© 2022 IJRTI | Volume 7, Issue 9 | ISSN: 2456-3315

Water Demand Assessment for Neil Island of Andaman and Nicobar Islands

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***Abstract*—Neil Island is a part of Andaman and Nicobar Islands which has limited water sources. It belongs to the South Andaman administrative district, part of the Indian union territory of Andaman and Nicobar Islands. The island is lying 36 km northeast from Port Blair. Agriculture is the primary occupation of the villagers, and the island supplies vegetables to the rest of Andaman. Despite its minuscule tourist infrastructure, an increasing number of tourists have chosen to stay at Neil Island. There are a handful of restaurants and basic beach hotels that cater to international and domestic tourists. The source of water in these islands is wells which are majorly used. In this project the population of residential and tourist was also projected to have the future water demand of the island and after field survey it was found that the water requirement is equal to the water available, but the water requirement will increase with years and this can lead to water scarcity.**

***Index Terms*— Population Forecast, Water Demand, Correlation.**

I. INTRODUCTION

The Andaman and Nicobar Islands, which are home to several indigenous tribes, are located in the Bay of Bengal 1,190 kilometers to the east of Chennai and 1,220 kilometers southeast of the coast of West Bengal. The Andaman and Nicobar Islands are a group of islands in the confluence of the Bay of Bengal and the Andaman Sea, one of India's seven union territories. Ritchie's Archipelago contains the Andaman Islands, one of which is Neil Island. It is a part of the Andaman and Nicobar Islands Union Territory of India's South Andaman Administrative District. Located 36 kilometers northeast of Port Blair, the island.Between Havelock Island and Rose Island, the island is a part of the Ritchie's Archipelago. The majority of the land mass was determined to be suitable for paddy production because the island is rather flat. Sadly, as a result of this, Neil has very little remaining forest cover, and what little there is mostly concentrated in the reserve forest on its northwest side. Due to the absence of forests, Neill Island typically stays one or two degrees warmer than Havelock. The island does have appeal, however it is a different, more rural kind of charm.

The 3040 people reside in five villages: Sitapur (274), Bharatpur (629), Neil Kendra (1000), Lakshmanpur (382) and Ram Nagar (2011 census population in parenthesis) (755). The majority of the locals work in agriculture, and the island provides veggies to the rest of Andaman. Even with its rudimentary tourist infrastructure, more travelers are choosing to stay on Neill Island. There are a few eateries and modest beachfront accommodations that welcome both domestic and foreign visitors. The project discusses the assessment for the water requirement of the peoples residing in the island and the people visiting the island and to suggest remedial measures that can help to reduce the water scarcity problem that are likely to be in the future. The first phase of this project involved the collection of the local population details from the Census Department of Andaman and Nicobar Islands and calculation of local population statistics using the population projection methods, to calculate the Sample strength of local as well as tourist population for water consumption, sample survey of local population to find the water consumption, determining the water demand of local population and determining the correlation between the different factors effecting water demand and the actual water demand by regression analysis. In the second phase, Collection of the tourist population details from I P & T, Port Blair and calculation of tourist population using the population projection methods, Survey of hotels for tourist population to find the water consumption, determining the water demand of tourist population, to generate a GIS map of all water sources in Hotels and Government establishments.

II. CALCULATING WATER DEMAND

Water demand is calculated for generally designing the water supply scheme to be implemented for the area undertaken, it is necessary to determine the total quantity of water required for various purposes by the area. After the calculation of water demand of the area the next step is to find the suitable water sources from where the demand can be met. While designing the water supply scheme, it is necessary to determine the total years demand as well as monthly demand variations in the demand rates. But as there are so many factors involved in demand of water, it is not possible to accurately determine the actual demand. Certain empirical formula and thumb rules are employed in determining the water demand, which is very nearby to the actual demand.

