Geochemical assessment of ground water in a small tropical coral island of kadamat, union territory of Lakshadweep, India

Abstract

In Kadamat ground water occurs under phreatic condition and floats as lens over the marine water and the principal aquifers are coral sands and coral limestones. The depth of the wells 1.5 – 3.8 mbgl and depth to the water table 1.2 to 3.6 mbgl. The ground water is under $\text{Na}^+ - \text{SO}_4^{2-}$ type, shallow meteoric percolation types and alkaline (EC variation 435 - 881 micromhos /cm at 25°C. The water sample is $\text{Ca} - \text{HCO}_3$ Type (recharge type). The hydrochemistry is mainly controlled by evaporation, partly influenced by water–rock interaction and aquifer materials. The evaporation process played major role in the evolution of water chemistry. The suitability of ground water in the study area for various purposes is highlighted.

Keywords: fresh water lens, chloro alkali indices, base exchange indices, ion exchange, permeability index

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Introduction

The Lakshadweep islands (LD islands) are coral islands, situated in Laccadive sea and separated from southern Indian peninsula by 400 km. There are 36 coral islands and among these 10 are inhabited. Kadamat island receives high precipitation, ground water water occurs as a small lens over sea water. The purpose of the study was to assess hydrogeochemical characteristics of sub-surface water of the Kadamat. The island hydrogeological studies were examined¹ on evaluation of factors influencing the groundwater chemistry in a Small Tropical Island of Malaysia,² applied factor analysis tool to the hydrochemical data set of Manukan Island,³ studied geochemical evolution of groundwater in an alluvial aquifer in the case of El Eulma aquifer,⁴ on sustainable water development and suitability of ground water for irrigation purposes in a small coral Island of Minicoy,⁵ on major ion chemistry and identification of hydrogeochemical processes of evolution of ground water in a small tropical coral island of Minicoy,⁶ on groundwater resources appraisal in the tropical coral island of Kalpeni,⁷ used application of multivariate statistical techniques in the assessment of groundwater quality in seawater intrusion area in Bafra Plain, Turkey,⁸ carried out assessment of groundwater quality for Veppanthattai taluk, Perambalur district, Tamil Nadu using Remote Sensing and GIS,⁹ on fresh water – salt water relation,¹⁰ appraisal of groundwater resources in an island condition and many others. In the present study hydrogeological scenario and geochemical processes of evolution of groundwater in the coral island have been examined.

Study area

Kadamat Island having an aerial extent of 3.20km² is elongated in shape with lagoon on the western side, measuring about 2km at the broadest point with a total area of 37sq km, located between Kadmath and Kavarati (in the N-S direction) and between Amini and Chetlat (in the N-S direction). It is having 550 metres wide at the broadest point with 8Kms long the island is 58km SW of Kiltan Island, 407km from Kochi, 324km Kozhikode and 407km Kochi. The island falls between north latitudes 11° 10' and 11° 16' and east longitude 72° 45' and 72° 48'. The island is having maximum elevation of 2 to 3m in the east and 2 to 4m in the west above the sea level. March to May is the

hottest; mercury level varies from 25-35°C and humidity 70-76 %. The Kadamat receives mean precipitation of 1600mm. The location map of LD islands along with Kadamat Island is compiled (Figure 1) and various salient features of Kadamat are compiled (Table 1). The coral polyps are responsible for the formation of the island.

Figure 1 Location Map of Lakshadweep Islands.

Materials and methods

The base map of Kadamat and other various layers have been created in GIS platform (Map Info 11 and resource estimation done by GEC 1997. The data on depth to the water level and water sampling carried out to get parameters of pH, EC, F⁻, Cl⁻, NO₃⁻, HCO₃⁻, SO₄²⁻, Ca²⁺, Mg²⁺, Na⁺, and K⁺.¹¹ The F⁻, Cl⁻ and NO₃⁻ (determined by ion selective electrode); HCO₃⁻ (potentiometric titration); SO₄²⁻ (modified titration method after^{12,13}); Ca²⁺ and Mg²⁺ (in absorption mode while Na⁺ and K⁺ in emission mode of the atomic absorption spectrophotometer. The results were tested by Normalized Inorganic Charge Balance¹⁴ and ion charge balance was little above ±5%

for the samples. The quality of the analysis was ensured by standardization using blank, spike, and duplicate samples. There were 7 samples each collected during pre and post monsoon

seasons at the depth variation between 1.2 and 3.6mbgl. The spatial quality variation depicted in the EC map.

