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IMPACT ASSESSMENT OF MINING AT ALAPPAD, KOLLAM, KERALA

Prof.Jency Nadayil[1], Gishnu S[2], Gopika Manoj[3], Fitha Pareeth[4], Jismi Muhammed[5]

[1]Assistant Professor, Dept. of Civil Engineering, Mar Athanasius College of Engineering, Kerala, India
[2-5]UG student, Dept. of Civil Engineering, Mar Athanasius College of Engineering, Kerala, India

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Abstract - *"Abandoned homes, deserted school, heaps of sand, a lone temple and dried up mangroves." These are the remnants of a once green coastal Alappad panchayat, where locals are up in arms against beach sand mining, blaming it for sea erosion eating up their lands. The study analyses direct and indirect impacts of mining at Alappad and Panmana in Kollam, Kerala. Due to mining, a number of negative impacts have been identified in these regions including coastal erosion, water quality deterioration, loss of agricultural land, depletion of groundwater table; etc. .The study further tries to assess the seriousness of the social, economic and environmental impacts that might result from the indiscriminate mining activity by profit oriented companies. Thereby mitigation measures have also been proposed. Hydraulic fill of land reclamation method is recommended. Land reclamation is the process of creating new land by raising the elevation of a seabed, riverbed or other low-lying land. The present study attempts to identify the correlation between years and the existing land areas. Land areas were found out using Google Earth Pro Software. Analysis of year and existing land area using SPSS software (Statistical Package for the Social Sciences) to find their correlation and their geographical comparison. Based on the analysis, forecasting for future period data is done with Microsoft Excel.*

Key Words: **Alappad, Panmana, Shoreline change, Water quality deterioration, land area prediction, Hydraulic fill, MS Excel, SPSS, and Google Earth Pro Software.**

1.INTRODUCTION

Alappad is a coastal village lies in the mineral-rich beach in Kollam known as Chavara Deposits. It's a 22.5-kilometer-long mineral sand beach with heavy mineral content such as ilmenite, rutile, zircon, and zillimanite, which are utilised in large amounts as raw materials in the production of various industrial goods such as titanium dioxide, welding electrodes, and ceramics. In 50 years, Alappad, which is situated between the Arabian Sea and the TS Canal, has reduced from 87.5 square kilometres to 8.7 square kilometres.

The Kerala government separated this deposit between Neendakara and Kayamkulam into eight blocks for mining lease purposes. Even-numbered blocks (II, IV, VI, and VII) were leased to Indian Rare Earths Limited (IREL) in 1970, whereas odd-numbered blocks were leased to Kerala Minerals and Metals Limited (KMML) in Kollam. The Government of Kerala granted IREL a mining lease to collect heavy mineral sand in the Eastern Extension of the NK Block IV in the villages of Alappad, Panmana, and Ayanivelikulangara in Kollam district for an area of 180 ha in 2007.

1.1 History of Mining

The history of mining starts from the year 1909 when the german scientist Herr Shomberg discovered the brilliance of black sand in coir products that are exported to Germany from the Travancore Backwaters. His enquiry led him to find out the deposits in Chavara. The first barge filled black sand was sent off to Germany in the year 1992. Complete minnig procedure began with the foundation of F X Perrera and sons ltd. in the year 1932. Travancore Mineral Corporation was was established on 1933. After that under the regulation of government company named Travancore Titanium Products was established on 1951 for the production of titanium dioxide pigment and related products. In the year 1956 the state government acquired F X Perrera and Sons and it became FXP minerals. The British company named Hockins and Williams limited which stared mining in collaboration with Travancore Mineral Corporation shut down in the year 1960. By the year 1971 private companies were completely eliminated from the mining field.

