Comparative assessment of the potential of alternative water supply sources across 5 cities in the Global South

the international water association

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INTRODUCTION

Urbanisation is rapidly growing, with the share of humans living in urban centres expected to rise from 54% to nearly 70% by 2050 (UN DESA, 2015), with such growth leading to dramatically increasing urban water demand, which could increase by more than 90% (World Bank, 2009). Many cities already face, or will face water supply challenges (Chidya et al. 2016). While institutional and governance factors are important, other reasons include absolute water source limitations; infrastructural limitations; or some combination. Between 40-70% of urban water uses do not require drinking-quality water (Loaiciga, 2014; car washing, garden watering, industrial processes). This 'non-potable' use represents an inefficient use of scarce resources. Such uses represent an opportunity for alternative water resources to supply water for these purposes.

By incorporating alternative water supply sources (AWS) (e.g. rainwater and stormwater harvesting - RWH, SWH, treated and re-used wastewater, TWW) into urban water supply systems, volumes can be augmented, and sources are diversified, increasing supply resilience while reducing pressure on traditional water sources. While the potential to implement alternative sources is increasingly studied, few assessments consider a range of options at the city level. In many cities in the Global South, there remains a paucity of data and assessments available to support decision-making on AWS strategies. The ability to select among a range of options for planning depends on availability of adequate data and on an appropriate assessment methodology. In this regard, this paper assesses the potential contribution of AWS to urban water supply in 5 cities facing a variety of challenges: Lilongwe (Malawi); Sharm El-Sheikh (Egypt); Accra (Ghana); Surabaya (Indonesia); Maputo (Mozambique).

METHODS

Assessed current and future *potential* water supply for augmentation for:

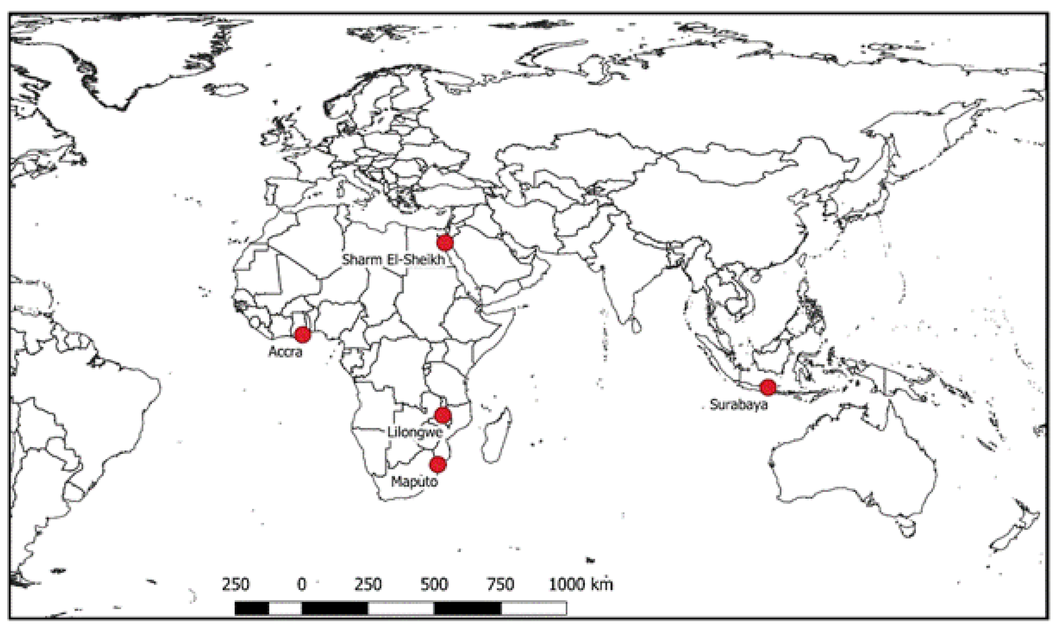
1) Rainwater harvesting (RWH)
2) Stormwater harvesting (SWH)
3) Treating and re-using wastewater (TWW)

Data from open sources (OSM, World Bank) and local municipalities.

Simple, rapid, data-light approach suited to developing cities.

