UNIVERSITY OF GHANA

DEPARTMENT OF MARINE AND FISHERIES SCIENCES

IMPACTS OF SHORELINE MORPHOLOGICAL CHANGE AND SEA LEVEL RISE ON MANGROVES; THE CASE OF THE KETA COASTAL ZONE

BY

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IGARSS 2013, MELBOURNE

Outline of Presentation

- Introduction
- Methodology
- Results
- Conclusions
- Acknowledgement
- References

Introduction

- Sea level rise
  - Global sea level rise has been estimated to be about 0.18–0.59m from 1980 to 1999 to the end of the 21st century (2090–2099) (Solomon et al., 2007).
  - Sea level in Ghana is rising at a rate of about 2-3mm/yr (Appeaning Addo et al., 2008, Addy-Sagoe and Appeaning Addo, 2012).
  - May result in the inundation of most coastal ecosystems, including mangroves.

- Mangroves
  - Taxonomically diverse group of salt-tolerant, mainly arboreal, flowering plants (Ellison and Stoddart 1991.
  - Pneumatophoric roots (*Avicennia, Sonneratia* species), stilt roots (*Rhizophora, Brugueria, Ceriops* species), salt-excreting leaves, and viviparous water-dispersed propagules (Kathiresan and Bingham,2001).

A section of mangroves (*Rhizophora* sp) at Atiteti

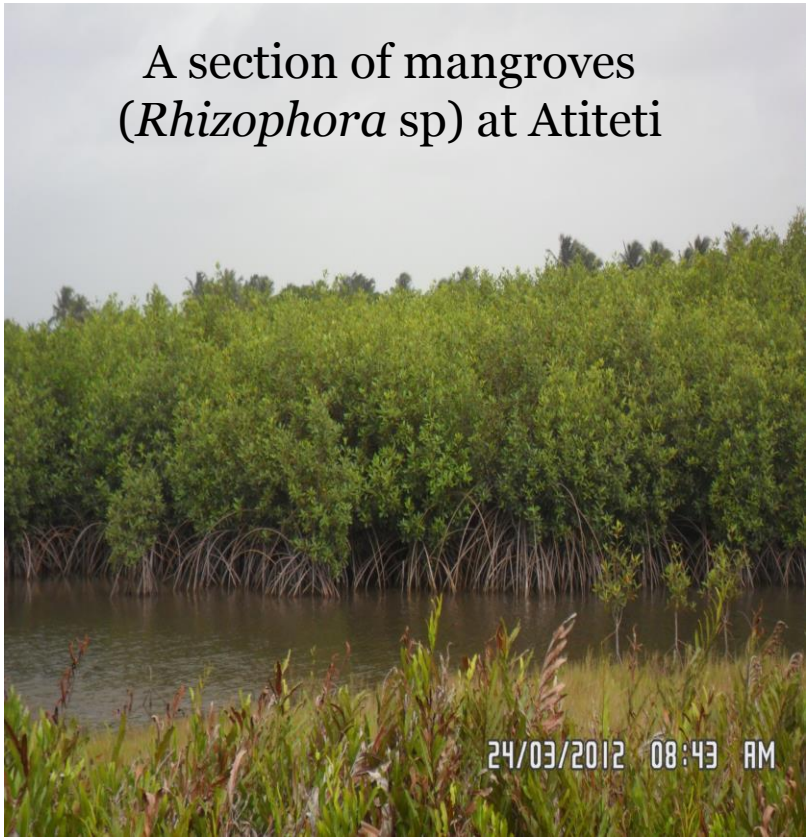


Photo Credit: Author, 2012

Importance of Mangroves

- Ability to break the force of waves and trap sediment.
- Prevent coastal-erosion processes through the use of their roots.
- Nurseries for economically important fisheries
- Filtering and trapping of pollutants.

Photo Credit: Author, 2012

- Threats to Mangroves
  - Inundation due to sea level rise
  - Shoreline retreat
  - Over exploitation

