# Estimation Of The Potential Of Rainwater Harvesting For Domestic Use In Arid And Semi-Arid Regions From Mozambique: Study Of Moamba

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**ABSTRACT-**Several studies are being carried out globally with the aim of proposing alternative solutions to minimize the water shortage that is now felt in several regions, especially in the arid and semi-arid regions. Therefore, studies related to the Rainwater Harvesting (RWH) become crucial. This study aimed to estimate the potential of rainwater harvesting for the district of Moamba. Rainfall data of 30 years, catchment area as well as runoff coefficient were analyzed. For a region with an average annual precipitation of 584.60 $mm$ , a family of 4 people, using a zinc sheet roof with sizes of 20, 60 and 100 $m^2$ , are estimated to capture the volume of 9353.584, 28060.752 and 46767.920 $L$ respectively. This amount would be sufficient to meet the water deficit at 146, 438 and 731 days, respectively, during the year. In the same way, the volume was calculated using the probability of occurrence of precipitation of 75%, where for the areas of 20, 60 and 100 $m^2$ was obtained 10706, 32118 and 53530 $L$. The results showed that the practice of RWH in the district of Moamba is a viable option.
**Keywords**: water scarcity, arid and semi-arid region, rainwater harvesting.



## 1. INTRODUCTION

Since the dawn of humanity, water has always been considered an indispensable element of life. Water is at the heart of sustainable development and it is fundamental for socio-economic development, for the balance of ecosystems as well as for human survival itself. It is vital for the production and preservation of a number of benefits and services for mankind. Agriculture, transport, leisure and other man-made activities have always been related to the existence of water. Water is also at the heart of adaptation to climate change, serving as a crucial link between the climate system, human society and the environment (Föeger, 2002, "Post 2015 global goal for water," 2017). However, the fact that water be considered an inexhaustible resource has caused the population to use water in an abusive and uncontrolled way and, as a consequence, to make it finite.

The ocean is the source of most precipitation in the world, but freshwater needs are met almost entirely by precipitation on land. However, due to oceanic changes, precipitation patterns are changing, affecting human well-being, living marine resources and other socio-economic resources on which many communities depend (Unep, 2007). Some international bodies point out that the contrast between precipitation, between wet and dry regions and rainy and dry seasons is likely to increase. Many arid and semi-arid mid-latitude regions are likely to receive less rainfall, with the likelihood of having droughts greater than those observed since 1900 ("Post-2015 global goal for water," 2017).

Freshwater withdrawals have increased globally by about 1% a year since the 1980s (WWAP, 2016). It is estimated that by 2050 global demand for water will increase by 55 percent and that by 2025, two-thirds of the world's population may be living in countries with water stress if current consumption patterns are not changed ("Post-2015 global goal for water, "2017). This situation will be aggravated as urban areas grow, which will put great pressure on neighborhood water resources (UN-Water, 2006). In addition, population growth, food security and energy policies and macroeconomic processes such as globalization of trade and changes in consumption patterns, among others, are at the root of global water demand (UN-WWAP, 2015; UNWWDR, 2016).

However, access to water becomes even more aggravating in arid and semi-arid regions, as these areas are most affected by droughts and wide climatic variability, which, when combined with population growth and economic development, the problems of water scarcity are more acute (UN-Water, 2006). In addition, normally in arid and semi-arid regions the potential for evaporation of water in the soil exceeds its retention capacity, resulting in frequent periods of drought, thus limiting the production capacity of agricultural crops (Velasco et al., 2000; Oweis & Hachum, 2009). Ibraimo & Munguambe (2007), also points out that water scarcity is more significantly felt in arid and semi-arid zones because in these areas the majority of the population depends for their subsistence agriculture and livestock, which end up facing several restrictions, due to the predominance of erratic rains, torrential rains, which are mostly lost to runoff or high rates of evaporation. According to Mati et al. ( 2005), about 69% of the lands in eastern and southern Africa are in sub-humid, arid, semi-arid and dry areas where rivers are few and far between ; in addition, where the exploration, development and abstraction of groundwater is expensive and out of reach of most farmers. It should be noted that there are characteristics that are common in arid and semi-arid zones (irregular rains, extreme drought, poor vegetation cover, etc.), among which precipitation is the main hydrological variable and varies significantly from place to place (Lin, 1999).

