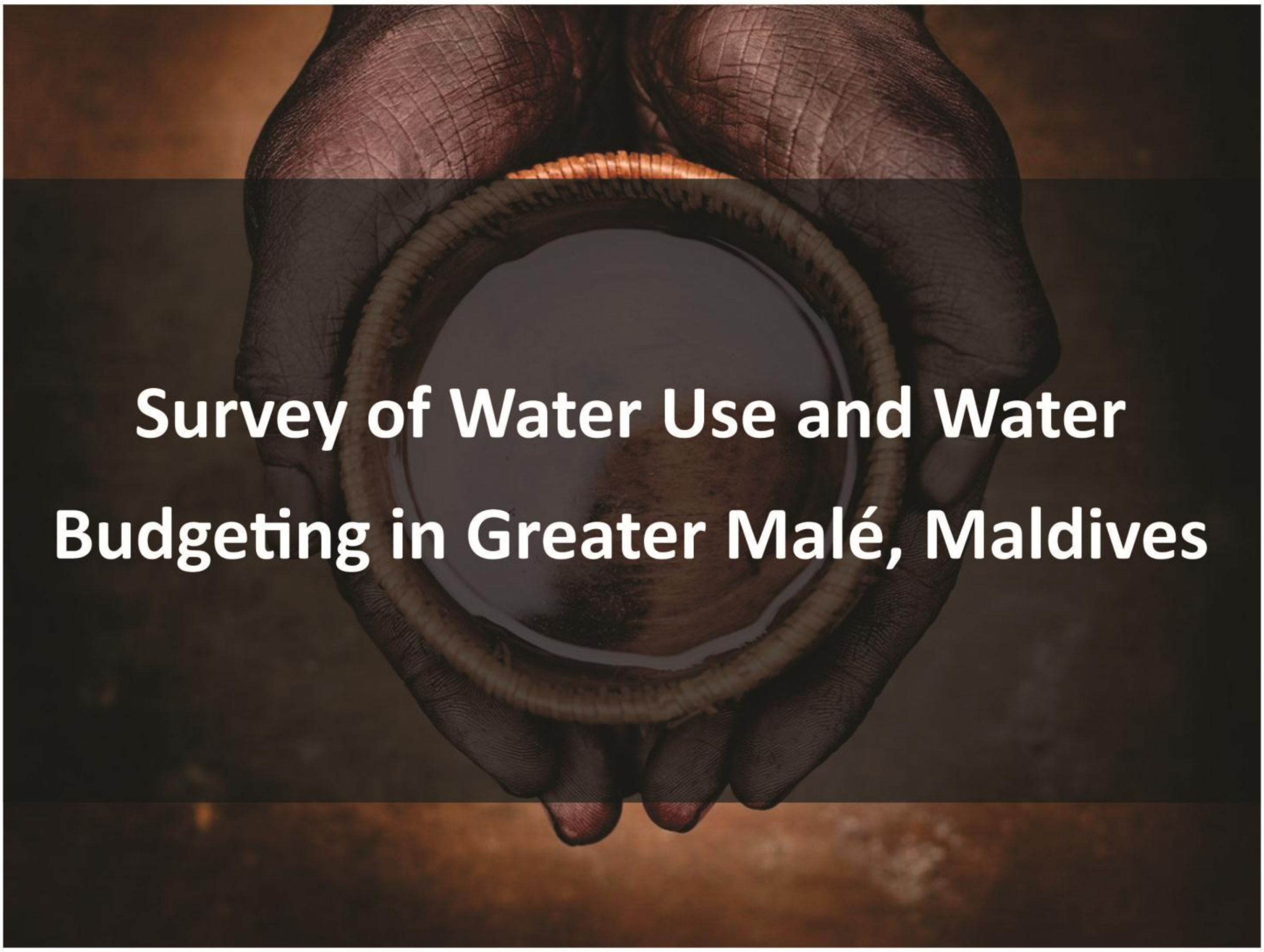

Survey of Water Use and Water Budgeting in Greater Malé, Maldives

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SURVEY OF WATER USE AND WATER BUDGETING IN GREATER MALÉ MALDIVES

(Malé, Villingili, Hulhumale & Hulhule)

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Abstract

The State of Environment (SOE, 2011) reports that in Maldives, the available ground water aquifers which are a limited resource have been extracted excessively. This condition has further been aggravated due to water pollution, inadequate awareness among the island dwellers and improper sewage disposal systems in Maldives. Although sea water desalination has been used as an alternative to address the fresh water scarcity, this method has direct impacts on the environment, energy and the economy of the republic as desalination is powered by fossil fuel.

