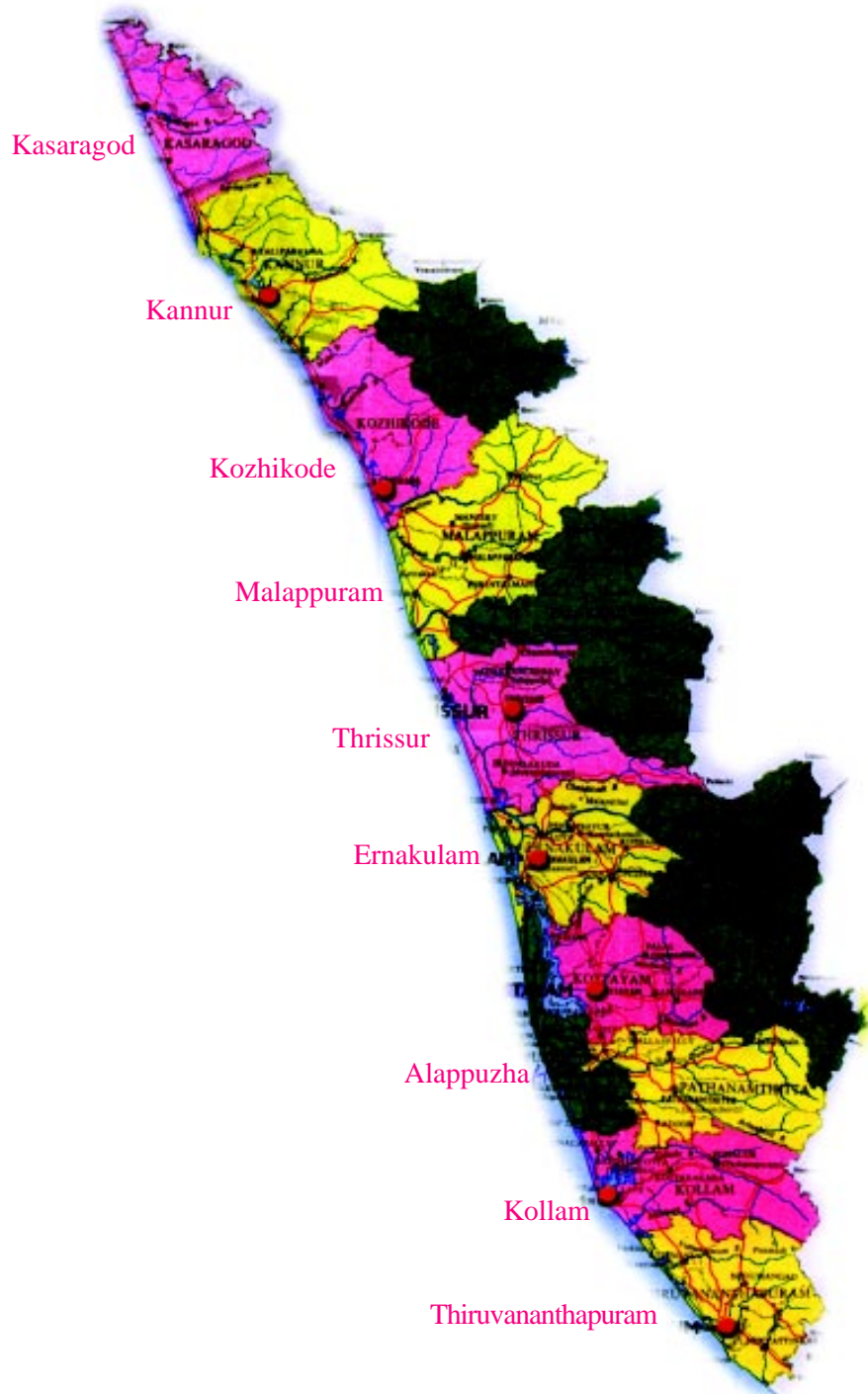


The Kerala Coast

Causes of its' ruin and methods for revival



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Part I By- gone Beauty and Prosperity

History of Kerala glitters with thrilling events and stories of the Arabian sea. But Malayalam literature has coolly ignored the sea. The exceptions are very few : Chemmeen by Thakazhi Sivasankara Pillai, Chuvanna Kadal by M. T. Vasudevan Nair and Kadappuram by Unni Joseph. The reason for the apathy of Malayalies in the affairs of the Arabian sea needs no search elsewhere¹.

The Arabian sea was gracefully calm along the Malabar (Kerala)² coast. The then - Malabar beach was much more beautiful than the modern beaches of Juhu, Goa, Marina etc. Now the remnants of that beach remain only at Kovalam. The white sandy beach and vast stretches of lush green vegetation along the land surprised the foreigners who came to Malabar in those days. Fascinated by the beauty of the land and serenity of the sea, the foreign visitors called Malabar, 'the pearl in the blue sea'.

The floor of the Arabian sea along Malabar coast was covered with mud - deposits, with the result that no waves were formed along the coastal sea. The sail - ships of those days could therefore anchor right in the sea, and remain as safely as in a pond³. Devoid of waves, the ships were free from the thrust and pull normally experienced in the open sea. Consequently the big vessels remained in the sea and the cargo used to be carried to and from the ships in the canoes and small boats even during monsoon season. (Map 1)

The fact that the ships of Vasco da Gama were anchored in the open sea at Panthalayini near Kozhikode from 20th May to 26th August during South West monsoon of 1498 is a historic proof⁴.

The mud - deposits in the sea floor which suppress the waves are the unique feature of Malabar Coast. It is due to a phenomenon called Chakara⁵, peculiar to the coastal sea of Malabar.

Chakara^{6,7}, a local term, denotes an area of the sea, where there are no waves; the sea is calm; the current is slow; and where the fish and prawns abundantly flock together. In Malabar, Chakara appear in different locations all along the coastal region of the Arabian sea during the monsoon. The phenomenon is the result of the geo - physical peculiarities of Kerala. (Map 2)

At present there are 41 west - flowing rivers in Kerala⁸. In ancient days Cochin river estuary did not exist. But there were many small rivers and creeks all along the coast. Though small in size their number compensated for the size and contributed to a uniform discharge of flood waters into the sea. There was no dam in any of the rivers. All rivers and creeks remained connected with lakes, lagoons and channels.

The annual rainfall was regularly 300 to 320 cm. A major part of the rain water used to flow through those rivers and creeks, and discharge evenly into the coastal region of the Arabian sea. These flood waters contained large quantities of elluvium (silt and clay). *

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1. A discourse between M. T. Vasudevan Nair and Thikkodiyan 1998 Mathrubhumi weekly - Onam special - p.20.
 2. Malabar and Kerala - are synonyms - the former being older
 3. Sir Robert Bristo (1967) Cochin Saga - Paico Publishing house, Ernakulam.
 4. Dr. Herman Gundardt Kerala Pazhama (Mal) Mathrubhumi Publications Ernakulam (1996) Translation, T. S. Krishnan.
 5. Chakara - Malayalam Word - both singular and plural
 6. Mud banks of Kerala coast - CMFRI Bull - 31 April. 1984.
 - * Fine sand silt and clay when carried by water the term is elluvium, when they settle as such it is alluvium and when settle in Colloidal form it is colluvium otherwise mud.

The silt and clay of laterite soil of Kerala consist mainly of silica, iron and alumina. When these elements come in contact with salt water in the sea, which contains sodium and magnesium, a chemical reaction takes place. The result is a complex colloid of sodium and magnesium with the elements in silt and clay. The sea water permeated with the colloid loses its fluidity and fails to form into waves. The current also slows down. The flood waters coming through the rivers are rich in zoo - plankton which is delicious for the fish and prawns. Attracted by the zoo - plankton the fish and prawns flock to that area, resulting in a Chakara⁶.

After the rainy season, when the water flow slows down, the colloid gradually settles down as mud on the floor of the sea. When, by tidal action sand is deposited over the mud deposits, the sea gets retreated resulting in the formation of land. Such marine formations continued till 1920⁹. According to scientific concept, the area between Quilandi and Quilon is a marine formation less than 3000 years old.

The sea was more than five kilometres away from the present position even when the Portuguese and the Dutch came to Malabar. The Kandezhuthu (a revenue term) of 1820 and survey and settlement of 1905 give details of marine formations which were added to revenue records¹⁰.

Marine deposits occur even today at Puthuvaippu and at Cherai beach in Vypeen Island. At Puthuvaippu it is clay deposits while at Cherai it is sand. The reasons for such deposits will be discussed later.

It is surprising to know that the present generation even at Chellanam, a place which has become a synonym for sea - erosion, is totally ignorant of the fact that a beautiful beach existed once in their own native village. The reason for the strange situation is that they have seen only a sea wall separating the land and the sea¹¹.

1.2 The Sea Coast

The sea coast throughout Malabar had two distinct portions : Beach and Board. The first was a splendid sandy beach of about one metre in height and width varying in kilometres. That portion was used for recreations and entertainments. It really functioned as ‘the lungs of the people’.