1.2 Use of Minerals

Ilmenite (FeO.TiO2): The Titanium Dioxide Pigment industry's primary raw ingredient. It's used in paints, lacquers, enamels, rayon, and other products as a white pigment. It's also utilised in the coating of welding rods.
Rutile (TiO2): It's used to make TiO2 pigment, welding electrodes, titanium metal, and titanium alloys, among other things. Titanium alloys are employed in severely corrosive environments because they are light, corrosion resistant, and erosion resistant.
Zircon (ZrO2.SiO2):It's used to make foundry moulds, refractory bricks, and crucibles, as well as as an opacifier in the ceramic industry. Zirconium alloys are utilised in nuclear power reactors, jet engine parts, medical tools, and high-intensity electric arc lamps, among other applications.
Monazite (Ce, Y, La, Th (PO4)): It's a rare earth phosphate with varying levels of thorium that's commonly mixed with silicate or phosphate. In nuclear reactors, thorium is primarily employed as a breeder. Glass polishing, arc carbons, and flint for lighters all require rare earth mixtures. They're found in things like optical lenses, prisms, television tubes, and faceplates.

Sillimanite (Al2O3.SiO2): This is most commonly employed in the production of refractory goods for lining furnaces, although it is also used in the ceramic sector.

1.3 Objectives

To find out and evaluate the Direct and Indirect impacts of sand mining, To propose measures to mitigate the environmental impacts and forecasting of land erosion.

2. LITERATURE REVIEW

a) Pratik D, Sanil D and,Prof. Sudeshna Wawhal (2018): Murum levelling and rotering with a static vibrator were used to prepare the ground for the construction of the new track. The land is prepared for construction purpose. It improved rail transportation by incorporating public transportation

b) Monalisha M, Panda GK(2018): The goal of this project is to investigate and assess shoreline changes in terms of accretion, erosion, and topsheets, among other things. They gathered erosion and accretion rates and came to the conclusion that erosion is more active than accretion.

c) K.K Basheer Ahammed, Arvind Chandra Pandey (2019) : Shoreline alteration studies revealed that 85 ha of land was taken out of the Alappad beach, out of a total coastal area of 671 ha. Between 2001 and 2012, 42.81 hectares of land were degraded. The current study looked into the dreadful changes that had occurred in the studied area.

d) Mark R Byrnes, Richard M Hammer, Tim D Thibaut, and David B, Snyder (2004) : Sand mining's physical and biological impacts were investigated. Sand mining study on the Alabama OCS should have low environmental impact on fluid and sediment dynamics, according to the literature, data collected, and simulations.

3. MATERIALS AND METHODS

Field visit was conducted .The socio economic impacts are assessed by conducting survey in the nearby human inhabitations in the mining affected area. Interviews were conducted with some officials and peoples who were actively engaged in the “Save Alappad Movement”. Water samples are collected from the study area and laboratory tests were conducted to analyse the extend of water pollution. Maps were collected from various sources to study the extend of land erosion. With the help of Google Earth Pro software existing land areas were calculated at different time lines and correlation between parameters, area and time was found out using SPSS software. Forecasting of the data was done by using Microsoft Excel Internet search was employed to collect the reports of similar movements around the world. Secondary data was employed for collecting the details about mining and its history.

4. ENVIRONMENTAL IMPACT ASSESSMENT

4.1 Project Location

1) Alappad Panchayath

North: Azhekkal

South: Kattil Mekkathil temple

East: T. S canal

West: Arabian sea

2) Panmana Panchayath

North : Kattil Mekkathil temple

South: IRE Ltd

East: T.S Canal

West : Arabian sea.

4.2 Environmental Impacts

4.2.1 Socio-economic Impacts

The proposed mining project will have a number of negative impacts. The coastline of Alappad is densely populated with fisherman community. The fishing depended population here is involved in activities such as small-scale fish distribution, fish curing, peeling etc. An economically important natural phenomenon that will be seriously affected by the proposed mining is the 'Mud banks' (locally called chakara), which used to be a regular feature on the Alappad coast and is becoming scarce.

Mining has adversely affected the agricultural land and the people who depend on the agricultural sector. Coconut and paddy cultivations were common in those regions.

Ground depletion in ground water table and degradation of surface water quality were the after effects of mining. “Kambavala”, which was a technique used by the natives to catch fishes during the past can’t be used nowadays because of the change in ecology and landscape arisen due to mining.

The West Coast Canal or National Waterway No 3 is a 205-km stretch of inland navigational route which runs from Kollam to Kottapuram. If the mining continue like this, it will adversely affect the waterway. The land area is depleting and finally the waterway will also become a part of Arabian Sea.

