Trans. Inst. Indian Geographers
Vol. 4, No. 1, January 1982

MORPHOLOGY AND EVOLUTION OF MODERN CAUVERY DELTA TAMIL NADU - INDIA

M. SAMBASIVA RAO, Madurai.

ABSTRACT : An area of about 7,500 km^2 covering Cauvery delta has been studied from aerial photographs (1 : 60,000) and Landsat imageries (1 : 250,000) with a view to deliniate landforms. The various landforms identified are ancient channels, natural levees fossil islands, ancient beach ridges, marshes, lagoons and coastal dunes. Apart from land-froms a few 'geomorphic highs ' which are considered to be structural highs formed during Neocene and Quarternary periods are recognised. The lineaments have been traced to study the possible effects on landforms. Majority of the lineaments trend is NE-SW and ENE-WSW in direction.

From the disposition and spacing of ancient beach ridges about three strandlines have been surmized. About twelve, abandoned meander lobes have been traced from the disposition of ancient channels, The possible paleoconfluences of the abandoned meander lobes have been traced. The rate of progradation of Modern Cauvery delta is 10 km per a thousand years. The growth of the delta is mainly by the successive deposits of detrial material brought by the river from its basin out into the sea. Fluvial processes dominate over coastal processes. The growth of the modern delta is from North to South and is considered to be Holocene in age.

Introduction

The Cauvery delta covering an area of about 7,500 km^2 falls within the districts of Tanjore and South Arcot and Karaikal (Pondicherry) in Tamil Nadu. The delta lies in the southern part of the east coast of India in between 10° 15′ to 11° 25′ N latitudes and 79° to 80° E longitudes. The cuspate delta of Cauvery have a coastline of about 190 km. From Adirampatnam in the south to 2 km. north of the confluence of Coleroon river.

Previous Work

Meijerink (1971) first mapped from air photos fluvial and coastal landforms of Cauvery delta and has concluded that the possible age of the modern Cauvery delta to be Holocene. Sastry et. al. (1973) have given a detailed seismic report of the delta and concluded that the major structural trend is NE-SW.

Studies also have been carried out in other deltas of India. Bagchi (1944) has described the different features of the Hooghly delta and has subdivided the delta into three major units namely the ' moribund ' ' mature ' and ' old '. Later morgan and mc.Intire (1959) have studied the Quaternary geology of Bengal Provinces of East Pakistan (now Bangladesh) and India and concluded that structural activity and primary faulting have significantly influenced the Quaternary geology of the Hooghly delta. Niyogi (1968)has explained the possible evolution of Subernarekha delta from a study of aerial photographs (1:30,000). Babu (1975,1978) has explained the different Geomorphic forms of Krishna and Godavari delta and has traced the evolution of former delta basing on disposition of ancient channels. Later Nageswara Rao and Vaidyanathan (1978) have explained the possible evolution of Krishna delta basing on disposition of ancient beach ridges and anc ient channels. Similar studies also have been carried out by Sambasiva Rao et al (1978), Sambasiva Rao and Vaidyanathan (1979) And Sambasiva Rao (1980) on Mahanadhi and Godavari deltas.

The purpose of this paper is to trace out the stages in the growth of delta fronts and abandoned meander lobes basing on disposition of landforms (ancient channels, and ancient beach ridges) from Landsat imageries and false colour composites (1:1 Million and 1 : 250,000) and air photos (1 : 60,000).

Regional Setting

The upper parts of the Cauvery delta are boarded by Cuddalore lateric sandstones of Plio-miocene age. Majority of the area is covered by alluvium. Coastal sands are noticed in a few pockets in southeastern part of the delta and along the coastline. The gradient of the delta is 1in 4,400 (44cm/1km) from the apex of the delta to the present coastline, indicating very gentle gradient in the Cauvery delta.

The River Cauvery rises in the Western Ghats 40 km south west of Mercara in Karnataka State and flows about 600 km before emptying into Bay of Bengal. It is joined by 12 tributaries with a drainage area of about 80,000 km.[2]

Methodology

Geomorphic study was undertaken on aerial photographs (1,60,000), landsat imageries and false colour composites on 1:1 million and 1:250,000 to trace out various landforms of the delta. The delta has been transfered to Survey of India base maps (58M/58N) on scale 1:250,000. The landforms were identified basing on tonalcontrast, relief, vegetation, alignment parallel to river courses and shoreline. Field checks have been carried out to confirm the landforms on the delta traced. Basing on wavying nature of ancient channels, the possible abandoned meander belts are traced. Stages in the growth of delta fronts are surmized from orientation of beach ridges. Basing on abandoned meander belts and delta fronts the over all growth of the delta is discussed.

