceramic jars, concrete tanks).
- Manufacturing and guiding people to use the tools to improve water quality such as coarse filters, first-flush diverters and facilities for the treatment of stored rainwater.
- If possible, investment should be made to gradually replace the thatched roof, thatch, coconut water leaves with a zinc coated roof or a tile roof to increase the coefficients of rainwater harvesting and also the water quality.

5 CONCLUSION

1. Freshwater resources of the city are under pressure of urbanization and industrialization. Ensuring clean water for all areas of the city is very difficult and costly, especially for those with lack of clean water source such as Can Gio, Binh Chanh, Nha Be. The pressure of the water supply is strong because the demand for water supply in the city is growing day by day to meet the requirements of socio-economic development.
2. The practices of rainwater use are still prevalent in the community of city dwellers. The rainwater collection system is simple; the materials used are cheap and locally available. However, part of the population tends to pay little attention to this water and have expressed to rely on the city's water supply.
3. The potential of rainwater harvesting for domestic water supply is very real. If such rainwater-harvesting systems are designed well, they might resolve a significant demand for fresh water, especially during the rainy months in the many areas of the city.
4. The use of rainwater brings huge benefits, including economic, social and environmental ones; it also contributes to the protection and saving of water resources for the city.
5. Rainwater storage harvesting systems are simple, inexpensive, and easy to install so they can be applied widely in the community. The development of this solution is convenient because the residents have their own traditions and good experience.
6. It is suggested that the city should have policies and guidelines on the utilization of rainwater, advocating everyone involved to take advantage of rainwater, and thus save city's water resources. There should be the need to develop mechanisms for supporting poor household’s collection and storage devices. In addition to rainwater storage networks for families, the planning of city large-scale rainwater harvesting systems in the long-term water supply should be concerned.

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