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Reseach Paper

Opportunities of Application of Advanced Methods of Surveying in Monitoring the Dynamics of Riparian Line Velipoj-Vlore in Albania

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Abstract*:* The purpose of this study is to analyze the current situation of Velipoj-Vlore *Seaside* dynamics under the optics of geodetic problems. Over the last 50 years, topographic surveys of *Coastline* dynamics have been conducted using methods based largely on information obtained from maps or images. It is necessary that these studies to advance more closely to the truth under the optics of implementation of advanced geodetic new methods and technologies, contributing scientifically to the discovery and explanation of the factors in this phenomenon in order to correct the orientation of development policies in these areas. Advanced methods of geodetic measurements enable capturing problematic not only in the beginnings of the phenomenon but also during its development, so in this study we want to contribute *by* clarifying and precisely identifying each of the influential vectors in this mutual land-sea relationship. The geodetic network set up consists of two polygonal satellite lines with an average side of about 10 km, the first in the vicinity of the costal line with about 15 polygonal points and the second 30-40km within the land with about 12 polygonal points. For this purpose, has been used mainly geodetic point of existing state geodetic network, new points located around objects with high geological stability and new fixed points on the ground in hill area. We think that such applications should be extended to precise the bottom relief of the sea near the riparian line. Also the creation of a prognostic maps, specific to the coast line, carried out every five years would help positively to increase the accuracy of the information in such studies.

Keywords: *Monitoring, topographic surveys, dynamics, credibility, geodetic measurements, Data Processing.*

Introduction

Over the last 50 years, topographic surveys of *Coastline* dynamics have been conducted using methods based largely on information obtained from maps or images. From the analysis performed, it turns out that these studies show some problems as they are conducted after the occurrence of the phenomenon, based on classical or digital graphic material. Also the reliability of these studies is not very high because the interpretation realized graphically and graph-analytically by joining the visual, logical and historical interpretation of the study period. In the geodetic aspect it results that to increase the reliability of the evaluation process: in the development of plans, maps should be drawn in scale and appropriate mathematical bases, as the main elements that this increase reliability, evaluation of the process based on altitude, with topographic maps has low credibility. Both of these issues have a negative impact on a more accurate assessment of the sea bed. It has low confidence in volume calculations of sentimental hydric flows, the dynamics of movements in plan and elevation of these volumes is not specified correctly, the dynamics of sediment movements in time, also is not given accurately, studies with satellite images, as long as high resolution images are not yet available in Albania, and as long as these images are not supported on an elevation system, in the absence of a national and international reference geoid, does not appear in the appropriate parameters of accuracy, nowadays there are precise detection and monitoring methods. After evaluating these studies, we stress the conviction that they should be deepened and completed with more complex studies in relation to: the use of digital methods and technologies for field measurements and inclusion of as many areas in the study, as for obtaining results with high standard of accuracy in order to increase the accuracy of these types of studies. Throughout its history, the earth has been in a process of permanent and unalterable change.

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As a result, the shores of the seas have been under these changes. Such phenomena have occurred and are happening even in our country. What we want to accomplish in this study is the fact that the studies done so far should be further advanced, considering the possibility of using direct geodetic methods with geodetic measuring technology from the most advanced of the time (Boci, 1981).

General Description

At first glance, the Adriatic Sea coastline has a stretch in the North-South direction, with a field relief as a result of the contact of the Western Lowland with the Sea. Based on the morpho-litologic characteristics, the Adriatic coastline is an accumulative coastline. Adriatic's Accumulative Coastline represents a length of 250 km or 55.5% of the total of the coastline of Albania's territory with a stretch of maximal width of 40-45 km toward Tirana and which is narrowed both in northern and southern parts (Figure1). Under the geomorphologic view, the area is represented by hilly ranges and areas in the form of alluvial separation valleys, as well as coastal areas with a morphological complex, with beaches, deltas, lakes and lagoons (Durmishi, 2010). From the tectonic point of view, the Adriatic coast is part of the Adriatic Lowland. The relief is formed at the end of Pliocene during the Quaternary.