This report will present the ground water capacities in the *Malé, Villingili, Hulhumale & Hulhule* and possible solutions for fresh water scarcity with a focus on economical and sustainable solar desalination. The paper also discusses mitigation options for water pollutions with an emphasis on reducing the use of fossil fuel which will help the reduction of green house gases.

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Introduction

The Republic of Maldives consists of 1,190, small, low lying and tiny Islands, grouped into 26 Atolls that together form over a chain over a 820 KM in length, over an area of more than 90,000.00 KM^2 in the Indian Ocean. Though a comprehensive land survey has not been carried out in Maldives, total land area of the Maldives is approx.300 KM^2. Geographically, Atolls vary in sizes where the largest being the Havadhu with and area of 2,800 KM^2 and the smallest is the Thoddoo with an area of 5.4 KM^2. Islands vary from 0.5 KM^2 to 5.0 KM^2 in extent (SOE, 2011).

According to UNESCO definition, Falkland (1993), any Island which is having a maximum width of 10 KM is classified as a small island and hence, in the Republic of Maldives, almost all the Islands are less than 10 KM width and hence Islands could be classified as small islands.

Climate

Maldives is located at the equator and experiences a monsoonal climate. Traditionally, two climate seasons include Southwest Monsoon from May to November, which is the wettest season and Northeast monsoon, which is the dry season from January to March. In these two seasons the temperature varies hardly. Since the Maldives consists of small islands and is surrounded by the sea, hot days are often tempered by cooling sea breezes and balmy evening temperatures. Throughout the year, temperature remains almost same in the Maldives. However, daily temperature ranges from around 31 degrees Celsius in daytime to 23 degrees Celsius in nighttime. The mean daily maximum temperature for Central parts (Hulhule) of the Maldives is 30.5 degrees Celsius and minimum temperature is 25.7 degrees Celsius.

On the other hand, mean daily maximum and minimum temperature for South (Gan) is 30.9 and 24.5 degree Celsius, respectively. Furthermore, mean daily maximum and minimum temperature for North (Hanimaadhoo) is 30.7 and 25.2 degrees Celsius, respectively. The highest temperature ever recorded in the Maldives was 36.8deg.C, recorded on 19 May 1991 at Kadhdhoo Meteorological Office. Likewise, the minimum temperature ever recorded in the

Maldives was 17.2&deg C, recorded at the National Meteorological Centre on 11th April 1978. The wet season- southwest monsoon runs from mid-May to November. In this season Maldives experiences torrential rain. Central, Southern and Northern parts of the Maldives receive annual average rainfall of 1924.7mm, 2277.8mm, and 1786.4mm, respectively. The highest rainfall ever recorded in the Maldives with in 24 hour period was recorded on 9th July 2002 at Kaadedhdhoo Meteorological Office and amounts to 219.8mm. On average Southern atolls (Gan) of the Maldives receives 2704.07 hours of sunshine each year. Furthermore, on average, central (Hulhule) parts of the country receive 2784.51 hours of sunshine per year (MALDIVES METEOROLOGY SERVICES, 2013)[i].

Recent Demographic changes in the Maldives

Maldives population is growing at an annual rate of 1.9 (Census, 2000) and according to a report on Water Resources Management in Maldives[ii]. In 1970, in Male, population was 15,279 and it had increased to 29,500 in 1972, which is an increase of approx.93% to 1970 level. In Male, whole population has access to desalinated water through piped network. In 2010, Maldives population was estimated to 319,740 and with regard to human development trends, the country ranks as high among the Asia-Pacific countries. Recent statistics compiled by the United Nations, World population report (2007), Maldives had an annual average population growth rate of 1.76% whereas as World average is 1.17% annual (State of Environment, 2011).

