SUSTAINABLE DEVELOPMENT CHALLENGES AT SOUTHERN MEDITERRANEAN COASTLINES

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I. Background, Objectives and Status of World's Lowland Coastal Areas

A. Background

At a global scale, effects of accelerated climate changes was demonstrated in the last decades. In August 2005, Hurricane Katrina generated an 8m storm surge and produced 2.3m waves which overpowered the Mississippi River Gulf Outlet. In autumn 2010, the storm Becky reached the Santander Bay, Spain with a peak of nearshore (significant) wave height of about 8m, and a storm surge reached 0.6m. On the Nile Delta Coast, effects of intense winter storms on Alexandria coastline and its adjacent shores appeared in the last decade to be more progressive in 2003, 2006 and recently in December 2010. The latest storm in December 2010, which hit the Nile Delta showed that generated surges, up to 1.2m as well as maximum waves of 7.5m height near the coast presented a major natural hazard in coastal and inland zones.

B. Objectives

Assess the impact of anthropogenic modifications, and accelerated climate changes on the effectiveness/adequacy of seawalls, other types of hard coastal structures to slow, mitigate coastal erosion and to protect the lowland coastal area of Abu-Qir Bay, east of Alexandria, Egypt from progressive storm flooding since 2003.

The second aim is to highlight design opportunities to use soft coastal defense measures and to pave the way for innovative integrated coastal and urban design.

Rosetta promontory

* 1800 to 1900
  Shoreline Advance (3.5 km)
  25 m/yr (E), 20 m/yr (W)
* 1900 to 1998
  Shoreline retreat 50 m/yr
  (4.8 km in 96 years)
* Operation of Aswan High Dam 1965

Coastal Retreat of Rosetta Headland (1900 to 2000)

Brilliance of the Seas Cruise Ship Faces Heavy Mediterranean Weather, Alexandria, Dec. 13, 2010

Progressive Climate Change and Wave Flooding Since 2003 in Alexandria

Alexandria Coastline during 2003 storm — Restaurants Complex, Alexandria Coastal Road , Dec. 2010

Beach segment at M. A. Seawall during 2010 storm — Alexandria Coastal Road , Dec. 2010

Location of Case Studies Considered for Coastal Protection in the Lowland Regions of the Abu-Qir Bay, Egypt

C. Status of World's River Delta Coastlines and Critical Coastal Areas

The Rosetta Headland of the Nile Delta, and Location of Case Studies in Europe and USA

Surge Barrier IHNC at Lake Borgne - Mississippi Delta, USA (2013), Delta Defense NL

Costa Marine Technologies

Consulting Services, Davis, California, USA & Alexandria, Egypt

Site Visit at Seawall – Cleveleys, Lancashire, UK 2007

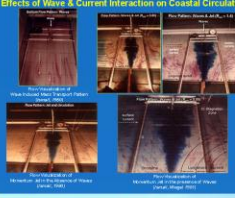
II. Nile Delta Coastline and Coastal Defense; Nile Delta Project (1981- Present)

D. Nile Delta Coastline and Coastal Defense

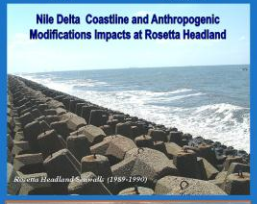
(currently wave dominated, after 1965)

Deltaic barriers islands –parallel to shore

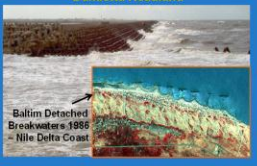
Effects of Wave & Current Interaction on Coastal Circulation



Nile Delta Coastline and Anthropogenic Modifications Impacts at Rosetta Headland

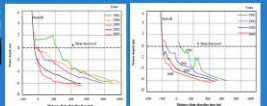


Damietta Sea Wall (1990) Damietta Headland



Satellite Images of Rosetta Seawalls & the Extent of Coastal Erosion Down-Drift the Headlands (2012)

Evolution of Cross Shore Beach Profiles at the Rosetta Western Seawall



Section W1 — Section W2

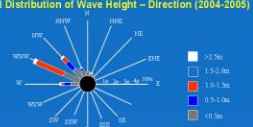
III. Wave Hydrodynamic Analysis and Impact of Climate Change on Coastal Structures at Abu-Qir Bay, Egypt

E. Wave Hydrodynamic Analyses and Impact of Climate Changes (SLR) at: I- M. A. Seawall & II- Western Strip of Rosetta Headland

Wave Breaking & Storm Surge & Runup & Overtopping

Rosetta Headland and Coastal Defense Structures

Total Distribution of Wave Height – Direction (2004-2005)



Estimated average annual sea level rise (cm) relative to year 2000 sea level, after El Shinnawy et al., (2010)

City	IPCC Scenario	Year 2025	2050	2075	2100
Burullus, Nile Delta coast	A1F1	13.0 14.75 27.9	34.0 37.5 68.8	55.0 60.3 109.6	72.0 79.0 144.0

Global Distribution of ESLR under Baseline Conditions for 40 Deltas (Ericson, 2006)

Estimated average annual seal level rise (cm) relative to year 2000 sea level, after El Shinnawy et al., (2010).

