Urban Rainwater Harvesting

Analysis of a Decentralized Approach for Meeting Water Demand in Urban Cities. An Opportunity for the US?

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Traditional Approach to Increasing Water Demand from Population Growth

- Large Centralized Engineering Solutions
  - New Dams
  - System Augmentation
  - Desalination Plants
  - Large Scale Water Water Recycling Schemes

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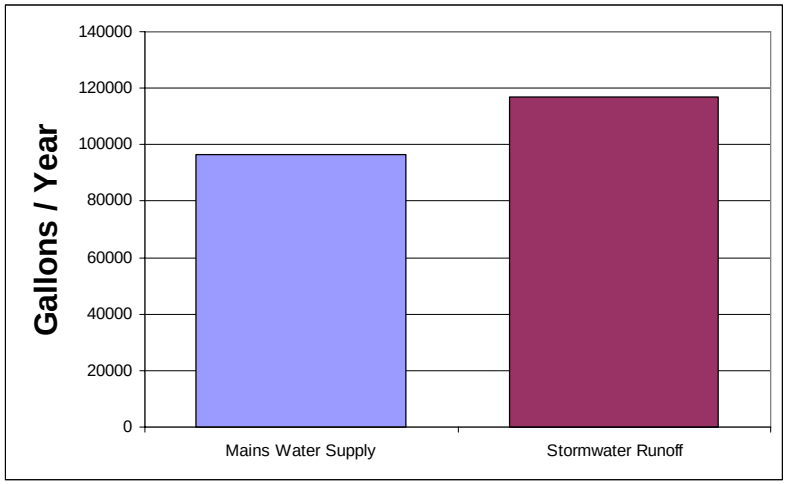
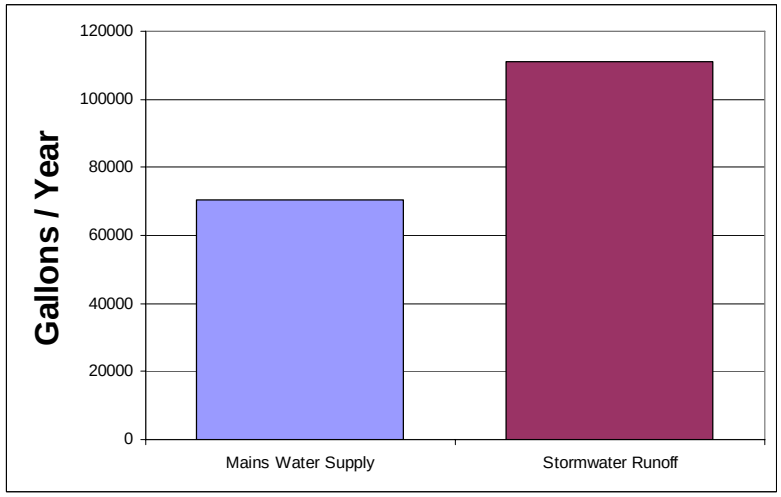
Water Available at the Allotment