The increased demand for water in places where the resource is scarce or where there is high water competition creates the need to use so-called "unconventional water sources." Techniques such as the RWH, reuse of gray water as well as wastewater recycling, among others, are considered as alternative sources to meet water needs (UNWWDR, 2016; Worm & Hattum, 2006). Technique of RWH has proven to be the best method since it is fresh in nature and easy to collect. According to UN-Water (2006) rainwater is the primary source for agricultural irrigation and not only, it is also used successfully for industrial and domestic purposes and is an essential element for the functioning of natural ecosystems. It should be noted that this technology is essentially relevant to arid and semi-arid zones (Critchley & Siegert, 1991), where the lack of water has been felt more acutely. According to Studer & Liniger (2013), the terms Water Harvesting (WH) and Rainwater Harvesting (RWH) are commonly used without distinction.

In order to estimate RWH potential, Silva and Almeida (2009) concluded in their study that only from a detailed statistical study of the rainfall regime, for each site, will it be possible to establish, with high precision, the potential of RWH. Lizárraga-Mendiola et al. (2015) conducted a study in the central zone of Mexico, an arid zone, with the objective of estimating the rainwater potential per aggregate. They concluded that RWH, even in areas with an average annual rainfall of 585.6 $mm$, is a good option. These recommend that it is important that filters are placed in the water storage system in order to separate the organic matter as well as the dust that may accumulate in the roof area.

Pande & Telang (2014) calculated the rainwater potential for the Indira Paryavaran Bhawan region (India) using annual mean rainfall, surface runoff and catchment area, where they also reaffirmed the importance of rainwater and estimated that The amount of water that could be used was 2 637 230 $L$, using a catchment area of 6 156 $m^2$, average annual rainfall of 714 mm and surface runoff of 0.6. In Tanzania, Gowing et al. (1999) reviewed RWH techniques and their evidence in order to assess the extent to which different RWH and used. Their results showed that there is no widespread practice of RWH. Manikandan et al. (2011) estimated the potential for utilization of rainwater on the roofs through the water budgeting study. In the Paris region (Belmeziti et al., 2013), they assessed the potential for saving potable water through RWH. In India, (Sethi & Singh, 2014) studied the sustainability of RWH on roofs. Jalfim (2001) concluded in their tests that for a minimum precipitation of 200 $mm$, using a catchment area of 70 $m^2$, it is possible to accumulate 10 500 $L$ of rainwater. In his research (Cain, 2010), after an exhaustive bibliographical review, he also concluded that although the costs of implementing RWH systems constitute a barrier, it says that simple systems are relatively cheaper and more complex can be (less expensive) if they are at the community scale. It should be noted that the results obtained in these studies in relation to RWH were all satisfactory, so that the collection and use of rainwater is a crucial technique in order to minimize the demand for water.

Modern research on water abstraction was initiated in the 1950s by Geddes in Australia, and it was who gave the first definition of WH as: "collection and storage of water from the stream for the use in irrigation "(Myers, 1975 cited by Boers, 1994). Other definitions that have been given show that water collection encompasses methods for inducing, collecting, storing and conserving runoff from various sources and for various purposes (Boers and Ben-Asher 1980 cited by Boers 1994). Mati et al. (2005) emphasize that RWH is a technique that involves the capture and storage of rainwater for agricultural, industrial and environmental purposes. RWH consists of a wide range of technologies used to collect, store and deliver water for the specific purpose of meeting the demand for water in humans and / or human activities (UNEP, 2009). For this paper, the definition proposed by Oweis et al. (2013) was adopted according to which the use of rainwater is a process of concentration of precipitation through the flow and subsequent storage for beneficial use.

Historically, RWH techniques were more applied in rural areas, where water shortages have been more pronounced due to the lack of centralized supply infrastructures, however in recent times, companies, governments as well as other stakeholders has advocated the implementation of these systems also in urban areas. However, in almost all the world the recommendation and implementation of these systems has been done without any study of its viability as well as performance (Stewart et al., 2015). In Africa, RWH technology spread rapidly in Kenya, where dozens of projects were developed between the late 1970s and 1980s, but despite the success of many individual projects, rural coverage of improved water supply still low (Gould, 1994).

Mozambique is a country on the African continent, located on the eastern coast, south of Ecuador, in the Southern Africa region, with boundaries: Tanzania to the north; to the northwest, Malawi and Zambia; Zimbabwe, South Africa and Swaziland to the west; to the south, South Africa and; to the east, the Indian Ocean. It presents a climate that varies from tropical to subtropical with some semi-arid regions in the southwest of the country. According to the 2017 Census, Mozambique is composed of 28 861 863 inhabitants and covers an area of 799 380 $km^2$ (INE, 2017). Mozambique is often affected by natural disasters such as droughts, floods and cyclones due to its geographic location (Ribeiro & Chaúque, 2010; Sitoe, 2005) as well as due to socioeconomic issues (Ribeiro & Chaúque, 2010) climate change and reduce the population's capacity to adapt and is considered one of the most vulnerable countries in Africa to climate change (Irish Aid, 2017; Ribeiro & Chaúque, 2010). Predictions indicate that the southern part of the country will be affected by longer periods of drought and the intensity of cyclones in the country will tend to increase (Aidenvironment & Water-is-Essential BV, 2015).