Figure 1 Map of Albanian seashore and its characterization

Figure 2 Tectonic Map of Albania

Differentiated neotectonic sequences during this period have permeated the hilly ranges over the anticline structures clenched during this period and the syncline valleys filled by the alluviums, which have experienced a weakening or decrease during this process. (Fig.2)

The Lowland is represented by several anticline and synclines ranges, which are reflected in the geomorphology of the relief. The geomorphology of the coastal plains is everywhere, characterized by the presence of beaches, deltas, dunes, littoral cordons and old river bedrails that have changed the direction of spills in the sea. During the Quaternary they are captured by differentiated positive neotectonic movements in anticline ranges, expressed today in hilly reliefs with a height of 200-300 meters, in some cases processed even by marine terraces (rock of Kavaja, Divjaka, Zvernec *etc*.). Rising or falling movements have been captured in the Kuanternar the separated syncline areas, occupied by flat valleys filled with quaternary deposits. The biggest decrease, these synclinals have had toward the sea, where have been formed bays such as that of Rodoni, Lalez, Durres *etc*. Today's natural equilibrium, dynamics and current swirling coastal movements are the result of the interaction of some types of sedimentation environments such fluvial, estuary, littoral and naval (Fig.3)

The presence of the river, deltaic environment as well as the transport of sediments in the sea, the interaction of marine factors: marine currents, waves, storms, have created the present natural ecosystems in the coastal lowlands of the region. Morphology, geometry, dynamics in time and space of the embouchure of the main rivers of Albania (Vjosa, Semani, Shkumbini, Erzeni, Ishmi, Mati, Drini and Buna) and their respective deltas have been the main factors for changing the coastal line configuration in time and space (Kabo, 1985). Albania lies in a subtropical area. It is a Mediterranean country. In Albania the amount of precipitation is about 1430 mm/year on average. According to hydrological calculations the rivers spill in the sea an average of 41.27 km^3 water per year, with a flow of 1308 m^3/s. These large flows from Albania along with the flows in the western part of the Adriatic Sea, mainly from the River Po in Italy, according to the studies carried out (Fig.4), create an “Aquatic Continental Bridge" with depths up to 600m, which has a great importance and influence on the regime and dynamics of developments in the Adriatic Sea (Pano et al, 2006). Figure 5 shows the sea currents in the region in July.

Figure 3. Picture of Seman riverside

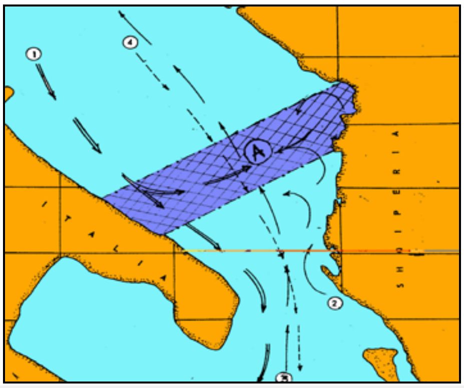

Figure 4. Aquatic Continental Bridge

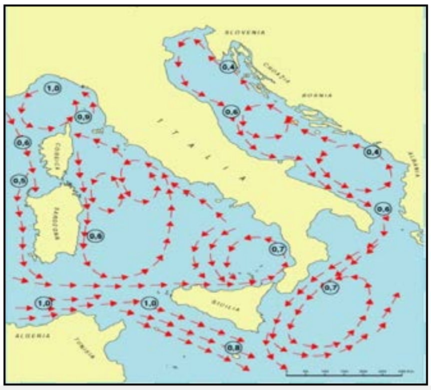

Figure 5. Sea currents in the region (July)

From this short hydro-climatic description, we come to conclusion of the influence of this factor in the Adriatic hydrographic regime, the sea bed topography and the dynamics of its movement and as a consequence of the riverbank dynamics. Basin-wide hydrographic observations performed in the eastern Mediterranean during the past 2 decades attest changes in the thermohaline circulation as well as new aspects concerning the onset and the follow up of the major transient event that occurred at the beginning of the 1990s, ie, the change of the dense water formation site from the Adriatic to the Aegean Sea (Manca *et al*, 2003).