Lineaments traced from landsat imageries are analysed with a view to bring out orientation, effect and possible origin.

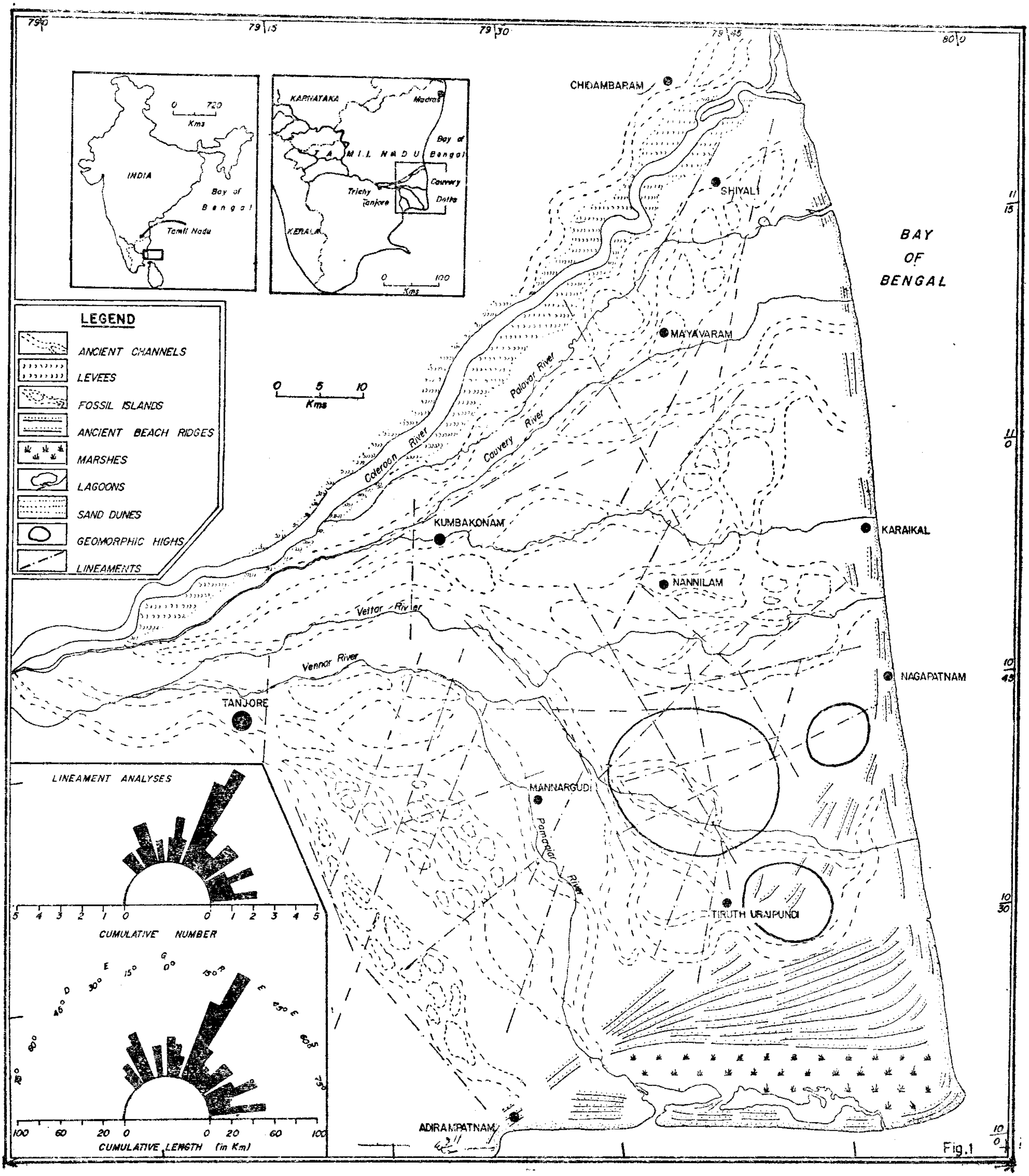
Morphology of the Delta

The River Cauvery debouches into Bay of Bengal with a major distributory namely Coleroon River. River Cauvery, River Vettar River Vennar and Pamaniar River are other minor distributaries The growth of the delta is mainly by the detrial materials brought by the river from its drainage basin. The delta laterally extends to a maximum length of 130 km from Adirampatnam in the south to Chidambaram in the north and is over 100 kms from 18 km north-west of Tanjore, the apex of the delta to the present coastline (Karaikal).

