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ADB

COASTAL RISK ASSESSMENT ALONG THE EAST COAST OF SRI LANKA

Trincomalee and Batticaloa

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Executive Summary

Introduction

This report presents the methods adopted and results of the study "Coastal risk assessment along the east coast of Sri Lanka" focusing on Trincomalee and Batticaloa districts. The project was funded via the Asian Development Bank – UNESCO-IHE (now IHE Delft) knowledge partnership and was conducted in cooperation with the Coast Conservation Department (CCD) of Sri Lanka.

The East coast of Sri Lanka is vulnerable to many natural disasters such as cyclones, storms, chronic coastal recession, and also tsunamis (as evidenced by the December 2004 Tsunami). The majority of communities and developments along the East coast are located in Trincomalee, Batticaloa, and Amparai districts; all of which are densely populated within the coastal belt. Since the end of the civil conflict in 2009, due to the many natural resources of the coastal region, ample opportunities for economic development have emerged, particularly along the coast of these districts. CCD is responsible for sustainable management of coastal zones in Sri Lanka and requires insight into the risks and opportunities along this coastal belt to help in fulfilling their mandate while promoting sustainable economic development.

Objective

The main objective of this study is to provide state-of-the-art probabilistic estimates of coastline recession and environmental losses over a 100 year time scale and to determine economically optimal coastal setback lines along the coasts of Tricomalee and Batticaloa districts.

Methodology

The Probabilistic Coastline Recession (PCR) model developed by Ranasinghe et al. (2012) was exclusively used in this study. The PCR model is designed to be used in a probabilistic manner to calculate a large number of long, realistic, sequences of beach erosion and recovery, and to then statistically analyse these sequences. It takes into account joint probabilities between all basic erosion variates including; wave height, period and direction, event duration, and the gap between storm events. The PCR model requires statistical parameters representing the wave climate and mean water levels as model forcing and beach profiles as model initialisation data. These data were collated for this study from a combination of global data bases and in-situ measurements. For this study, the PCR model was adapted to accommodate the prevailing conditions along the East coast of Sri Lanka, and applied at a total of 85 cross-shore profiles over the period 2016 - 2116.

By producing a sufficiently large database of possible future coastal recession estimates, PCR model results enable statistical analyses, and thus provided exceedance probabilities of coastal recession at all modelled profiles along the coastline of Trincomalee and Batticaloa. Spatial maps of 1 % and 50 % exceedance probability coastline recession contours computed for Trincomalee and Batticaloa study areas are shown in Annex 1. The values of 1 % and 50 % exceedance probability coastline recession at the exact locations of the modelled cross-shore profiles are given in Table format in Annex 3.

Statistical analyses of coastal recession estimates obtained from the PCR model results were subsequently used to determine the position of the economically optimal coastal setback line along the coasts of Trincomalee and Batticaloa districts to directly feed into risk-informed land-

use planning. Essentially, an estimate of the optimal position of a setback line (or, the economically optimal balance between risk and reward) can be obtained from the would-be behaviour of rational, well-informed, profit-seeking individuals in a world without market imperfections. Such an economically optimal setback line (EOSL) serves as a solid reference for coastal zone managers/planners who have to make on-the-ground decisions on implementing effective setback lines.

A state-of-the-art economical modelling approach which makes use of the economical constants of future rates of return on investment, discount rates and risk preferences and their uncertainties as well the probabilities of damage to potential development due to coastal recession (provided by PCR model output) was applied to the study area. Results were used to develop an EOSL along the coastline of Trincomalee and Batticaloa districts. Note that, due to the high rates of return on investment in parts of Trincomalee district, there we have also introduced a Retreat Setback Line 2075 (RSL 2075), which indicates the position landward of which developments with an intended life span greater than 50 years (starting from 2025) may be allowed. Maps of EOSL and RSL2075 are presented in Annex 2 and associated EOSL/RSL2075 positions are given in Table format in Annex 4.

To estimate the environmental risk along the coast of Trincomalee district, a three step approach was used: (1) quantifying the value of coastal ecosystem services (CES) through applying accepted economic valuation techniques; (2) identifying the potential changes in ecosystem services by 2100 due to coastal recession; and (3) translating these changes to quantitative monetary values. Social, environmental, and economical data provided by CCD, on site interviews of residents and visitors, together with a worst-case recession scenario (total beach loss) fed into this analysis which is presented in Chapter 6.