Harvested Mangroves at Anyanui

Erosion at Atiteti

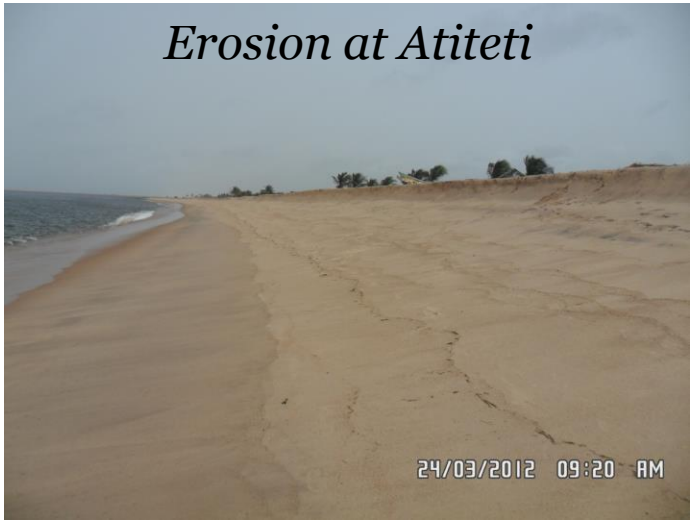


Photo Credits: Author, 2012

Problem Statement

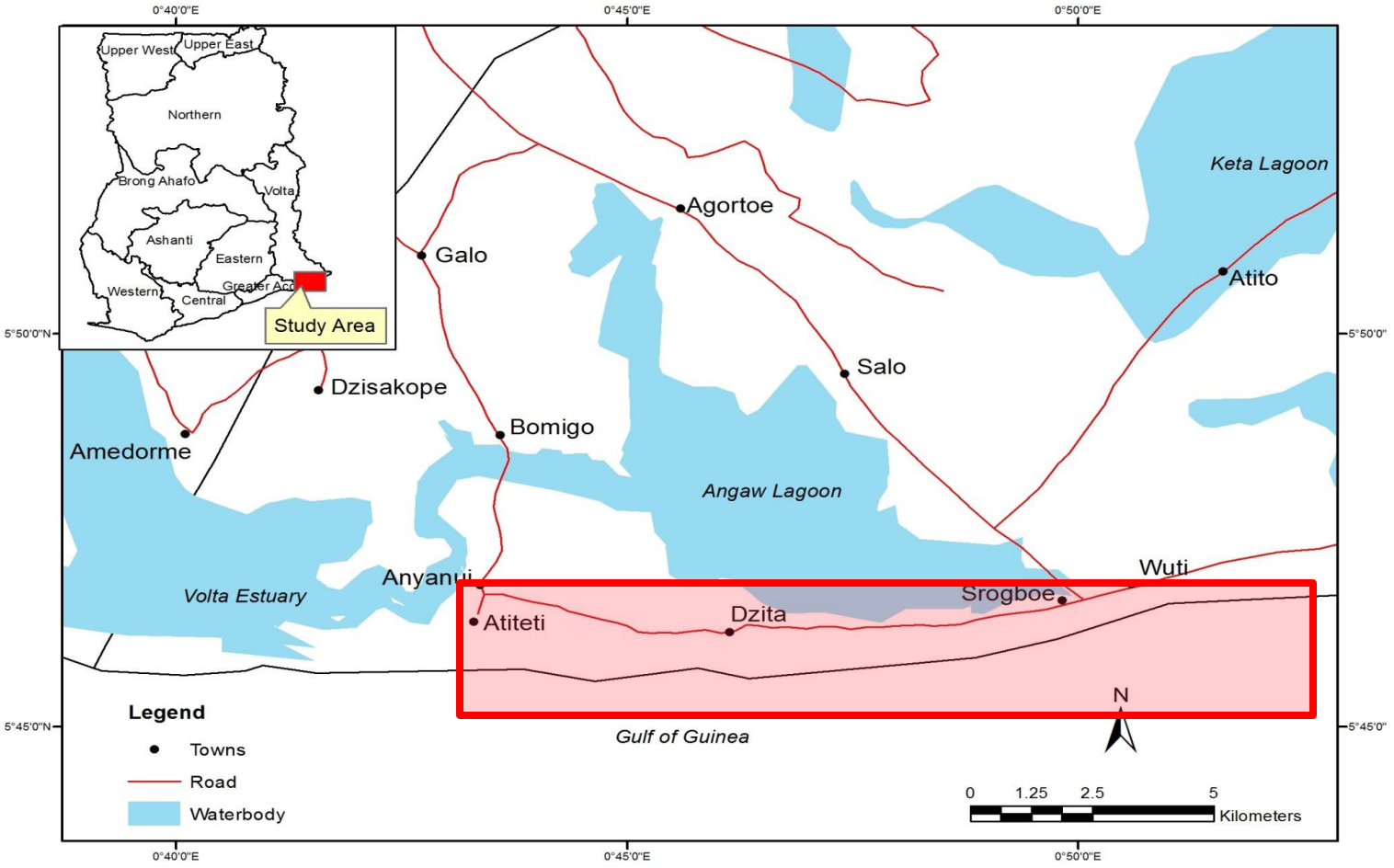
- Mangroves at the Keta coastal area are under the threat of over exploitation (Armah et al,1998)
- Shorelines are changing (Camfield and Morang, 1996).
  - Erosion trend is expected to increase under the scenario of rising sea level (Anthony, 2005; Appeaning Addo et al., 2008).
  - Erosion in Keta area between 4 and 8 m/yr (Ly, 1980)

Objectives

- Main Objective
  - Evaluate the effect of sea level rise on mangroves using geospatial data and modelling techniques.

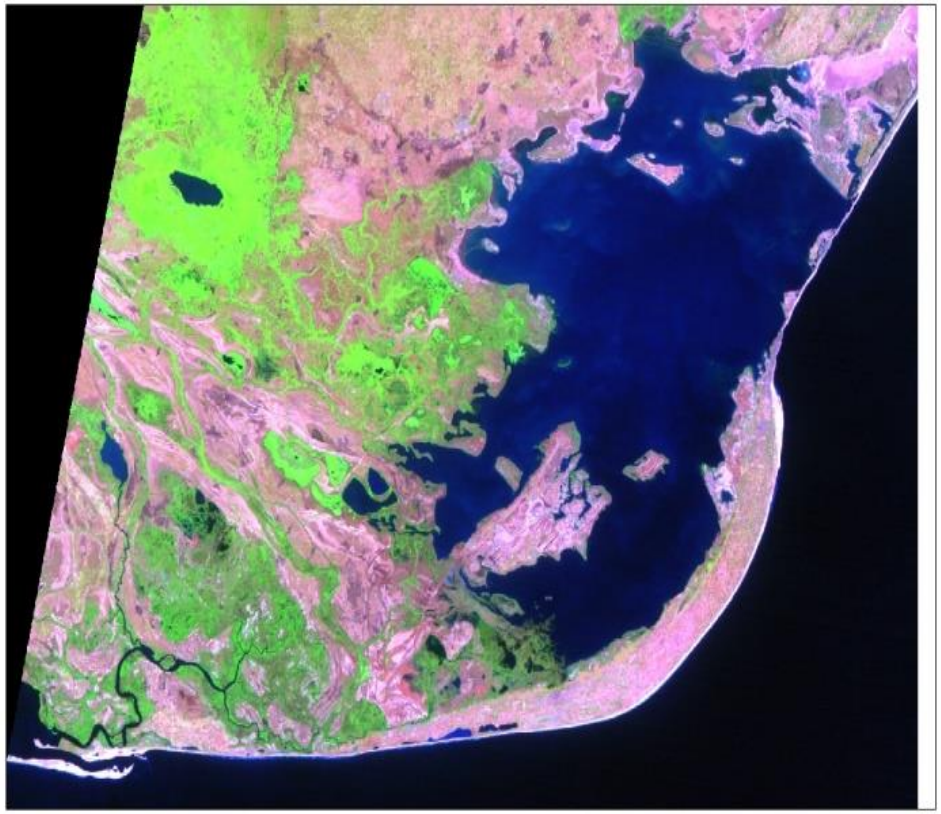
- Specific Objectives
  1. Assess sea level rise situations in Ghana and determine the local trend
  2. Estimate historic shoreline change and the rates at which this change is occurring
  3. Detect spatial change in mangroves
  4. Determine impact of sea level rise on mangrove colony by predicting future shoreline positions.

