NOWDAY STATE OF THE SEA OF AZOV SOUTH-EASTERN COAST

by

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ABSTRACT

In this paper the results of field research of a modern state of costs of the Sea of Azov and existing coast protection constructions within chosen lythodynamic systems are presented. It was revealed that predominance of abrasion and a local accumulation is the peculiarity of a modern dynamics of studied coasts. A high rate of coast retreat in conditions of relatively weak wave influence is promoted by active falling-landslide processes, oscillations of the sea level under the influence of wind; geological structure of the coasts and anthropogenic activity.

1. INTRODUCTION

In the coastal zone of the Sea of Azov there are rich natural resources and is an object of intensive economic activity. But many ordinary and long-term projects do not include measures directed on the preservation and reproduction of natural resources of nearshore zones.

Natural habitat of living and reproduction of marine biota is destroyed (Yesin, Kos'yan, Ivanov, 1996). General activization of abrasion and beach erosion, falling-landslide processes and flooding of low nearshore areas when the sea level is raised under the wind influence resulted in destruction of industrial objects and transport, blocks of flats and public buildings, constructions of resort complex, communications, valuable arable lands, etc. and it causes a serious damage to economy of the country (Kos'yan et al, 2000).

In presented paper modern state of coasts of the Sea of Azov within the Krasnodar region and principal method of their protection is considered in complex that is necessary for elaboration of scientifically grounded notion about natural and technogenous impact on the coast evolution.

2. PHYSICAL-GEOGRAPHICAL FEATURES OF THE COAST OF THE SEA OF AZOV WITHIN THE KRASNODAR REGION

A total length of the coastal line of the Sea of Azov from the border of Rostov region to the Port-Kavkaz is 572 km. 182 km from them are the coasts of Yeisky, Beisugsky and Akhtarsky firths and 390 km – are coasts of Taganrog gulf. Geomorphologic conditions of Azov coast in Krasnodar region are characterized by great diversity that depends on complex manifestation of endogenous and exogenous factors. The newest tectonics finds its reflection by relief, and this attaches a complex shape of the coastal line of the peninsula.

Kuban River and 15 smaller water flows fall into Sea of Azov within the area of Krasnodar region. Regulation of river flows by dams of water storage basins and using of river water for irrigation and water-supply resulted in decrease of liquid run-off for 9.5 cubic kilometers per year (Simonov, 1989)

Regulation of river run-off and increased water consumption in the basin resulted in decrease of solid run-off. Liquid run-off of small rivers is regulated almost completely and during the years when water discharge is mean it does not get into the sea.

The Sea of Azov is tideless sea and fluctuations of its level depend on the components of water balance and neo-tectonics oscillations. Intra-annual fluctuations of its level depend mainly on seasonal climatic factors. Water exchange with the Black Sea greatly influences upon the level regime of the Sea of Azov: credit of the water balance is 30%; debit – 50%. Together with seasonal fluctuations of the level, aperiodic sea level drop-rise phenomena are observed. The rise of the sea level can reach 3.5-4.2 m over average many year values. Sea level drops and rises may be of catastrophic nature and cause flooding of vast low land areas. On the eastern and north-eastern coasts of the Sea of Azov maximum velocity of wind can be 28-34 m/sec. small dimensions of the Sea of Azov and its shallow water limit the development of wind waves, the height of the largest waves reach 3-3.5 m. Wave period does not exceed 4-5 sec.; length – 50 m. waves are characterized by large steepness (Hydrometeorological conditions…, 1986).

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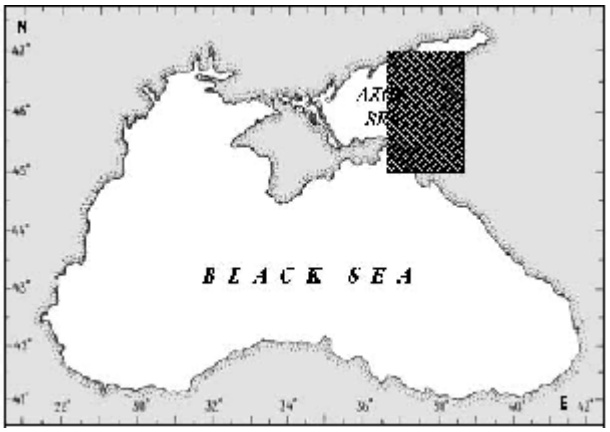
Eleven coast sections are chosen and studied on the shore of the Sea of Azov within the Krasnodar region (Fig. 1):