Table 1 Population growth from 1985 to 2006

Year	Male (% & population)	Female (% & population)	Total
1985	93,482 – 51.91%	86,606 – 48.09%	180,088.00
1990	109,336 – 51.28%	103,879 – 48.72%	213,215.00
1995	124,622 – 50.90%	120,192 – 49.10%	244,814.00
2000	137,200 – 50.80%	132,901 – 49.34%	270,101.00
2006	151,459 – 50.66%	147,509 – 49.34	298,968.00

(Census records, Dept of National Planning, Maldives)

Table 2 Tourists arrival & Average stay from 1983 to 2008

Year	No. of tourists	Average stay (No. of days)
1983	74,163	8.7
1984	83,814	9.4
1985	114,554	9.2
1986	113,953	9.1
1987	131,399	9.6
1988	155,755	9.7
1989	158,488	9.2
1990	195,156	8.6
1991	195,112	8.8
1992	235,852	8.4
1993	241,020	8.7
1994	279,982	8.4
1995	314,869	8.7
1996	338,733	9.0
1997	365,563	8.9
1998	395,725	8.8
1999	429,666	8.7
2000	467,154	8.4

2001	460,984	8.5
2002	484680	8.4
2003	563,593	8.3
2004	616,716	8.3
2005	395,320	8.3
2006	601,923	8.0
2007	675,889	8.5
2008	683,012	8.8

Socio Economic condition in Maldives

Tourism contributes approx. 27% of the GDP while fisheries, construction and commerce contribute to 5-50 of the GDP in recent years (SOE, 2011).

Table 3 Change in socio economic conditions of the Maldivians (UNDP, 2013)iv

Year	Life Expectancy at birth (yrs)	Expected years in schooling	Mean years of schooling	GNI per capita (2005 PPP $)	HDI
1980	52.6		4.5		
1985	57.3		4.5		
1990	60.9	10.8	4.0		
1995	65.2	10.8	3.5	3.069	.529

2000	70.3	12.2	4.2	4.158	.592
2005	74.3	12.5	5.0	5.040	.639
2010	76.5	12.5	5.8	7.061	.683
2011	76.8	12.5	5.8	7.489	.687
2012	77.1	12.5	5.8	7.478	.688

Motivation

In 81 Islands of the Maldives, (2004-2010), on average, there had been a water shortage. Today, on average, 90% of drinking water is from rainwater in Maldives. Fresh water aquifer is already stressed due to increased demand in water and there is a tendency to dry completely if dry season extends. Fresh water has been extracted excessively and, in addition, waste water contamination as well as sea water intrusion into the fresh water aquifers had been highlighted. By the year 2020 demand for energy will increase by 20% with respect to present use (State of Environment, Maldives, 2011[iii]). Report on World Water Resources – A new Appraisal and Assessment for World Water, by the State Hydrological Institute, Russia[iv], indicated that complete recharge of deep ground water takes some 1500 years. In the future, total water withdrawal will grow by about 10-12% every ten years, and by 2025 it will reach approximately 5100 km3/year (World), a 1.38-fold increase with respect to present rate with no exception in Maldives.

According to a paper presented to Twelfth International Water Technology Conference, IWTC12, Egypt, Industrial and domestic water use increases at twice the rate of population increase. Water consumption increased seven-fold since 1900. In total, water demand doubles every 20 year.

Most of the water available on earth has the salinity up to 10,000 ppm whereas seawater normally has salinity in the range of 35,000–45,000 ppm in the form of total dissolved salts. According to World Health Organization (WHO),the permissible limit of salinity in water is 500 ppm and for special cases goes up to 1000 ppm. Excess brackishness causes the problem of health. Intergovernmental panel on Climate Change recommends a reduction of 75% of the carbon emission worldwide by the end of this century in order avoid uncontrollable effects of climate change and economic condition. It has been estimated that production of 13 Million of M3 of F.W per day requires 130 M tons of Oil per year, according to a report presented to Twelfth International Water Technology Conference, Egypt[v].

Literature Survey

According to Zahid, Thickness of fresh water lens available for extraction (Withdrawal) is influenced by number of factors such as Island width, Island geology/geography (Aquifer permeability and porosity), rainfall recharge rate, abstraction rate, Eva transpiration and tidal movement (Bailey et al 2008;Falk 1993:Falkland2001b;Ibrahim 2008;Woodroffe 1989).Annual water recharge in Maldives is estimated to, on average, 40% from the rainfall where above average vegetation is present, and 50% of the re-charge from the annual rainfall where vegetation is less than the average.

