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# Modern Conceptual and Technological Approaches to the Georgia Black Sea Coastline Protection

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**Abstract:** Economic development of the world's maritime nations, including Georgia, is directly related to the coastal environment and the ongoing natural or anthropogenic processes which determined its sustainability and exploitation opportunities. In the coastal zone are located the urbanized areas, agricultural lands, motorways and recreational complexes. Georgia's Black Sea resorts continue to attract tourists to the resort areas of the coast that required the expansion, restoration of eroded beaches and the development of appropriate infrastructure at international standards. Unfortunately, the prevalence of the parochial bureaucratic interests over environmental issues and ignorance of negative coastal process development, inefficiency of implemented coast protection measures and limited funding for carrying out necessary works, caused Georgian shoreline erosion. In this regard, coast may not be discussed as isolated body because it is part of one natural system and changes caused by natural phenomena or man-made impact will be reflected on the coast of neighboring countries. In whole, human intervention (withdrawal of beach sediments, river channel regulations, dam and reservoirs constructions and port structures assembling in coastal zone) in natural processes not only improved country economic state, but together with current natural events, due to sea level rise, causing storm phenomena activation and land inundation, shore subsiding, provoked the increase of coast erosion tendency, activation of beach disappearance and threatened to located there infrastructure with destruction and huge material losses. The recovery of latter requires several billion U.S. dollars worth of materials and works. In the presented article is discussed the problem of Georgia Black Sea coast erosion and necessary measures for its protection on the basis of conceptual approaches, which also imply the using of new technologies and methods of beach protection. In case of given proposal implementation in practice, the results of planned research can be widely applied both for sandy as well as pebbly-gravel beaches of any sea.

**Keywords:** Beach, Breakwater, Shoreline, Protection, Environment

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## 1. Introduction

During only twenty years, almost 1,4 thousand hectares of valuable coastal territory of Georgia were eroded and washed away, meanwhile for coast protection works implementation have been spending the amount of 44,4 million rubles. The process of coastal erosion has been driven primarily by the incompatibility of coastal territorial-industrial complex practical measures development and the scale of natural

resources protection. For example, over the last five decades in the framework of the industrial complexes development there was removed of 40 million cubic meters of river sediment and beach material. In addition, a large part of the coastal zone was formed by the solid sediment (sand, gravel, pebble), brought by mountain rivers and distributed by waves along the shore within a dynamic system.

Coast protection structures, built along the most of the Georgian Black seashore (groynes, sea-walls, breakwaters,

jetties etc.), were aimed to reduce/ mitigate the results of possible danger events caused by storm wave, but as a rule they were protecting only local sectors of beaches and could not exclude the core reason of their erosion- the sediment's sharp deficit. Instead of 25 years of exploitation, they have been broken after 7-8 years of their construction. Therefore, in order to extend terms of their "work", very often protecting them reinforced concrete structures and other types of berms were built, which restricted the beach for recreational use, ecologically and esthetically polluted the environment and also were doomed to break. In doing so, they did not give a positive effect and the same time caused the increasing the degree of coastal landscape technological overload and, in some cases, prevented sediment alongshore drift, consequently contributed to the violation of its balance.

Since coastal protection is increasing annually, the question of how to decrease the cost of construction is becoming very important. Often, the most rational way to achieve this aim is to create new structures and building technologies using low-cost construction materials.

The main **goal** of presented project is the design and development of new, more effective and rational method for Georgian coastline protection- the creation of artificial beach in combination with an extended submerged breakwater, using Geo-tube, made of 4 mm. thickness, permeable polymer sheet, widely used abroad, with goal of river banks, sea coasts protection and small size marine port construction [1]. As a pilot-project, it is considered the restoration and protection of the most erodible, Batumi coastline sector - Adlia beach, adjacent to strategic object- airport runway, taking into account the local conditions of its dynamics, principles of urban planning and on the basis of modern conceptual approaches of coastline protection. This beach artificial nourishment needs on average of 100 thousand cubic meter of inert material annually [2, 3, 4].