Ancient Channels

These are usually the low lying fields on the present delta recognised by tonal contrast, relief and alignment parallel to the present river courses. These are frequently subjeeted to floods during monsoon periods. The wavying nature of ancient channels with a number cutoffs show successive changes in the courses of old rivers as delta prograded. To a large extent the geology, topography and gradients of the basin determine the changes in the river courses during growth of a delta

It is noticed that majority of the points of bifurcation of old river courses have taken place near to the apex in the Cauvery delta (Fig. 1). After bifureation hydrodynamics play a major role in determination of new courses. Some times tectonics also play a major role. Once the change in river course takes place the site of active deposition of deltaic sediments shift. As a result old river courses get



INDIA
Bay of Bengal
Tamil Nadu
KARNATAKA
Madras
TAMIL NADU
KERALA
Trichy
Tanjore
Cauvery Delta
LEGEND
ANCIENT CHANNELS
LEVEES
FOSSIL ISLANDS
ANCIENT BEACH RIDGES
MARSHES
LAGOONS
SAND DUNES
GEOMORPHIC HIGHS
LINEAMENTS
Kms
CHIDAMBARAM
SHIYALI
BAY OF BENGAL
MAYAVARAM
Coleroon River
Palavar River
Cauvery River
KUMBAKONAM
KARAIKAL
NANNILAM
Vettar River
Vennar River
NAGAPATNAM
TANJORE
MANNARGUDI
Pamaiar River
TIRUTH URAIPUNDI
ADIRAMPATNAM
LINEAMENT ANALYSES
CUMULATIVE NUMBER
CUMULATIVE LENGTH (in Km)

Fig.1

filled up slowly. A group of ancient channels in an abandoned meander belt is considered to represent a major abandoned distributary that debouched into Bay of Bengal, during certain period of the growth of delta (Sambasiva Rao and Vaidyanadhan 1979). About 12 major abandoned river courses have been traced basing on disposition of wavying nature of ancient channels (i, 2, & 3 S in Fig. 2).

The central and northern part of the delta seem to be dominated by fluvlal process es. Perhaps this may be due to more fluvial action and development of flat off-shore profiles. Wright and Coleman (1973) pointed out that configuration of land-forms suits characteristics of any given delta depend to a considerable degree on wave power abjacent to the shore and on river discharge relative to river forces. River dominated shoreline configurations result only when river is able to build up flat offshore profiles (Mississippi). The same concept implies to Mahanadi and Cauvery deltas on east coast of India.

Natural Levees

The active River Coleroon has developed a few levees parallel to its course on either side of the banks. These can be recognised by tonal contrast, relief and proxmity to river course. Bagchi (1944) while discussing the landforms of Ganga delta has described seasonal accretions and formation of levees on either side of the river during flood periods. Perhaps the same process may be applied to the formation of levees in Cauvery delta.

Fossil Islands

The old river courses during their period of active deposition have deposited a few islands in their river courses. Later after the abandonment of old river courses, the islands stand out prominently and relatively high in the abandoned courses. They are recognised by relief, tone and their occurrence in old river courses.

Ancient Beach Ridges

These are low ridges lying parallel to the shoreline produced by wave action. The variations in spacing of beach ridges indicate changes in coastal configuration.

From the spacing and disposition of beach ridges about three strandlines have been surmized. A strandline here Indicates a group of approximately parallel ridges formed during a certain period of time. Ridges in the Cauvery delta are developed on south eastern part and along the Coast-line. Due to more erosive action of fluvial processes no traces of ridges are noticed on central or northern part of the delta.

The first series of ridges are recognisable at a maximum distance of about 35 km from the coastline near Tiruthuraipundi (Fig. 1). About 3 to 4 ridges are traced. The trends of these ridges are NE-SW and NNE-SSW The second series of ridges range from 10-12 with general trend ENE and WSW in direction. The third series of ridges lie almost parallel to the present coastline· Table I gives data on strandlines.

Marshes

Marshes are seen in recent coastal plain in south eastern part of the Cauvery delta. They are generally submerged during high tides and are highly alkaline.

