

EARTH SYSTEM DYNAMICS EMBEDDED IN ANCIENT TAMIL CULTURAL REMAINS AND SATELLITES OBSERVED EVIDENCES, INDIA

Professor S.M. Ramasamy

DST Geospatial Chair professor

Centre for remote sensing, Bharathidasan University

Tiruchirappalli- 620023, India email:smrsamy@gmail.com

Abstract

The Tamil society is one of the oldest societies in the world as evidenced from the large cultural remains available in the form of literature, historical data, epigraphy, archaeology etc; These cultural remains have hierarchy of information on the ancient Tamils, their culture, social systems and civilization, ancient architecture, the different rulers/ dynasties and their contributions, maritime histories and the inter/intra continental trades, their in depth knowledge in astrology, astronomy, mathematics etc; Interestingly the ancient Tamils have meticulously documented all these in their above cultural remains. In the course of these narrations, there are mentions in many places about the planet Earth and its dynamics, flow paths and the behaviour of the river systems, land-ocean interactive dynamics, natural disasters etc; These, on one side show the wisdom and the knowledge of the ancient Tamils, on the other side had information of contemporary relevance to present day science and technology based development. In this connection, the present article brings out certain newer information on the citations and descriptions made on Earth system dynamics in these cultural remains and their confirmation by the modern satellite based remote sensing technology.

Key words: Ancient Tamils, cultural remains, earth system dynamics of South India

Introduction

Tamil society is one of the oldest in the world and hence mentioned in ancient literature that “கல் தோன்றி மண் தோன்றா காலத்தே வானோடு முன் தோன்றி மூத்த குடி எம் தமிழ் குடி” (means Tamil society is older than even the rocks and soils of the Earth). So, obviously such oldest society has a strong culture and such culture is reflected in the form of various cultural remains like Tamil literature, history, epigraphy, Archaeology etc. These different modes of reflections of Tamil culture elaborately narrate about the

civilization, living style and social systems, ancient architecture, war, the rulers and their contributions, war, religion, maritime history and intra and intercontinental trades, irrigation and water management etc; But the deeper look on such cultural remains of the Tamils show that these have treasure of information much beyond the above on astrology, astronomy, Earth and its ecosystems etc. In this connection the present paper discusses about the information embedded in the cultural remains of the Tamils on the dynamics of the Earth, life history of rivers, land-ocean interactive phenomenon, natural disasters etc., and the validation /confirmation of these made by the polar orbiting satellites, which continuously revolve around the earth and collect digital photographs /images of the earth(called as remote sensing technology) .

For example, the ancient Vedic *Mahabharata* mentions that the river Yamuna was flowing 60 to 70 kms west of its present course in Agra region where Lord Krishna is said to have played with *Gopis*, and these areas are now seen as vast fertile agricultural flats. But the satellite based remote sensing data show swarms of buried courses of Yamuna in this area . Similarly, Chamberlein (1894) has inferred that once upon a time ,in the northern part of the Indian peninsula, there was only one river system called '*Indobrahm*', flowed from Assam in the northeast has flowed south westerly along the present IndoGangetic plains, cut across the Aravalli mountains and confluenced the Arabian sea in Rann of Kutch after flowing in parts of Thar desert . But later when the Himalayas rose, the *Indobrahm* is said to have fragmented into five rivers namely Brahmaputra, Ganges, Yamuna and Saraswati flowing easterly and confluencing the Bay of Bengal and Indus towards westerly to meet the Arabian sea. Later, because of the tectonic movements in the Himalayan catchment, the river Saraswati has drifted towards westerly to Thar desert. Ramasamy et al.(1991) have further inferred that initially Saraswati flowed close to Aravalli hill ranges and later ,because of the uplift of the Aravalli mountains it has anticlockwisely migrated ,flowed in different parts of Thar desert and finally buried as river Gaggara in the northern part of the desert. While such earlier paths of river Saraswati is seen as buried river courses in satellite photographs/ images both in black and white and computer aided False Colour Composite images (FCC-False Colour Composites) in different parts of the desert (Yashpal et al.1980) the earlier traces of river Saraswati are seen as buried river courses in satellite images in a fragmented fashion up to Allahabad and the people believe that rivers Saraswati, Ganges and Yamuna still meet (*Triveni Sangamam*) and take holy dip there.