Project Objectives: For project goal implementation the complex of following theoretical, field and laboratory studies have to be conducted:

- The determination of the dangerous winds parameters and directions of Batumi coast;
- The planning of beach and the underwater slope in range of 0-15 m depths;
- The measurement of sea' alongshore currents directions and speeds;
- The collection of coastal geological structure data;
- The determination of different probability wave parameters and propagation direction, their front refraction and elements calculation on different depths, breaking types and depths;
- The poll of coastal communities and facilities staff located in the beach vicinity (bar, restaurant, cafe, rental point) about damages and casualties caused by sea storm;
- The evaluation of the recommended coast protection structure effectiveness by the providing of hydraulic modeling (beach and underwater slope deformation measurements).

The expected results: On the basis of theoretical, field and laboratory research results will be determined the following:

- Modern boundaries of dynamic system;
- The rate of coast evolution, natural phenomena or man-made impacts on the current coastal processes;
- The state of existing coast protection facilities, their effectiveness and impact on the environment;
- The geological structure of the coast;
- Coastal sediment map;
- The intensity of a beach erosion in long-term period;
- The quantitative and spatial characteristics of sediment alongshore and transversal movement;
- Sediment balance and root causes of its loss;
- Sources of beach sediment supplies;
- Location of beach forming material quarries, their reserves and sediment granulometry;
- Beach sediment balance after shore protection measure implementation;
- Volume of coast protection measure and the total cost, including construction sequence;
- The recommended method effectiveness (artificial beach width, length and height; breakwater installation depth, distance from shoreline edge, and the depth of its top under the calm sea surface of 50% probability and structure geometrical dimensions; geo-tubes sections optimum dimensions, quantity of their layers, the volume of geo-tubes filler inert material, the volume of material mixture needed for artificial beach and coastal underwater slope restoration; geo tubes filler an inert material extraction sites, quarries, full budget of materials and works for the measures implementation);
- List of technical means and machineries necessary for the implementation of the a. m. measures;
- Risk maps (scale 1:25000) will be prepared in the GIS format, for the forecasting and preparedness for small, as well as medium flooding and disastrous ones, caused by sea wave and its level rise.

The obtained data will be used for the coastal zone development planning, for the monitoring and environment state improvement etc. On the basis of planned complex scientific-engineering researches the general schema of coastal zone of Georgia has to be elaborated and appropriate norms and standards of its exploitation- urbanization have to be issued as soon as possible.

## 2. Methods of Research

The main part of the project contents the complex of the theoretical, field and laboratory studies of the coast under research. In order of theoretical study, based on the analysis of published articles, reports, and visual materials- maps and photos, the quantitative assessment of the natural and anthropogenic factors impacted on hydro, litho and geomorphologic processes, previously took place there, will be made through the comparison of coastal deformation maps and sediment balances.

Field study includes the assessment of coast present

conditions – the mapping of beaches' accumulative or erosive sections, measurements of beach material volume, determination of sediment grain sizes and composition, measurements of the coastal currents velocities, measurements of underwater slope inclination using sonar, the photo-shooting of subwater geomorphological forms located on the slope, measurements of sediment volume, silted in river mouths and reservoirs, by echo sounding.

Laboratory research was conducted in the wave-pool of Tbilisi State University' Fluid Mechanics and Oceanology Laboratory, at a scale of 1:100, using hydraulic modeling methods. Hydraulic simulation conditions considered the absence of sediment alongshore flow, while the different hydrological regimes, using the variety of breakwater shapes, sizes and depth of its location. The identification of the optimum effectiveness of this shore protection measure was made. During the experiments was determined the shape and size of the underwater as well as artificial beach dry slopes, by the measurement of their parameters before and after breakwater existence, also the calculation of displaced material volume was carried out.

