DEVELOPMENT OF ALTERNATIVE WATER RESOURCES IN THE USA: PROGRESS WITH RAINWATER HARVESTING

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Abstract

Because of rising population and limited water supplies, there is a need to develop alternative water resources in the USA, particularly in the western states. One alternative source of water is harvested rainwater which can serve a number of different purposes. Examples from Texas and from other states in the USA illustrate the different uses and benefits of rainwater harvesting.

Rainwater cisterns were used in Texas in the early 1900s, but became obsolete as municipal water distribution systems were being developed. Since the early 1990s however, due to population increase and a higher demand for water supplies, there has been a renewed interest in rainwater harvesting in Texas by private individuals, corporations, water utilities, cities, counties and the state government. The Texas legislature has supported and encouraged the use of rainwater harvesting in the state. House Bill 2430 that was passed in 2005 established the Texas Rainwater Harvesting Evaluation Committee consisting of representatives from the Texas Water Development Board, Texas Commission on Environmental Quality, Texas Department of State Health Services and the American Water Works Association (Texas Section). The committee was required to evaluate the potential for rainwater harvesting in the state, develop minimum water quality guidelines and treatment methods for the safe use of rainwater for indoor purposes, and recommend ways in which harvested rainwater could be used along with existing municipal water supply systems. I served as committee Chair and we addressed all the above tasks, and proposed 10 key recommendations to the legislature for ways in which rainwater harvesting can be further promoted in the state. This paper includes the findings and recommendations of the committee, which may serve as a model for other states and countries.

To determine the potential for rainwater harvesting, satellite imagery was used to determine roof areas and compute the amount of roof runoff that could be expected from average annual rainfall. For example, in a large metropolitan area the size of Dallas, if 10 percent of the roof area were used to harvest rainwater, approximately two billion gallons (approximately 7.6 billion liters) of water could be collected annually. Census data from other cities were used to estimate the rainwater that could be potentially harvested in those cities and statewide as well. Many cities in the United States and in other countries could potentially generate large quantities of "new" water through rainwater collection.

Rainwater harvesting systems are being used in at least a dozen states and U.S. territories. It is estimated that more than a half million people currently use harvested rainwater from roof surfaces in the United States and its territories. Millions of others use rainwater runoff collected from land surfaces in ponds and small reservoirs, for agricultural and livestock purposes.

The Need for Developing Alternative Water Resources

In the United States, many large dams have been built during the 20th century to harness the rivers and to make water supplies available for both urban and rural needs. In general, many of the ideal sites have already been utilized for reservoir construction. In addition to surface water sources, groundwater resources have been used traditionally to provide the needed water supplies.
As the population increases and total water supplies diminish with time, water deficits become evident, particularly due to competing water demands by the urban and rural sectors. Figure 1 shows regions of western states where existing water supplies may not be adequate to meet the needs in 2025 (USBR, 2005), and could lead to potential crises.

![Potential Water Supply Crises by 2025](Image)

**Figure 1: Water Supplies in the Western States (U.S. Bureau of Reclamation, 2005)**

There is a need to develop alternative water resources, especially in the western and southwestern parts of the country. To augment traditional surface and groundwater resources, several alternative sources can be used. At the Texas Water Development Board (TWDB), the Innovative Water Technologies (IWT) program is involved with three alternative methods to augment existing water supplies – Rainwater Harvesting, Desalination and Water Reuse. This paper will focus on rainwater harvesting, the topic for the IRCSA conference.

**Rainwater Harvesting in Texas**

During the early part of the 20th century, Texas residents built cisterns and collected rainwater from their rooftops to serve their daily needs. As public distribution systems were being developed, those cisterns gradually become obsolete. During the past 10-15 years however, there has been a renewed interest in rainwater harvesting because of a number of different reasons. Many cities have growing populations but limited water supplies. Building reservoirs or developing well fields and building treatment plants are all expensive propositions and take time to implement. Water conservation and rainwater harvesting are immediate ways to reduce the demand for treated water supplies. Thus cities and local communities are interested in promoting rainwater harvesting. Over 9,000 rain barrels have...
been sold in the past few years by the City of Austin at a discounted price of $60 each to residents. Even though their capacity is only 75 gallons (285 L), they fill at least five times during the rainy season, thus resulting in a total storage capacity of 375 gallons (1,425 L). In addition to discounted rain barrels, the city of Austin also provides rebates for larger rainwater harvesting systems. Harvested rainwater can be used for landscape watering, resulting in a lower total demand for treated water. Those who live in rural or semi-rural areas either have to contract with water supply companies for a water line, drill a well, or collect rainwater. Oftentimes, rainwater harvesting is the most economical option. It is estimated that a total of about 15,000 rainwater harvesting systems – large and small – are operating in Texas, some of which serve both potable and non-potable needs. This growth has occurred essentially during the past 10-15 years.