Similarly there are a lot of citations in Tamil literature, history and epigraphy and archeological evidences about the earth system dynamics and some of these are discussed here, as how, where and what have been cited and how these are confirmed by the studies carried out using IRS FCC data (Indian Remote Sensing Satellite False Colour Composite).

Citations in Tamil Cultural Remains and Satellite Based Evidences

Earth Movements in India

In *Thiruvilayadarpuranam*, there is a mention that once upon a time all the *munivars* have moved and congregated in the northern part of India and due to which northern part of India (1) has subsided and the southern part (2) has risen up, and to balance and bring back India to it's normal position Agasthiya *munivar* was sent back to south (Fig.1).

Such types of earth movements can happen, only when some East-West ridges or deep earth cracks are there in the central part of India to act as fulcrum for such movements. The recent studies carried out based on satellite based remote sensing and ground based geological and geophysical surveys have brought out a major fault (deep earth crack) exactly in the central part of India (3, Fig.1) from Saurashtra in the west to Bihar in the east called 'SON-NARMADA LINEAMENT' which remains active since near 60-70 million years (Pal and Bhima Shankaran 1976; Bhagawandas and patel 1984; Ramasamy 1985) and this would have acted as a fulcrum for such upward and downward movement of India, cited in Tamil literature *Thiruvilayadarpuram*



Fig.1: Regions where subsidence of the northern(1) and the emergence of southern (2) parts of India were cited in *Thiruvilayadar puranam* when all the *munivars* from south have moved over to north and the Agasthiya *munivar* was sent back to south to restore normalcy; and the recent studies using satellite data showing an East-West SON-NARMADA lineament (3) which would have acted as a fulcrum For such earth movements

Old river system north of Chennai

There are several mentions about a major river system in Kortallaiyar region (1) north of Chennai (2, Fig.2). Foot(1864) was the first to visualise a major river system in the region. The Tamil Nadu historical Society (1975) documented evidences for a major river system from the thick river sediments laid over lateritic soils and the river cut terraces at an elevation of about 100m from the present bed level of river Kortallaiyar. The archaeological studies carried out by Krishnaswamy (1947) and Ramachandran(1980) have also brought out river terraces at different elevations again from the bed level of river Kortallaiyar. They have also collected a lot of tools and implements from the river sediments of this area related ancient river valley civilization and observed that the civilization existed in the area may be co-eval to Narmada man .

Now, there is no such major river system in the area. But in contrast , the recent satellite data based explorations revealed the existence of a major buried river(1) branching off from the present day river Palar (3) and ending up as buried deltas (4) north of Chennai (2) and south of Pulicat lake (5, Fig.2) (Ramasamy et al.(1992). Ramasamy et al. (1992) have further inferred that this major buried river course is the left out path of river Cauvery which has flowed in this area from 500 thousand years to 3000 Yr. BP (years before present).These inferences drawn from the satellite based remote sensing studies confirm the observations made in Tamil literature, historical evidences and the archaeological excavations.

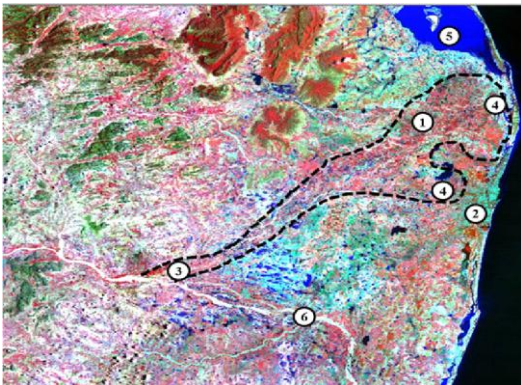


Fig.2:Kortallaiyar river valley (1) where Tamil literature and the archaeological excavations have cited evidences of a major river system with fluvial sediments, river terraces and tools and implements related to flourishing civilization north of Chennai (2); and the IRS FCC data showing a major buried river system branching off from river Palar (3) and ending as deltas (4) north of Chennai (2) and south of Pulicat lake (5); present course of river Palar(6)

Migration of River Palar near Kanchipuram

In ancient Tamil literature, *Kalingathuparani* it's author JayamKondanar mentioned that during 1100 Yr.BP when King Karunakara Thondaman proceeded for

war with Kalingas, from his capital Kanchipuram, (1, Fig.3) used ferries for his warriors to cross over the river Palar which is said to have flowed north of Kanchipuram during that period. Similarly, the Kondapuram koil (2, Fig.3) stone inscriptions show that the Kondapuram temple was located south of river Palar. But no river flows north of Kanchipuram and further the said river Palar is now flowing south of Kondapuram temple.

