

only be interpreted as increasing/decreasing trends for a particular site.

1. Bogaert, J., Van Hecke, P. and Ceulemans, R., *Environ. Manage.*, 2002, **29**, 673–682.
2. Forman, R. T. T. and Godron, M., *Bio-science*, 1981, **31**, 733–740.
3. Skole, D. and Tucker, C. J., *Science*, 1993, **260**, 1905–1910.
4. Forman, R. T. T., In *Land Mosaics: The Ecology of Landscapes and Regions*, Cambridge University Press, Cambridge, 1997.
5. Sala, O. E. *et al.*, *Science*, 2000, **287**, 1770–1774.
6. Roy, P. S. and Tomar, S., *Biol. Conserv.*, 2000, **95**, 95–109.
7. Phipps, M., In Proceedings of the International Congress (eds Tjallingii, S. P. and De Veer, A. A.), Center for Agricultural Publishing and Documentation, Wageningen, 1981, pp. 57–64.
8. Forman, R. T. T. and Godron, M., *Land-scape Ecology*, John Wiley, New York, 1986.
9. Singh, G., In Proceedings of Symposium on Water Erosion, Settlement and Resource Conservation, Dehradun, 25 March 1990, CSWCTR, Technical Report, vol. 1, pp. 1–36.
10. Roy, P. S. and Joshi, P. K., *Int. J. Remote Sensing*, 2002, **23**, 4881–4896.
11. Roy, P. S. and Kaul, R. N., *Int. J. Remote Sensing*, 1985, **65**, 411–418.
12. Khan, M. L., Menon, S. and Bawa, K. S., *Biodivers. Conserv.*, 1997, **6**, 853–868.
13. Behera, M. D., Ph.D. thesis, Gurukula Kangri University, Haridwar, 2001.
14. FSI, State of Forest Report 1987, Forest Survey of India Dehradun, 1988, p. 86.
15. FSI, State of Forest Report 1989, Forest Survey of India Dehradun, 1990, p. 50.
16. FSI, State of Forest Report 1993, Forest Survey of India Dehradun, 1994, p. 82.
17. FSI, State of Forest Report 2001, Forest Survey of India Dehradun, 2002, p. 130.
18. Anon., Indian Institute of Remote Sensing, Dehradun, 2002, p. 296.
19. FSI, State of Forest Report 1995, Forest Survey of India Dehradun, 1996, p. 7.
20. Anon., *Down to Earth*, 2002, 26–34.
21. www.iussp.org/Banekok2002/S17Mishra.pdf.
22. Shannon, C. E. and Weaver, W., *The Mathematical Theory of Communication*, Urbana, Illinois, 1949.
23. Pielou, E. C., *Ecological Diversity*, John Wiley, New York, 1975.
24. Pielou, E. C., *Mathematical Ecology*, John Wiley, New York, 1977.
25. Yeh, A. G. O. and Li, X., *Photogramm. Eng. Remote Sensing*, 2001, **67**, 83.
26. Sudhira, H. S., Ramachandra, T. V. and Jagadish, K. S., *Int. J. Appl. Earth Obs. Geoinf.*, 2004, **5**, 29–39.

ACKNOWLEDGEMENTS. The study has been funded by ISRO–GBP. We appreciate the fruitful discussion and support from Mr H. Sudhira.

Received 17 May 2005; revised accepted 16 March 2006

P. K. JOSHI*
NIKHIL LELE
S. P. AGARWAL

*Forest and Ecology Division,
Indian Institute of Remote Sensing,
4 Kalidas Road,
PB No. 135,
Dehra Dun 248 001, India
*For correspondence.
e-mail: joshi@iirs.gov.in*

Reconstruction of the ancient Port, Korkai in Tutukkudi District of Tamil Nadu

Chronologically, Korkai is the oldest port site of Tamil country possibly since the beginning of the first millennium BC. However, its emergence as a significant emporium may have been only around the fourth and fifth century BC. Korkai (8°40'N; 78°5'E) is recognized by the Periplus of the Erythrean Sea as Colchis and by Ptolemy as Kolkhoi. Correct identification came in 1838. Early archaeological excavations carried out by Caldwell in the Tamiraparani delta in the 19th century, affirmed its present site almost in ruins close to a place called Eral¹. It was a dual centre of the early Pandya rule, identified with Pandya-Kavada by the *Ramayana* and the *Mahabharat*, and as Kapatapuram in *Kalithogai*. Its reputation is spoken of in *Akananuru* and *Ainkurunuru*. The entire Gulf of Mannar is recognized by the Periplus as the Colchic Gulf, due to pre-eminent status of Korkai. Excavations by Nagaswamy and others