Study Area

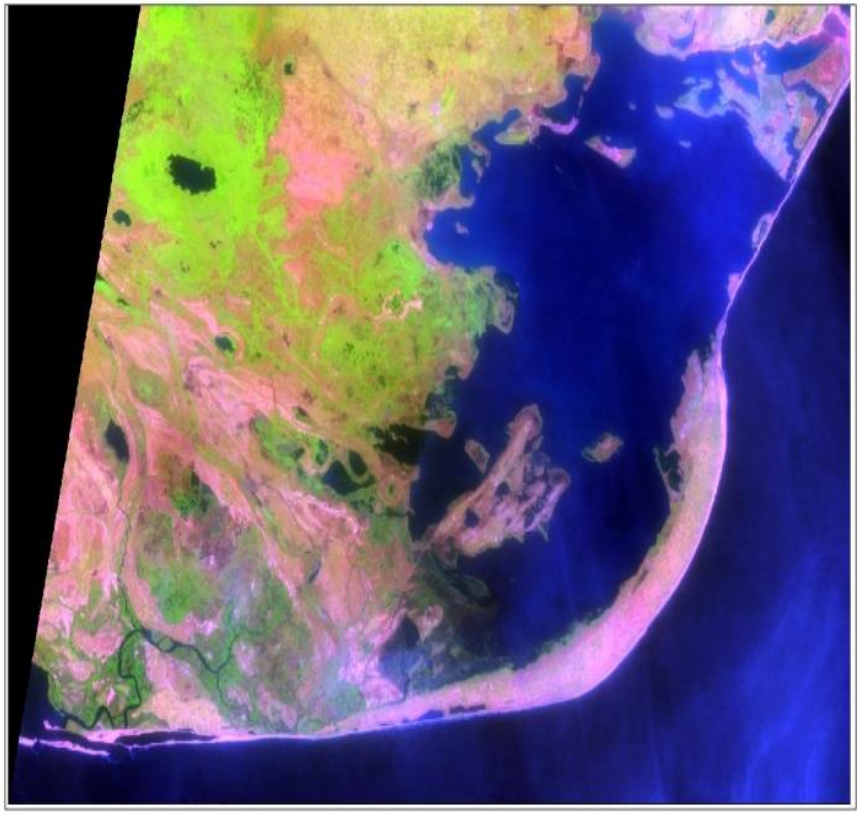


Shoreline along the Keta Municipality

Satellite imagery for 25 year period

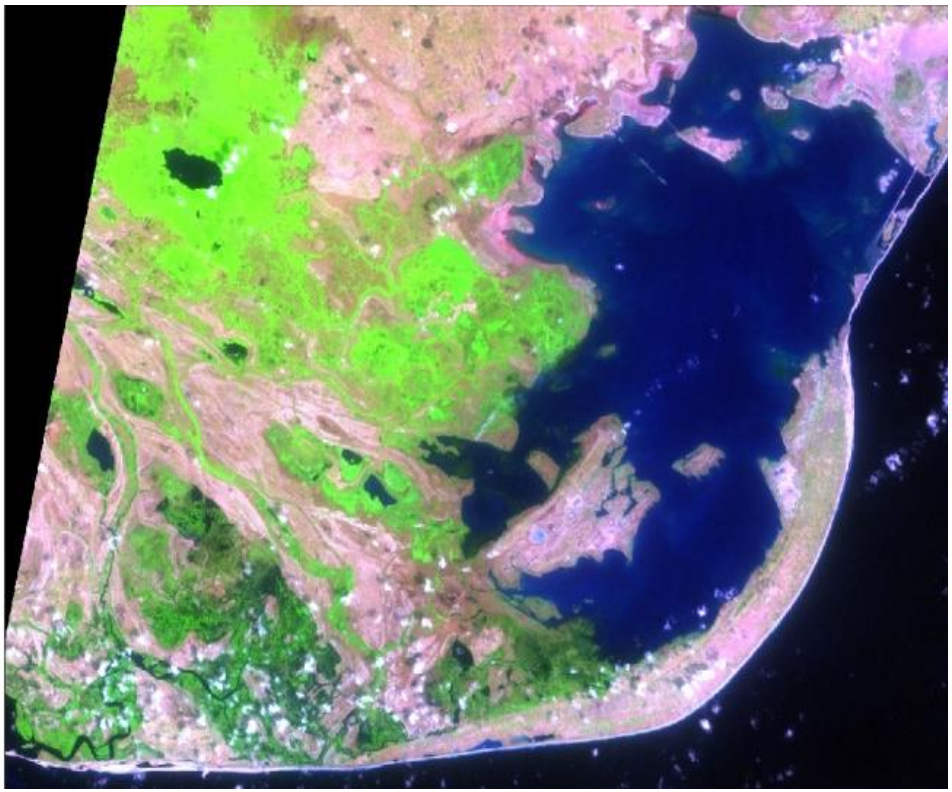


1986 TM

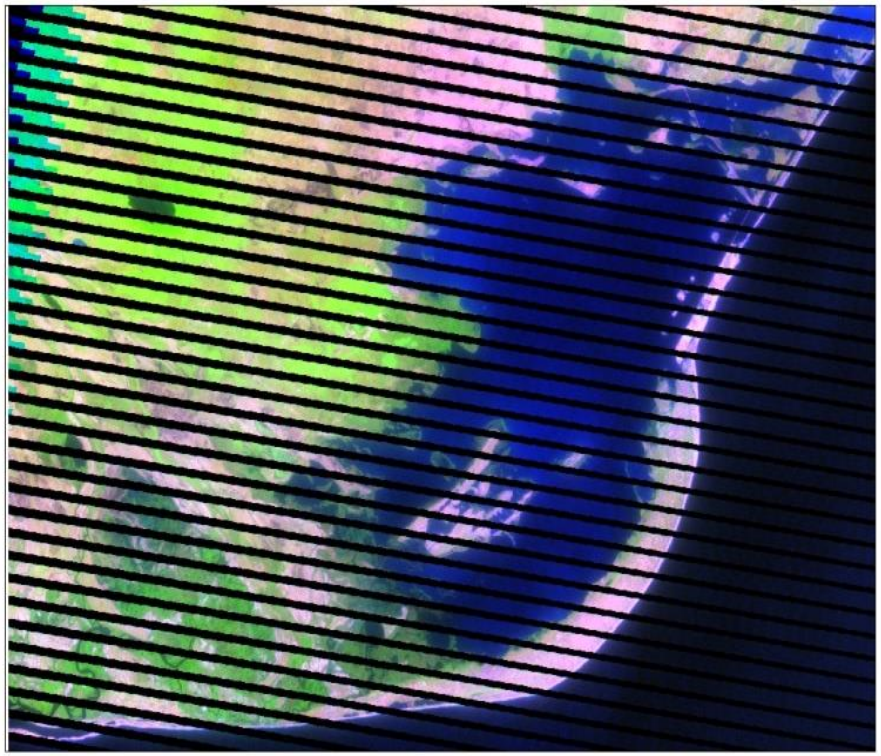


1991 TM

Colour Composites of the Satellite Imageries
(Credit USGS, 2012)



2001 ETM+



2011 ETM+

Colour Composites of the Satellite Imageries
(Credit USGS, 2012)

Methodology

- Data acquisition
- GPS data collection