### 3. Discussion

Due to the river materials naturally uneven distribution along Georgia Black Sea coastline, especially unwanted structure of sediment balance was created. Out of almost 19.0 million cubic meters of river sediment, 4-5 million cubic meters could not reach the river mouth, due to its accumulation in H/P reservoirs. In coastal zone came only 11.7 million cubic meters. In addition, due to sediment' particles small sizes, 7.0 million cubic meters of it did not participate in beach forming processes. Besides, in coastal canyons, presented there, disappeared for about 50-80% of river sediment (fig.1). The situation was exacerbated by the withdrawing of 1.5 million cubic m./per year sediments, from the quarries operated in river mouths, among them of Adjara region, for construction purposes. In this regard, special attention should be paid to the fact that Adjara coastal zone is mainly built by the river Chorkhi sediment of 0.25 mm and bigger size particles, brought to the seashore and drifted in a South-West direction by the prevailing waves. Currently, this process on Chorokhi - Batumi and Bartskhana - Natanebi sections is fully terminated, due to construction of Deriner Dam cascades on the Turkish side of Choroki river.

In the Chorokhi submarine canyon, the head of which located at the distance of 70-110 m from the river mouth, every year 1 800 000 cubic meters of river sediment was draining and only a small portion was participating in alongshore drift. At the same time, though, the canyon movement towards land was not noticed, out of sediment, total alongshore flow- 4,700 million cubic m., only 1850 thousand cubic meters of it were involved in coast forming processes. The construction of marine port and groyne has interrupted sediment alongshore drift, by which Kobuleti city beaches were nourished.

Head of the Batumi submarine canyon is bounded with the

same named cape and port. Over the past 150 years, the canyon was moving back with the rate up to 3-4 m per year. In 1902, with the goal of the shore water protection, Storm waves and port from the silting at the cape end was built -170 meters length groyne, which prevented cape growth. In order to avoid negative consequences, caused by alluvial material flow in the depth, periodically, the sediment removal and other parts of the beach replenishment was conducted, means beach profile recovery after the storm season.

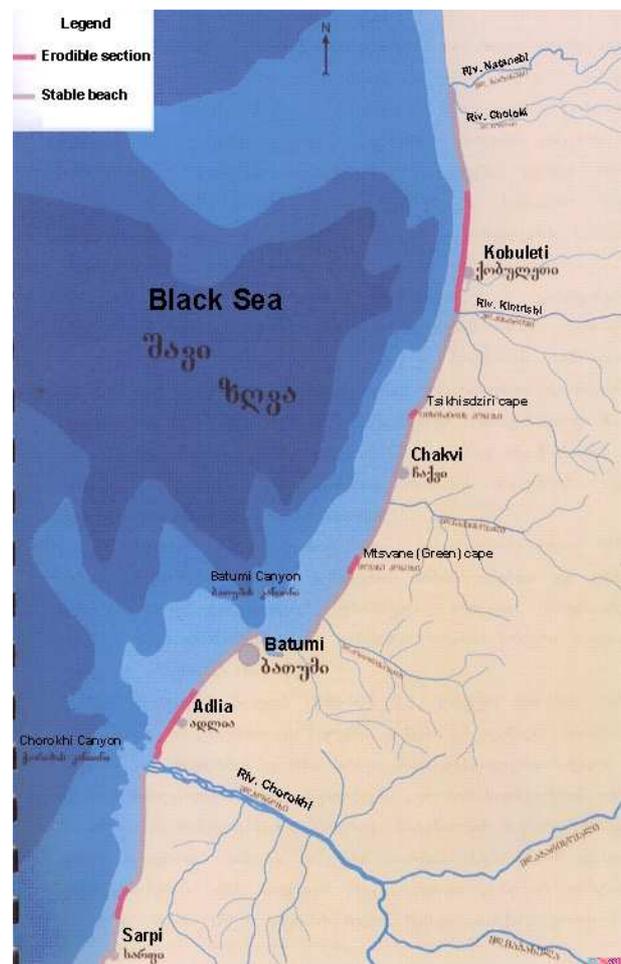


Figure 1. Map of Adjara coastal zone current state.