Lagoons

During the growth of the delta there are chances for the formation of coastal lagoons along the delta fronts. There are two prominent lagoons nearer to the marshy zone of Cauvery delta. Later they are likely to be filled up slowly by the actioh of both fluvial and coastal processes.

Coastal Dunes

Along the coast of Cauvery delta the dunes are poorely developed. The maximum height of the dune is about 4.5 metres. Maritime bushy grasses such as '*Spinifex Litoreus*' cover the sand dunes. The dunes extend almost parallel or sub-parallel to the coastline.

Lineaments

Lineaments are traced from landsat imageries 1 : 250,000 based on their expression from tonal contrast, vegetation, alignment

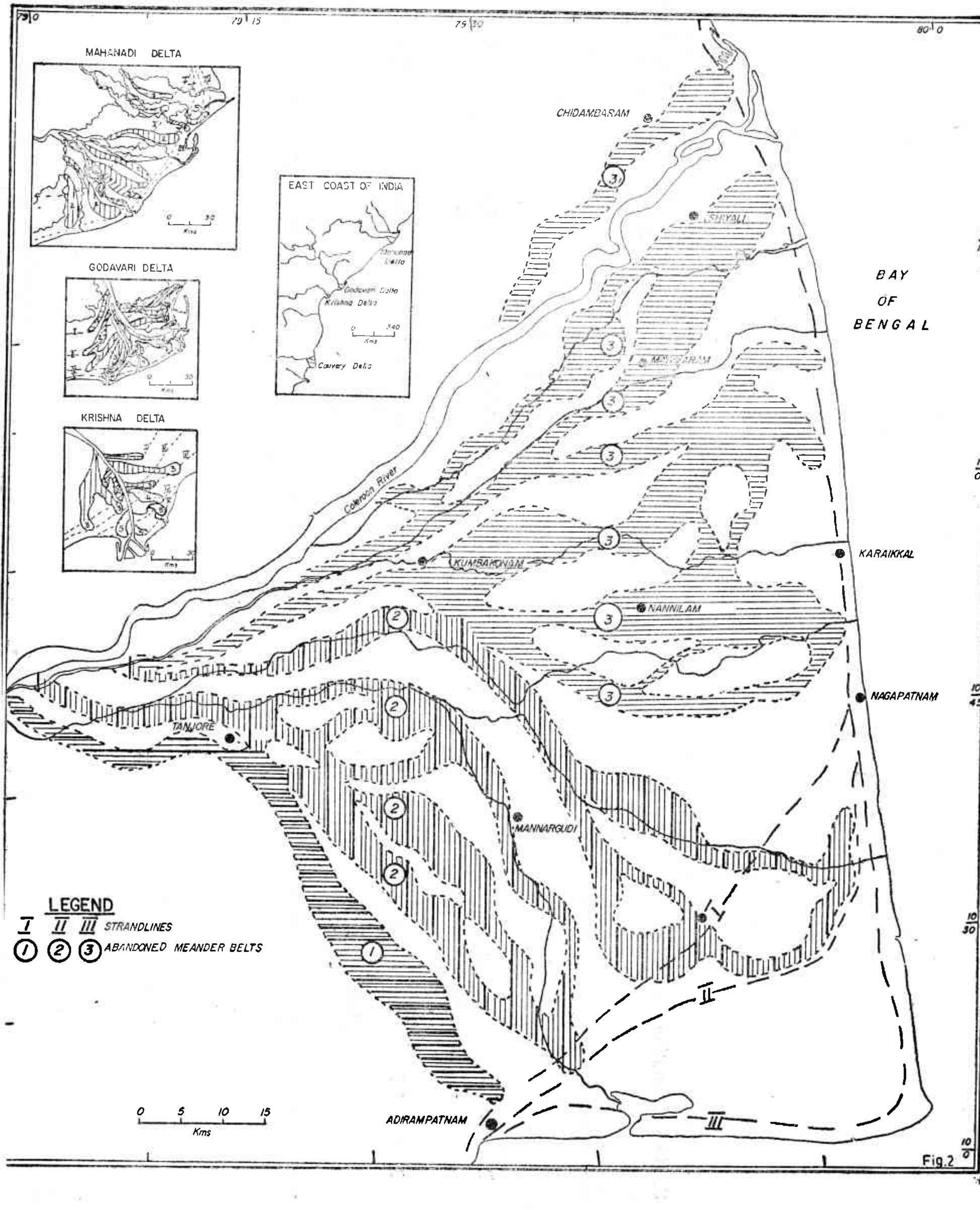

MAHANADI DELTA
GODAVARI DELTA
KRISHNA DELTA
EAST COAST OF INDIA
Godavari Delta
Krishna Delta
Cauvery Delta
CHIDAMBARAM
SHIYALI
KUMBAKONAM
NANNILAM
KARAIKKAL
NAGAPATNAM
TANJORE
MANNARGUDI
ADIRAMPATNAM
Coleroon River
BAY OF BENGAL
LEGEND
I II III STRANDLINES
1 2 3 ABANDONED MEANDER BELTS
0 5 10 15
Kms
79 0
79 15
79 30
80 0
11 15
11 0
10 45
10 30
10 0

Fig.2

Table I

S. No.	Strandline	Location	Max. distance from present Shoreline	No. of Ridges	Width in km.	Direction	Max. Height in Metres.	Min. Height in Metres
1.	I	Tiruthurai-poondi	35 km.	2-3	5	NE-SW NNE-SSW	7.2	4.5
2.	II	8.5 km. South of Tiruthurai-poondi.	25 km.	10-12	15	ENE-WSW	6.9	3.8
3.	III	Parallel to the present shore-line	3.75 km.	3-4	4	Parallel to the present shoreline	5.5	1.9

of streams initiation of meanders and sudden changes in river courses. About 36 lineaments are traced. Perhaps 20 per cent of them may be fractures affecting the trend of different landforms. However in the present study they are not separately identified. Similarly lineaments also have been traced by Babu (1975, 1978), Nageswara Rao and Vaidyanadhan (1978), Sambasiva Rao et. al. (1978), Sambasiva Rao and Vaidyanadhan (1979) and Sambasiva Rao (1980) in other parts deltas on east coast of India.

By and large NNE-SSW and NE-SW trendlines are dominant on the present delta. Table II shows the cumulative number and cumulative length lineaments. These are represented in the form rose diagrams in the inset map of Fig. 1. Largely the cumulative length is more in between North 20° East to North 55° East.

Effects of the Lineaments