Fresh water lens volume

Lens volume = Lens Area (m2) x Fresh water Lens thickness (m) x S porosity, taken as 30% which is 30% for the sand (Folkland 2000; Zahid). Daily re-charge is calculated by dividing annual recharge by 365 days.

Only 30% of the recharge quantity is available for discharge (withdrawal) in order for water sustainability. (Falkland, 2001b).

Typically, depth of fresh water zone of a small coral islands fresh water lens is generally between 10- 20 M thick.

Relationship between fresh water lens thickness (to mid- point of the transition zone), annual rainfall and Island width, as follows;

H/P = 6.94 log a – 14.38. Here, H = Height of the fresh water lens (In Mtrs), P = Average Annual rainfall (In mm), a= Width of the island (in Mtrs).

Between 1980 -2010, Average temperature at Hulhulle, Closest to Hinnavaru, was 28.4 C. Annual Rainfall – long term, on average, 1826 mm/yr and rainfall drops almost to zero in January through March in some years. Population growth and water pollution is the key o stress on fresh water resources on these imperil islands (USAID –Disaster Assistance – Maldives – 2012)[vi].

It is indicated that plant life also protect soil from pounding forces from direct rainfall which break open soil aggregates which result in clogging open pore spaces at the soil and thus reducing the infiltration (Khoury-Nolde, 2008; soil infiltration 2011[vii]. According to Soil Infiltration.2011, existence of plant life, up to 30 cm height, will increase infiltration rate because roots of the plants activate and avoid pore spaces become clogging. Since larger pores at the soil level will have a major effect on the water infiltration into the sol, Hydraulic conductivity (k) of the soil is important. (k) Value should range from 10^{-6} to 10^{-3} to achieve an acceptable infiltration rates.

A rough estimate of the groundwater resources, based on an assumed 0.1 m/year[viii] recharge throughout the country (300 KM^2), is 0.03 KM^3/year =1,000,000,000.00 $M^{3)}$, which equals to 30,000,000.00 M^3 which would be the only renewable resource of water Maldives, though hardly exploitable because of seawater intrusion and pollution[ix]. In 1987, water demand for domestic (including municipal) and industrial (including commercial) uses were 3.32 and 0.054 million M^3 respectively. Groundwater sources met the majority of this demand with quantities of 3.15 and 0.053 million M^3. According to Pacific institute, Minimum Average fresh water requirement for a person is 5L per day.

Average ground water recharge is about 30 to 40% of the annual rainfall, besides other influential factors such as vegetation, Hydraulic conductivity (Soil condition), proximity to rivers, streams etc[x].

Water requirement for a Maldivian (Jayne Millar.2002):

For drinking: 1 M3/year

For domestic purposes – 100 M3/year.

For food - 1000 M3/year

Maldives has little capacity for agriculture and hence there is no documented conflict water for drinking/domestic and food purposes.

Sea Level Rise

According to (USAID –Maldives-2012), by 2020, on average, it is predicted to increase sea level by 110 mm from 2010 level and by 2100, sea level rise is projected to be 495 mm with a range of 300 mm & 760 mm against the level of 2010.

Water Pollution

According to (USAID –Maldives-2012), pollution of fresh water is a major concern in Maldives. Contaminants found in water and waste water includes excess of Phosphate, Sulphapate, Iron, Chloride and Nitrite. Phytoremediation helps in minimizing water pollution by way of absorption of excess contaminants of water and waste water. The presence of plant roots facilitates the absorption of excess contaminants of water and waste water[xi].

Rainy water Management

According to (USAID –Maldives-2012), rainwater is not well managed at the end of the rainy season.

With a provision of 2,500 L tank, by a roof top area of 46.5 M^2, would reliably provide water demand, 20L/day for a household.

Waste Water Treatment

Sewage is anything carried by sewers. Waste water coming from domestic or industrial houses or garbage dumps is generally called sewage. Treatment of wastewater involves the following six steps[xii] where first four steps are called primary treatment whilst last two steps called secondary treatment. Nowadays, waste water is not permitted to discharge without primary treatment, which means that gross impurities can be removed before waste water is discharged.

Sedimentation: This process occurs naturally in reservoirs and is accomplished in treatment plants by storing sewage or waste waters in basins or settling tanks. Silt, clay and other fine materials settle to bottom when water is allowed to stand or flow at low velocity. However, plain sedimentation will not remove extremely fine particles.

