

## **Annex X: TRANSPORTATION (Roads & Bridges, Ports and Inland Waterways)**

### **A. Background**

1. The transport sector, especially roads and ports along the coastline, in Tamil Nadu, Kerala and Pondicherry was seriously damaged by the tsunami. One railway line along the coast in Nagapattinam district of Tamil Nadu was also damaged, but was restored by the Indian Railways within one month of the disaster. No damage to the transport sector was reported in Andhra Pradesh except for village roads.

2. **Road Subsector:** Road transport accounts for 60 percent of freight movement and 80 percent of passenger traffic in the country. State, district and rural roads<sup>35</sup> which carry about 60 percent of total road traffic provide linkages with the national highways, district headquarters, important towns, tourist centers, and minor ports. Given that 70 percent of the total population lives in rural areas, improvement of rural roads is directly related to the economic activities and quality of life of the region. Tamil Nadu has a total road network of 57,407 km, of which 7,230 km, 7,383 km and 41,191 km are respectively state highways, major district roads (MDR) and other district roads (ODR). ODRs along the coast have traffic of 800 to 1,500 passenger car units (pcu). Kerala has a total road network of 22,335 km, of which 3,785 km, 11,711 km and 5,316 km are respectively state highways, major district roads and other district roads. Pondicherry has a road network of 1,310 km, of which 35 km and 507 km are state highways and other roads.

3. **Port Subsector:** Out of more than 160 ports in India, 12 major ports handle about three-fourths of the total traffic of 330 million tons. Major ports are managed by port trusts under the regulation of the Tariff Authority for Major Ports while minor ports are under state government control. In Tamil Nadu, there are two intermediate ports and 12 minor ports. The intermediate port, Nagapattinam, has been handling 30,000 to 40,000 tons a year importing oil and exporting cement. The fishing harbor located on the river upstream of the port is also under the jurisdiction of maritime board of the state. There are three intermediate ports and 14 minor ports in Kerala under the jurisdiction of the state government, out of which four ports have been damaged by the tsunami.

### **B. Damage Assessment**

4. **Road Subsector:** In the districts of Nagapattinam, Kanniyakumari and Cuddalore of Tamil Nadu, and Pondicherry, more than 80 km of ODR and MDR, located within 800 m of the coastline, were seriously damaged. Damage to national highways and one state highway was reported in Tamil Nadu. Some bridges and embankments were totally destroyed or washed away, and other sections had damage to shoulder protections, beams and pavement. In Nagapattinam district, one bridge and two bridge structures under construction were destroyed. Within two weeks of the disaster, a temporary diversion road had been constructed on a temporary embankment across the river. However, this remains vulnerable to cyclones and floods, and reconstruction of the bridge is urgently needed, based on a design incorporating protection against cyclone surges and tsunami. In Kanniyakumari district, a bridge across the Pazhayar River was hit by the tsunami with four decks washed away and one deck partly damaged. In Karaikal, Arasalar bridge which provided the main link between Karaikal town and the southern part of Tamil Nadu was badly damaged – two spans

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<sup>35</sup> This annex covers other district roads excluding Panchayat (village) roads.

and piers collapsed. The Indian Army, in a very short time, restored the connection by providing a bailey bridge. In Cuddalore district, district roads along the coast were seriously eroded.

5. In Kerala, roads along the coasts in Kollam and Alappuzha were worst hit with about 60 km of MDR as well as panchayat roads affected with shoulders and pavement damaged. The state government immediately removed debris and sand to make the breached roads passable for relief vehicles at a cost of Rs. 500,000 (\$11,500<sup>36</sup>). It is urgent that damaged shoulders and pavement be restored before the advent of monsoon rain and storm surges.

6. Another affected sector in Kerala is inland waterways. The draft of the inland waterway has been reduced in several areas due to sand deposits. Although the state government carried out temporary dredging, capital dredging is required to restore the draft for river crossing ferries.

7. **Damage, roads and bridges:** It has not been possible to distinguish the damage attributed to the tsunami from any previous deterioration in road and port assets. The estimates of damage refer to the cost of restoring the assets to good condition. This does not reflect the cost of additional upgrading beyond normal standards. The total damage to the road sector is estimated by the joint assessment mission around Rs. 50.0 crore (\$11.5 million). Restoration costs were estimated based on market rates for pavement, shoulder improvement and bridges. The total restoration costs of the destroyed bridges are estimated by the districts at Rs. 0.90 crore (\$206,900) in Nagapattinam, and Rs. 8.6 crore (\$2.0 million) in Kanniyakumari. However, the design specification for the bridges will need to be based on studies of wave height, including that of the tsunami and future traffic of each area. Also, roads around ports, fishing harbors and city centers need to be upgraded in terms of width and height for both expected wave height and future traffic. It is assumed that the immediate restoration costs will increase by 30 percent as a result of this upgrading.