1. Cape Kamenny –Temryuk (44 km)
2. Temryuk – issue of Protoka river (64 km)
3. Distal end of Achuevskaya spit – coasts of Akhtarsky firth (45 km)
4. Primorsko-Akhtarsk – distal end of Yasenskaya spit (29km)
5. Distal end of Yasenskaya spit – coasts of Beisugsky firth (88 km)
6. Yasenskaya crossing – Kamyshevatskaya spit (33 km)
7. Kamyshevatskaya spit – Dolgaya spit (51 km)
8. Dolgaya spit –Yeiskaya spit (53 km)
9. Coast of Yeisky firth (53 km)
10. Glafirovskaya spit - Sazalnitskaya spit (31 km)
11. Sazalnitskaya spit – Molchanovka (12 km)



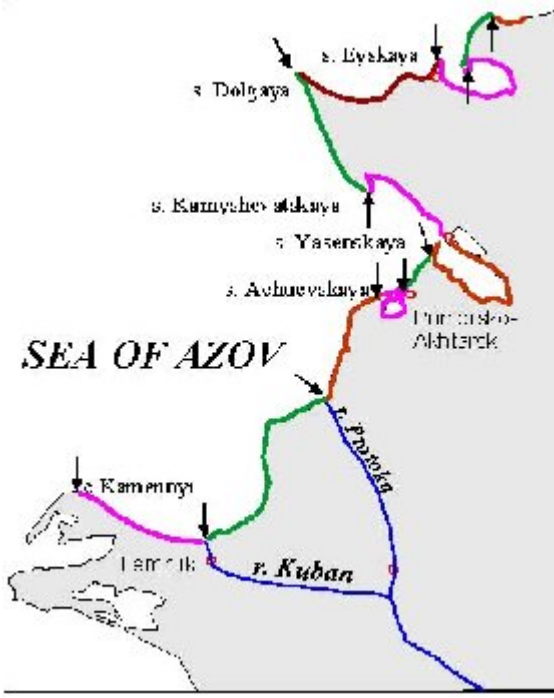


Figure 1: Coast of the Sea of Azov within the Krasnodar region and borders of the lithodynamic systems

3. CHARACTERISTICS OF COAST SECTIONS

3.1 Cape Kamenny - Temryuk

Near the cape Kamenny a coast is abrasion-land sliding, it is composed of easily washed out sandy loams. Capes are formed by rocks more resistant to abrasion. Parallel stepped landslides are observed between them, they envelop a coastal belt, of 800-1000 m wide (Fig. 2). Even slopes covered by sod undergo landslide process. The width of landslide on Pekly cape is 200-300 m. Landslide processes are observed near stanitsa Golubitskaya

too. Rate of coast washing out here is 0.5 m/yr. Between Pekly cape and Peresypsky mouth coast is leveled, loess loams are outcropped on the precipices. The height of almost vertical abrasion-falling coast with narrow beach (5-10 m varies from 20 to 60 m (Fig. 3).

Figure 2: Landslide coastal slope near settlement Priazovsky

Figure 3: Typical coast to the east of settlement Kuchugury

Semi stabilized dunes of the village Niznie Kuchugury composed of shell detritus and quartz sand refer to accumulative eolian forms. The height of sandy dunes is about 5 m. The inclination of a sea slope of dune reaches 45, shore slop is gentle one.

The height of an accumulative bay-bar in Akhtanizovsky firth is 0.5-0.7 m above the sea level (Fig.4). As a while coast section is stable, the broadness of a shelly-sandy beach is 20-25 m. During strong storms with the rise of the sea level a bench of the terrace and beaches are eroded with an average rate of 0.5 m/yr, in some periods 1-1.5 m/yr.