In the result of natural conditions' maximal use, these measures should facilitate the management of coastal processes and cover the coastal zone in closed borders of a dynamic system. That is why the need to develop new approaches to problem solving is risen, provided protection structure's maximal efficiency, reduction of their negative impacts on the natural environment and minimization of the financial cost of their further exploitation. In this regard, has to be mentioned the particular role of scientific-industrial agglomeration, "Sakzghvanapirdatsva" (Georgian Coast Protection) founded in 1981, created cheap, fundamentally new method of coastal protection (instead coast protection structure building, the restoration of sediment balance, through the artificial beaches creation). During its functioning were restored 100 km length beaches of

Abkhazia: Gagra, Sukhumi, Ochamchira; Guria- Poti, Adjara: Chakvi, Makhinjauri, Kobuleti etc., total area exceeded 150 hectares. On the whole, only for Adjara beaches restoration, in ten years has been brought almost 6,2 million cubic meters

of inert material, in the result of which the coastal area was increased by 54 hectares. The schedule and quantity of materials for the coast artificial nourishment is given in table 1.

**Table 1.** The Volume of Coast-forming Material Brought in Adjara Coastal Zone During 1982-1992 Years (thousand m<sup>3</sup>).

Place	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Sum
Kobuleti	47	104	15	-	165	45	181	190	51	50	-	848
Bobokvati	-	-	-	91	131	228	158	133	-	79	-	820
Chakvi	20	136	443	215	261	220	254	251	62	-	-	1862
Makhindjauri	-	18	145	156	192	226	213	153	166	111	25	1405
Adlia	88	130	100	108	160	115	141	239	131	54	2	1268
Total Sum	155	388	703	570	909	834	947	966	410	294	27	6203

**Table 2.** The Volume of Coast-forming Material Brought in Adjara Coastal Zone during 2007-2014 Years (thousand m<sup>3</sup>).

Place	2007	2008	2009	2010	2011	2012	2013	2014	Sum
Kobuleti	140	-	-	-	-	-	5	-	145
Bobokvati	-	-	-	-	-	-	50	-	50
Chakvi	-	-	-	-	-	-	50	-	50
Makhindjauri	-	-	-	-	-	-	-	-	-
Adlia			100	100	100	50	18	82	450
Total Sum	140		100	100	100	50	123	82	695

Unfortunately, since 1991, after the organization cancellation, Poti city sandy beach was totally washed away, degradation began on pebbly-gravel ones, especially along the Adjara coastline.

Since 2007 till 2014 Adjara beaches artificial nourishment was conducted by the deposits, extracted from quarries operating on river Chorokhi terraces, Kintrishi river bed, Batumi cape, at volume of 695 thousand cubic meters, what was not good enough for making its balance (table 2). Such deficit of sediment on the background of annual sea level rises at 2-3 mm /year increases the greater intensification of coastal erosion. That's why in order of Georgia Black Sea erodible coastal zone, including Adjara shore, protection it is necessary to maintain a natural process recovery of coastline dynamic, by the filling of sediment sharp deficit. The latter can only be achieved through the restoration of artificial beach complete profile and its protection. Also, it is possible the creation of beach protection structures in areas where they have a positive impact on the natural geo-morphological process development and create conditions for coastal zone rational use. If coast protection measures are not carried out in the near future, we will be faced to the most irreversible complex process outcomes.

The proposed approach and its technological solution to the Black Sea shoreline protection practice is innovative. Each of the coasts, including the object under research, is characterized by the definite hydrodynamic, sediment dynamic, morpho-dynamic, and orography, etcetera features, that are necessary to be considered, not only for the shoreline protection, but also for urban planning and development, geopolitical, demographic, and other problems solution. Therefore, for this project engineering decision-making, we

will be guided by the following conceptual principles [5]:

- engineering and architectural appearance of the structures must be in an organic relationship, harmoniously combined with the landscape and existing objects. To do this, the replacement or transformation of the engineering structures, rend the integrity of beach resorts and the apparent dissonance with the surrounding topography and architecture is necessary;

