

## OUTLOOK ON SEAWATERS DYNAMICS AND GEOLOGICAL SETTING FACTORS FOR THE ALBANIAN ADRIATIC COASTLINE DEVELOPMENTS

#### Neki FRASHERI<sup>1</sup>, Niko PANO<sup>2</sup>, Alfred FRASHERI<sup>3</sup>, Salvatore BUSHATI<sup>2</sup>,

 <sup>1</sup> Faculty of Technology of Information, Polytechnic University of Tirana, Albania. E-mail: nfrasheri@gmail.com
<sup>2</sup>Academy of Sciences of Albania. E-mail: evispano@hotmail.com
<sup>3</sup> Faculty of Geology and Mining, Polytechnic University of Tirana, Albania. E-mail: alfred.frasheri@yahoo.com
<sup>2</sup>Academy of Sciences of Albania. E-mail: sbushati@yahoo.com

#### OBJECTIVES

 Results of integrated hydrographical studies and offshore and onshore geological-geophysical surveys in Albanian Adriatic Littoral are presented in this paper.

According to:

- the evaluation of the discharge regime in Albanian rivers system and its impact on the hydromorphology of Adriatic Sea,
- the river bed deformation, migration and new river mouths investigations,
- seismic and geoelectrical marine and onshore surveys,
- geological onshore mapping and underwater offshore sampling,
- boreholes and oil and gas depth wells,
- geodesic and bathymetric mapping

have been classified the segments which have different geomorphology with in mainland and in marine area of Albanian Adriatic Shelf.

#### ALBANIAN ADRIATIC AND IONIAN SEAS COASTLINE AREA.



•1. Albanian Sedimentary Basin; 2- Periadriatic Depression; 3- Ionian tectonic zone; 4- Kruja (Gavrovo-Dalmatic-Montenegro) tectonic zone; 5- Apulia platform, Paksos zone

Geomorphological Scheme of Albanian Adriatic and Ionian Seas coastline.

Adriatic coastal line from southern city up to Shëngjini Bay, in the north, have South Adriat

- The marine accumulation flattened littoral,
- The marine erosion coast, and
- The submerged areas, where
- is observed marine ingression towar

In some areas there is cliffed coastline.



Accumulative coastline; 2- Erosion coastline; 3- Submerged littoral zone; 4- Shoal shelf area with sand deposits;
Flat shelf area with sandy-silt deposits; 6- Inclined shelf area with muddy silt and deposits; 7- Continental slope with argillaceous sediments; 8- Isobaths; 9-Western flank of the South Adriatic Sedimentary Basin.

#### **Flattened Albanian Adriatic Litoral of Western Albania**

Adriatic coastline is lies over the Neogene Peri-Adriatic Depression, covered by Quaternary deposits, in western plain areas of Albania.

Flattened accumulative coast is general characteristic of this coastline.



There are also some hilly marine caps with cliffed coast. The caps are located in the sectors where the Neogene structure of the Peri-Adriatic Depression are abrupt by coastline and continues in the Adriatic Sea,

There are also old river deltas or mouths and submarine coastal bar.

## Adriatic coastline is divided in different characteristics zones:

## Segment 1

# Mouth of Buna River at the north to Rodoni Cap coastline.

This unit has a length about 60 km and consists for almost 90% of beaches fed by fluvial imputes. The remaining 10% is clifts. Four rivers outflow within this area: from north to south Buna, Drini, Mati and Ishmi rivers All together they discharge on average



Discharge of the solid material by Mati River in Drini Bay, Albanian Adriatic Coastline.

796 m<sup>3</sup>/sec of water. The total solid load of the last three rivers is about 21,680x110<sup>3</sup> tons/year.

Intensive change dynamics were observed in this area.

## Geomorphological Evolution view of the Drini -Durrësi Bays coastline in the Albanian Adriatic Littoral

This littoral is characterized by presence of the different Quaternary deposits genetic types.

Marine Quaternary littoral deposits,

presented by fine, medium, and

Coarse gray—white, gray-yellow sand,

silty clay and mud interbeds. Present days micro and macrofauna

of seawaters comes across everywhere.

Very beautiful sandy beaches are extended in Drini, Lalezi, bays.



Active reverse fault & thrust; 2- Dextral strike-slip;
Sinistral strike-slip; 4- Old Mati River bed;

5- Wetlands; 6- Erosion and marine ingression; 7- Lagoon extension; 8- Coastal deposition; 9- Lagoon surface diminishing (Neotectonics active reverse faults & thrusts (after Aliai Sh et al. 2000)

### General Geomorphological Evolution view of

## the Vjosa River Mouth- Mati River

Patoku beach in the southern side of the Shengjini Bay represent submerged areas within accumulative coastline. Submerged process is caused by the neotectonics activity, consequently there are observed a marine transgression.

The same phenomena is observed also in Semani beach at central segment of the Albanian Adriatic Littoral.



Patoku submerged Beach



Semani submerged Beach

Mouths in the Albanian Adriatic Littoral. (Geologic Map of Albania, at scale 1:200.000, 1983, the neotectonics active reverse faults & thrusts after

Aliaj Sh. et al. 2000).