Current Topographic and Geodetic surveys

Periods of study

From the study of the collected materials we can say that the current studies of the dynamics of the coastal line movement can be grouped into three major periods of study:

- Historical studies up to the 1870s,
- Topographic studies from 1870-1990
- Satellite studies from 1990 to present day.

The first period is the period of study based on historical and archaeological material. Based on the writings on the history of the Apollonia City (the distinguished Greek geographer Straboni, in his work "Geography", first century AD), it turns out that the town was lied 1.5km north of Vjosa River. The fact is confirmed by the port of the city in the southern part of where the goods came from, and it was traded by ship. According to the writings of the period the earthquakes of the years 234 and 345, as a result of large land slides, they made possible the blockage of the riverbed and the deviation of the riverbed to the south almost where it is today. This fact shows that even in this area and along this riverbed there have been major changes.The second phase of the mapping of the phenomenon is the period that begins at the time of the design of the first topographic maps of the territory of Albania of Gubernatis at the scale of 1: 400.000 for southern Albania from the 1870's to the 1990's with the acquisition of accurate topographic maps based on accurate mathematical elements produced by the proper geodetic and cartographic institutions. For special areas, there are used plans or maps of scales 1: 2000 and 1: 5000 (Boci, 2002). During these studies, which extend over 120 years, all of the authors together have been identified as the main factors for changing the coastline: the activity and regime of rivers in their deltas, tides and ebb- tides, the activity of the waves and the sea currents, winds , age-old relocations and human intervention.The third period of study is characterized by graphical and mathematical analysis of materials obtained from aerial photographs and satellite imagery, which have provided fuller and more accurate results on the dynamics of coastal line motion. In this period, other factors influencing the process, such as climate change for the global warming effect and environmental pollution from major industrial and social development, have been uncovered as a result of the use of global satellite data. Based on the study results of these periods, we noticed that the change of the coastal line or its dynamics does not result in a regular, constant, symmetrical, parallel process. As a consequence, it is an asymmetric process in the 4 dimensions (X, Y, H and t-time) that makes us think that the causes that affect this dynamic movement give different impacts independently of each other (Nurce, 2012). This is an important conclusion, so for this reason we can really evaluate these studies as a major scientific base for future studies, despite the lack of potential for the use of direct field test methods.

Reliability of the periods of studies

Recent studies are mainly based on the analysis after occurrence of the phenomenon based on comparison of graphical materials (maps of areas) and digital graphics (orthophoto and satellite images). By the very fact of the huge volume of information they carry, the speed and the quality of the information, the latter creates more premises for a more complete study and from which more accurate conclusions can be drawn.

But that does not mean that the first method does not accomplish the purpose of the study. In the first phase the maps were simply schematic, with no mathematical element, and the studies carried out on these graphical materials have low credibility. In the second period, the interpretation of the phenomenon was the most accurate and was realized with the graphical-analytic method as the maps began to be enriched with mathematical elements and direct information from terrain measurements. But the maps of this period in the study have been in the process of improvement and consolidation. In order to make a precise and reliable conclusion, these maps must meet certain minimum conditions of comparison: to be of the same degree, to be of the same projection and to be on the same ellipsoid. The mathematical basis of most of the maps produced for Albania and consequently taken in the study is Gauss-Kryger's projection and Krasovsky's ellipsoid with the central meridian 21^{o}. In this orthogonal system the values of the coordinates of the points, the deformation of the distances and the surfaces and the declination depend on: point distance from the central meridian and point width. Specifically, referring to the extreme points of the western part of our country, with coordinates:

