Climate change impacts on Coasts and Islands and possible adaptations- Sri Lanka

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Out line of the presentation

Introduction
Sri Lankan geographical out line
Impacts and Vulnerability
Mitigation Options and Adaptation response
Lesson learned from DRR Activities for coastal areas

- **Introduction**

- Coastal Communities are doubly vulnerable from the impacts of climate change because they are sandwiched between sea level rise or tidal surges on one hand and hazards from continued deforestation and other activities in upstream environmental problems on the other hand.

- Coasts and Islands are extremely vulnerable to rising and warming seas, that threaten to submerge our coasts, islands and kill our economy, environment and many more.

- We are not responsible for the hundreds of years of carbon dioxide emissions, which are now cooking the planet.
- But the dangers climate change impacts to our countries, means that this crisis can no longer be considered somebody else's problem.
- Whether we like it or not, we are all in this fight together.

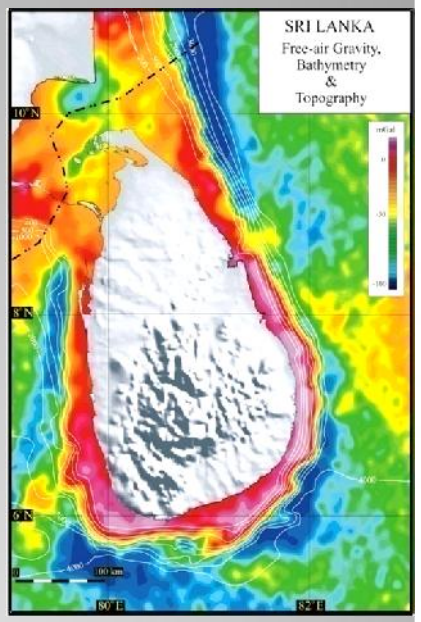
Maldives President Nasheed
(UN climate change Conference)

Per capita emissions in South Asian countries in comparison to USA

Country	Per Capita emissions (carbon tons)	
	1990	1996
USA	5.18	5.37
Bangladesh	0.04	0.05
Bhutan	0.02	0.04
India	0.22	0.29
Maldives	0.19	0.31
Nepal	0.01	0.02
Pakistan	0.16	0.18
Sri Lanka	0.06	0.11

Sri Lankan geographical out line

- Located at Indian Ocean
- Areal Extent - 65,610 km ^{2}
- Maximum length - 435 km
  width - 240 km
- Maritime Zones - 489,000 km ^{2}
- Topography mountainous area – South Central vast coastal plain



Rainfall

- Minimum annual average rainfall 1000mm in semi- arid parts
- Maximum annual average rainfall 5000mm in central hills
- Rainfall seasons
  1. South- West Monsoon (May to September)
  2. North – East Monsoon (December to February)

Temperature

- Slight seasonal variation
- Mean Annual Temperature - coastal area 28^0 c
  hill area 19^0 c
- Higher temperature – Northern, North central, Eastern Region- 34^0 c

Relative humidity

- varies from 70% during the day to 90% at night.

•Population and Human Settlements

- Total Population – 20 millions (2005)
- Population density – 300 people per square kilometer
  wet zone - 650 per square kilometer
  dry zone – 175 per square kilometer

Per capita income in 2005 US $1160

Social Profile

Education

- Literacy rate – 96%
- 14 National Universities and 35 Technical Inst
- Education totally free with university Education

Health

- Public (totally free) and Private sector
- Western, Indigenous, Homeopathy systems are practiced

Political Profile

- Parliament base Central Government

Impacts and Vulnerability

Climate Change
Increased temperature & Precipitation

- During the last century, global temperature has increased by 0.6 ^{o}
- In Sri Lanka, the average temperature has increased at the rate of 0.16^{o}C per decade since 1960
- According to meteorological records rain fall pattern has been changed over the last few decades
  - highly urbanized areas like Colombo city are frequently being flash flooded
  - heavy rainfall in hilly areas have resulted in landslides

Significant Features of the Sri Lanka Coastal Zone

- Approximately 24% of the land area and 32% of the population
- 65% of the urbanized land area
- Principal road and rail transport infrastructure
- Principal commercial ports, fishery harbours and anchorages
- 65% of the industrial output
- 80% of tourism related infrastructure
- 80% of fish production

Possible Disasters in the Coastal areas of Sri Lanka

- Coastal Erosion
- Salinity intrusion into the Coastal land and unavailability of Drinking water
- Coastal Floods
- Degradation of Coastal ecosystems and lost of Livelihoods
- Tsunami, and Cyclones
- Outbreak of Deceases
- Oil Spills

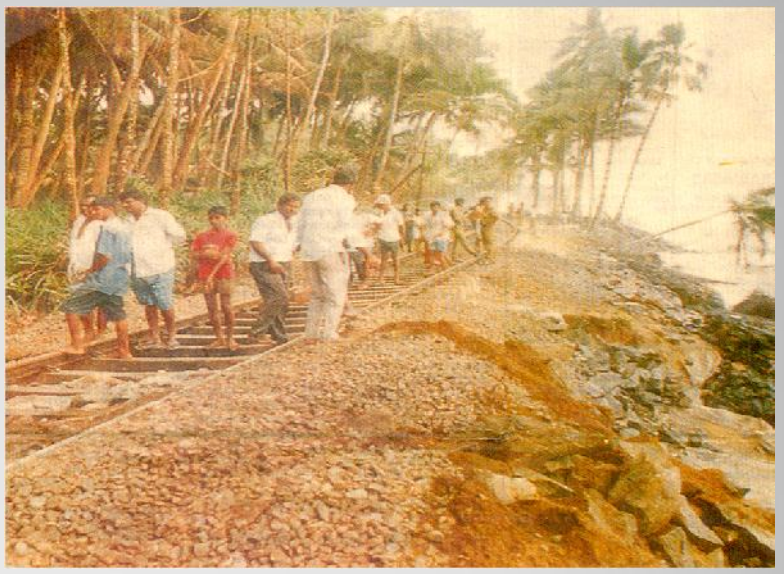
Other Sectors

- Agriculture
  Reduction in Crop Yields
  Changes in harvesting patterns
- Tourism
  Loss of beaches
- Fisheries
  Depletion of fish stocks due to Temperature variations
- Human Settlement
  Inundation of low lying areas
- Water Resources
  Salt water intrusion into the river system affecting water supply scheme
- Human Health
  Increase in the spread of vector bone diseases such as Malaria & dengue

Overview of Erosion areas and Erosion rates

Main Sector	Local Area and time Period	Yearly erosion rate in M/year
Colombo to Dickowita	Mutwal to Kalani river	0-1
	Palliyawatta – Uswatakeiyawa	2-3
Maha Oya Lansigama	Wikkal (1988 – 1998)	8-10
	Gin Oya Sand Bar (1991 – 1999)	10-12
	Wallamankara (1994 – 1998)	11 - 13