Coagulation: Coagulation is done by using special chemicals such as coagulants/ flocculants, such as potash alum. This step is also known as flocculation.

Filtration: Fine particles and colloidal materials are combined into conglomerates by coagulation. These are called floe (plural: floes) and are large enough to settle in basins and to be caught on surface of filters. Suspended solids, colloidal material, bacteria and other organisms are filtered out by passing the waste water through a bed of sand or finely graded coal or through a matrix of fibrous material supported on a perforated core. However, soluble materials such as salts and metals in ionic form are not-removed by filtration.

Disinfection: After filtration the water undergoes disinfection. There are several methods of treatment of water to kill living organisms' particularly pathogenic bacteria. The application of chlorine or its compounds such as bleaching powder is commonly used for disinfection. Less frequently used methods of disinfection include the use of ultraviolet light, ozone, or silver ions. Boiling is the favorite household emergency measure for disinfection.

Softening: Softening is a process of treatment of water by which undesirable cations of calcium and magnesium are removed from hard waters. Two methods are used for softening: (1) the water is treated with lime and soda ash to precipitate calcium and magnesium ions as carbonates, after which the precipitate is filtered; (2) the water is passed through porous cation exchangers and is left cation free.

Aeration: Aeration is a process of exposing water to air by forcing air through water in the form of bubbles to add oxygen and reduce carbon dioxide, hydrogen sulphide, and taste producing gases or vapors. Among such approaches, wastewater reuse has become increasingly important in water resource management for both environmental and economic reasons and some of them are ;

- Protect the environment;
- Are less polluting;
- Use all resources in a more sustainable manner;
- Recycle more of their wastes and products; and
- Handle residual wastes in a more acceptable manner than the technologies for which they are

Data Collection

Rainfall data from 2008-2012 recorded at Hulhule Meteorological station, Maldives was collected and used in the analysis.

During my personal visit to Maldives Water & Sewerage Company and interview with Mr. Mohamed Rasheed, Engineering Maanager (MWSC) , the following data/information were collected;

Maximum capacity of desalination at Maldives Water & Sewerage Company, Male - 17,000.00 M3/day.

Current demand for desalination water (In greater Male area i.e. Villingili, Hulhumale, Hulhule & Male) - 13,000.00 M3/day.

Water tariff structure

Domestic use:

- Connection charges - Sewerage - MRf - 2,700.00/connection
- Connection charges - Water - MRf - 1,600.00/connection
- Tariff per month: For Households
- First 3 Cub.m - MRf 20 per Cub.m
- First 12 Cub.m - MRf 70/Cub.m
- First 50 Cub.m - MRf 95/Cub.m
- Institutional (Government & Schools)
- Flat Rate - MRf 75.95/Cub.m

Commercial:

- Connection charges - Sewarage - MRf - 5,400.00/connection
- Connection charges - Water - MRf - 3,200.00/connection.
- Flat Rate - MRf 101.26/Cub.m

Sewerage disposal is done at four corners of Male Island. It reaches those points through pipelines after intersecting many septic tanks and gullies. The disposal locations are at a minimum of 15m and maximum up to 40 M under the sea, with a lateral distance of 300-400m from the shore. Maldives Water & Sewerage Company, Male serves for ;

- Villingilli
- Hulhumale
- Male
- Maafushi

Data Analysis & Management

Desalinated water capacities at Maldives Water & Sewerage Company and related energy consumption and cost. Figures for the year 2020 have been calculated based past records and based on the regression output obtained.**Error! Not a valid link.**