On the eastern border of that area, there were rows of screw - pine shrubs (*PANDANUS*). The surface area was covered by creepers like *Ipomea* sp and *Umbelliferae* sp. The leaves of screw - pine were largely used in cottage industries and handicrafts. It was a tangible source of income and employment. The creeper *Ipomea* was used as feed for the rabbits reared in most houses. The *Umbelliferae* was used as a delicious salad having nutritional and medicinal values.

The second - sea board - also had two portions. The first, a slopping portion from the beach towards the sea, was hard and partially wet. The fishermen used that area to keep their vessels and materials.

The next part of the sea board was a level area often soaked. During high tide this area used to have water a metre deep. There at low tide, even the children could easily catch the small fish trapped in shallow ditches. Getting immersed twice daily was the beauty of that part of sea-board!¹¹.

7. William Logan Malabar Manual (Mal. by T. S. Krishnan) Mathrubhumi Publications Ernakulam 1985.

8. Rivers of Kerala (Mal.) Viswa Vijgana Kosam Vol. 4 P.446
SPCS - Publications Kottayam 1971

9. Fr. Benovencher OCD (1952) Manasserry in History (Mal) Little Flower Publications Manjummel

10. Kandezhuthu, Kettezhuthu & Survey and settlement Records Archives Ernakulam.

11. Personal experience and discussions of the author.

12. The map was first published in the Platinum Jubilee Souvenir of St. George School Chellanam in 1991.

Foot Note 1 : Cochin, Calicut, Alleppey, Quilon etc is now written as Kochi, Kozhikode, Alappuzha, Kollam etc. In citing old references older form is followed.

1.3 The Oldest Map of Kerala Coast

A map prepared by Jan Thin, a Chinese skipper and renewed in 1687 by H. G. Faarant, a Dutch Engineer is the oldest map known about Kerala Coast, equally so with any part of India¹². The map was in possession of the Dutch Government. When Mr. K. P. Fabian, Indian Ambassador to Holland returned after his term, that map was presented to him. As it pertained to Kerala Coast particularly from Kodungalloor to Kollam, Mr. Fabian presented the map to the Archeological Museum at Mattancherry where it is now displayed. A concise form is Map 1. A lot of information about the coast is available in the map. They are :-

- (1) The map clearly shows the condition of the Arabian sea during the 17th century.
- (2) The loss of about three - quarters of land in Vypeen Island can be reckoned from the map. The present church on the western border of the Island was on the eastern border according to the map.
- (3) Big ships anchored in the sea and cargo being carried in small vessels are clearly depicted.
- (4) Presence of big ships in the sea proves that the sea was calm and without waves.
- (5) The presence of mud - deposits at the bottom of the coastal sea is also indirectly proved.
- (6) Cruz - de - Milegree, St. John's Church and St. Tago's Church, which were later destroyed by the sea are seen in the map.
- (7) The beach was convex in shape from Kochi to Pallana (beyond Alappuzha); but today it is concave.

A drawing of Kannur Fort and adjoining sea by an unknown artist has been reproduced in 'Viswa Vijgnana Kosam - Malayalam Encyclopedia'. Though the date of drawing is unknown, that picture also depicts a calm and waveless sea¹³. (It might be of the Portuguese period)

The map of Faarant and the drawing of Kannur Fort are documentary evidences of calm and safe condition of the Arabian sea along the coastal region of Malabar during the 17th century.

1.4 Travel and Trade

Foreign travel and trade were not then confined to harbours. Thankasserry (Kollam), Kunjithai (Aruthunkal), Manakkodam (Andhakaren Azhi), Saudi (Kochi), Maalippuram etc. were small harbours, from where foreign travel and trade were conducted.

Fr. Gasper Pius, who came by ship at Arthunkal and constructed a church (St. Andre) there on 30-11-1581. Fr. Jacomo Fenicio also came to Arthunkal in 1584 and lived there till his death in 1632. (His tomb stone is still preserved in that church)¹⁴.

The author of 'Historia do Malavar', Fr. Diago Gonsalvus came to Purakkad by sea.

Bl. Chavara Kuriakose in his diary states that Bishop Maurilius Stabilini who was staying at Arthunkal, went to Rome by ship from Kunjithai near Arthunkal in 1832¹⁵.

The inland travels were by country boats, canoes and roofed country crafts. (Ibid 15)

The main trade centres were Kollam, Kochi, Kodungalloor, Kozhikode and Kannur. The Chinese were the early traders at Kollam. They were followed by Muslims. Jews were the traders in all other centres except Kozhikode, where the Arabs dominated.

13. Viswa Vijgnana Kosam (Mal) Vol. 3 P.384 - SPCS Publication, Kottayam 1971.

14. Jacomo Fenicio, (Mal) K. L. Bernard, Kochi

15. 'Nalagamangal' (Mal) Bl. Chavara Kuriakose Vol. 1 p. 20.

16. K. P. Padmanabha Menon - History of Cochin State (Mal) Mathrubhumi Publications Kozhikode - 1989.

17. Glymptses of History (Mal) Francis Thankasserry - Coastal Publications, Vadi, Kollam - 1990.

Lt. B. S. Ward of the British Army conducted a reconnaissance survey during 1816 - 20 along the coasts of Travancore - Cochin states. In that survey starting on 20-4-1819 from Kochi Ward went towards south through the coastal villages of Saudi, Manassery, Andikkadavoo, Maruvakkad and reached Andhakaren Azhi (Pallithode), where he found a chowki (police out - post) of Travancore Police. On his return journey he came again to Maruvakkad and found there a Jew's house built in 1718. (A piece of land is still known there as 'Juthanparambu' meaning Jew's property). During his journey he also visited a farm of Mr. Salomi, another Jew at Vettakkal.

There were many houses of Black Jews along the coast. There were Jewish settlements also at Saudi (Kochi) Manakkodam, Vypeen, Njarakkal, Mathilagam etc. Being a trading community, the Jews might have preferred to stay, scattered in villages along the sea coast, for the convenience of trading with the ships anchored near the coast.

When the Portuguese came to Malabar they controlled the trade. They were followed by the Dutch and the English.

Pepper and spices topped the commodities of export. Other items were diamond, teak, rose - wood, sandal, medicines, fine cotton fabrics etc. Main import goods were copper, silver, brass, glass and mirror, woolen goods, satin and other consumables^{16, 17}.

1.5 Habitation

The land adjacent to the beautiful beach was a healthy residential area. The houses of the rich in the coastal belt concentrated in that area, where fresh water was available in the ponds. In most ponds, the sacred lotus was commonly grown.

Europeans when they came to Malabar, also preferred that area for their stay. European Bungalows seen at Kollam, Alappuzha, Kochi, Kozhikode, Kannur etc. stand in support.

1.6 Education

The education was conducted in single teacher institutions called 'kalari'. Each village had its own kalari. The teachers were paid in kind, contributed by the parents.

Children, 8 - 10 years old were taught Malayalam, Arithmetic and Social Sciences. The text was on Palm - leaves. Teaching method was by recitation. Writing started on the sand and completed on palm leaves. A pupil studying for 4-5 years used to acquire a standard equivalent to modern matriculation in the subject taught.

The first European school was started at Fort Kochi. Surprisingly it was a girl's school, in honour of Mother Mary, meant for Indian women married to Portuguese soldiers. Subsequently other institutions were also started by the Portuguese, followed by the English¹⁸.

1.7 Economy

According to Rev. J. C. Vischer, the coastal area was the richest and prosperous part of Kerala. His observation was based on (1) very high cash income from coconut, rice and marine products, (2) presence of fertile soil and fresh water and (3) easy access by the then prevalent water transport system with ships, boats and canoes, through sea, lakes, rivers and canals¹⁹.

Cattle rearing was very common. Most houses had cattle; which were let loose for grazing. The milk was locally consumed. By dusk, the cattle used to rest in rows along the sea board. Unfortunately that idyllic scene is unknown to the present generation! Similar scene still exists in parts of Gujarat and Maharastra coasts.

18. Education (Mal) Viswa Vijgnana Kosam Vol. 4 P.684

19. Tour Notes of Rev. Jacob Canter Vischer.

20. Memories of the survey of Travancore - Cochin states 1816 - 20.
Lt. B. S. Ward. Supt. Govt. Press, Madras 1891.

1.8 Antiques

In old days beautiful Chinese crockery like plates, cup and saucers, jars etc. was largely used besides bronz utensils. Oils from Marotti (Hydro carpus sp) and Punna (Calophyllum sp) were used for light in houses. They were burnt in open pan stand and hanging lamps made of bronz. (Nilavilakku and Thookkuvilakku). The poor used “maroti” shells with wicks as lamps.

Subsequently they were replaced by kerosene lamps introduced by the Portuguese. They were very attractive table lamps made of glass, brass etc.

Many curious items were available in rich houses. Most of them were lost when the sea thrashed down those houses in the coastal region.

No wonder, the curios were lost in the peril of losing houses and properties. But the people who were ignorant of the value of the antiques caused to lose even the survived items!

The coastal region of Kerala which was rich and prosperous, had its decline from 1930. In about 50 years, the once prosperous coastal region became a poverty belt, with many have-nots --- no drinking water ----- no proper roads ----- no industries ----- no employment ----- but the majority with BPL certificates!