- Artificially created landscape has to be organically fit to traditional, modern and prospective situation-based on architectural and engineering solutions;
- Civil engineering structures have to neutralize the wave impact on the beach facilities and protected areas;
- Recreational facilities of the beach should provide maximum safety, comfort and service entire range for visitors, by the way of efficient use of existing terrain and artificial areas;
- All civil engineering structures must be more versatile. This will allow rational use of the territory and avoid the use of Mono-functional structures that are economically ineffective (have a distinct cost nature) and, accordingly, is unlikely to attract investment;
- Redeveloped area for today is an active recreation and urban complex, so it is necessary to take into account the current urban situation and reconstruction in stages, combining the interests of the city with the interests of the users of the site and without displaying the entire object of exploitation in general;
- It is necessary to create a comfortable and safe environment for tourists, which is impossible without the objects service by transport. Therefore, has to be done the separation of the pedestrian and vehicular

flows with a simultaneous increase of their quality opportunities, that cannot be solved at the same level on a such over closed territory. In addition, technical area of the vessels and facilities operation, rend the integrity of beach recreation facilities and endangering the health of tourists, has to be removed out of beach borders;

- Given the existing shortages of the most popular and most visited recreational beaches, the reduction of their size and length along the water line must not be allowed;
- Beach protection constructions and engineering activities for the slopes and other territories development should improve the ecological situation offshore and adjacent territory.

The above principles must be laid down as a basis for the resort town development and the formation of the landscape, taking into the consideration the historical situation of urbanization.

These conceptual principles most fully correspond to the formation of artificial free beaches in a wide range of the beach forming material size. These beaches can be applied both on the natural shore and the artificially created coastal forms like bays are, where the sediment reverse circulation, using alongshore current and deep bypassing, is created. In certain circumstances, artificial beaches can be created in conjunction with beach protection structures. The development of any activities in accordance with the above conceptual principles must necessarily be preceded by an assessment of the current state of the coast protected section in relation to the dynamic equilibrium as to the calculated wave and sea level, as well as the trends of its further development, including, under the influence of creating beach facilities.

While the designing activities for the protection of the beach should be borne in mind that the effectiveness of any complex shore structures will be determined by the existence of the beach with its wide surface area, sufficient to absorb the calculated wave energy. The using of coast protection structures of various types is acceptable, when no conditions for free artificial beaches creation are there. Coast protection activities should be linked to other activities designed to prevent the dangerous geological processes.

In the implementation of the concept the following tasks and activities have to be solved:

- The identification of the coastal current state and the efficiency of existing coast facilities;
- The identification of the priorities, targets and areas of coastal protection, taking into account the socio-economic and environmental conditions;
- The identification of coastal areas to organize and conduct a priority and urgent measures against coastal erosion and landslides;
- The determination of quantitative and qualitative characteristics of key natural and anthropogenic factors affecting the dynamics of the seacoastal area and coast protective structures;
- The determination of the coast protecting activities

optimal variant taking into account all key natural and anthropogenic factors;

- The implementation of a package of environmental measures aimed at improvement of ecological conditions in the seacoast area boundaries;
- The increment of the sea coastal area recreational potential through the implementation of coast protection activities;
- The development of activities for the protection of survived relict beaches and the sources of their nourishment;
- The development of existing and organizing of new quarries of beach forming material.

As noted above, the best coast protection structure, the free artificial beach is. But under certain geomorphologic, hydrodynamic and economic conditions the creation of free artificial beach on the coast is impossible, hence, in this case, the various types of marine structures made of concrete, reinforced concrete, stone, etc. are used.

While the choosing of coastal protection facility type, must take into account the natural conditions of the litho-dynamic system. At the same time have to be complied with the limitations imposed by the requirements of the environment ecology and nature protection, providing of water exchange and the sanitary- hygienic standards on the place of structures location.

As a rule coast protection activities should be designed for each litho-dynamic system as a whole. In the project of protecting activities the choice of the method must be based on the wave climate in the middle and extreme conditions, on the results of the sediment budget study, given the economy and the impact of activities on the environment.

Coast protection activities must ensure minimum disruption in the present and the future of the natural factors in the physical and environmental aspects and the aesthetics of the litho-dynamic system. While the selection of the coastal protection structure type, size and location in the mentioned system should be taken into account not only the achievement of the goal on the protected stretch of coastline, but also the impact of the projected shore protection structures and activities on the surrounding areas of the coast.