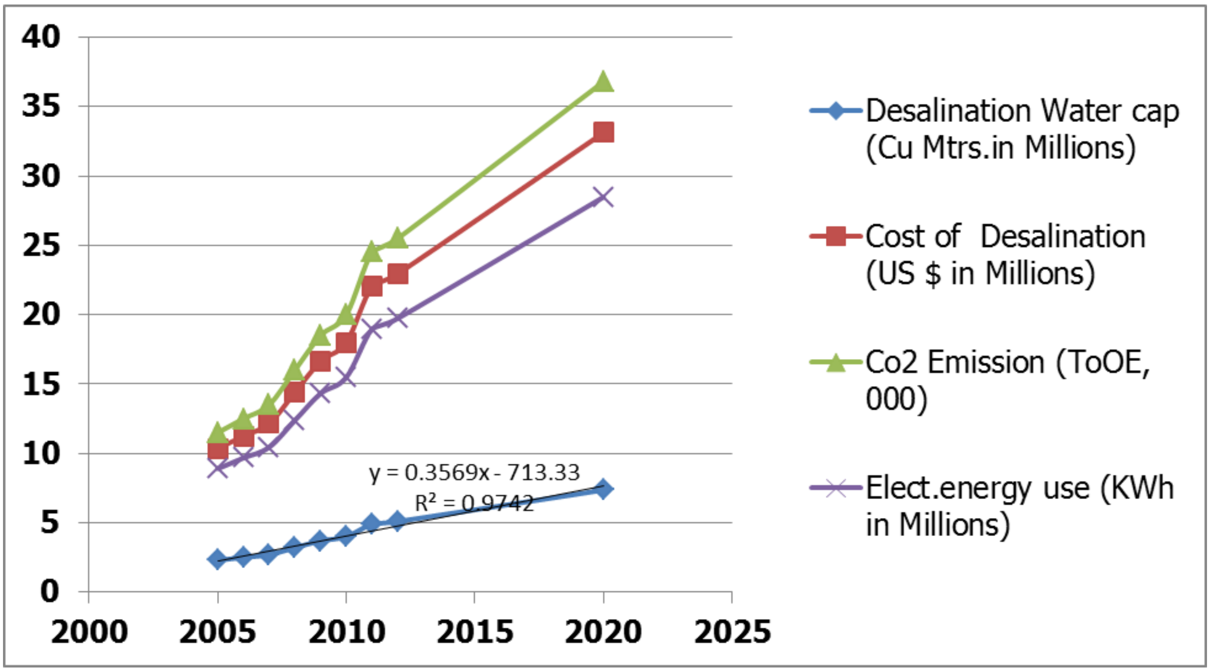
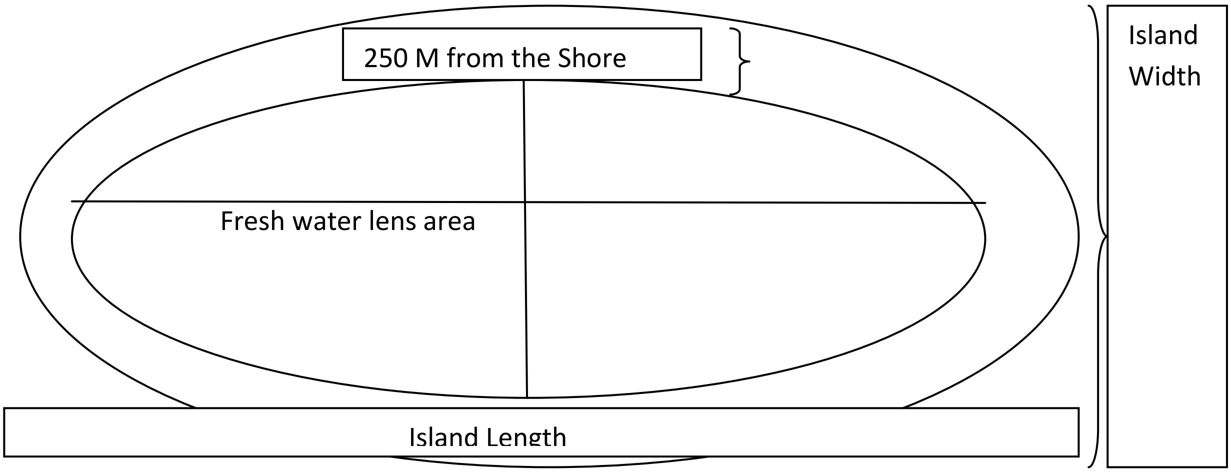


Figure 1 Past, present, furture (Predicted) desalination capacities, at Maldives Water Sewerage Company and related energy cost & consumption and related Co2 emission

Calculation of fresh water lens Areas & volumes in Hulhule, Hulhumale, Villingili and Male

The following factors have been considered in calculating fresh water lens area, as per the thesis of Dr. Zahid and further clarification when I met him at his office (Meteorological Service office, Hulhule).