Table I Salient features of Kadamat Island

#	Item	Detail
1	Latitudes	11° 10' and 11° 16' N
2	Longitudes	72° 45' and 72° 48' E
3	Total geographical area	3.20 sq.km
4	Population (as per 2011 census)	5389
5	Average annual rainfall	1600 mm
6	Annual range of temperature	27- 30 OC
7	Major geological formation	Coral
8	Ground water balance available (Ha.m)	20.9
9	Stage of ground water development	48.40%
10	Lithology	Coralline sand and coral lime stones
11	Drainage	Surface water bodies and rivers generally absent or ephemeral.
12	Aquifer geometry	Not well defined by coral colonies & eustatic changes
13	Effect of over draft of ground water	Upconing of saline water from bottom
14	Effect of recharge	Fresh water lens expands & fractional rise in levels
15	Ground water estimation	By water balance or chloride budgeting
16	Ground water potential	Lower the per permeability, higher the potential
17	Ground water occurrence	As lens, in hydraulic continuity with sea water
18	Effect of over draft of ground water	Upcoming of saline water from bottom

Results and discussion

The various factors controlling geological and geochemical behaviour of sub-surface water resources are discussed.

Geological aspects

General Physical set up

The availability of the freshwater is mainly influenced by intensity of rainfall and evapotranspiration. Tropical monsoonal climate exists in Kadamat; March to May is the hottest period of the year. The temperature varies from 25°C to 35°C and humidity 70-76%. The monsoonal showers experience from 15th May to 15th September. The coral reefs maintain calm environment within the lagoon. The evapotranspiration is high and, in some months, even more than rainfall. There is no surface run off as the area is occupied by good porous and permeable sands. The coconut, bushes and grasses are the flora in the island. The typical atoll of Kadamat with an elevation of 2-4m above msl and the water bearing formations include coral sands and coral limestones. The depth of interface in the island can be determined by Ghyben-Herzberg law. The depth of wells and water level ranges from 1.5 to 3.5 and 1.2 to 3.6mbgl respectively with fluctuation in water level of 0.20 to 0.22m.

Hydrogeology of Kadamat

The Kadamat Island is made up of coral reefs and coral sands, generally enclosing a lagoon. The fine coral sand extending over the surface of all the islands. The principal aquifers are the coral sands and the coral limestones and limestone (CaCO₃) in the island is the

principal lithology of the coral island. The ground water which is occurring under phreatic condition at a depth of 1.2 to 3.6m below ground level and occur as a lens floating over marine water and in hydraulic continuity with the sea water (Figure 2). The Islanders use large diameter open dug wells as common ground water abstraction structures in addition to filter point wells. The hard-coral limestones are seen at the bottom of the majority of wells. The calcareous sands occupying the Island are highly porous with high infiltrate rate and the infiltrating rainfall displaces the saline water to a freshwater lens due to density difference and the hydraulic continuity of ground water with seawater. Rainfall received in the Island is fully recharged and adjusted in the fresh water lens, as a result of which significant rise in water level is not discernible in the wells even after PSM. As the ground water is in hydraulic continuity with seawater, it is highly influenced by tidal fluctuations. The magnitude of the tidal fluctuation is dependent on several factors amongst which the permeability of the aquifer material, the proximity of the site to the sea and the magnitude of tidal variation in the sea play significant roles. There is a time lag between tidal fluctuation in the sea and in the ground water levels, which is also dependent on the above factors.

The Kadmat trends in NNE-SSW direction and is an elongated island and due to its shape (maximum width of 0.5km), the occurrence of freshwater lens is very limited. The southern portion lying to the south of Bader palli has brackish water with EC of >3000 µS/ cm, whereas the north central parts of the island has freshwater with EC in the variation of 500-2800 µS/ cm. There are about 925 wells with a density of 296 wells/sq km. The well density is the lowest compared to the rest of the islands. The depth to water level varies from 0.43

to 3.88 m and the depth of wells varies from 1.61 to 4.95m. bgl. The depth to the water table and hydrogeological maps has been prepared (Figure 3 & Figure 4).

Figure 2 Freshwater lens in the small Island of Kadamat (Exaggerated vertical scale).

Figure 3 Depth to Water level map of Kadamat (mbgl).

Source of water in Kadamat

The ground water from dug wells is the source of fresh water. The manually made dug wells are the extraction structures with

diameter of 1 to 2m width having a few meters depth and are mainly used for domestic purposes, vegetation and livestock. The islanders conserving water by using water of step wells, ponds or tanks. The centrifugal pumps 1/2 HP capacities are increasingly used for the lifting of ground water.