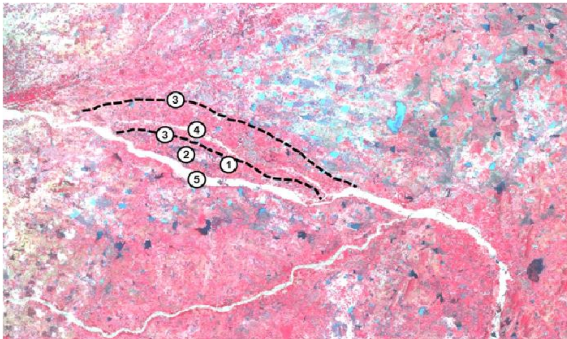


Fig.3: Discriptions made in Kalingathuparani and Kondapuram koil inscriptions about the flow of river Palar north of Kanchipuram (1) and Kondapuram(2); IRS FCC data showing wide abandoned course (3) of Palar which is now occupied by the river Vegavati river(4), with the present course of Palar (5) to it's south

In contrast, the IRS FCC satellite data shows a wide buried river course (3) in the form of a broad meander loop with present Palar flowing south of it (5) and again the said old course or the abandoned course of Palar is currently occupied by river Vegavati (4) (Fig.3). This lead to the surmise that during 1100 Yr.BP, which is the age of *Kalingathuparani* and well as the Kondapuram inscriptions, river Palar might have flowed north of Kondapuram temple and Kanchipuram and shifted it's course to south of these locations and its left out course has been occupied by river Vegavati.

Flow of River Palar in Chengalput

In the book *Ptolemy* written by Raghavan (1978), it is mentioned that during Ptolemy's period (1800 Yr. BP), the river Palar is said to have flowed close to Chengalput, but how it flows 2-3 kms west of it.

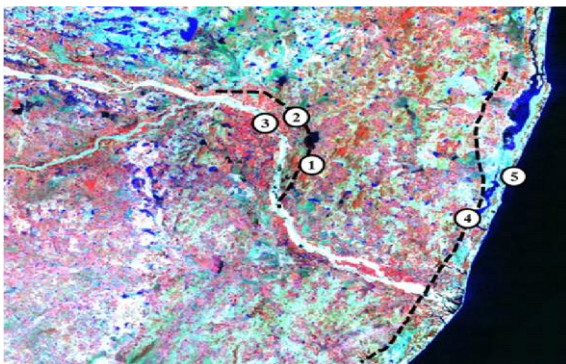


Fig.4: References in book *Ptolemy* about the flow of river Palar close to Chengleput (1) during 1800 Yr BP; IRS FCC showing it as a major buried meander scar (2) indicating the earlier flow upto Chengleput and the present river Palar (3) 2-3 west of Chengalput; Past (4) and the Present(5) shorelines.

But the interpretation of IRS FCC data shows that there is an old river course (1) close to Chengalput in the form of an arcuate mender scar (2) showing convexity towards northeasterly and linked up with river Palar (3) on it's either ends showing convexity towards northeasterly (Fig.4). This shows that the river Palar might have flowed with the meandering pattern upto Chengalput during 1800 Yr. BP and later on it would have straightened out taking the present path (3) because of the uplift of the region as demonstrated by Ramasamy (2006a) or the fall of sea level and the recession of the coast line (4 to 5, Fig.4).

Disappearance of River Cauvery in Hogenekkal

Singaravelan (1976) in his book *Cauvery valam* has mentioned that the river Cauvery which has flowed down from Thalaikkaveri, its place of origin, has suddenly disappeared near Hogenekkal (1, Fig.5) and a holy Chola king has drowned and sacrificed his life and as mark respect to his soul, it has re-appeared and started flowing towards Cholamandalam namely Tiruchirapalli-Thajavur region(2, Fig.5).