1. The lineaments did participate in changing a few old river courses(Fig. 2. I). For example the lineaments trending NE-SW and ENE-WSW are partly responsible for maintainance of old river course in NE-SW directions North of Kumbakonam. Similarly the oldest river course NW of Adirampatnam which was flowing in NE-SE direction seems to be controlled by two lineaments whose trendlines are NW-SE and WNW-ESE.

2. The effect of lineaments on the present levees it insignifficant.

3. Lineaments are not traced in the coastal plain of the delta.

4. A major ' Geomorphic high ' sonth of Tiruthuraipundi is associated with a number of lineaments crossing one anothar(Fig. 2 1).

Origin of Lineaments

In the Precambrian craton majority of the lineaments are faults and fractures. A few may be Geomorphic lineaments and a few of unknown origin. In the case of the delta it is next to impossible even to recognise these lineaments in the field among vast alluvial plains. They are to be seen only in the air photos and landsat imageries. However it is presumed that some of the lineaments recognised in the delta, may be rejuvenated ones from the underlying basement rocks/sediment and some of them may have resulted due to differential compaction of sediments along certain directions. In the next phase of the study it is proposed to investigate the fault fracture patterns in the hard rock areas to establish a relation between the lineaments in the craton and delta.

Geomorphic Highs

Aprat from geomorphic features described, a few geomorphic anamolies are recognised from the landsat imageries by slight tonal contrast, relief and drainage characteristics, since these features appear to have a slight positive relief. These are here named as ' Geomorphic highs '/Morphostuctures.

A morphostructure consists of earth's surfaces which are produced by interaction between endogenetic and exogenetic forcest the endogenetic factor being prenominant in the tectonic movements of the earth's crus, (Fairbridge 1968). In general it is an actively developing element formed due to tectonic movements during the latest geological times namely Neocene and quaternary.

The ' Geomorphic highs ' are identified on the south eastern part of the delta by relief, tone and shape. They are slightly high above the surrounding area. A major anamoly is identified south of Tiruthuraipundi basing on alignment of old river courses. Here the old river courses did go almost near and around the high. Only a small old channel is traced in it. However, in general the courses of the rivers were, widely separated possibly due to the formation of this Geomorphic high.