It is now proper and necessary to explore the causes of that decline within a period of less than 50 years!

Part II

The Causes of Ruin

The direct cause of ruin of the coast of Kerala is sea - erosion. But the sea - erosion is an effect of many factors. It is therefore worth examining the role of each factor.

2.1 Areas of sea - erosion in Kerala

Sea - erosion now exists all along Kerala coast in different intensity. One common feature is that everywhere it is in the monsoon. Kerala Irrigation Department who are associated with Anti - sea - erosion works have prepared a list of places which are prone to and likely to cause sea - erosion.²¹

They are:-	Poovar	-	Vizhinjam area
	Kovalam	to	Valiathura
	Perunnathuruthu	to	Neendakara
	Neendakara	to	Kayamkulam
	Kayamkulam Pozhi	to	Ambalappuzha
	Ambalappuzha	to	Thumboli
	Andhakaren Azhi	to	Chellanam
	Chellanam	to	Cochin Harbour
	Cochin Harbour (Vypeen)	to	Azhikkode
	Azhikkode	to	Kozhipram
	Engadiyoor	to	Chavakkad
	Velliamkottu	to	Ponnani
	Tirur- Parappanangadi	to	Kadalundi
	Kadalundi	to	Elathur
	Cherianangad	to	Tikkodi (Theakkodi)
	Ayanikkadu	to	Murad - Vadakara

Madakkara	to	Puthiyappa Angadi
Thrikkaripur	to	Neelaswaram
Kanjangad	to	Kasargode - Manjeswaram

Among the places, two areas are very seriously and dangerously affected. They are:

1. From Neendakara to Ambalappuzha and
2. Andhakaren Azhi to Cochin Harbour

The latter is known more commonly as Chellanam area, which has become a synonym for sea - erosion.

2.2 Reasons for sea erosion

Irrigation Department in the same report have stated six reasons for sea - erosion. They are

1. Heavy monsoon showers with thunder and cyclones.
2. Loose sandy sea - shore.
3. Sub - terranian pressure from low - inland areas.
4. Increase of water level in the sea due to melting of ice in the polar region.
5. Destruction of mud deposits in the sea.
6. Heavy discharge of water devoid of elluvium (silt and clay).

Heavy monsoon showers with violent storms and cyclones have been present in Kerala from ancient times. It may be recalled that the area between Quilandi and Quilon was formed even with showers and cyclones. Therefore the first reason has very little relevance.

Though the sea - shore is sandy, it was expanding till recently. Sir Robert Bristo himself has stated that the beach was 'making and not losing'. The sandy beach need not be a reason for sea - erosion. (3 op.cit)

Sub-terranean pressure from the low inland areas creating sea-erosion, does not agree with the findings of CMFRI. According to them, sub-terranean pressure and resultant up-welling in the sea, promote mud-banks. A factor promoting mud - bank production cannot create sea erosion.

The next point is that the water level increases in the sea consequent to melting of ice in the Polar regions. However, due to increase in temperature, when the ice melts, evaporation will also increase and both will mutually compensate. Moreover, the increase in water level is not perceptible in rivers, lakes, ponds etc. where the water level is steadily going down. No change has been made in mean - sea - level and bench marks. New formations at Cherai, Pathuvaippu etc. do not get submerged even with increase of water level.

The real reasons for sea - erosion are heavy flow of water without elluvium due to dams in rivers and Cochin harbour. As the real reasons of sea - erosion cannot be admitted at this stage, vague reasons are propounded. The reasons of sea - erosion are very clear and simple. They are:

- (1) When the dams are constructed, the elluvium (silt and clay) settle in them. Clear water alone goes out. Consequently, colloid formation and mud - deposits are curtailed.
- (2) As a large part of water was retained in the dams, small rivers and creeks got silted up. An even discharge of water into the sea has become impossible.
- (3) When small rivers and creeks became defunct water force in major rivers increased. Heavy flow of water without silt and clay - the beneficial materials, created dangerous currents in the sea, which destroyed the shores devoid of protective mud deposits.
- (4) Cochin river, when converted into a major harbour by increasing depth, width and length, turned to be the 'Yama' (Devil - terminator) of the coastal area. No wonder, then, in the

practice of 'Devil money' - Bhoothappanam in that harbour!

The dams and Cochin harbour are directly and indirectly responsible for the ruin of the coastal areas.

The sea - erosion has its origin in 1341 AD with the formation of 'Kochazhi'. No land record was then available. As a result the details of loss by sea - erosion are wanting.

The Irrigation Department who started the anti - sea - erosion works prepared their projects based on a map of 1850 (Admiralty Map). Within the period of five centuries (1341 - 1850), a few kilometers of land have gone into the sea. As stated earlier, Lt. B. S. Ward conducted a survey, of the coastal area during 1816 - 20. A map of 1687 is also now available. With the help of the stray evidences available, the magnitude of loss can be perceived. Therefore it would be proper to find out the role of each factor of sea - erosion and losses by it, historically.

2.3 Kochazhi (Cochin river)

According to history, a narrow strip of land, existed between Cochin and Vypeen, washed off in the unusual flood due to heavy the rains of 1341 AD, resulting an azhi called Kochazhi. When Kochazhi was formed, many small rivers and creeks along the coast were silted up. The river at Cochin (Kochazhi) became the main source of drainage. Vypeen, with a length of 20 miles and width of 3 miles, became an island^{16, 22}.

The newly formed river Kochazhi had only a depth of 10 - 12 feet, underneath was rock - like ridge of sand (Footnote - 2). Though Kochazhi functioned as a harbour, ships of 8 - 10 feet depth could alone enter.

Waterflow through a narrow and shallow river is harmless in summer season. But during the monsoon heavy, vigorous flow of water hitting against the water-wall of the sea, results in whirl - currents. The whirl - currents destroyed the protective mud-deposits along the coast and attacked the land. Thus sea - erosion started with the origin of Kochazhi, and it is the result of destroying the environmental protection of the sea - coast.

In the beginning, the sea - erosion was confined to 10 - 12 kms on both sides of bar - mouth, as the depth of water was only 10 - 12 feet. On the northern side, half of the island was exposed to erosion. Vypeen area of the island was reduced to one - third of its original width (3 miles). Cruz - de - Milegre seen in the map of Faarant was destroyed in 1850. (²³/₇)

When the sea - erosion threatened the existance of Vypeen Island, Mr. Allan Campbell, Engineer under Madras Government, constructed a sea - wall with groins (²³/₅). But the sea - wall constructed with laterite stones was destroyed in 1920. Unfortunately Campbell was unaware of the fact that the laterite stones would disintegrate in sea water.

On the southern side of Kochazhi, the attack was upto Cheriyakadavoo. But Manassery was the worst hit area, where four churches were swallowed up by the sea. The location first church in honour of Mother Mary is eight kilometers in the sea, west of the present one(Ibid 9).

During monsoon season, the sea used to grab the land vigorously, but during the summer, a part of it would be redeposited. There was no loss to individuals, as the land was not surveyed and assigned. It was lying fallow.

2.4 River Cranganoor (Kodungalloor azhi) alias Musiris

River Cranganoor has no parallel in the history of Kerala. History is very eloquent about Musiris. But there is no mention anywhere in the history or literature about Kodungalloor azhi causing sea - erosion. Honour and respect for a person, place or thing are gained when they become useful or at least harmless to the society. There are many reasons for Kodungalloor azhi not causing erosion.

(1) In Kodungalloor azhi, there are many ridges of rock - like sand banks, still in different places and directions. The water flow gets obstructed in its movement in between and over the sand ridges. (foot note 2)

(2) Before the formation of Kochazhi, Kodungalloor azhi and many small rivers and creeks together contributed to form Chakara along Malabar Coast.

(3) River Cranganor takes a turn towards south to join the sea. As the flow is not due west, whirl - currents are not formed in the sea. Moreover, as the flow is towards south, water currents of the sea promote the flow and do not prevent.

(4) When the flow from Kodungalloor azhi gets trapped in the deep channel of Cochin harbour (since 1930), a sudden drop in flow occurs. The solid particles in the flood water are dropped according to sedimentation principle (ie. heavy first and light later). Consequently sand deposits occur at Cherai and silt deposits at Puthuvaippu.(supra.cit)

2.5 Rivers and water - flow

Within the coastal region of 571 kilometers* from Parasala to Manjeswar 41 rivers discharge their contents into the Arabian sea (table 1). The total estimated volume of water from all those rivers is 82,308 million cubic metre (Mcum)*. Malabar coast (North Kerala) covering 50% of the total coastal length has 27 rivers (66%). From 27 rivers (66%) in Malabar, the volume of discharge is only 38,320 Mcum (ie. 46.5%). While 14 rivers (34%) in South Kerala (TC area) the volume of flow is 43,988 Mcum (53.5%). A heavy frantic flow of water in rivers of south Kerala is quite natural.

Varkala formation - laterite rock - exists at Varkala. Similarly granite rock exists at Ezhimala. South of Varkala and north of Ezhimala, the sea - erosion is not serious. But the sandy belt of about 300 km between Varkala and Ezhimala is the critical area of severe and devastating erosion.