Finally, at the request of CCD, a comparison between currently adopted setbacks (defined by CCD as reservation and restricted zones, adding up to a total setback) and those computed in this study was performed (Chapter 7). As per the different definitions adopted by CCD and in this study, the computed EOSL was compared with the landward edge of the CCD Reservation zone, while the RSL 2075 (only applicable in Trincomalee district) was compared with the CCD Total setback (i.e. reservation + restricted zone).

Products

The main products of this study are:

1. Spatial maps showing exceedance probability contours of coastline recession due to storms and sea-level rise for Trincomalee and Batticaloa districts (given in Annex 1). An example map (in the Kalmunai - Karaitivu area in Batticaloa district) is shown below in Figure E1 (left).

2. Maps showing the economically optimal setback line computed for Trincomalee and Batticaloa districts (given in Annex 2). An example map (in the Kalmunai - Karaitivu area in Batticaloa district) is shown below in Figure E1 (right).

3. Estimates of environmental losses that may be expected by 2100 in Trincomalee district (given in Section 6). A summary is given below in Table E1.

4. Quantitative comparison of the current CCD setbacks and the EOSLs/RSLs computed in this study (Tables E2 (Trincomalee) and E3 (Batticaloa). In these tables, locations where the computed EOSL/RSL lie seaward of the CCD Reservation/Total setback (i.e. locations where the

existing setbacks could be relaxed) are highlighted in dark green (high), light green (moderate) and blue (low) while locations where the computed EOSL/RSL lie landward of the CCD Reservation/Total setback (i.e. locations where it is advisable to implement setbacks that are more stringent than those currently adopted) are highlighted in red (high), orange (moderate) and yellow (low). Please see the colour key within the tables for the distance ranges associated with each different colour.