$(\phi_1=40^{o}30' ;\lambda_1=19^{o}16')$ and

$(\phi_2=42^{o}10' ; \lambda_2=19^{o}20')$

We have a point shift to effect the change of projection in the respective values which, in function of the map scale by relation (Eq. 1):

$$\delta_{sh}=\delta/sh \quad \text{(Eq. 1)}$$

Have the values presented in the following table in mm:

Table 1. Point displacement for projection effect

Point	The scale				
	1:100000	1:50000	1:25000	1:10000	1:5000
1	0.37	0.74	1.48	3.75	6.50
2	0.32	0.64	1.28	3.21	6.42

But we also know that: the allowed graphic error of point in the map is evaluated by the equation (Eq. 2):

$$\delta = 0.2\text{mm sh} \quad \text{(Eq. 2)}$$

So for the scales in the study we have the corrisponding values of δ in m, inTable 2:

Table 2. The allowed graphic error of point in the map in m.

The scale	**1:100000**	**1:50000**	**1:25000**	**1:10000**	**1:5000**
δ	20	10	5	2	1

These values are smaller than the point's displacement for the effect of changing the projection. To eliminate this boundary, we should be careful that during work on map, measurements should be given **in** a suitable methodology where the projection error is inconsiderable. If the measurements are performed parallel to the Y axis, i.e two points 'I' and 'J' with the same width φ and the respective length λ, the scale of distance of the Gaus-Kryger projection is given by the equation (Eq. 3):

$$m_i = 1 + 0.0001523\,(\lambda_i)^2 \cos^2(\phi_i) \quad \text{(Eq. 3)}$$

Displacement point 'i' for effect of equalization projection (Eq. 4):

$$\delta_i = y_i\,(m_i - 1) \quad \text{(Eq. 4)}$$

and deformity of the segment 'ij' equation (Eq. 5):

$$\delta_l = \delta_i - \delta j \quad \text{(Eq. 5)}$$

In Bonn's pseudoconical-equivalent projection, the scale along the parallel is 1; therefore even the parallel-measured segments are not deformed. According to this analysis it is concluded that for the coastline, the elipsoid and projection error is close to that of the graphic error of the map i.e 0.2mm, which means that the graphical accuracy of the map scale is maintained.

Also, when using maps for information regarding the coastline, consideration should be given to the *impact of deforming the map itself*. This kind of deformity is a function:

- The quality of paper on which the map is printed,
- Its terms of maintenance,
- Conditions of use and scale of use.

The impact of this factor generally results to be small and it is therefore inconvenient in the final assessment. However, the correction value for the distance measured in the map according to respective axes is calculated according to these equations (Eq. 6) and (Eq. 7):

$$dl_x = l_m x\ \delta_x \quad \text{(Eq. 6)}$$

$$dl_y = l_m x\ \delta_y \quad \text{(Eq. 7)}$$

where: δ_x, δ_y, are deforms in the respective axes.

From the statistical studies carried out in some works it is concluded that the measurements in the map are not the function of the measurement direction, i.e. they are the same as in the X axis and Y axis and all deforms are not homogeneous.It should also be noted that obtaining information from the map is also a part of the way of receiving information from it, which is realized from the most direct visual way by continuing with the cart metric method with the use of various meter instruments and equipments and also the logical way. Each of these ways has its own impact on the accuracy of information and as a result, even of the processing and completion. Below, in Figure 6, two cartographic studies have been carried out for the Seman river embouchure (left) and Erzen river embouchure (right). Period covered in study 1918-1990.

