# Study and Analysis on the Instability Of Galati Town at Danube Cliff Area

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**Abstract:** The problem related to the instability of the Danube cliff in Galati town, must be considered in the context of the Region of Danube Delta, which is an ecosystem linked and interdependent with a flora and fauna rich and unique. The region has a great biodiversity, different soil with low instability. The health of the soil of the cliff is influenced by the human interference as regards the configuration, the structure and the composition of the soil. Should be taken into consideration and the erosion of the cloff land along the Danube with the effective measures to stop this phenomenon. We must taking into account the development of the potential of these areas in the domains such as tourism, construction and transport.

**Keywords**: cliff Danube; settlements; erosion; soil failing

## 1. Introduction

The present study is intended to trigger an alarm signal on the continuous degradation of the cliff concerned city of Galati. Since 1960 since he started systematization of the cliff there have been decopertari of land for the achievement of the Great Union There, but also with fillings of filler material in several areas. In the area from the Botanical Garden where it was a caramidarie had to bring the largest quantity of material of the stuffing because in the old days it was a great excavatie resulting from the clay extraction process.

Along with the building blocks of on the cliff were blocked part of the sails fraetice which deversau into Danube River. In the past 50-60 years due to locking of those waters groundwater were made underground accumulations. Accumulations of water have led over time to the complex surparea from "French", to uneven tasarei surpari and of the land in the area.

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The study of a critical analysis based on research and own measurements, but also of some institutions of prestige from the country with the purpose of measures to be taken of consolidation which are urgent.

## 2. Research Carried out in Zone "to Propellers"

Instability of the land from "Propellers" appeared after in 2010. In the framework of the work on the project ISPA, was built pumping station and the sewerage collector. In accordance with the expertise of the no.994/04.05.2012, carried out by the Technical University of Civil Engineering Bucharest (with our contribution) have been carried out nine drilling in the "Propellers" area, aiming to find the causes of land subsidence in this area[1].

Works which have been carried out aimed to find the cause of the affected of the old sewerage collector that have more than a hundred years. The waters of this manifold pressure in the land in the area have led to the first subsidence of the road (figure 1).

The conclusions of the study were that surparea highway was caused by several causes: partial wetting of the land in the area, with water infiltrated rainfall, the missing of land sistematisation on the vertical and possible loss of water from the sewerage networks in the area. The process of infiltration of the waters in the field was favored because of the existence in the area of unomgeneous soil filling.

As a result of these causes, the land has been the subject of additional settlements when dried and implicitly to the appearance of "the phenomenon of soil collapse".

[1] Geotechnical study Nr.994 / 04.05.2012, Technical University of Civil Engineering Bucharest, Contract No. 10.240 / 29.01.2014 Galati City Hall.

**Figure 1. The sewerage collector from the "Propeller area"[1]**

The study and expertise drawn up in 2012, with regard to the area at the "Propellers" and the area of blocks of flats P, has included both samples and measurements to the ground, and comments from satellite which have highlighted the displacement of soil in the area to a level of 10 mm in one month.

The drainage system built in the years '60, when it has been sistematisation of top cliff, was made up of a magistral pipe that must to collect and transport all the sewerages in the cliff area.The waters were rainwater drained through tubes and discharged into a drain channel.

When it has been installed the main sewerage gallery on the cliff, were destroyed all the tubes connecting through which the captured waters are draining into the drain pipe and then in the Danube.

## 3. "French" Area

The cliff, to zone "French area" was made up of clay interrupted in some places, by small watercourses that draining to the Danube. The area was sistematsated in 1963, on three levels on high, having variable quotas from +5m to +48 meters. These watercourse was interruption in time and determine the growup of groundwater level in the area.

[1] Costel Crangan, "Galatiul se prabuseste in Dunare cu 12 cm pe an/Galati collapses in the Danube by 12 cm per year", adev.ro/ogbrk6.