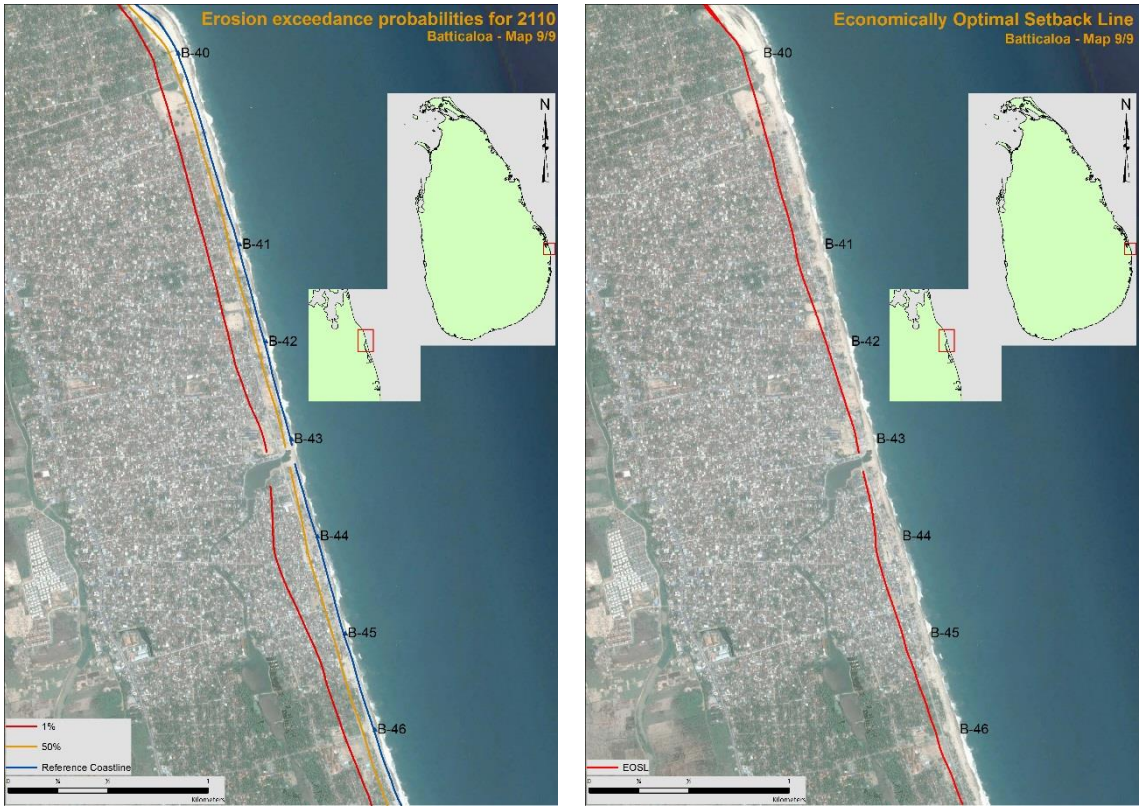

Figure E1. Example of computed 1% (red) and 50% (orange) exceedance probability coastal recession contours (left), and associated Economically optimal coastal setback line (right) in the Kalmunai-Karaitivu region in Batticaloa district.

Table E1. Summary of the estimated environmental losses, expressed as coastal ecosystem service losses, in Trincomalee district due to coastal recession.

Estimated loss in tourism value of coastal ecosystems of Trincomalee (million US$)	Estimated loss in amenity value of coastal ecosystems of Trincomalee (million US$)	Estimated annual loss in fishery value of coastal ecosystems of Kinniya division (milion US$)
9.3 – 11.7	12 - 18	1.8 – 2.25

Table E2. Comparison between EOSL/RSL and CCD setbacks at Trincomalee. All distances measured from vegetation line (positive (negative) values indicate landward (seaward) distances from the vegetation line).

Profile	Lon.	Lat.	EOSL (m)	RSL 2075 (m)	Current CCD Setbacks				
					Zone		Setback (m)		
					From	To	RSV	RST	TS
T-1	81.090	8.842	45	57	Salpayaru Bridge (SLTDA Tourism Zone) [8°47'27.80"N, 81°07'13.10"E]	Kuchchaveli Puduwakattu [8° 51' 33.40"N, 81° 05' 6.10"E]	20	30	50
T-2	81.093	8.833	54	61			20	30	50
T-3	81.097	8.825	34	45			20	30	50
T-4	81.103	8.818	32	38			20	30	50
T-5	81.107	8.810	54	59			20	30	50
T-6	81.112	8.802	35	41			20	30	50
T-7	81.117	8.795	31	41			20	30	50
T-8	81.124	8.788	39	44	Irrakkandy Bridge (River Mouth) [8°43'55.40"N, 81°10'24.60"E]	Salpayaru Bridge (SLTDA Tourism Zone) [8°47'27.80"N, 81°07'13.10"E]	50	-	50
T-9	81.129	8.781	27	32			50	-	50
T-10	81.135	8.774	53	62			50	-	50
T-11	81.149	8.762	63	71			50	-	50
T-12	81.154	8.754	54	60			50	-	50
T-13	81.159	8.747	48	54			50	-	50
T-14	81.165	8.740	65	70			50	-	50
T-15	81.177	8.726	61	74	Gangei Bridge [8°27'37.50"N, 81°13'44.10"E]	Irrakkandy Bridge (River Mouth) [8°43'55.40"N, 81°10'24.60"E]	20	30	50
T-16	81.179	8.722	66	76			20	30	50
T-17	81.184	8.715	27	34			20	30	50
T-18	81.187	8.711	8	15			20	30	50
T-19	81.189	8.707	42	49			20	30	50
T-20	81.191	8.703	57	67			20	30	50
T-21	81.196	8.690	97	114			20	30	50
T-22	81.199	8.686	72	86			20	30	50
T-23	81.201	8.682	72	86			20	30	50
T-24	81.203	8.678	53	69			20	30	50
T-25	81.206	8.674	73	87			20	30	50
T-26	81.209	8.671	72	85			20	30	50
T-27	81.212	8.667	108	118			20	30	50
T-28	81.223	8.639	61	75			20	30	50
T-29	81.219	8.609	79	94			20	30	50
T-30	81.221	8.604	88	98			20	30	50
T-31	81.223	8.599	18	31			20	30	50
T-32	81.225	8.594	41	56			20	30	50
T-33	81.227	8.589	18	28			20	30	50
T-34	81.230	8.584	61	71			20	30	50
T-35	81.238	8.571	4	7			20	30	50
T-36	81.238	8.570	-17	-7			20	30	50
T-37	81.239	8.568	23	55			20	30	50
T-38	81.239	8.567	-4	18			20	30	50
T-39	81.240	8.566	14	39			20	30	50

Recommended landward shift of present RSV and TS

High	> 25 m
Medium	10 m - 25 m
Low	0 m - 10 m

Recommended seaward shift of present RSV and TS

High	> 25 m
Medium	10 m - 25 m
Low	0 m - 10 m

* RSV = Reservation; RST = Restriction; TS = Total Setback

Table E3. Comparison between EOSL and CCD setbacks at Batticaloa. All distances measured from vegetation line (positive (negative) values indicate landward (seaward) distances from the vegetation line).