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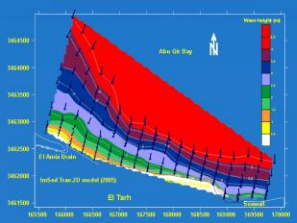
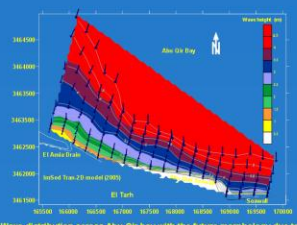
Burullus	A1F1	13.0 14.75 27.9	34.0 37.5 68.8	55.0 60.3 109.6	72.0 79.0 144.0

Distribution of Groins Set in the Western Side of Rosetta Promontory

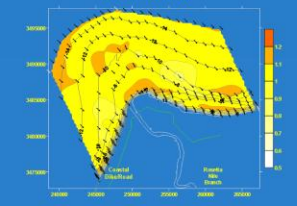


Wave distribution across Abu Qir bay with the current morphology due to the maximum yearly wave condition. Wave height is denoted by the color scale in meters and wave direction by arrows.

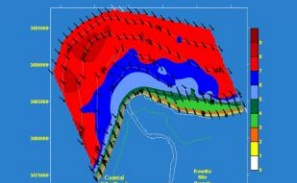


Wave distribution across Abu Qir bay with the future morphology due to the maximum wave condition (50 years return period). Wave height is denoted by the color scale in meters and wave direction by arrows.

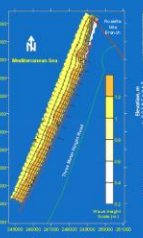
Wave distribution across Rosetta promontory for average wave conditions (Hsig= 1.12, Tz 6.0 sec., NW direction, at 18.0 m depth). Wave height is denoted by the color scale in meters and wave direction by arrows.



Wave distribution across Rosetta promontory due to maximum 50-years wave condition (H_{max}= 7.60, T= 10.7 sec., NW direction at 18.0 m depth). Wave height is denoted by the colorr scale in meters and wave direction by arrows.



Detailed wave distribution at the western groin set (9), west Rosetta promontory, for average wave conditions (H_{sig}= 1.12, T= 6.0 sec., NW direction, at 18.0 m depth). Wave height is denoted by the color scale in meters and wave direction by arrows.



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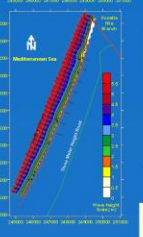


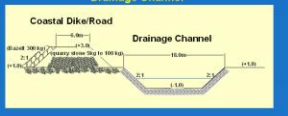
Profile cross section at the beach - Case Study I

Wave breaking and run-up on beach segment in the worst storm conditions

Upgraded beach for resistance of wave flooding - Case Study I

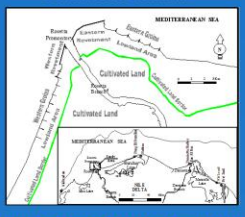
Upgrading beach for resistance of wave flooding - Case Study I

Cross Section of Coastal Dike/Road and Drainage Channel



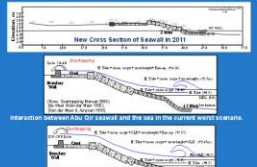
IV. Results of the Current Work

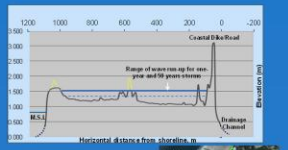
F. Results and Recommendations for Coastal Measures & Structures for the Inland Lowland around Rosetta Headland



Site of Mohamed Ali Seawall, 2012

Impact of Climate Change on M. Ali Seawall Design (2011-2012)





Cross Section of land ground profile at the location denoted in Red. Coastal Dike/Road and drainage channel are shown.

V. Recommendations for New Coastal Measures

Planned Coastal Design For Future Urban Development - Step I

Planned Coastal Design For Future Urban Development - Step II

VI. Concluding Remarks

- The results show that progressive climatic changes and human interference required the upgrade of M. Ali Seawall (rubble mound armors), at Abu Qir Bay, as well as elevating its top level. Further, it was necessary to improve the stability of the cross shore-beach segment to create wave overtopping resistance conditions under storm conditions and well maintaining the agricultural drainage channel to absorb the over flow storm flood.
- Sustainable coastal design should aim to eliminate/slow the adverse effects of the nine (9) groins system on the coastal erosion at location II of Abu Qir Bay. A detached low crested breakwaters/geotextile bags was proposed. Field tests are being planned at location II, Abu Qir Bay, to check the shoreline response to the placement of the spaced geotextile bags. Additional soft engineering defense systems are introduced which include beach nourishment, raising the ground level (+2m) of the shoreline inland strip (1.0 km width), and creating marsh/wetland coastal strip. Use of these integrated barrier islands/breakwaters, coastal lagoons and vegetated wetlands will act as a buffer zone to protect mainland areas.

Thank You

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