Table 1: Domestic Use As Per IS: 1172-1983 [4]

Sl. No.	USES	Consumptions per day (litres)
1	Drinking and cooking	4.5
2	Washing clothes, utensils and houses, ablution and bathing	49.5
3	Water closets	22.5
4	Trade and industry	22.5
5	Municipal street watering, public baths, flushing sewers, and extinguishing fires	13.5
6	Animal drinking and cleansing of stables	13.5
	TOTAL	135 - 225 litres

Table 2: Water Supply Requirements for Public Buildings As Per IS: 1172-1983 [4]

Sl. No.	Type of building	Consumptions per day (litres)
1	Hospitals (including laundry) per bed a) No. of beds not exceeding 100 b) No. of beds not exceeding 100	340 per bed 455 per bed
2	Nurses homes and medical quarters	135 per head
3	Hotels	180 per head
4	Concert halls	70 per head
5	schools	45 per head

III. COLLECTION OF POPULATION DETAILS

The population details of people residing in the Neil Island was collected from the CENSUS DEPARTMENT, PORT BLAIR and the tourist population and its flow during peak and off seasons was collected from I P & T, PORT BLAIR, which is based on the head count of the tourist entering the island through vessels of DSS and other private owners on monthly basis and the total inflow is obtained.

Table 3: Details of Population According To Census Department [2]

YEAR	POPULATION
1981	1560
1991	2463
2001	2868
2011	3040

Table 4: Details of Inflow of Tourist in Neil Island on Peak and off Seasons [3]

SL.NO	MONTH	2013	2014	2015	2016
01.	JANUARY	2201	9500	10209	9919
02.	FEBRUARY	1981	9059	9925	10817
03.	MARCH	1983	9398	10642	11817
04.	APRIL	1544	3455	6861	6764
05.	MAY	2716	4025	5652	4973
06.	JUNE	2410	1930	2822	3291
07.	JULY	211	1023	1522	2135
08.	AUGUST	878	2193	2653	3381
09.	SEPTEMBER	1351	4955	4375	4287
10.	OCTOBER	4590	9472	8906	8575
11.	NOVEMBER	3870	8487	5068	7906
12.	DECEMBER	5354	9492	6071	9153
		29080	**72989**	**74706**	**83018**

IV. POPULATION PROJECTION

Population projection is a scientific attempt to peep into the future population scenario, conditioned based on assumptions, using data and information related to the past. Assumptions used and their probability of occurrence in future acts as a critical input in this effort. A scientific population projection has useful role as a tool to plan and design the crucial infrastructure service without which urbanization cannot be turned into an opportunity to ascertain improved in economic conditions at an optimized cost of larger investments. Projected population aids in visualizing need towards future planning for the Urban Local Bodies and Authorities.The methodology used for determing the population projection in this project is simple graphical curve method, Graphic projections are most commonly made using arithmetic, semilog, or probability paper. The data used in the plotting are historic data from decennial census reports and from available local or State census reports from intermediate years. The historic data are often plotted on all three types of graph paper, and the plot which comes closest to a straight line indicates the mathematical form to be used for the projection. In using the plotted information for projection purposes, the analyst assumes that the condition implied by the straight line will continue into the future. The graphical representation of both the population local as well as tourist is done using this method and the graphs are plotted. The data used in the plotting are historic data from decennial census reports and from available local or State census reports from intermediate years.