Figure 4: A bay-bar of Akhtanizovsky liman

3.2 Temryuk – mouth of Protoka

A coast near Temryuk town from morphological point of view presents low-land islands separated by channels of the youngest part of Kuban delta. Accumulation on the submerged slope and protrusion of the coast is typical for the whole length of Petrushinsky coast section, except Novo-Kurchansky mouth where coast abrasion is 5-7 m/yr. Before the regulation of Kuban River its delta near Petrushinsky branch was protruded towards sea for 30 m/yr as an average (Peshkov, 2003). Construction of moles of the Port of Temryuk promoted accumulation of river and marine sediments from the wind-ward side; Caikinsky shallow water bank was formed. Shell (70-90%) and sand prevail in deposits. The coast in the mouth of Protoka River is alluvial-marine, low, it is covered with reed, and here a second near-issue bar is formed. Beaches are composed of sand. Inclination of the bottom down isobath of 6 m is 0.002.

3.3 Achuevskaya spit – coasts of Akhtarsky firth

The coast section between the firth of Protoka and Achuevskaya spit is greatly eroded. The rate of washing out is 4 m/yr. The length of Achuevskaya spit, which is situated to the East of Talgirsky section, is about 31 km. Location and morphology of the coast indicates to a large role of north-western waves which determine transportation of material into Akhtarsky firth. The beach broadness on the sea coast of the spit varies from 5 to 15 m, inclination – from 0.01 to 0.02. Shell and detritus are predominant in the sediments (70-90%), fine sand is observed too (10-30%).

Low sandy coasts of Akhtarsky firth are almost completely covered by reed (Fig. 5). A coast is stable but rise of the sea level under influence of wind is observed.

Figure 5: Coast of Akhtarsky firth near settlement Sadki

3.4 Primorsko-Akhtarsk – Yasenskaya spit

A coat between Primorsko-Akhtarsk town and the root of Yasenskaya spit is abrasive on the whole length. A mean height of cliffs is 4 m, maximum – 8 m (Fig. 6). The structure of the coast is scalloped; capes are formed by dense loams. For many years an average velocity of abrasion is equal to 1.0 – 3.6 m/yr, maximum – 6.0 m/yr (Peshkov, 2003). Coast shelf is composed of loess loams and clays and practically they do not give beach-forming material. Therefore abrasion terrace only in several places is covered with thin layer of sand, and on a large length it is bare.

At present a baffle plate and groins protect coasts of Primorsko-Akhtarsk (Fig.7). A total length of protected coast section is 3.8 km. Gravel-sandy beach, 35 m wide, is built in the central part. Several groins are damaged; a baffle plate drops directly to water to the west from the town centre.

A coast to the south of the root of Yasenskaya spit is protected by bank retaining wall with a berm in the basement and parapet in the upper part of the wall. A length of protected coast is 450 m. construction was performed in 1985-1986 (Peshkov, 2000). To the south of this section an abrasion cliff begins, its height is 1.5 – 2 m. Further a second fragment of coast-strengthening construction is situated (about 400 m). It consists of concrete berm, bank retaining wall and massive parapet with deflector. Parapet crown towers above an average sea level for 3.5-4.0 m (Fig. 8). Margin parts of the wall are washed away.

Figure 6: Abraded coast to the north of Primorsko-Akhtarsk light house

Figure 7: Baffle plate, groins and man-made gravel-sandy beach

Figure 8: Coast protection near bowery Morozovsky

3.5 Yasenskaya spit – coasts of Beisugsky liman

On the coast section between the root of Yasenskaya spit and st. Yasenskaya there are two accumulative bodies with common genetic features - Yasenskaya spit and bay-bar of Khanka Lake. Yasenskaya spit, 18 km long, was formed mainly by biogenic material. The beach broadness does exceed 5 m. The broadness of beach becomes larger to 15-20 m in the central part and in distal part -50 m. The root of Yasenskaya spit is protected by stone berm, diameter of stone blocks is 10 - 50 m. The width of berm is 6 m, height – 1 – 1.5 m. Bay-bar of Khanka Lake is 25 km long and 1-2 km wide. 80- 90% of barrier spit body is composed of shell detritus with a small addition of sand, gravel and pebble from rocks of eroded coast. The broadness of beach near crossing exceeds 30 m.

To the north-west a steep, falling-abrasion coast begins. The height of almost vertical cliffs composed of loess loams is 15 m. The structure of the coast is marked scalloped. There is almost no a beach. The southern-eastern coast of the firth is considerably stable one, costs are covered with reed.