6,458 sqf lot, 3,229 sqf roof, 807 sqf other impervious Surfaces

Sydney, Australia

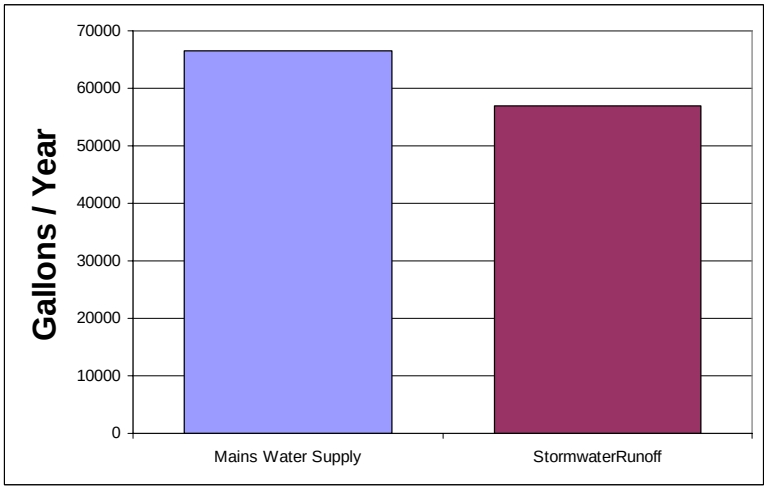
47.2 inches average rainfall





Brisbane

43.0 inches average rainfall



Melbourne

25.4 inches average rainfall

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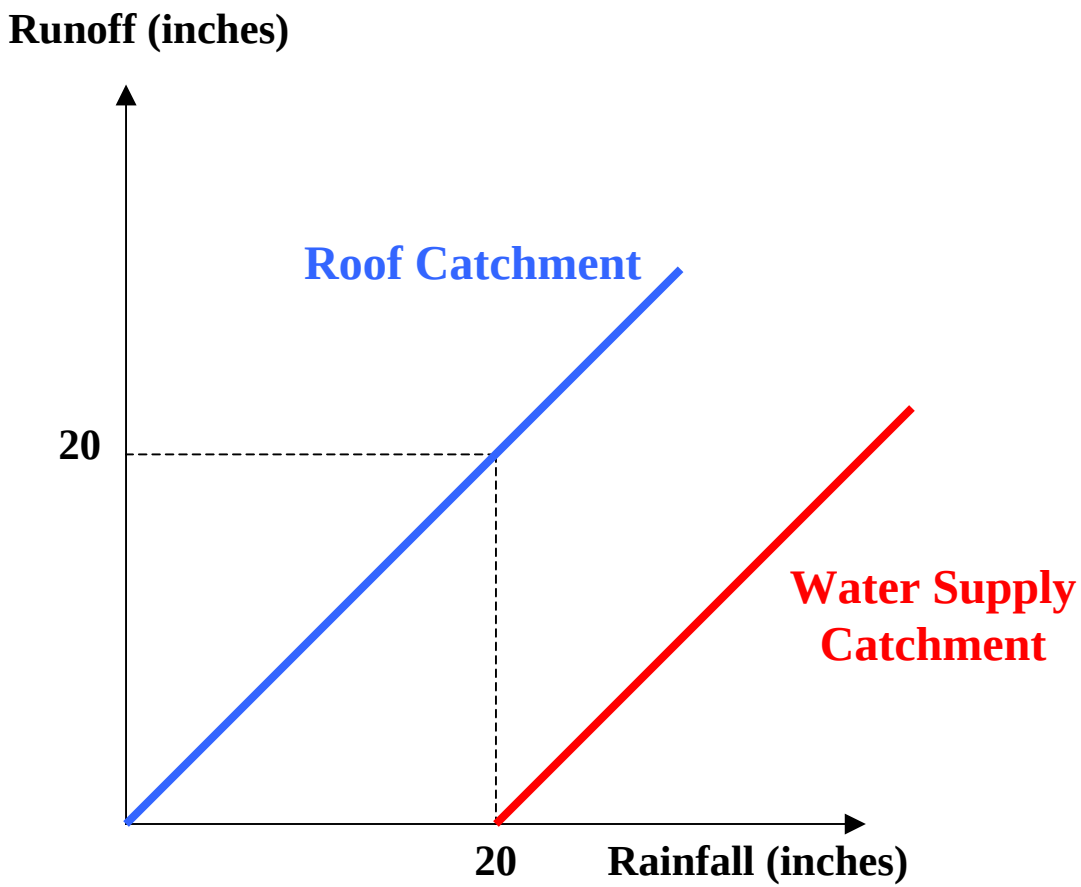
Harvest Efficiencies of Natural and Roofed Catchments



Once rainfall falls below about 20 inches, annual runoff in water supply catchments is insignificant due to evapotranspiration and infiltration

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Decentralized Solutions as an Alternative

- Potable drinking water demand is only about 1% of total water use in a city
- Rainwater has been found acceptable for hot water, toilet and outdoor uses (Coombes and Spinks)
- Utilize rainwater tanks for internal non-potable applications (toilet flushing, laundry and hot water represent about 85% of indoor water usage)
- Reduced stormwater runoff (economic and environmental benefits)
- Significant reductions in operating costs and greenhouse gas emissions (Coombes)