- Shape of the Island is oval.
- Fresh water lens exist 250 Meters away from the island (towards inner side of the island



- Hulhule – 650 M (w) x 1,483.62 M(L), F.W. Lens area = 1,550,212.612 M2
- Hulhumale - 1000 M (W) x 639.40 M (L). Lens area = 917,502.134 M2
- Villingili - 600 M (W) x 329.93 M(L), Lens area = 87,887.625 M2
- Male - 1050 M (W) x 1,470.40 M (L), Lens area = 3,067,199.74 M2

Hulhule

Hulhule – 650 M. – Rainfall in 2012 - 1661.1 mm (Meteorological service records – Hulhule)

F.W. lens thickness in Hulhule H/1,66.1 = 6.94 log 650 – 14.38

F.W lens thickness = 8.5407 M

F.W lens volume = Lens thickness (m) x lens Area (m^2) x porosity (30%)

= 8.5407 x 1,550,212.612 x .30

= **3,971,970.257 M^3**

Hulhumale

Rainfall in 2012 - 1661.1 mm (Meteorological service records – Hulhule)

1000 M (Approx width).

F.W. lens thickness in Hulhumale H/1.6611 = 6.94 log 1000 – 14.38

F.W lens thickness = 10.6974 M

F.W lens volume = Lens thickness (m) x lens Area (m^2) x porosity (30%)

= 10.6974 x 917,502.136 x .30

= **2,944,466.205 M^3**

Villingili

Rainfall in 2012 - 1661.1 mm (Meteorological service records – Hulhule)

600M (Approx width).

F.W. lens thickness in Villingili = H/1.6611 = 6.94 log 600 – 14.38

F.W lens thickness = 8.1393 M

F.W lens volume = Lens thickness (m) x lens Area (m^2) x porosity (30%)

= 8.1393 x 87,887.625 x .30

= 214,603.123 M^3

Malé

Rainfall in 2012 - 1661.1 mm (Meteorological service records – Hulhule)

1,050M (Approx width).

F.W. lens thickness in Malé = H/1.6611 = 6.94 log 1050 – 14.38

F.W lens thickness = 10.93 M

F.W lens volume = Lens thickness (m) x lens Area (m^2) x porosity (30%)

= 10.93 x 3,067,199.74 x .30

= **10,057,347.950 M^3**

Table 4 Ground water availability

Island name	Island) area (M^2)	Estimated f.w. lens area (M^2)	Recharge volume (M^3- 2012)	Recharge volume (M^3/day-2012)	Sustainable extraction capacity/day (30% from the recharge	Ground water availability/ day in Ltrs
Hulhule	3,030,000.00	1,550,212	3,971,970.257	10,882.11	3,264.63	3,264,630
Hulhumale	2,009,000.00	917,502	2,944,466.205	8,067.03	2,420.10	2,420,100
Villingili	622,000.00	87,887	214,603.123	587.95	176.38	176,380
Male	4,851,000.00	3,067,199	10,057,347.950	27,554.37	8,266.31	8,266,310

Table 5 Fresh water requirement

Name of the Island	Population (Total in 2012) @1.76% annual increase	Fresh water requirement For drinking/washing/bathing (Except toilet flushing) (82L/Person/day)	Ground water availability L/day	Balance (water for flushing not considered Apprx.50L/person/day
Male	114,643	9,400,276	8,266,310	(1,133,966)
Villingili	7690	630,580	176,380	(454,200)
Hulhule	-	-	3,264,630	3,264,630
Hulhumale	3168	259,776	2,420,100	2,160,324

As far as the sewage water is concerned, Maldives Water and Sewerage Company provides facility to dispose the households waste water and this is service free to those, other than a fixed connection charge of waste water, who are having water service from the MWSC. In MWSC also it is understood that there is no waste water treatment process and they dispose the collected water into 30-40 M depth into the sea without treating.