Similar anamolies also have been identified in other parts of the deltas on east coast of India by Babu (1975, 1978), Nageswara Rao and Vaidyanadhan (1978). Sambasiva Rao et. lal. (1978), Sambasiva Rao and Vaidyanadhan(1979)and Sambasiva Rao (1980). Based on studies of morphostrucrures in Krishna and Godavari

Table II

S. No.	Direction	Class Interval in degrees	No. of lineaments	Cumulative length in km.
1.	N-E	0-5	1	35·50
2.	,,	6-10	2	28.75
3.	,,	11-15	1	15.00
4.	,,	16-20	--	--
5.	,,	21-25	4	77·00
6.	,,	26-30	5	109.50
7.	,,	31-35	2	34-50
8.	,,	36-40	1	19.25
9.	,,	41-45	1	17.50
10.	,,	46-50	2	35.25
11.	,,	51-55	2	35.25
12.	,,	56-60	–	–
13.	,,	61-65	1	26.50
14.	,,	66-70	2	49.50
15.	,,	71-75	1	21.50
16.	,,	76-80	1	19.25
17.	,,	81-85	2	52.75
18.	,,	96-90	–	–
19.	N-W	0-5	--	--
20.	,,	6-10	1	26.75
21.	,,	11-15	--	--
22.	,,	16-20	2	37.25
23.	,,	21-25	2	46.25
24.	,,	26-30	1	37.75
25.	,,	31-35	--	–
26.	,,	36-40	1	21-50
27.	,,	41-45	1	13.75

deltas Babu (1973) concluded that the trend of these anamolies follow that of Eastern Ghat mountains which are further inland.

Characteristics of the Modern Cauvery Delta

a) The Cauvery delta is asymmetrical in-form. The asymmetrical growth of the delta is identified from the uneven progradation of delta fronts and shape of the delta with refererence to the apex.

b) Ancient channels show major shifts in river courses as the delta prograded.

c) The ancient beach ridges run almost parallel or sub-parallel to one another within each strandline.

d) Lineaments indicate that along some of them there could be disturbances in the sediments and landforms. Largely NE--SW and ENW-WSW trends are predominant.

e) Geomorphic highs are prominent in the South Eastern part of the delta.

Evolution of the Modern Cauery Delta

A few authors made attempts to bring out the stages in the growth of deltas on east coast of India. Niyogi (1968), Babu (1975), Nageswara Rao and Vaidyanadhan (1978),

Table III

S. No.	Stage	No. of Abandoned meander belts.	Direction and Max. width in km.	Length of the Abandoned meander belt in km.	No. and Location of Paleoconfluences
1.	I	1	NW-SW 6	75	1 Near Adirampatnam
2.	II	4	NW-SE 5 NW-SE 5	85 60	12.5 km. NE of Adirampatnam
					2
			NW-SE 7.5 NW-SE 10	75 140	12.5 km. South of Nagapatnam
3.	III	7	E-W 3.75 E-W 7.5	60 55	7.5 km. North of Karaikal
			E-W and ENE-WSW 7.5 E-W and ENE-WSW 3.75	85 70	10 km. North West of Karaikal
			ENE-WSW 10 ENE-WSW 7.5	55 42	4 10 km. East of Shiyali
			NE-SW 6	37.5	10 km East of Chidambaram.

Sambasiva Rao et. al. (1978) and Sambasiva Rao and Vaidyanadhan (1979) are worth noting. Russel (1942) and Guilcher (1963) generalized that shifting of river courses is a major phenomenon in deltaic evolution. From the disposition of beach ridges and ancient channels successive growth of delta fronts and abandoned meander belts have been inferred. The following conclusions may be drawn from interpreted map showing the stages in the growth of delta fronts and abandoned meander belts of the Cauvery delta (Fig. 2).

1. Three stages in the growth of delta fronts are surmized from the disposition of ancient beach ridges in each strandline (I) II, & III in Fig. 2).

2. About twelve abandoned meander belts have been recognised from the disposis tion of ramifying ancient channels (1, 2, 3 s in Fig. 2).

3. From the disposition of twelve abandoned meander belts the possible locations of the confluence with the sea at successive stages of the growth of the delta are traceable (Fig. 2). Table III gives data on location, iength and direction of abandoned meander belts.

4. The earliest river course was due southeast of the present river course, apparently as the main river with practically no other distributary and discharging into the around Adirampatnam (1 in Fig. 2).