3.6 Yasenskaya crossing – Kamyshevatskaya spit

A coast in the vicinity of settlement Yasenskaya crossing is low, accumulative one. A broadness of shelly beach is 5-20 m.

On the length of 15 km to the north-west from st. Shilovka coasts are composed of loess loams. They undergo active fall-abrasion processes, there are often crumbling and drop. A height of cliff varies from 18 to

7-8 m. Beach is narrow – 5-10 m. It is formed by shelly material, small pebble and gravel.

3.7 Kamyshevatskaya spit – Dolgaya spit

Kamyshevatskaya spit is located on the southern-eastern extremity of Yeisky peninsula. It is a plain surface with a system of ancient coast bars and low-lands oriented from the north-east to south-west. Its length is about 6 km; a width of root part is 4.0 km. It is composed of shell shelly detritus, quartz sand, gravel and small amount of pebble. During the latest years a western coast of the spit is washed out, and its distal end is increased and at the same time is turning to the shore.

Between st. Kamyshevatskaya and the root of Dolzanskaya spit fundamental coast refers to abrasion-falling type. Coast cliffs, 7-15 m high, are composed of loess loams, which are bedded by Scythian clays. Broadness of leaned beach is 10-25 m. Composition of beach forming material is the following: fine sand with the addition of shell.

Dolgaya spit is located near the entrance of the Taganrog gulf. Its length is 12 km. There is an island opposite distal end of the spit; it is separated from the spit by washout. Spit's body is formed mainly by shelly material. The width of beach from the open sea is 25-40 m (Fig. 9), coastal line is stable one. A north-eastern coast of the spit retreats with the rate of 6-8 m/yr (Mamykina, Khrustalev). Broadness of sandy-shelly beaches is only 1-4 m. A coast is eroded with the rate of 10 m/yr, a part of construction on the line of edge has already come down (Fig. 10, 11).

Figure 9: A beach of Admiral's berth

Figure 10: Partially damaged due to the coast washing out building located on the edge

Figure 11: Eroded sea wall near sanatorium "Azov"

3.8 Stanitsa Dolzanskaya – Yeiskaya spit

Abrasion coast is observed between st. Dolzanskaya and Yeisk town (Fig. 12). Cliffs are formed by loess loams, their height near Yeisk town reaches 20-26 m and 36 m near st. Dolzanskaya. Beach is narrow – 5 m. It retreats with an average velocity 1.9 m/yr, maximum – 5.0 m/yr.

In Yeisk a coast is protected at the length of 3.5 km. Protection of this coast section was carried out in 1988-1996 as anti-accident measure. Stone-gravel berm was rip-raped at the distance of 20-40 m from the foot of cliff, 19-21 m high. A construction safely protects coast from erosion not only during ordinary storms but when there is a high rise of the sea level under influence of wind.

Yeiskaya spit is composed of quartz sand, shelly material and detritus with addition of pebble and gravel (Fig. 13). Surface of the spit is sharpened. Beach width in distal part from the side of firth is 13-15 m, from the side of Taganrog gulf – 20-30 m. Reinforcing of Yeiskaya spit from the Taganrog gulf was fulfilled between the port and its distal part at the length of 1.8 km (Fig.14).

Figure 12: Abrasion- falling coast section between st. Dolzanskaya and Vorontsovka

Figure 13: Distal part of the Eyskaya spit

Figure 14: Coast protection complex, s. Eysk

3.9 Coast of Yeisk liman

Coast cliffs of Yeisk firth are formed by loess loams and they are considered as falling-abrasion type with the height being 5-19 m. Cliffs are cut by ravines and gullies. Broadness of beach is 4-6 m. a bench is almost completely bare. On the shelf of small height caving and crumbling is observed, on more high ones (higher 18 m) – caving and landslide. Coast erosion is observed on the southern shore of firth, where railway Krasnodar- Yeisk runs. To the west of settlement Shirochanka and within Yeisk town coast along the railway is protected at the length of 7 km (Fig. 15).

Coast protection system is presented by stone berm and baffle plate, 1.5 m high. In came places baffle plate is damaged, and a beach belt is absent at a considerable length of the section or is only 1-5 m in width. But even these coast protection constructions provide stability of a coastal line during 30 years. Today about 80% of coastal slope is covered by turf.

