WATER EFFICIENCY CONFERENCE 2018 – AVEIRO PORTUGAL

POTENTIAL OF RAINWATER HARVESTING IN A BRAZILIAN NEIBORHOOD

Sara Lopes Souto

Prof. Dr. Marcus A. Siqueira Campos – EECA/UFG/Brazil

UFG
UNIVERSIDADE FEDERAL DE GOIÁS

PPG GECON
Programa de Pós-Graduação em Geotecnia, Estruturas e Construção Civil

INTRODUCTION

- Rainwater harvesting system (RWHS) has been used as a way to promote water conservation in buildings
- RWHS – it also can contribute to urban drainage
- Few papers focus on the RWHS role in urban storm water management – In Brazil there are some studies in different regions (South and Southeast)

OBJECTIVE

To measure the impact on urban drainage when residential rainwater harvesting systems (RWHS) will be installed in a neighbourhood´s scale in the city of Goiânia.

METHODOLOGY
GOIÂNIA

- Capital of Goiás State
- Planned in the early´s 1930´s - to 50.000 people
- 206 Km From Brasilia
- Population – Around 1.500.000
- Hottest months Septmeber and October (Around 26^0 C on average)
- Total rainfall – Around 1500 mm/year
- Many Green areas and parks – specially in afluente areas