Coastal Erosion and its impacts on economy



Coastal Erosion

Stable beach at the LOP site ***– before SW Monsoon, May-2008***

Beach erosion just north of the LOP site ***– after SW Monsoon, October-2008***

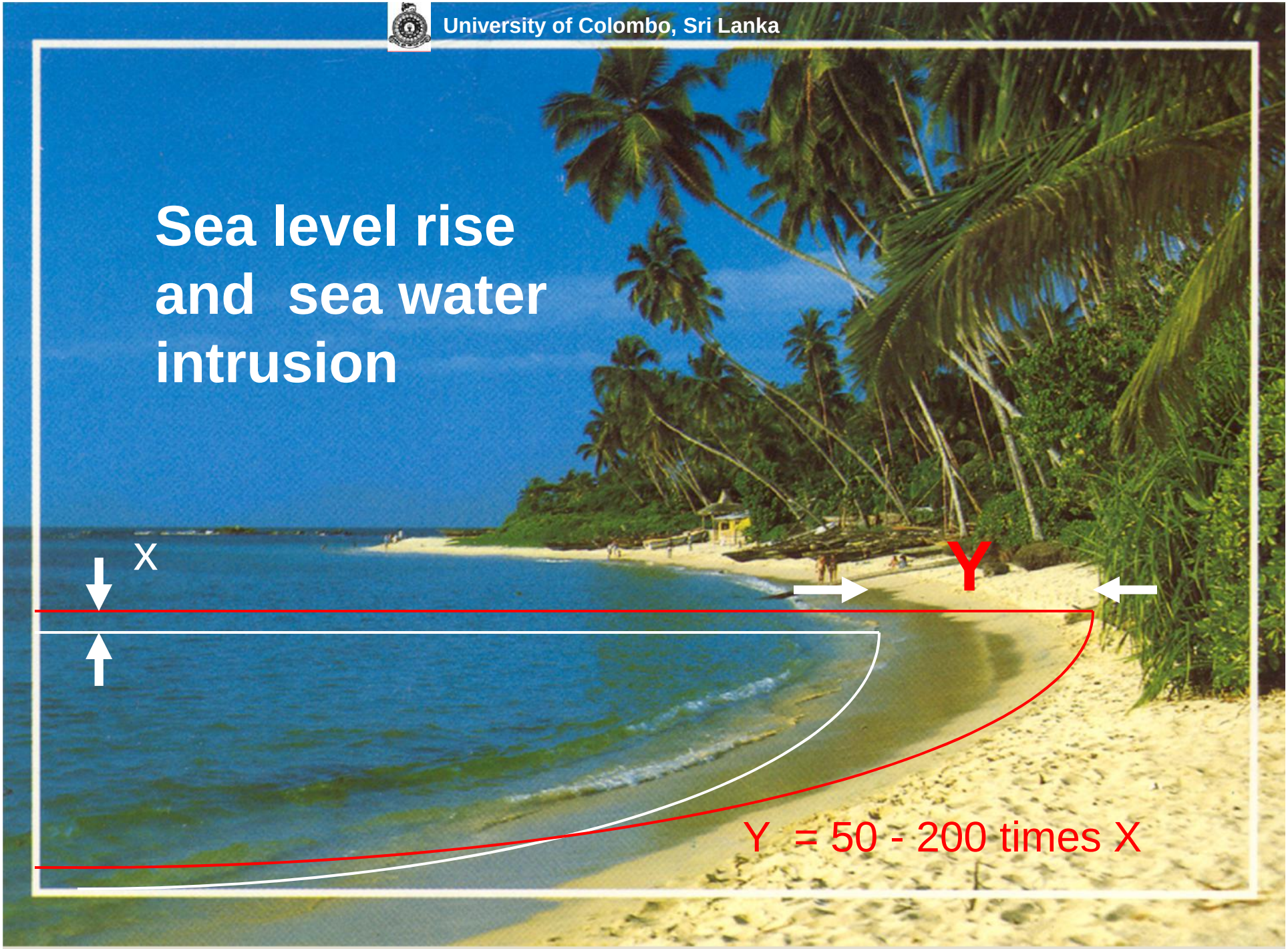
2006 May **2007 May**

Due to river sand mining coastal erosion is fact

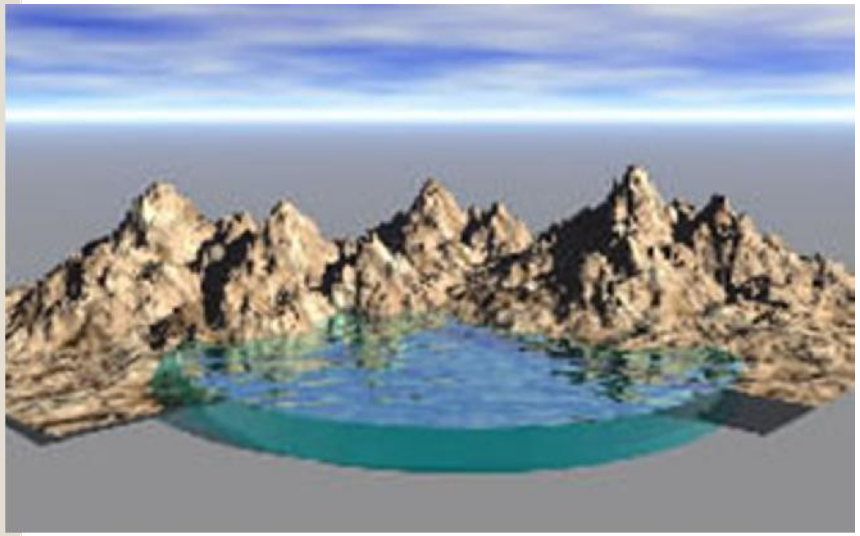
Its directly affect to groundwater quality in coastal belt

