



FIG
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From the wisdom of the ages
to the challenges of modern world

**COASTAL RISK ANALYSIS OF THE
BLACK SEA UNDER THE SEA LEVEL
RISE**

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CONTENT

- Introduction
- Aim of the Study
- Black Sea Level Variations
 - Linear Trend in the Black Sea Mean Level
- Black Sea Bathymetry
- Implications of Sea Level Rise along Turkey's Black Sea Coast
- Conclusions and Suggestions

2

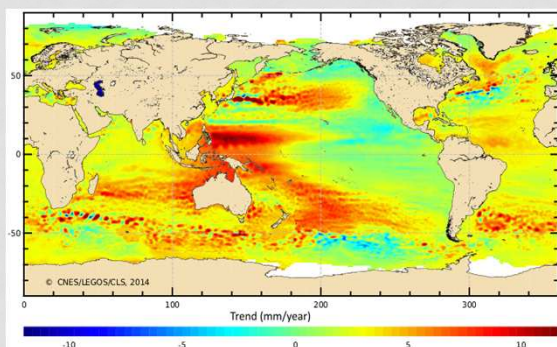
INTRODUCTION...

- Global mean sea level rise will accelerate during the 21st century in response to ocean thermal expansion and glaciers/ice sheet melting (Church et al. 2013).
- Sea level rise causes physical impacts such as permanent/temporal inundations (including floods), coastal erosion, destructive storms, and saltwater intrusion.
- It is essential to monitor sea level changes and its impacts on coastal communications.
- Coastal zones have changed progressively along the history with urbanization, populations, economies, etc.

3

INTRODUCTION

- Although some coastal areas are already well protected against rising sea levels (e.g. the low-lying sections of the North Sea coast), other coastal zones such as those of Bulgaria and Romania have far less protection (Brown et al. 2011).



- Moreover, sea level variations differ from the global to regional mainly due to non-uniform ocean warming and salinity variations.

4

AIM OF THE STUDY...



The Black Sea is a nearly closed sea having limited interaction with the Atlantic Ocean.

The Black Sea's physical and chemical structure is taken form with its hydrological balance. ⁵

AIM OF THE STUDY

- The past measurements of both tide-gauges and satellite altimetry have revealed that the mean sea level of the Black Sea has risen rapidly (Cazenave et al. 2002; Kubryakov and Stanichyni 2013; Vigo et al. 2005).
- The purpose of this study → to assess of the possible consequences of sea level rise in the Black Sea coasts.
- An important part of the most critical coastal erosion areas in the Europe is in the Black Sea coastline: 13% erosion loss (Hills et al. 2013).
- Increased storminess and erosion might also damage oil and gas infrastructure on the Russian, Ukrainian, and Georgian coasts. ⁶

BLACK SEA LEVEL VARIATIONS

- From satellite altimetry and tide-gauges data.

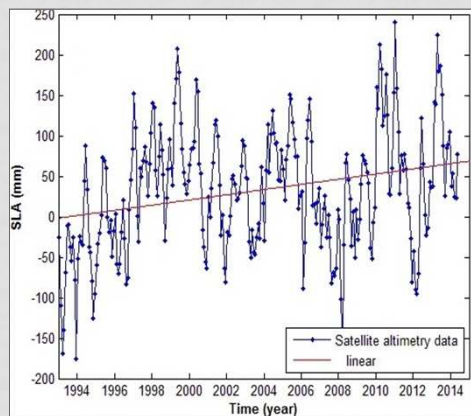
Altimetric data sets:

- All-sat-merged MSLA gridded data in delayed time (from AVISO).
- Daily data at $0.125^\circ \times 0.125^\circ$ grids.
- Time span: from 1 January 1993 to 31 May 2014.
- Reference period : 1993 – 2012.

7

LINEAR TREND IN THE BLACK SEA MEAN SEA LEVEL...

- Monthly satellite altimetry data set was obtained at all the grid points.



The trends were calculated using the method of least squares.

Trend $\rightarrow 3.19 \pm 0.81$ mm/year.

The Black Sea mean sea level has risen over 1993 – 2014.

8

LINEAR TREND IN THE BLACK SEA MEAN SEA LEVEL

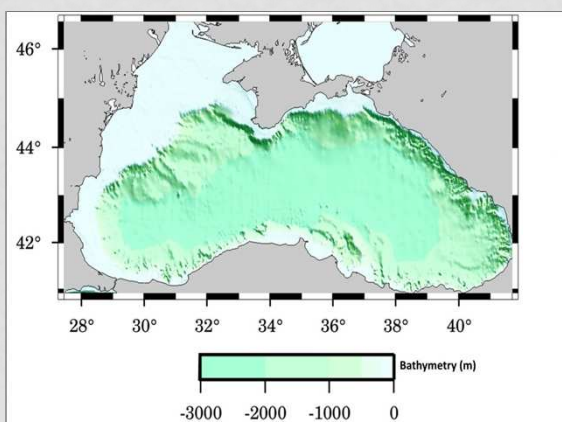
- Tide-gauge measurements reflect the variations particular to coast better.
- Three tide-gauge stations having long-term data from the Permanent Service for Mean Sea Level (PSMSL).