The angle of the embankment of the cliff created in the "French area", is sfety if the groundwater level is not over 1/3 from high of embankment.

The sails of the groundwater in the area must to be positioned at the base of the cliff embankment. Once exceeded this level, (1/3 the height of the embankment) the embankment can be destroyed when land of the cliff slides.

## 4. Research in "PARK VIVA" Area

One of the mistakes that they pose a danger to the stability of the cliff embankment in this area is lifting some heavy construction, villas, and blocks with ten floors, without kip the zone of the embbkment protection. On the top platform of the cliff, has been established an area of the guard of 50-60 meters, for heavy constructions and possible loss of water, that can put in danger the stability of the cliff.

Because are not respected the rules for the construction, the heavy blocks was buit less of 50 m of the cliff embankment. The area of clearance at high blocks is now reduced to 15 meters in front of cliff embankment and not 50-60meters as it was originally laid down.

The study was performed by analysis of the situation in the 16 sections on the "PARK VIVA" toward the "Propeller" area, data being combined in the calculations by which has been determined the stability of the land in the area. From the calculations showed that at this moment the land is stable, but the infiltration of surface water or losses in the pipes may result in damage to its stability.

It is recommended to keep the curve of depression of the groundwater at depths of more than 2/3 of the height of the taluzului, and among the technical solutions are building via the drilling rig directed, a drain system in the vicinity of "ridge taluzului" and on the level immediately following, because the water ingress to be discharged in the Danube.

## 5. Measurements and Recordings in the Southern Area of the Botanical Garden (Toward the Frry- Boat)

In this area of the cliff top was made the monitoring by the satellite and the terrestrial. It has been shown that there is a dynamic accentuated because of the soil filling that made in the in hurry in year '60. This added landthat iz made in time, is

not pressed at asking parameters and under the influence of groundwater slide sensibility was accentuate.

This region have the most sensitive risk imminent danger of collapse for the road curve of the cliff (that piedmont has already damage: asphalt wrinkled and visible cracked due the jarring induced by the lorries and trucks of more than 5 tonnes, then when climbing or lower it to embark.

In this area of the top of the cliff i.e. toward the south of the botanical garden the situation has worsened from the expertise in 2012 at the 2014. In this area have brought large quantities of material of the stuffing (sagging incorrect) to bring it to the dimension of achieving portion of the Great Union There (figure 2). With the green color is represented the material of the stuffing added in the '60. Yellow and brown represents the old ground over which was added the material to the filling. The color of the light blue represents the groundwater and The Blue Danube.

Under the influence of the groundwater, which was raised from 40 to approximately15 meters, in the loess laier have formed numerous caves and settlements which endanger the safety of the buildings in the area. Slip the material of the filling is added 8-12 millimeters per year.

During a drilling up to 40 meters executed in the area from deep of 16 to 26 meters, piping of the drilling rig was immersed simply in empty. Also, the expertise that made for discovered networks of utilities curtailed and canivouri whose position does not appear on any map.