have brought to light the early artifacts of the site at Korkai. Stone inscriptions in the Koil of Vetrivelamman and the Pillayar Kovil at Korkai and at Attur across the river on the opposite bank reaffirm that the site is the old port of Korkai. A lone 'Vanni' tree standing in Korkai is about 2000 years old, according to the Tamil Nadu Archaeological Survey.

Upstream of Korkai about 20 km away on the same river valley on the right bank of Tamiraparani is Aditchanallur, the largest megalithic burial urn area in South India². Its proximity and the find of megalithic burial urns at Korkai itself indicate that the valley side was fairly well-populated during megalithic times. Carbon dating of the artifacts in the area indicates an age of 785 BC, while Aditchanallur findings of copper finds including an icon of Mother Goddess of 8th century BC indicate that it was an active settlement,

and probably river navigation extended up to it from the delta mouth.

Korkai is sited on an alluvial terrace, above the present-day flood plain of the river. The archaeological finds are about 3 m below the terrace level. Excavations have revealed Mauryan pottery of 2nd and 3rd century BC and the glazed pottery found belong to Northern Black Polished ware. The burial urns lie adjoining a structure built with large bricks. Adjoining on the west end are heaps of pearl oyster shells, and three ring wells. More significantly, the finds of black and red pottery ware with old Tamil Brahmi scripts (two to four letters in a line or two), apart from drawn graffiti of the sun, fish, bow and arrow have been dated to a period between 3rd century BC and 2nd century AD. The occurrence of Roman ware, and rouletted ware indicates their external links. Archeologists have found ruins of chank-cutting factories, centres for split opening

of pearl oysters at the site. Archaeologists opine that Korkai indicates the closing phase of the megalithic period and Korkai itself was a major Pandyan port during this period. Though it continued to function till the 5th century AD, it was on a decline since the 3rd century AD. Probably with this decline is linked the shift of the Pandyan capital from Ten-Madurai or Korkai itself to the later capital at Madurai.

Korkai is located 7.5 km away from the sea, close to Eral. It is on the northern left bank of Tamiraparani river close to the apex of the bird-foot delta. The agriculturally productive delta of the river known

for abruptly rising flash floods is dynamic and fast growing out into the sea, due to heavy sedimentation of the river alluvium in a relatively tideless sea. Palaeo-channels traced from the satellite imagery scenes all around Korkai indicate that the river has shifted its course progressively east and south. As can be seen from a scrutiny of the topographic sheets and satellite imagery and tracking of palaeo-channels, Korkai, once on the sea has receded away from the shore (Figure 1). The nature of the bird-foot delta, lobes, lagoons, marine terraces, beach ridges and bars on the sea front, newly formed and old islands have all helped in tracing the probable stages in

the evolution of the delta, as the river course progressively shifted south, and the distributaries elaborated. The Korkai Bay in the advancing front of the delta lobe got silted, and the port had to decline. The siltation is so rapid that in the last 2000 years of the historic past, land has advanced into the sea over a distance of about 8 km.

After the decline of Korkai, Palayakayal emerged as a new port, but never rose to the prominence of Korkai. The replacement of Korkai by Kayal might have commenced around the 6th century AD. But its importance as a major port did not take effect till the 12th century AD. The port site is at a location called Palayakayal on