Figure 4 Hydrogeological map of Kadamat island.

Assessment of water resources

The dynamic ground water resources calculated by computing various components of recharge and draft. The main recharge component is rainfall but evapo-transpiration (consumptive use), outflow into the sea and domestic consumption is the components of draft. The 20% of the annual water surplus is reserved as buffer zone for reserve during delayed or deficit monsoon years and the other details are compiled (Table 2).

Geochemical aspects

The sub-surface water of the island is fresh with EC variation of 960 to 3000 $\mu\text{S}/\text{cm}$ at 25°C. Water is neutral to slightly alkaline with pH variation of 7.43 to 8.12. The chloride variation of 90-1000 mg/l and that of Fluoride 0.59 to 0.83 mg/l. About 70% of samples shown the EC range <3000 S/cm at 25°C and 85 % of samples shown the chloride range <1000 mg/l. The spatial variations in EC are depicted in Figure 5.

Geochemical process

The groundwater can be categorised based on ionic strength of select anions¹⁵ as Normal chloride type ($\text{Cl}^- < 15 \text{ meq/l}$),

Normal sulphate ($\text{SO}_4^{2-} < 6$ meq/l) and Normal bicarbonate type ($\text{HCO}_3^- 2-7$ meq/l). In the Island, most of the samples are of Normal chloride type, followed by Normal bicarbonate type and concentration depends on the geology, environment, and movement of water.¹⁶ Based on base exchange indices, $r_1 = \text{Na}^+ - \text{Cl}^- / \text{SO}_4^{2-}$ meq/l) and r_2 ($r_2 = \text{K}^+ + \text{Na}^+ - \text{Cl}^- - \text{SO}_4^{2-}$ meq/l) after.¹⁷ The

water may be $\text{Na}^+ - \text{HCO}_3^-$ if $r_1 > 1$ and $\text{Na}^+ - \text{SO}_4^{2-}$ type with $r_1 < 1$; $r_2 < 1$, shallow groundwater is of shallow meteoric percolation type and > 1 , shallow meteoric percolation type. The water samples are of $\text{Na}^+ - \text{SO}_4^{2-}$ type and shallow meteoric percolation type except two post monsoon water samples and the chemical analysis details are compiled (Table 3 & Table 4).

Table 2 Dynamic Ground Water Resources of Kadamat (As in March 2013)

#	Annual components of water balance	Kadamat
1	Population (As on 2013)	5400
2	Area (Ha)	312
3	Normal Monsoon Rainfall (m)	1.326
4	Rainfall Infiltration Factor (%)	30
5	Total Resource (Water Surplus) (Ha.m) [2*3*4]	124.1
6	ET loss from Trees for 6 non-monsoon months (Ha.m)	33.8
7	Water loss due to outflow to sea [20% of (3) (Ha.m)]	24.8
8	Buffer zone for reserve during delayed or lesser monsoon period [20% of (3)] (Ha.m)	24.8
9	Balance available resource (Ha.m)	40.7
10	Domestic draft @100 lpcd [1*100*365] (Ha.m)	19.7
11	Gross Annual GW Draft (Ha.m)	19.7
12	Groundwater balance available [7-9](Ha.m)	21
13	Stage of ground water development [9*100/7], %	48.4
14	Category	Safe