In Mozambique, water demand is largely influenced by population growth and also by the large portion of the population that depends on agriculture (70% of freshwater abstracted is destined for agriculture), and the main source of water is surface water (Aidenvironment & Water-is-Essential BV, 2015).

Rainwater exists in abundance in Mozambique, especially in the period from December to March (Carvalho & Placido, 2015), with hurricanes and typhoons occurring between November and February (Aidenvironment & Water-is-Essential BV, 2015). The average rainfall of the country is 1,032 mm per year, with large variations ranging from 1000 to 2000 mm in the north and 500 to 600 mm in the south (Aidenvironment & Water-is-Essential BV, 2015). RWH technology becomes essential and applicable in this country (B. Mati et al., 2006).

The RWH technology in Mozambique has been traditionally applied in several areas, where governmental organizations (such as DARIDAS - Directorate for the Development of Arid and Semi-Arid Zones) and non-governmental organizations (such as AFRHINET, WaterAid, etc.) have been promoting the use of these practices, so that studies related to this technology have already been carried out (Carvalho & Placido, 2015; Department of Civil Engineering, 2011), but still few in relation to the pertinence of the subject.

## 2. OBJECTIVE

The objective of this research is to estimate the RWH potential for domestic use in the district of Moamba.

## 3. DESCRIPTION OF THE STUDY AREA

The district of Moamba is located in the northern part of the province of Maputo, 75 $km$ from the capital of the country and is positioned between the parallels 24 ° 7 'and 25 ° 50' South and the meridians 31 ° 59 'and 32 ° 37 ' East. This district has as limits the Massintonto river that separates it of the district of Magude, to the south the districts of Boane and Namaancha, to the East the districts of Manhiça and Marracuene and to the West an artificial border line with the South African province of Transvaal. According to national statistical institute (INE), the area of the district is 4,589 $km^2$ (INE, 2012) and its population is estimated at 83,879 inhabitants (INE, 2017).

This district presents two distinct seasons, namely warm with very high temperatures and marked rainfall that goes from October to March and another cool one that goes from April to September. According to the classification of Koppen, this is dominated by climate type BS dry steppe climate with annual rainfall between 580 to 590 mm, and also along the border of Ressano Garcia by BSW weather of steppe with dry winter and lower rainfall to rest district. In terms of average annual temperature, this varies between 23 ° and 24 ° (MAE, 2014). As far as soils are concerned, red, pedoctalic, pardos, hydromorphic and alluvial soils predominate (Gouveia & Azevedo, 1949).

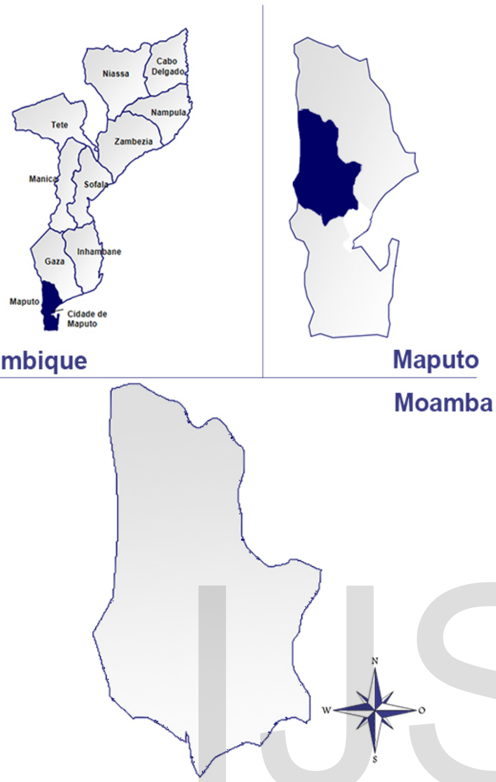



Figure 1: Location map of Moamba district.

As for water resources, the district of Moamba is crossed by the Incomati river, that is born in South Africa and enters Mozambique by the throat of Komatipoort, flowing in the vicinity of the town of Moamba. The Incomati river has as tributaries in Mozambique the Massintonto and Sabié rivers, located in the north zone of the district. These rivers have a periodic regime, being dependent on precipitation, which is why their flow is high during the rainy season, which varies from December to April in Massintonto and from January to March in Sabié and practically disappearing in the dry season (MAE, 2014).

