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MINISTRY OF WATER RESOURCES

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CENTRAL GROUND WATER BOARD

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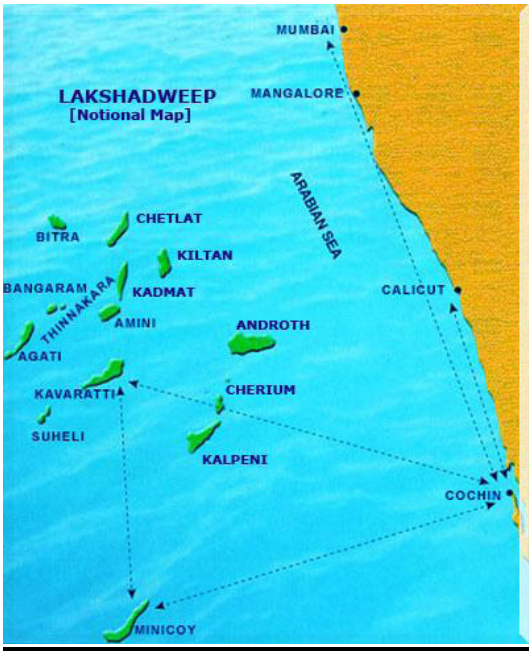
KERALA REGION

भूजल सूचना पुस्तिका, लक्षद्वीप

GROUND WATER INFORMATION BOOKLET OF LAKSHADWEEP ISLANDS UNION TERRITORY OF LAKSHADWEEP



तिरुवनंतपुरम

Thiruvananthapuram

GOVERNMENT OF INDIA
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GROUND WATER INFORMATION BOOKLET
OF
LAKSHADWEEP ISLANDS
UNION TERRITORY OF LAKSHADWEEP

द्वारा

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OF
LAKSHADWEEP ISLANDS,
UNION TERRITORY OF LAKSHADWEEP

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LAKSHADWEEP ISLANDS AT A GLANCE

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	Latitude	8^0-12^0N
	Longitude	71^0-74^0 E
	Total no. of islands	36
	Total no. of inhabited islands	10
	Total geographical area (sq. km.)	32
	Total land area (sq. km.)	26.32
	Total lagoon area (sq. km.)	4200
	Population (As per 2011Census)	64473 (2011 census)
	Normal Annual Rainfall (mm)	1803
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GROUND WATER INFORMATION BOOKLET OF LAKSHADWEEP ISLANDS, UNION TERRITORY OF LAKSHADWEEP

1. INTRODUCTION

Lakshadweep islands consist of a group of tiny coral islands, located in the Arabian Sea, about 400 km from the main land (southern tip of the Indian Peninsula). The Union Territory of Lakshadweep consists of 10 inhabited islands, 17 uninhabited islands, attached islets, 4 newly formed islets and 5 submerged reefs. These islands are scattered in the Arabian Sea between North Latitudes 8° 00' and 12° 13'N and east longitude 71° 00' and 74° 00'E (Fig.1). These islands are typically a chain of low islands surrounding a shallow lagoon, consisting largely of recent sediments on top of older coral limestone. The inhabited islands are Agatti, Amini, Androth, Bangaram, Bitra , Chetlat, Kadmat, , Kalpeni, Kavaratti and Minicoy. Chetlat, Kiltan and Kadmat are closely spaced and are on the northern part of the archipelago, whereas Kalpeni is on the east central part of the group and the Minicoy Island is located in the southernmost part and far away from the other islands. Androth, having an area of 4.84 sq.km. is the largest Island, whereas Bitra, with an area of 0.1 sq.km is the smallest.

Lakshadweep islands have a delicate ecosystem with very limited fresh water resources. Though the islands receive high rainfall, the lack of surface storage and the limited ground water storage capacity, where fresh water is occurring as a small lens floating over salt water, makes fresh water a precious commodity. High porosity of the aquifers allows mixing of freshwater with sea water. Due to the dense population, waste water gets mixed with the fresh water in the aquifer. These constraints complicate the management of the limited fresh water resources in the islands. Growing population and the constantly improving standards of living also impart considerable stress on the available fresh water resources.

1.1 Administration

The entire Union Territory of Lakshadweep is considered as one district and is governed by an Administrator appointed by the President of India. The U.T is further sub-divided into 10 Sub Divisions. The Administration Secretariat is at Kavaratti. Matters coming under District Administration, such as revenue, land settlement, law and order are under the purview of the Collector cum Development Commissioner who is also the District Magistrate. The District Magistrate is assisted by one Additional District Magistrate and Ten Executive Magistrates for enforcement of law and order.

For the purpose of implementing community development schemes, the territory is divided into five Community Development Blocks with Kavaratti, Amini, Androth, Minicoy and Kiltan as block headquarters. To bring Administration closer to the people there are eight Sub Division Officers and two Deputy Collectors posted on all inhabited islands except Bangaram which is part of Agatti Sub Division. They also function as Block Development / Additional Block Development officers of concerned islands.

U.T of Lakshadweep has a population of 64,473 as per 2011 Census out of which 31,350 are women. The population density for the Union Territory as a whole is about 2013 persons/Sq.km. Fishing is the main livelihood of the people.

2 Drainage and Vegetation

There are no streams or major surface water bodies in the island. Brackish water ponds exist at Bangaram and Minicoy. In Bangaram the pond has been formed during the process of growth of

the Islands where the outlet of the bay has been blocked by sand. At Minicoy, a similar pond is being formed at the southern edge.

Vegetation in the Islands consists of shallow rooted plants and deep rooted trees. The shallow rooted vegetation, which includes grasses, crops and shrubs obtain their moisture requirements from the soil moisture zone. The deep rooted vegetation consists of those trees whose roots can, where conditions are favorable, penetrate below the soil moisture zone and through the unsaturated zone to the water table. Coconut trees are the major deep rooted vegetation on the islands of Lakshadweep. In relatively shallow areas, coconut trees typically have some roots within the soil moisture zone and some which penetrate to the water table.

1.3 Land Use & Cropping Pattern

Out of the total area of 3200 Ha., about 650 Ha. are not suitable for cultivation due to various reasons. Almost the entire remaining area has coconut plantations with houses / shops in between. Coconut is the only major crop in all the islands. Plantain and vegetables are grown in small patches of low- lying lands.

1.4 Work carried out by Central Ground Water Board

All the inhabited islands except Bitra (0.1 sq.km) have been studied by CGWB under systematic hydrogeological surveys and subsequently by micro level studies. Ground water exploration was carried out in Kavaratti Island through drilling of exploratory tube wells at five sites down to a maximum depth of 30 m. Salient details of exploratory wells constructed are furnished in Annexure – 1 and the hydrochemical data of water samples collected from the exploratory wells are given in Annexure - 2. As per directions of Honorable High Court of Kerala in 1987, CGWB undertook the study of feasibility of water supply scheme using ground water in Kavaratti Island and informed the court that single point pumping of ground water is not recommended in the islands due to the possibility of up-coning of saline water. CGWB has also constructed two rain water harvesting structures through Lakshadweep PWD under Central Sector Scheme for Recharge to Ground Water in Kavaratti Island.

2. CLIMATE AND RAINFALL

Climate:

Lying well within the tropics and extending to the equatorial belt, Lakshadweep islands have a tropical humid, warm and generally pleasant climate, becoming more equatorial in the southern islands of the territory. From the point of view of temperature, the climate is equable and no distinct and well-marked seasons are experienced. Southwest monsoon period is the chief rainy season which lasts from late May to October.

Rainfall

Southwest monsoon is the rainy season, which extends from June to October with 80-90 rainy days a year. The average rainfall is 1640 mm. Annual rainfall decreases from South to North. The rainfall infiltrates into the ground and a small portion goes to recharge the ground water and the major portion is lost as subsurface run off and as potential evaporation losses

Rainfall distribution: The normal rainfall distribution of the islands is given below in Table 2.1.