Table 3 Chemical analysis data of ground water in Kadamat

Pre-monsoon (PRM) 2010																	
#	pH	EC	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	F	SAR	RSC	TDS	%Na
1	8.16	881	300	72	29	46	2.1	0	378	89	44	3.3	1.05	1.2	0.2	475.5	25.5
2	8.3	688	300	74	28	17	1.3	0	409	36	14	1.4	0.91	0.4	0.7	377.1	11.4
3	7.66	820	285	72	25	36	8.3	0	317	100	29	21	0.93	0.9	-0.5	450.7	23.9
4	7.97	494	234	57	22	7.4	0.4	0	303	20	9	2.4	0.83	0.2	0.3	270.5	6.6
5	7.72	819	315	78	29	33	3.1	0	366	64	27	35	0.57	0.8	-0.3	452.7	19.4
6	8.02	435	190	44	19	9.9	0.1	0	246	17	13	3.4	0.8	0.3	0.3	230.2	10.3
7	8.18	499	178	33	23	20	3.3	0	195	50	30	2.7	0.98	0.7	-0.3	260.5	21.2
Mean	8	662	257	61	25	24	3	0	316	54	24	10	0.87	0.6	0.1	359.6	16.9
Min	7.66	435	178	33	19	7	0.1	0	195	17	9	1.4	0.57	0.2	-0.5	230.2	6.6
Max	8.3	881	315	78	29	46	8	0	409	100	44	35	1.05	1.2	0.7	475.5	25.5
SD	0.24	185	56	17	4	14	3	0	76	32	12	13.03	0.16	0.3	0.4	104.2	7.4
BIS DWS - MDL	8.5	750	300	75	30	NR	NR	NR	500	250	200	45	1				
Post-monsoon (PSM) 2010																	
1	7.75	770	340	92	27	25	1.7	0	433	43	22	4.3	0.59	0.6	0.3	432	14
2	7.62	551	250	68	19	15	1.9	0	329	25	10	1.7	0.38	0.4	0.4	305	12
3	8.06	651	245	72	16	33	6.5	0	299	53	24	14	0.53	0.9	0	369	25
4	7.94	567	270	80	17	13	0.7	0	335	25	11	2	0.61	0.3	0.1	317	10
5	7.84	831	300	72	29	54	12	0	427	68	27	8.9	0.22	1.4	1	485	31
6	7.79	949	365	86	36	71	0.2	0	500	85	23	1.7	0.6	1.6	0.9	554	30
7	7.9	419	210	57	17	13	0.1	0	268	21	19	0.4	0.43	0.4	0.1	262	12
Mean	7.84	677	283	75	23	32	3	0	370	46	19	5	0.48	0.8	0.4	389	19
Min	7.62	419	210	57	16	13	0.1	0	268	21	10	0.4	0.22	0.3	0	262	10
Max	8.06	949	365	92	36	71	12	0	500	85	27	14	0.61	1.6	1	554	31
SD	0.14	183	55	12	8	23	4	0	84	24	7	4.97	0.14	0.5	0.4	106	9
BIS DWS - MDL	8.5	750	300	75	30	NR	NR	NR	500	250	200	45	1				

BIS DWS – MDL - Bureau of Indian Standards Drinking Water Standards; NR - Not recommended.

Table 4 Different parameters of Pre and Post monsoon water samples

Well No	Cl ⁻	SO ₄ ²⁻	HCO ₃ ⁻	Base exchange index, (r ₁)	Base exchange index, (r ₂)	Na/Cl	Ca/Mg	Chloroalkali indices for cations, CAI-1	Chloroalkali indices for anions, CAI-2
Pre-monsoon, 2010 (PRM)									
1	2.51	0.92	64	-0.74	-0.5	0.8	1.51	0.18	0.06
2	1.02	0.29	84	-2.74	-0.83	0.73	1.61	0.24	0.03
3	2.82	0.6	60	-3.1	-1.73	0.55	1.75	0.37	0.17
4	0.56	0.19	87	-2.69	-1.24	0.57	1.57	0.41	0.04
5	1.81	0.56	72	-1.77	-0.52	0.79	1.63	0.16	0.04
6	0.48	0.27	84	-1.34	-0.17	0.9	1.41	0.1	0.01
7	1.41	0.63	61	-1.39	-0.73	0.62	0.87	0.32	0.12
Mean	1.52	0.49	73	-1.97	-0.82	0.71	1.48	0.25	0.07
Min	0.48	0.19	60	-3.1	-1.73	0.55	0.87	0.1	0.01
Max	2.82	0.92	87	-0.74	-0.17	0.9	1.75	0.41	0.17
SD	0.91	0.26	12	0.88	0.52	0.13	0.29	0.12	0.06
Post monsoon, 2010 (PSM)									
1	1.21	0.46	81	-1.6	-0.18	0.58	2.07	0.07	0.01
2	0.71	0.21	86	-2.7	-0.02	0.6	2.17	0.01	0
3	1.5	0.5	71	-1.6	0.21	0.62	2.73	-0.07	-0.02
4	0.71	0.23	85	-2.5	-0.53	0.52	2.86	0.17	0.02
5	1.92	0.56	74	-1.1	1.31	0.79	1.51	-0.38	-0.1
6	2.4	0.48	74	-1.9	1.45	0.84	1.45	-0.29	-0.08
7	0.59	0.4	82	-0.9	-0.06	0.62	2.04	0.04	0.01
Mean	1.29	0.4	79	-1.8	0.31	0.65	2.1	-0.07	-0.02
Min	0.59	0.21	71	-2.7	-0.53	0.52	1.5	-0.38	-0.1
Max	2.4	0.56	86	-0.9	1.45	0.84	2.9	0.17	0.02
SD	0.69	0.14	6	0.7	0.76	0.12	0.54	0.2	0.05