- Shoreline extraction
- Shoreline preparation and change analysis
- Rate of Change Calculation

- Image Classification
  - Unsupervised Classification
  - Supervised Classification
- Mangrove Change Statistics and Change Map
- Predicting future shoreline positions

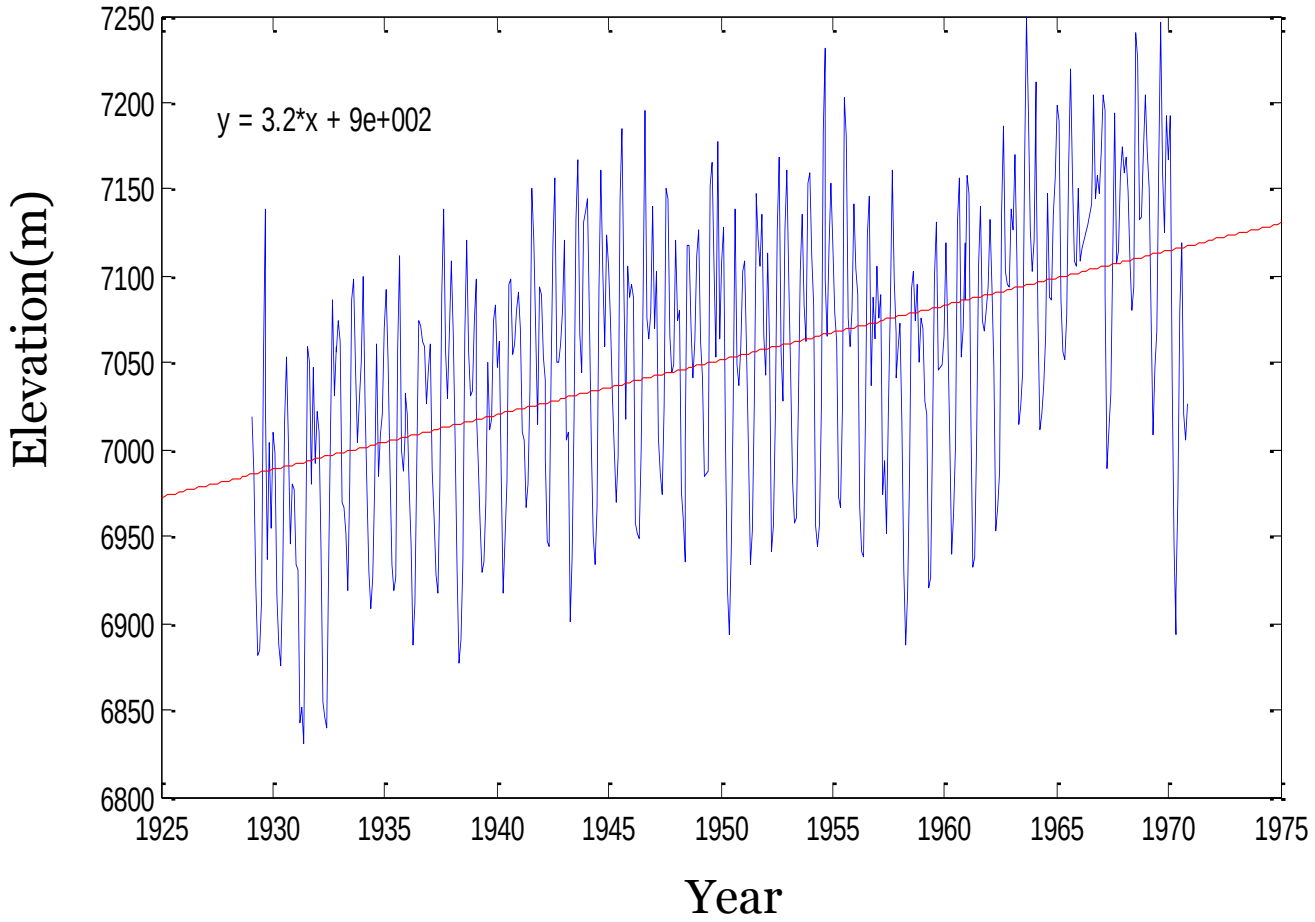
$$E2 = \frac{E1 \times S2}{S1}$$

where
S_1 = Historic Sea level
S_2 = Future sea level
E_1 = Historic erosion rate
E_2 = Future erosion rate.