Table 2.1: Normal rainfall distribution of Lakshadweep Islands

Station	No of years (Data)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Minicoy	50	A	43.2	22.3	20.8	51.3	179.6	309.1	238.3	209.3	158.2	179.1	143.3	85.9	1640
		B	2.6	1.3	1.4	2.9	8.7	17.4	13.9	12.4	10.1	10.6	8.1	4.7	94.1
Amini	50	A	20.6	2.0	4.3	25.4	125.2	380.7	311.9	217.2	149.6	141.1	85.6	40.9	1504
		B	1.3	0.3	0.3	1.4	5.2	17.3	16.5	12.3	10.2	8.4	5.0	2.2	80.4

(A) Normal rainfall in mm; (B) Average no. of rainy days (days with rain more than 2.5mm)

Humidity:

Humidity is high throughout the year and is generally higher in the morning hours compared to the evening hours. It is lower during January to April when it is between 75 and 78% in the morning hours and 66 to 69% in the evening hours. It is higher during June to August when it ranges from 85 to 87% in the morning hours and 83 to 86% in the evening hours.

Temperature:

April and May months are the hottest with the mean minimum and maximum temperatures of 26.8^{o}C. and 33.1^{o}C respectively. December and January are the coldest months with the mean minimum and maximum temperatures of 24^{o}C and 31.1^{o}C respectively.

Evapotranspiration:

Vegetation intercepts part of rainfall and causes transpiration to occur. Interception and transpiration tend to decrease recharge and hence, decrease the available ground water resource. Depending on the depth to water table and type of vegetation, direct transpiration losses from groundwater aquifers can increase. In Lakshadweep islands, the variability of evapotranspiration is much lower than that of rainfall. Typical annual values of potential evapotranspiration in the islands are between 1600 mm and 1800 mm.

3. GEOMORPHOLOGY AND SOIL TYPES

The total geographic area of Lakshadweep islands is 32 sq.km. The islands do not show any major topographical features but are largely low leveled and flat topped, generally rising to the height of a few metres above sea level. The height of the land above the sea level is about 1-2 m. Occasionally, old sand dunes on the sides of the lagoons and storm beaches on the seaward side of the islands rise up to height of 8 m. The storm beaches consist of coral pebbles and boulders piled up well above the high tide mark.

Most atolls have a northeast-southwest orientation with an island on the east, a broad, well-developed reef on the west and a lagoon in between. All islands of Lakshadweep are of coral origin and some of them like Minicoy, Kalpeni, Kadmat, Kiltan and Chetlat are typical atolls. The islands on these atolls are invariably situated on the eastern reef margin except Bangaram and Cheriyakara which lie in the centre of the lagoon. In the case of Bitra, the island is on the northern edge of the lagoon.

The development and growth of the islands on eastern reef margins is controlled by a number of factors. The cyclones from the east have piled up coral debris on the eastern reef while the very high waves generated annually during the southwest monsoon have pounded the reef and broken this into coarse and subsequently to fine sediments which were then transported and deposited on the eastern side behind the coral boulders and pebbles on the eastern reef. A

gradual accretion of sediments by this process has led to the growth of the islands. Even in atolls where the islands are not yet fully developed (Suheli, Valiyapanniyam and Bitra), sandy bays occur on the eastern reef margins. In some of the lagoons like Kiltan and Chetlat, the islands are growing at a very fast rate and during the next decade or so, the lagoons themselves may be filled up with sediments. In atolls where openings occur in the reef or where the lagoon is too wide for the sand to be transported across its entire width, sand banks usually develop and enlarge towards the centre of the lagoon leading to the formation of the island in the centre such as in Bangaram, Suheli etc.

The entire Lakshadweep group of islands lies on the northern edge of the 2500 km long North-South aligned submarine Lakshadweep-Chagos ridge. The Lakshadweep Sea separates this ridge from the west coast of India. The ridge rises from a depth of 2000-2700 m along the eastern side and 400 m along the Western side. The eastern flanks of this ridge appear to be steeper compared to their western counterparts. The ridge has a number of gaps, the prominent being the Nine Degree channel.

Soils

Most of the islands of Lakshadweep have a soil layer overlying coral limestone. The soils are mainly derived from coral limestone and include coral sands and lagoonal sands and mud. The soils over most of the islands are highly permeable and allow rainfall to readily infiltrate, with the result that surface run-off does not occur except in local areas of compacted soils. In some areas of the islands of Lakshadweep, such as along the coast and around the lagoon, the soils are far less permeable and ponded water is often found after rainfall. These less permeable soils cover a small proportion only of the islands.

4. GEOLOGY

The Lakshadweep Islands are composed mainly of coral reefs and material derived from them. Barrier reefs and lagoons are seen in almost all islands. The hard coral limestone is generally exposed along the coast during low tides and is also seen in well sections. A bore hole drilled in 1972 in the 9° Channel of Lakshadweep ridge by the drill vessel 'Glomar Challenger' at a water depth of 1764 m. down to a depth of 411 m. below sea floor encountered calcareous sediments of Upper Paleocene to Pleistocene age. Palynological and other studies indicate that the ridge was faulted down during Lower Eocene period which resulted in the formation of Lakshadweep Sea and separation of the ridge from Peninsular India.

Coral atolls generally consist of a layer of recent (Holocene) sediments, comprising mainly coral sands and fragments or coral, on top of older limestone. An unconformity separates these two layers at typical depths of 10m to 20 m below mean sea level. Several deeper unconformities may exist due to fluctuations in sea level which results in alternate periods emergence and submergence of the atoll. During periods of emergence, solution and erosion of the reef platform can occur, while further deposition of coral limestone can occur during periods of submergence.

5. GROUND WATER SCENARIO

5.1 HYDROGEOLOGY

The Lakshadweep Islands are made up of coral reefs and materials derived from them and generally enclosing a lagoon. The hard coral limestones are exposed all along the beach during low tides and in well sections. Hard pebbles of coral limestone along with coral sand are generally seen.

Ground water occurs under phreatic conditions as a thin lens floating over the sea water in hydraulic continuity with it and hence is influenced by tidal fluctuations. The coral sands and the coral lime stones form the principal aquifers.

The upper sediments are of primary importance from a hydrogeological viewpoint as freshwater lenses occur solely or mainly within this layer . The occurrence of such lenses within this layer is due to its moderate permeability (Typically 5 to 10 m/day) compared with higher permeability of the older limestone (typically 50 to 100 m/day). Permeabilities greater than 1000 m/day occur in solution cavities within the limestone. These extremely high permeabilities allow almost unrestricted mixing of freshwater and sea water which is less likely to occur in the upper sediments. The upper unconformity, therefore, is one of the main controlling features of the thickness of the freshwater lens.

The hydrogeologic conditions of all the islands are more or less similar. The position and the thickness of the interface / interface zone between fresh and saline water mainly depends on the diurnal tidal fluctuation, seasonal water level fluctuation, ground water recharge and draft, dispersion of the flow pattern, molecular diffusion and so on. Depending upon the permeability and porosity, the shape and thickness of the fresh water lens also vary.

Ground water is developed by dug / open wells and to a limited extent through shallow filter point wells. Details of the range of depth to water level and the depth of the wells in the major islands are shown in Table 5.1. The water levels are highly influenced by the tides. The ground elevation above sea level and thickness of the fresh water lens are directly proportional.

Table 5.1: Depth to Water Level in Islands of Lakshadweep

Sr.No	Island	Depth of Wells (m)	Depth to Water Level (m)	Tidal Fluctuation (m)
1	Agatti	2.1 to 4.5	1.3 to 3.6	0.15 to 0.25
2	Amini	1.6 to 7.5	1.2 to 3.8	0.08 to 0.16
3	Androth	1.9 to 5.2	1.1 to 3.9	0.09 to 0.14
4	Chetlat	1.7 to 3.9	1.1 to 3.5	0.05 to 0.20
5	Kavaratti	2.0 to 4.5	1.75 to 2.5	0.08 to 0.23
6	Kalpeni	1.0 to 3.5	0.80 to 3.0	0.01 to 0.21
7	Minicoy	1.2 to 3.5	1.0 to 2.0	0.13 to 0.26

Hydrogeological features of important islands in the U.T of Lakshadweep are shown in **Fig.2 to Fig.6**.