Man-made gravel beach, 1 km long, was built on the southern coast of Yeisk gulf near settlement Alexandrovka. Coast protection measures were fulfilled early in 90ies for stabilization of coastal line and creation of recreation beach. 15 m wide beach is stable and it protects the coast from abrasion. In the eastern and north-eastern part of the firth coasts are relatively stable ones. Loam cliffs are separated from the water edge by reed brake (Fig. 16).

Figure 15: Coast protection complex of the railway roadbed

Figure 16: Typical kind of the coast near settlement Nikolaevka.

3.10 Glafirovskaya spit – Sazalnitskaya spit

A length of Glafirovskaya spit is about 7 km. Its distal end is bent towards Yeisky firth. Beach is composed of mean shells; its broadness is 12-20 m. It should be noted that a western margin of Glafirovskaya spit retreats with the same velocity, as an adjacent section of abrasion coast, and a distal end grows. Adjacent to the spit coast is steep; it is composed of loams (Fig. 17). An average height of cliffs is 10-15 m, maximum one is

observed near settlement Shabelskoye – 26 m. Coast is of abrasion-landslide type. Sandy-shelly beach is leaned against the foot of abrasion cliff; its width is 7-22 m.

Figure 17: Root of Glafirovskaya spit

3.11 Sazalnitskaya spit - Molchanovka

Sazalnitskaya spit has a shape of symmetrical accumulative jut. Its length along the axis oriented in northern direction is 3 km; width of basement along died off cliff is about 7 km. Beaches the broadness of which is 10-13 m in near root part and 20-25 m – in central and distal parts for 50-60% are formed by abrasion material, i.e. fine quartz sand, gravel and pebble. In the south near a high fundamental coast opposite issues of gullies opening towards the spit slightly domed fans were observed.

Coasts near village Molchanovka are steep, they are composed of loams. The height of a steep abrasion cliff with wave suppressing niches is 10-12 m. Beach broadness under the cliff varies within 3-10 m and is formed by clay, in some places it is covered by sand.

A coast from village Molchanovka towards Sazalnitskaya spit in mainly abrasion. Steep cliffs are composed of clays and loess loams. Beaches are narrow and their width increases only opposite gullies, they are formed by sand and shell.

4. CONCLUSION

Predominance of abrasion and local nature of abrasion is the main feature of modern dynamics of the eastern and north-eastern coasts of the Sea of Azov. Not only fundamental coast but accumulative bodies are washed out. Erosion of unique Azov spits, which are very value as recreative complexes, continues. Falling-landslide processes are active at a large length of Azov shore. An average rate of coast erosion reaches 3-4 m/yr, maximum -6-8 m/yr.

Large rise of the sea level under influence wind to a great degree intensifies abrasion effect of storm wave impact upon the shore. Geological structure of coast composed mainly of loess loams and clays promotes this. When such rocks are eroded they almost completely are washed out and in suspension are carried away into a deep sea and do not give material for beach forming. This becomes a reason of high rates of coast abrasion even when wave influence is relatively weak.

Accumulative type of coast is presented by coasts of rather different structures, genesis and modern dynamics. Their morphology one way or another is connected with source of material and its composition, regime of waves and alongshore streams. Wide-spread accumulative forms get their nourishment due to bottom sediments of the bay-bars of Khanka Lake, Beisugsky and Akhtanizovsky limans.

Stable coasts where today abrasion or accumulative processes are not pronounced have been singled out. As a rule, they are observed in firths and on the sections which are blocked by spits and between issues of Kuban River and Protoka River. It should be noted that a term “stable” can be used only in a sense of weak wave effect directly on the coast. At the same time, at the most part of the coastal line is retreating what can be explained of relative rise of the sea level and by other processes.

By today coast protective works have been fulfilled on 12 sections (33 km) of researched part of the Sea of

Azov. Far from all cases building of coast protection resulted in stabilization of the coast. On some sections a complex of coast protection constructions is damaged completely or partially. Protection of the main part of coasts is solved with the help of bank retaining walls of different structure without taking into consideration a broadness of existing beaches and influence of projected constructions on their future state. In future when elaborating and performing coast protection measures at the coast of the Sea of Azov it is necessary to make prognostic estimations of the coast evolution in natural conditions and, under implementation of coast protection measures, and with obligatory taking into account of singled out lythodynamic systems.

5. ACKNOWLEDGMENTS

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