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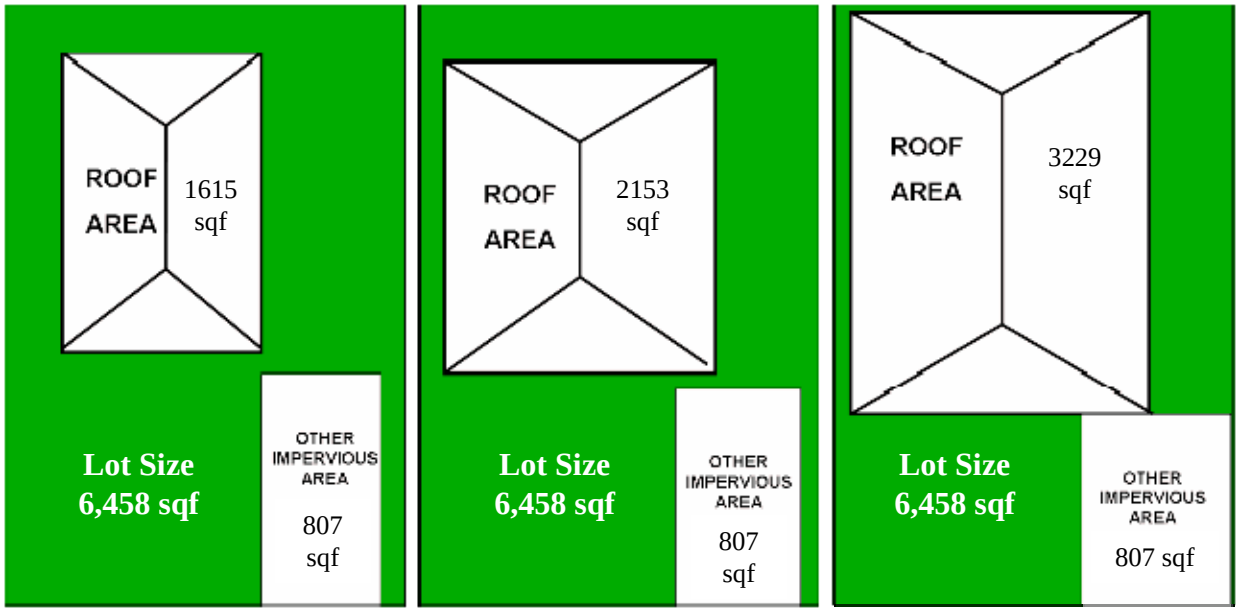
Method

Two Integrated Water Cycle Management (IWCM) Options Evaluated

Strategy	Abbreviation	Occupation	Roof Area (sqf)
Demand Mgt Only	DM Only	1,2,3,4,5 people	1615, 2153, 3229
Demand Mgt + Rainwater Tank	DM + RWT	1,2,3,4,5 people	1615, 2153, 3229

Allotment area and Impervious areas used for each Scenario



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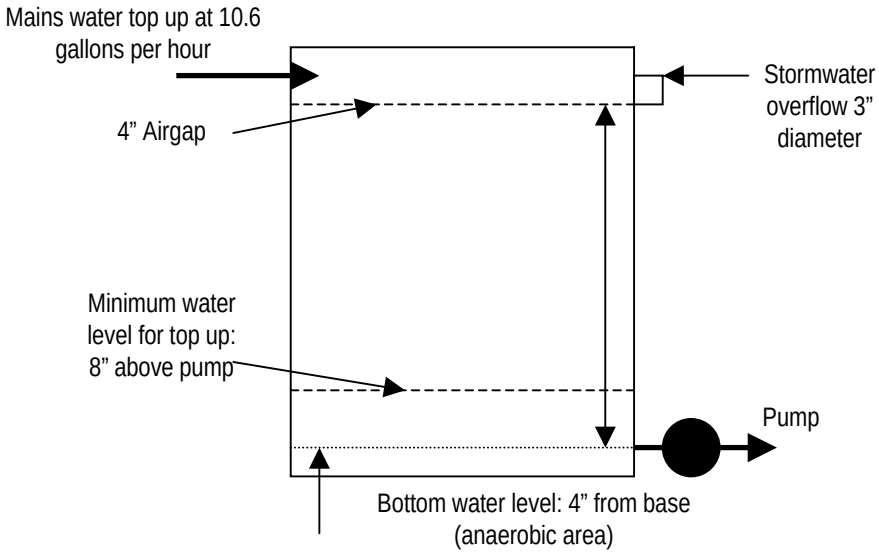
Method

