Rainwater Harvesting in Austin, TX

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1 Abstract

Rainwater harvesting, the collection of rainwater from a roof catchment, is an alternative water resource and can be used for non-potable and potable purposes. Some people in central Texas already using rainwater they collect for non-potable uses (i.e., irrigation) and potable use after some type of disinfection. It is likely that many more people are interested in harvesting their rainwater but do not know the capacity of their house or how seasonal variations would affect their supply. In this project, I estimated the volume of water that could be collected from my house at 5605 Courtyard Dr., Austin, TX. I used maps to estimate the catchment area of the roof and precipitation data from the last ten years to determine the possible volume that could be harvested. A ten-year annual water balance showed that a 300 m^3 reservoir would be sufficient for supplying water for two people living in that house, even during a drought.

2 Background

The Texas Water Development Board (TWDB) reported in 2005 that over 400 full-scale rainwater harvesting systems had been installed by professionals and over 6,000 barrels had been installed (TWDB, 2006). The City of Austin and the State of Texas offer tax incentives for installing these systems because they foresee rainwater harvesting as a way to help close the growing deficit between water supply and demand. The TWDB provides guidelines for constructing these systems, which are essentially rules of thumb gained from experience. In this project I wanted to use the mapping and data resources of ArcGIS and Hydro Desktop to try to accomplish a similar objective through different means.

3 Methods

In order to assess the potential for rainwater harvesting, I choose to examine a specific site, my house at 5605 Courtyard Dr., Austin, TX. First, I determined the maximum possible catchment area. Second, I obtained precipitation data near the site. Then I processed the data and determined the maximum possible volume that could have been captured.

I first found the catchment area using ArcGIS. The Capitol Area Council of Governments provides orthoimages with 6-inch resolution for each Q4 tile in the six counties they represent. I used their larger maps showing the quadrangles and their subsequent divisions in order to determine in which Q4 tile the site was located. Using ArcGIS to view the file, I identified the house (Figure 1) and used the measure tool to determine the horizontal surface area of the roof, which was 2761 ft^2. The pertinent catchment area is that which is orthogonal to the flow, so assuming that precipitation falls vertically, this area is the horizontal one. Since the image is a birds-eye view of the house, the measured area is the catchment area and the angle of the roof is irrelevant.

Figure 1. 5605 Courtyard Dr as viewed in ArcGIS 10.

Because the goal of the project is to help the average homeowner better understand their potential to harvest rainwater, I also wanted to determine the catchment area using ArcGIS Explorer because it is a free online program. The available map just shows the footprint of the house and is limited in its resolution (Figure 2). Explorer also has a measure tool and using it yielded an area of 2568 ft^2. This area is approximately 200 ft^2 less than that found with the CAPCOG map in ArcGIS 10, and there are a few possible reasons for this discrepancy. First, with a lower resolution, it is more difficult to discern the boundaries of the house. Another implication of the lower resolution is that smaller error in outlining leads to a bigger error in the area enclosed. Third, a certain degree of user error through using a mouse is expected in both programs. Because the areas are fairly similar, a difference of 7%, and the accessibility of ArcGIS Explorer is more desirable, its area of 2568 ft^2 was used.

Figure 2. 5605 Courtyard Dr as viewed in ArcGIS Explorer.

After determining the maximum possible catchment area, I gathered precipitation data using Hydro Desktop, another free and open source program. I made a query for all precipitation data in Travis County, the county in which the house is located, over the last ten years, and received thousands of time series. Because that much data was cumbersome, I restricted it to six gauges near the house (Figure 3). These data points were actually multi-sensor precipitation estimates gathered by the National Oceanic and Atmospheric Administration's National Weather Service West Gulf River Forecast Center.