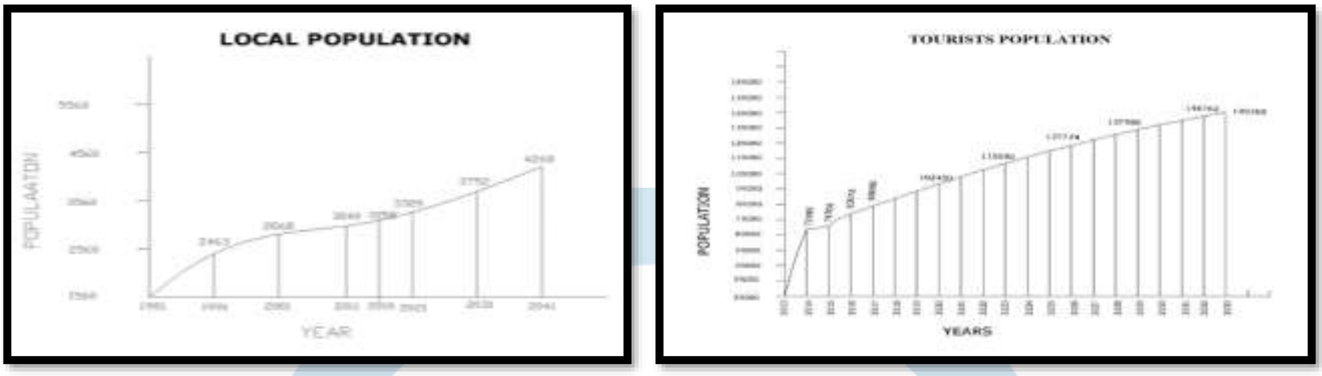

Figure 1: Future Residential Population and Tourist Population Projection Using Simple Graphical Method

V. PROJECTION OF FUTURE WATER DEMAND

The projection of future water demand for local as well as tourist population is achieved by multiplying the projected population with the demand WATER SUPPLY REQUIREMENTS FOR PUBLIC BUILDINGS AND DOMESTIC USES AS PER IS: 1172-1983 as mentioned in the table above and the future water demand is being projected. The projected water demand local and tourist population as per IS: 1172-1983 for domestic uses is 135 LPCD and for tourist is 180 LPCD.

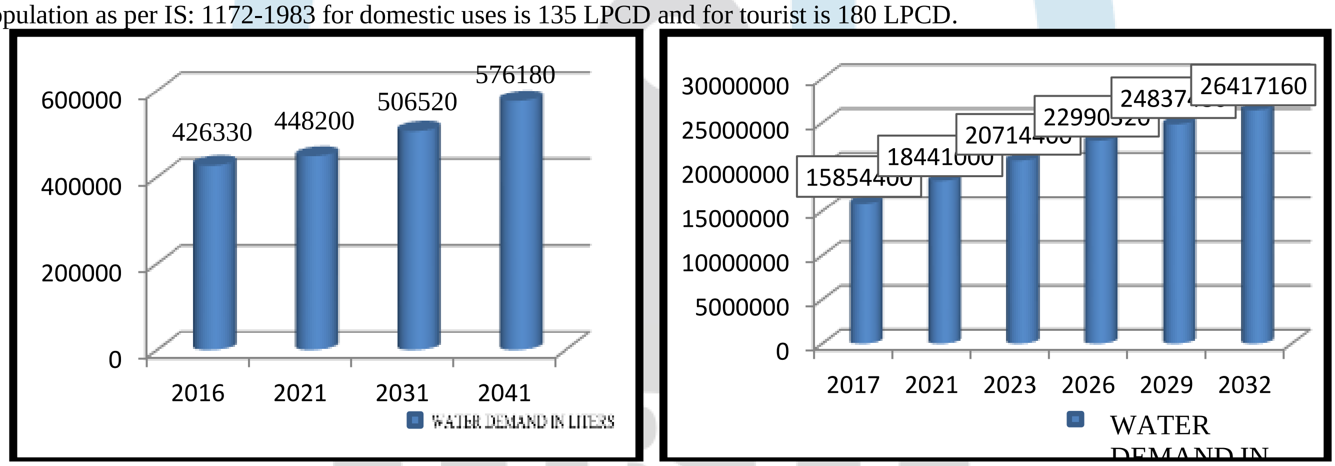

Figure 2: Water Demand of Projected Residential Population (135 LPCD) and Tourist Population (180 LPCD)

VI. FIELD SURVEY ON WATER USED

Field research or fieldwork is the collection of information outside a laboratory, library or workplace setting. The approaches and methods used in field research vary across disciplines. For field survey questionaries where made and the assessment was done the question. The field survey was conducted for local people residing in the island to assess the requirement of water on daily basis and the hotel survey was also performed to check the inflow of tourist and to collect the information regarding the source of water and to assess the water requirement.