8. **Losses, roads and bridges:** As the damaged sections are passable except for a few bridges, the loss in most areas is limited to the increased travel time and vehicle operation cost caused by diversions and deteriorated surfaces. This is currently low because local traffic around the ports and fishing harbors has not yet recovered to the pre-tsunami level. The loss from the impassable bridge in Kanniyakumari is estimated at Rs. 130,000 (\$3,000) so far<sup>37</sup>. It is reported that the cost of eight damaged rail cars in Cuddalore is Rs. 180,000 (\$4,140).

9. **Ports:** Nagapattinam Port located along the Kaduvaiyar River in Tamil Nadu was severely damaged. The two breakwaters at the mouth of the river were destroyed and one barge carried by the tsunami collided with a coastal protection groyne between the sea and river. This led to sand drifting from the sea to the channel and basins as well as reduction of calmness of the channel and basins. The tsunami waves came over the fishing harbor seawall destroying parts of wharfs, the fish market and the auction center. The waves also destroyed fishing boats and a dredger, and left them along the channel and on the wharfs of the port. As a result of reduced draft of the channel and basins, and the broken facilities, the port has suspended operation. This problem with the channel has also prevented fishing boats from plying to and from the fishing harbor. Similarly, Cuddalore Port, located at the confluence of the rivers Gadilam and Paravanar, suffered damage to breakwaters, the sea wall, equipment, the basin and the channel. In addition, Colachel port and Pondicherry port, and five fishing harbours (Pazhavar, Thirumullai Vasal, Chinnangudi, Nagore in Nagapattinam and

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<sup>36</sup> For the purposes of currency conversion an exchange rate of Rs 43.5 / US\$ is used.

<sup>37</sup> Calculated as follows: Rs 10/hour @ 0.5 hour @500 pcu/day @ 51days.

Chinnamuttom in Kanniyakumari) were affected and need urgent dredging as well as restoration of jetties and retaining walls. In Kerala, sand drift caused by the tsunami has led to serious reduction of the draft in four minor ports (Vizhinjam, Neendakara, Beypore and Azhikkal) and eight fishing harbors and landing spaces.

10. **Damage - ports:** The cargo volume or fish catch of the damaged ports and fishing harbours are not expected to recover their capacities in the near future. Hence, the costs have been based on restoring the original level of capacity. As the damage behind Nagapattinam port was serious, the cost of extending breakwaters and reinforcing groynes were included in the mid term restoration cost. The restoration cost for each port was estimated based on market unit rates for reconstructing breakwaters, wharfs and buildings, dredging, and procurement of a dredger etc. The total damage is estimated around Rs. 95.0 crore (\$21.8 million).

11. **Loss - ports:** The loss from the damage is significant because of complete or partial suspension of imports and exports, and fishing activities. Assuming that imports and exports for this region are transferred from Nagapattinam port to Chennai port, the additional transport cost in one year would be Rs. 1.4 crore (\$0.32 million) (30,000 tons @ Rs. 4500/ 10 tons) excluding warehouse and time costs. In Kerala, some maritime cargo is being transshipped offshore from vessels to small barges which can ply the shallow channels and basins. Other maritime cargo is now being transported by trucks at higher cost. There is a loss of port related services such as fuel and water supply. In Tamil Nadu, one vessel in Nagapattinam port and three vessels in Kanniyakumari had damage worth Rs. 0.30 crore (\$69,000) and Rs. 0.48 crore (\$111,500) respectively. In Chennai and Pondicherry, three and two vessels were respectively damaged. It is also reported that substantial numbers of the labor force are unemployed as a result of limited or suspended port operation.

12. The estimated restoration costs for damaged roads and bridges in the three states are in Table 1 below.

**Table 1. Damage to transport sector in the three states (Rs. crore)**

States	Tamil Nadu	Pondicherry	Kerala	Total
Roads and Bridges	27.66	24.45	6.14	58.25
Ports and fishing harbors	65.41	5.00	24.24	94.65
Total (Rs. crore)	93.07	29.45	30.38	152.90
Total (\$ million)	21.40	6.77	6.98	35.15

### C. Reconstruction Strategy

13. The reconstruction program in the transport sector should follow the following principles which have been identified to guard against the risk of coastal disasters including tsunami, cyclone surges and monsoon floods.