27 June 2006

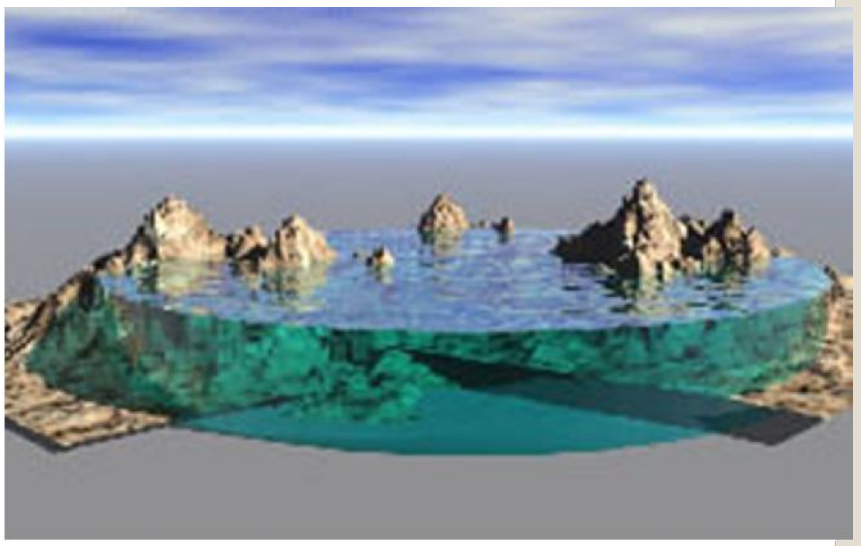
Sea level rise and sea water intrusion



Coastal flooding or inundation of coastal area

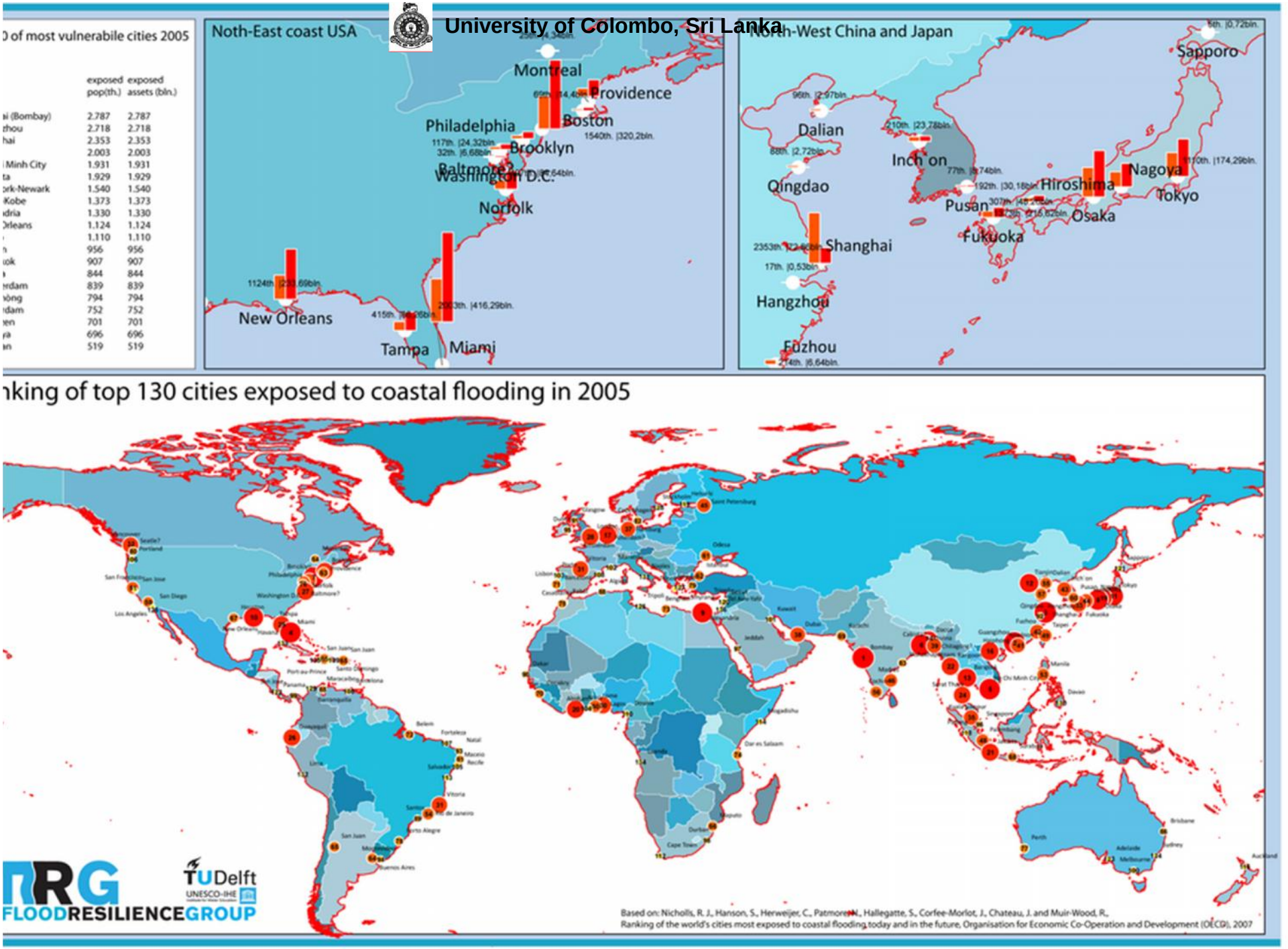


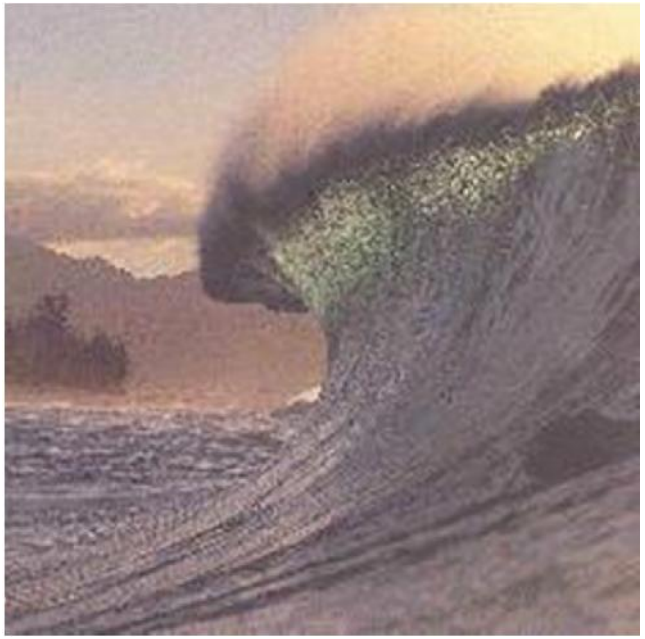
A diagram of a normal water level



A diagram of a flooded area

Environmental pollution, damage and degradation of valuable properties, lost of lives, many people lost their shelters .etc are some of the issues created by floods.


of most vulnerabile cities 2005
exposed pop(th.)
exposed assets (bln.)
(Bombay) 2.787 2.787
zhou 2.718 2.718
hai 2.353 2.353
2.003 2.003
Minh City 1.931 1.931
ta 1.929 1.929
ork-Newark 1.540 1.540
Kobe 1.373 1.373
dria 1.330 1.330
Orleans 1.124 1.124
1.110 1.110
956 956
ok 907 907
844 844
erdam 839 839
hong 794 794
dam 752 752
en 701 701
ya 696 696
an 519 519
Noth-East coast USA
Montreal
Providence
Boston
1540th. |320,2bln.
Philadelphia
117th. |24,32bln.
32th. |6,68bln.
Brooklyn
Baltmore?
Washington D.C.
Norfolk
1124th. |233,69bln.
New Orleans
415th. |86,26bln.
2503th. |416,29bln.
Tampa
Miami
North-West China and Japan
Sapporo
96th. |2,97bln.
Dalian
210th. |23,78bln.
88th. |2,72bln.
Inch'on
77th. |9,74bln.
Qingdao
192th. |30,18bln.
Hiroshima
Nagoya
Tokyo
Pusan
Osaka
Fukuoka
2353th. |72,46bln.
Shanghai
17th. |0,53bln.
Hangzhou
Fuzhou
274th. |6,64bln.
nking of top 130 cities exposed to coastal flooding in 2005
TUDelft
UNESCO-IHE
FLOODRESILIENCEGROUP
Based on: Nicholls, R. J., Hanson, S., Herweijer, C., Patmore, N., Hallegatte, S., Corfee-Morlot, J., Chateau, J. and Muir-Wood, R.,
Ranking of the world's cities most exposed to coastal flooding today and in the future, Organisation for Economic Co-Operation and Development (OECD), 2007