Mining has also affected the coir and coir products depended population in the area. Apart from selling coconuts as an edible good, people was involved in manufacturing coir from husk of the coconuts.

Abandoned houses, temples, churches, schools and many more buildings are the results of unsustainable mining. A locally famous temple Kattil mekhathil Durga temple, located in the KMML mining site of Panmana village and a church of Pandarathuruth region are affected as a result of massive mining and related land loss. Due to mining activities,

temples were isolated and cultural centers were abandoned, resulting in the deprivation of cultural values.

The study conducted by Institute for Ocean Management Anna University, Chennai and Ministry of Environment and Forests Government of India on the shore line of kerala found out that Ponmana in Panmana panchayath is the only region in Kerala coast which is undergoing high erosion.[6]

Loss of agricultural land, unemployment, erosion etc. has led to migration. People of Alappad are forced to migrate to some other places. Resettlement plans were also less effective.

4.2.2 Ecological Impacts

Fauna: No animals, included in Schedule I of Wildlife Protection Act 1972 were observed in the study area. Severe land loss due to mining has affected the sea turtles, migratory birds and otter. No endangered or endemic animals were also observed during the ecological survey. There is no stability for soil habitat in this area.

Flora: No endangered species or threatened species or plants included in the Schedule I of Wild life protection act of 1972 were observed. Mangrove forest was sufficient in the mining area but was completely destroyed due to the mining activities which in turn destroyed the natural protection system of the coastal areas.

5. FINDINGS

5.1 Shoreline Change Assessment

The shoreline of Kerala has been subjected to severe coastal erosion in recent times. The mining and removal of sand will have a negative impact on coastal topography.

In this study the chosen region is from Vellanathuruth in Alappad Panchayat to IRE ltd. in Panmana Panchayat, a region prone to notable shoreline change which stretches around 5.4 km .Following are the shoreline changes observed in historic satellite images over a period of 1985-2021.

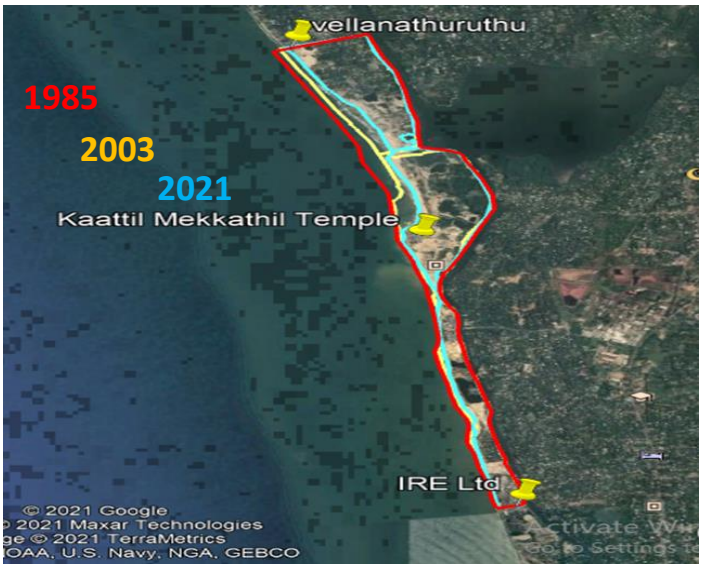

Fig 1 : Reduction in Land area

Table 1: Reduction in Land area

Date	Year	Area (sq metre)
5-12-1985	1985	1953539
7-1-2003	2003	1627665
12-03-2005	2005	1591665
27-03-2009	2009	1520788
01-01-2011	2011	1485793
12-12-2011	2011	1467789
08-02-2012	2012	1464137
31-12-2012	2012	1432249
05-03-2013	2013	1414649
15-03-2014	2014	1396448
09-02-2015	2015	1379560
06-01-2016	2016	1360959
17-01-2017	2017	1341960
10-02-2018	2018	1314587
06-01-2019	2019	1312558
16-02-2020	2020	1304546
06-06-2021	2021	1303858

5.2 Water Quality Deterioration

Water quality changes are widely considered to be the most significant consequence of mining activities. The surface and groundwater characteristics have been established through field monitoring data at 5 locations generated during the study with respect to physicochemical characteristics and pollutant levels and the same has been compared with quality criteria for drinking water.5 water samples were collected.