- The PURRS (Probabilistic Urban Rainwater and wastewater Reuse Simulator model (Coombes and Kuczera) to evaluate effectiveness of rainwater tanks
- PURRS analyzed
  - Demand Management (water efficient toilets, shower roses & washing machines)
  - Rainwater collected from roofs via 5.3 gallon (20 liters) first flush device
  - Initial loss of 1/32 inches (0.5mm)
  - 1,320 gallon (5,000 liter) rainwater tanks
  - Water from tank for hot water, laundry, toilet (85% of indoor) + outdoor
  - Tank topped up by mains at 10.6 gallons (40L) per hour when below 8” (200mm)



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Climate Data

Location	Annual Av. Rainfall	Relative Rainfall Depth / Distribution	Water Demand Distribution
Sydney Observatory Hill	47.2 in	High - Uniform	Summer
Melbourne Regional Office	25.4 in	Low - Uniform	Summer
Brisbane Airport	43.0 in	High - Uniform	Summer

Water Demand

Location	# of People	Indoor (gallons/day)	Outdoor (gallons/yr)	Total Demand (gallons/yr)
Sydney	1,2,3,4,5	60.8, 113.6, 169.1, 221.9, 280.0	15,533	37618, 56903, 77138, 96423, 117636
Melbourne	1,2,3,4,5	37.0, 74.0, 108.3, 145.3, 179.6	13,182	26998, 40498, 53046, 66545, 79067
Brisbane	1,2,3,4,5	26.4, 50.2, 84.5, 124.2, 153.2	24859	34712, 43403, 55925, 70402, 80995

Results - Sydney

Benefits	Roof Area	DM	DM + RWT
Mains Water Savings	1,615 sqf	3,434 to 15,850 gallons	22,190 to 43,324 gallons
Mains Water Savings	3,229 sqf	3,434 to 15,850 gallons	25,889 to 53,099 gallons

Benefits	Roof Area	DM	DM + RWT
Stormwater Runoff	1,615 sqf	75,289 gallons	56,269 to 47,815 gallons
Stormwater Runoff	3,229 sqf	117,028 gallons	94,574 to 80,044 gallons

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Results - Sydney

		No. of People				
Sydney	Roof Area (sqf)	1	2	3	4	5
DM Only	1615, 2153, 3229	8.7%	10.9%	11.9%	12.5%	12.9%
DM + RWT	1,615	58.6%	48.7%	42.6%	38.4%	35.3%
DM + RWT	2,153	64.8%	54.5%	47.8%	42.0%	38.7%
DM + RWT	3,229	68.1%	58.2%	51.6%	46.9%	43.3%

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Results - Melbourne

Benefits	Roof Area	DM	DM + RWT
Mains Water Savings	1,615 sqf	2,113 to 10,039 gallons	17,964 to 30,644 gallons
Mains Water Savings	3,229 sqf	2,113 to 10,039 gallons	20,605 to 41,739 gallons

Benefits	Roof Area	DM	DM + RWT
Stormwater Runoff	1,615 sqf	32,229 gallons	30,644 to 16,643 gallons
Stormwater Runoff	3,229 sqf	57,061 gallons	41,739 to 20,605 gallons

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Results - Melbourne

		No. of People				
Melbourne	Roof Area (sqf)	1	2	3	4	5
DM Only	1615, 2153, 3229	7.8%	10.1%	11.3%	12.0%	12.4%
DM + RWT	1,615	65.1%	54.8%	47.3%	41.9%	37.9%
DM + RWT	2,153	71.8%	62.7%	55.2%	48.3%	44.7%
DM + RWT	3,229	75.0%	67.5%	61.4%	56.1%	51.7%

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Discussion / Conclusion

- Decentralized approaches, climatic regime and water demand significantly impact on mains water savings and stormwater runoff
- Significant mains water savings can be found by implementing decentralized water cycle management strategies
- Additional stormwater savings can be found by implementing decentralized water cycle management strategies
- The implications for reducing stormwater runoff with decentralized water cycle management strategies are economic and environmental
  - Lower stormwater runoff means drainage networks and detention basins can be smaller and will require less maintenance
  - Reduced stormwater runoff means reduced contaminant loads can be transported to natural waterways, which will preserve water quality in many urban areas

Questions?

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