- 1- Alluvium Quaternary Deposits; 2- Marine Quaternary deposits; 3- Boggy Quaternary Deposits; 4- Pliocene Rogozhina conglomerate suite; 5- Pliocene Helmësi suite;
- 6- Neotectonics active reverse fault & thrust; 7- Coastal erosion; 8- Accumulative area; 9-Submerged littoral area; 10- Marine Electrical Sounding center.



#### Segment II

## Rodoni Cap, Durrësi Bay up to Shkumbin River mouth coastline.

Cape Pallës, Cape Selitës, Lalëzi Bay, Durrësi Bay and Shkumbini River mouth are main sectors of this littoral area. Lalëzi Bay has a length of coastal line of 32 km, and 65% consists of sandy beaches fed by the sediment load of Erzeni River. The remaining 35% consists of rocky cliffs. Durrësi Bay has a length of 35 km from Pallës Cap to the Selitës Cap. Main part of the bay littoral, about the 54% of their length, by sandy beaches is presented. Frequently, with dune ridges, vegetate by pine trees, there are extended. Sediment inputs in to the bay are provided by Darci River and from beach and cliff erosion.



Accumulative Coastline in Durres.



Heavy and rare mineral placers in acummulative coastline, Lalezi Bay.

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of Quaternary Deposits in Durrësi Bay.

•The maximal thickness of the Marine Quaternary deposits is observed at the central part of the marine bays, according to the marine electrical soundings and mapping boreholes data.

 In the Durresi Bay. The maximal thickness is 48m at the central zone of the bay, about 6 km south of the Durrësi city



1.Boundary of distribution of sand-argillaceous sediments; 2- Contours of the Quaternary deposits thickness; 3- Marine mapping boreholes; 4- Marine electrical sounding centers.

#### Erosive coast line in Durresi anticline, Currila sector

Durresi–Pallë Cape area is one most typical erosive segment of the Albanian Adriatic littoral. Durrës-Kepi Pallës coastline is extended along the western flank of the Miocene-Pliocene molasses anticline. The sea-floor sandy belt, of 2.5 km width, which lies parallel to the coastline in the shoal zone. According to the integrated marine geological-geoelectrical surveys there are observed, submarine Miocene-Pliocene eroded bedrock banks





Correlative Schema of Apparent Resistivity according to the Marine Electrical Profiling, offshore erosive littoral at Durrësi-Kepi Pallës area.

#### Geoelectrical Line, erosive littoral at Durrës-Kepi Pallës area.



1- Geoelectrical boundary; 2- Tectonic fault according to the geoelectrical data; 3-Electrical sounding curve; 4- Apparent resistivity profile, according to the electrical profiling with array A500M20N, C→∞; 5- Digits in the line show the electrical resistivity values of the rocks; 6- Seismic reflector.

## Shkumbin-Seman-Vjosa rivers mouths up to Zvërneci hills coastline

Segment III

Is located in southern part of Central Albania, and have 40 km length. It expands in the western part of Ardenica and Divjaka hills. Karavasta Bay and Karavasta Lagoon are also part of this littoral area. From the geological viewpoint, this territory represents a new soil, constituted at the end of Pliocene and during Quaternary. The coastline in this region has a very intensive dynamics.

Present time shore sand knolls have a length up to 4-5 km, width 35-80 m and some meters highs. At the northern bays, the coarse sand is

predominated. This sand belt are composed by two or three parallel onshore dunes:

the first dune is extended directly at the water line, the second at the distance 90-100 m and

the third dune 150-200 m.

Photo: Sandy burried dunnes in Semani acummulative coastline



#### Geomorphologic view

of Shkumbini River-Vjosa River mouths coastline

There are observed the re-activation of the disjunctive tectonics at the littoral area Seman beach - Karavasta Lagoon -Shkumbini River mouth, in the both flanks of the Semani asymmetric anticline structure the disjunctive tectonics, with small amplitudes of 200-400m, are re-activated.



1. Active reverse fault & thrust; 2- Dextral strike-slip; 3- Sinistral strike-slip; 4- Old Shkumbini River bed; 5- Coastal deposition with predecessor erosion; 6- Coastal deposition; 7- Coastal erosion; 8- Submerged littoral area. *Neotectonics active reverse faults & thrusts (after Aliaj Sh. et al. 2000).* 

#### Marine Electrical Resistivity Tomography Line,

#### Semani Adriatic Shelf.

According to the marine electrical resistivity tomography, performed by marine electrical soundings, the morphology of the marine Quaternary loose deposits has a horizontal layering at the western side of the Semani beach. In south and east northern sides of the geoelectrical line is observed reversed fault impact.

Consequently, the Semani sandy beach, which is located at western side of this fault, in the submerged process, is found, from 4 km of south of the Semani River Mouth up to Semani Beach area, in the about 10 km long segment .



## Segment IV

## Vlora Bay

Is represented southeastern edge of Otranto Strait.