Establishing correlation between the factors and water demand:

In statistical modeling, regression analysis is a statistical process for estimating the relationships among variables. It includes many techniques for modeling and analyzing several variables, when the focus is on the relationship between a dependent variable and one or more independent variables (or 'predictors'). More specifically, regression analysis helps one understand how the typical value of the dependent variable (or 'criterion variable') changes when any one of the independent variables is varied, while the other independent variables are held fixed. Most commonly, regression analysis estimates the conditional expectation of the dependent variable given the independent variables – that is, the average value of the dependent variable when the independent variables are fixed.

Linear regression is an approach for modeling the relationship between a scalar dependent variable y and one or more explanatory variables (or independent variables) denoted X. The case of one explanatory variable is called simple linear regression. For more than one explanatory variable, the process is called multiple linear regression. Factors affecting the water demand are in abundant but in this project some of the factors are considered, they are:

- Population
- Rainfall
- Temperature
- Livestock

- Agriculture

The correlation is set up for all the above factors with the water demand and the regression analysis is carried out using SPSS software, which is a regression analysis software.

Table 5: Regression Analysis of Water Demand with Population:

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.004	1.496		.003	.998
	NoMember	2.220	.023	.990	97.823	.000

a. Dependent Variable: WaterDemand

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.998[a]	.997	.997	12.683

a. Predictors: (Constant), NoOfMember
b. Dependent Variable: WaterDemand

Table 6: Regression Analysis of Water Demand with Rainfall:

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95% Confidence Interval for B Lower Bound	95% Confidence Interval for B Upper Bound
1	(Constant)	1802.104	1430.691		1.260	.043	-1497.075	5101.283
	Rainfall	-2.575	3.206	-.273	-.803	.024	-9.967	4.817

a. Dependent Variable: WaterDemand

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.996[a]	.992	-.041	587.992

a. Predictors: (Constant), Rainfall
b. Dependent Variable: WaterDemand

Table 7: Regression Analysis of Water Demand with Temperature:

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95% Confidence Interval for B Lower Bound	95% Confidence Interval for B Upper Bound
1	(Constant)	34093.705	46973.395		.726	.020	-115396.601	183584.011
	MinTemp	-1887.923	1638.482	-.542	-1.152	.033	-7102.303	3326.456
	MaxTemp	316.040	819.395	.181	.386	.025	-2291.640	2923.721

a. Dependent Variable: WaterDemand

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.996[a]	.993	-.102	629.489

a. Predictors: (Constant), MaxTemp, MinTemp
b. Dependent Variable: WaterDemand

Table 8: Regression Analysis of Water Demand with Livestock:

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95% Confidence Interval for B Lower Bound	95% Confidence Interval for B Upper Bound
1	(Constant)	1.332	.730		1.826	.069	-.107	2.772
	TOTAL LIVESTOCK	2.342	.105	.845	22.205	.000	2.134	2.550

a. Dependent Variable: TOTAL WATER DEMAND FOR LIVE STOCK

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.956[a]	.913	.912	9.559

a. Predictors: (Constant), TOTAL LIVESTOCK
b. Dependent Variable: TOTAL WATER DEMAND FOR LIVE STOCK

Table 9: Regression Analysis of Water Demand with Agriculture:

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95% Confidence Interval for B Lower Bound	95% Confidence Interval for B Upper Bound
1	(Constant)	9.169	6.171		1.486	.139	-2.999	21.338
	AGRICULTURAL AREA IN HECTARE	281.771	10.356	.888	27.207	.000	261.348	302.194

a. Dependent Variable: TOTAL WATER DEMAND FOR AGRICULTURE IN LITRES/HECTARE/DAY

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.991[a]	.982	.988	81.385

a. Predictors: (Constant), AGRICULTURAL AREA IN HECTARE
b. Dependent Variable: TOTAL WATER DEMAND FOR AGRICULTURE IN LITRES/HECTARE/DAY

VII. WATER DEMAND ASSESSMENT

With the increase in worldwide water demand over the last few decades, water utilities face problems of supplying the quantity of demanded water. Water pricing, together with other options, showed to be an efficient tool in controlling water consumption. Many studies have researched the influence of pricing. The journals "Land Economics" and "Water Resources Research" have dedicated much space to this study. Water use can mean the amount of water used by a household or a country, or the amount used for a given task or for the production of a given quantity of some product or crop, or the amount allocated for a particular purpose.