Sample points;

1. A stream where the main drainage of KMML plant is opened which is within a distance of 100m from the plant.
2. A stream where the old drainage of KMML plant is opened which is at a distance of 100m away from the plant.
3. A main stream near KMML plant where the streams collecting water from old and new drainages of KMML is joining which is within a distance of 200m away from plant.
4. T.S Canal which is at a distance of 800m from the plant.
5. Well water sample from a house near KMML which is at a distance of 1200m away from the plant.

Table- 2: Water quality Test Results

Sample No:					
Test for	1	2	3	4	5
pH	2.1	6.53	2.31	5.61	6.63
Acidity (mg/l)	49000	70	38000	92	33
Sulphate (mg/l)	117	199	68	174	28
Chloride (mg/l)	4990	99.96	3990	7490	17.49
Iron (mg/l)	6.8	-	3.5	-	-
D.O (mg/l)	4.2	4.8	4.2	6	7.1
BOD (mg/l)	100	105	250	75	210
Turbidity (NTU)	237	4	15	7	14
MPN	+ve	-ve	+ve	+ve	-ve
TSS (mg/l)	1460	300	640	1120	460

Table- 3: Water quality Inferences

Test for	Inference
pH	6.5 – 8.5 (IS 10500 : 2012)
Acidity (mg/l)	For drinking water it should be nill
Sulphate (mg/l)	< 200 mg/l is potable , < 400 mg/l is permissible in the absence of an alternate source. (IS 10500 : 2012)
Chloride (mg/l)	< 250 mg/l is potable , < 1000 mg/l is permissible in the absence of an alternate source. (IS 10500 : 2012)
Iron (mg/l)	< 0.3 mg/l is potable , No relaxation. (IS 10500 : 2012)
D.O (mg/l)	> 6 mg/l (IS 2296 - 1982)
BOD (mg/l)	For drinking water BOD < 5 mg/l , For treated effluent to discharge to a sewerage system BOD < 30 mg/l
Turbidity (NTU)	< 1 NTU is potable , < 5 NTU is permissible in the absense of alternate source. (IS 10500 : 2012)
MPN	+ve : Presence of E-coli
TSS (mg/l)	< 100 mg/l (IS 10500 : 2012)

5.3 Interview Session

Interviews were conducted with certain people who are directly involved in Alappad issue. Interview provides information about the history of mining and its ill effects. Sources of different maps of alappad panchayth at different time were mentioned. This helps to estimate the eroded area of Alappad Panchayt by analysing the survey numbers in the map.

Open cast mining is done to a depth of approximately 7m. This will lead to the formation of cone of depression in that region of the ground water. If the open cast mining site is not reclaimed properly it can lead to depletion of ground water resources. In further process the natives will dig the well much deeper for water.

5.4 Socio-Economic Survey

Data regarding the existing socioeconomic conditions were collected by circulating questionnaires among the families living in the project affected areas of Alappad and Panmana of Kollam district. Survey form includes 35 questions. 50 families were covered under the survey.