Compared to the topographic maps of various scales, satellite imagery that we have been able to use since the 1990s, provide the opportunity for a fuller and more accurate analysis. This is because they are products that contain high spectral resolution, by which we are able to determine objects, changes or development that can be eluded by the human eye. As such, while working with them, unlike the previous method, a series of graphical errors of the measurement processes on topographic maps are eliminated (Parkinson, 1996). Satellite images recorded by multispectral scanners in 1992, 2002, 2007, 2010 were used to detect changes that occurred during this period from the Buna River spill in the north to the Gulf of Vlora in the south of the Adriatic coast. Currently, the latest information on satellite imaging missions reports for 0.4 to 1.0 m resolution for Landsat Missions (IKONOS), Spot, INVISAT, etc. On the other hand, the spatial resolution is directly related to the geometric precision of obtaining the products. This ratio is where the accuracy usually takes as much as 1/2 of the resolution value. Below in Figure 7, we demonstrate the use of two Landsat scenes belonging to the coastal line of Lalzi Bay.

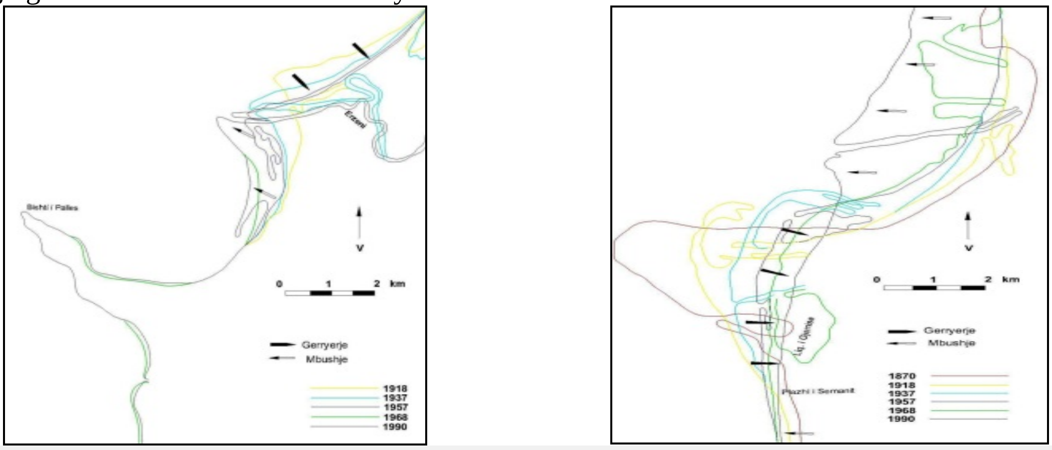

Figure 6. Coastline study from 1918-1990 with cartographic method

Figure 7. June 1992 July 2002 .Colour composition (bands 742=RGB) from Landsat images of 1992 and 2002 in the coastal sector between Pali Cape–Erzeni River embouchure. The image covers a 12x12 km

The first scene recorded by the Landsat TM (Landsat symbol 5) multispectral scanner on June 30, 1992, while the second scene was recorded by the Landsat ETM + multispectral scanner (detector 7) on June 16, 2002. Both scenes are made available by Global Land Cover Facility GLCF of Maryland University, USA. These Landsat scenes are part of NASA's world record. The first three images of the MAD / MAF containing the information on the changes are presented in Fig.8.

Figure 8. Three images of the MAD/MAF containing the information on the changes.

We are focusing only on the most important changes of each of the three MAD / MAF variants that was the threshold by holding only pixels with values higher than two standard deviations from the average and smaller than the two standard deviations from the average. The images came to a close as a mixture of colour (Figure 9) was combined, which was interpreted together with visual analysis of landscapes and knowledge of the study area.(Gjata, 2007)

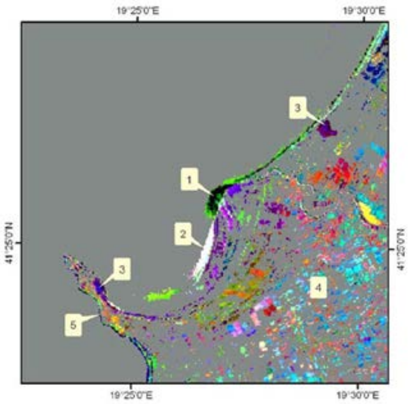

Figure 9. Colours compositions of the three first variants MAD/MAF (MAD/MAF variants 321=RGB). The numbers indicate the change of the surface area mentioned in the text.