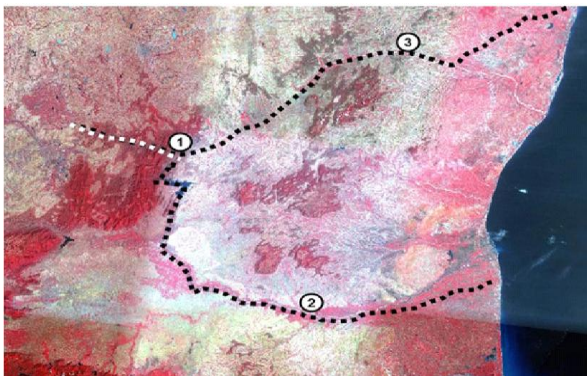


Fig.5: References in history on the disappearance of river Cauvery near Hogenekkal (1) and the drifting of the river (2) towards Cholamandalam. IRS FCC showing the abandoned earlier path of Cauvery (3) along Hogenekkal- Chennai and the present course (2) along Tiruchirappalli-Thanjavur plains.

Ramasamy et al. (1992) have inferred from their remote sensing studies that the river Cauvery had earlier flowed from Hogenekkal to Chennai via; Dharmapuri, Ambur, Vaniyambadi, Walajapet, Thakkolam, Arakkonam and Pulicat lake (Fig.2) during 500 thousand years to 3000 Yr. BP and later shifted and taken the Hogenekkal-Tiruchirappalli path. In this context the location Hogenekkal where the river Cauvery is said to have buried, re emerged and drifted towards Cholamandalam is significant because, only keeping Hogenekkal as it's axis the river Cauvery has clockwise migrated from Hogenekkal- Chennai path(3) to Hogenekkal- Tiruchirappalli-Thanjavur path(2)(Fig.5).

Radhakrishna(1994) also made similar observations that there is a North - South cymatogenic arch in Hogenekkal region and due to which only the river

Cauvery took a zig-zag path in the area and drifted southerly towards Tiruchirappalli plains and ,if so , such cymatogenic arching phenomenon would have contributed to the disappearance of Cauvery. However such fascinating historical evidences cited by Singaravelan(1976)is significantly coinciding with recent scientific studies.

Flow of Cauvery in Tiruvidaimaruthur region

The stone inscriptions of 1000 YrBP found in Mahabaliswarar temple at Tiruvidaimaruthur (1, Fig.6) show that the temple lands of the area were irrigated by a river called “*Palam Cauvery*” during those years (Fig.6).

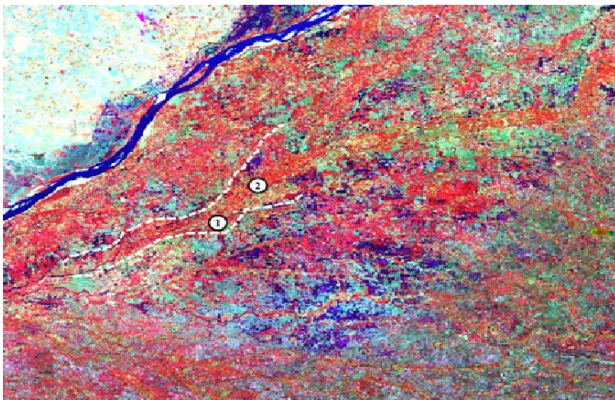


Fig.6: Epigraphic evidences from the stone inscriptions of Tiruvidaimaruthur temple (1) about the irrigation of temple lands by the *Palam Cauvery* river during 1000 Yr. BP and the IRS FCC showing an old course of Cauvery river (2) along Tiruvidaimaruthur.

Where as there are no rivers now in Thividaimaruthur area and in contrast, the studies carried out using IRS FCC data show a major buried river course (2, Fig.6) and this course only ends up at Kaveripoompattinam where the ancient and the popular river mouth port city was located during Sangam period . This indicates that the Cauvery might have flowed along Tiruvidaimaruthur before or around 1000 Yr. BP which is the period of the Tiruvidaimaruthur inscriptions and might have shifted later on from this path . In fact Ramasamy et al. (1992) have demonstrated that the river Cauvery which entered into Tiruchirappalli Thanjavur plains around 2300 Yr. BP flowed initially along the southern part of the present day Cauvery delta and then anticlockwisely migrated towards northerly and reached Coleroon’s path around 750 Yr. BP after flowing in different parts of present day Cauvery delta . Ramasamy et al.(2006b) again, on the basis of radio Carbon dating, inferred that the river Cauvery flowed in this region within this period only.

Thus, the citations made in the stone inscriptions corroborate with recent research findings using advanced tools and technologies.