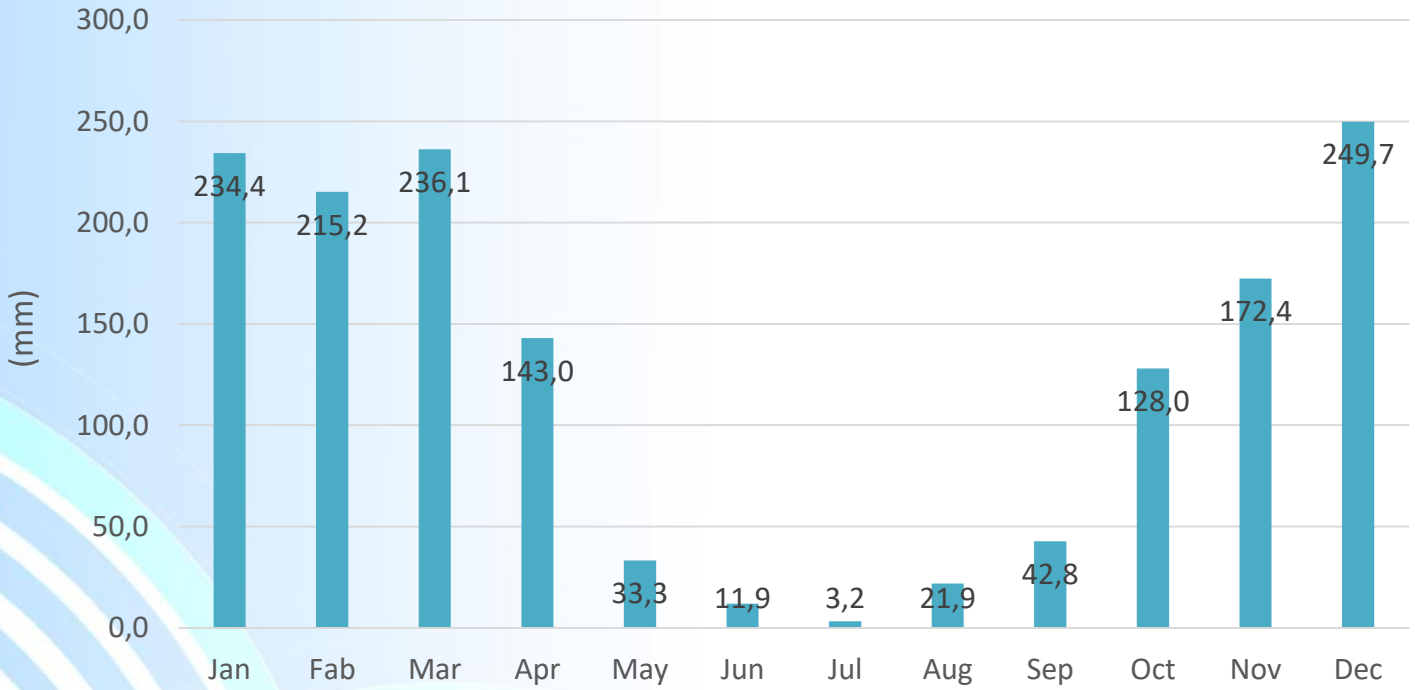
METHODOLOGY
NEIGHBORHOOD SELECTION

- Three criteria were considered :
  - the neighborhood should be basically composed of single-familiy buildings;
  - it had to be already built;
  - buildings should be similar to each other.
- It was chosen a housing project conceived in the 80's and located in the southeast region of the city of Goiânia named Parque Atheneu:
  - 1,86 km² of surface ;
  - an estimated population of 14.068 habitants;
  - the average income is among 683 USD and 890 USD in this region.

METHODOLOGY
NEIGHBORHOOD SELECTION

METHODOLOGY

RAINFALL PATTERNS



METHODOLOGY

MATERIALS

- Daily rainfall data from 2000 to 2017 recorded by (AGRITEMPO, 2018).
- It was also used images and tools available in the computer programs Google Earth Pro and QuantumGIS 2.18.17 to obtain the use of the lots.
- Goiânia's Geographic Information System (SIGGO) to obtain the limits and characteristics of blocks and lots.

METHODOLOGY

Sizing of the rainwater tank

- It was used the Netuno software
- It calculates the potential for rainwater use - it simulates from 0.5 m^3 to 100 m^3 performed every 0.5m^3.
- minimum difference of this potential of two consecutives storage volume must have. To this paper, it was chosen 1%/ m^3

METHODOLOGY
SIZING OF RAINWATER TANK

- It was considered that the RWHS will supply the following activities: toilets flushing, external floor cleaning and water gardening.
- Toilet flushing (6,8 l/flush) around 6 times/day/person.
- The water gardening spent 2,4liters/m^2 and it will happen three times a week (Mondays, Wednesdays and Fridays).
- The external floor cleaning, in turn, will happen every day but on Sundays. On weekdays, it will use a cloth and a bucket to cleaning, what results in a 0,5 liters/m^2 consumption. On Saturdays, the cleaning is with a broom, squeegee and bucket and it will spend 1,0 liter/m^2.

METHODOLOGY

MODEL LOT CHARACTERIZATION

- Satellite images of Google Maps and vector files, obtained from the Goiânia's Geographic Information System (SIGGO) were superimposed on the QuantumGIS computer program.
- It was removed from the Attributes Table;
  - Parcels indicated as public areas
  - Parcels that did not had any edification
  - Parcels where were recognized as different of a single-family housing.
- Polygons were built in QuantumGIS to represent the dimensions of roof areas and pervious areas in lots from a block.
- External impervious areas were obtained by the difference between the total lot area and the roof and permeable areas sum;

METHODOLOGY

MODEL LOT CHARACTERIZATION

METHODOLOGY

Result analysis

- To analyse the results, it was used again Netuno Software
- This program calculates the daily overflow in a residence for one year. These quantities were measured for three volumes: the one sized by the software, 1m³ and 5m³.
- Six scales of urban implantation : 0, 10%, 25%, 50%, 75% and 100% of the residences.
- the possible impacts of the RWH systems implantation in the runoff volume was verified in 18 scenarios