The water demand is calculated by equating the population and the factors with the ideal water requirement and the demand is achieved. Water demand is sub-divided into other demands like domestic demand, commercial demand, fire demand etc. but among all the demands the commercial and domestic demand is given more privilege in this project and is determined using the population and equating it with the ideal water demand per capita.

Yield of Well:

It is well known that under the favourable condition water tries to maintain its own level. Hence, it is obvious that the level of water in a well approximately indicates the level of waters table under normal conditions of no withdrawal. As the water is pumped out or withdrawn from the well the level of water in the well falls more quickly than the ground water level and consequently if forms a cone of depression. The difference of level of waters table and the water level in the well now is called a head of depression.

Specific Yield of Wells:

Rate of water percolation in the well or yield of a well in m3/hr under a head of one metre is called the specific yield of the well. From the above definition it is clear that the specific yield depends on:

(i)Position of the water-table

(ii)Permeability and porosity of the soil formation

(iii)The rate of water withdrawal from the well

(iv)Quantity of water storage in the well.

Specific yield of the well is also called specific capacity of the well. The yield of sample wells are also calculated using recuperation method.

It can be calculated from the following formula:

$$K = 2.303 \,[A/T \log H1/H2] \qquad (1)$$

Where K is specific yield of a well in m3/hr under depression head of one metre.

A is area of well in plan in m2.

T is total time of recuperation to bring water level from depth H1 to H2

H1 is difference of water level in the well just after stoppage of pumping and the normal water level of the well.

H2 is difference of water level in the well after time T and normal water level of the well.

$$Q \propto H \qquad (2)$$

$$Q = K \times H \qquad (3)$$

Table 10 : Yield of Wells

Notation	**Located At**	**Dia/size (m)**	**initial depression head (H1) (m)**	**final depression head (H2) (m)**	**recuperation time (Hr)**	**Area of well in (m^2) (A)**	**Specific capacity of well in m^3/ Hr under 1m head**	**Average depression head (H) (m)**	**Yield of well (m^3/ Hr)**
W1	Sitapur	1	0.15	0.084	0.167	0.786	2.734	0.066	0.180
W2	Sitapur	1.5	0.15	0.104	0.167	1.768	3.886	0.046	0.179
W3	Sitapur	1.2	0.15	0.093	0.167	1.131	3.246	0.057	0.185
W4	Ramnagar	1.2	0.15	0.096	0.167	1.131	3.030	0.054	0.164
W5	Ramnagar	2	0.15	0.116	0.167	3.143	4.848	0.034	0.165
W6	Ramnagar	1.8	0.15	0.113	0.167	2.546	4.327	0.037	0.160
W7	Bharatpur	2	0.15	0.115	0.167	3.143	5.011	0.035	0.175
W8	Bharatpur	1	0.15	0.086	0.167	0.786	2.623	0.064	0.168
W9	Bharatpur	1.8	0.15	0.112	0.167	2.546	4.463	0.038	0.170
W10	Neil Kendra	2	0.15	0.116	0.167	3.143	4.848	0.034	0.165
W11	Neil Kendra	1.5	0.15	0.106	0.167	1.768	3.683	0.044	0.162
W12	Neil Kendra	2	0.15	0.117	0.167	3.143	4.686	0.033	0.155
W13	Laxmanpur	2	0.15	0.118	0.167	3.143	4.526	0.032	0.145
W14	Laxmanpur	1.8	0.15	0.114	0.167	2.546	4.193	0.036	0.151
W15	Laxmanpur	1.5	0.15	0.108	0.167	1.768	3.485	0.042	0.146
W12	Neil Kendra	2	0.15	0.117	0.167	3.143	4.686	0.033	0.155
W13	Laxmanpur	2	0.15	0.118	0.167	3.143	4.526	0.032	0.145
W14	Laxmanpur	1.8	0.15	0.114	0.167	2.546	4.193	0.036	0.151
W15	Laxmanpur	1.5	0.15	0.108	0.167	1.768	3.485	0.042	0.146

VIII. PLOTTING THE WATER SOURCES

To know the available drinking water sources, mapping of the well as sub-surface water has been done using GIS software. Base map was being collected from the ANDAMAN PUBLIC WORK DEPARTMENT (APWD) PORT BLAIR [1] office from the town planning section which gives an overall view of Neil Island with specific boundary.