5.2 GROUND WATER RESOURCES

The dynamic ground water resources of Lakshadweep islands (2009) have been assessed by computing various components of recharge and draft using the concept of climatic water balance. Rainfall is the only source of recharge in the Islands, whereas domestic draft, evapotranspiration losses and water loss due to outflow into the sea are the major components of draft. A part (20%) of the annual water surplus is reserved as buffer zone for reserve during delayed or deficit monsoon years. The total annual ground water recharge (total resource) has been estimated to be 35.14 MCM.

As per the computation, the total annual surplus of ground water in the islands amount to 1054.35 ha.m, ranging from 41.36 Ha.m in Chetlat Island to 192.49 Ha.m in Androth Island. Evapotranspiration from coconut trees during 6 non-monsoon months amounts to 282.75 Ha.m,

whereas the water loss due to outflow into sea is of the order of 210.87 Ha.m. An equal quantum of water is reserved as buffer to cater to late or deficit monsoon years in the islands. The net ground water resources available for development ranges from 13.57 Ha.m (Chetlat) to 64.20 Ha.m (Minicoy), amounting to a total of 349.86 Ha.m for the group of Islands as a whole.

Ground water draft in the Islands, by and large, is for domestic uses of the populace. The draft component ranges from 9.33 Ha.m in Chetlat islands to 46.01 Ha.m in Androth Island, amounting to a total of 258.79 Ha.m.

Balance ground water resources available in the Islands range from 3.50 Ha.m (Amini) to 24.65 (Minicoy), adding up to a total of 91.07 Ha.m for the group of Islands as a whole. The stage of ground water development for the group of islands is of the order of 73.97 % and ranges from 56.23% (Kalpeni) to 89.72% (Amini). In the absence of long-term water level data, the islands have been categorized solely based on the stage of development. Based on the Stage of Development, Agatti, Amini, Androth, Kiltan and Kavaratti Islands have been categorized as 'Semi-Critical', whereas the remaining islands have been categorized as 'Safe'.

The details of computation of dynamic ground water resources in the islands are furnished in Table 5.2.

5.3 QUALITY OF GROUND WATER

The ground water in the islands is generally alkaline with few exceptions. The electrical conductivity ranges from 500 to 15,000 µs/cm at 25^0C. Higher concentrations of the dissolved solids are generally seen along the peripheral areas of the islands and also close to pumping centers. The quality variation is vertical, lateral and temporal. The quality is highly variable and reversible. It is observed that the quality improves with rainfall. Other factors affecting the quality are tides, ground water recharge and draft. There is a vertical variation in the quality due to the zone of the interface and underlying sea water. It is also seen that any perforation like drilling, which acts as a conduit for up-coning of sea water affects the ground water quality. Spatial distribution of Specific Electrical Conductivity in the major islands is shown in Figs. 9 to 15.

Ground water quality in the islands varies with time. Hand drawn wells retain more or less the same quality over a long periods whereas the quality deterioration is observed around pumping centers. A trend towards sea water composition is observed with increasing electrical conductivity in and around pumping centers. Similarly, brackish water is seen along topographic lows and where coarse pebbles and corals are seen. Quality variations observed in different islands are detailed below:

Agatti: Quality of groundwater in the island is good and potable. It is mainly Mg-Ca types and is suitable for irrigation and other purposes also. pH values ranges from 7.38 to 9.65. The EC values are generally in the range 500-1000 µs/cm at 25^0 C and about 90% of the wells have EC less than 3000 µs/cm at 25^0 C. Salinity is highest around the southwestern part of the island where it is 12200 µs/cm at 25^0 C. Chloride content shows vide variation from 64 mg/l to 4402 mg/l. The fluoride content is in the range of 0.3 to 1.6 mg/l.

Table 5.2: Dynamic Ground Water Resources of Lakshadweep Islands (2009)

Sl. No.	Annual components of Water Balance	Name of Island									Total
		Agatti	Amini	Androth	Chetlat	Kadmat	Kalpeni	Kiltan	Kavaratti	Minicoy	
1	Population (As n 2009)	8662	8371	12606	2557	7120	4569	4386	11794	10836	70901
2	Area (Ha)	271	259	484	104	312	228	163	363	437	2621
	Normal Monsoon Rainfall (m)	1.326	1.326	1.326	1.326	1.326	1.326	1.326	1.326	1.417	
	Rainfall Infiltration Factor (%)	30	30	30	30	30	30	30	30	30	30
3	Total Resource (Water Surplus) (Ha.m)) [2*3*4]	107.779	103.007	192.492	41.362	124.086	90.678	64.827	144.369	185.756	1054.354
4	ET loss from Trees for 6 non-monsoon months (Ha.m)	29.25	27.75	53.25	11.25	33.75	24.75	17.25	38.25	47.25	282.75
5	Water loss due to outflow to sea [20% of (3) (Ha.m)]	21.556	20.601	38.498	8.272	24.817	18.136	12.965	28.874	37.151	210.871
6	Buffer zone for reserve during delayed or lesser monsoon period [20% of (3)] (Ha.m)	21.556	20.601	38.498	8.272	24.817	18.136	12.965	28.874	37.151	210.871
7	Balance available resource (Ha.m)	35.418	34.054	62.245	13.567	40.701	29.657	21.646	48.371	64.203	349.863
8	Domestic draft @100 lpcd [1*100*365] (Ha.m)	31.62	30.55	46.01	9.33	25.99	16.68	16.01	43.05	39.55	258.79
9	Gross Annual GW Draft (Ha.m)	31.62	30.55	46.01	9.33	25.99	16.68	16.01	43.05	39.55	258.79
10	Groundwater balance available [7-9](Ha.m)	3.801	3.500	16.233	4.234	14.713	12.980	5.637	5.323	24.652	91.074
11	Stage of ground water development [9*100/7]	89.27	89.72	73.92	68.79	63.85	56.23	73.96	89.00	61.60	73.97
12	Category	Semi-Critical	Semi-Critical	Semi-Critical	SAFE	SAFE	SAFE	Semi-Critical	Semi-Critical	SAFE	Semi-Critical
13	Annual replenishable groundwater resource (m)	0.0140	0.0135	0.0335	0.0407	0.0472	0.0569	0.0346	0.0147	0.0564	0.0347

Amini: The ground water is fresh in the south western half of the island except in two small saline patches in the south western tip of the island. There is another vast stretch of fresh water lens on the north eastern part of the island and a small fresh water lens within the island in the south eastern part. The water is generally brackish (with E.C more than 3000 µs/cm at 25^0C) in the central part, south eastern and north western parts. The water is alkaline with pH in the range of 7.13 to 7.49. The chloride content shows a wide variation of 99-3756 mg/lit, whereas the variation in bicarbonate is limited (317-702 mg/lit). Fluoride is in the range of 0.2 to 1.4 mg/lit.

Androth: In general the ground water quality of the island is fresh with EC in the range of 1000-2000 µs/cm at 25^0C whereas along the western tip of the island a higher ground water mineralization is noticed. Water is almost neutral to slightly alkaline with pH values in the range of 7.0 to 7.6.

Chetlat: The ground water is fresh and is suitable for drinking purposes except along the northern and southern tips of the island where it is brackish. The EC values are generally within the range of 100-2000 µs/cm at 25^0C. All the other chemical parameters are within the permissible limits for drinking purposes.

Kavaratti: Quality of ground water in the island is good and potable. It is mainly Mg-Ca bicarbonate type and is suitable for irrigational and other purposes also. The EC values are generally within the range of 500-1000 µs/cm at 25^0C. The chloride content shows a very wide variation of 11-1846 mg/lit. The western tip of the island is brackish.

Kalpeni: The best quality of ground water is encountered in the central part of the island where the water is very fresh with the EC less than 1000 µs/cm at 25^0C. The water is brackish in the northern tail of the island and in the north western coastal area. A zone of high conductivity is observed in the south eastern part of the island also. All the parameters are within the permissible water standards.