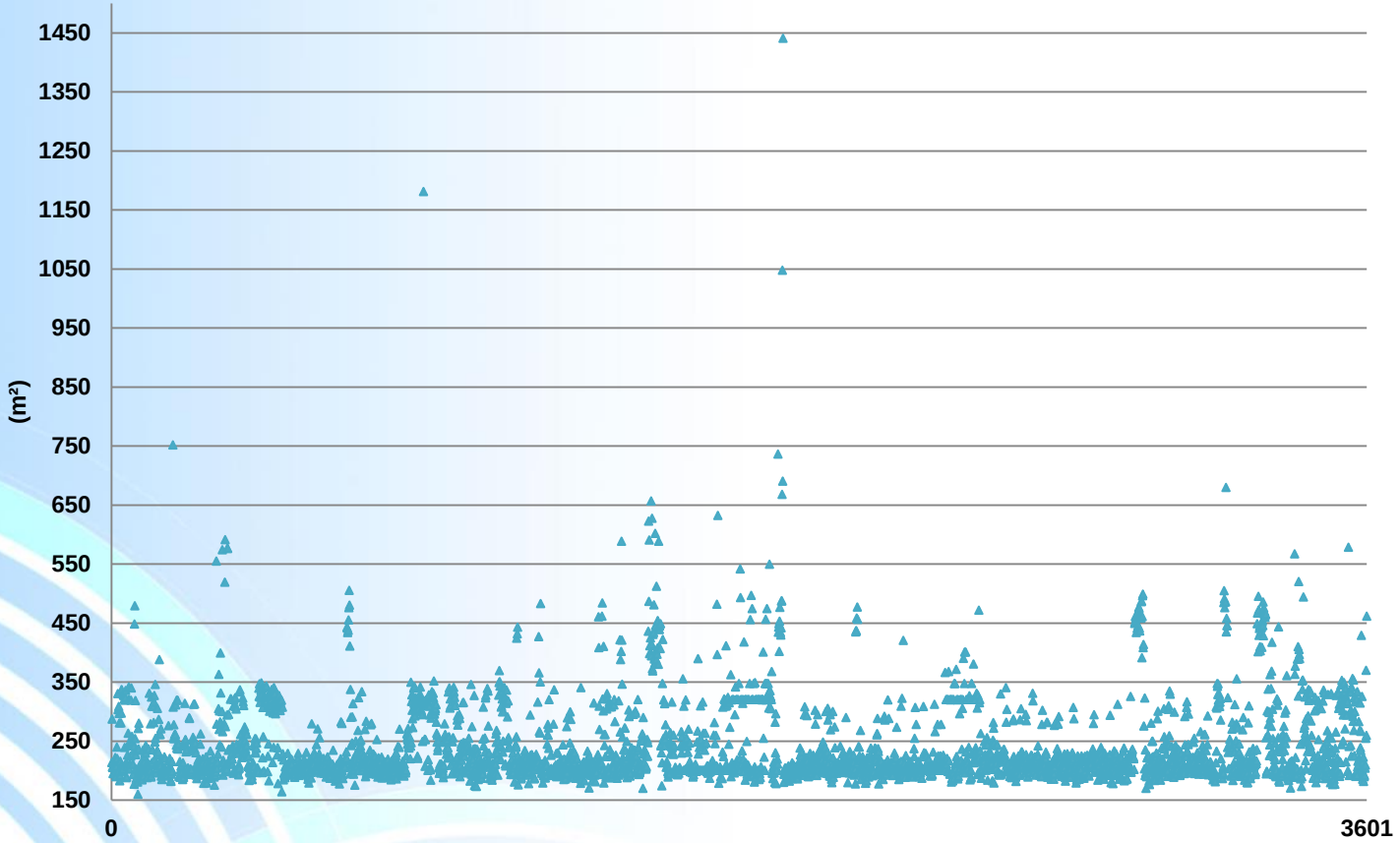
RESULTS

Model Lot characterization

- The neighborhood has 4159 lots, which 3601 are single-family buildings
- The largest and the smallest lot has 1440,67m² and 159,56m², Respectively
- almost 75% of the lots have areas between 159,56m² and 250m².
- The Standard Lot area is 242,02m²