Tsunami Flooding

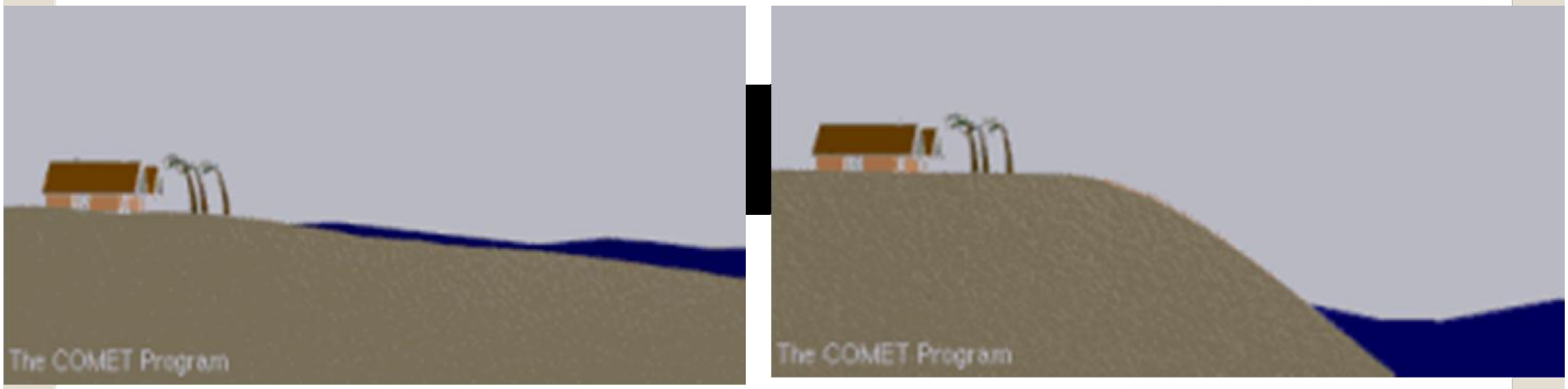
Submarine earthquakes cause giant tidal waves