Findings from the survey carried out in Hulhumale, a residential island

- Nearly 100% of the dwellers are lacking an awareness on how much water and how many KWh of electricity is used by their homes.
- Nearly 100% of the dwellers are lacking awareness on whether there is water pollution/environmental pollution in their respective islands.
- In Male, as a whole, all collected garbage and other waste materials are dumped into Thilafushi dump yard.
- In Hulhumale, there is a dump yard towards one corner of the island and collected synthetic materials are burned there. It seems that no consideration is taken towards the environmental pollution caused due to burning of large quantities of synthetic materials etc.
- Per Capita use of desalinated water use per day is 81.58L with a standard deviation of 75.22L. (This excludes the use of ground water for toilet flushing – Approx. 50 LPCPD).
- Almost 100% of the households are lacking awareness about how much water per month is being used, and they, during my survey there, responded with the amount of money paid per month.
- Approx. 100% of the households are lacking knowledge whether there is water pollution in their island.
- Common garbage collection facility is provided in Villingili and Hulhumale islands.

Based on the collected data, Fresh water requirement & Water balance by 2020.

Island Name	No.of inhabitants by 2020 (@ an 1.76%/yr)	Total Requirement (Approx) (L)/day 40% addition from the 2012 requirements	Ground water Availability (L/day)	F.W balance (L/day)
Male	131,142	13,160,386	8,266,310	(4,894,076)

Vilingilli	8,342	882,872	176,380	(706,492)
Hulhulle	-	-	3,264,630	-
Hulhumale	3,625	363,686	2,420,100	2,056,414

Table 6 Fresh water requirement & Water balance by 2020

Ghermandi and Messalem (2009) states that with current technology, it should be possible to achieve Potential economically cost-competitive photovoltaic (PV) powered reverse osmosis unit with costs as low as US$ 2 to 3/m3.

Further, solar stills could be used for small scale pure water making process where 1 M^2 area is required for 4 L water. But when compared to the simplicity, cost easiness, less maintenance, other than regular cleaning, it is worthwhile, to sue solar stills for small communities. Life time of the solar still has been estimated as 20 years.

Plant capacity also affects the financial operation of a desalination plant. Large and medium scale desalination plants (6,600 m3/day and 2,600 – 5,300 m3 /day respectively) benefit from economies of scale (AWA 2008).

Pacific Institute (2006) estimates that small cost of producing water using smaller plants would increase around 50% - to 100% than the large scale plants.

Economics of Desalination

Method	Quantity M3)	Cost/M3	Remarks
Reverse Osmosis	1000.00	2-3 US$/M3	Photovoltaic solar powered Remote Osmosis system (**www.deswater.com**) H. Al-Qahtani, Feasibility of utilizing solar energy to power reverse osmosis domestic unit to desalinate water in the state of Bahrain.
Solar Stills		Nil Only capital cost	US $ 7/1L production capacity – Capital cost. No operational cost.
Solar Thermal	230 M3/day– Onshore M3/day (Smallest size)- Onshore		ROI – 35% - Solar Water Energy LLC, http://www.solarwaterenergy.net/solardesalinationplant.html

Recommendations

1. Portable solar distillation could be easily used for individual household requirements. The stills do not use energy, especially fossil fuel, other than making the stills, which will help to ensure the environmental and energy sustainability.
2. Water desalination, using fossil fuel at present, at Water & Sewerage Company, can be converted to Solar Desalination.
3. During the survey, in the residential island of Hulhumale, it was revealed that nearly 100% of the household are lacking awareness on how much water and how many units of electricity (KWh) are being used by them. An extensive awareness program needs to be carried out about the safe usage of electricity and water.
4. In Male, all collected garbage/other synthetic materials are being transported to Thialafushi and dumped/burned there without considering the environmental pollution being done. A proper garbage disposal method needs to be introduced without further delay to ensure to minimize environmental pollution.
5. Though Maldives Water and Sewerage Company (MWSC) is responsible for collecting waste water from the Islands, Male, Villingilli, Hulhumale & Hulhule, there is no waste water treatment process is in progress. So, there is a very high possibility of treating collected water before disposing into the underground.
6. During the survey carried out in residential Islands of Hulhumale & Hulhule, it was revealed that, nearly 100 % of the households, are lacking the awareness whether there is a water/an environmental pollution due to human activities. Hence, awareness program will greatly help to ensure energy/ environmental sustainability in Maldives.
7. Numbers of cars/motor cycles in the Main city of Male were huge. Hence, a kind of control of vehicle importation to Male will help environmental sustainability.
8. Though rain water harvesting is not practiced in the Greater Male area, there is a room for rainwater harvesting and management as done before in Male. This could be initiated in order to lower the use of energy/cost and environmental pollution, due to desalination using fossil fuel at present.

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