According to the 3rd General Census of Population and Habitation (INE, 2012), in a universe of 14,610 households, 75% have zinc sheet roofs and the remaining 25% have tile roofs, palm trees, concrete, among others. According to the same source, 22% of the population has channeled water out of the house, 30% search for rivers / lakes / ponds, 29% seek water in a well, open water, without a pump, 7% in protected wells, 9% in the landfill, 1% other sources and 0% rainwater as well as mineral water.

## 4. METHODOLOGY

### 4.1. Water supply

*Rainfall regime*

Rainfall data were obtained from the region under study corresponding to 30 years (1983-2012) through INAM (Instituto Nacional de Meteorologia). The INAM is the national meteorological institute of Mozambique. The data were grouped using the frequency distribution and following the monthly and annual chronological sequence (sum of daily values and monthly values), where in SPSS (Statistical Package for Social Sciences) the data analysis was performed, which consisted in calculating the mean , the maximum, the minimum and the standard deviation.

*Volume of RWH*

RWH can be defined as the direct activity of collecting and storing water. And to plan the volume of water that can be captured, annual or monthly precipitation can be used as basis (Velasco et al., 2000; Govt of India, 2002).

For the volume of water that can be captured, was used the methodology applied by Manikandan et al. (2011), Nascimento et al., (2016), Pande & Telang (2014), in which:

$$V_c = P \cdot A \cdot C \quad (1)$$

Where,

$V_c$ is the volume of RWH ($L$)

$P$ is the annual precipitation ($mm$)

$A$ is the catchment area ($m^2$)

$C$ is the runoff coefficient (non-dimensional)

With the annual rainfall data, 3 scenarios were chosen, the driest year, the mean and the wettest year, respectively, to estimate the potential of RWH, where it was considered that $1mm = 1L/m^2$. Considering that the majority of dwellings in the district of Moamba have roofs of zinc sheets, for the runoff coefficient was used 0.8 (this value corresponds to the average between the values proposed by Govt of India (2002), this is, the runoff coefficient for the zinc sheets ranges from 0.7 to 0.8). In addition, estimates were made with catchment areas with sizes of 20, 60 and 100 $m^2$, in order to bring more sustainability to the study.

### 4.2. Estimates of water demand for domestic use

*Average number of persons per household*

The number of people per household was calculated using the methodology proposed by Carvalho & Placido (2015), using the following equation:

$$N_{PA} = \frac{N_D}{N_{AD}} \quad (2)$$

At where:

$N_{PA}$ is the average number of persons per household

$N_D$ is the total number of population in the district

$N_{AD}$ is the total number of households in the district

Data on the total number of population as well as the total number of households in the district of Moamba were obtained through INE (INE, 2017).

*Water consumption per household*

Estimating water consumption is not an easy task as it may seem, as children and adults consume different amounts of water, and not only, depending on the season (winter or summer) people will use different amounts of water and also the number of households may vary at different times of the year (Worm & Hattum, 2006). According to Jalfim (2001), the human consumption of water in the rural environment is 6 $L$ per capita per day. However, this study used the results of the basic survey of PRONOSAR (Programa Nacional de Abastecimento de Água e Saneamento Rural) (Ministério das Obras Públicas e Habitação, 2012) according to which the average daily consumption of water in rural areas per capita per day is 16 $L$.

*Water demand*

According to (Worm & Hattum, 2006), the water demand can be calculated according to the equation:

$$Demand = water\ use \times number\ of\ member\ per\ household \times 365\ days \quad (3)$$

**5. RESULTS AND DISCUSSION**

**5.1. Water supply**

Precipitation and water from soil are fundamental parts of all terrestrial and aquatic ecosystems that provide goods and services for human well-being, so their availability and quality will determine the productivity of the ecosystem itself (UNEP, 2009). According to Velasco et al. (2000), precipitation is one of the factors that must be analyzed to determine whether or not it is feasible to use rainwater.

Figure 2 shows the annual precipitation distribution in the district of Moamba for the period 1983 to 2012. According to the figure it is possible to see that the rainfall regime has not been well distributed throughout the period in question, with the minimum registered in the year 1986 and the maximum in the year 2000. Mozambique, mainly in the south, in 2000 was hit by extreme rains that resulted in floods, which is why this year was the rainiest during the period under analysis.

