

Availability of Freshwater in Greater Male

Summary

As in the rest of the Maldives, groundwater and rainwater is available in the Greater Male Islands (Male, Villingili, Hulhumale & Hulhule). The fresh water aquifers are stressed due to increased demand in water, excessive extraction, waste water contamination and sea water intrusion. Greater Male is at the leading edge of water sustainability under urbanization across the 194 inhabited islands and across other coastal systems. We carried out a survey in Greater Male to analyze the availability of water, desalination and mitigation options for freshwater security and environment pollution. We estimate the water budget in the islands, surveyed households with regard to awareness and mitigation options for water scarcity. This poster presents the methodology and preliminary findings. The water demands has far outstripped demand and become dependent of expensive desalination plants. Water contamination has been aggravated due to inadequate awareness, and improper sewage, stormwater, sewage and solid waste disposal system. Now, there is a need to minimize the draw on desalination, renew and enhance rainwater harvesting systems and reduce demand and contamination.

Introduction



Figure 1a : Map of Male, Villingili, Hulhule and Hulhumale islands in Maldives.

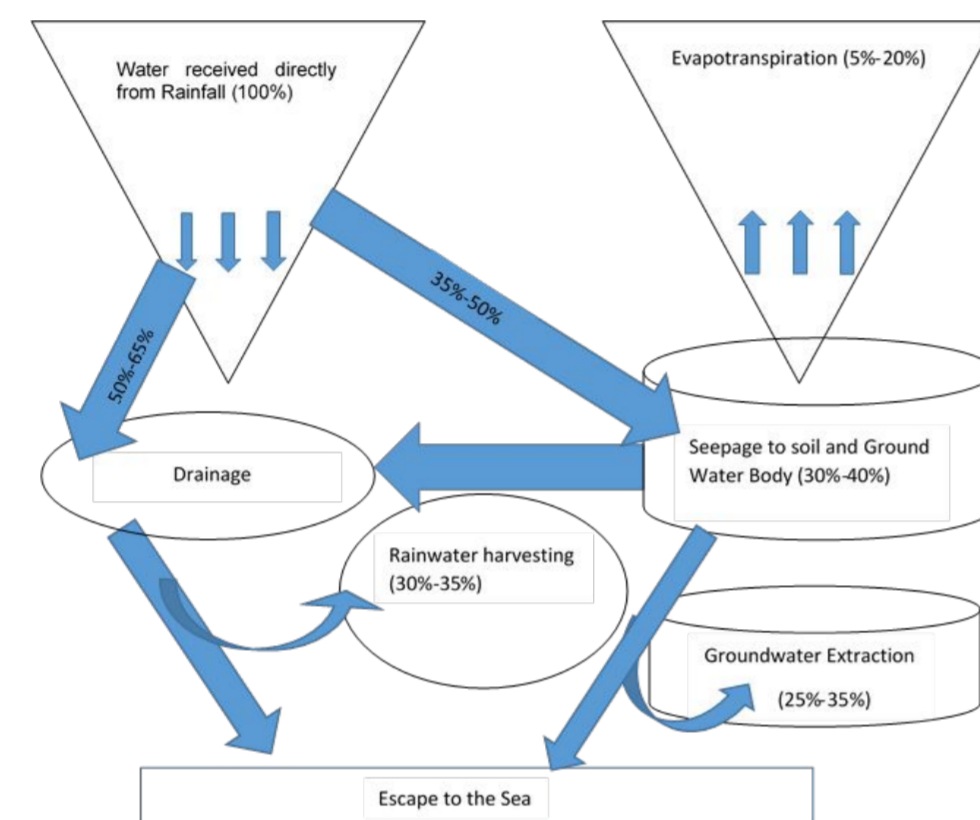


Figure 1b : Schematics of typical water balance for Maldives

The Maldives consists of 1,190, small, low lying and tiny Islands, grouped into 20 Atolls that together form a chain of islands over 820 KM in length, over an area of more than 90,000 km² in the Indian Ocean. Greater Male' in Maldives comprises of four inhabited islands namely Male' Villingili, Hulhumale and Hulhule. While Hulhule is the international airport island, Villingili, Hulhumale and Male are inhabited islands. The population in Male is around 150,000.00 (2013). In 1988, the government of Maldives introduced sewerage network in Male and in 1995 a desalination plant with a water distribution network. 60% of water and waste water in Greater Male is collected and desalinated by the Maldives Water Supply and Sewerage Company. Sea water desalination has been used to some extent as a mitigation option for water scarcity. The whole population of Male has access to desalinated water through piped network, and sewerage systems. Similarly systems are installed in 22 other islands. Between 2004 - 2010, water shortages were experienced by 81 Islands in the Maldives. According to Ministry of Housing & Environment by the year 2020 the demand for energy is supposed to increase by 20% with respect to the present usage.