(# Concentration, meq/l)

Spatial variation of facies

The Modified Piper diagram¹⁸ has been utilised to know the hydrochemical facies and nature of phreatic water. The PRS water samples fall within the field 5 of the Chadha's diagram and are characterized by Alkaline earths and weak acidic anions exceed both alkali metals and strong acidic anions, respectively $-(Ca+Mg)+ (CO_3+HCO_3)^-> (Na+K)+(Cl+SO_4)$. All the samples of PRM and PSM falling under Sub-field I of Chadh and are Ca-HCO₃ Type and are of recharge type also.

Hydrogeochemical evaluation

The enhanced sodium content in phreatic water may be by dissolution of halite and further concentration resulted by evaporation and / or evapotranspiration (consumptive use). The Na⁺/Cl⁻ molar ratio will be 1 if halite dissolution is responsible for increased sodium and >1 Na⁺ supplied from silicate weathering.¹⁹ The Na⁺/Cl⁻ molar ratio is >1 in the samples of water can only evolve to brine rich in NaCl if it encounters highly soluble chloride minerals, typically associated with evaporative deposits / evaporates.²⁰ As the PRM and PRS samples with Na⁺/Cl⁻ molar ratio less than one, halite dissolution resulted enhanced sodium in the area.

Evolution of groundwater

The²¹ plots, in which TDS vs Na⁺ / (Na⁺+Ca²⁺) for cations and TDS Vs Cl⁻ / (Cl⁻+ HCO₃⁻) for anion were plotted to know the processes of formation of phreatic water like evaporation, precipitation and rock - water interaction. While plotting the data in Gibb's diagram, all the samples fall on evaporation field. On the basis of this, it can be ascertained that evaporation played a major role in the evolution than rock-water interaction. Besides geological location is also controlling quality of the resources.²²

Ion exchange processes

The chloro alkali indices for cations (CAI-1) and anions (CAI-2) - CAI-1 $[Cl^- - (Na^+ + K^+)]Cl^-$ and CAI-2 $[Cl^- - (Na^+ + K^+) / (SO_4^{2-} + HCO_3^- + HCO_3^- + NO_3^-)]$, after²³ demonstrates ion exchange between ground water and aquifer. If chloro alkali indices with negative values, ion exchange of Na⁺+K⁺ in water and Ca²⁺-Mg²⁺ in rocks.²⁴ When different aquifer materials are in river basins, hydrochemistry may be altered during its movement and with residency time.²⁵ The majority of the PRM and PSM samples with positive values indicate lesser role of ion exchange and some PSM samples having negative values. During post-monsoon ion exchange might have occurred.

Irrigation suitability

The suitability of the subsurface water has been investigated various parameters (Table 5) and the data is compiled (Table 6). The EC of five categories¹⁶ and the PRM and PRS samples come under good to permissible. The sodium alkali hazard or sodium absorption ratio (SAR) is an indicator of sodium hazard in irrigation water²⁶ and as per,²⁷ the SAR values are excellent. The % Na is important in irrigation suitability as more sodium may enhance the exchange of sodium availability of irrigated soil and change permeability, structure and cause toxicity to vegetation.^{7,28,29} The PRM and PRS samples fall under excellent to good and water can be utilised for different types of soil. The permeability index (PI) is of 3 types - class I, II and III³⁰ and all the water samples come under Class II.³¹ And³² proposed irrigation water quality based on the sodium concentration against calcium and magnesium. When Kelley's Index (KI) is <1, water suitable for irrigation, >1 poor quality and unsuitable >2 KI. Both cation exchange and reverse ion exchange are encouraged by aquifer materials and land use practices, in waterlogged area, marshy/swampy land, creek, mud / tidal flat represented by Montmorillonite clays, which lead to the release of Na or Ca into groundwater and adsorption of Ca or Na, respectively.³³ All the water samples with KI <1. Water with less than or equal to 50 Soluble Sodium Percentage (SSP), good and 50 unsuitable for irrigation as permeability will be very low. All the PRM and PSM samples with <50 SSP and thus water can be utilised for soils of all categories. In Karamat except PRM Sample at Kadamat (Agriculture office, Soil Testing Lab.) with MR values less than 50.³⁴⁻³⁷

Figure 5 Spatial variations in EC in Kadamat.