Minicoy: In general, the water in this island is fresh and the quality is within the permissible limit for drinking purpose in 87% of the dug wells in the area. The water is almost neutral to slightly alkaline with the pH in the range of 7.1 to 8.0. The chloride is in the range of 25 to 433 mg/l. The fluoride and nitrate values range from 0.3-1.2 mg/l and 0.2- 68mg/l respectively.

Contamination of ground water due to anthropogenic causes is gradually becoming a concern in the islands. The human and animal waste, oil spills and leachate from burial grounds are among the main causes of ground water contamination.

6. GROUND WATER DEVELOPMENT

Large diameter dug wells are the traditional ground water abstraction structures in all the islands. As the depth from the surface to the groundwater table is generally just a few meters, and the soil is fairly easy to excavate by hand, open wells or pits, 1m to 2m in diameter, are excavated to depth of 30 to 90 cm below groundwater table. Almost every household is having a dug well which is mainly used for domestic purposes. Some are drawing water for coconut seedlings or for livestock. The islanders have been conserving water by using step wells, ponds or tanks for washing and bathing purposes. In recent years, use of small capacity centrifugal pumps, mostly of 1/2 HP capacity has become common.

7. GROUND WATER MANAGEMENT

There are no surface water bodies such as streams and rivers in Lakshadweep. A limited quantity of ground water is available for utilization of local population. The water requirement for drinking and domestic uses is on the rise due to increase in population and improvement in the standard of living. Due to the peculiarities associated with the location, geomorphology, rainfall pattern and hydrogeology, the availability of fresh water in the islands is limited. Due to the high permeability of the sub-surface material and limited subterranean storage space available, a substantial portion of the infiltrated water percolates into the sea. The outflow, coupled with evapotranspiration losses leaves only a small fraction of the total infiltrated water as effective recharge into the shallow aquifer. Water quality deterioration due to natural and anthropogenic factors is another major constraint in ensuring safe drinking water supply in the islands. The demand of water is being met from ground water resources, rainwater harvesting and contribution from brackish water desalination plants. The expert team appointed by the Rajiv Gandhi National Drinking Water Mission in 1995 suggested rainwater harvesting and seawater desalination as viable alternatives for meeting the drinking water demand in view of the delicate ground water scenario prevailing in the islands. Based on various studies carried out, roof-top rainwater harvesting and construction of scientifically designed radial wells/infiltration galleries & subsurface dykes at suitable locations have been prescribed as the most suitable ground water management strategies for the Lakshadweep islands.

7.1 Rain Water Harvesting

Rainwater harvesting through suitable storage options is the most suitable and cost-effective water conservation measure in the Lakshadweep islands. The rainfall distribution pattern of the Lakshadweep islands show that the average monthly rainfall is more than 40 mm for eight months a year, from May to December. Further, most of the buildings have tiled or RCC roofs and hence ideal for roof water harvesting.

Provision of eve gutters for the roof water collection and leading the same to surface level / sub-surface collection tanks is the best available mechanism for rainwater harvesting in the Islands. Filter beds are to be provided at the inlet points of this roof water to the storage tanks. The filter beds may consist of coir fibre, charcoal, fine sand and gravel. The water from the first rain after a long dry spell is to be let out by means of a diversion so that the dust and aerosols accumulated on the roof and gutters are washed out.

7.2 Measures for Ensuring Long-term Sustainability of Ground Water Resources

On the basis of various studies, the following measures have been suggested for sustainable development of the limited ground water resources in Lakshadweep Islands

- Efficient use of water through adoption of water conservation measures.
- Regulation of ground water development.
- Rehabilitation, restoration, renovation and protection of ponds.
- Land use and cropping pattern suitable for the hydrogeological settings of islands.
- Large scale implementation of roof-top rainwater harvesting schemes through people's participation.
- Periodic monitoring of water levels and water quality.

- Creation of awareness and education on the importance of water, rain water harvesting and water conservation

7.3 Area Notified by CGWA/SGWA

No island in Lakshadweep is notified by CGWA or SGWA at present as there are no critical or over-exploited islands.