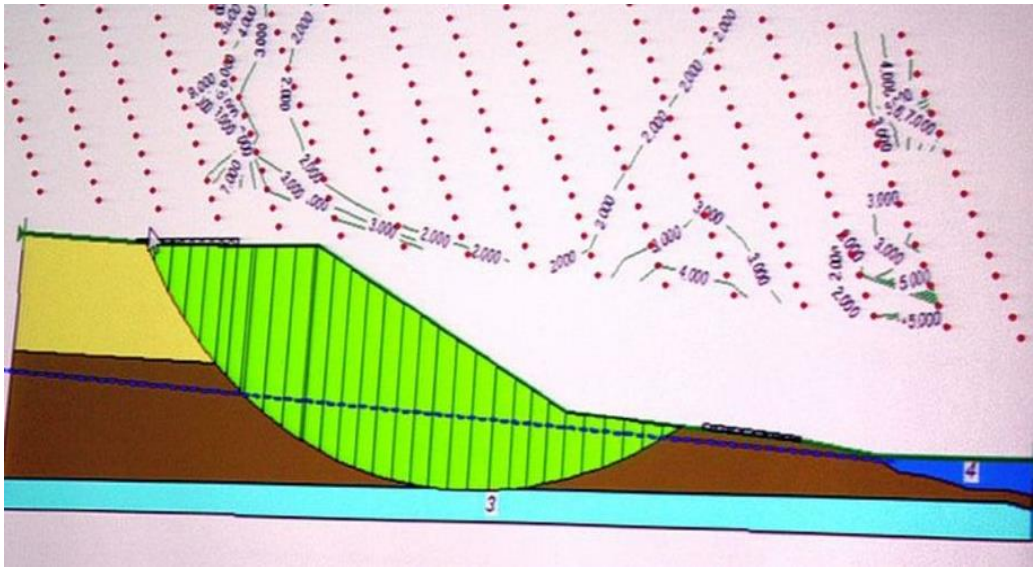


**Figure 2. The diagram in the technical study, which shows the subsidence**[1]

From measurements on which we made them and on a path of the coast of the curve in the hairs are already visible cracks in the asphalt, which means that the movements are produced continuous. As regards the movements of land recorded, the most disadvantageous situation is in the south of the Garden. The movement in this area is a shear bolt, area of disposal is at approx. 30 meters depth and shifts are 3 cm in a month having regard as the direction toward the ferryboat.

It is necessary to prohibit the heavy between 5 and 100 tonnes (lorries and dumpers) loaded with calacar which in their movement induces in the area of the tank, microseisme approximately 3.5 degrees Richter. In that area the movements and cracks on the corresponding piedmont "avenue the Great Union" - namely the southern part of the Garden. It is recommended to complete shutdown of the movement of heavy vehicles on the avenue of "the Great Union" and area ferryboat to avoid the curve damage.

[1] Costel Crangan, "Galatiul se prabuseste in Dunare cu 12 cm pe an", adev.ro/ogbrk6.

**Figure 3. The area "Curve to the ferryboat"[1]]**

## 6. Conclusions

At this time, the flow of groundwater in the area of the municipality is uncontrolled. We do not have a complete picture of the networks captive screws, of the levels of groundwater. In the area of the top of the cliff, of the monitoring of the satellite and the terrestrial, it has been shown that there is a dynamic accentuated because of the umpluturilor with material adios, executed incorrectly, made in the '60. It is necessary to a campaign for the monitoring of the top of the cliff to highlight the plan for the disposal, with deep drilling up in a solid area. One solution is to reconnect the drainage system of the groundwater in the area of the cliff.

[1] Costel Crangan, "Galatiul se prabuseste in Dunare cu 12 cm pe an", adev.ro/ogbrk6

Shall be prohibited to carry heavy (Lorries over 5t) because determine a lot of jarring in the area of the ferryboat and its routing must construct outside of the Galati city.

The action to raise awareness about the protection of soil could be achieved in cooperation with the European Alliance for land and improvers (ELSA - European Land and Soil Alliance).[1]

The vision for the year 2020 in matters of stability and biodiversity included in "actions in the framework of the strategy for the Danube Region", will contribute to the implementation of EU strategy on the soil degradation.

It is necessary to public awareness and the political decision factors with respect to the issues of the cliff in the area of the city of Galati. It is necessary to adopt a strategy and measures for the stabilization of soil and the implementation of concrete initiatives in the field of the environment in the region of the Lower Danube, because in time this region suffered many damage and transformers.

## 7. References

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[1] European Union Strategy for the Danube Region - Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions{COM(2010) 715/4; SEC(2010) 1489 http://ec.europa.eu/regional_policy/sources/docoffic/official/communic/danube/com2010_715_danube_ro.pdf;b http://ec.europa.eu/regional_policy/sources/docoffic/official/communic/danube/action_plan_danube.pdf.