Profile	Lon.	Lat. (m)	EOSL (m)	Current CCD Setbacks				
				Zone		Setback (m)		
				From	To	RSV	RST	TS
B-1	81.713	7.730	68	Kallady Beach Park (Sarawanaady Road) [7°43'05.10"N, 81°43'08.80"E]	Batticaloa Light House (Paalmeenmadu) [7°45'18.50"N, 81°41'07.50"E]	45	80	125
B-2	81.714	7.726	9			45	80	125
B-3	81.716	7.722	-8			45	80	125
B-4	81.719	7.718	104	Kaththankudy Dean Road (Al Tharika Mosque) [7°41'40.38"N, 81°44'5.40"E]	Kallady Beach Park (Sarawanaady Road) [7°43'05.10"N, 81°43'08.80"E]	35	60	95
B-5	81.722	7.714	24			35	60	95
B-6	81.725	7.710	68			35	60	95
B-7	81.730	7.702	48			35	60	95
B-8	81.735	7.694	35	Batticaloa - Ampara District Boundary [7°27' 15.40"N, 81°49'09.72"E]	Kaththankudy Dean Road (Al Tharika Mosque) [7°41'40.38"N, 81°44'5.40"E]	30	50	80
B-9	81.737	7.691	29			30	50	80
B-10	81.740	7.687	31			30	50	80
B-11	81.742	7.683	6			30	50	80
B-12	81.745	7.679	43			30	50	80
B-13	81.748	7.675	44			30	50	80
B-14	81.750	7.671	41			30	50	80
B-15	81.759	7.655	50			30	50	80
B-16	81.768	7.639	33			30	50	80
B-17	81.776	7.623	46			30	50	80
B-18	81.784	7.606	68			30	50	80
B-19	81.790	7.589	99			30	50	80
B-20	81.793	7.580	28			30	50	80
B-21	81.795	7.572	34			30	50	80
B-22	81.797	7.563	92			30	50	80
B-23	81.800	7.554	31			30	50	80
B-24	81.801	7.545	50			30	50	80
B-25	81.803	7.536	73			30	50	80
B-26	81.806	7.527	8			30	50	80
B-27	81.809	7.500	80			30	50	80
B-28	81.813	7.482	35			30	50	80
B-29	81.817	7.464	34			30	50	80
B-30	81.819	7.456	70			30	50	80
B-31	81.820	7.451	150	Nindavur Wowal Lagoon Mouth (Theater Road) [7°20' 02.70"N, 81°51'47.30"E]	Batticaloa - Ampara District Boundary [7°27' 15.40"N, 81°49'09.72"E]	25	40	65
B-32	81.821	7.447	117			25	40	65
B-33	81.822	7.442	120			25	40	65
B-34	81.823	7.438	27			25	40	65
B-35	81.824	7.434	69			25	40	65
B-36	81.826	7.429	99			25	40	65
B-37	81.829	7.426	45			25	40	65
B-38	81.832	7.422	71			25	40	65
B-39	81.835	7.418	-5			25	40	65

Recommended landward shift of present RSV and TS

High	> 25 m
Medium	10 m - 25 m
Low	0 m - 10 m

Recommended seaward shift of present RSV and TS

High	> 25 m
Medium	10 m - 25 m
Low	0 m - 10 m

Profile	Lon.	Lat. (m)	EOSL (m)	Current CCD Setbacks				
				Zone		Setback (m)		
				From	To	RSV	RST	TS
B-40	81.838	7.414	36			25	40	65
B-41	81.841	7.406	112			25	40	65
B-42	81.842	7.401	82			25	40	65
B-43	81.844	7.397	61			25	40	65
B-44	81.844	7.393	62			25	40	65
B-45	81.846	7.388	111			25	40	65
B-46	81.847	7.384	76			25	40	65

* RSV = Reservation; RST = Restriction; TS = Total Setback