Tide-gauge station	Country	Time-span	Trend (mm/year)
Batumi	Georgia	1882 – 2013	1.97 ± 0.08
Poti	Georgia	1874 – 2013	6.65 ± 0.07
Tuapse	Russia	1917 – 2011	2.41 ± 0.11

9

BLACK SEA BATHYMETRY...

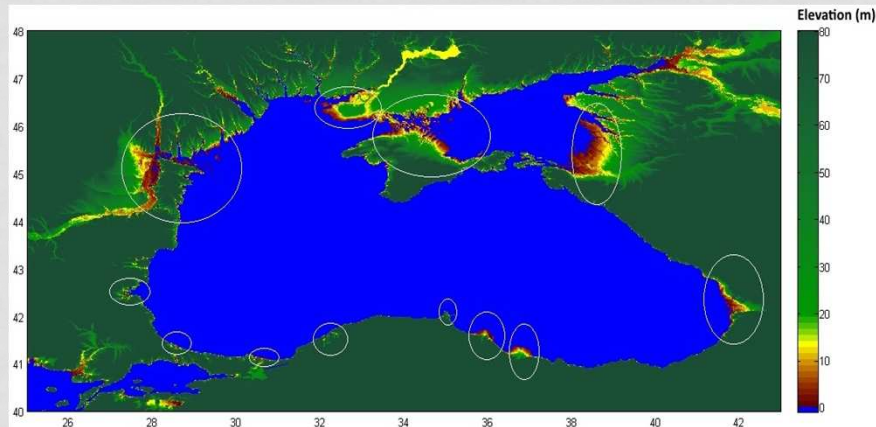
- The bathymetry of the Black Sea using the data at 30" x 30" grids presented by GEBCO.



- In the north-western part of the Black Sea, the shelf is over 200 km wide with as depth ranging from 0 to 100 m.
- In other parts, it has a depth of less than 100 m and a width of 2.2 to 15 km.

10

Coastal areas below 20 m elevation along the Black Sea shore.



- These areas are highly vulnerable to sea level rise.
- General characteristic of the areas should be examined in terms of soil type, land use, population, income, etc.


11

IMPLICATIONS OF SEA LEVEL RISE ALONG TURKEY'S BLACK SEA COAST...


- The inhabitants in the Turkey's Black Sea region are highly concentrated in a narrow coastal strip.
- The warming sea surface temperatures can increase storminess and flood frequency by affecting the precipitation patterns in the Black Sea (Karaca and Nicholls 2008).
- The transportation route between the eastern and western ends of the Turkish Black Sea coast will definitely be damaged in the long term by coastal erosion and, in the shorter term by increasing storm and surge effects.
- Terkos Dam Lake, which is an important freshwater supply for Istanbul, is at high risk of inundation (Demirkesen et al. 2008).

12

The mean annual rate of shoreline recession at Kizilirmak Delta was 6 cm/year over September 1992 – February 2012 (Simav 2012).




The maximum erosion on Karasu coastline was ~100 m between 1987 and 2013 (Gormus et al. 2014).



- The common vulnerability of Kizilirmak and Yesilirmak Deltas, and Karasu region to accelerated sea level rise is to sediment-starved as a result of dam or port constructions.
- At present, coastal erosion is a major challenge for these alluvial areas.

13



At the eastern side of Yesilirmak Delta, the beach have destroyed and the shoreline have gotten near the afforested area.

- In these areas, the movement of saline water into fresh water sources areas threatens the activities such as agriculture and fishing.
- Submersion of lagoons and low-lying coastal areas, and gradual transformation of the lagoons into bays is other impacts.
- Most vulnerable areas in the Turkey's Black Sea coast occur at Samsun and Istanbul cities considering population, settlements, land use, wetlands, contribution to national agricultural production, and taxes (Kuleli et al. 2009).

14

CONCLUSIONS AND SUGGESTIONS...

- In the 21st century, sea level change will have a strong regional pattern.
- It should be considered the implications of sea level rise for population location, economic, infrastructure, and construction planning.
- The governments and local authorities should design long-term policy for coastal planning taking into account socio-economic factors as well .

15

CONCLUSIONS AND SUGGESTIONS

- In Turkey's Black Sea coast, there are serious impacts of sea level rise in terms of coastal erosion and the social-economic values.
- In such areas as Kizilirmak Delta and Karasu, the physical effects of sea level rise should be modelled quantitatively on the basis of available data as to morphology, hydrodynamics, sediment budgets, and land subsidence.
- In order to predict regional/local sea-level rise accurately, it should be developed reliable methods by understanding coastal sea level forcing mechanisms in the Black Sea.

16



Thank you for your interest...

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