As an artificial or natural beach protection structure, among widely used at Black sea coast, an extended-submerged breakwater, intended to reduce the volume of alongshore sediment transport, the wave parameters, change wave velocity field and reconstruct wave transformation zone, has been chosen. The selected method differs from traditional ones and can be widely used as a material-retaining construction. In spite of its considerable size, the cost of this type of breakwater is low, owing to the use of tube, made from polymer textile, sand, pebble, gravel, or their mixture as tube filler (fig. 2). In case of natural stone sources availability, the breakwater main body can be built with them and covered by tubes (fig. 3). An extended-submerged breakwater “working” efficiency has been studied in laboratory conditions.

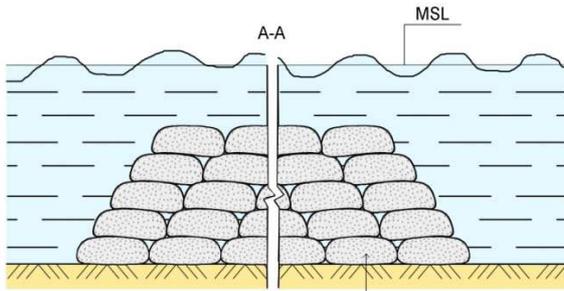


Figure 2. Cross-section of an extended-submerged breakwater made by tubes.

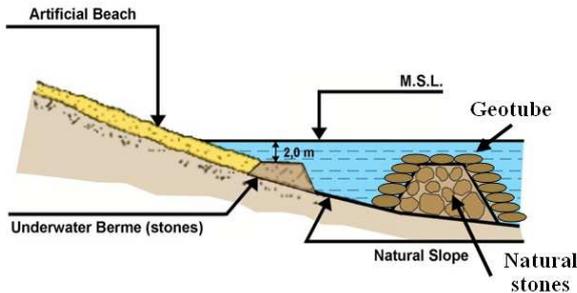


Figure 3. Cross-section of artificial beach with an extended-submerged breakwater.

Laboratory testing has been made for different size and cross-section structure of the breakwater, in various depths of its location, wave parameters, water level, wave front angle, etc. The results have been shown the effective reduction in beach erosion. Sediment down drift practically was reduced to zero. Breakwater effectiveness has been calculated using the formula [6]:

$$E=1-G/G_0 \tag{1}$$

where  $G_0$  is the volume of alongshore sediment transport for the case of a shoreline without a structure,

$G$  is that transported for the shore with the breakwater, and may be written as follows [7]:

$$G=6,06 \times 10^3 \times 3H2\sin\alpha\cos\alpha/d^{1,35} \tag{2}$$

where,  $H$  is the height of the heist 1% probability waves at the breaking line (in m.),  $\alpha$  is the angle between the wave ray and a line normal to the shore, and  $d$  is the mean size of the beach material (in mm). A mathematical model has been derived for the calculation of wave height ( $H$ ) and angle ( $\alpha$ ).

Analysis of experimental results has made it possible to understand the characteristics of the breakwater. If the breakwater is located farther the natural zone of wave breaking, it will force waves transformation on its seaward side, causing them to roll onto its surface. This, in turn, reduces the wave height, hence its energy, also mean wave level at beach line. Thus, wave heights behind the breakwater are lower than under normal conditions, when they tend to break on the free, undefended, slope. This type of breakwater also causes supplementary refraction of waves, since finally they approach beach more normally than originally. The combined action of these two mechanisms (wave height

reduction and reconstruction of their velocity fields) produces, essentially, a reduction of alongshore sediment transport volume.

The derived results for the efficiency of different varieties of breakwater, and for different depths of installation, are shown on fig.4. The analysis of these curves shows that for increases of a relative depth  $h/b$  from 0 to 4-5, efficiency of a one-sided breakwater quickly reaches 70%; when  $h/b = 4-5$ , an increase in depth does not influence the efficiency. Hydraulic modeling has confirmed the calculations and has shown also that, under the same conditions, the use of the two-sided (slope) breakwater decrease down drift alongshore transport by factor of 1,4-2,7 times in comparison with one-sided one, this means an increase in efficiency of some 15% (curve  $h^*8$ ). It should be noted, nevertheless, that the efficiency of a one-sided breakwater reached 70% [1].