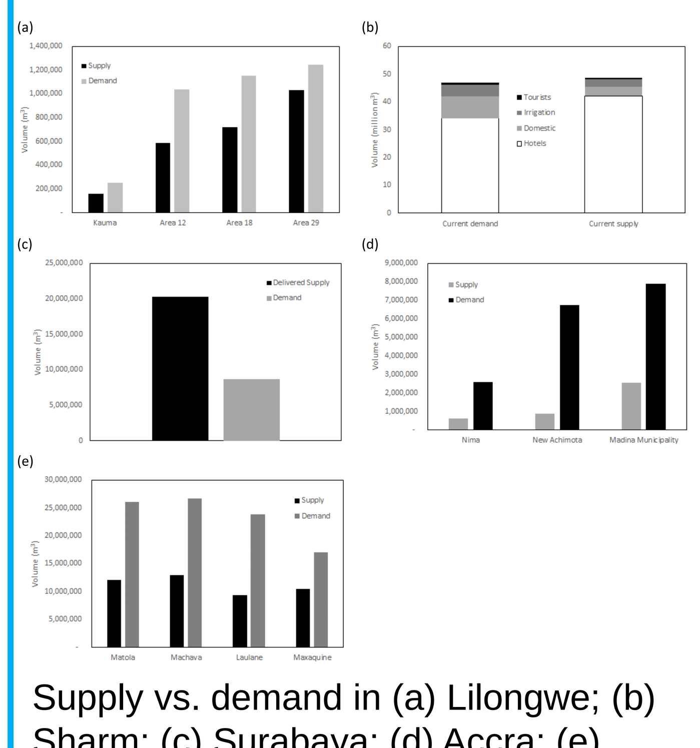
Get first-order impression of the possible contribution of different AWS sources.

Also considered potential water uses and barriers/challenges to implementation.

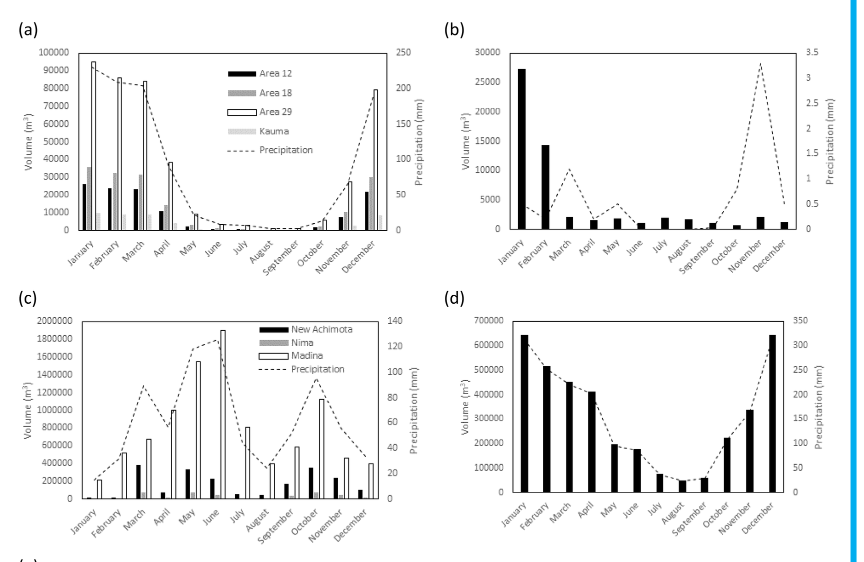


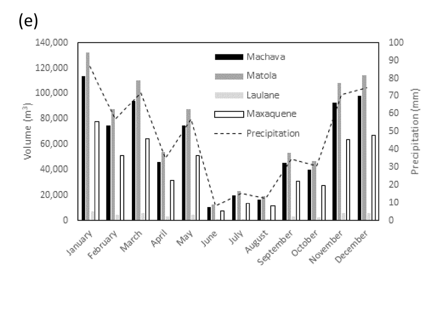
Country	City	Sub-area(s) assessed	Population [density per km^{-2}]	Annual average precipitation (mm)	Precipitation characteristics	Social development level (low/medium/high)	Current AWS implementation
Egypt	Sharm El-Sheikh	Entire city boundary	83973 [57]	20-50	Only significant rain in January	Variable within the city	Extensive private desalination. Negligible traditional nomadic systems.
Malawi	Lilongwe	Area 12	3400 [1350]	852	Rainy season November-April	High	Small scale RWH and SWH
		Area 18	14979 [6400]			Medium	Small scale RWH and SWH
		Area 29	609 [232]			Industrial zone	-
		Kauma	27435 [6000]			Low	Small scale RWH and SWH
Ghana	Accra	Nima	80800 [46000]	730	Peak rainy season March-June. Second rainy season September-November	Low	Occasional RWH
		New Achimota	5500 [520]			Medium-High	Occasional RWH
		Madina Municipality	157000 [13300]			Medium	Occasional RWH
Indonesia	Surabaya	Sukomanuggal district	105647 [12800]	1620	Wet season December-March	Medium-High	None reported/observed
Mozambique	Maputo	Matola	-	700	Wet season November-March	Industrial zone	Reuse of wastewater practiced
		Laulane	592899 [12875]			High	Small scale RWH observed
		Machava	731700 [13784]			Medium	Small scale RWH observed
		Maxaquene	387433 [11161]			Low	Small scale RWH observed