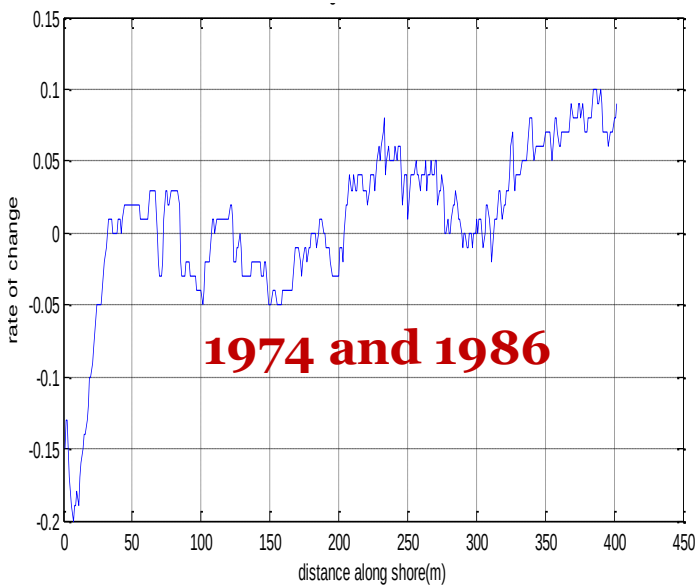
Results

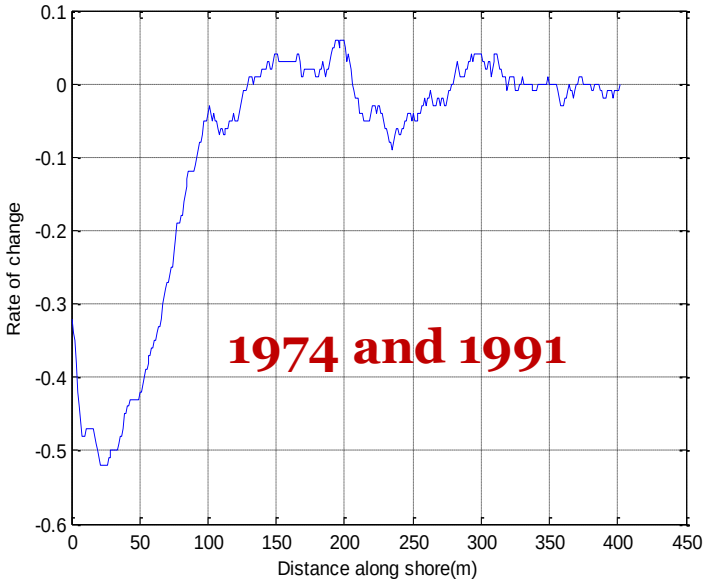
1. Local trend in sea level rise: $y = 3.2x + 9e{+}002$

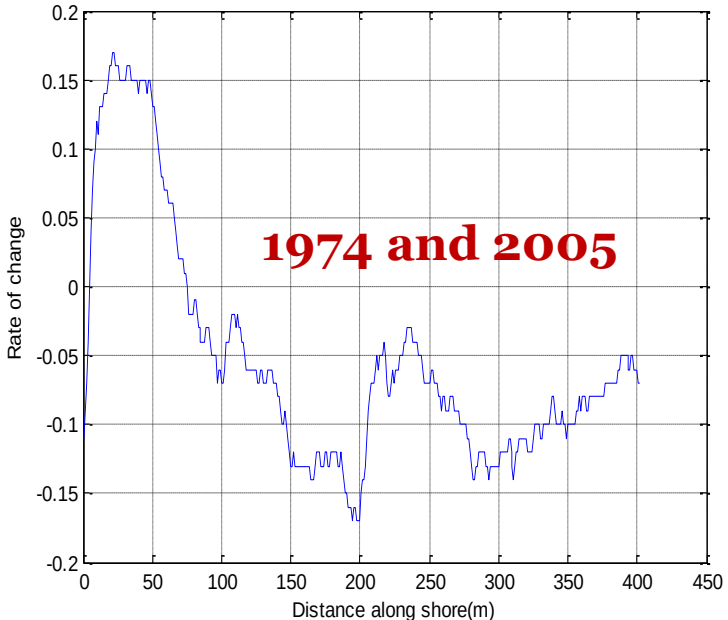
where: **y** = average mean sea level, **x** = year/period