e.g. S.E. Asia 2004

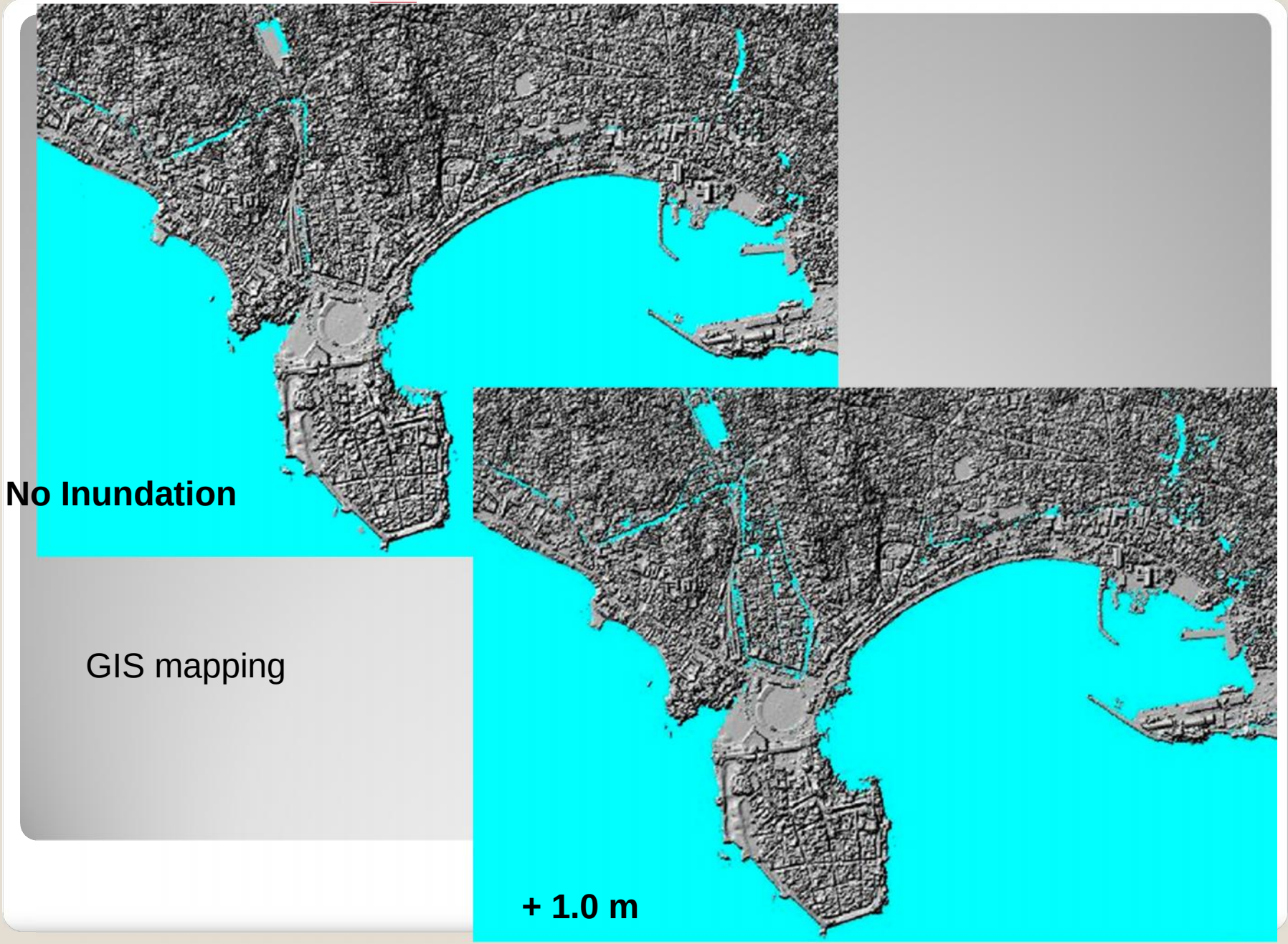
Western Sri Lanka

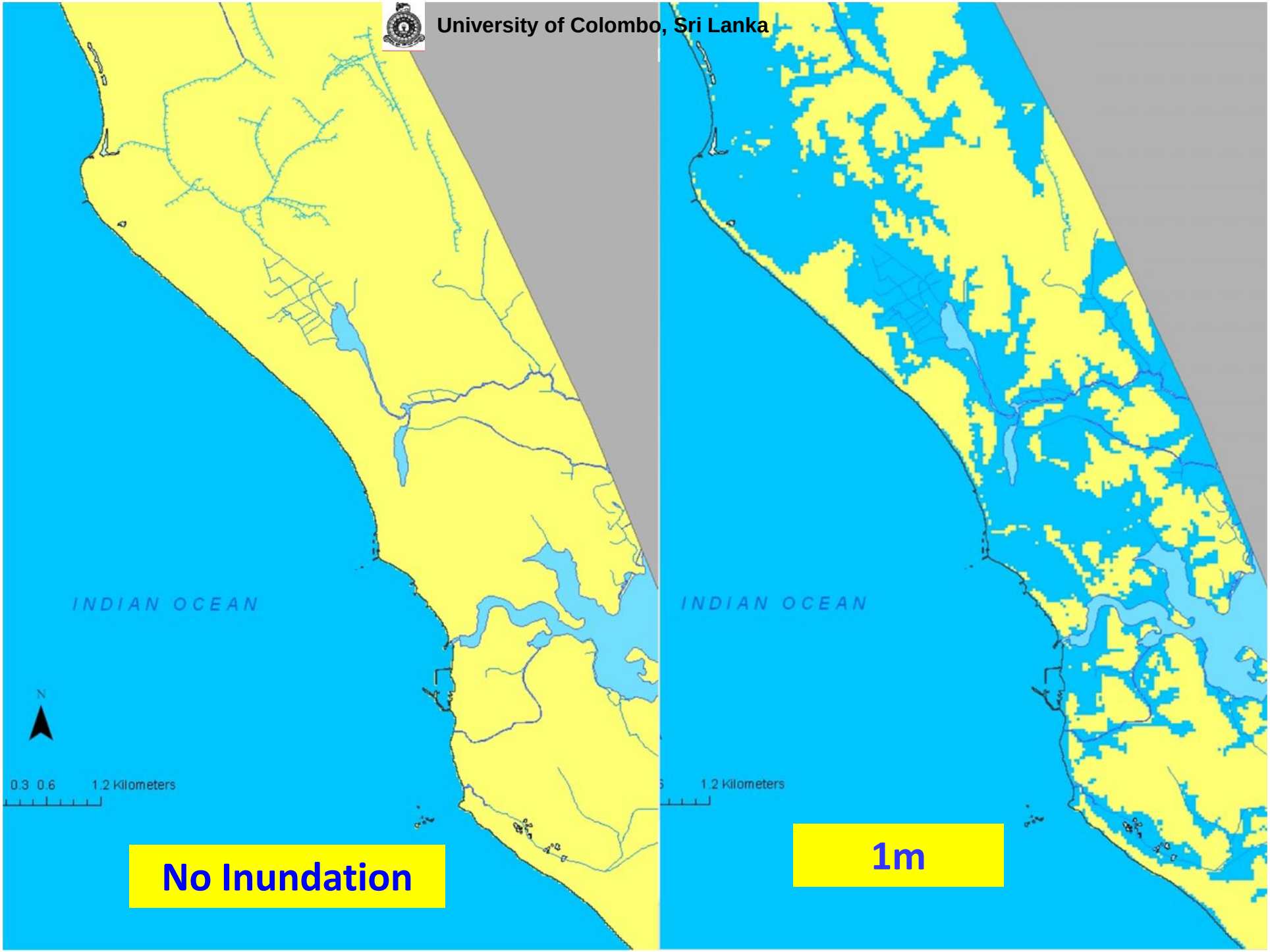
Depends on Morphology of the coast

The level of surge in a particular area is also determined by the slope of the continental shelf. A shallow slope off the coast (left picture) will allow a greater surge to inundate coastal communities.