- Protective works for ports and fishing harbors: Fishing activities such as landing, auction, and maintenance of nets and equipment will continue to be conducted at the fishing harbor or coastal space. Therefore, reinforcement of seawalls and extension of breakwaters are essential to protect major ports from future disasters. These improvements also reduce the requirement for frequent dredging of the channel after cyclones and floods, and improve the calmness of the channel and basins.

- Development of ports and fishing harbors can affect the littoral sand drift along the coast. For instance, extension of a breakwater or a groyne could encourage erosion of remote beaches. Hence, careful and comprehensive simulation will need to be carried out for planning the development of ports and fishing harbors. Coastal protection works also need to be considered in such plans.
- Evacuation path: In the event of a future disaster warning, appropriate evacuation paths are required, particularly in the port and fishing harbor area. One possible evacuation path is the cross-river bridge. Detailed analysis is necessary to design shortest paths for employees and residents in these areas. Multistorey buildings and high shelters should also be considered in these areas. In Alappuzha district of Kerala, a bridge between the villages and the mainland was proposed for emergency evacuation across the inland water. In Cuddalore, a bridge, proposed to fill the missing link, is expected to secure the evacuation and emergency path of the area. The characteristics of tsunami and cyclones waves should be reflected in the design of the bridges.

14. In villages where entire relocation is to be implemented, restoration of the damaged roads should be decided subject to whether the road is on the access route to the relocated villages. In villages where sea walls will be introduced, restoration of access roads needs to be completed as soon as possible to avoid further damage by cyclone surges and floods. When a road along the coast is widened or raised in restoration, the design should be carried out in coordination with coastal protection design.

15. The new bridge at Alappuzha district for evacuation, and the upgrading of coastal roads, were categorized into mid-term needs due to uncertainties in the relocation of villages and options for coastal protection works, and need for further studies.

16. In restoring damaged ports and fishing harbours, the immediate needs are for breakwaters and dredging to resume port operations and fishing activities as soon as possible. Remaining investment for restoring facilities and equipment can be implemented in the mid-term implementation schedule.

17. Reconstruction cost: Based on the proposed recommendations of the reconstruction strategy and the damage assessment, the tentative cost estimate for immediate, mid term and long term reconstruction is as follows.

18. Based on the proposed reconstruction strategy and the damage assessment, the cost estimate for short and medium term reconstruction is as follows.

**Table 2. Transport Reconstruction Needs (\$ million)**

<b>TAMIL NADU</b>		Short-term	Medium-term
Roads & Bridges			
	Road reconstruction	21.27	0.00
	Bridges reconstruction	14.69	25.85
	Studies and consulting services	1.00	4.00
	<b>Sub Total</b>	36.96	29.85
Ports and Fishing harbours			
	Port reconstruction	60.10	14.60
	Fishing harbour reconstruction	5.31	1.83
	Studies and consulting services	4.00	4.00
	<b>Sub Total</b>	69.41	20.43
<b>Total</b>	<b>(Rs. crore)</b>	106.37	50.28
<b>Total</b>	<b>(\$ million)</b>	24.45	11.56
<b>PONDICHERRY</b>			
Roads & Bridges			
	Road reconstruction	29.25	0.00
	Bridges reconstruction	2.54	0.00
	Studies and consulting services	1.00	1.00
	<b>Sub Total</b>	32.79	1.00
Ports and Fishing harbours			
	Port & Fishing harbour reconstruction	5.00	0.00
	Studies and consulting services	2.00	1.00
	<b>Sub Total</b>	7.00	1.00
<b>Total</b>	<b>(Rs. crore)</b>	39.79	2.00
<b>Total</b>	<b>(\$ million)</b>	9.15	0.46
<b>KERALA</b>			
Roads and Bridges			
	Road reconstruction	7.98	16.50
	Bridges reconstruction	0.00	15.00
	Studies and consulting services	1.00	5.00
	<b>Sub Total</b>	8.98	36.50
Ports and Fishing Harbours			
	Port reconstruction	9.84	11.50
	Fishing harbour reconstruction	14.40	15.00
	Studies and consulting services	1.00	5.00
	<b>Sub Total</b>	25.24	31.50
<b>Total</b>	<b>(Rs. crore)</b>	<b>34.22</b>	<b>68.00</b>
<b>Total</b>	<b>(\$ million)</b>	<b>7.87</b>	<b>15.63</b>

19. Over the long-term, state governments have proposed some roads, ports and fishing harbor projects. Although these projects have impacts on the recovery of the regional economy, it would be necessary that detailed studies for the cost, benefits and environmental and social impacts be carried out.