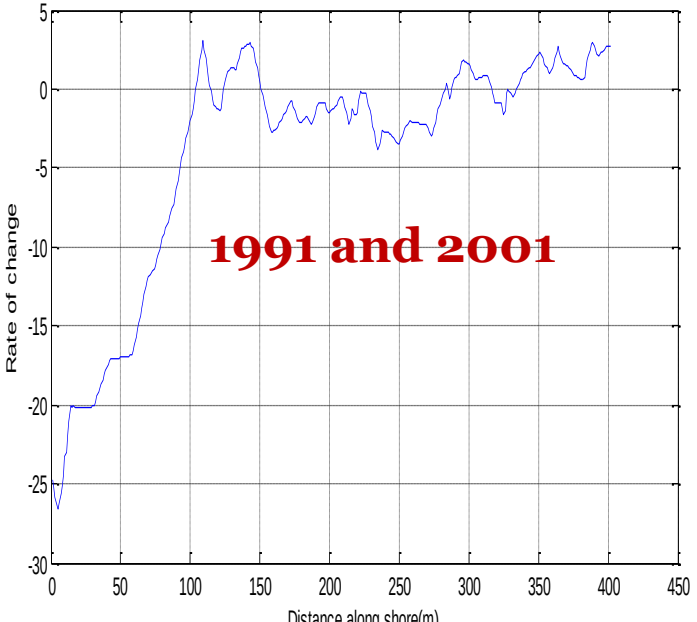


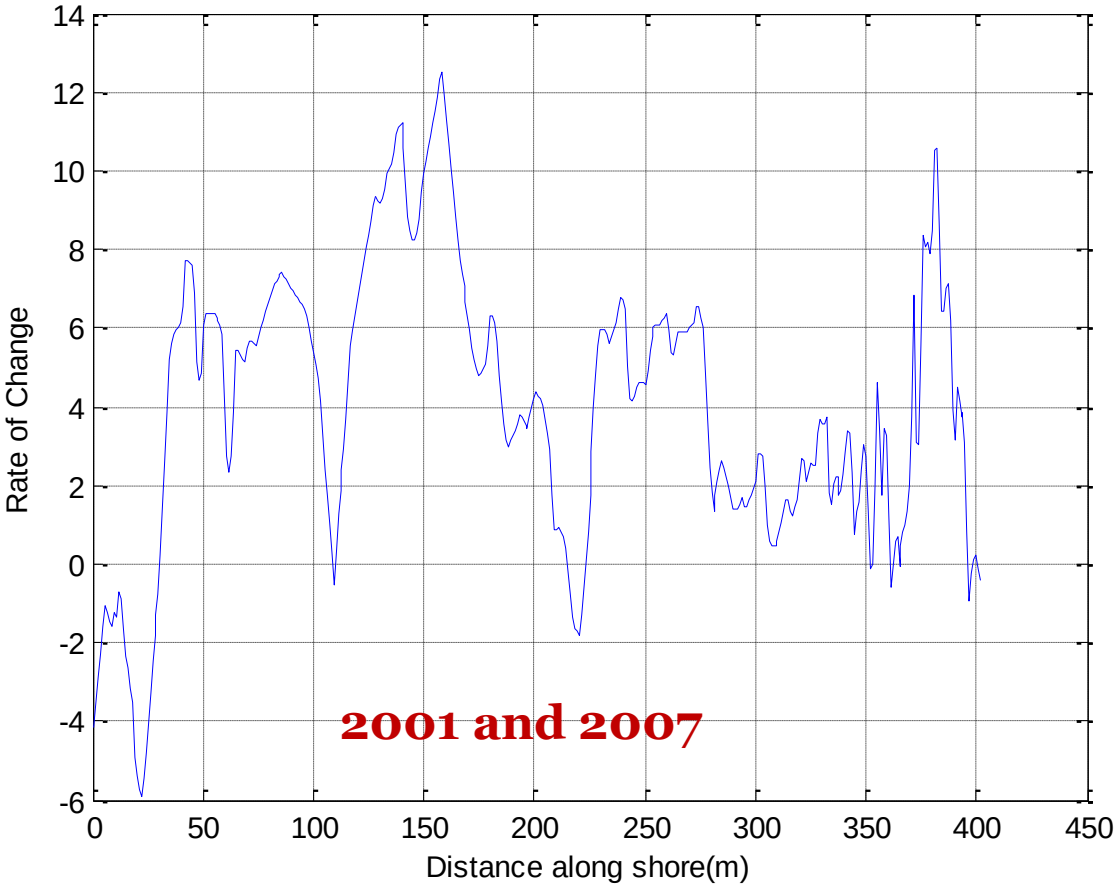
2. Rates of shoreline change between various years







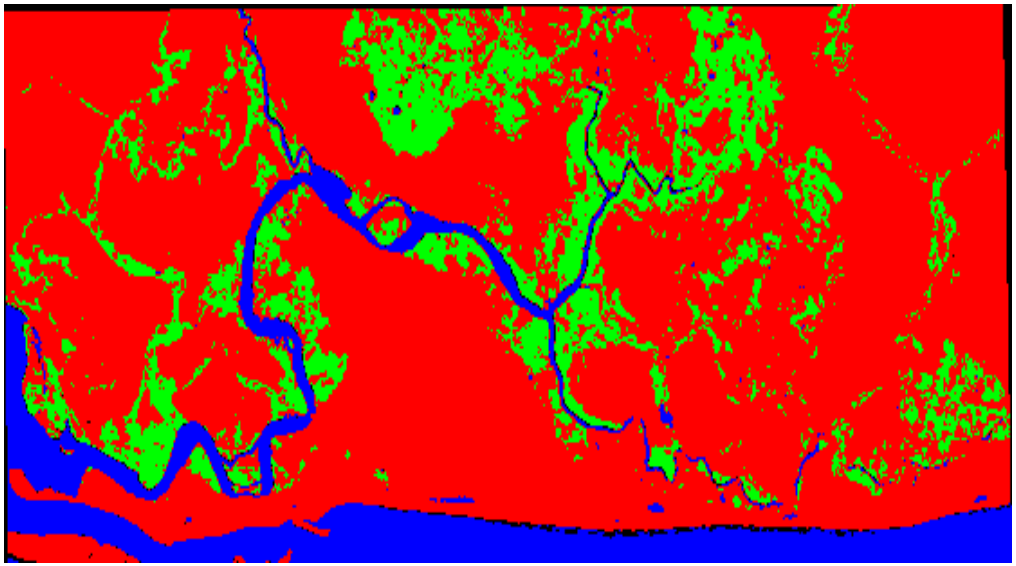



Rate of Change
Distance along shore(m)
2001 and 2007
14
12
10
8
6
4
2
0
-2
-4
-6
0
50
100
150
200
250
300
350
400
450