RESULTS



Supply vs. demand in (a) Lilongwe; (b) Sharm; (c) Surabaya; (d) Accra; (e) Maputo





Potential RWH contribution in (a) Lilongwe; (b) Sharm; (c) Accra; (d) Surabaya; (e) Maputo

- RWH and SWH very seasonal. TWW uniform over a year – based on demand
- Population growth a significant demand increase driver (4 – 144% demand growth)
- Climate change impact highly variable (+89% to -92%) depending on season and location
- Ability of AWSs to close supply-demand is significant (in absolute potential terms)
- Many obstacles and challenges to widespread uptake and implementation of AWSs
- Can form part of urban water supply security strategy

DISCUSSION

Potential barriers to implementation and uptake:

- Perception issues of the water sources, and related social-religious issues (e.g. SWH not acceptable in Surabaya; storm and waste water not acceptable to Muslim communities in Accra)
- RWH generally seen as more favourable, acceptable and feasible
- Space and home ownership constraints for system installation
- Costs of system installation and / or maintenance
- No requirement and / or assistance to install a system
- Other ongoing challenges (e.g. droughts in Maputo; dealing with high loss rates; service extension)

	Lilongwe	Sharm El-Sheikh	Accra	Surabaya	Maputo
Climate	Humid, high rainfall	Hyper-arid	Humid, high rainfall	Moderate rainfall	Low rainfall
Traditional sources availability	Overexploited resources	No viable traditional resources – desalination dominates	Local water supply sources are short	Supply sources almost completely utilised	Dependent on upstream countries. Supply shortages related to climate change and of increasing concern
Preferable AWSs	High potential for RWH, SWH and TWW depending on city zone	Desalination likely to continue dominating the market – increased inequality?	RWH and TWW beneficial in different areas	RWH most promising, but TWW offers reliable source	RWH potential in residential areas, TWW for industrial zones
Key findings?	Address closing supply-demand gap, tailor solutions to specific city areas areas (e.g. targeted re-use of treated waste water in industrial areas)	Address inequality between citizens and hotels in terms of water supply	Reduce NRW rates and work to secure potentially abundant supply	Focus on demand management to ease pressure on a fully utilised resource	Reduce NRW and diversify supplies to reduce reliance on upstream countries. Tailored AWS solutions for different areas
Reduce high NRW figures along with other demand management interventions					
In all locations, some form of alternative water systems are already implemented, though usually informally, and usually at small scales. This represents an opportunity to build on					
Climate change will impact on AWS contribution as well as traditional supply					
Public preferences and perceptions vary greatly among the cities, yet dramatically shape the typology, location and scale of AWS uptake in all cases					
Financing, perceptions, space, lack of incentives and home ownership are common themes acting as barriers to uptake and implementation					
There is an urgent need to secure financing options for household and city-level implementation of AWSs					

- AWS can significantly contribute to urban water supply security
- However many barriers to overcome to affect widespread implementation
- Must be combined with water demand reductions (NRW reduction, per-capita demand reduction) and efficient water use strategies
- Link to other urban development strategies to help raise funding needed
- Cross institutional, long term planning needed to widely adopt and use AWS sources

AWS cannot by themselves solve the issues being faced around the world with respect to urban water supply security, but as part of an integrated plan and suite of solutions can significantly contribute to boosting the security of urban water supply. More notice should be given to the integration of AWSs in new urban developments, as well as retrofitting existing environments. Comprehensive, cohesive urban planning is needed to fully integrate and exploit AWS solutions.

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