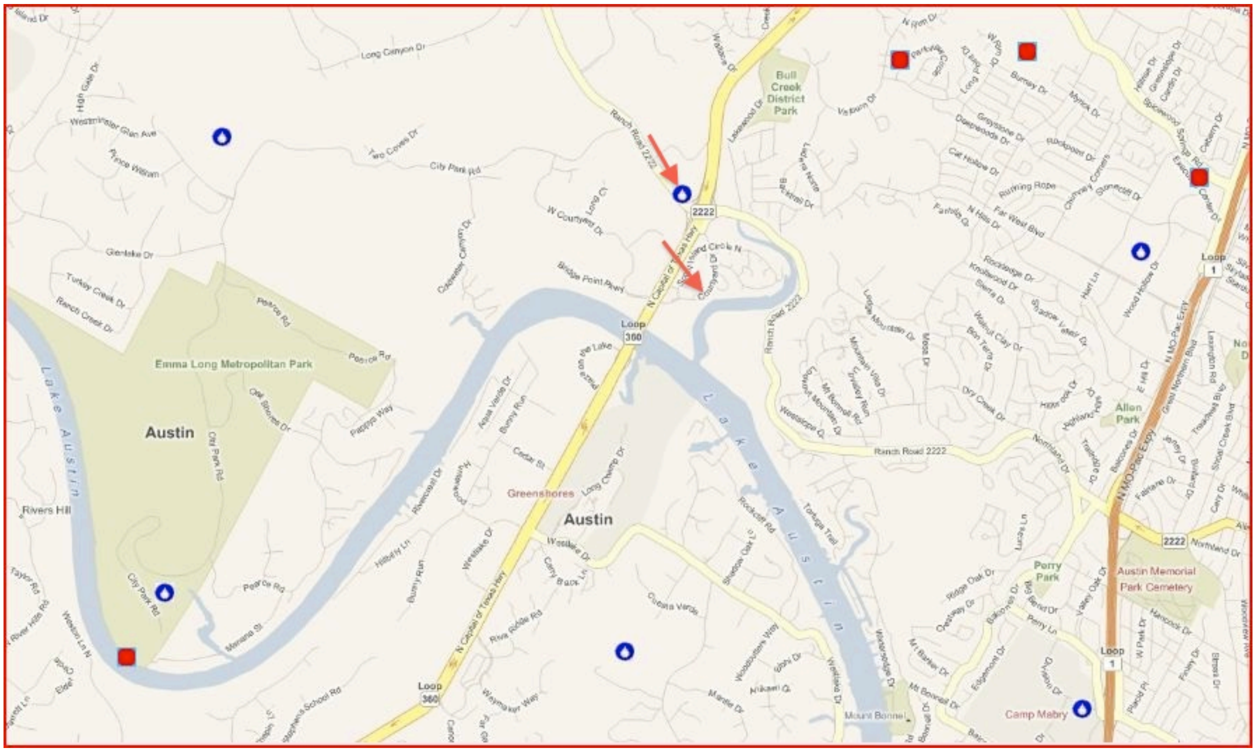

Figure 3. Data points near the site. The blue dots are the six multi-sensor precipitation estimates considered. The top arrow points to the gauge closest to the house and the bottom arrow points to the house.

I initially considered six data points because there can be substantial regional variation in precipitation in Austin and seeing the variation among the gauges would provide a better understanding of how precipitation varies over the small area around the site. A histogram of precipitation in inches over the last ten years at these six points shows that spikes occur at the same time, but actual precipitation on a single day can vary by a few inches (Figure 4). After seeing the similarity in the trends among the six locations, I restricted my analysis to the precipitation data from the gauge nearest the house, as indicated in Figure 3. Those data were compiled into annual sums, showing that it rained a lot in 2004 but very little in 2008 (Table 1).