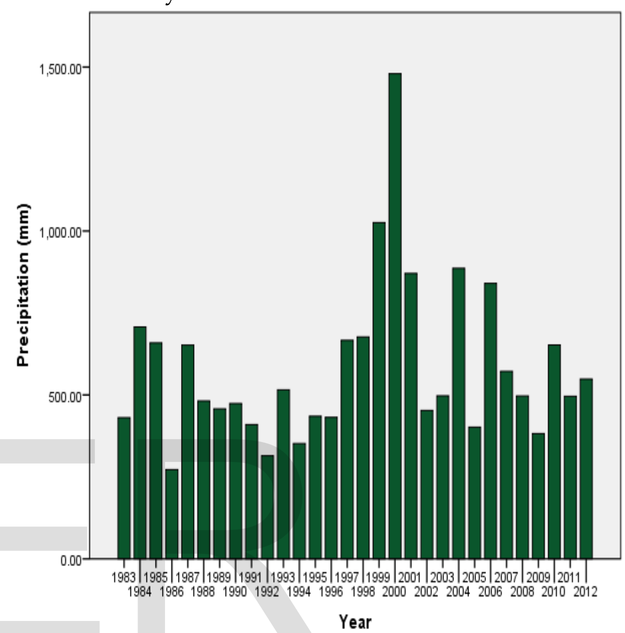



Figure 2: Distribution of annual precipitation, for the district of Moamba, from 1983-2012

Table 1 shows the descriptive statistics (extremes, mean and standard deviation) as well as probable values occur at 50, 75 and 85 % probability for the referred period. There was a great variability in relation to the average annual precipitation and associated to this fact, considering that the average annual precipitation is approximately 584.60 $mm$, it can be seen that only 40% of the studied years reached the expected average. It should be noted that the average precipitation obtained in this study is in agreement with the theoretical result, which states that rainfall in that region ranges from 580 $mm$ to 590 $mm$ (MAE, 2014).

The Moamba district is part of the arid and semi-arid regions of Mozambique (FAO, 2009). This statement can also be sustained by means of the average precipitation obtained (approximately 584.60 $mm$), because according to Worm and Hattum (2006), a region that receives between 500-750 $mm$ corresponds to semiarid. According to Velasco et al. (2000), precipitation in arid and semi-arid areas results in many cases in convective processes that produce relatively short duration and relatively high intensity and in a limited area. Others studies indicate that precipitation in arid zones is so erratic that the minimum requirement to be used for water collection would be an annual average of 100-200 $mm$ for large works and 500-600 $mm$ for small works (College of Postgraduates, 1991). Worm & Hattum, (2006) states that as a general rule, to make rainwater harvesting viable, precipitation should be greater than 50 $mm$ during the month or should be at least 300 $mm$ during the year (unless other sources are extremely scarce). Thus, the result of the average annual precipitation obtained for the district of Moamba satisfies the previously mentioned conditions.

Figure 3 shows the graph corresponding to the driest year and the wettest year. It can be seen that in 1986, although it was the most critical year, there was rainfall throughout the year, contrary to the year 2000, that even though it was the wettest year, there was no record of rainfall for the month of August. The minimum obtained in the driest year was 0.32 $mm$ and the maximum was 67.67 $mm$. For the wettest year, the minimum was 0.0 $mm$ and the maximum was 557.47 $mm$. In terms of standard deviation for the driest and driest years, they were 24.2641 $mm$ and 161.7850 $mm$ (see table 2). According to Worm & Hattum (2006), rainfall patterns throughout the year play a key role in helping to verify whether or not rainwater harvesting can compete with other water supply systems.



Table 1: Descriptive statistics (minimum, maximum, mean and standard deviation) for the period between 1983-2012.

| | | |
|---|---|---|
| N | Valid | 30 |
| | Missin g | 0 |
| Mean | | 584.5967 |
| Std. Deviation | | 246.5775 2 |
| Minimum | | 272.50 |
| Maximum | | 1479.70 |
| Percentils | 50 | 497.0500 |
| | 75 | 669.1250 |
| | 85 | 850.6750 |

In figure 4, the monthly mean precipitation distribution plot for the period under study is shown. Comparing monthly rainfall averages over 30 years, it was observed that the monthly average was 48.7 $mm$. In addition, the months of November, December, January, February and March are the most rainy, with higher than average sums, and the driest are the months of April, May, June, July, August, September and October respectively. With this data it is possible to verify that the district of Moamba is divided in two quite distinct times, rainy season that goes from November to March and another cool one that goes from April to October. Results shown by the MAE (2014) indicate that the rainy season runs from October to March and the cool season from April to September. This difference between the results obtained in this study and those obtained by the MAE is acceptable and may be due to factors such as different methodologies, different samples, among other factors. It should be noted in this figure that the wettest month is December, with an expected monthly average of about 100.97 $mm$, and the driest month is August, with an expected monthly average of 7.68 $mm$. Once again, it is important to study the rainfall variability, because through this it is possible to make a better planning with regard to the months of greatest drought.