Water Supply

Rainwater harvesting is the primary source of drinking water in 90% of the outer islands with groundwater being used for washing, agriculture and other domestic uses. Annual water recharge in Maldives is estimated to, range on average, 40%-50% of the rainfall falling above the vegetation lines. Given the low cost of rainwater harvesting, its contribution to future supply should be maximized. **Groundwater:** The thickness of fresh water lens available for extraction is influenced by number of factors such as Island width, island geography/geography, rainfall recharge rate, abstraction rate, evapo-transpiration and tidal movement.



An artisanal well in Maldives.

Artisanal Well: In 1970s each household in Male included of a shallow well at a depth of 1.0 -1.5 meters. In recent years, these wells are not being used for drinking although it could be used for flushing toilets and similar uses. **Water-Reuse:** Waste water, namely Grey water A & B (wastewater from washing hands/face, drinking, bath, heating and cooling; and wastewater from kitchen); and Black water (waste water from toilet) should be reused.

Water Treatment and Desalination

Villingili and Male are the two islands which have freshwater scarcity problem with deficit freshwater availability than the freshwater requirement. The highest freshwater requirement is recorded in Male. 7 Million Cu.Mtrs/year of water are being desalinated. Water desalination is a way of mitigation of freshwater scarcity in Greater Male due to limited space availability.

To estimate the desalination capacities for Greater Male', secondary data on desalinated water capacities, related energy consumption and cost (2005 - 2015) were obtained from Maldives Water & Sewerage Company.