Fig 1: Index Map of Lakshadweep Islands

Fig 2: Hydrogeology of Androth Island

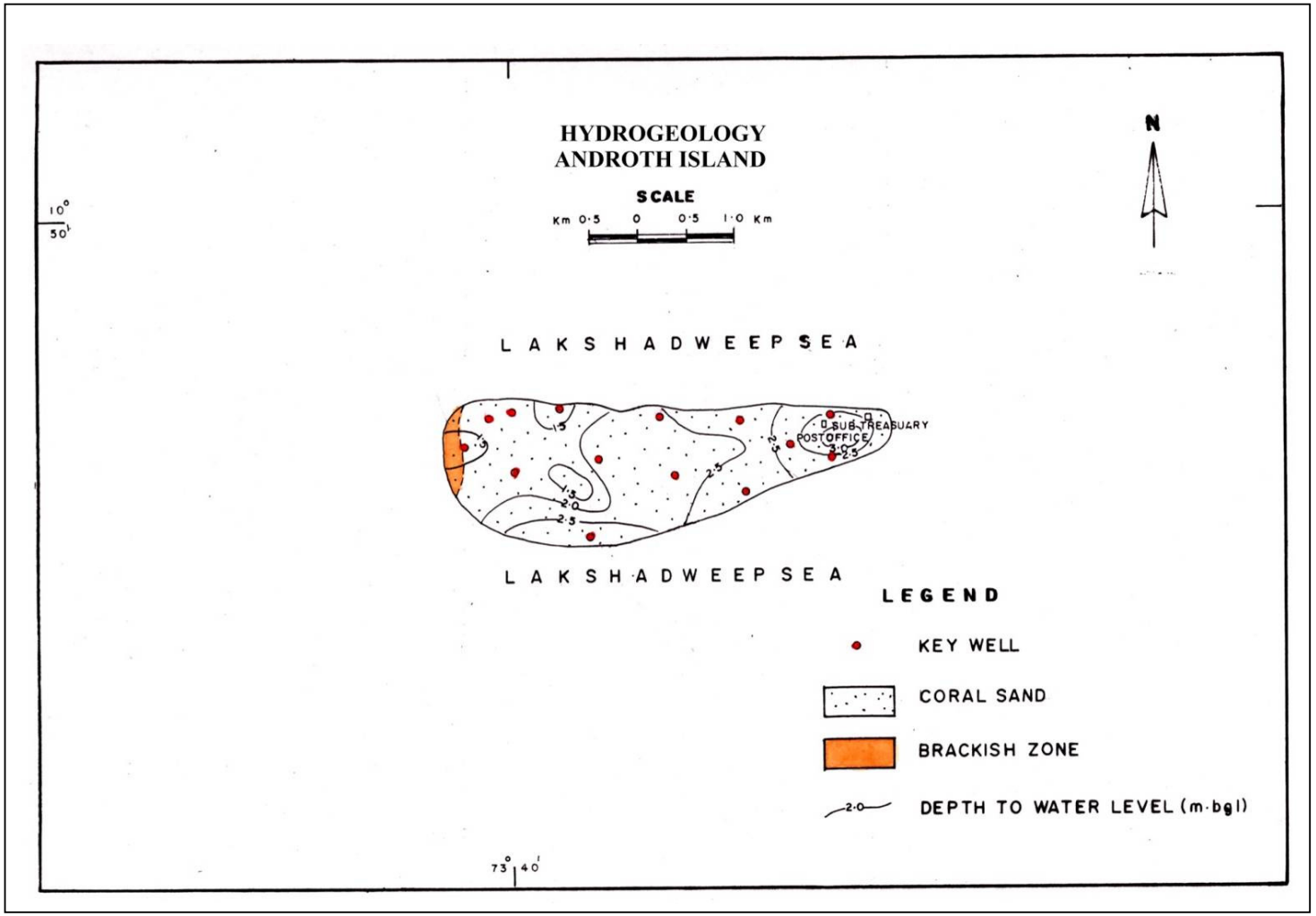


Fig 3: Hydrogeology of Agatti Island

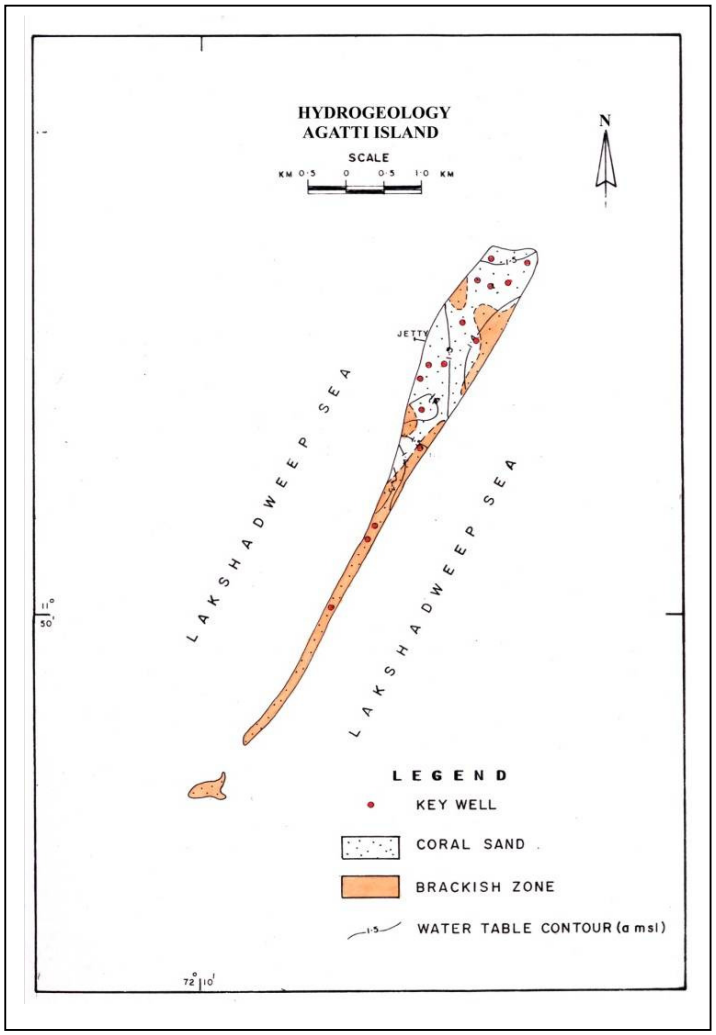


Fig 4: Hydrogeology of Chetlat Island

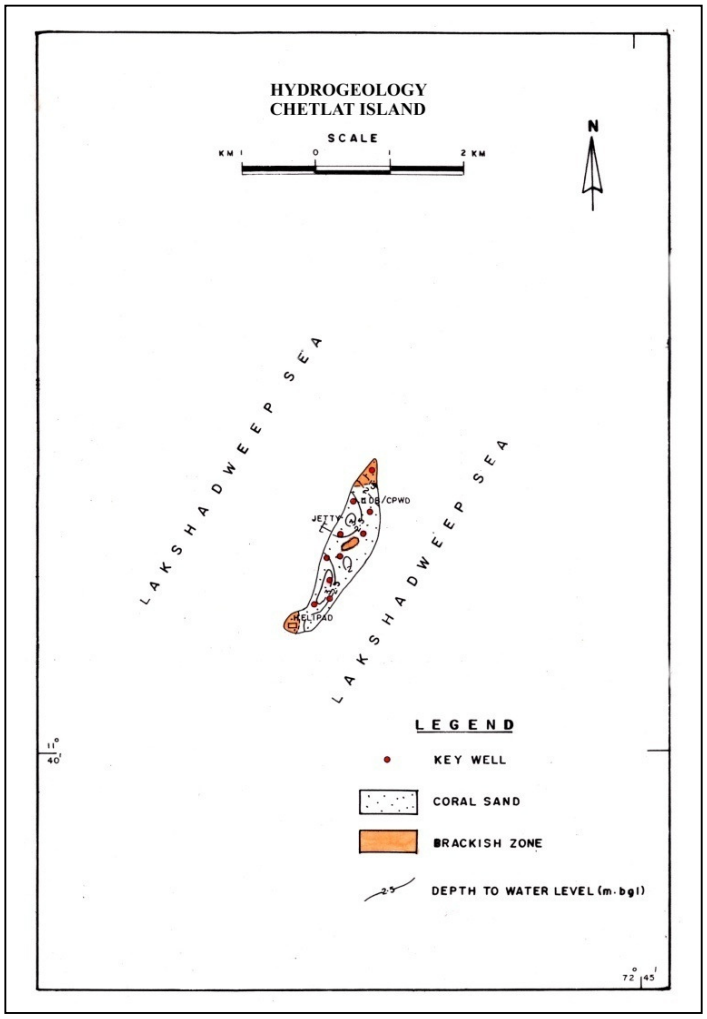


Fig 5: Hydrogeology of Kalpeni Island

Fig 6: Hydrogeology of Amini Island

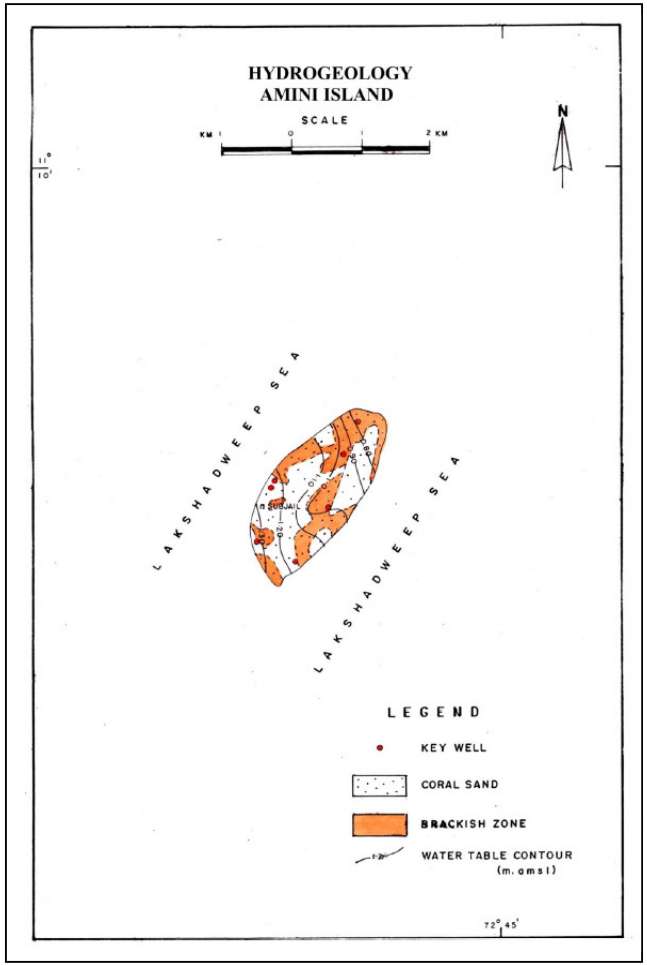


Fig 7: Hydrogeology of Kavaratti Island

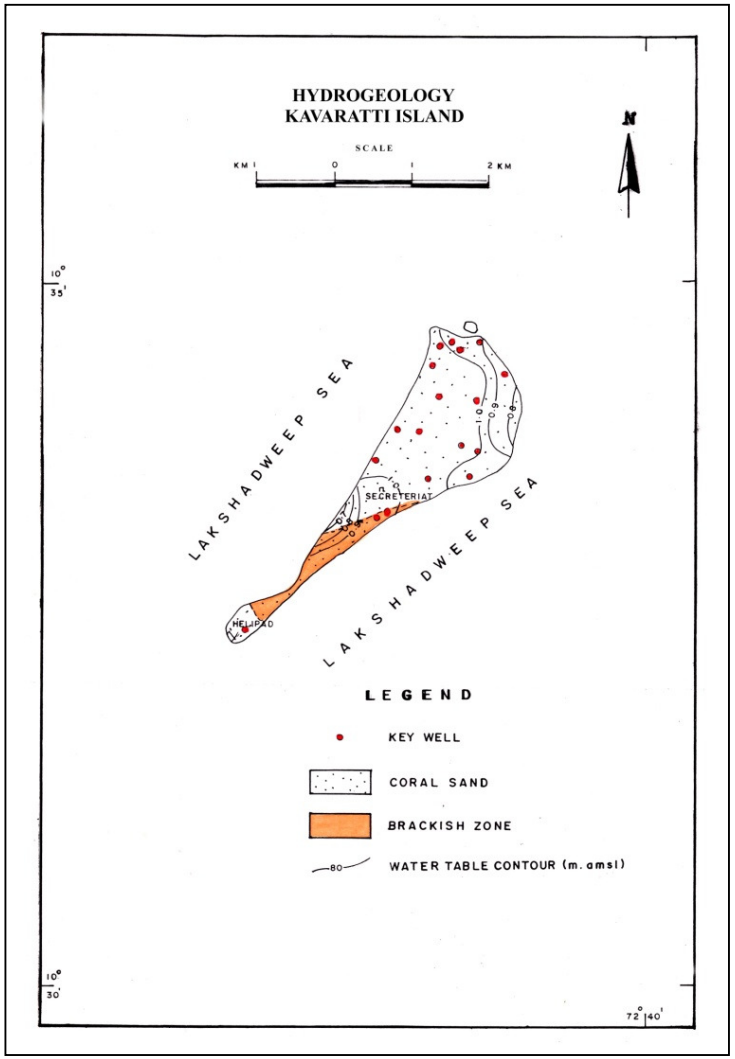


Fig 8: Hydrogeology of Minicoy Island

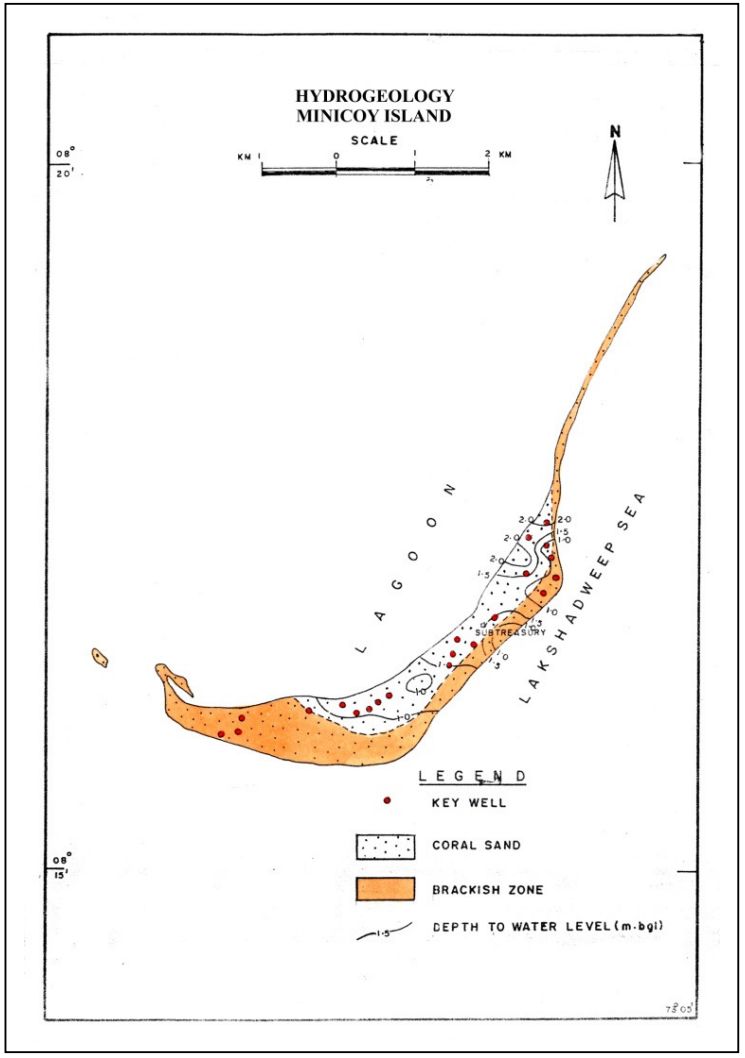


Fig 9: Ground water quality in Agatti Island

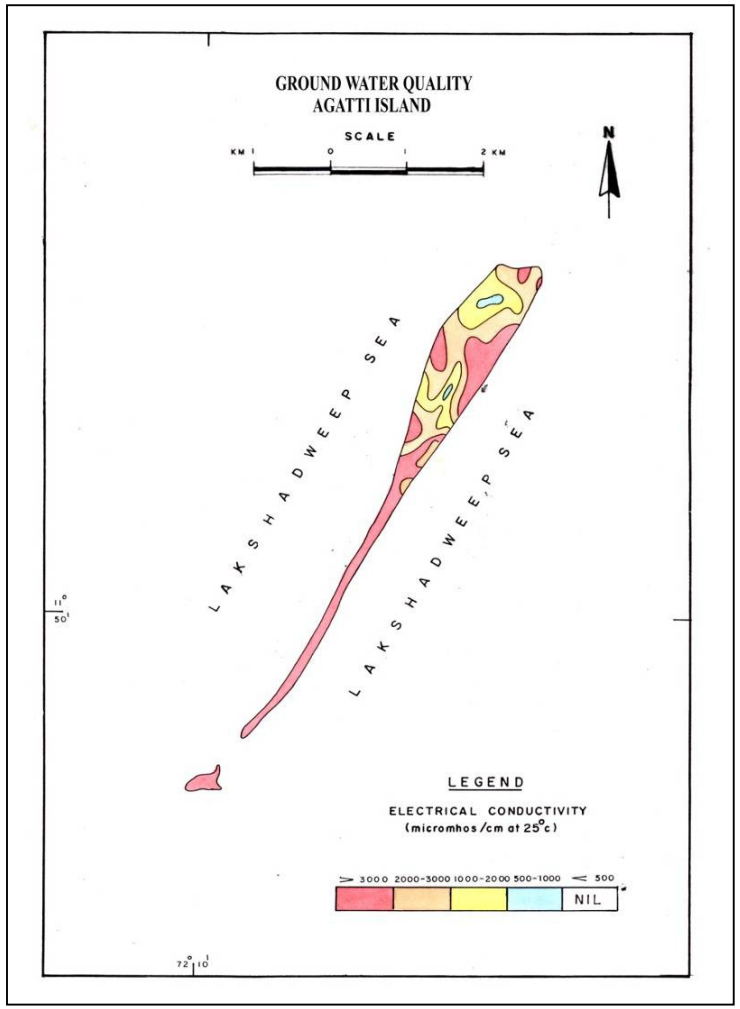


Fig 10: Ground water quality in Amini Island

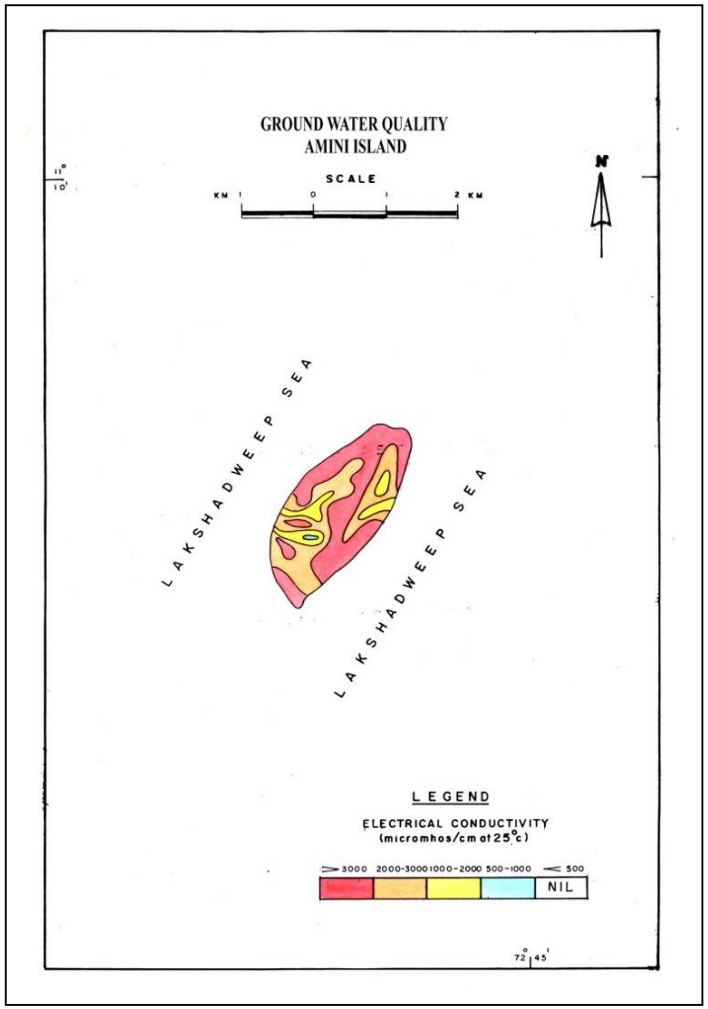