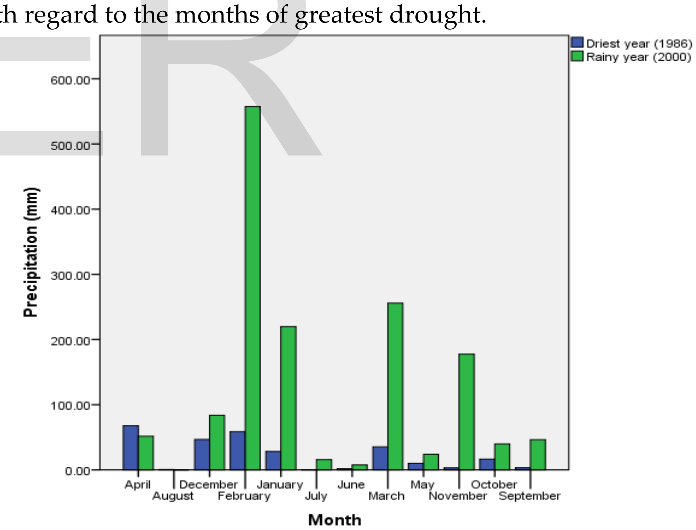



Figure 3: Annual rainfall distribution for the district of Moamba, corresponding to the driest and rainiest year.

Analyzing the rainier months (see Figure 5a, 5b, 5c, 5d and 5e), it is observed that the minimum value for November was in 1986 and the maximum in the year 2000. In December, the minimum was registered in the year in 1983 and the maximum in 1987. Analyzing the month of January, it is observed that the minimum value occurred in

1989 and the maximum in 2006. Going to February, it is observed that the lowest value occurred in 1987 and the maximum in the year 2000. The minimum value in the month of March occurred in the year 2007 and the maximum in the year 2000. It can be noted that there is no uniformity regarding the years that the possible minimums and maximums occurred. It should also be noted that the years in which the monthly peaks occurred, most of them do not coincide with the wettest year, with the exception of November and February, which peaked in the year 2000. The same finding is valid for the months of extreme drought, these also do not coincide with the driest year.

Table 2: Minimum and maximum to driest and rainy years for the period between 1983-2012.

| | | Driest year (mm) | Rainy year (mm) |
|---|---|---|---|
| N | Valid | 12 | 12 |
| | Missing | 0 | 0 |
| Minimum | | .32 | .00 |
| Maximum | | 67.67 | 557.47 |

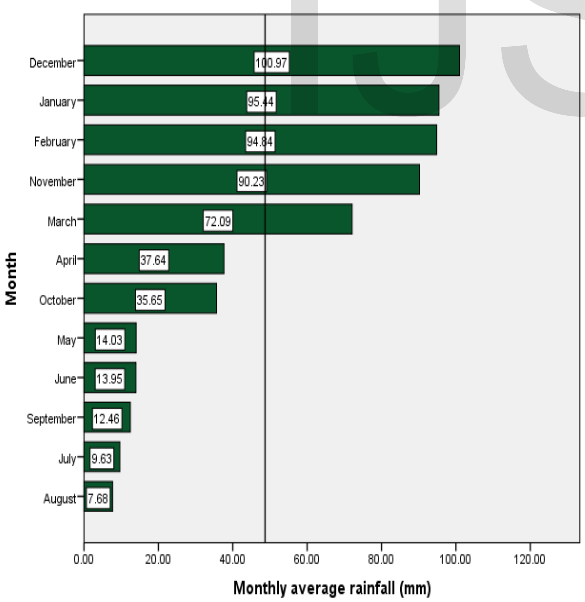
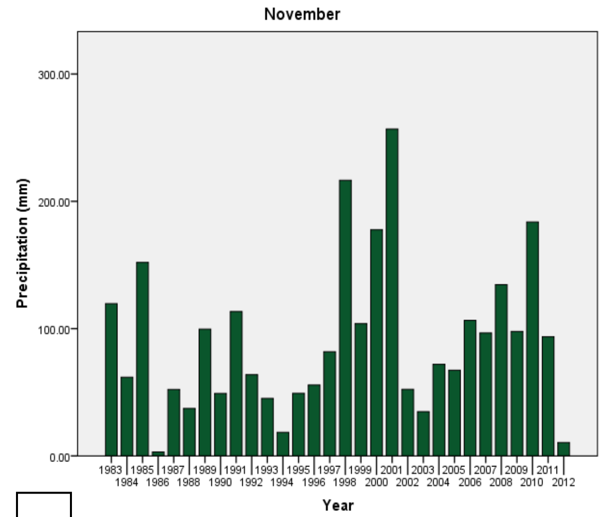
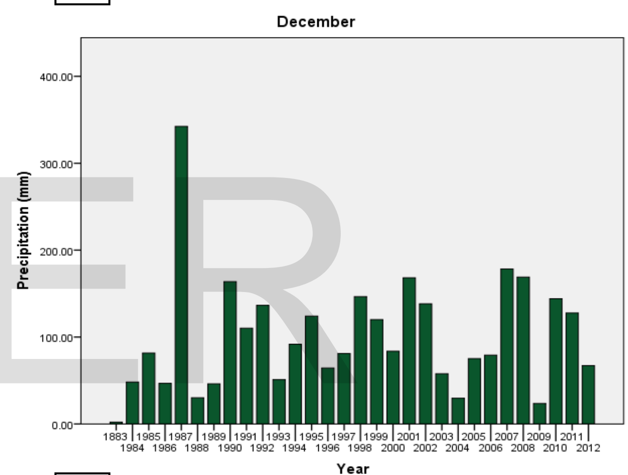