Average Erosion and Accretion Rates

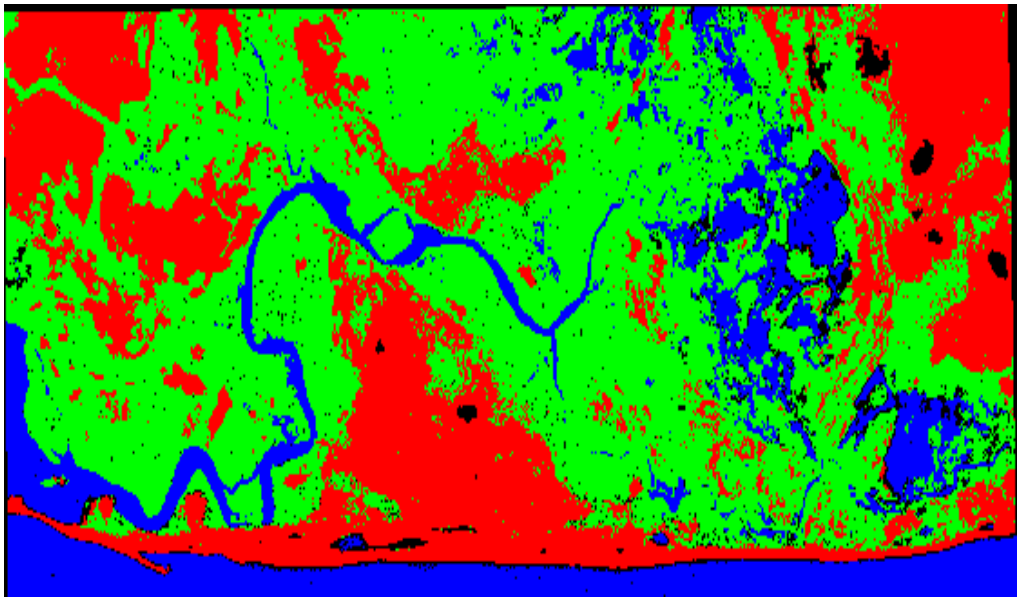
Period	Erosion Rate Av (m/year)	Accretion Rate (m/year)
1974- 1986	-0.04	0.05
1974-1991	-0.16	0.03
1991-2001	-6.88	1.48
1974-2005	-0.09	0.11
2001-2007	-4.89	0.74
Average	**-2.40**	**0.48**