Key factors assisting in the growth of rainwater harvesting systems are the availability of pertinent information and literature on rainwater harvesting technology, governmental incentives, and rebates by cities for incorporating such systems. The TWDB has published three editions of the Texas Manual on Rainwater Harvesting since 1997. The third and latest edition published in 2005 is available on-line from the TWDB website at [http://www.twdb.state.tx.us/iwt/rainwater.asp](http://www.twdb.state.tx.us/iwt/rainwater.asp)

An amendment passed by Texas voters in 1993 exempted from property taxes water conserving equipment (including rainwater harvesting equipment) for commercial applications in Texas. In 2001, the Texas Legislature passed Senate Bill 2 which allowed local taxing units the option to exempt from property taxes all or part of the value of the property on which the water conservation modifications were made. Senate Bill 2 also provided sales tax exemption for all rainwater harvesting related equipment sold in Texas.

The cities of Austin and San Antonio provide rebates for rainwater harvesting systems based on the amount of water conserved. The city of Austin also participates with a local car dealership in a sweepstakes for those that purchase water conserving equipment. The sweepstakes award a free hybrid vehicle to the grand prize winner each year.

**Texas Rainwater Harvesting Evaluation Committee**

In 2005, the Texas legislature passed House Bill 2430 that established the Texas Rainwater Harvesting Evaluation Committee (TRHEC). It consisted of representatives from the Texas Water Development Board (TWDB), the Texas Commission on Environmental Quality (TCEQ), the Texas Department of State Health Services (TDSHS), and the Conservation and Reuse Division of the American Water Works Association, Texas section. I was nominated as the TWDB representative on the committee, and served as committee Chair.

House Bill 2430 directed the Texas Rainwater Harvesting Evaluation Committee to evaluate the potential for rainwater harvesting in Texas and to recommend:

(a) minimum water quality guidelines and standards for potable and non-potable indoor uses of rainwater;
(b) treatment methods for potable and non-potable indoor uses of rainwater;
(c) ways, such as dual plumbing systems, to use rainwater harvesting systems in conjunction with existing municipal water systems; and
(d) ways that the state can further promote rainwater harvesting.
The bill required the Texas Commission on Environmental Quality to adopt the recommended standards, and the Texas Rainwater Harvesting Evaluation Committee to submit a report to the Texas Governor, Lieutenant Governor, and Speaker of the Texas House of Representatives by December 1, 2006.

**Rainwater Harvesting Potential**

The TRHEC determined that in most areas of the state, rainfall is sufficient to make rainwater harvesting a reliable and economical source of water even during short-term droughts. Because rainfall is generally harvested in the same location where it will be used, the need for complex and costly distribution systems is eliminated. An estimated 2 billion gallons (7.6 billion L) of water could be generated annually in a large metropolitan area the size of Dallas if 10 percent of the roof area were used to harvest rainwater. Approximately 38 billion gallons (144.4 billion L) of water would be conserved annually in Texas if 10 percent of the roof area in state were to be used for rainwater harvesting.

A map of Texas showing the average annual runoff from a typical 2,000 square feet (186 sq. m.) roof was developed for the TRHEC report and is shown in Figure 2. Assuming a rainfall collection efficiency of 80 percent, a rainwater harvesting system using 2,000 square feet of roof area would generate approximately 1,000 gallons (3,800 L) of water for every inch (2.5 cm) of rainfall. This mathematical relationship holds true in almost any part of the world. In Austin, where the average annual rainfall is 33 inches, we expect to collect approximately 33,000 gallons (125,400 L) annually from a 2,000 square foot roof. Similar maps can be generated for any state, province, region or country.
Figure 2: Average annual runoff from a typical 2,000 sq. ft. (186 sq. m.) roof in Texas

Water Quality Guidelines and Treatment Methods for Rainwater
Harvested rainwater may be the only source of water supply for many rural and remote households where no other water supply is available. In urban and suburban environments, rainwater harvesting could help public water systems reduce their peak demands and help delay the need for expanding water treatment plants. Rainwater harvesting can reduce storm water runoff, erosion, and non-point source pollution. Rainwater is valued for its purity and softness and is generally superior for landscape irrigation to most conventional public water supplies.