Figure 4: Distribution of the monthly average precipitation, for the district of Moamba, referring to the period of 1983-2012.




a

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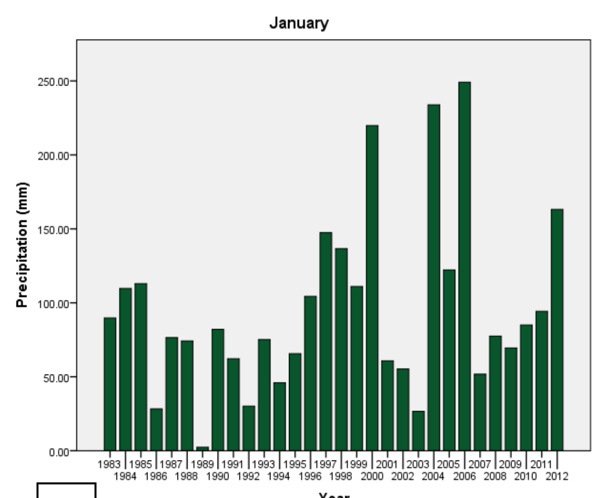


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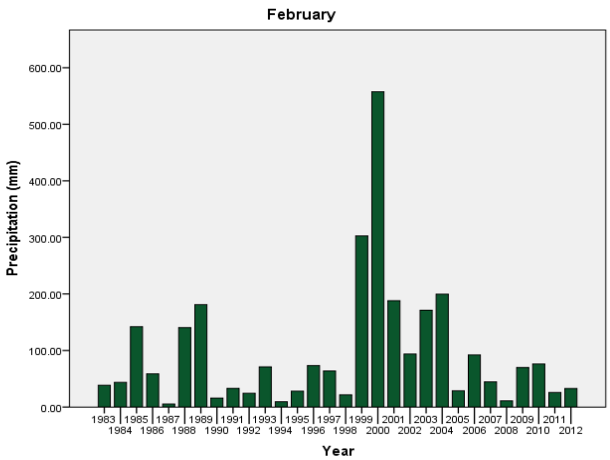


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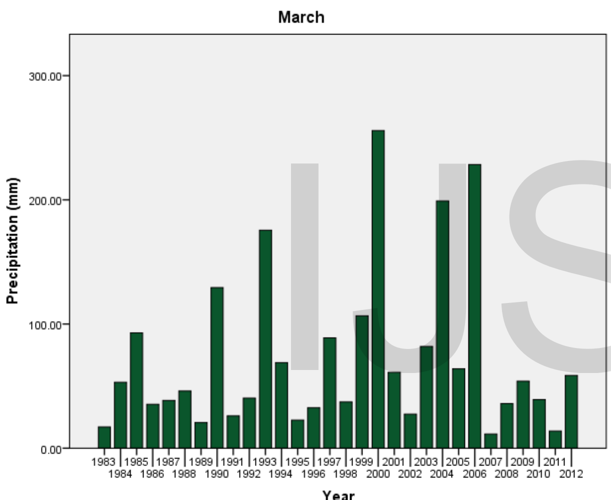


e

Figures 5a, 5b, 5c, 5d and 5e show the mean rainfall distribution for the rainier months, namely November, December, January, February and March.

### 5.2. Average number of persons per household

Preliminary results of the 2017 Census indicate that the population of Moamba is estimated at 83879 inhabitants and that it has 23243 households. This time, using equation (2), the average number of people per household is approximately 4.

### 5.3. Volume of RWH and Water consumption per household

Domestic water demand includes all water used in and around the home for drinking, preparation and cooking of food, personal hygiene, discharge (for cases where it is valid), washing of clothes and cleaning, washing of household utensils, and other economic and productive uses (the latter only when sufficient rainwater is available) (Worm & Hattum, 2006). Assuming that in the rural area the daily average water consumption per capita, in liters, is 16, for a family of 4 people would need 23040 $L$ to meet their needs for 365 days.