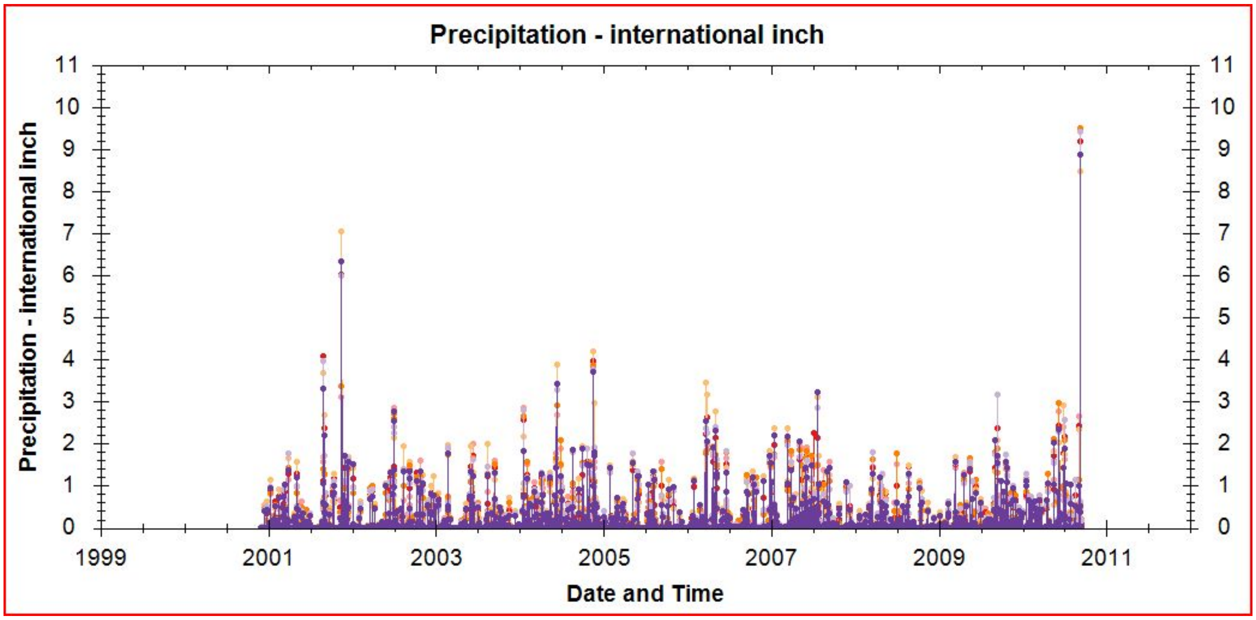

Figure 4. Precipitation at six points from 29 November 2000 – 14 September 2010

Table 1. Annual precipitation in inches. Blue indicates the wettest year and red the driest

Date Range	Yearly Sum (in)
11/29/00-11/29/01	35.19
11/30/01-11/29/02	33.76
11/30/02-11/29/03	19.88
11/30/03-11/29/04	**49.32**
11/30/04-11/29/05	22.72
11/30/05-11/29/06	26.29
11/30/06-11/29/07	40.27
11/30/07-11/29/08	**16.77**
11/30/08-11/29/09	30.82
11/30/09-09/14/10	40.31

4 Discussion

After obtaining the necessary surface area and precipitation data, I calculated an annual water balance for the house. Calculating the water balance required a few assumptions. First, I assumed two people were living in the house. Second, I used the estimate from the American Water Works Association that each person consumes 70 gallons of water per day. Third, I assumed that after the system and reservoir were installed, they would be allowed to fill for one year before the residents began consuming their harvested rainwater. Finally, I assumed there would be perfect capture. This assumption is not entirely realistic since a small volume of water is usually allowed to wash off the roof before rain is actually captured and it is possible that not all of the water would drain to a gutter. Given that this exercise was meant to be a means by which homeowners could estimate their collection potential, these rough assumptions are acceptable.

These assumptions were used to create a ten-year annual water balance on the reservoir (Table 2). The table shows that there was always water in the reservoir, even during a severe drought. The volume in the reservoir was lowest in Year 9 (i.e., 2009), the year after the least rain, suggesting a recovery period for the system. Table 1 shows that rainfall in Austin, TX can vary significantly from year to year, and Table 2 shows that these annual fluctuations allow a rainwater harvesting system to recover from drier years because they are usually followed by a year or two of heavier rain. For this specific house, these trends suggest that a tank of 300 m^3 would be sufficient.

Table 2. Ten-year annual water balance. Blue indicates the wettest year and red, the driest.

Year	Volume Harvested (m^3)	Volume Used (m^3)	Volume Remaining (m^3)
1	213	0	213
2	205	193	224
3	121	193	151
4	**299**	**193**	**257**
5	138	193	202
6	159	193	168
7	244	193	219
8	**102**	**193**	**128**
9	187	193	122
10	244	193	173

5 Conclusion

This analysis shows that domestic rainwater harvesting in Austin, TX is a viable alternative water resource. For the house studied, a tank of 300 m^3 would be sufficient to hold the captured rainwater and cover the annual usage. ArcGIS and Hydro Desktop were used to evaluate this individual location, and other homeowners could follow this procedure and develop a similar evaluation for their home.

6 References

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