Table 5 Methodology adopted for computations of Irrigation Suitability

Aspects	Formula	Range	Classification	Reference
EC, $\mu\text{S}/\text{cm}$ at 25°C		<250	Excellent	16
		250-750	Good	
		750-2000	Permissible	
		2000-3000	Doubtful	
		>3000	Unsuitable	
SAR	$\text{SAR} = \text{Na} / \sqrt{(\text{Ca} + \text{Mg}) / 2}$	<10	Excellent	27
		10-18	Good	
		18-26	Doubtful	
		>26	Unsuitable	
%Na	$\% \text{Na} = ((\text{Na} + \text{K}) / (\text{Ca} + \text{Mg} + \text{Na} + \text{K})) * 100$	<20	Excellent	16
		20-40	Good	
		40-60	Permissible	
		60-80	Doubtful	
		> 80	Unsuitable	
PI	$\text{PI} = ((\text{Na} + \sqrt{\text{HCO}_3}) / (\text{Ca} + \text{Mg} + \text{Na})) * 100$	>75	Class I	30
		25- 75	Class II	
		<25	Class III	
KI	$\text{KI} = \text{Na} / \text{Ca} + \text{Mg}$	>	Unsuitable	31
		2-Jan	Poor	
		< 1	Suitable	
SSP	$\text{SSP} = \text{Na} * 100 / \text{Ca} + \text{Mg} + \text{Na}$	>50	Unsuitable	37
Mg Ratio	$\text{MR} = (\text{Mg} * 100) / (\text{Ca} + \text{Mg})$	< 50	suitable	35
		>50	Unsuitable	
		< 50	suitable	

Table 6 Quality parameters of PRM & PSM water samples determined for Irrigation Suitability

#	Location	SAR	%Na	KI	PI	SSP	EC, μ S/cm	Mg Ratio
PRM water samples, 2010								
1	Kadmath (JB School South)	1.2	26	0.33	56	25	881	40
2	Kadmath (Water Supply Well near OHT)	0.4	11	0.12	49	11	688	38
3	Kadmath HS	0.9	24	0.28	53	22	820	36
4	Kadmath Census Office	0.2	7	0.07	51	6	494	39
5	Kadmath-Govt. Quarter near Fisheries Dept	0.8	19	0.23	50	19	819	38
6	Kadmath (Govt. Quarter near Govt. Press)	0.3	10	0.11	58	10	435	42
7	Kadmath (Agriculture office, Soil Testing Lab.)	0.7	21	0.25	60	20	499	53
Mean		0.6	17	0.2	54	16	662	41
Min		0.2	7	0.07	49	6	435	36
Max		1.2	26	0.33	60	25	881	53
SD		0.3	7	0.1	4	7	185	6
PSM water samples, 2010								
1	Kadmath (JB School South)	0.6	14	0.16	47	14	770	33
2	Kadmath (Water Supply Well near OHT)	0.4	12	0.13	53	12	551	32
3	Kadmath HS	0.9	25	0.29	57	23	651	27
4	Kadmath Census Office	0.3	10	0.1	49	9	567	26
5	Kadmath-Govt. Quarter near Fisheries Dept	1.4	31	0.39	60	28	831	40
6	Kadmath (Govt. Quarter near Govt. Press)	1.6	30	0.43	57	30	949	41
7	Kadmath (Agriculture office, Soil Testing Lab.)	0.4	12	0.13	55	12	419	33
Mean		0.8	19	0.23	54	18	677	33
Min		0.3	10	0.1	47	9	419	26
Max		1.6	31	0.43	60	30	949	41
SD		0.5	9	0.13	5	9	183	6

Conclusion

The geochemical assessment of ground water in the area has been examined. In this tiny island formed water exists under phreatic situation and sinks like a convex lens over marine water and is extracted by open wells and filter point wells. The depth to the water table and depth of extraction structures are 1.20 - 3.60 and 1.50-3.80 mbgl respectively; and water table fluctuation influenced by tides. The phreatic resource of Kadamat is characterised by EC variation of 435 to 881 micromhos /cm at 25 °C, Ca-HCO₃ type / recharge type, shallow meteoric percolation and evaporation-controlled genesis. Spatial variation of Facies examined by Modified Piper diagram but the general quality plotting EC contouring. It is to be noted that evaporation and shallow meteoric percolation type played major role in the hydrochemistry. Besides rock-water interaction, geological location etc played minor role in the evolution of ground water resources in the tiny island of Kadamat. The phreatic resources are suitable for potable and irrigational purposes.

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Conflicts of interest

The author declares that there is no conflicts of interest.

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