PRE- AND POST-TSUNAMI

Is the Sethusamudram Shipping Canal Project Technically Feasible?

The tsunami of December 26 has given us an idea of what might happen to the proposed Sethusamudram Shipping Canal. Rushing through with the project without analysing issues related to sedimentation and meteorological regimes might cause a great economic disaster.

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The Sethusamudram Shipping Canal Project (SSCP) is an off-shore shipping canal project in the Palk Bay. It plans to cut short the distance navigated by ships sailing from the west coast and bound for ports on the east coast by avoiding circum-navigation of Sri Lanka. Ships would navigate through the Gulf of Mannar and Palk Bay and enter the Bay of Bengal directly.

The tsunami that battered the east coast on December 26, 2004, has generated a renewed debate on the technical feasibility of the canal. We shall look into the pre- and post-tsunami technical issues that the canal project is facing.

Let us first consider the events that occurred at the project site during the tsunami. We base our observations on the three animation models by 'tsunami and water body modelling experts' around the world[1,2,3] and the newspaper reports of the events that had affected the places in the project area.

Tsunami and Palk Bay

The December 26 tsunami was generated by an earthquake of 9 Richter magnitude off the west coast of north Sumatra. Its hypo-centre was at a depth of 30 km below mean sea level. The earthquake was unusually large in geographical extent. An estimated 1,200 km of faultline slipped 20 m along the subduction zone where the India Plate dives under the Burma Plate. The seabed of the Burma Plate is estimated to have risen several metres vertically up over the India plate, creating shock waves in the Indian Ocean that travelled at up to 800 km/per hour, forming tsunamis which, while less than a metre high in deep water, resulted in huge waves when they reached land.

The tsunami waves travelled west and eastwards. The eastern wavefront was blocked by the Thai, Malaysian and Indonesian landmasses. Hence a portion of the undissipated energy of this eastern wave front should have been transferred to the western wave front travelling toward Sri Lanka and the Indian east coast.

The wave reached the Sri Lankan east coast 100 minutes after the earthquake. In the next 20 minutes it had touched the midline of the Sri Lankan south coast, the east coast of India stretching from Karaikal to Kolkata and the Arakan coast of Myanmar. Over the next 10 minutes it engulfed Point Pedro,Valvettithurai, Kankesanthurai (all located at the north-eastern and north-western coasts of Sri Lanka) and Nagapattinam in India. On the southern side, at this time, the waves had touched Galle (located on the south-western coast of Sri Lanka) and had started moving towards Kanyakumari and the Gulf of Mannar. At 140 minutes, the waves that were striking Nagapattinam got refracted towards the south. Palk Strait is located here. The sea off Nagapattinam is 1,000 metres deep, whereas the sea depth at Palk Strait is just around 6 to 20 metres. This sudden rise in the sea bed from north to south obstructed the refracted waves for a few minutes at which time the wave energy should have accumulated manifold. By 150 minutes, the stranded waves at Palk Strait managed to enter Palk Bay in the north, and touch and pass Colombo in the south. By 160 minutes, the waves were well inside Palk Bay and in the south had touched Kanyakumari, the Kudankulam coast (where two atomic reactors of 1,000 MWe are coming up), and were approaching Tuticorin; they had touched and passed Puttalam at the west coast of Sri Lanka and had entered Gulf of Mannar. By 170 minutes, these waves from the south had touched Rameshwaram and Adams Bridge thus meeting the waves from the north in Palk Bay. This should have caused a lot of turbulence in the shallow waters of the bay. The south-western front of the tsunami wave proceeded toward Maldives at this time. A portion of the wave started sweeping over the western coast of Kanyakumari district of Tamil Nadu. By 180 minutes the wave had reached the east coast of Maldives, touched and passed Thiruvananthapuram, and had touched Kollam. By 190 minutes, the waves had crossed Maldives. The pull exerted by the westward speeding wave towards the African east coast, seemed to pull all the sea water toward itself, thus causing a recedence of sea level in Gulf of Mannar. This pull had changed the northward current direction, of only 10 to 20 minutes earlier at the Gulf of Mannar, to a current moving southward. This caused the sea water to flow from the Palk Bay into Gulf of Mannar.