The main changes shown from the numbers in (Figure 9) are:

1. Erosion of the Erzen River delta,
2. The creation of the land surface south of the Erzen River,
3. The surface of the wetland is growing,
4. Changes in fertile lands,
5. Erosion of the southwest part of the hills of Pali Cape.

Because of the high accuracy requirements that are required in these monitoring studies, satellite imagery needs to meet two conditions:

Firstly, they should have high geometric accuracy,

Secondly, they should create the possibility of extracting data and information at a high level (Nikolli, 2010).

In the context of our country, obtaining accurate and qualitative data in the radiometric view, coupled with other data obtained from GPS satellites, still pose problems (Misra, 1999). This is because obtaining accurate elevations requires reference leveling points, which are in reference to national and international geoids. The lack of geoids certainly reduces the credibility of point assignment, especially when it comes to point elevation. In this context, the undertaking of a geoids design project in our country would greatly help and support a qualitative use of satellite imagery in the context of coastline study.

Summary of the results obtained by these two study methods

In conclusion, as we have mentioned above, we should emphasize that during these studies and not only, are these general conclusions derived from the phenomenon: The phenomenon that is developed along the ***Coastline*** is a function of the influence of many complex factors. 'Sea-Land war' is unpredictable because it is subject to the influence of these influencing factors, which are complex and intercommunion during the last 140 years, it is concluded that until the 1940s, due to normal natural development, the process of accumulation along the coastal line has been dominated by the flow of rivers, after the 1940s and onwards, this process of accumulation has remained almost constant due to the decrease in the flow of rivers from dike construction, irrigation channels, water use in coastal areas and others. The factor of human influence is present and gives a great influence on the phenomenon. Also in the geodetic aspect it results that: To enhance the process assessment reliability in plane developments, the maps should be scalable and with appropriate mathematical bases, like the main elements that reduce this credibility, Evaluation of the process based on altitude, with topographic maps has low credibility. Both of these issues have a negative impact on a more accurate assessment of the surface of the end of the sea has low credibility in volume calculations of sentimental hydro flows. The dynamics of the movements in plane and height of the volume are not correctly determined. The dynamics of timely movement of sentiments are also not given. Satellite image study, as long as these images are not based on an elevation system, in the absence of a national and international geoids reference, the study of such a phenomenon does not appear in the proper parameters of accuracy. For this reason all these studies on the coastal line dynamics make recommendations on the necessity of using the data obtained from direct field measurements with the most advanced geodetic methods and technology, which enable geodetic products with high standard of accuracy and consequently a good opportunity to increase the accuracy of these kinds of studies. Advancement or withdrawal of the sea is a phenomenon of interaction between the sea water and the soil below it.

Study and Design of a Survey Geodetic Bases a Long The Coastal Line

Therefore, these geodetic studies should contribute to clear the four situations that appear in this interaction (Figure 10).

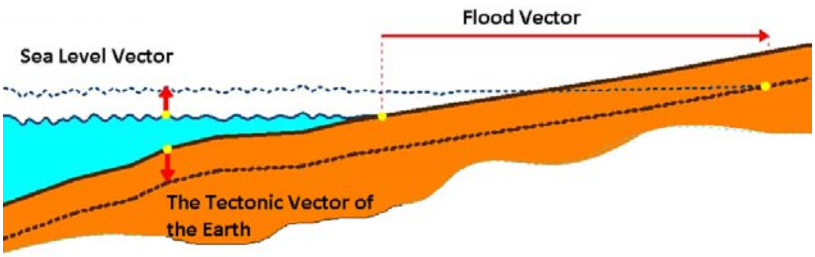

Figure 10. The fourth situation

1 - If the sea level rises, it will advance to the land (flood occurs) and otherwise (new land acquisition occurs).
2 - If the land declines, the sea will advance to the land (flood occurs) and otherwise (new land acquisition occurs).
3 - If they both approach each other, they get new land twice more and faster in time.
4 - If both go away from each other, they flood twice more and faster in time.