Five rivers in Kannur district discharge their contents into the lagoon - Ettikkulam, and from there water gradually flows and joins the sea, preventing the chance of serious sea erosion, where as three rivers, Valapattanam, Ancharakkandi and Ponniam - falling into Tellicherry lake create heavy flow and currents, and hence the sea - erosion in Kannur - Tellicherry region.

The volume of water in 11 rivers between Kodungalloor and Kollam is 40,640 Mcum. But nine of them, (Keecheri, Karuvannur, Chalakkudy, Periyar, Moovattupuzha, Meenachil, Manimala, Pampa and Achankoil) together have 36,864 Mcum water. This huge volume of water is discharged into the sea surprisingly through two rivers - Kodungalloor and Kochi.

When the total volume of water in 27 rivers is 38,320 Mcum, that of two rivers - Kochi and Kodungalloor is 36,864 Mcum. However Kodungalloor river is still having the rock - like sand - ridges and the water flow is often impeded. Cochin harbour has increased in depth, width and length. It is through Cochin harbour, the water is mostly discharged into the sea. Therefore the force and ferocity of water flow are imaginable!

Huge volume of water running in force and ferocity, when discharged into the sea, through a single river, cannot but create dangerous currents and sea - erosion.

Worse is the situation, when that huge volume of water is devoid of elluvium also. !

2.6 Dams

There are now in Kerala 14 completed dams in different rivers²⁶. A large part of water is retained in the dams. The elluvium (silt and clay) in the water totally settle down and clear water alone goes out. As a result, the production of colloid in the sea is largely reduced.

The water devoid of elluvium, secures a little of elluvium in its subsequent flow, What little colloid formed with that elluvium, gets dissolved in the strong flow of water itself.

The water flow, even if strong, contains sufficient elluvium which create colloid, suppress strong waves and thus prevent sea - erosion. But water flow without elluvium increases sea - erosion.

2.7 Cochin Harbour and sea - erosion

Though Kochazhi dates back to 1341 AD, no details of damage are available for three centuries. First available details are from the map of H. G. Faarant in 1687. The loss of three - quarters of land in Vypeen has been mentioned earlier. The rest of the land was also under threat.

Lord Wellington, then Governor of Madras Presidency, happened to see the river at Kochi. He got enthused with the beauty and lay of the river, and its surroundings, and foresaw the potentialities of a beautiful harbour. Immediately he brought down Mr. R. C. Bristo from England and put him in charge of a project of his ambition.

Bristo studied in detail the river, the sea, the coast, the water flow currents etc. and prepared his project in 1920. Having foreseen the damages likely to happen due to water flow and currents from the harbour, Bristo included in his first report sea walls to a length of 12 miles on both sides of the proposed harbour ^(27.)

During the discussion on the Project by the Governor with the King of Cochin and the Diwan of Travancore (representing that state) - the partners in the project, the state governments expressed their inability to share the huge expenses of the Project. Bristo was therefore forced to cut - short the estimate.

To reduce the estimate, Bristo decided to drop the construction of sea - walls which he himself once thought essential for the safety of the coastal area. Yet he was particular to construct a small sea wall at Vypeen area, for which the reasons put forward by Bristo were:- (3 op. cit.)

- (I) That Vypeen Island is essential for the beauty and secrecy of Cochin harbour and
- (II) if that island is lost, the harbour would become only a pond in the Arabian sea.

Bristo therefore decided to construct 3000 ft. of sea - wall in 29 pieces in a special design. Each piece had a little twist towards south - west at one end, and slightly over lapping at the other end. So much so, they functioned both as sea - wall and groins. Thus he completed 29 granite sea - wall cum groins at a cost of Rs.1,12,620/- (during 1920 - 25) and saved Vypeen Island from a total disaster. Thanks so much to Mr. Bristo!

To drop the construction of protective sea - walls on the southern coast, Bristo cunningly utilised a partial truth. What he said about the coast in the south of harbour was that it was 'making and not losing'. The statement was true in respect of Kumbalangi and Chellanam villages at that time (stated in this book elsewhere). But he overlooked the fact that there was severe sea - erosion upto Cheryakadavoo and disastrous disastrously at Manassery. Bristo coolly ignored the sea - erosion areas and utilised safe areas to justify his project. What - would - happen - when - harbour - channel - deepened was also wilfully ignored by Bristo ^(23/6).

In the case of Vypeen Island Bristo thought of the after - effects of the harbour, while the same factor was not shared in the case of the coast in the south, which was more vulnerable technically.

Had it been the financial problem, the work could have been deferred and taken up after completing the harbour. Bristo did actually ignore the people along the coast, even after commissioning the harbour.

Heavy rains and floods occurred in 1857, 1879, 1882, 1907, 1920 etc. The unusual flood of 1920 in the Periyar caused sea - erosion for the first time at Andikkadavoo. That situation further confirmed the hypothesis that the flood and resulting whirl currents are the causes of sea - erosion.

With a hollow praise about the sea coast south of the harbour, Bristo proceeded with his project ignoring the sea - erosion that then prevailed upto Andikkadavoo and that in a ravile form at

Manassery. Consequently the disaster to that coast was inversely proportional to the progress in the harbour.

Bristo did not see the 'land losing' in the vicinity of harbour upto Andikadavoo, but clearly saw 'land making' beyond Andikadavoo. What a pity!

According to KERI research²⁸ the water currents in the sea are towards south from May to August. As a result, the south coast succumbed more when the whirl - currents of the harbour were forcibly diverted towards south by the normal currents of the sea.

When the harbour channel of 12 feet was deepened to 40ft., the sea - erosion spread upto 50 km. on the south coast. When the length of the channel reached three miles, the danger zone spread over 100kms.

After commissioning the harbour (Dec.1935) with a channel length of three miles, width of 450 ft and depth of 40ft., more than half - a - kilometer width of land area was swallowed up by the sea in less than 50 years. More than double of that area was made saline by frequent flow of sea water..... Ponds and other sources of drinking water were made brackish..... Most of the economic pursuits were curtailed..... High yielding paddy fields became unproductive....²⁹ Cocout yield miserably reduced... Coastal area turned a poverty belt ---- and a backward area in all respects.

Footnote 2 : Sand, silt and clay in fresh water undergo a physical process resulting in clay concrete. Bristo called it "most formidable rock-like sand banks. The local term is 'arava'.

The same materials in saline water (in sea) undergo a chemical reaction forming colloid which finally transform into mud.

21. Coastal erosion in Kerala - Protective measures Irrigation Wing, PWD, State of Kerala 1986 (Aug)
22. History of Kerala (Mal) A. Sreedhara Menon SPCS Publication, Kottayam 1969
23. Bristo Remembered - compiled by the Bristo Centenary Celebration Committee (1981) 18 articles
 - (5) Sir R. C. Bristo's persistent role in making Cochin harbour - P. V. Raghavan.
 - (6) Cochin Port - A historical Retrospect - A. Sethuraman.
 - (7) Port of Cochin - its origin and growth to maturity - L. M. Pylee.
 - (9) History of mud - banks and drawings of Sir R. C. Bristo - P. V. Raghavan
- * Total length of Kerala 580km. Coastal length 571 km
- * Million Cubic meter - abbreviated as Mcum
24. Mud Banks of K Kerala-Karnataka - E.G. Silas, CMFRI Bulletin 31. April 1984
25. Mud Banks of Kerala Coast - CMFRI Bulletin 31. April 1984 (Total 12 articles)
26. Dams (Mal) Viswa Vijgnana Kosam Vol. 1 Page 199.
27. Harbour Papers - Archives, Ernakulam.
28. KERI - Kerala Engineering Research Institute, Peechi. Reports from 1968 to 1981.
29. Prawn business started only after 1975 in paddy fields which became saline by sea erosion.

Part III

The Extent of Damages

As stated earlier, the land was unsurveyed and lying vacant. The magnitude of loss could be conceived only with respect to damages caused to the institutions then existed. A few cases are detailed below.

3.1 Self - explanatory cases :-

1. At Manassery, the location of the first church in honour of Mother Mary was about eight kilometres to the, west of the present one, which is the fifth²⁹. and only metres away from the sea.(Ibid 9)
2. The first church at Saudi (Kochi) supposed to be constructed in 9th century and where the Franciscan fathers who came with Capt. Cabral had stayed and worked in 1500 A.D. was also destroyed by the sea. A huge five - and - a - half - foot granite statue of Mother Mary of Health donated by the Portuguese, is still in the present church³⁰.