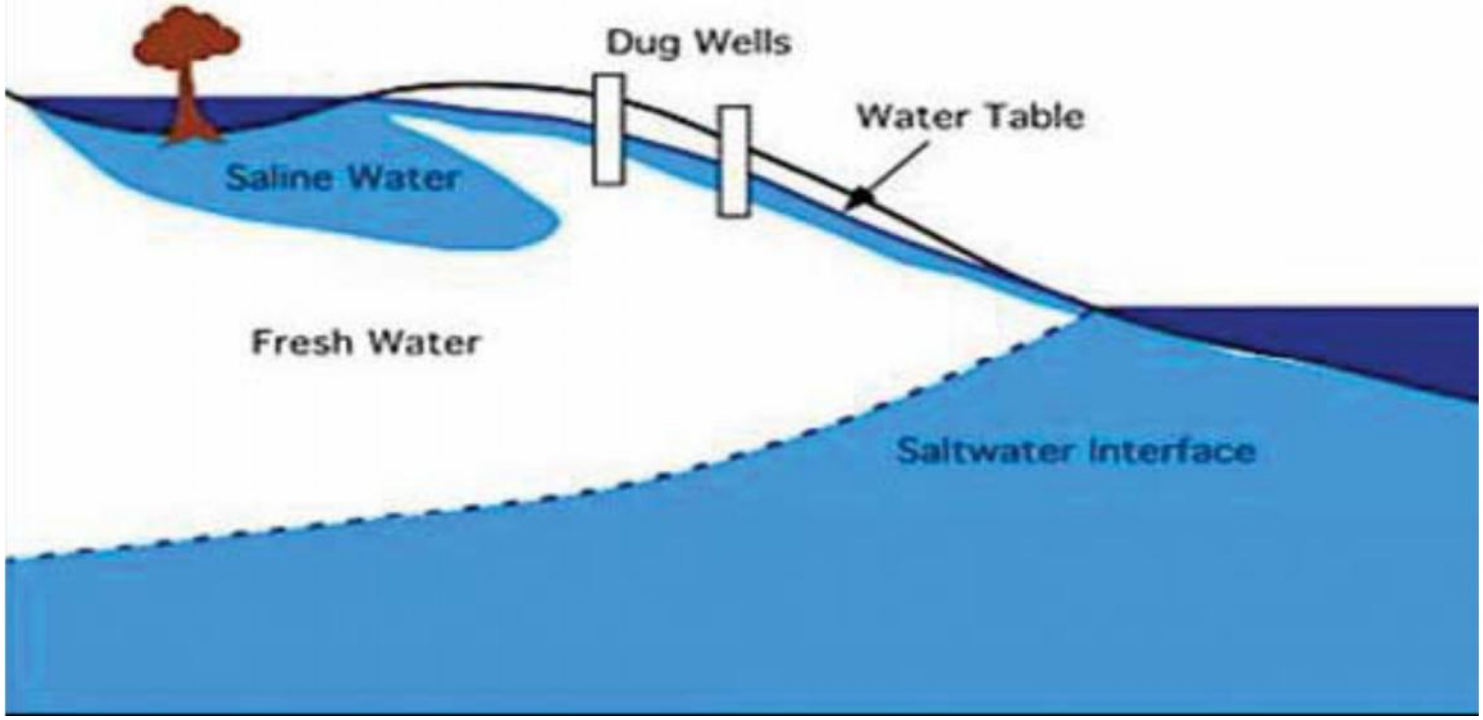


Communities with a steeper continental shelf (right picture) will not see as much surge inundation,


No Inundation
GIS mapping
+ 1.0 m


University of Colombo, Sri Lanka
INDIAN OCEAN
N
0.3 0.6 1.2 Kilometers
No Inundation
INDIAN OCEAN
1.2 Kilometers
1m

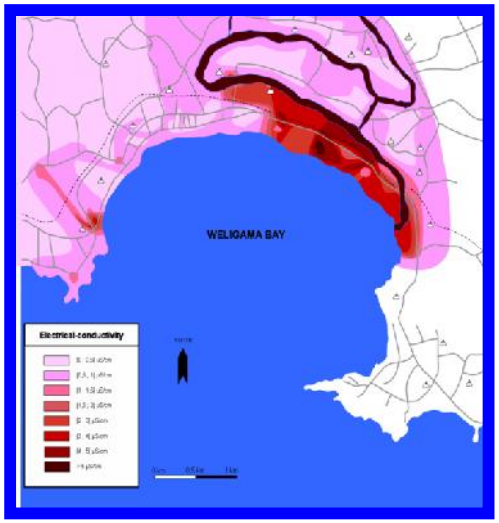
Inundation of coastal areas and its impacts on groundwater