Path of Cauvery cited in *Periyapuranam*

Veerasamy (1990), the author of *Periyapuranam*, mentioned numerous settlements located along the southern and northern banks of river Cauvery. For example, the villages Senganur (1), Bandanallur (2), Adanur (3) and Tiruppanandal (4) were located in the southern bank and Tiruppurampayam (5), Illuppaipattu (6), Talainayar (7) and Achalpuram (8) were located in the northern bank of river Cauvery during *Periyapuranam* period of 1100AD(900 Yr.Bp) (Fig.7). But Cauvery is not flowing now in between these sets of villages and now flows as river Coleroon little north of this *Periyapurnam* course.

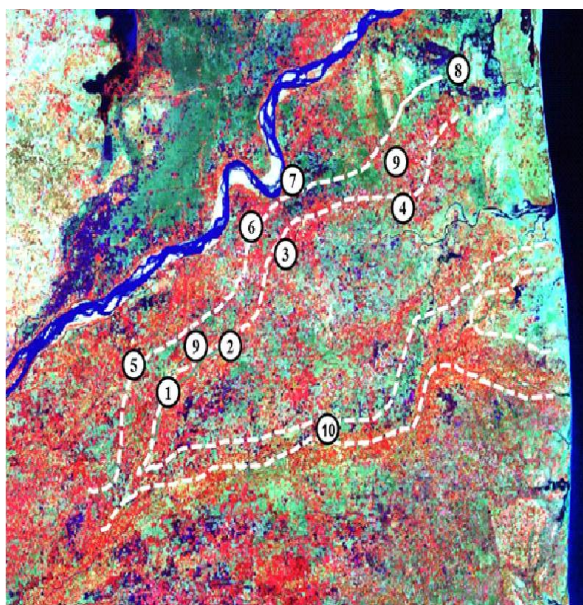


Fig.7: Narrations in Tamil literature *Periyapuranam* that villages Senganur (1), Bandanallur (2), Adanur (3) and Tiruppanandal (4) were located in the southern bank and Tiruppurampayam (5), Illuppaipattu (6), Talainayar (7) and Achalpuram (8) in the northern bank of Cauvery which flowed in between these set of villages during period of *Periyapuranam* (900 Yr. BP) ; The IRS FCC data showing a major buried river along this path (9) described in *Periyapuranam* ; another old course of Cauvery (10) seen to the south of it only is the *Palam Cauvery* that flowed along Tiruvidaimaruthur at the mouth of which only Poompuhar was located.

But the analysis of IRS FCC satellite data shows a well-defined buried course of a river (9, Fig.7) from which it can be conformably said that the river Cauvery might have flowed along this path during *Periyapuranam* period. It also matches with overall migratory pattern of river Cauvery established by Ramasamy et al. (1992) and Ramasamy et al. (2006a).

Ancient sea upto Madurai

In Tamil literature *Tiruvilayadarpuranam*, there is a mention that the sea waves were hitting the walls of Madurai city and King Sundara Pandiyan has thrown an arrow and because of which the sea has receded from Madurai.