Fig 11: Ground water quality in Chetlat Island

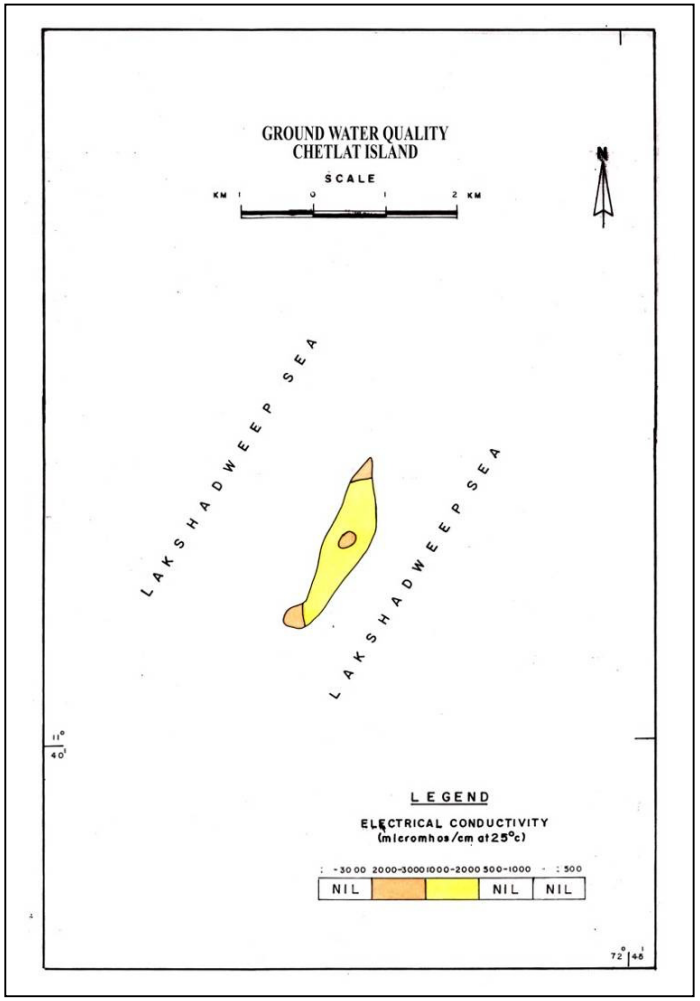


Fig 12: Ground water quality in Androth Island

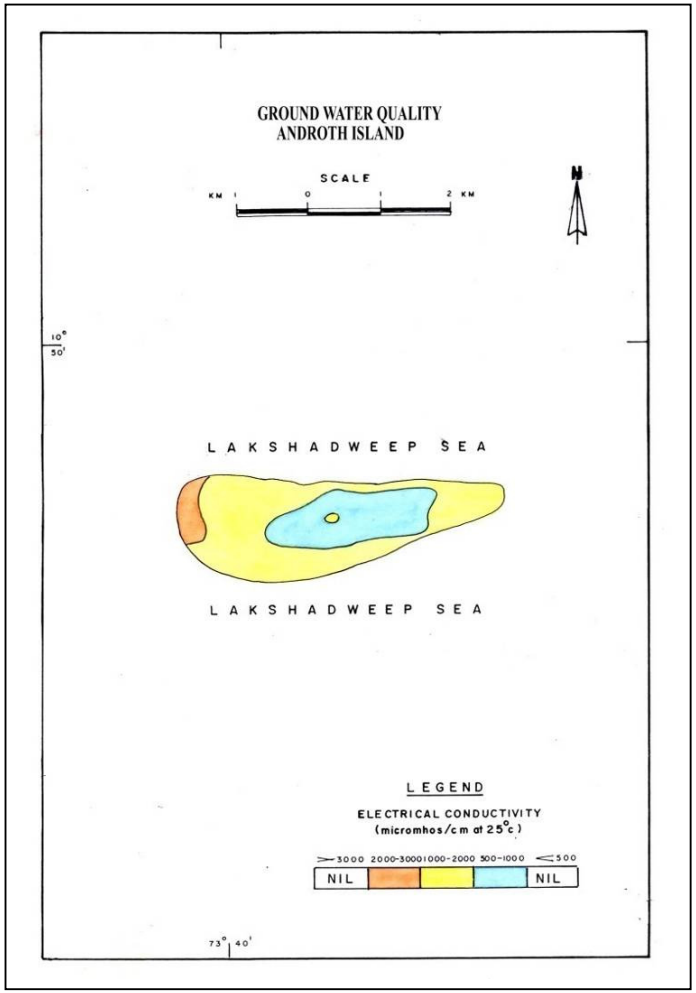


Fig 13: Ground water quality in Kavaratti Island

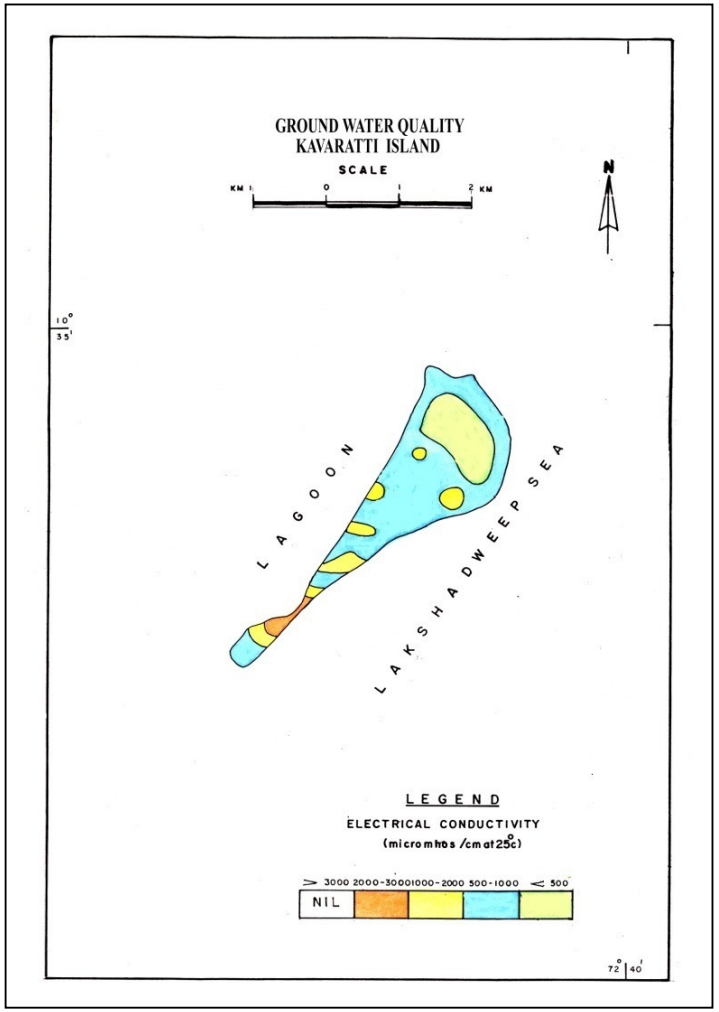


Fig 14: Ground water quality in Minicoy Island

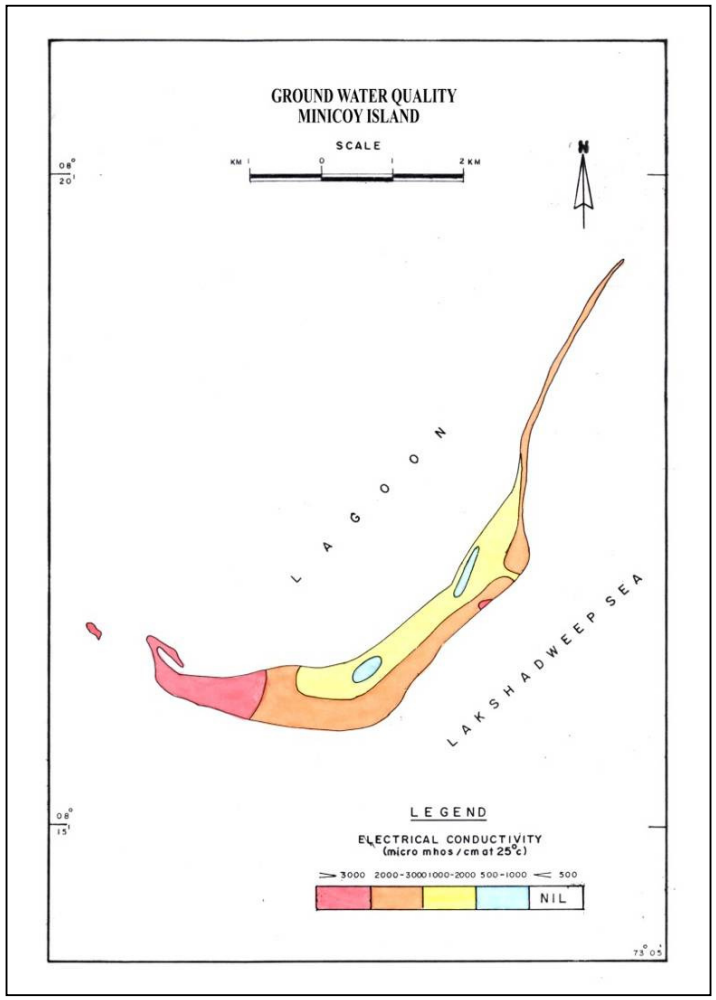
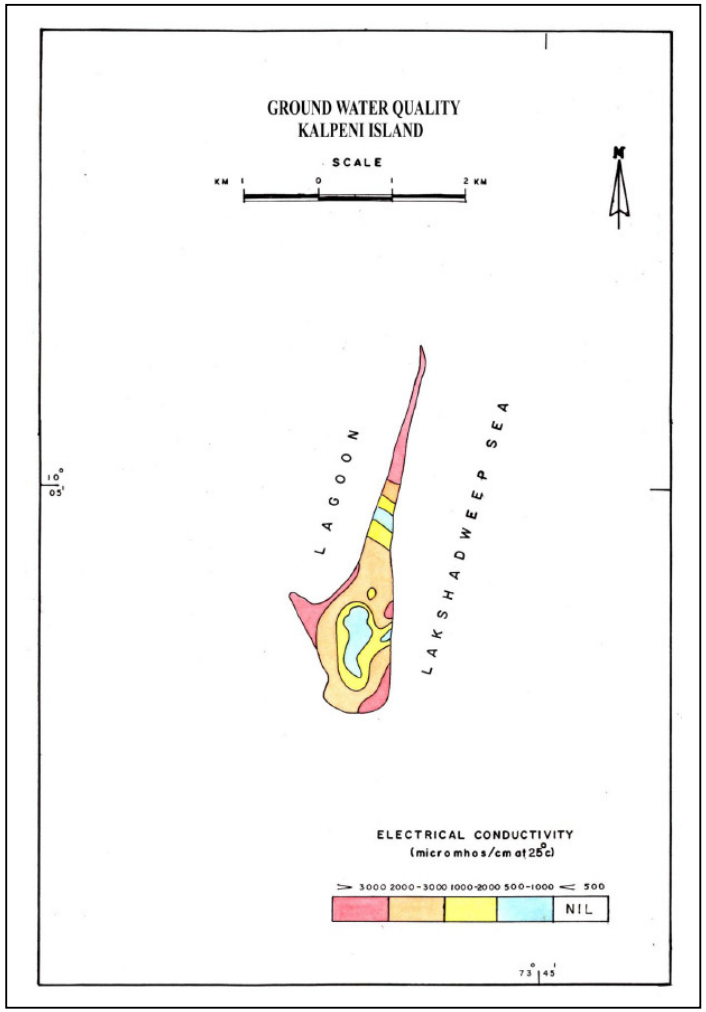


Fig 15: Ground water quality in Kalpeni Island



Annexure I

Salient Details of Exploratory Wells Drilled in Kavaratti Island, U.T of Lakshadweep.

Sl. No.	Location	BH No.	Depth (m.bgl)	Zones Screened (m.bgl)	DTW (m.bgl)	Water quality (EC in µS/cm at 25ºC)*
I	**Kavaratti (south)**					