RESULTS

Model Lot characterization



RESULTS

Rainwater tank size and runoff volume

Months	weekday	Estimated Rainwater Daily Demand (Liters/person)			
		Toilet Flushing	External Floor Cleaning	Water Gardening	Total
December to March (rainy season)	Sunday	40,80	0,00	0,00	40,80
	Monday	40,80	0,00	0,00	40,80
	Tuesday	40,80	0,00	0,00	40,80
	Wednesday	40,80	0,00	0,00	40,80
	Thursday	40,80	0,00	0,00	40,80
	Friday	40,80	0,00	0,00	40,80
	Saturday	40,80	0,00	0,00	40,80
April to November	Sunday	40,80	0,00	0,00	40,80
	Monday	40,80	6,34	2,71	49,84
	Tuesday	40,80	6,34	0,00	47,14
	Wednesday	40,80	6,34	2,71	49,84
	Thursday	40,80	6,34	0,00	47,14
	Friday	40,80	6,34	2,71	49,84
	Saturday	40,80	12,68	0,00	53,48

TANK SIZED BY NETUNO SOFTWARE 23,5 m^3

RESULTS – original design

- **Rainwater efficiency**

Month	Saving Potential (%)		
	1m³	5m³	23,5m³
Jan	92,7%	100,0%	100,0%
Feb	93,5%	100,0%	100,0%
Mar	92,5%	100,0%	100,0%
Apr	62,4%	96,5%	100,0%
May	25,8%	60,1%	100,0%
Jun	9,2%	27,3%	100,0%
Jul	4,1%	4,4%	90,4%
Aug	8,3%	12,5%	57,8%
Sep	31,3%	41,9%	51,9%
Oct	62,7%	86,4%	90,1%
Nov	89,2%	100,0%	100,0%
Dec	97,0%	100,0%	100,0%
Average	53,4%	67,2%	90,3%

RESULTS

Table 3. annual runoff volume compared with total rainfall volume

Tank volume (L)un	Rate of domestic buildings with RWHS system					
	0%	10%	25%	50%	75%	100%
1000	26,1%	25,7%	25,2%	24,3%	23,4%	22,6%
5000	26,1%	25,6%	25,0%	23,9%	22,9%	21,8%
23500	26,1%	25,3%	24,2%	22,4%	20,6%	18,8%

Table 4. Annual runoff volume contribution decrease rate

Tank volume (L)	Rate of domestic buildings with RWHS system					
	0%	10%	25%	50%	75%	100%
1000	0,00%	1,34%	3,35%	6,70%	10,05%	13,40%
5000	0,00%	1,64%	4,10%	8,20%	12,30%	16,40%
23500	0,00%	2,78%	6,95%	13,89%	20,84%	27,79%