5. In the second stage of the delta front, the River Cauvery was flowing into the sea through four distributaries. These abandoned distributaries merge together into two before they empty into the sea (2s Fig. 2).

6. About seven abandoned meander belts are traced in the third stage of the growth of the delta. The River Cauvery seemed to be very active during this stage of growth of the delta. Fluvial action is dominant.

7. The present river debouches into the sea with a major distributary namely Coleroon river. River Pallvar, River Cauvery, River Vettar, River Vennar and River Pamaniar are other minor distributaries.

8. It ls noticed from the disposition of delta fronts and abandoned meander belt that the growth of the delta is from south to north. Further major part of the delta has been built up in the third stage of the growth of delta.

Variations in Evolution of Major Modern Deltas on East Coast of India (Inset map Fig. 2.)

a) The growth of Mahanadi delta is asymmetrical with three major delta fronts and ten abandoned meander belts.

b) The growth of Godavari and Krishna deltas are symmetrical with four and five delta fronts respectively.

c) The Cauvery delta is asymmetrical with three uneven delta fronts.

d) There seems to be some similarities in progradation of Cauvery and Mahanadi deltas. Both the deltas are dominated by river action.

e) The extent of oldest shoreline lies 35 km away from the shoreline in the four deltas.

f) The shifts of old river courses was uneven in Krishna and Godavari deltas.

g) The shifts of old river courses was from south to north in Cauvery delta.

Age of the Modern Cauvery Delta

Naidu (1968) has suggested that there was a lowering of sea level due to glaciation, off the east coast of India around 10,800 $\pm$ 155 B. P. basing on 14c dating of calcareous Colite sample separated from a subsurficial layer of a deep marine core sediment collected from 200 km NE of Kakinada. Sambasiva Rao and Vaidyanadhan (1979) have presumed that growth of Modern Godavari delta to be Holocene age basing on Naidus (1968) suggestion. However due to lack of any age data it is not advisable to come to a firm cocnlusion regarding the age of the delta. Studies made by Nageswara Rao and Vaidyanadhan (1978) and Sambasiva Rao et. al. (1978) on deltas of Krishna and Mahanadi concluded that the modern Krishna and Mahanadi deltas are Holocene in age.

It is presumed by the author after restoration of sea level around 10,800 + 155 B. P. the early growth of modern Cauvery delta would have started. However this does not worth to the delta forms and deltaic sediments beneath the modern delta, being much older in age.

Rate of Progradation

If we consider that the early growth of modern delta could be discussed on the surface might have started through suceessive detrial materials brought by the River Cauvery during Holocene i.e. after restoration of sea level around 10,800 ± 155 B. P. as suggested by Naidu (1968) the rate of progradation of modern Cauvery delta would be about 10 km for one thousand years from the apex of the delta to the present shoreline being 100 km.

Rate of Progradation of some of the deltas in other parts of the world are reported to be as follows :

20 km/1000 years Mississippi delta in USA Seruton (1960);

8.5 km/1000 years Po River delta in Italy. Nelson (1970);

2 km/1000 years Seyhan delta in Turkey, Evans (1973);

3.5 km/1000 years Rhone delta in France, Cokmens (1970);

20 km/1000 years Orinoco delta in Venezuela, Vas Andel (1967);

3 km/1000 years Meander River delta in Turkey. Eisma (1962);

40 to 50 km/1000 years Tigris Euphrates in Iraq, Larsen and Evans (1978).

Conclusions

The delta comprises mainly ancient channels and beach ridges. About three strandlines have been surmized from the disposition in spacing and orientation of beach ridges. About 12 abandoned meander lobes have been interpreted from the disposition of ancient channels. The lineaments indicate that along some of them there could be disturbances in the sediments and landforms. Largely NE-SW and ENE-WSW trends are predominent. Basing on disposition of delta fronts and abandoned meander lobes the over all growth of the delta has been discussed. Like other deltas on east coast of India the modern Cauvery delta also is presumed to be Holocene in age. The rate of Progradation of the modern delta is about 10 km per thousand years.

References

Andel, T. H. VAN. (1967) : The Orinoco delta-*Journ. Sedi. Petrol* 37 (2) : 297-310.

Babu, P. V. L. P. (1973) : Morphostructures of Krishna and Godavari delta region-*Photonirvachak* (journ. Indi. Society. Photointer.) 1 (1-2) : 65-57.

———(1975) : Morphological evolution of the Krishna delta-*Ibid.* 3 (1) : 21-27.