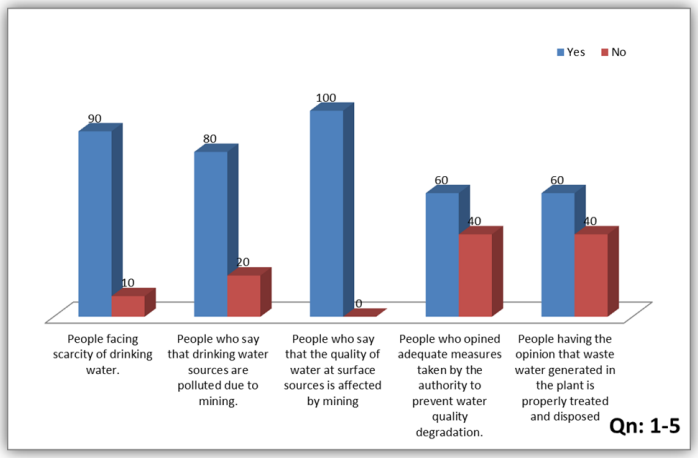

Chart-1: Survey response of question no. 1-5

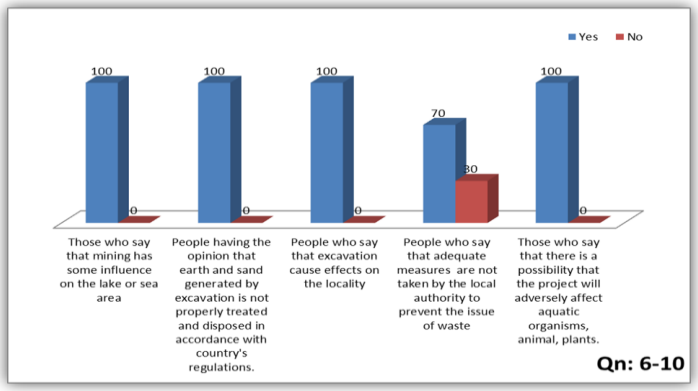

Chart-2: Survey response of question no. 6-10

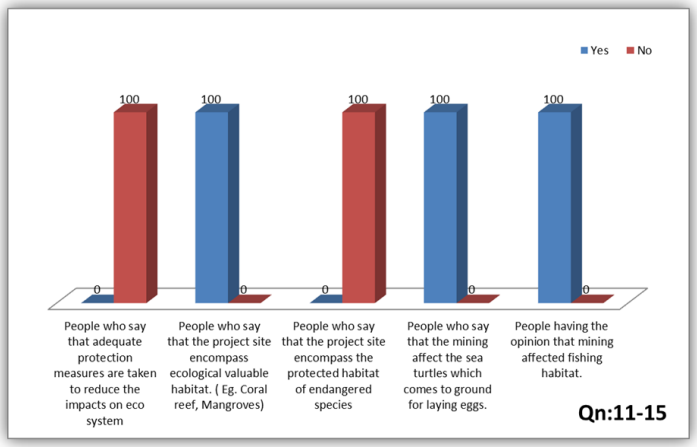

Chart-3: Survey response of question no. 11-15

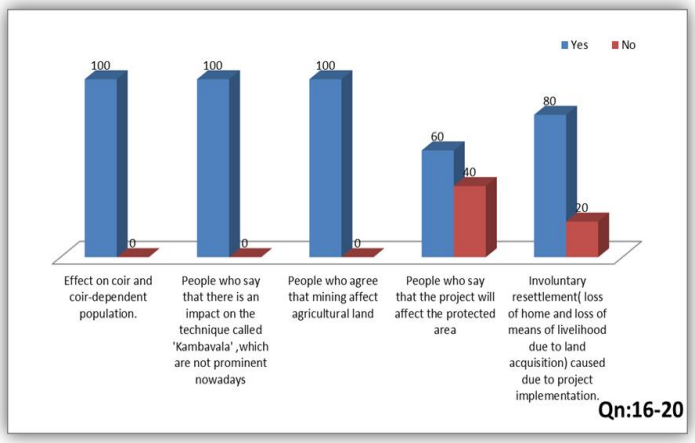

Chart-4: Survey response of question no. 16-20

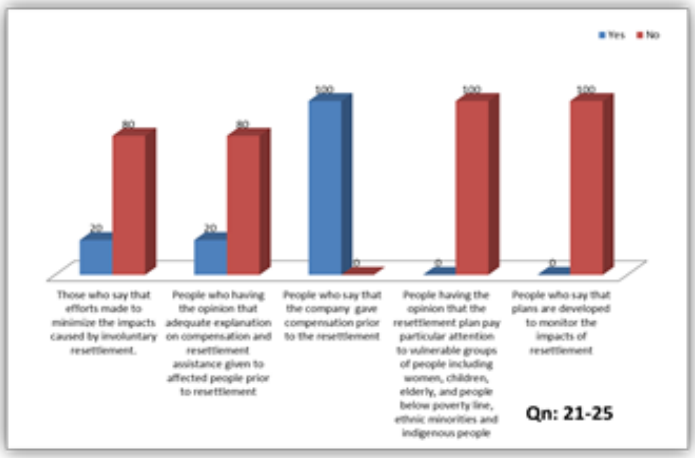

Chart-5: Survey response of question no: 21-25

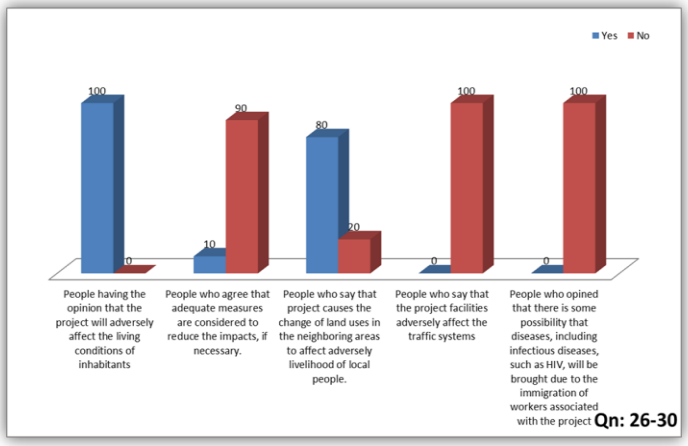

Chart-6: Survey response of question no. 26-30

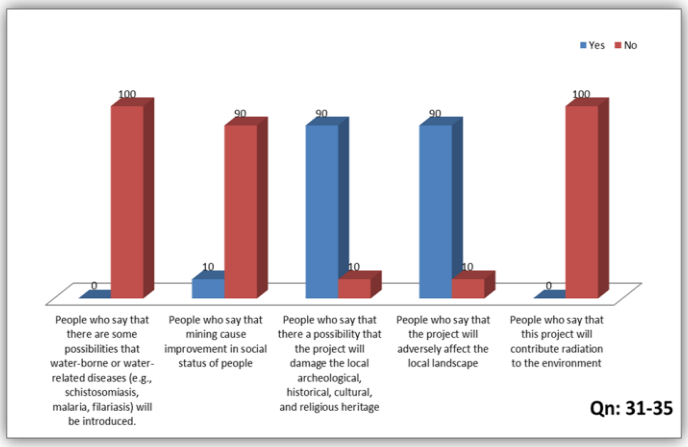

Chart-7: Survey response of question no. 31-35

6. ENVIRONMENTAL MANAGEMENT PLAN

The goal of the environmental management plan (EMP) is to maintain ecological balance while also limiting the negative effects of inland mining. It guarantees that environmental management measures are integrated into the mine planning process. Many aspects of environmental planning necessitate a multidisciplinary approach. The proposed schemes should be specified and, if necessary, changed from time to time.

Among the numerous ways of land reclamation , the hydraulic fill approach is the most suitable. Flooding is a constant threat in Polders, and care must be taken to safeguard the neighbouring dikes. Dikes are often constructed using locally available materials, each of which carries its own set of risks: Sand is prone to collapsing due to water saturation; dry peat is lighter. Some animals build tunnels through the barrier, allowing water to seep in. Because peat decomposes when exposed to oxygen from the air, polder land made up of peat will sink in comparison to its prior level. Because of the considerable distance of transportation, dry earth movement for land reclamation is more expensive than hydraulic fill. This process entails filling the land with boulders and sand, which results in the breaking down of mountains, causing environmental devastation. Landfill has a substantially lower density profile than hydraulic fill. As a result, granular soil densification is usually required in landfills. The key reason for hydraulic fill's economic advantage over dry fill is that it minimises nonproductive time.

A seawall reduces the amount of energy available to produce erosion by reflecting incident wave energy back into the sea. Slope and loose material ensure maximum dissipation of wave energy. The porous patterns of rock and concrete armour are used in mound type seawalls. It is a less expensive choice. On the seaward side of reclaimed land, a mould type seawall can be built along a 5.4km stretch. In mound type seawalls, porous patterns of rock and concrete armour are utilised. A mould type seawall can be built on the seaward side of reclaimed land

On the seaward side, more tetrapods can be assembled in a pell-mell pattern. Tetrapods are meant to lessen the force of approaching waves by causing the water to flow around them rather than against them. They also limit displacement by allowing tetrapods to interlock in a random distribution.