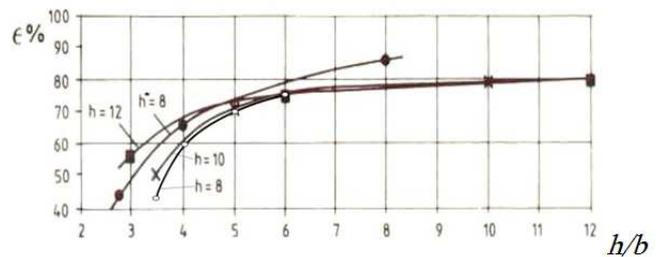


Figure 4. Breakwater efficiency (E) dependence upon relative depth ( $h/b$ ) and water depth ( $h$ ) ( $b$  is vertical distance between breakwater top and mean sea level –MSL,  $h$  is water depth at its location).

The recommended method virtually eliminates the sediment alongshore movement, after the wave last breaking line, because an extended- submerged breakwater location depth, shape and dimensions provoke the wave front full refraction, restructure of its velocity field, reconstruction of transformation zone and, at the same time a significant reduction of the wave parameters [8, 9, 10]. The artificial beach, with its gently underwater slope, will cause the additional dissipation of already reduced wave energy, and therefore, the mitigation of material losses (sediment abrasion and flowing into the canyons). In state of the sediment lack, it has extremely great significance for our coasts sustainability and marine recreational infrastructure development.

Also should be noted that this method of beach restoration – protection is considerably cheaper than traditional ones and does not require: cement, steel materials (water-related environmental pollutant components), special steel forms, great H/P energy, construction sites, special cranes, sea-bed preparation, as well as a large number of employees and special maritime means of transport. Its construction is characterized by speed high efficiency. Unlike traditional method does not require a lot of time (15-20 - times less than what is required for the manufacture of reinforced concrete structure only) and mainly depends on the pump performance capacity; It can be built at site, as from sea as well as from the shore; the filling of geo-tubes can be by any type of ecologically clean materials (sand, gravel, pebble, even freed up waste, left after tunnels and roads construction - 0,15-250

mm. size stone). The measures have to be conducted virtually eliminates the possibility of corruption between the customer and the performer as costs of geo-tube and inert material used, including losses, are easily calculated.

As the shoreline protection event content and the level of its complexity is fully depended on the environment natural conditions, at the stage of protection method choosing the problem of ecosystems natural environment change at some degree, within protected and adjacent areas, will be considered. Also, all positive as well as negative factors impacting on environment that cause particular changes of ecology within the protective section of the coast also will be taken into account. In order to minimize the damages to ecosystems, caused by coastal erosion process and shore protection measures implementation, and environmental conditions improvement in order to maintain biodiversity, it is necessary to lay rock- stones of 500-1000 mm size at both sides of breakwater, or artificial reefs made of neutral concrete and to breed on them marine mussels colonies. The reefs will reduce erosion of the breakwater's bottom and increase the ecosystem diversity of the coastal waters in 2-3 years, sanitary - hygienic conditions will follow.

The same method of such activities can be used through the creation of an artificial dunes (as beach protecting morphological structure), for recovery and expansion of eroded the sandy beaches of the Black Sea coast, like Poti city beach is etc.

## 4. Conclusions

Today humanity lives in the period of scientific - technical progress and at the same time of the deep ecological crisis. One difference is, if a state of economic and scientific progress can develop within a country, the environmental crisis spread independently of political frontiers and can cover a significant areas. It is well known that economy and ecology are dependent on each other and at the same time are contradictory phenomenon. Social development leads to environmental violations both human as well as marine ecosystems. In order to eliminate the latter the economy of developed countries has the financial potential, but lack of funds, especially heavily affects the fate of a developing country, like Georgia is, where natural resources are the only means of existence, further destruction of which only aggravates the crisis.

Disturbance of the natural balance has especially hard impacted on the ocean and sea water areas, and above all in the coastal zone and its vicinity, where, unfortunately, most environmental disasters have a place. The Black Sea is no exception, its beaches are always attracted tourists particular attention, which was conditioned not only due to a wealth of natural resources and its strategic location but also to its high economic importance. This tendency is especially increased after the collapse of the Soviet Union and the socialist camp. Black Sea states actually try to re-establish their interests in the sea waters. In the foreground of the Black Sea economy, the use of old "silk road" for shipment, as well as oil and gas extraction and transportation, has become. In this regard existing ports

expanding and construction of new ones, on the background of ecological imbalance and the strengthening of coast stability breaking, has already begun.