3. Another church, St. Tago existed at Kallencherry, for the spiritual needs of the Dutch soldiers. Capt. Van Guan of the Dutch army had visited that church³¹. The location of that church is shown in the map of H. G. Faarant according to which the church St. Tago was about 1½ miles south - east of the then church at Manassery. Subsequently St. Tago church was also swallowed up by the sea.
4. Even the second church at Kandakkadavoo was demolished by the sea in 1920³².
5. During the survey (stated earlier) Lt. B. S. Ward visited the coastal villages of Alleppey, Kattoor, Arthunkal, Muttom, Kadakkarappally, Parayakad, Andhakaran Azhi (Pallithode), Ezhupunna etc. He reached Kadakkarappally on 11-4-1819 (foot note 3) and recorded that the sea was six furlongs away from the then - church (Holy cross church at Kadakkarappally). Further he mentions about a Chowki (Police out - post) at Andharan Azhi which was 5¼ miles north of that church. Again he states that the sea was a quarter of a mile away from that 'Chowki'. The present position of that 'Chowki' would be another quarter of a mile west in the sea.
6. The technical presentation of the damage by the sea to a width of 625 meters in 100 years at Cheriyakadavoo based on Admiralty map is given in Diagram 1⁽³³⁾.
7. KERI estimated an annual loss of 5 metres of shore based on data for 120 years from 1850 to 1970.
8. Severe damage by sea - erosion was during the 30 years from 1936 to 1965. By the year 1965, dams were constructed in major rivers. The water flow was considerably reduced. Along with the reduction of water, the elluvium content was also reduced. As a result, within a period of 12 years from 1964 to 1975, the loss of land increased to 80 metres. The water without elluvium increased sea - erosion even when the water volume reduced.
9. The church at Arthinkal was four miles away east of the sea coast. (See Kochuvava Mapillai, 1922)
10. The author has personal experience of a loss of 25 - 30 rows of coconut trees ie, 250 - 300 metres of land in less than 15 years. Many rich families completely collapsed. The houses losed by the poor were innumerable. The monetary loss of land, trees, houses etc. along the coast would amount to a few hundred crores of rupees. (based on then - rates)
11. By sea - erosion from 1930, along the coastal region from Kochi to Purakkad, the dwelling area was reduced to half. But within that period, the population increased four - fold^{34,*}. Dwelling and living became a problem.. The reason for the strife and restlessness along the coast is the after - effect of sea erosion

3.2 Sea - erosion—result of Environment Destruction

For centuries, the Arabian sea along Malabar coast was under the protection of mud - banks. But after the construction of dams in the rivers, the elluvium settled in the dams and mud production ceased in the sea. What little colloid formed with elluvium gained in the subsequent flow of rivers, was destroyed by the force of water itself. The shore devoid of protective mud banks, was devastated by the strong water currents. Thus the destruction of the coastal environment resulted in sea - erosion – an issue of Environment Destruction.

3.3 Another Concept on Sea - erosion

A widely and wilfully popularised concept is that the sea - erosion is due to increase of water level in the sea consequent to melting of ice in the Polar region due to increase in atmospheric temperature. As the increase in atmospheric temperature is a global phenomenon, no permanent solution is possible for the sea - erosion. But the concept does not agree with the situational realities and circumstances experienced by the affected people. The realities and circumstances which refute the concept are :

1. If and when the temperature rises and ice melts, the evaporation will equally increase and both are often mutually compensated.

2. Those who have seen the tyranny and ferocity of satanic whirl - currents and the gigantic waves which surge on the land, trees and houses, cannot agree that sea - erosion is only due to rise of water level in the sea.
3. Even the new formations at Puthuvaippu, Cherai etc. are not submerged by increase of water level.
4. The increase of water level in the sea is not reflected in lakes, lagoons, ponds and canals which often get unusually dried up.
5. A tangible variation in tidal amplitude is not reported. It is often within a metre in Kerala.
6. No change is brought about in mean - sea - level and bench marks.
7. The sea erosion occurs only during the monsoon when the flood water joins the sea.
8. The experience is that sedimentation occurs where ever the current is prevented or blocked.
9. The studies conducted by CMFRI at Gangotri during 1986 and 1995 revealed that the melting of ice in summer is equally compensated by formation of ice in winter. They have also reported that the ozone layer in Polar region is absolutely safe^{35,36}.

As the real causes of sea - erosion can not be corrected now, high sounding hollow theories are being put forth.

3.4 Problem now worse confounded

(1) When the dams were constructed in the rivers, the elluvium settled in them. That disadvantage was partially compensated by a reduction in the volume of water - (water flow). When water flow reduced the sea - erosion slowed down slightly. But when the water flow reduced, silting up increased in the harbour. To overcome the silting problem in the harbour, the remedy was to reduce the water - spread - area, and to increase the flow - speed. The Wellington Island Augmentation Project is to reduce the water - spread and to increase the force of flow. Consequently the sea - erosion regained its ferocity. Very severe attacks by the sea in recent years are the results of it.

This situation also supports the hypothesis that the forceful flow of water and whirl - currents are the causes of sea - erosion.

(2) LNG Terminal at Puthuvaippu*

It is now known that a plan to put up LNG terminal has been finalised with a tank capacity of 1,10,000 cubic metres at Puthuvaippu. To protect the tank from the waves and currents in the sea, two groins are also included. For the waves and currents from the north - west, a groin of 870 metres is proposed on the north of the tank. Similarly to protect from the waves and currents from the south - west, another groin of 820 metres is included on the south of the tank. But nothing is known of any precautionary work included against the after - effects of this huge project on the coasts.

The groin on the north side of the tank is likely to create land formation and therefore no problem is likely to occur there, whereas on the southern side, the project - particularly the groin of 820,m is likely to be the death - knell to the coast, south of Cochin harbour.

It is a strange fate of this country, that development projects are taken up without considering their after - effects to other parts in the country! A development plan which does not take cognisance of its after - effects to the country (particularly the negative aspects) is a clever cheat.

The people along the coast are not against development programmes of the country. But at the same time, it is their right and demand that sufficient precautionary measures must be provided against the damages that are likely to occur due to the project.

The groin on the southern side if made longer by 50% than that on the northern side, the damage to the coast on the south can perhaps be reduced. Detailed study and appropriate measures to ward off the after - effects are solicited.

3.5 Harbour Agreement

An agreement signed between Lord Wellington, the Governor of Madras Presidency (Govt. of India), the King of Cochin, the Diwan of Travancore (representing that state) and Mr. Robert C. Bristo, representing the harbour, is known as Harbour Agreement³⁷. A glaring point of the agreement is that it included a special assurance to the King of Cochin, that the interests of his subjects would be protected then and for ever from any damage due to the harbour.

The wording from 'A Queen's story' by Dr. Babu Paul who was Port Trust Chairman also, is given below (p.77)

“The document fully and completely protected
all present and future interests of his subjects”

Neither the Madras Government (Govt. of India) nor the Port Trust ever thought of the promise after commissioning the harbour. The humble demand of the people of the coastal area is to be honest to the promise.

3.6 The sea - erosion and CRZ rules³⁸

The Hon. Supreme Court of India passed Coastal Regulation Zone Rules in 1991. The aim of the rules is to protect the Coastal Ecology. But the coastal environment in Kerala was destroyed by Cochin Harbour - the Government Agency itself. It was done more than 50 years before the Hon. Supreme Court thought of the Ecology. As a result, there is hardly any sea coast left in Kerala. Consequently there are thousands of houses within 8 - 10 metres from the sea, facing destruction. The destroyed and dilapidated coast still faces the threatening of the sea.

The present condition of the coastal environment is similar to barren hills devoid of vegetation. The barren hills do not contribute to a forest ecology. Similarly, the preservation of the destroyed environment of the sea coast of Kerala will not satisfy the objective of CRZ rules. What is required, is the revival of the lost environment.

The coastal environment in Kerala was not destroyed by the people or their factories or institutions. The culprit is the Arabian sea, by the connivance of Cochin Harbour. The sea is still continuing the destruction. If the present condition is allowed to continue, there is every chance of the Arabian sea reaching the Western ghats in not - so - far - off - future.

Within 8 - 10 kilometres from the sea, there are 45 lakes and lagoons, having a total length of 440 kilometres⁴⁰. They are inter-connected and also with the sea. All of them are subject to tidal action and salinity. But the CESS (Centre for Earth Science Study) have skilfully exempted Kuttanad from the purview of CRZ rules. Thanks to CESS!

The geographical area of Kerala including that swallowed up by the Arabian sea is 38,813 sq.km. The area under forest is estimated at 10,815 sq. km. The lakes, lagoons, rivers and canals together occupy 716 sq. km. The area left for cultivation and living is thus limited to 27,282 sq. km. An area of 3593 sq. km. is estimated under the ambit of CRZ rules, which is equivalent to 13.18% of usable land. In a small state like Kerala frozen of 13.18% of the usable land is in polite terms. cruel (Table - 2). When 13.18% of the usable land become frozen, it will indirectly bring about the effect of an increase of 15% in population. The consequences are dangerous and explosive!

The Government of Kerala failed to bring the special conditions of Kerala to the notice of Hon. Supreme Court in proper time. Only after passing of CRZ rules, the Government of Kerala realised their lethargy and inaction. Though the Hon. Supreme Court has since made some modifications, they will not satisfy the critical situation of Kerala.

In Kerala, the coast was actually destroyed by Cochin Harbour and the sea. But the Hon. Supreme

Court exonerated the culprits and penalised the poor men along the coast through CRZ rules. Justice demands that the Hon. Supreme Court reconsider their orders.