———(1978) : Geomorphology of the Krishna-Godavari delta region, interpreted from Landsat imagery. *The Natio. Geogr. Journ of India.* Special issue 24 : 55-65.

Bagchi, K. (1944) : The Ganges Delta-*Calcutta University Publication,* Calcutta : 157 pp.

Evans G. (1973) : Recent coastal sedimentation : A review. In ; *Marine Archaeology* (Ed. Blackman. D. J.) ; 89-114.

Fairbridge, R. W. (1968) : The Encyclopedia of Geomorphology - Encyclopedia Earth Sciences. Vol. 3. *Reinhold Book Corporation.* New York, p. 731.

Guilcher, A. (1963) : Estuaries, Deltas, Shelf. Slope-In : *The Sea* (Ed. Hill, M. N.) Vol. 3, Ch. 24 : 620 654. *Inter Science Publ.* New York.

Larsen, E. C. and Evans, G. (1978) : The Holocene geological history of the Tigns Euphrates Karuna Delta. In : *The Historical Geography of Middle East.* (Ed. Brice, W.) Academic Press. Inc : 227-244.

Meijerink, A. M. J. (1971) : Reconnaissance Survey of the Quaternary Geology of the Cauvery delta-*Journn. Geol. Soc. India* 12 : 113-124.

Morgan, G. T. & W. G. Mc.Intyre (1959) : Quaternary Geology of the Bengal Basin East Pakistan and India *Geol. Soc. Amer. Bull* 70 : 319-342.

Nageswara Rao K. and R. Vaidynadhan (1978) : Geomorphic features in Krishna delta and its evolution. *Symp. Morphology and Evolution of Landforms.* Dept. Geology. University of Delhi, New Delhi : 121-130.

Naidu, A. S. (1968) : Some aspects of texture, minerology and geochemistry of modern deltaic sediments of Godavari river *Unpnbl. Ph. D. thesis* of Andhra University. waltair, India.

Nelson, B. W. (1978) : Hydrography, Sediment dispersal and Recent historical development o Po River delta, Italy-In *Deltaic Sedimentation, modern and ancient* (Ed. Morgan, J P. *Spc. Publ. Soc. Eco. Paleon Minero Tulsa.* 15 : 152-184.

Niyogi, D. (1968) : Morphology and evolution of Suharnarekha delta, India-*Saertryk of Geogr. Tidsskrift* 67 : 230-241.

Okmans (1970) : Depositional sequence and sand distribution in the Post Glacial Rhone delta complex *Spec. Pub. Soc. Eco. Paleo Minero Tulsa* 15 : 198-212.

Russel, R. J. (1942) : Geomorphology of the Rhone delta-- *Annals Assoc. of Ameri. Geographers.* 32 (2) 149--254

Sastry V. V., R. N. Sinha, Gurucharan Singh and K. V. S. Murthy (1973) : Stratigraphy and Tectonics of Sedimentary basins on East Coast of Peninsular India. *Am. Assoc. Petrol Geol-Bull* V. 74 : 1089--1100.

Scruton P. C. (1960) ; Delta building and deltaic seqneuce--In : *Recent sediments of North West of Mexico* (Eds. Stiepard, F. P. F. B. Philegar and Andel. T. H. Van). *Am. Assoc. Petrol Geol. Bull* : P. 82--102.

Sambasiva Rao M., K. Nagerwara Rao and R. Vaidhyanadhan (1978) : Morphology and evolution of Mahanadi and Brahmani--Baitarani deltas--Symp. *Morphology and Evolution ot Landforms.* Dept. Geology. University of Delhi, New Delhi; 241--249.

Sambasiva Rao, M. and R. Vaidyanadhan (1979): Morphology and evolution of Godavari delta, India- *Z. Geomorph N. F*: 23 (3): 243- 255.

Sambasiva Rao, M. (1980) : Geomorphology and evolution of Modern Godavari delta Andhra Pradesh, India. *Unpubl. Ph. D, Thesis of Andhra* University, Waltair, India.

Wright, L. D. and J. Coleman (1973) : Variations in morphology of mjaor river deltas as functions a of ocean waves and river discharge regimes--Am. Assoc, *Petrol. Geol. Bull.* 57 (2): 370--398.

Address of the author

Dr. M. Sambasiva Rao, Lecturer, Department of Geography, Madurai Kamraj University, Madurai, 625002,