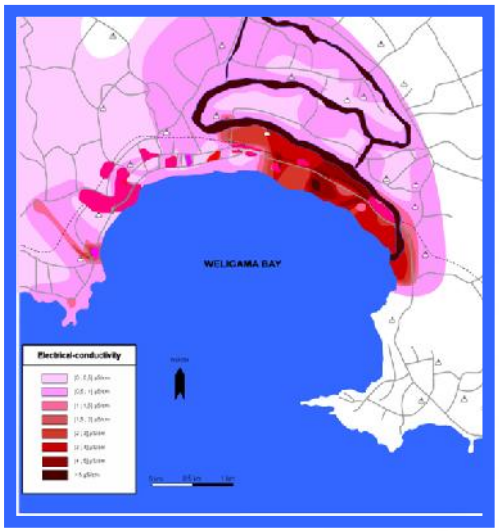
Its directly affect the agriculture and drinking water resources

The groundwater resources have badly affected by increased saltwater intrusion and invaded pollutants to the wells. Due to TSUNAMI

Changes in Electrical conductivity level

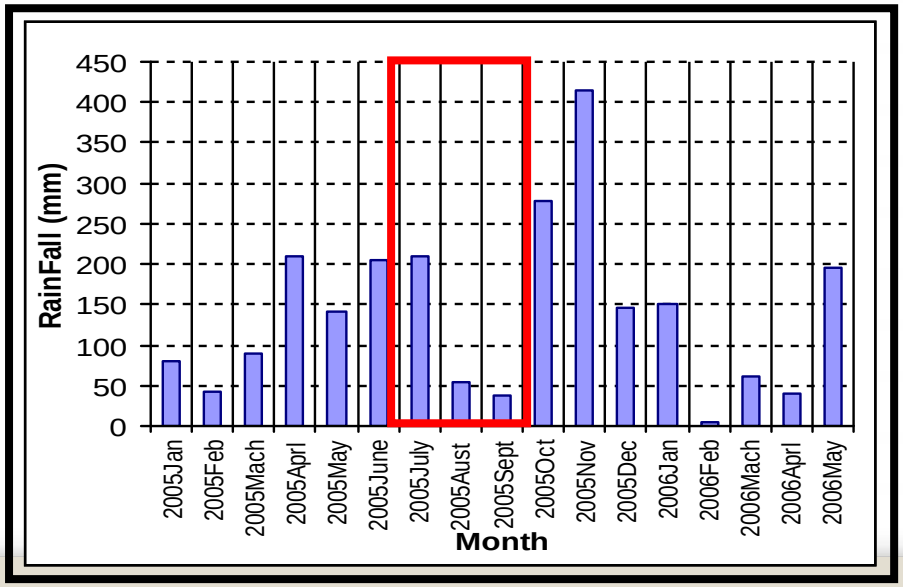


EC level in May 2005



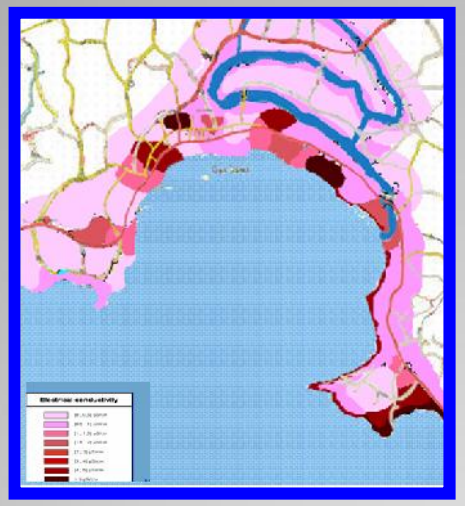
EC level in September 2005

Very low rainfall received in August & September

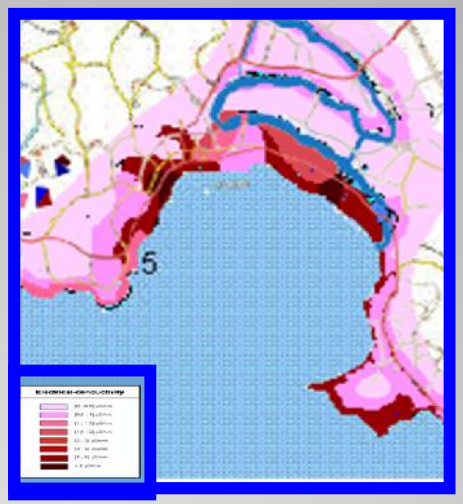


EC values in river increased up to 10000 µ Siemens/cm

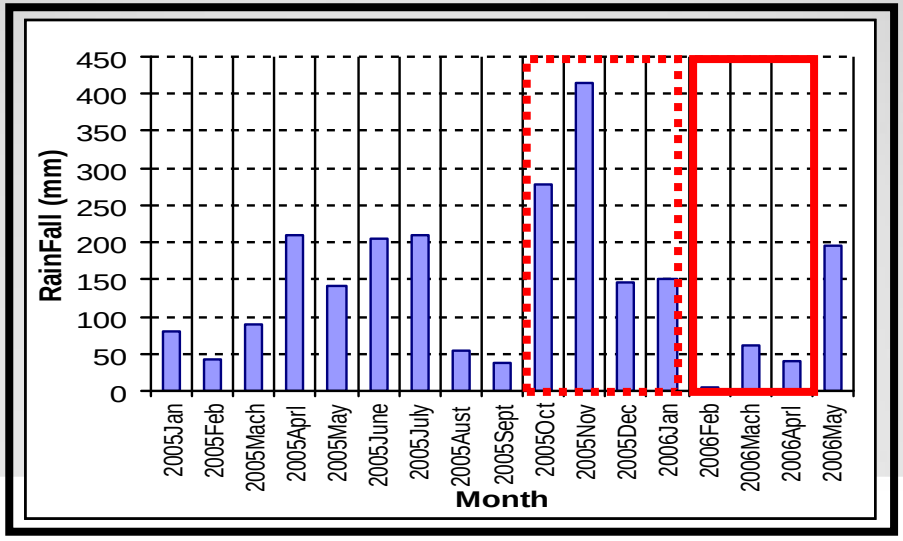
Changes in EC level



2006 February EC

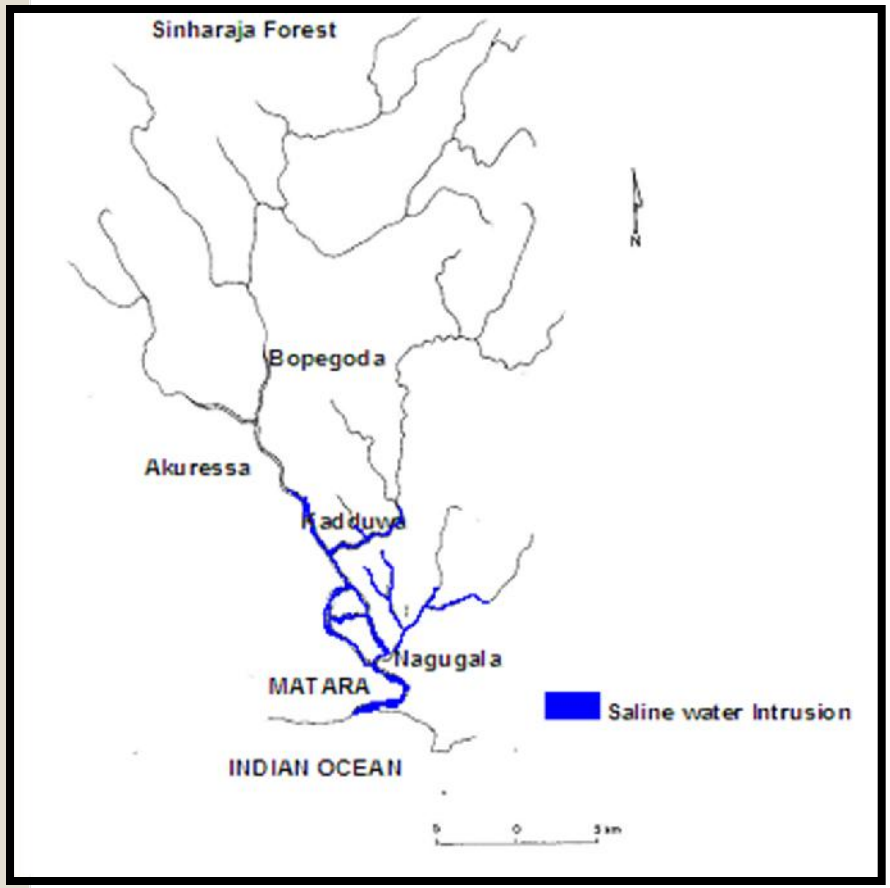


2006 May EC



Central and western regions with the atmospheric precipitation salinity, TDS, and EC concentrations slightly increased in some places

Salinity in river water



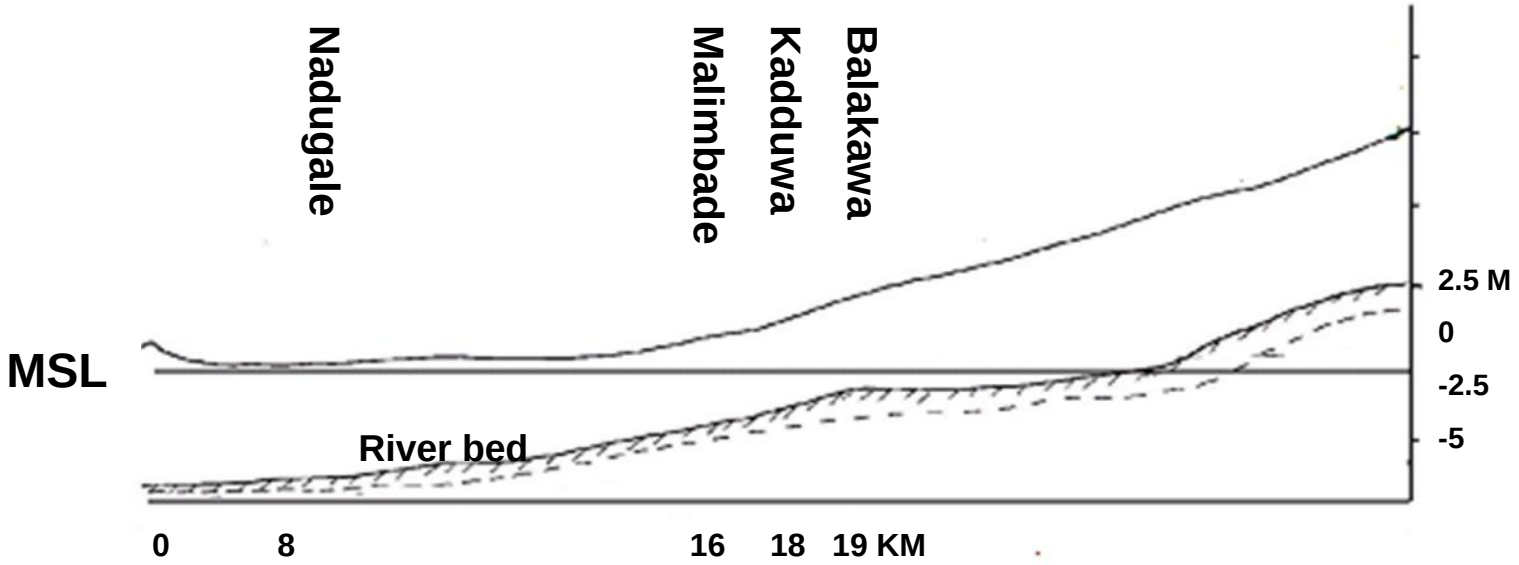
With the lowering of the riverbed tidal water tends to flow into the country along the course of the Nilwala River and it's tributaries .

salinity level at different points of the river were varying due to the differences of density of saline and fresh water

(density of fresh water = 1.0000 g/cm^3 and
saline water density= 1.0027 g/cm^3).

Nilwala River is the only source of drinking water in the Matare district

Initially water pumping station stationed Nadugala (8KM). Now pumping station is located at Balakawa, over 19 Km away from the sea



All this moves were triggered by the salinity intrusion of the river


paddy fields in Kiralakele (5000 ha),went out of the cultivation due to Acid Sulphate problem.