The restoration of eroded beaches and creation of new, wide ones' can significantly reduce/mitigate effects of natural disasters, caused by storm wave activity and sea level rise. These beaches, in combination with comfortable recreational infrastructure and wide range services, much increase the coast attractiveness and its recreational potential, thereby creating new jobs for the local population, to ensure the development of the hotel and agriculture businesses, as well as cooperation in the food and other areas of services. All of the above will greatly improve the employees' socio - economic conditions and in general promote sustainable development of the coastal regions.

It is well known that the conduction of more extensive shoreline protection measures, the better results will be to the coasts adjacent states. Therefore, operational information about coast state and current or planned activities there has to be shared in electronic form, as it is practiced in several foreign countries. The latter is a precondition of the problems solution (mutually beneficial consultations, fundraising, basin neighboring countries geopolitical or economic interests consideration, eco and public diplomacy development) etc. The similar procedure has to be conducted for the information of the coastal population about the coast environment, since the greater part of the viability is connected with coast sustainability and its potential use. Dissemination of information among the community contributes to raising the level of awareness and preparedness to possible adverse natural events. Unfortunately, it is not practiced among the Black Sea basin countries. So, in order to eliminate this gap on local level, the research outcomes will be distributed among the local and accredited in Georgia foreign, non-governmental organizations of environmental and social profiles in the bilingual booklets form. The conducted research main results as recommendations will be presented to local structures of self-government bodies, the press, to Adjara municipalities' environment protection and urban planning departments etc.

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## References

- [1] N. Tsvitivadze "Methods of Beach Protection in Use Along the Black Sea Coastline", J. Shoreline Management 2, Elsevier Applied Science Publishers Ltd, England, 1986, pp. 55-64.
- [2] S. Khorava, A. Kikava "Protection of Adjara Coast Zone by Artificial Beach". Proceedings of International Conference "Applied Ecology: Problems, Inovations". Ltd "Kalmosani" Publ. Georgia, 2015, pp. 192-197.
- [3] A. Kiknadze, G. Russo, S. Khorava. "Engineering Problems of Georgia: Condition and Perspectives, Georgian Engineering Academy. Georgia, 1998, pp. 137-147.
- [4] G. Russo, S. Khorava." Creation of artificial beaches, islands and other constructions in the coastal zone of seas, lakes and reservoirs ". Proceedings of International Conference, Russian Academy of Sciences, Siberian Office. Institute of water and environmental problems. 2009, RF, pp. 246-251.

- [5] N. Tsivtsivadze, G. Metreveli, L. Lagidze, N. Motsonelidze, L. Zazadze. "New Approaches of Georgian Black Sea Coast Protection". Workbook of I International Conference "Kolkhety Lowland Water Ecosystems Protection and Efficient Use". Ltd "Kalmosani" Publ. Georgia, 2013, pp. 34-40.
- [6] I. Kantarji, Y. Shulgin. "The compulsory transformation- new method of beach protection". Transport Construction- (Transportnoe Stroitelstvo), Moscow, 9, 1981, pp. 7-46
- [7] N. Yaroslavtsev. "The investigation of pebbly beach dynamics". J. Water Resources (Vodnie Resursi), Moscow, 5, 1981, pp. 77-81.
- [8] H. Kunz, "Spatial costal protection as too for sustainable development of coastal zones" Dynamics of Coastal Zone of Non-tidal Seas . Kaliningrad, Terra Baltica, 2008, 87. <http://www.coruna.coastdyn.ru/iczm08/day1/kunz.pdf>
- [9] C. Macaskili, "Reflection of water waves by prmeable barrier, J. Fluid Mech., 95, 1979, 1.
- [10] A. Kiknadze "About sea beach protection in Georgia, In: Sea' Coastal Zone (Beregovaia Zona Moria), Nauka, Moscow, 1981, pp. 83-90 (in Russian).