The beach to a width of many kilometres was lost when the Kochazhi developed. Apart from it, when Cochin Harbour was completed, the surveyed land to a width of more than 500 metres was swallowed up by the sea. When another 500 metres of land is also frozen under CRZ rules, there will be no place left for dwelling in the coastal districts. The felt - need is therefore to regain the lost land. If land lost is regained, many other problems will also be solved simultaneously.

- 30 Fr. V. P. Joseph Valiaveetil, Kerala Coastal Gazetteer 2001. Page 78
31. The Dutch in Kerala (Mal.) Dr. T. I. Punnen, SPCS Kottayam 1964
32. Silver Jubilee Souvenir 1977 Diocese of Alleppey
Footnote 3 - Kadakkarappally was then famous with the world renowned book ' Hortus Malabaricus'.
33. History of Kerala shore J.J. Erattupuzha & H. Padmanabhan. J. of inst. of Engineers (India) Vol. 51(2) 16 July 1972.
34. Census Reports 1961 to 1991. Govt. of India
35. Scientific Report of II India Expedition to Antarctica Publ. No.3, Dept. of Ocean Development, New Delhi 1986.
36. Scientific Report of Eleventh Indian Expedition to Antarctica Tech. Bull. No.9. Dept. of Ocean Development, New Delhi 1996.
37. Electricity from waves - Mohanan Kaithavalappil, Kaitharam, Manorama dt. 30-5-96.
38. CRZ rules - Coastal Regulation Zone Rules 1991 Hon. Supreme Court of India.
39. A feature on CRZ rules - Boby Thomas Malayala Manorama (4 articles)
40. Keralam (Mal.) Viswa Vijgnana Kosam Vol. 3-4. SPCS Kottayam

Part IV

Remedial Measures Attempted

Based on the findings of Anti-sea-erosion Research conducted at various institutions, attempts were made at different times to prevent sea-erosion along the coast of Kerala . They are being reviewed here under.

4.1 Central Water and Power Commission and Research Centre at Poona were the pioneers in the field. Their recommendation was to construct sea - walls with groins at intervals, to break the force of waves and currents.

The technique and skill for the construction of the groins were also detailed in their report⁴¹. The groins are to be constructed slopping towards the sea with big heavy granite stones. The waves get thrashed when hit on the groins. But the construction of sea - walls alone is done by the Irrigation Wing of KPWD, who execute the anti-sea-erosion works. So much so, the effect is only partial and not permanent.

Ordinary people construct groins where ever water flow and currents occur in their proprieties.

The first anti-sea-erosion works supposed to have done in 1890 at Chilikkur near Varkala were groins which still remain with the damages of time.

Anti-sea-erosion work by Allen Campbell at Vypeen in 1913 had groins. The sea - wall constructed with laterite stones, was the cause of its ruin.

The protection bund and groins supposed to be constructed by the Dutch at Kallencherry, against ripples of a lagoon still remain with the normal damages of 400 years.

Bristo constructed 29 pieces of granite sea wall in a special design by which they served the purpose of both sea - wall and groins. The work was therefore successful and still remains.

The works cited above confirmed the recommendations of the Poona Institute. But the limitations are (1) as the sea - walls have been completed in many places in Kerala, it is now difficult to construct groins on the western side of those sea - walls and (2) while the construction of the groins will help to prevent further attack by the sea, it will not help to regain the lost land.

4.2 Anti-Sea erosion work at Thumba

When there was danger to the Rocket Launching Station at Thumba, by sea erosion studies were conducted by Hydrolic and Hydrologic Institute at Poondi.

According to their recommendation when 20 - metre - length groins using granite stones of different sizes were constructed in a special design, erosion was prevented (Diagram 2)⁴². The work at Thumba also proved that the groins alone would prevent sea-erosion.

Thumba still has 40 - metre width of sea-coast, where the construction could be done conveniently. But in other places, there is no beach at all at present. The design of Thumba is therefore not practical in many places in Kerala.

4.3 Fate of Sea - walls without groins

Construction of sea - walls without groins in Kerala coast where waves and currents are very strong and dangerous, seems strange and curious.

During 1936 - 49, Government of Cochin constructed eight kilometres of sea walls from Manassery to Pallithode, and at Vypeen, Kuzhippally etc. using small granite stones. All of them completely sank into the sea-board.

In 1953 when the sea-erosion was again very serious at Manassery, a sea - wall of 1.6 km was constructed. It was also destroyed by the sea.

The sea -walls constructed by Madras Government in 1940 using big granite stones do exist at Tellichery.

KERI recommended the use of granite stones of 170 dm³ for construction of sea - walls. Based on their recommendation, forty kilometres of sea walls were constructed during 1959-63. The cost of construction was Rs. 12-15 lakhs per kilometre. Even in that work groins were not included.

4.4 Tetrapods⁴³

South Mumbai was once subject to sea-erosion and caving in of the shore. If the force of waves is broken and the currents are obstructed, sedimentation is a natural occurrence in the sea. Huge hollow tetrapods were carried in barges and spread in the entire area indiscriminately. The present South Sea Reclamation of Mumbai⁴⁴ is the result of sedimentation of the sea, when the tetrapods were spread out and the force of waves and currents destroyed.

The peculiarity of the tetrapods is that it will maintain the same erect position even if tilted by waves. They will always be in a firm and fixed position and long distance movements will not occur. The waves and currents hitting on the tetrapods will lose their force (energy), and the waves devoid of energy, will dispossess their contents around and inside the hollow tetrapods. Therefore the sedimentation is expedited by planting tetrapods.

4.5 KERI Research

Kerala Engineering Research Institute at Peechi, additionally recommended to build up the

coast artificially. They recommended planting of mangroves but planting of mangroves is not practical when there is no beach. Planting of tetrapods may be the easiest and practical method to build up the coast artificially.

4.6 Research at Madras Port

Madras harbour is not connected to any river. The coast disintegration in that port, was due to wind and water currents in the sea. Yet the dredged materials from that harbour were utilised to nourish the coast⁴⁵.

Though Bristo cunningly disowned the liability of protecting the coastal area of Cochin harbour, the moral responsibility still remains entangled on the Solemn Promise to the Venerable King of Cochin. Yet the Cochin Port Authorities totally ignore the coastal area and find fancy in creating Islands utilising the dredged materials from the harbour.

4.7 Central Minister Gulzarilal Nanda (late)

Shri Gulzarilal Nanda (late) Central Minister in one of his speeches in Parliament remarked as follows *

“If an enemy captures any part of India, the expense will not be a bar to recapture that land. Sea-erosion must be treated similarly and the land captured by the sea, must be recaptured”

In honour of his visit to the sea-erosion areas and his remark in Parliament, the sea - walls constructed since his visit with big granite stones (1959 - 63 and after wards) are known by the name Nanda Bund.

The lost land and, by-gone beauty and prosperity of the coastal area must be regained. If the land is regained, the coastal area will simultaneously become a fresh water zone. Fresh water will bring in Prosperity.

4.8 CORNISH⁴⁶ is a Gulf-word for artificially created and beautifully designed beaches in Gulf countries. They imported fertile soil from Africa and created beaches artificially. The newly formed area was aesthetically developed with roads and parks. It was a very costly venture; but money was not a limitation for them.

The artificial building of similar beaches in Kerala is unthinkable. Moreover, it may not be feasible in Kerala due to the peculiarities of the Arabian sea. But prudent programmes with limited investments appropriating the boons of nature and the sea, can be thought of for Kerala.

41. Kadalakramanam (mal) Viswa Vijnana Kosam vol. 3. p.529

42. Alternative protection measures for coastal erosion at Thumba (IHH report 13/82) June 1982)

43. Tetrapods Reinforced concrete block laid against sea - wall to break the force of the waves. Chambers Dictionary

44. South-Sea Reclamation - personal communication.

45. Near shore sediment Dynamics around Madras Port (India) KVSR Prasad and B.S. Reddy (1988) American Journal of Waterway, Port, Coastal and Ocean Engineering Vol : 114 (2) pp.206-219.

46. Cornish - Gulf word- Mathrubhumi Daily - Ernakulam Aug - 1991.

* (source - Late Sri. Joseph Mathen. Ex. M.P. Rajya Sabha)

PART V

A Proposal to regain the lost land

If the lost land of Kerala can be regained it will be a great boon. The sedimentations at Mumbai, Puthuvaippu, Cherai etc. are eye openers to appropriate the rules of nature to the benefit

of the country. According to the principles of sedimentation, if the forces of the waves and currents are broken, the materials carried by them as suspensions, will be relinquished. The materials are nothing but sand, silt and clay. When the sedimentation occurs at shore, the result is land formation. The success in South Sea Reclamation at Mumbai gives an idea for an action plan.

Two or three rows of huge hollow, tetrapods can be planted in the coastal sea, upto a distance of 20-25 metres from the shore. The coastal sea being deeper in Kerala, the size of tetrapods can be 3,4 and 5 metres with tie in bigger ones. They can be planted in the sea according to the depth in a zig - zag fashion. The forces of the waves and currents will be broken when they hit on the tetrapods. The resulting calm water will shed its suspensions around and inside the tetrapods. As the tetrapods get filled, they can be pulled back into the sea and the process can be continued.