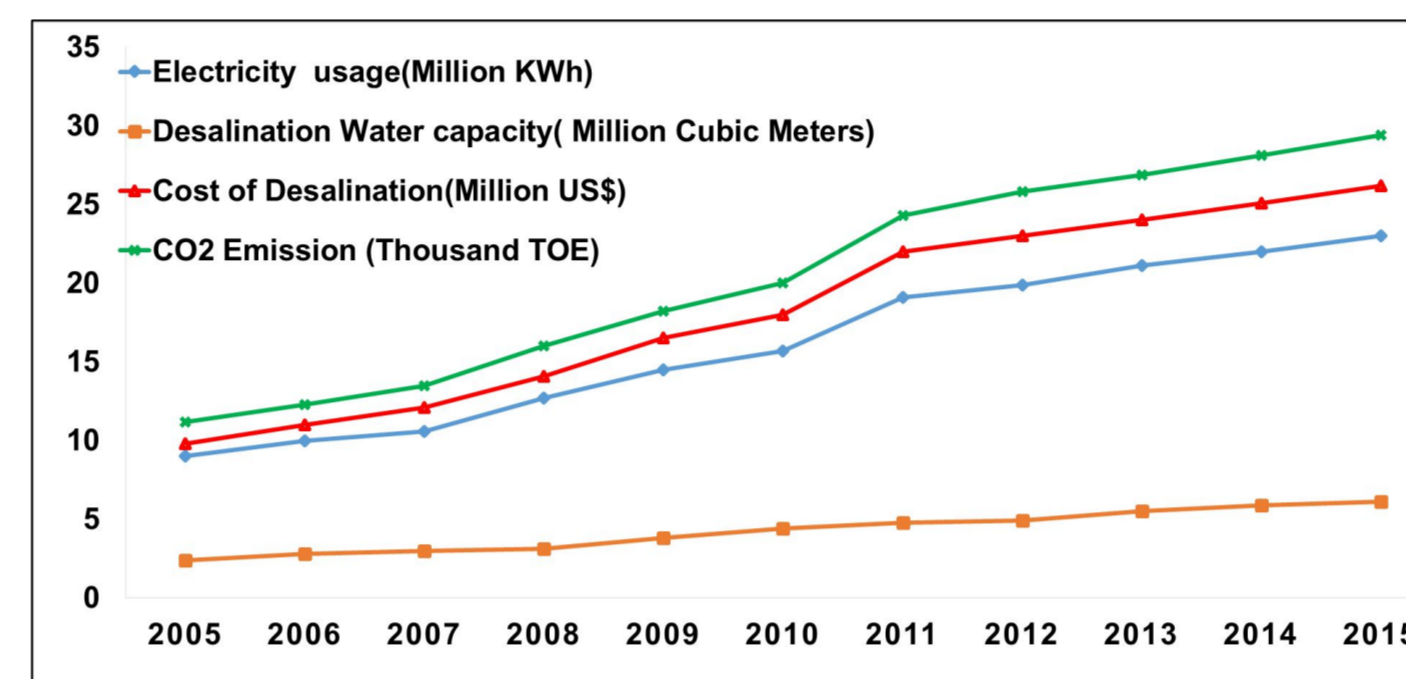


Figure 2: Desalinated water capacities at Maldives Water and Sewerage Company and related energy consumption and cost per year

Water Budgeting

Freshwater lens were calculated according to the methods used in Dr. Zahid's thesis which assumes freshwater lens exist 250 Meters from the coast. Recent rapid changes in land reclamation, population, tourism & industry in Hulhule and Hulhumale are not accounted for yet.

Islands	Population	Annual Rainfall (mm)	ET (mm)	Water usage (Cubic mtrs/day)	Water Demand (Cubic mtrs/day)	Groundwater availability (Cubic mtrs/day)
Male	114643	1660	250	9400	12600	8270
Villingili	7690	1660	215	630	840	180
Hulhule	300	1660	215	30	30	3260
Hulhumale	3168	1660	180	260	350	2420
Total				10320	13820	14130

Table 1: Population and estimations for water balance in Greater Male (2012)

The desalination water capacity in Greater Male was recorded in MWSC as 13420 Cu.Mtr/day in 2012 whereas total water demand for four islands can be estimated as 13820 Cu.Mtr/day. The freshwater availability per day in Greater Male is approximately 14130 Cu.Mtrs.

The groundwater availability was estimated as 30% of the calculated freshwater lens volume. The freshwater requirement was calculated using primary data obtained through household surveys (30 housing units in Greater Male' area - Villingili & Hulhumale), meetings with stakeholder agencies and technical personnel's.