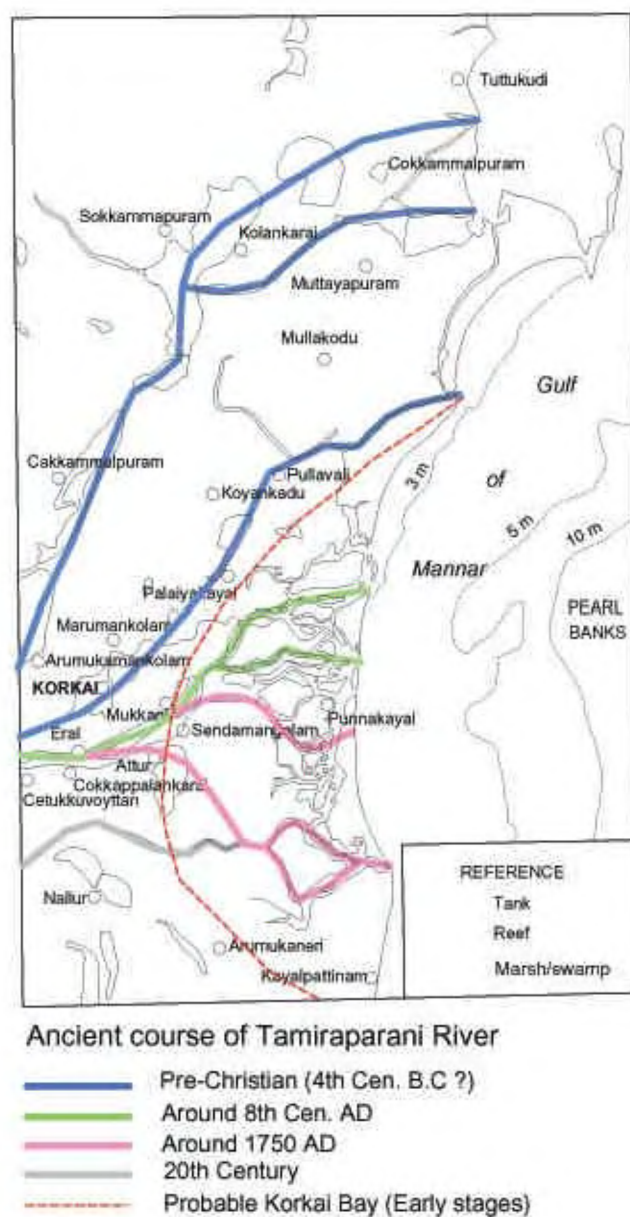


Figure 1. Map showing ancient course of Tamiraparani river.



Figure 2. Satellite imagery of the study area.

a northern distributary of the delta, about 5 km northeast of Korkai.

Interpretation of satellite imagery (Figure 2) indicates that in the 1st and 2nd century AD, the Tamiraparani river might have flowed towards northeast from Eral, parallel to the coast and joined the sea south of Tuttukudi town. Korampallam tank, Peykulam, and Arumugamangalam tank might be the relicts of palaeochannel of the Tamiraparani river. In Tamil, Aru means river and Mugam means face. The name of the settlement 'Arumugamangalam' might have been derived since it was situated on the bank of the river. At present there is no river in the area, but there exists a tank, which is elongated in

shape, situated parallel to Peykulam, and Korampallam tanks. This tract has fertile alluvial deposits in a linear pattern. So, this must be the old river course of the Tamiraparani river. The ancient port Korkai might have been situated on one of the distributaries of the Tamiraparani close to the sea coast. About 1 km southwest of Korkai there is a settlement called Kana-visamudram, indicating presence of sea or extensive water body nearby. There must have been a bay close to Korkai in the Gulf of Mannar, which would have allowed more ships to anchor. Due to heavy sedimentation and deposition both by the sea and the river, the bay would have got silted up; Palayakayal might have emer-

ged as a new port in place of Korkai. Later, the coast might have prograded towards the east giving rise to new ports like Punnakayal and Kayalpattinam. At present the coast is about 200 m east of Kayalpattinam.

The Tamiraparani river might have flowed towards north of its present delta and joined the sea south of Tuttukudi town. Palaeo-channels traced from the satellite imagery indicate that the Tamiraparani river might have shifted course progressively from north to south and in the east. The siltation is so rapid and heavy that in the last 2000 years of the historic past, land has advanced into the sea over a distance of 7.5 km.

1. Gurumurthy, S., *Archaeology and Tamil Culture*, Madras University, Chennai, 1974.
2. Ramachandran, K. S., *Archaeology of South India, Tamil Nadu*, New Delhi, 1980.

Received 5 September 2005; accepted 22 March 2006

B. ARUNACHALAM¹
B. SUKUMAR^{2,*}
AHALYA SUKUMAR²

¹305, New Moonlight Apartments,
Mahakali Caves Road,
Andheri (East),
Mumbai 400 093, India

²Centre for Earth Science Studies,
Akkulam,
Thiruvananthapuram 695 031, India

*For correspondence.

e-mail: bsuku@rediffmail.com