7. PREDICTION

7.1 Correlation

Correlation is a statistics that measures the degree to which two variables move in relation to each other. Here the parameters involved are year and area of land. Using SPSS software, correlation between the parameters are found out by Pearson Correlation method. Based on correlation table, the nature of dependence of land area and year were found out .The correlation table is shown below:

Table-4: Pearson Correlation

		Year	Area (sq metre)
Year	Pearson Correlation	1	-.996**
	Sig. (2-tailed)		<.001
	N	17	17
Area (sq metre)	Pearson Correlation	-.996**	1
	Sig. (2-tailed)	<.001	
	N	17	17

**. Correlation is significant at the 0.01 level (2-tailed).

After correlation analysis, only moderately and strongly correlated parameters are considered as significant correlation. Weak correlations are those in which correlation value varies from 0.1 to 0.3, moderate correlations value varies from 0.3 to 0.5 and strong correlation value varies from 0.5 to 1.0. If the value of correlation is negative it means that if one parameter increases then other decreases and if it is positive then both increase or decreases. Also the SPSS software analysis shows that the parameters are negatively correlated.

7.2 Forecasting

Using Google Earth Pro Software, land area is calculated. From the data, graphs are plotted using Excel software. This graph is used to show change in area.

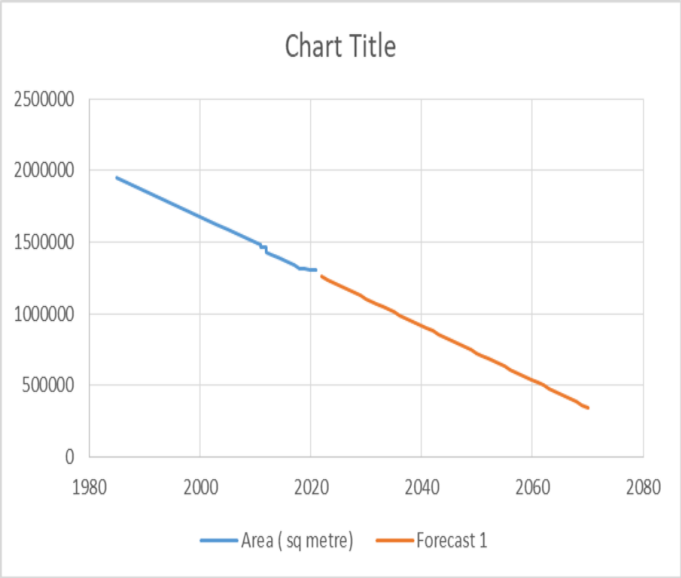

Chart-8: Forecasted Area

The land area and time are inversely related. Land area till 2021 is found out using Google Earth Pro software and on forecasting up to 2070 the land area is found out to be depleting.

8. CONCLUSION

The study on impacts of sand mining at Alappad and surrounding areas revealed both positive and negative effects It used questionnaires and interviews to highlight the perspectives of those who had been affected. The socioeconomic factors have been thoroughly examined, considering all social impact elements, and the survey shows that mining leads individuals to lose their regular jobs. Water quality were determined using samples collected from five locations during the study and compared to drinking water quality criteria in terms of physicochemical properties and contaminant levels. The findings revealed that the water quality has deteriorated.

The extent of land area lost due to unsustainable mining, over a period of 1985-2021 is observed and evaluated using Google Earth Pro software for analyzing the shoreline change and future prediction is done using Microsoft Excel and SPSS. Forecasting till 2070 shows a continuous declination in the land area.

From the year 1985 to 2021, the change in land area is about 33.25%. From the prediction , the change in land area from the year 2021 to 2070 is 73.5% .To evaluate the environmental aspects and their possible associated impacts that would arise due to the proposed heavy mineral sand mining and to work out mitigation measures to minimize the adverse environmental impacts. Environmental Management Plan includes land reclamation using hydraulic fill method, then a mound type seawall can be constructed on the seaward side of reclaimed land over a stretch of 5.4km.Further tetrapod's can be arranged in a pell-mell fashion on the seaward side.

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