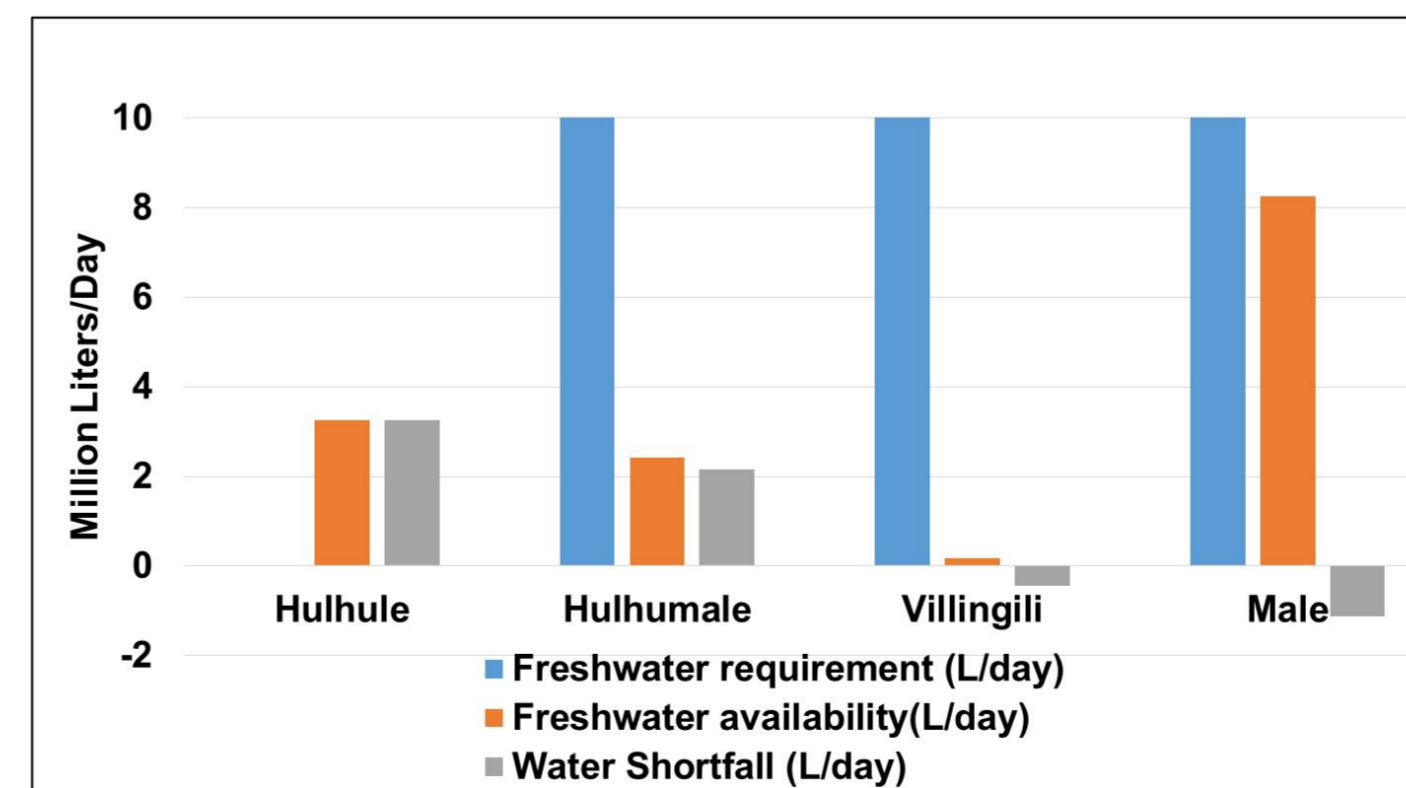


Figure 3: Freshwater requirement for households in Male, Villingili, Hulhule and Hulhumale in 2012 without toilet flushing usage.

Survey and Findings

K. Wijeratne, and Y. Ashraj carried out this survey in 2013 with guidance from Zubair, Rasheed and Zahid to estimate/ analyze the groundwater capacities in Male, Villingili, Hulhumale & Hulhule and identify the possible mitigation options for freshwater scarcity. Overall survey of water supply, demands and its histories were obtained through interviews with key informants and literature review. In Villingili and Hulhumale 30 housing units were surveyed to calculate the freshwater requirement and energy consumption. The Average and standard deviation of per capita use of water were calculated using research questionnaires.

Findings of the survey:

- Per Capita use of desalinated water/day was 81 L with a standard deviation of 75 L
- Almost all households did not know about:
 - The amount of water being used
 - energy consumption
 - environmental pollution
 - water pollution in their island
- The waste water disposal quantity (2013) is 5 Million Cubic meters and being pumped under ground without being treated.



Photo credit: FECT
People lining up to collect water in Male in 2014

- Solid garbage disposal is approximately 250 MT/day which is dumped and burned and has indirect impacts on water supply. In addition, disposal for plastic water bottles is a major contributor to non-biodegradable waste. Better solid waste management is essential.
- Key recommendations from the Survey are that:
- Awareness among all stake holders in the Maldives is necessary on the use of water, energy and disposal of waste water and solid garbage.
 - Some, water can be reused by applying waste water treatment in Greater Male area. Groundwater should be used for toilet flushing and more efficient toilets too can be promoted.

Lessons and Recommendations

Through review of history, water budgets, household surveys and analysis of trends in water supply and demand, we have been able to assess the water use practices, some of the mitigatory steps for meeting demand while reducing the need for costly desalination:

- Improved awareness on water usage, water pollution, and environmental pollution
- Refining rainwater harvesting and management in Greater Male
- Water desalination using fossil fuel at MWSC can be converted to Solar Desalination.
- Improving waste water treatment techniques
- Increasing storage capacity of rainwater harvesting.
- Storm-water and Sewerage disposal within Male has to be better managed.

Water Demand has been increasing exponentially – now with the government proposing to relocate the majority of people to Hulhumale and with recent agreement to set up an additional desalination plant, there could be rapid change in circumstances. Still the lessons from water budgeting, analysis of the economics and environmental costs of mitigation options and household surveys still is relevant.

References

- Zahid, The influence on Asian monsoon variability on precipitation patterns over the Maldives.(2011)
- Wijeratne, K., Internship report on the status of freshwater and the environment in Greater Male. (2013)