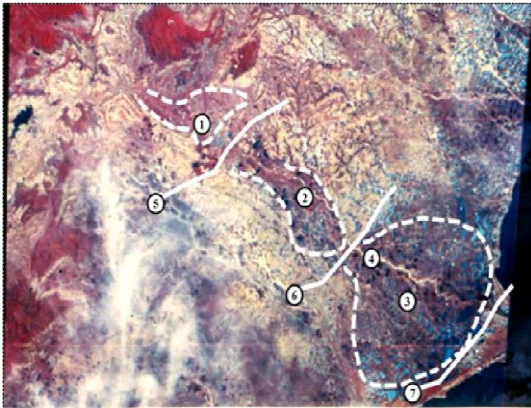


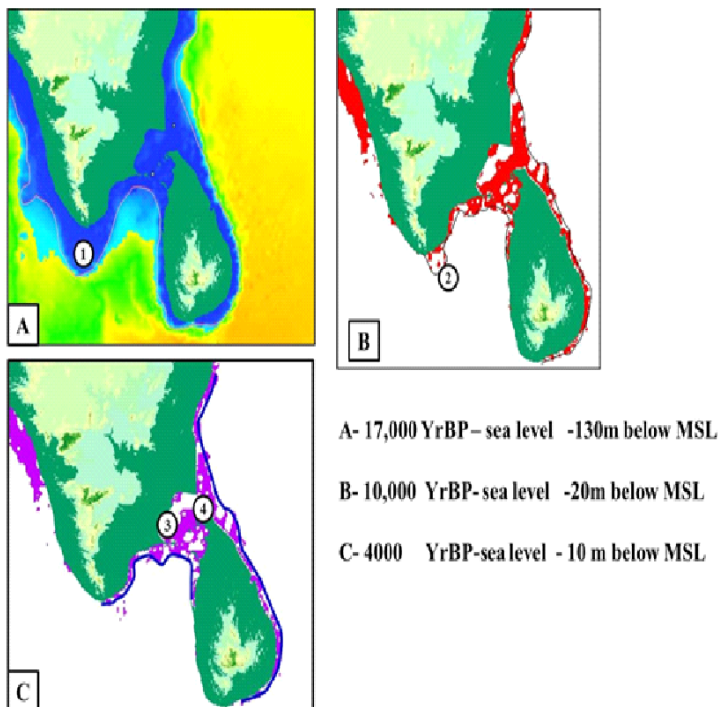
Fig.8: Narrations in Tamil literature *Tiruvilayadarpuram* about the hitting of Madurai walls by the sea waves, throwing of an arrow by the King Sundara Pandiyan and the recession of the sea; IRS FCC data showing the delta-1(1) north west of Madurai, delta-2 in Tiruppuvanam area (2), delta-3 (3) with its apex from Paramakkudi (4) onwards indicating the old shore lines(5,6,7) south east of these deltas, endorsing the above narrations.

Though this narration warrants deeper studies, the preliminary studies carried out using satellite data show ample evidences for it. The satellite pictures show a major delta (delta-1) northwest of Madurai, delta-2 in Tiruppuvanam area and delta-3 with its apex at Paramakkudi and spreading over upto the present coast (1,2,3 Fig.8). These are the well developed lobate deltas which normally grow where ever the land is gradually uplifting and the sea is consequently receding, facilitating the deltas to slowly prograde, lobes after lobes as concentric rings with inter lobal depressions becoming water bodies later on(Thornbury 1995; Ahmed 1973; Ramasamy 2006b). Ramasamy (1992) has explained that these unique deltas were formed at three stages in between Madurai and the present day coast due to the pulsatory uplift and the resultant probable stand still periods during the recession of the sea.

Further, the satellite images show three definite old shorelines, south east of Madurai (5), Tiruppuvanam (6) and east of Ramnad (7) (Fig.8). Thus such phenomenon cited in literature are confirmed by the modern scientific tools. However such phenomenon of land ocean interaction provide multi dimensional information on the earth system dynamics which have direct bearing over natural resources, ecosystems, natural disasters, ancient civilisation and the maritime histories.

Submergence of Kumarikkandam

There are several mentions and descriptions on ‘Kumarikkandam’ (Lemuria Continent) in Sangam and post sangam literature (*Kumari Kandam - Wikipedia*) that there was a huge landmass south of Cape Comorin, India during 32,000 -18,000 Yr.BP which was the actual place of origin of the ancient Tamils). The Great Tamil Epic *Manimeghalai* mentioned that this land was swallowed by the sea due to “Kadal Kol” (Swallowing up by the sea or Tsunami). However except the narrations in Tamil literature, not much of studies have been carried out to understand the *Kumarikkandam* comprehensively. However, the recent studies carried out using DEM (Digital Elevation Model) of GEBCO data (General Bathymetric Chart of Ocean) which shows the sea bed topography of the ocean, and the wrapping of the past sea levels over it showed the occurrence of a large land mass South of Cape Comorin during 17,000 Yr.BP and later it’s gradual shrinkage and submergence due to the sea level rise.



Madurai and then to Manalur

Fig:9: *Kumarikkandam* cited in Tamil literature *Manimeghalai* and the visualisation of land-ocean boundaries during 17,000 Yr.BP(A), 10,000 Yr.BP(B) and 4000 Yr.BP (C) and the probable landmass south of Cape Comorin (1 & 2) where only Kapadapuram(1) and Vada Madurai(2) might have been located and the landmass at Vaigai mouth(3) where Manalur was located; (4) water covered area; When the sea level rose the *Kumarikkandam* seems to have submerged and in that process when Kapadapuram submerged, the Pandiya kings have shifted their capital Kapadapuram to Vada-

The sea level curve brought out by the IPCC (InterGovernmental panel on Climate Change) shows that around (i) 90,000 Yr. BP the sea level was 10m above the

present mean sea level (PMSL), (ii) 65,000 Yr. BP – 80m below PMSL, (iii) 35,000 Yr.BP – 5m below PMSL, iv) 17,000 Yr. BP – 130m below PMSL and (v) Since 17,000 Yr.BP there has been a continuous rise of the sea level.