The *Upper* Cretaceous- Triassic limestone mountains are encircled southwestern and southeastern shores of the bay. In the north,



the mountain chain is continued with Neogene's deposits hills. Limestone coast of the Adriatic Sea in Vlora Bay is generally abrupt. At the northwestern direction of the Vlora City, there is a coastline of the Albanian Adriatic Shelf. Configuration the Vlora Bay has started to form from the Pliocene age, when the molasses of the Panaja Hills have been outcropped at surface.

Actually, Later Quaternary Marine deposits  $(Q_4^m)$  are created the present Vlora Bay. Offshore these deposits  $(Q_4^m)$ , according to the marine electrical soundings and boreholes, have 190 m thick.

# General Evolution view of the Vlora Bay

Vlora Bay has a length of 36 km and 10 km width.

The maximal depth of this bay is 57 m. The coastline of Vlora Bay-Vjosa River Mouth area has continuously modified its configuration by sedimentation of alluvium transported by Vjosa River water and the swell of the Adriatic Sea.

The coastal area is characterized by prevalence of winds blowing from the NW direction with a maximal speed 35-45 m/sec.

The tidal range in this part of Adriatic Sea is low, reaching a maximum of 30-50 cm.

The wave action is characterized by calm in 35% of the cases, by wave with a higher of less than 0.5 m in 20% of cases and waves higher than 2.00 m in 3% of cases.



Marine shoal with sand deposits; 2- Littoral with sand beaches; 3- Rocky coastline; 4- Alluvium flow; 5- Marine current direction; 6- Accumulation area; 7- Erosion area; 8- Southern edge of the sediment replacement;
Active reverse fault 8 thrust 40. Sand: 41. Old Views Diver had: 42. Filling exactline: 42. Freeien exactline:

9- Active reverse fault & thrust; 10- Sand; 11- Old Vjosa River bed; 12- Filling coastline; 13- Erosion coastline.

#### A correlation between geological setting Adriatic Albanian

### Shelf and sea hydrology

Two Albanian Oceanographic Expedition have presented data, which have argument that the total discharge of the Albanian rivers system in the Adriatic and Ionian Seas have a minimal discharge is 700-800 m<sup>3</sup>/s during the hydrological dry years of low precipitation and maximal values 1900-2200 m<sup>3</sup>/s during the hydrological wet years of high precipitation.

The oceanographically situation of the wet years 1963-1964 has been characterized by formation of "The Bridge" of low salt content and density, and higher temperatures of the seawaters in the Adriatic Sea. A higher surface water temperature in the Drini Bay is confirmed also by satellite observations, with a higher temperature of 3-4°C.



- 1. Adriatic Deep Water Mass; 2. Eastern Adriaric Superficial Water mass;
- 2. 3. Intermediate Levantine Water mass; 4. Northern Adriatic Water mass.

#### Vertical temperature section

#### Vertical salinity section.



Adriatic Sea, wet hydrographical year 1963

Adriatic Sea, wet hydrographical year 1963.

 The "Bridge", includes surface water layer, and the Levant Intermediate Water (LIW) up to 600 m. depth. This phenomenon has a complex and an important influence on many dynamics aspects of the formation Adriatic Deep Water (ADW), and the monitoring mechanism of water into Otranto Street.

#### Adriatic Heat Flow Density Anomaly

This "Bridge" is correlated with the heat flow density anomaly at the sea bottom (Geothermal Atlas of Europe, 1992). The "Bridge" direction is corresponds also with the prolongation into Adriatic Sea Albanian Shelf of well-known Scutary-Pec regional tectonic transversal over the Albanides, which is outcropped in Albanian mainland, with a SW dextral strike-slip direction.



Adriatic Sea Surface Temperature, restore from satellite data 19.08.2005 (Sputnik SST, 1999 SMIS IKI RAN, Moscow)



### Climate change

Ground surface history after geothermal inversion and meteorological data were observed a climate worming for about 1°C during the first half of XX century. Thirty quart of this century has been characterized by a cooling for 0.6°C. Later, up to present a worming for 1.2°C is observed. The warming period in Albania is accompanied with changes of the rainfall regime, wind speed and wetness. There are observed a decreasing of the total year rainfall quantity, for about 200-400 mm. This warming is part of the global Earth warming during the second half of XX century. These climate changes have their impact on country water system, on and water resources, and in the erosion processes .

## Inland water resources change has its impact on the hydrographic regime in Albania.

These climate changes have their impact on country water system:

- on and water resources,
- on the erosion processes, and
- on the hydrographic regime of the Adriatic Sea.



- Albanian littoral has two major units: accumulative Adriatic coastline and erosive Ionian seaside.
- Albanian Adriatic coastline has an intensive change and continuously modifying its shape.
- Submerged process, caused by neotectonic activity, is observed in some sectors within accumulative Adriatic coastline.
- The climate at coastal plane region of Western of Albania has a warming of 0.6 K occurred, from last quarter of 19<sup>th</sup> until present-day. These climate changes have their impact on country water system, on and water resources, on the erosion processes, and on the hydrographic regime of the Adriatic Sea.
- The oceanographically situation in the Adriatic Sea is characterized by the formation of "The bridge" with continental water in the Adriatic Sea. "The bridge" is closely linked with the intensity of the Albanian rivers flow to the sea.



## Thank You for your attention!