The tsunami, before touching Sri Lanka, was travelling westward. On striking Sri Lanka and the east coast of India, a clockwise swirl was created with the Palk Bay as its hub. Kodiakkarai, Kankesanthurai, Valvettithurai and Point Pedro were damaged extensively by this tsunami. Rameshwaram, Thiruchendur, Tuticorin, and Puttalam located on Gulf of Mannar have not faced much damage. However, Galle had faced severe damages.

The ocean current at Palk Bay was north to south at 140 to 160 minutes; when the waves entered the Bay from the Gulf of Mannar through Adams Bridge at 170 minutes, the meeting of the two waves travelling in an opposite direction should have caused much turbulence; this turbulence should have remained for 20 minutes, i e, up to 190 minutes. At 200 minutes, the westward spreading wavefront off Maldives pulled the sea from the Gulf of Mannar, thus causing a recedence of the sea from the coast. This should have made the currents take a north to south direction again, thus causing water flow from Palk Bay to the Gulf of Mannar. From 200 to 220 minutes, the refracted water from the east coast of Maldives entered the Gulf of Mannar, thus changing the existing north-south current into a current that flowed once again from south to north.

Had the SSC been operational at the time of this tsunami, the fast changing currents at the Bay and the associated turbulence would have damaged the canal considerably and would have caused a dispersal of the dredged dumps placed at sea to places unknown.

The pattern of damage from Kankesanthurai to the Point Pedro stretch in the northern coast of Sri Lanka and at Kodiakkarai of India tells us that the wave energy at the Palk Strait should have been very much higher than that at Gulf of Mannar.It is at this location that the 54.2 km northern leg of the canal is supposed to be dredged.

Pre-December 26 SSCP

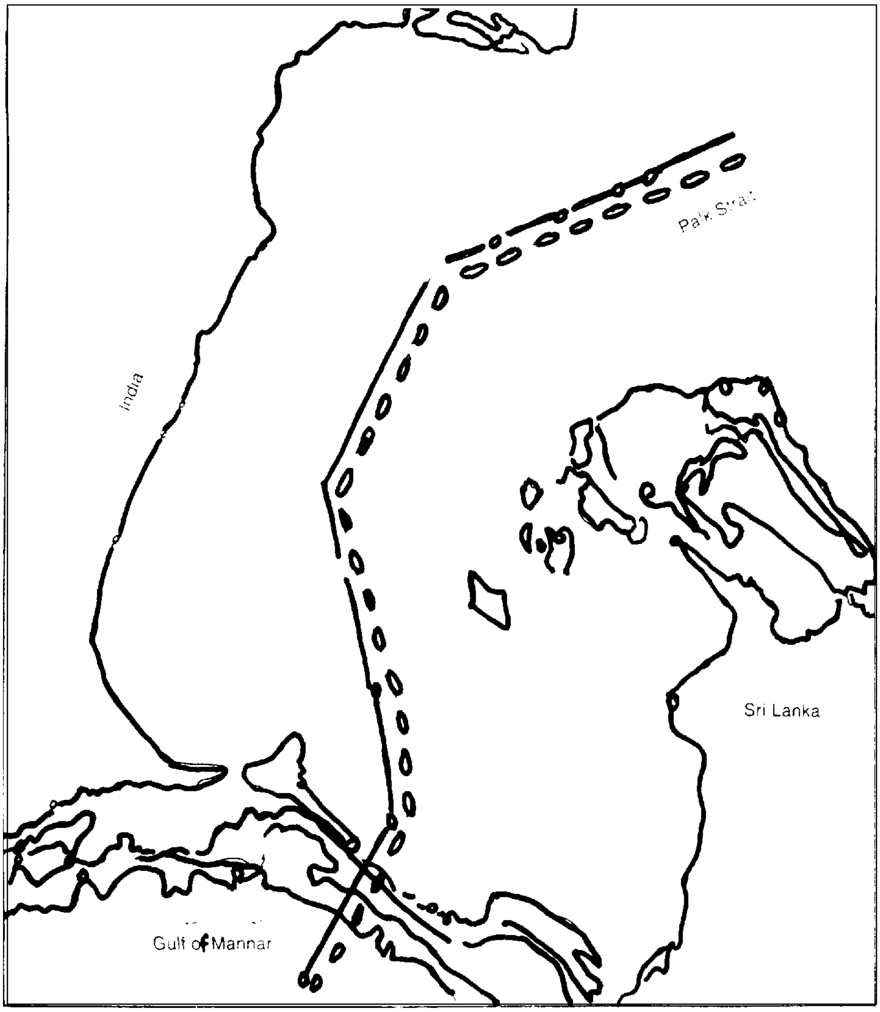
Dredging the shallow sea bed of the Palk Bay and Adam's Bridge to a depth of 12 metres in order to make navigation possible for ships drawing a draught of 9.15 or 10.7 metres is the central objective of the project. The canal's width would be 300 metres. The total length of the canal in the Palk Bay is 152.2 km. This is divided into three legs; the southern leg in the Adam's Bridge area is 20 km, the northern leg in the Palk Strait area is 54.2 km and the central portion is 78 km in length. Dredging would be done in the southern and northern legs; the central leg does not require dredging as it has the adequate depth of 12 metres.[4]