From the IPCC sea level curve, the sea levels of 17,000 Yr.BP(-130m below PMSL), 10,000 Yr.BP(– 20m) and 4000Yr. BP(10m) were wrapped over the digital elevation model (DEM) generated from GEBCO data(A,B,C Fig.9) and the land-ocean boundaries for these periods were brought out using GIS.(Fig.9). This showed that during 17,000 Yr.BP ,when the sea level was below 130m from the PMSL, India and Sri Lanka were together as one piece of land (Fig.9A) and in addition, a huge triangular shaped land of several thousand sq.kms. was seen (1, Fig.9A).This might have been the part of during *Kumarikkandam* 17,000 Yr.BP. where only the Pandiya kings might have established their capital city Kapadapuram. When the sea level was risen in the computer visualization and brought to 20m below PMSL, to represent the land-ocean boundary during 10,000 Yr.BP, this land mass has shrunk .In such comparatively shrunk land mass ,the Pandiya dynasty might have established their second capital Vadamadurai(2, Fig.9B) once Kapadapuram submerged due to sea level rise. When the sea level was further raised to 10m below PMSL in the computer based visualization to draw the land-ocean boundary during 4,000 Yr. BP, an undulating sea bed appeared with appreciable piece of land at the mouth of river Vaigai (3, Fig.9C) where only Manalur was established as their 3rd capital by the Pandiya kings , when Vada Madurai submerged .

Thus the preliminary study validated the *Kumarikkandam* cited by the early Tamils and the detailed studies will bring out more information on this.

Symptoms of Earthquakes

It appears that the ancient Tamils had knowledge in predicting natural diseases too. In sangam literature *Silappathikaram* these is a mention that Kaunthi Adigal when left Kannaki and Kovalan with Aadhirai at Madurai asked her to take care of them , because there are symptoms of Earthquake in the area. Though real meaning is to be interpreted but the recent studies showed active faults from Pondicherry in the north east to Cumbum valley(1, Fig.10) in the south west in close proximity to Madurai (Ramasamy and Kartikeyan 1998)

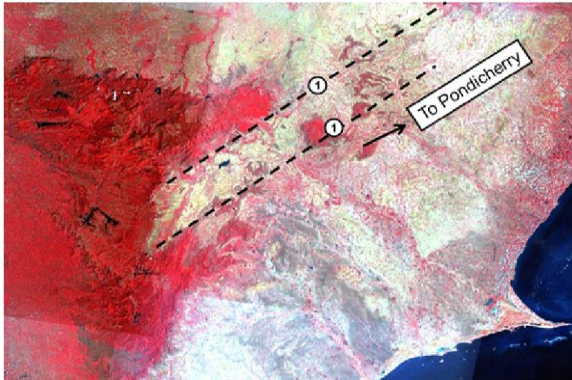


Fig.10: Mentions have been made in great Tamil epic *Silappathikaram* that when Kaunthi adigal left Kannaki with Adhirai at Madurai, she mentioned that an earthquake is likely to occur and she has to take care of Kannai safely; the analysis of satellite data (IRS FCC) shows that there are two seismic prone faults in between Pondicherry in the north east to Cumbum valley (1) in the south west

Discussion and Conclusion

The Tamil society is one of the oldest societies in the world as witnessed from the strong cultural imprints like Literature, History, Epigraphy, Archaeology etc; These have enormous information on the ancient Tamils Viz; social systems, culture, civilization, ancient rulers, ancient architecture, maritime history, astrology, astronomy etc; Though much research have been done in the above areas, these have mostly brought out the past glories, and not much of work has been done to unearth the treasure of information embedded in these cultural remains on astrology, astronomy, planet earth etc. In this context, the present study has made an attempt to gull out some information embedded in the ancient Tamil cultural remains, especially in the areas of Planet earth/ Earth System Sciences, which revealed that the tectonic movements, river flow dynamics, land-ocean interactive dynamics along the east coast of Tamil nadu, natural disasters etc; which have been cited in the ancient cultural remains are confirmed and corroborate with the studies carried out in the recent years using modern higher technologies like satellite based remote sensing. This indicates that the ancient Tamil cultural remains warrant detailed studies in this direction.