For the above ranking, the numerical value determination for all the vectors in all cases is a relatively difficult geodetic task. Only direct measurements on the same terrain geodetic points and repeated in time, based on global positioning technology, can provide accurate results for these definitions (Parkinson, 1996).

This sea-to-land interaction in the coastal area, based on the results of the studies so far, has a different impact on different areas, as we have said that the legality is not uniform, so the line does not shift parallel to the land or vice versa. Being an interruption shift means that we have points of change in the phenomenon. So a part of the land formation between the two switched points and then another part in the flood between two other switching points (Frasheri, 1999). Precisely here among the switched points are the areas with high intensity of varying of the relief of the shore. And in these cases, we think that modern detection methods like those with Laser Scanning and Image Scanning should be used, as they are very fast, with high density information and can therefore be performed several times in the same place with certain time difference. A result taken from these types of surveys creates the ability to quickly and thoroughly capture data obtained on the land as well as obtaining a maximum accurate result. All we have said above can be summarized in the necessity of accomplishing these main tasks: The necessity of a state institution that takes over the management of all studies in all areas, their continued support and the data obtained from these studies to digitalize. The financial support of these studies will result in minimal cost for the government in the long-term development of the coastal area, compared to the colossal costs that would have to be used to recover all the damaging consequences that would come from the application of wrong projects in the area without taking over the dynamics of its development. All studies and results obtained in the area from these studies should be based on a single state coordinated system. Only then they can complement each other and the phenomenon in general, thereby providing the most accurate conclusions about the phenomenon. The data should be extracted from materials that complement and enhance the accuracy of the study.

Figure 11. Geodetic monitoring network

The study, as a result of high technological development, modern methods of collecting data from the field and their processing in the office, should be applied. At present, the new influencing factor influencing the water balance (seas, oceans) and the land along the coast (offshore) results in global sedimentation, which affects both water and land level in an integral way (Frasheri & Pano, 2003). This, of course, considering other factors such as geotectonic, hyperopic levitations, hinders these studies, which on the other hand, the data they provide, are of fundamental importance to the infrastructural development and the living of the coastal lines. If we were to supplement our goal of building such a geodetic and monitoring base, we can say that it is: The unification of all studies in a single reference system, i.e. in a single coordinate system and creating monitoring opportunities to carry out direct field geodetic measurements, where the phenomenon occurs or is expected to occur. The geodetic network set up consists of two polygonal satellite lines with an average side of about 10 km, the first in the vicinity of the costal line with about 15 polygonal points and the second 30-40 km within the land with about 12 polygonal points, fig (11).

The point fixing method. For this purpose, has been used mainly geodetic point of existing state geodetic network, new points located around objects with high geological stability and new fixed points on the ground in hill area.

Method of measurement. GPS System Topcon GR-3 with accuracy static positioning 3mm + 5ppm in horizontal and 5mm + 5ppm vertical, with Post Processing method. Total station Topcon IS-203 Image scanner with measuring the distance with accuracy 2mm + 2ppm and accuracy in measuring the angles 2”.

Survey Program. Measurements are designed to be implemented in time intervals every 4 months. *Data Processing and Extracting Results*. Data processing will use the TopCon Tools I software specified for this type of data analysis.

Conclusion

We think that such applications should be extended to precise the bottom relief of the sea near the riparian line. Also the creation of a prognostic map, specific to the coast line, carried out every five years would help positively to increase the accuracy of the information in such studies. Application of all methods, for the fact of reliance on satellite and digital technology, requires the promotion and realization of projects started in the direction of modern national positioning systems linked to global positioning systems. The construction of road infrastructure (Adriatic Ring), is a way to minimize the negative effects of the phenomenon in terms of land.

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