Navigation channels have so far been dredged on the east coast only near the shipping ports. This probably is the first effort by India to dredge a navigation channel that is to be located 30 to 40 km away from the coast. This, again, is the longest sea bed dredging project planned so far in India. Navigation channels of ports of the east coast have been facing three major and persistent problems. They are (1) problems due to sedimentation, (2) problems due to tropical cyclonic disturbances, and (3) issues related to dumping of the dredged material. Sethusamudram Shipping Canal Project will also be facing these problems. Will it be able to cope and handle these issues effectively?

Surveying and analysing the knowledge base on the issues of sedimentation and cyclonic disturbances in the Palk Bay is the first requirement to answer this question.

Palk Bay is one of the five major permanent sediment sinks of India. Chandramohan et al (2001) have calculated the total annual sediment load for this sink as $58.8000 \times 10^6 m^3$. This sediment load is said to cause a sea depth reduction of one cm/year.[5] Marine and riverine sources contribute these sediments. Small rivers draining into Palk Bay[6] off the Sri Lankan and Indian coasts, longshore currents from Bay of Bengal in the north and Gulf of Mannar in the south transport these sediments into the Palk Bay. Sanil Kumar et al (2002) have calculated the net quantum of littoral sediments entering into the Palk Bay from the Nagapattinam coast as $0.095 \times 10^6 m^3$.[7] The Environmental Impact Assessment (EIA) for SSCP by the National Environmental Engineering Research Institute (NEERI), Nagpur, has calculated the net annual sediment transport by long shore current and tides in the Adams Bridge area as $0.2657 \times 10^6 m^3$. The sediment contribution from the rivers is yet to be calculated. These studies indicate that we are yet to pinpoint the sediment source for about $58.4393 \times 10^6 m^3$ (i e, 99.4 per cent) of the total sedimentation volume as indicated by Chandramohan et al's (2001) study.

Map of Palk Bay and the Proposed SSCP



Median Line of Fishing.
Undredged Portion of the Navigation Channel - 78 km.
Palk Strait Portion of the Dredged Navigation Channel – Northern Leg - 54.2 km.
Adam's Bridge Portion of the Dredged Navigation Channel – Southern Leg - 20 km.

S M Ramasamy et al (1998) have identified that in the Vedaranyam-Jaffna peninsular stretch of Palk Bay, the sediment building activity due to sea (littoral) currents seems to be happening at the rate of 29 metres/year and hence they have opined that there is a possibility for such land building activity to connect Vedaranyam to the Jaffna peninsula in another 400 years.[8] G Victor Rajamanickem (2004) has noted that the spit growth in Manamelkudi is of the order of 0.75 metres per year. He has also noted that the maritime surveys conducted between 1960 and 1986 reveal the change of contour to the tune of 6 metres shallowness in the Palk Strait; which means that around 24 cm per year is being silted off in the Strait.[9] These findings tell us that there are specific regions in Palk Bay where the annual sea depth reduction is 25 to 75 times higher than the average value proposed by Chandramohan et al for the entire Bay. The two legs of the SSCP where dredging is required happen to cross two such micro regions with high sedimentation rates.