Acknowledgement

The author acknowledges the NRDMS, Dept of Science and Technology, New Delhi for having provided the DST Geospatial Chair Professorship, under which only the study was carried out.

References

- 1) Ahmad Enayat (1973) Coastal geomorphology of India. *Orient Longmans Bombay*; 222p
- 2) Bhagawandas and Patel NP (1984) Narmada-Son lineament *Jour. Geol. Soc. Ind.* 25(5): pp 267-276
- 3) Foote RB (1916) The Foote collection of Indian Prehistoric and Protohistoric Antiquities - Notes on their ages and distribution. *Madras Government press*
- 4) Krishnaswamy VD (1947) Stone age India. *Ancient India* .3: pp 3233
- 5) Pal PC and Bhima Sankaranan VLS (1976) Tectonics of the Narmada - Son-Brahamaputra lineament. *Geol. Surv. Ind. Misc. publ.* 34: pp 133-140
- 6) Radhakrishna BP (1994) Neogene uplift and geomorphic rejuvenation of the Indian Peninsula, *Current Science Special issue : Quaternary period in India*. 64: pp 787-792
- 7) Raghavan VSV (1978) Ptolemy (AD 119-161). *Chidambaram: Manivasagar Pathipagam*
- 8) Ramachandran KS (1980) Archaeology of south India. Delhi: *Sandeep Prakashan*
Ramasamy, SM, (1985) Deformation Tectonics of Deccan Volcanics of Southern Saurashtra, India and its Relation to Western Extension of Narmada Lineament. (Ed.) Rajesh Srivastava and R. Chandra. *Spec. Vol. on Magmatism in Relation to Diverse Tectonic Setting, Oxford IBH* : pp. 195 - 208.
- 9) Ramasamy SM (1992) A remote sensing study of river deltas of Tamil nadu. *Memoirs of Geological Society of India* , No(22): pp 75-89
Ramasamy SM (2006a) Remote sensing and active tectonics of South India. *International Journal of remote sensing, Taylor and Francis, London, Vol 27, No 20* : pp 4397-4437
- 10) Ramasamy SM (2006a) Remote sensing and active tectonics of South India. *International Journal of remote sensing, Taylor and Francis, London, Vol 27, No 20* : pp 4397-4437
- 11) Ramasamy SM (2006b) Holocene tectonics revealed by Tamilnadu deltas, India, *Journal Geological Society of India* . Vol 67 (5): pp 637-648
- 12) Ramasamy SM and Karthikeyan N (1998) Pleistocene /Holocene graben along Pondicherry-Cumbum valley, Tamilnadu, India. *Geo Carto international Vol. 13(3)*: pp 83-90

- 13) Ramasamy SM ,Bakliwal PC, and Verma RP (1991) Remote sensing and River migration in western India . *International Journal of Remote sensing, Taylor and Francis Ltd, London,Vol 69(12),pp 2597-2609*
- 14) Ramasamy SM, Saravanavel J and Selvakumar R (2006a) Late Holocene geomorphic evolution of Cauvery delta. Tamil Nadu. *Journal Geological Society of India .Vol 67:pp 647-652*
- 15) Ramasamy SM, Venkatasubramanian V, Riaz Abdullah and Balaji S.(1992) The phenomenon of river migration in Northern Tamilnadu- Evidences from satellite data ,Archaeology and Tamil literature .*Man and Environment,Pune V(XVII) (2):pp 13-25*
- 16) Ramasamy SM, Saravanavel J, Yadava MG and Ramesh R (2006b) Radio carbon dating of some palaeo channels in Tamilnadu and their significance .*Current Science, Vol 91.No 12: pp 16091613* Singaravelan S (1976) Cauvery Valam. *Kazhaga Veleyedu publication*
- 17) Tamilnadu Historical Society(1975)*History of Tamilnadu(Stone Age)* Thornbury (1985) principles of geomorphology, 2nd edition.*Jhon Wiley and inc.New York: 594p*
- 18) Veerasamy TV (1990) *Periyapurana sirappu Periya agarathi .Thnjavur :Tamil university*
- 19) Yashpal SB,Sood RK and Agarwal DP (1980) Remote sensingand the lost Saraswati river.
- 20) *Proceedings of the Indian Academy of Sciences, Delhi (Earth and Planetary sciences) 69:pp 317-331*