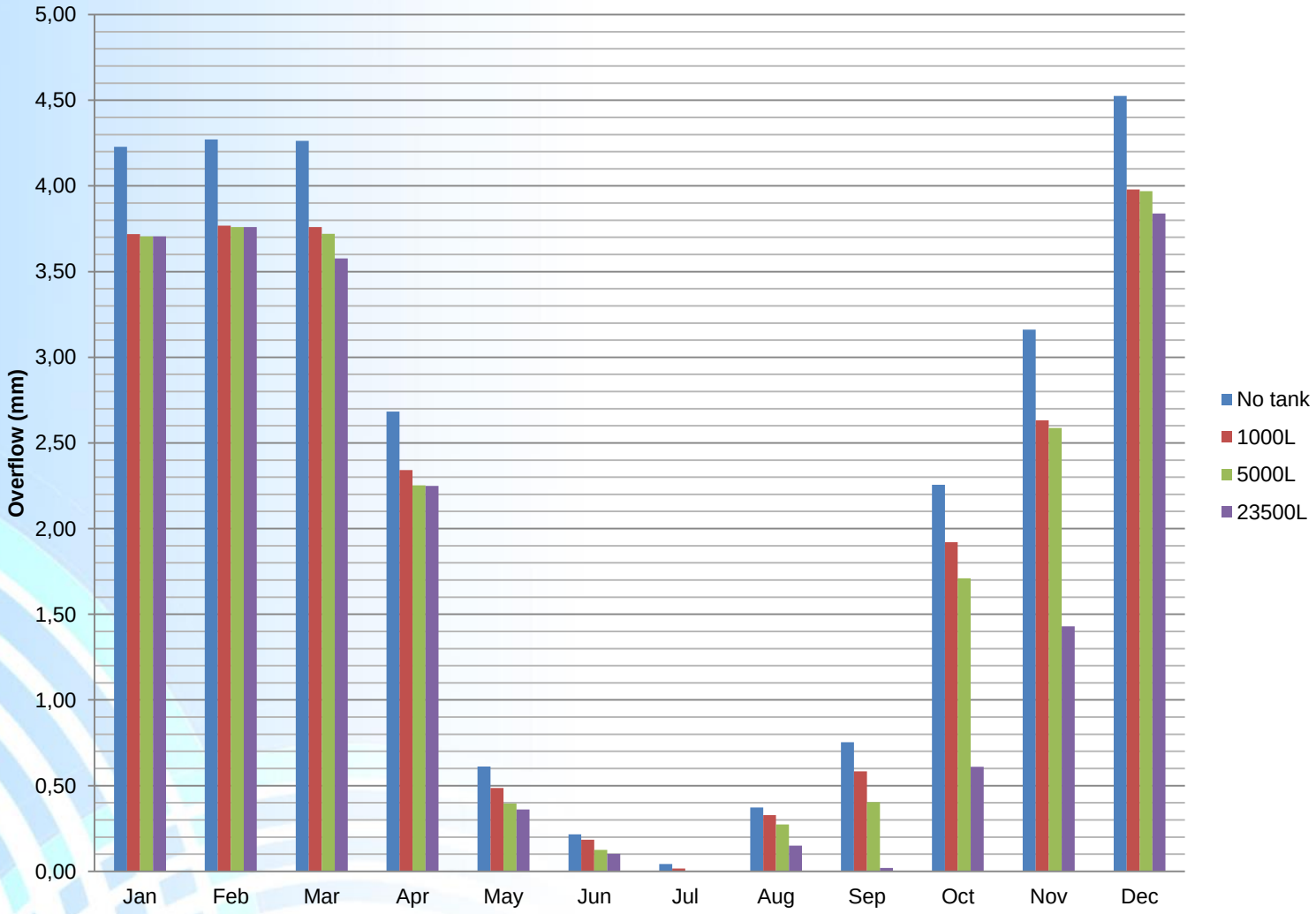
RESULTS –
daily runoff volume decrease rate –
100% of dwellings

Month	Tank size		
	1000L	5000L	23500L
Jan	12,02%	12,33%	12,33%
Feb	11,78%	11,99%	11,99%
Mar	11,81%	12,74%	16,09%
Apr	12,75%	16,05%	16,18%
May	20,61%	35,47%	40,95%
Jun	14,52%	41,81%	52,78%
Jul	63,12%	100,00%	100,00%
Aug	12,21%	26,53%	59,71%
Sep	22,47%	46,42%	97,33%
Oct	14,87%	24,23%	72,94%
Nov	16,75%	18,18%	54,78%
Dec	12,06%	12,29%	15,17%
Average	13,39%	16,37%	27,68%

RESULTS

- 26% of the total runoff comes from roof´s rainfall.
- In the scenario that 100% of dwellings have installed the 23,5 m^3 tank, the runoff volume would decrease in 27,79%.
- Daily runoff volume has a contribution decrease rate higher in dry season. The higher value is in July, the driest month, when the decrease rate achieves 100%

RESULTS



CONCLUSIONS

- Total roof area of the residential buildings cover 47% of the neighbourhood area
- Rainy season – the reservoir tend to be full – reduction of the impact of runoff control.
- Volume used : to alternative supply x runoff control especially in rainy season
- adoption of public policies that promote the mass implementation of RWHS, thus allowing a more efficient management of rainwater in the cities

CONCLUSIONS

- Futures Works:
  - Economic feasibility.
  - Other neighboorhoods
  - Evaluations from different cities

THANK YOU – OBRIGADO

marcussiqueira@yahoo.com.br

ACKNOWLEDGMENTS