The rein-forced concrete tetrapods can be cast on the land having a water front; and can be transported to the venue of planting with the help of Cranes fitted on floating bridges. Cranes can be used for transport, planting and also for change of positions.

The number of tetrapods required for a length of one kilometre will be 300 of all sizes together. Approximate cost of casting, depositing and maintenance will be less than one crore of rupees per kilometre. A higher estimate is made for concrete tetrapods to be cast with corrosion resistant steel reinforcement, using saline resistant cement and also for plastering using water - proofing materials.

As a trial, planting of tetrapods can be done in 100 kilometre from Cochin harbour to Purakad. Being an area of very severe and disastrous sea-erosion, and due to proximity to the harbour, that area is likely to give spectacular results in very short time. If found successful, the project can be extended to Varkala in the South and Ezhimala in the north. By proper planning and execution an area of about 120 sq. km of land can be regained in a semi-ellipse between Varkala and Ezhimala.⁽⁴⁷⁾ Approximate cost will be about Rs. 300 Crores. The value of the land regained will be more than ten times of investment, besides other indirect benefits.

If properly planned, a beautiful beach - a Kerala Cornish - can be developed in place of present dilapidated shore. Besides the benefits of prevention of sea - erosion and regaining the lost land, many indirect advantages can also be achieved.

- (1) The unproductive expenses of anti sea erosion works get eliminated
- (2) Drinking water and many other public health problems will be solved.
- (3) A strong military and navy settlement can be built up in the south - west Corner of India.
- (4) A beautiful high - way from Kanyakumari to Mumbai can be planned.
- (5) The areas adjacent to High - way bridges (which would be necessary for rivers and creeks) can be set apart for fishermen for their vocation.
- (6) Though fishing facilities are provided the fishery industries must be kept out of the Cornish to keep up beauty and sanitation.
- (7) Certain marine species like Dolphin, Turtle, seal, some species of shell fishes etc. facing genetic extinction can be saved.
- (8) The energy required for the coastal area can be generated from wind, waves and currents.⁽³⁷⁾
- (9) Excess sand along the beach can be made available for construction purposes on a planned basis..
- (10) When the regained land is developed into **Kerala Cornish**, coastal tourism will spring up spontaneously. With the advantages of the vital triad - sun, sea, and sand, and the close presence of lakes, lagoons and creeks, the tourism is sure to flourish in the coast. The beauty and prosperity will then recur along the Kerala coast.

A Possibility :- Apart from the direct and indirect benefits stated above, the author, based on his acquaintance with the sea - coast for more than sixty years, envisages a possibility of mineral accretion along the beach, if it is regained. His assumption is based on the following:

The author remembers to have collected (while playing on the sea-board in his childhood) black shining fine sand from the shore. It was curious, strange and heavier than white silica sand which was then in huge quantities along the coast. The black shining fine sand might have been minerals like thorium, titanium, ilmenite etc. as seen now at Chavara and other places. While mining, white sand and black sand were seen in alternate layers in the profile.

The Arabian sea is proved to be a treasure of precious minerals⁴⁸. The waves in their cyclic movements gather small quantities of minerals from the reserve and deposit them along the shore. Now there is no shore and no deposition occurs. If the coast is regained, at least, to the level of a semi - ellipse between Ezhimala and Varkala, there is every chance of mineral accretion along the regained coast. The present dilapidated and poverty - tridden coast will then become a mine of precious minerals.

The persons interested in relief works during sea - erosion may not relish a permanent solution. The relief works as emergency programmes are more acceptable to persons associated with it. As a result, anti - sea-erosion works have gained the notoriety of “throwing stones into the sea”.

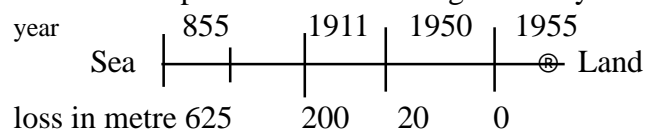
A permanent remedy for sea-erosion can be achieved only through economically feasible and profitable programmes. And that alone is apt.

47 Fomulae used for semi-ellipse $\frac{1}{2} (\pi \frac{AB}{2} \times \frac{CD}{2})$ where length AB is taken as 300 km and length CD one kilometer. Half of it is reckoned as area for semi-ellipse.
Hand book of Agricultural fact and figures. Dept of Agriculture, Govt of Madras 1952.

48. Speach - Prof.(Dr.)Bahauddin. Ex. Principal REC Kozhikode and Ex. V. C. University of Kozhikode
* (Source - Metro Manorama 02 - 09 - 03)

Diagram 1

Technical Representation of damage in 100 years by sea at Cheriakkidavoo from 1855 to 1955



source : J.J. Erattupuzha & H. Padmanabhan

Table : 1
The West Flowing Rivers

	Name	Length km	Volume of water mcum	Remarks
1.	Manjeswar	16	100	
2.	Uppala	50	640	
3.	Shiriya	61	1380	
4.	Kumbala	11	70	
5.	Mogaral	34	200	
6.	Chndragiri	105	3520	
7.	Kalnad	8	40	
8.	Bakkel	11	70	
9.	Chittare	26	220	
10.	Nileswaram	47	1610	
11.	Karinkode	64	1610	
12.	Kawayi	23	220	
13.	Perumbra	40	750	
14.	Ramapuram	19	90	
15.	Kappam	71	1430	
16.	Valapattanam	113	3120	
17.	Ancharakkandi	64	280	
18.	Ponniam (Thalassery)	29	150	
19.	Mayyazhi	55	580	
20.	Kutteppuzha (Murad)	74	1500	
21.	Korappuzha	40	1820	
22.	Kallayi	23	230	
23.	Chaliyar	169	5910	
24.	Kadalundi	130	2490	
25.	Poorapparamba	8	50	
26.	Tirur	48	200	
27.	Bharathapuzha	251	9960	38320
28.	Keecheri	43	510	
29.	Karivannur	48	1340	
30.	Chalakkudy	145	3190	
31.	Periyar	228	13890	
32.	Moovattupuzha	121	2990	
33.	Meenachil	68	3076	
34.	Manimala	92	2320	
35.	Pampa	177	7110	
36.	Achankoil	129	2436	36,864
37.	Kallada	121	2436	
38.	Ithikkara	56	1340	40640
39.	Vamanapuram	80	1160	
40.	Karamana	68	1240	
41.	Neyyar	56	95	43988
		3022	82308	

Table 2
The details of area falling under CRZ Rules 1991
(Courtesy - Bobby Thomas - Malayala Manorama)

S. No.	Name of District	Involved areas			Length of Sea coast Km.	The area within 200m. limit sq. km.	200 - 500 meter sq. km.	Area within 50 meter sq. km.	Remarks
		Panchayat	Municipality	Corporation					
1.	Thiruvananthapuram	25	1	1	15.40	17.90	8.50		
2.	Kollam	25	2	-	6.63	13.40	25.00		
3.	Alappuzha	25	3	-	17.20	26.20	19.00		
4.	Ernakulam	19	2	1	8.12	-	-	doubtful	
5.	Thrissur	24	2	-	15.94	54.00	27.30		
6.	Malappuram	13	2	-	6.90	14.77	4.60		
7.	Kozhikode	19	1	1	16.11	25.40	16.85		
8.	Kannur	20	3	-	13.00	18.05	25.96		
9.	Kasargode	14	2	-	18.14	25.29	11.19		
	Total	193	18	3	117.44	175.01	136.40		
	Kottayam	5	1	-					

Total Geographical area of Kerala 38,813 sq.km.

1. Forest 10815 sq.km.

2. Lakes lagoon 652 sq.km.

3. Rivers 64 sq.km.

Total 11531 sq.km.

Distribution of affected area

under CRZ rules 1991

1. In Urban areas 670 sq.km.

2. In rural areas 2923 sq.km.

Total 3593 sq.km.

Balance area for cultivation and living

11531 sq.km.

22,282 sq.km.