1	Near Govt. High School	GHS1	12.0	6.0 – 12.0	1.90	5100
2	Near Govt. High School	GHS2	38.0	26.0 – 38.0	1.75	>20000
3	Near Govt. High School	GHS3	7.5	4.5 – 7.5	1.98	790
4	Water testing lab	WTL1	10.0	7.0 – 10.0	2.45	17300
5	Water testing lab	WTL2	15.0	11.0 – 15.0	2.06	11400
II	**Kavaratti (north)**					
6	Chekkikulam	CHK1	22.5	10.5 – 22.5	1.26	12600
7	Chekkikulam	CHK2	11.5	8.5 – 11.5	1.52	800
8	Chekkikulam	CHK3	8.5	5.5 – 8.5	1.47	970
9	Ujrapalli	UJR1	25.0	13.0 – 25.0	0.45	12400
10	Ujrapalli	UJR2	15.0	9.0 – 15.0	0.95	6400
11	Ujrapalli	UJR3	11.5	8.5 – 11.5	0.53	1010
12	Ujrapalli	UJR4	8.5	5.5 – 8.5	0.73	810
13	Pallikunnu	PLK1	29.0	23.0 – 29.0	0.45	>20000
14	Pallikunnu	PLK2	8.5	5.5 – 8.5	0.63	1120
15	Pallikunnu	PLK3	5.5	2.5 – 5.5	0.58	610

Annexure II

Results of Chemical Analysis of Ground Water Samples from Exploratory Wells Drilled in Kavaratti Island, U.T of Lakshadweep.

Location	pH	EC in µS/cm	----------mg/l----------										
			TH	Ca	Mg	Na	K	CO_3	HCO_3	SO_4 ppı	Cl	F	No_3
CHK 1		13800									4620		
CHK 2	7.99	558	214	40	28	14	2.5	0	246	22	20	0.12	0.1
CHK 3	8.25	467	194	34	27	15	1.0	0	227	21	39	1.04	0.1
UJR 1		10900									3590		
UJR 2	8.17	1950	400	38	74	186	11	30	214	81	398	0.64	0.5
UJR 3	8.31	409	140	20	22	14	2.3	14	151	9.2	23	0.17	0
UJR 4	8.31	342	150	20	24	12	2.6	14	151	8.6	16	0.16	0
PK 1	8.19	1460	350	70	43	137	4.4	0	215	38	362	0.16	0
PK 2	8.42	534	172	18	31	38	3.9	17	156	19	68	0.12	0
PK 3	8.44	311	124	18	20	10	2.2	14	127	10	13	0.12	0