The TRHEC developed minimum water quality guidelines and treatment methods for both potable and non-potable uses of rainwater. A copy of the full report that includes these guidelines is posted on the Texas Water Development Board website at http://www.twdb.state.tx.us/iwt/rainwater/docs/RainwaterCommitteeFinalReport.pdf

Using Harvested Rainwater in Conjunction with Municipal Water Supply

The TRHEC recommended that in conjunction with municipal water supply, harvested rainwater may be used at this time only for landscape watering and non-potable indoor uses (washing machines and toilets). Toilets and washing machines consume about 40 percent of the water that is used inside the home (Vickers, 2001). If those two uses can be served with rainwater, a significant water saving will result. It is important to provide adequate protection such as back flow prevention at the meter, and an air gap at the public water supply entry into the storage tank. A typical schematic recommended for rainwater use in conjunction with municipal water supply is shown in figure 3.

TRHEC’s Recommendations

The following 10 recommendations were submitted to the Texas legislature for their consideration, to expand the state’s role in promoting rainwater harvesting:
1. Direct all new state facilities with 10,000 square feet or greater in roof area (and smaller facilities, when feasible), to incorporate rainwater harvesting systems into their design and construction. Harvested rainwater at these locations may be used for restroom facilities and/or landscape watering.

2. Develop incentive programs to encourage the incorporation of rainwater harvesting systems into the design and construction of new residential, commercial, and industrial facilities in the state.

3. Consider a biennial appropriation of $500,000 to the Texas Water Development Board to help provide matching grants for rainwater harvesting demonstration projects across the state.

4. Direct the Texas Commission on Environmental Quality and other state agencies to continue to exempt homes that use rainwater harvesting as their sole source of water supply from various water quality regulations that may be required of public water systems.

5. Direct the Texas Commission on Environmental Quality and other state agencies to require those facilities that use both public water supplies and harvested rainwater for indoor purposes to have appropriate cross-connection safeguards, and to use the rainwater only for non-potable indoor purposes.

6. Appropriate $250,000 to the Texas Department of State Health Services to conduct a field and laboratory study to assess the pre- and post-treatment water quality from different types of rainwater harvesting systems in Texas.

7. Direct Texas cities to enact ordinances requiring their permitting staff and building inspectors to become more knowledgeable about rainwater harvesting systems, and allow such systems in homes and other buildings, when properly designed.

8. Direct a cooperative effort by the Texas Commission on Environmental Quality and the Texas State Board of Plumbing Examiners to develop a certification program for rainwater harvesting system installers, and provide continuing education programs.

9. Direct Texas Cooperative Extension to expand their training and information dissemination programs to include rainwater harvesting for indoor uses.

10. Encourage Texas institutions of higher education and technical colleges to develop curricula and provide instruction on rainwater harvesting technology.

Subsequent to our committee’s recommendations, House Bill 4 was filed in the Texas Legislature. The bill covers several topics related to water conservation including rainwater harvesting. At the time of submitting this paper, recommendations 1, 4, 5 and 10 from the above list are included in the draft bill. In addition, a rider to provide $500,000.00 to the TWDB (per recommendation #3) appears likely. The current legislative session in Texas ends on May 31, 2007 and an update on the bill and related provisions on rainwater harvesting will be provided during the conference presentation.
Rainwater Harvesting in other States

In the USA, rainwater harvesting is being practiced in at least a dozen states and territories. It is estimated that there are over 100,000 rainwater harvesting systems in the USA and its territories. In addition to Texas, others with significant numbers of rainwater harvesting systems are Hawaii, Washington, Oregon, Kentucky, Ohio, and the U.S. Virgin Islands. Even though a major use of harvested rainwater is for landscape watering, there are a number of systems that serve indoor uses as well. With proper design and appropriate treatment, harvested rainwater is becoming recognized as a safe and dependable source of water for potable uses as well, particularly in remote communities.

References