Table 3
List of Dams in the rivers of Kerala

- | | |
|---|---------------------|
| 1. Pallivasal (the first hydro-electric dam in Kera state, built in 1940) | |
| 2. Chenkulam | 3. Panniyar |
| 4. Neriamangalam | 5. Peringalkuthu |
| 6. Kallada | 7. Kuttiadi |
| 8. Malampuzha | 9. Neyyar |
| 10. Vazhani | 11. Valayar |
| 12. Peechi | 13. Gayathri |
| 14. Pothundy | 15. Bhothathankettu |
| 16. Idukki, including Cheruthoni and Kulamavu | |
| 17. Sabarigiri, including Pampa and Kakki | |
| 18. Parambikulam - Aliyar Project including Sholayar, Thoonakkadavu, Paeruarippallam and Thekkadi | |

(The dams blocked free-flow of water from 28 rivers)

Table 4
Important Lakes, Lagoons and Canals in Kerala

LAKES

Major Lakes

- | | | |
|-----------------------|-----------------------|------------------|
| 1. Veli lake | 2. Kadiriamkulam lake | 3. Anchego lake |
| 4. Edava lake | 5. Nadayar lake | 6. Paravoor lake |
| 7. Ashtamudi lake | 8. Kayamkulam lake | 9. Vembanad lake |
| 10. Kodungalloor lake | | |

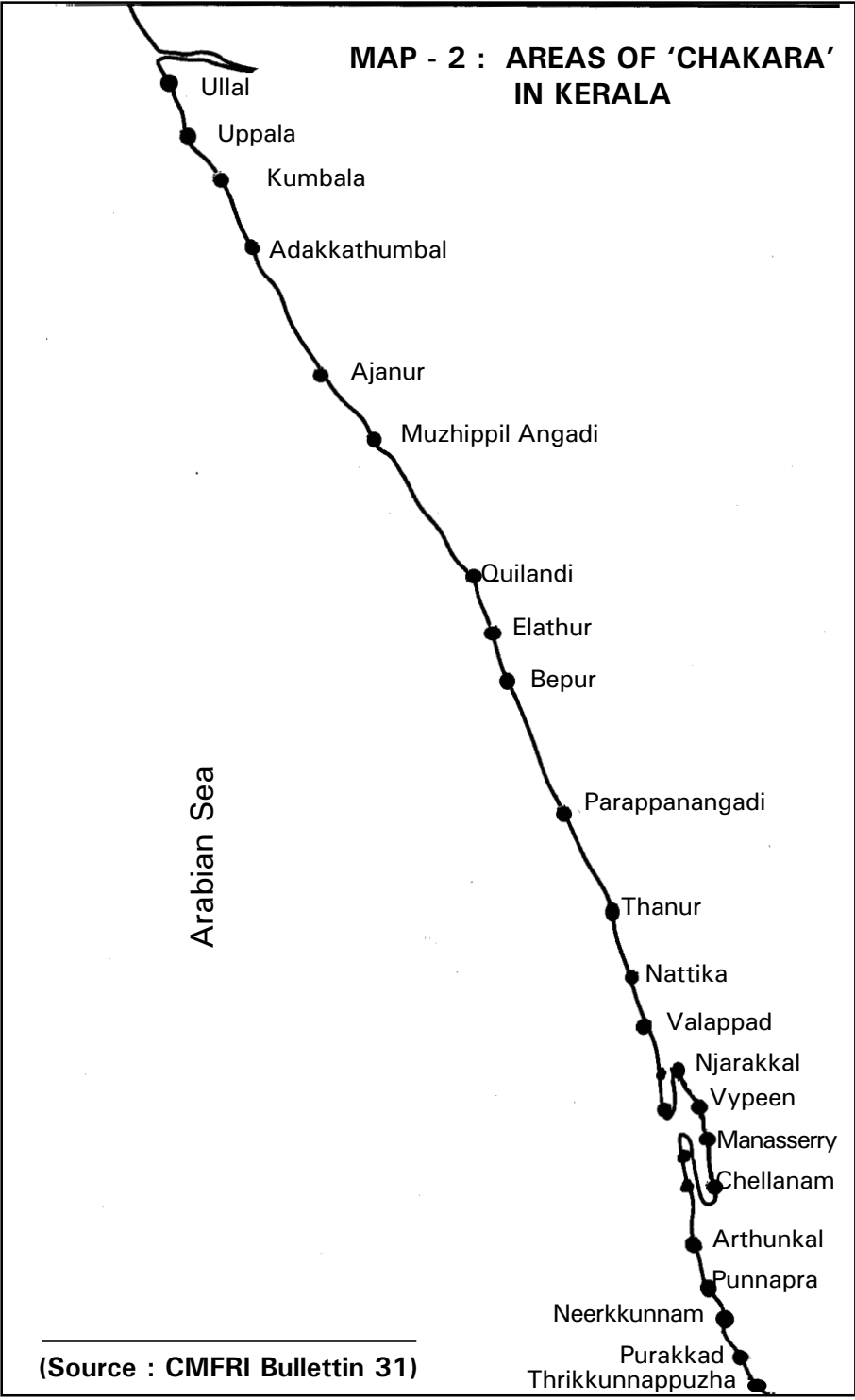
Minor Lakes

- | | | |
|---------------------|------------------------------|-------------------|
| 11. Vellayani | 12. Sasamkotta (fresh water) | 13. Enammakkal |
| 14. Manakkodi | 15. Kattukambal | 16. Muriyad |
| 17. Kumbala | 18. Kalanad | 19. Backel |
| 20. Kawayi | 21. Kalluncherry | 22. Punnamada |
| 23. Ettikkulam | 24. Tellicherry lake | 25. Payippad lake |
| 26. Veluthulli lake | 27. Chavakkad lake | 28. Varappuzha |
| 29. Cherukolppuzha | 30. Mayyazhippuzha | |

CHANNELS AND CANALS

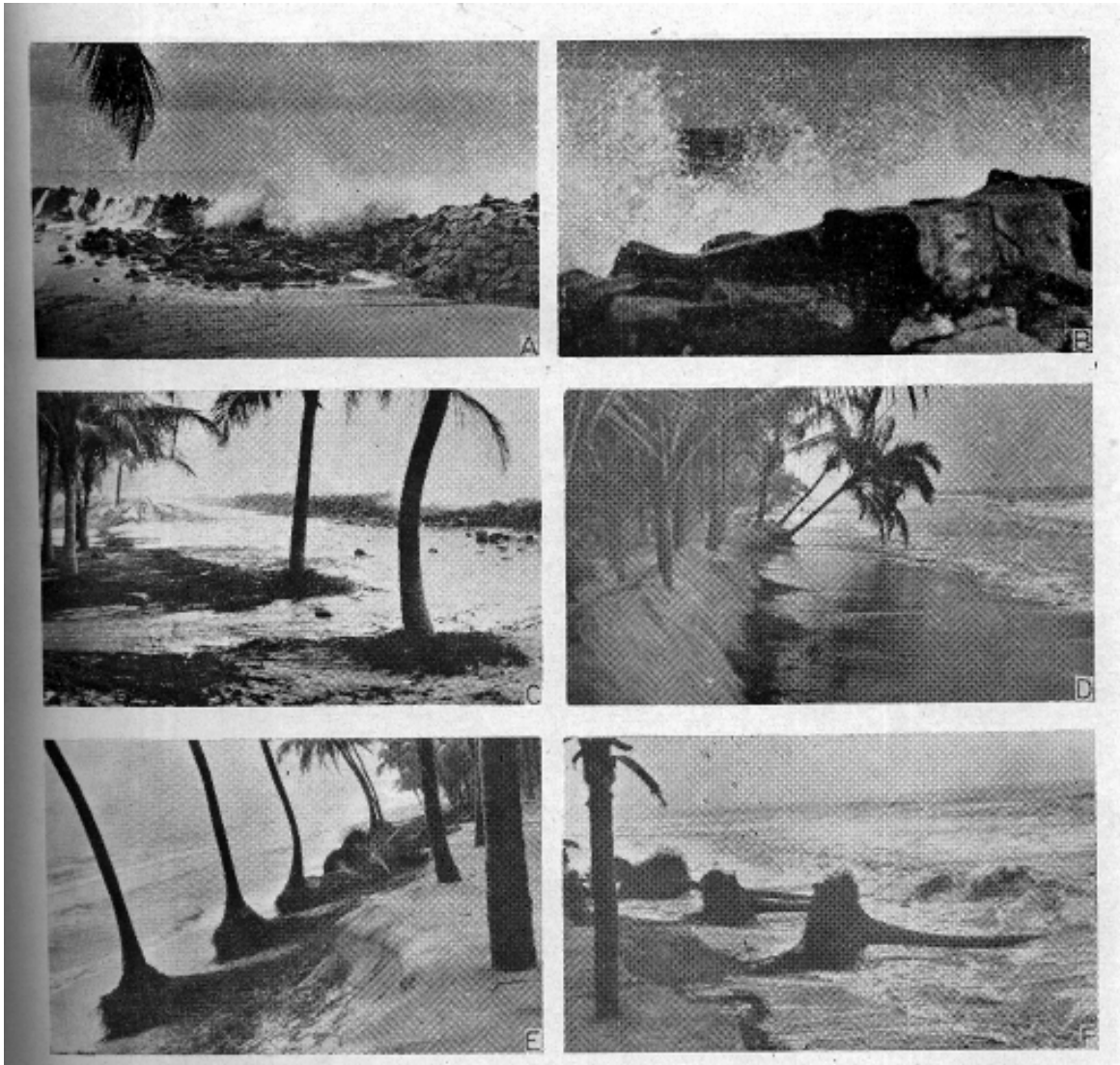
Velliakodu thodu, Katholi thodu, Chavara thodu, Karippuzha thodu, Sulthan thodu, Tanur-Kuttiyadi thodu, Elathu-Kallayi thodu, Puthiyathodu(Vypeen).
Champakara Canal, Vijayan Canal, Muroe Canal, Canoli Canal.

MAP - 2 : AREAS OF 'CHAKARA' IN KERALA



(Source : CMFRI Bulletin 31)

FURY OF THE SEA



Heavy monsoon seas and coastal erosion at Chellanam and adjacent areas on the Alappuzha-Kochi coast. (Courtesy : E.G. Silas, *CMFRI Bulletin* 31, 1984)