Assuming that the runoff coefficient is 0.8 and that the mean annual precipitation in the district is about 584.60 $mm$, for a small dwelling with capture area measuring 20 $m^2$, it is estimated that all of 9353.584 $L$, enough to supply the water deficit in 146 days, that is, approximately 5 months. Similarly, when the catchment area is 60 $m^2$ it is possible to take advantage of the volume corresponding to 28060.752 $L$ and when it is 100 $m^2$ can capture the volume of 46767.920 $L$. These quantities can supply the water demand for 438 and 731 days, that is, they cover the whole year and still have left. These results confirm that the larger the catchment area, the greater the volume used.

Using the same approach and analyzing the driest year (corresponding to approximately 272.50 $mm$), it can be noted that for a dwelling with a catchment area of 20 $m^2$, the all demand cannot be satisfied, and it is estimated that approximately 4360 $L$ will be collected. This volume is sufficient to meet the water needs of 68 days, that is to say, 2 months, and in the remaining months would be necessary to look for other alternatives. A report presented by (Jalfim, 2001) suggests that in cases where roofs (roofing of houses) are relatively small, a technology based on a larger catchment area (100 $m^2$) constructed from compacted soil and cement is adopted and, subsequently coupled to a semi-submerged plate tank. For an area of 60 $m^2$, it is estimated to collect 13079.472 $L$, enough to feed 204 days and, if the area is of 100 $m^2$, the stored amount (21799.120 $L$) will be enough to feed a family of 4 people for 341 days. It can be observed that even in the worst case scenario, the collected volume can guarantee water for a minimum time of at least 2 months.

Analyzing the best scenario, where the annual rainfall is the maximum possible (1479.70 $mm$), for the smallest area used in this study (20 $m^2$) it is verified that the accumulated volume, corresponding to 23674.704 $L$, which is enough to cover the demand of a family of 4 people for 365 days. The same happens for a scenario as well as for. However, for rainwater to meet anticipated needs, it is crucial to manage it well, especially in arid and semi-arid areas where climatic conditions are not very favorable (Worm & Hattum, 2006).

Nascimento et al. (2016) states that average precipitation alone does not provide a reliable probability of data, presenting the 95% probability as extremely reliable, 85% reliable, and 75% tolerable. Thus for this study, in addition to the calculation of the volume using the annual mean rainfall, the one of the driest and rainiest year, was also calculated using the probability of 75%. The results showed that using this probability for an area of 20 $m^2$ it is possible to take advantage of the volume of 10706 $L$. In addition, for an area of 60 $m^2$, volume of 32118 $L$ and 100 $m^2$ or volume of 53530 $L$. The volume of 10706 $L$ covers the needs of water in 167 days, of 32118 $L$ in approximately 502 days and 53530 $L$ in approximately 836 days. With these data it can be seen that, unfortunately, large amounts of water are being wasted, so it is important to take the necessary procedures so that the practice of RWH is increasingly widespread

## 6. CONCLUSIONS

The objective of this study was to estimate the potential of rainwater harvesting for domestic use in the arid and semi-arid regions of Mozambique, having the Moamba district as the case study. The results obtained showed that the rainwater harvesting in the Moamba district is a favorable option to minimize water demand. Assuming that the district of Moamba has an average annual rainfall of 584.60 $mm$ and that the average number per household is 4, a dwelling with a catchment area of 20 $m^2$, can collect the minimum volume of 9353.584 $L$.

For a dwelling with area of capture of 40 $m^2$ it is possible to capture the volume of 28060.752 $L$ and for an area of 100 $m^2$, the volume of 46767.920 $L$ can be harvested. When the catchment area is about 20 $m^2$, the volume captured is not enough to cope with the water needs of a family of people all year round. That is, this volume covers approximately 5 months, so in the remaining months you will need to find alternative ways to meet your water needs. But if the catchment area is of 60 $m^2$ or 100 $m^2$, the volume captured meets the needs for a family of 4 people during the whole year and still left over for the following year.

Using the 75% probability, it was concluded that, for catchment areas measuring 20, 60 and 100 $m^2$, it is possible to obtain 10706, 32118 and 53530 $L$. The volume obtained is sufficient to minimize the problem of lack of water in a minimum period of 4 months and maximum of more than 48 months, according to the catchment area. The larger the catchment area, the larger the volume harvested. It is important to mention that the volume that can be harnessed obtained in this study is overestimated, since it was not considered the discarding of the first rains.

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