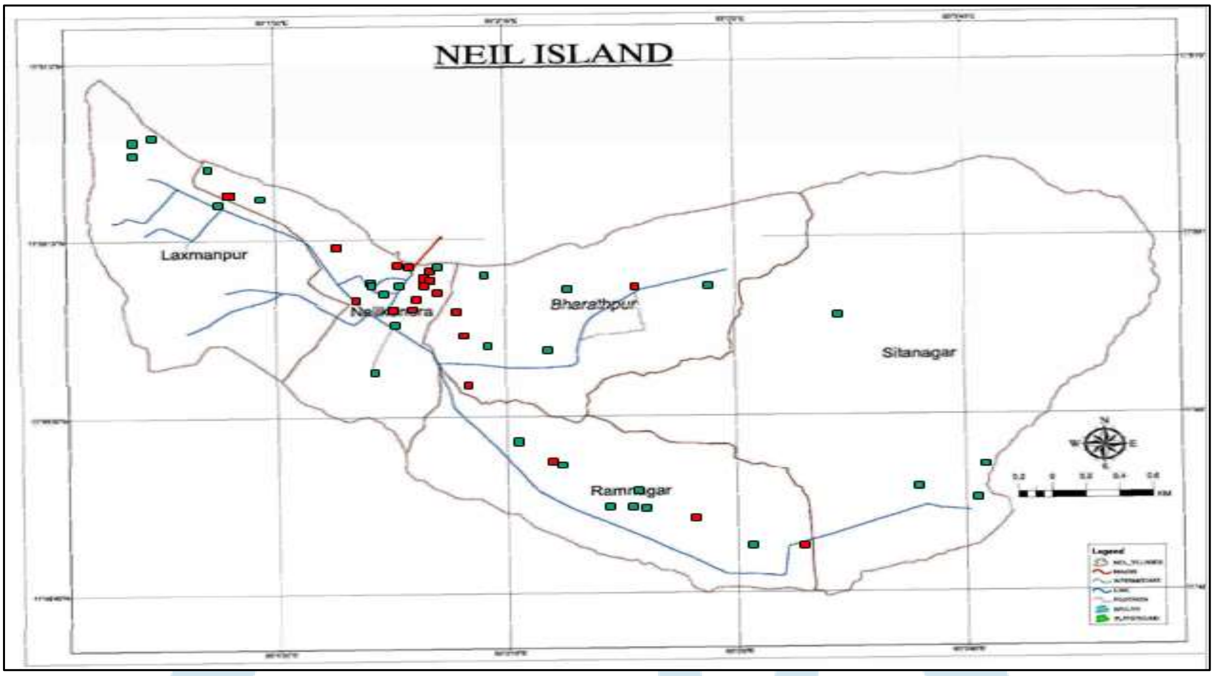

Figure 3: Water Sources plotted using GIS

IX. CONCLUSION

From this project we would like to conclude that:

1. The Residential population of Neil Island as per Census Department for the year 2011 is 3040 and as per I P & T Department the tourist population entering the island in the year 2016 is 83018. The population after projecting by simple graphical curve method for residential population for a period of 30 years is 4268 and for tourist population is 149368 and the future water demand is 576180 litres and 26417160 litres respectively.
2. The source of water in these islands is wells which are majorly used. The total number of wells that are used is 189 wells in which 115 are used by the residential population, 20 are utilized by the Government establishment and 54 are used for commercial purpose like Resort / Hotels. The average yield of wells is 0.165 m3/ hr. The wells utilized by the hotels and government establishment are being plotted using Arc GIS Software.
3. From this project we can say the water available in the island satisfies the water demand but the present available water cannot fulfill the future water demand which can lead to water scarcity problems in the island

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