Mitigation Options and Adaptation response

Coast Protection

- Change in the Erosion Control Methodology

  Reactive / defensive approach

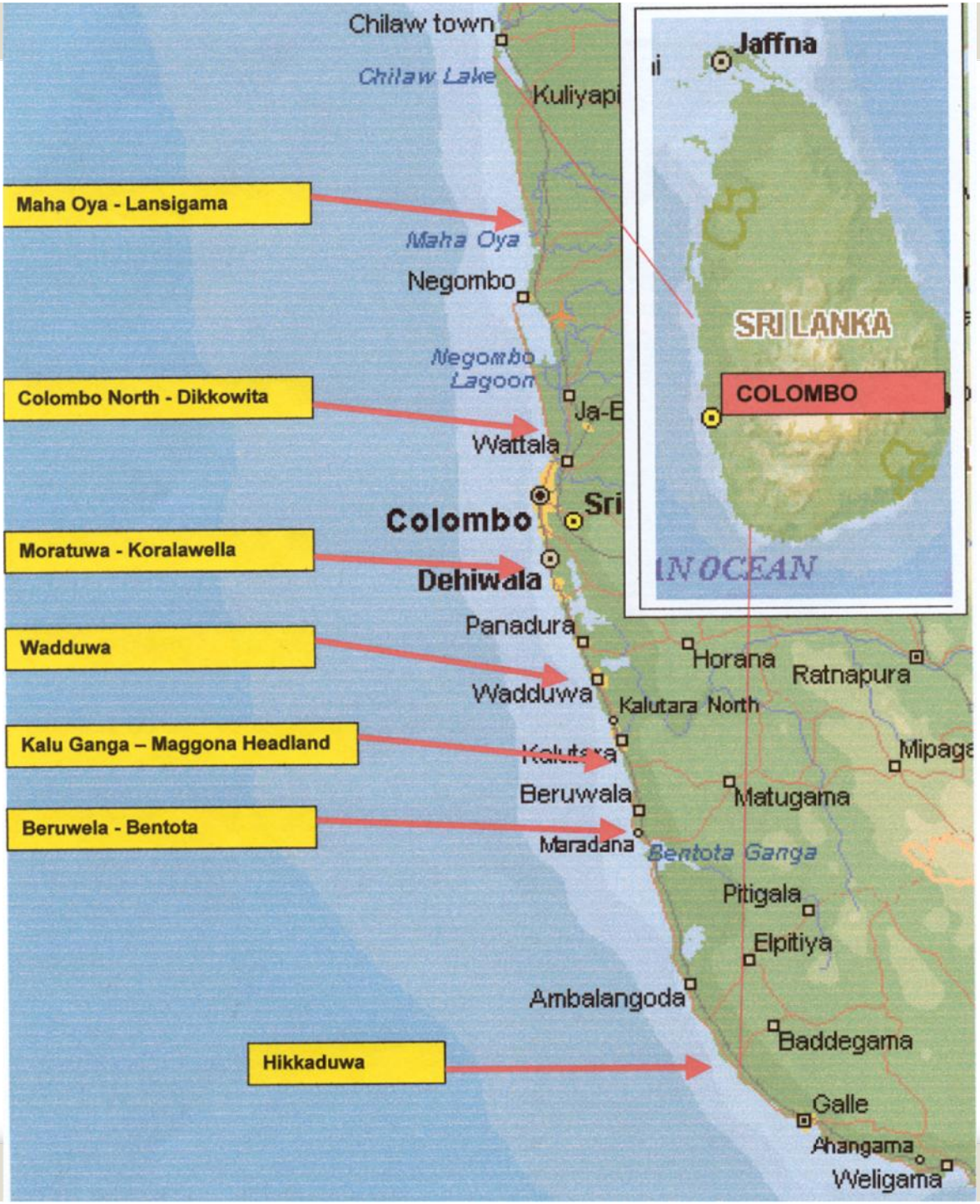
  ↓

  Proactive / preventive approach

- Maintain the existing define line where possible
- Stakeholder consultations

  ↓

  Hybrid approach → hard structures
  Hybrid approach → sand fill
  Hybrid approach → beach nourishment


Chilaw town
Chilaw Lake
Kuliyapi
Maha Oya - Lansigama
Maha Oya
Negombo
Negombo Lagoon
Colombo North - Dikkowita
Ja-E
Wattala
Colombo
Sri
Moratuwa - Koralawella
Dehiwala
Panadura
Wadduwa
Horana
Ratnapura
Kalutara North
Kalu Ganga – Maggona Headland
Mipaga
Beruwala
Matugama
Beruwela - Bentota
Maradana
Bentota Ganga
Pitigala
Elpitiya
Ambalangoda
Baddegama
Hikkaduwa
Galle
Ahangama
Weligama
Jaffna
SRI LANKA
COLOMBO
IN OCEAN

Coastal Stabilization Component
Maha Oya-Lansigama 13 km

Revetments, Breakwaters, Groynes, Beach Nourishment)

Ranweli Hotel Premises

2003 – before construction of C3 - C4- Kolinjadiya

2006 - After construction C3-C4

Coastal Stabilization – Colombo North 6.8 km

540 m sea wall at Mutwal, 5 m walkway, Detached breack waters, Groynes, Sand fill Uswetakeiyawa

Colombo Sea Wall

Before construction of sea wall

After construction of sea wall

Uswetakeiyawa – Sand fill

Coastal Stabilization - Kalu Ganga- Payagala 7.5 km

4 Detached breakwater, 5 groynes, 250 m revetment

River mouth construction work at Kalutara

After construction of Groyne at Kalutara

Sand fill at Payagala

Implementation of the Coastal Zone Management Plan by CCD

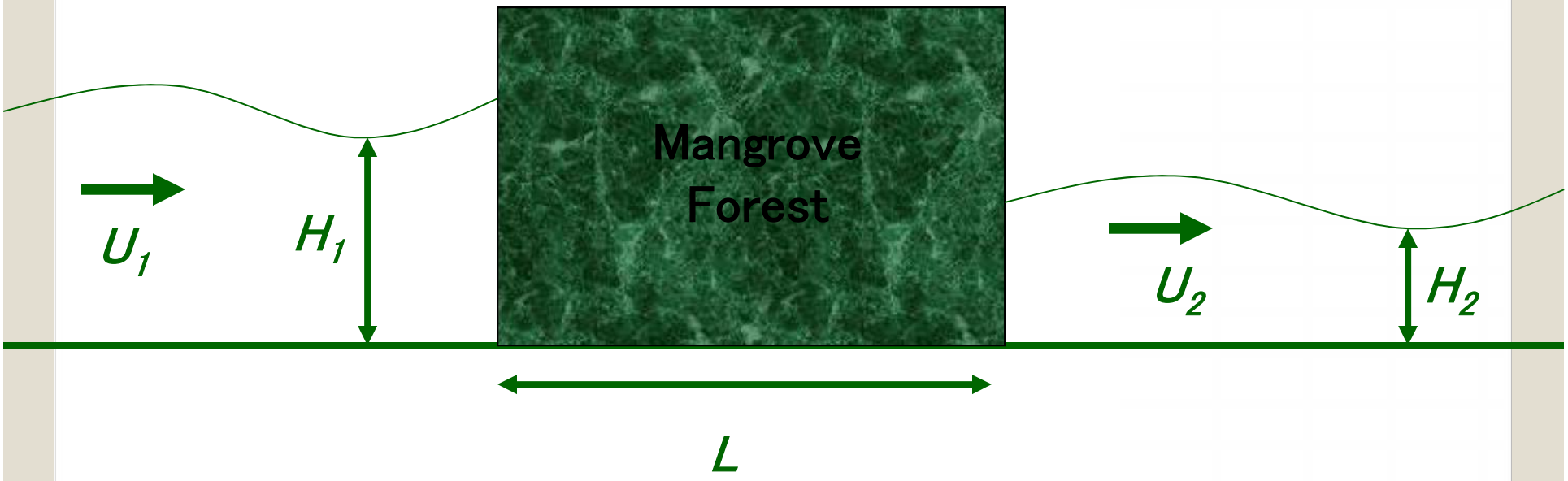
- Regulation of development activities and Requirement of a permit for development activities that are likely to alter the physical nature of the coastal zone.
- Prohibits engaging in mining, processing and transporting coral within the coastal zone.
- Controlling sand mining to a satisfactory degree.

Contd. .....

- Setback, an area left free of any physical modification to allow for dynamics of seasonal and long term fluctuations of the coastline and to ensure public access and visual access.
- EIA for large development projects.
- Compliance with the conditions stipulated in the permit through a monitoring system.
- Coastal Erosion Management.

function of coastal ecosystems

- There are scientific evidence from 5-6 year old Mangroves planted in 1 m intervals reduced wave energy at a rate of 20% per 100m of forest (Mazada et al 1997)
- In case of mangrove and non mangrove forest, their shielding ability depends on density, width and structure of forest.



$$\Delta H = \left(H_1 + \frac{U_1^2}{2g} \right) - \left(H_2 + \frac{U_2^2}{2g} \right)$$

$$i = \frac{\Delta H}{L} = au + bu^2$$

Rehabilitation of Mangroves

- Preparation of guidelines
- Community awareness and education
- Research
- Coordination

DRR Manual to minimize to impacts of climate change

- To build capacity of the Coastal zone Managers and communities on disaster risk reduction and to design and implement projects that enhance the protection of live and livelihoods

Lesson learned from DRR Activities for coastal areas

- Communities cannot be motivated to the DRR activities until they fully understand the situation
- Financial support given to the communities for disaster reduction activities has created negative impacts
- Appropriate results for DRR can not be achieved through single agency involvement or single approach. It is required multi-disciplinary approaches and inter-agency involment

Future plan

- Build a simulation model to identify climate extreme events in Sri Lanka.

THANK YOU

University of Colombo, Sri Lanka

- Acknowledgements

✓Coastal Zone Management Plan, 2004 – Coast Conservation Department