Image classification



Supervised Classification of 1986 Landsat TM image

Key	
Land	**Red**
Vegetation.	**Green**
Water	**Blue**
Unclassified	**Black**



Supervised Classification of 2002 Landsat TM image

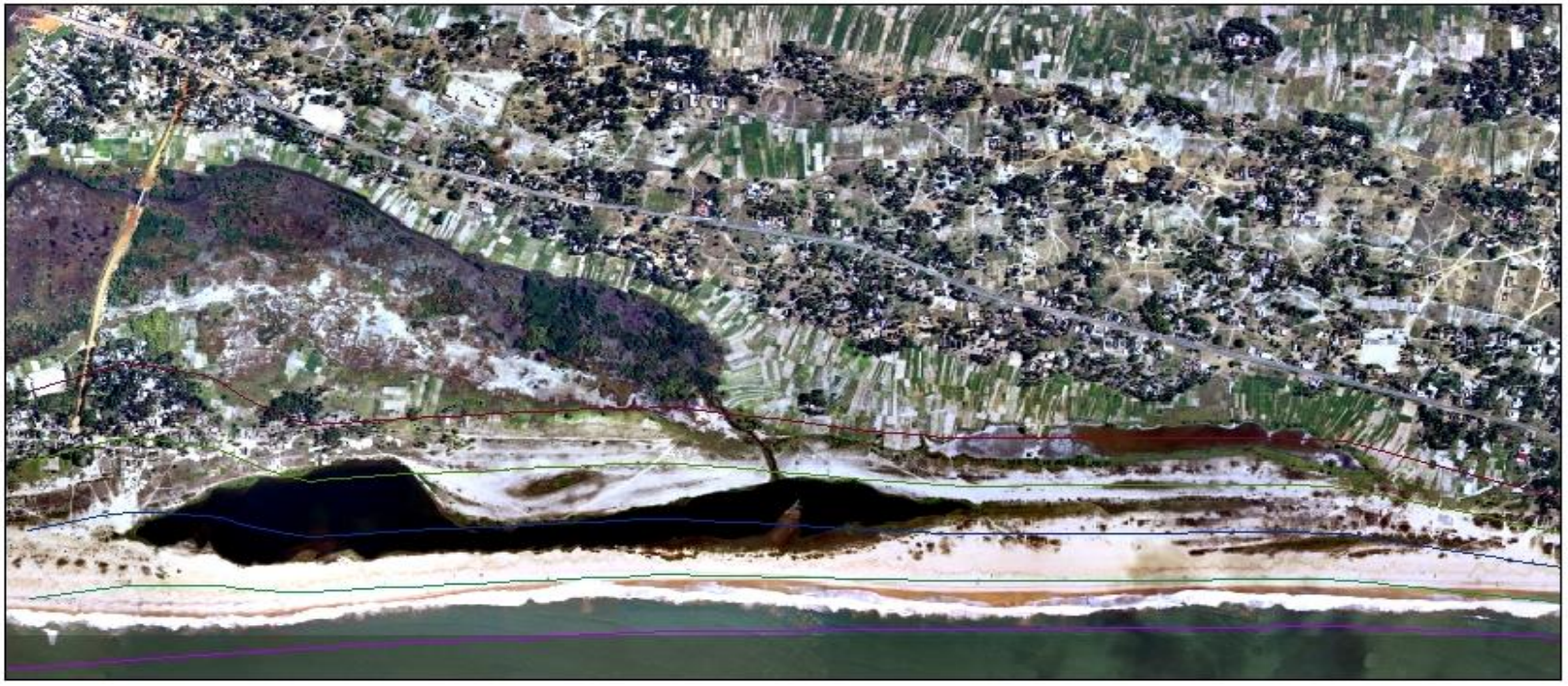
3. Change Statistics for Mangroves

	Mangroves [Green] 535 points	Bare land [Red] 499 points	Water [Blue] 765 points	Row Total	Class Total
Unclassified	605	659	2953	4217	5956
Bare land [Red] 288 points	2128	11673	6733	20534	20830
Mangroves [Green] 261 points	17031	895	47146	65072	65281
Water [Blue] 429 points	314	953	36150	37417	37621
Class Total	20078	14180	92982	0	0
Class Changes	3047	2507	56832	0	0
Image Difference	45203	6650	-55361	0	0
Percentages					
	Bare land [Red] 499 points	**Mangroves [Green] 535 points**	**Water [Blue] 765 points**	**Row Total**	**Class Total**
Unclassified	3.013	4.647	3.176	70.803	100
Bare land [Red] 288 points	10.599	82.32	7.241	98.579	100
Mangroves [Green] 261 points	84.824	6.312	50.704	99.68	100
Water [Blue] 429 points	1.564	6.721	38.878	99.458	
Class Total	100	100	100	0	0
Class Changes	15.176	17.68	61.122	0	0
Image Difference	225.137	46.897	-59.539	0	0

Change Statistics for Mangroves – cont'd

Area (Square Meters)					
	Bare land [Red] 499 points	**Mangroves [Green] 535 points**	**Water [Blue] 765 points**	**Row Total**	**Class Total**
Unclassified	544500	593100	2657700	3795300	5360400
Bare land [Red] 288 points	1915200	10505700	6059700	18480600	18747000
Mangroves [Green] 261 points	15327900	805500	42431400	58564800	58752900
Water [Blue] 429 points	282600	857700	32535000	33675300	33858900
Class Total	18070200	12762000	83683800	0	0
Class Changes	2742300	2256300	51148800	0	0
Image Difference	40682700	5985000	-49824900	0	0

4. Projected shoreline positions



Projected shoreline positions using change rates between 1991 and 2001

Conclusions

- Study confirmed that local sea level is rising at a rate of 3.2mm/yr, which is in conformity with global levels.
- It was found that rising sea level will cause shorelines to retreat and this will affect coastal ecosystems, especially the mangrove areas.
- The shoreline at Keta was found to be retreating at a rate of 2.4mm/yr which is consistent with other areas of the Ghanaian coastline that have been estimated.
- An 8km shoreline retreat was estimated for the next 100 years at Keta based on the Bruun model.
- Increase in the mangrove cover at Anyanui between 1986 and 2002 was observed.

References

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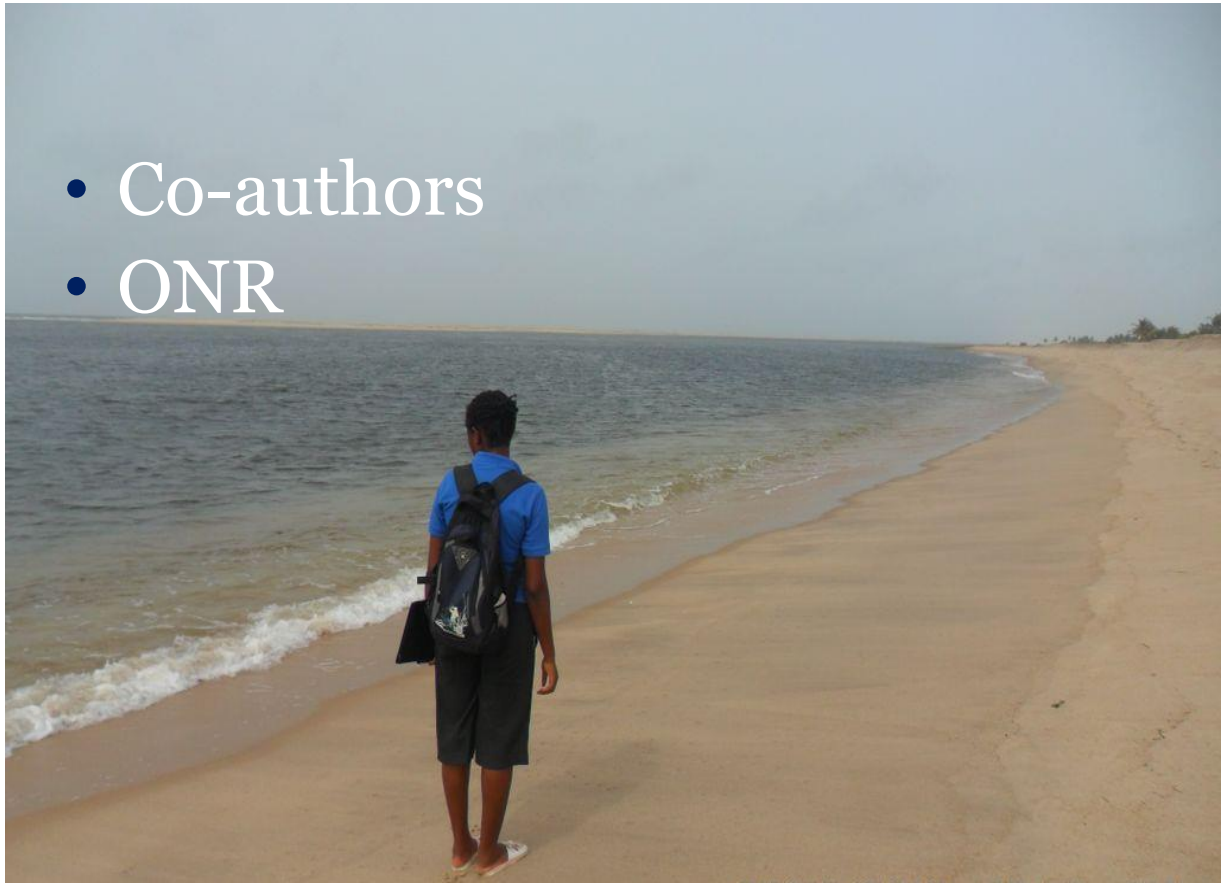
Acknowledgements



Thank you