Sixty-four cyclones have crossed the Tamil Nadu coast in the period 1891-2000. Fifty-five per cent (36) out of these cyclones happened to be severe cyclonic storms (wind speed more than 89 kmph). Out of the 61 cyclones that have crossed the Tamil Nadu coast in the period 1891-1995, six have directly crossed the Palk Bay; 14 have crossed the Nagapattinam coast and three have crossed the Gulf of Mannar. Based on the storm surge values (3 to 5 metres), the Indian Meteorological Department considers the coastal stretch between Nagapattinam and Pamban as a high risk zone to tropical cyclones.[10] The 1964 December 23 cyclone had produced a storm surge of 6 metres.[11] Based on the degree of uncertainty in the prior prediction of cyclones Sutapa Chaudary et al (2004) have named this coastal stretch (and that of Bangladesh) as the most vulnerable ones among the many coastal regions of the Bay of Bengal, for severe tropical cyclones.[12] Cyclones have caused large scale damages in this area in the past. Studies on the pattern of movement of sediments during the cyclonic storms are not available at the present time. However, it has been noted that these storms have a tendency to transport sediments into Palk Bay from the Nagapattinam coast and from Gulf of Mannar.

Usha Natesan (2004) explains, using satellite imagery, the accretion and land building in the Vedaranyam offshore area. She describes how the SW monsoon disturbs the sediments of the tidal flats in the northern portion of Palk Bay and how these sediments are obstructed in their northerly movement by the Vedaranyam land projection; the study also describes how the sediments transported from north during the NE monsoon are unable to take a bend around the Vedaranyam tip; it also describes that a portion of these sediments start travelling eastwards and the rest move down south along with the longshore currents.[13]

There are two previous records of tsunami destruction in this area. The first record is that of an earthquake which originated at the Car Nicobar islands on December 31, 1881. It had generated a tsunami in the Bay of Bengal and this had been felt at Pamban.[14] The second record is from August 27, 1883 when the Krakathova volcano of Indonesia erupted and created a tsunami which reached Nagapattinam.[15]

The total quantity of spoils that would come from capital dredging is supposed to be 81.5 to 88.5 × $10^6 m^3$. The quantum of dredged spoil that would come from maintenance dredging is supposed to be 0.1 × $10^6 m^3$/year. Specific dump sites have been identified only for 8.5 to 9.5 per cent of the total dredged spoil. Idea about the nature of the dredged spoil is available presently, only for about 38.5 to 40.5 per cent of the total dredged spoil. No idea exists at the present time on the nature of the dredged spoil that would be generated for 59.5 to 61.5 per cent of the total dredged material. We do not know the exact dump sites for about 90.5 to 91.5 per cent of the dredged material.[16] However, the SSCP project authority has filed for a No Objection Certificate from the Ministry of Environment and Forests and the Tamil Nadu Pollution Control Board.

Conclusion

The current status of knowledge on the sedimentation regimes existing in the various micro regions of Palk Bay is incomplete. The issue of cyclones had been dogging the pre-December 26 tsunami SSCP proposal. Both these issues had warranted a detailed study of these factors before determining the best possible alignment of the canal and the dredge material disposal. The tsunami has given us a preliminary idea of what might happen to the canal and the dredged material in the event of future tsunamis and cyclones. The northern Palk Strait leg of the canal seems more vulnerable to these than the southern Adams Bridge leg. Yet, the Environmental Impact Assessment and the Technical Feasibility Report, both prepared by NEERI, had given the least importance to the studies of this part of the canal. Also, they have not consulted any of the above cited studies. They have totally ignored the issues of cyclones and tsunamis.

This note postulates, based on the above findings, that the SSCP is not feasible technically, at the present moment, with the current level of knowledge of the sedimentation and meteorological regimes of the project area. Rushing without analysing these issues to dredge the canal in the name of 'national development' might cause a great economic disaster. EPW

Notes

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