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ENVIRONMENTAL ASSESSMENT OF WATER EROSION IN BOVILLA CATCHMENT BASIN AND ITS IMPACTS ON WATER POLLUTION

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Abstract

Watershed basin of water Bovilla was created by surface watercourses and catchment basin groundwater of the Bovilla area. Water collected in the water basin constitutes the main reserve source of drinking water for the city of Tirana. A portion of it is planned as well to be used for irrigation of plants cultivated in this area. Catchment basin is part of the administrative geographical unit of the Tirana district. Topographic relief is relatively steep slope over 15%. The soils of the basin are used and continue to be used for the growth and expansion of forests, pastures, little agricultural plants and partly cultivated land without vegetation. Water erosion of soil in this basin is very visible and reaches very high values. The effects of erosion are visible not only in the loss of land but also in water pollution of the watershed basin. Factors that cause erosion are geological construction of the soil, climate, landscape rake, lack of vegetation cover and land composition. Solids and organic matter transported through surface and ground water are the main causes of reduced volume of water in the basin and both are the main pollution factor for the water and the environment. This study helps in recognizing the negative role of the soil erosion by water, its effects on land, water and environment around. At the same time we have studied and proposed measures to improve the situation and "making healthier" environment in the basin and catchment basins of Bovilla.

Keywords: *Soil erosion, erodibility, erosivity*

Introduction

Soil erosion is a natural phenomenon and a result of trends and tendencies of the different forces of the nature that causes distortions in the earth crust. Consequences of soil erosion are depending on its topographical characteristics, soil, climate, hydrographic network and land cover. Human activity is another determining factor that influence in the accelerating, minimizing or eliminating of the effects and consequences of the erosion.

Viewed in the geological timeframe, erosion constitutes the starting point of the creation of soils with a variety of land types and subtypes, setting in the same time the natural balances between eroded soil and new created one. On the other hand, climatic, biological and soil factors are giving their effects and transform the normal course of erosion development.

In this paper are presented not only theoretical aspects of water erosion but also are provided techniques and methodologies of assessment of actual and potential erosion risk. In the end, are given some measurements for preventing and minimizing soil erosion.

In the basin of Bovilla, soil erosion in the catchments, presents a potential and actual risk not only to soil loss but also in terms of transportation and deposition in the expense and surrounding environment and other elements of physical and chemical pollutants.

We have reflected the techniques and methodology for assessing potential and actual soil erosion according to CORINE method used by Food and Agriculture Organization (FAO). The results of scientific research conducted in areas close to water basins are obtained from the study CLC - 2006 (Corin Land Cover) carried out in cooperation with the European Environment Agency.

Assessment of erosion in Basin of Bovilla is based on soil erodibility, erosivity, relieve and land cover. Syntheses elements to calculate erodibility are: soil texture, soil depth and content of stone. For erosivity the calculating elements are Fourner and Gaussen index while for the relieve those are slope angle. Finally, are given the measurements for erosion prevention and obstruction of solid materials carried out through water streams and small rivers.

Material and methods

Real and potential risk assessment caused by surface erosion water in the watershed of Bovilla basin is based on the land erosion, landscape and plant cover. To calculate the erosive elements, are considered soil texture, depth of soil profile and content of rocks in the soil layer. Erosion is evaluated through indexes and Gaussen Fourner. For relief it is estimated the slope angle of the terrain and the type of vegetation cover plant.

Methodology used to assess the actual and potential risk from soil erosion is based on the known system CORINE. This method is widely used by FAO in many Mediterranean countries (Giordano et al., 1992). Previously in our country this methodology is used in an area of Lezha and then to the watershed of coastal area in the south-western part of Albania**.** (Kovaçi and Dedaj, 2008)

To estimate actual and potential erosion risk in the CORINE model, the required database parameters are soil erodibility, erosivity, topography (slope), and land cover. Every index is the product of synthesis of elements for each factor separately. (Giordano, 1987).

Erosivity is calculated by combining two climatic indexes including the Fournier index and Bagnouls - Gaussen aridity index (BGI).

The slope data layer is generated in GIS environment from topographic maps and digital terrain models. In this study, the digital topographic maps with the scale of 1:25000 were used to generate a Digital Elevation Model (DEM) of the study area. To the land cover the data of Corine Land Cover Albania, 2006 are used.

The geostatistical analysis was performed using ArcGIS (v. 8.3.) and the extensions of Geostatistical and Spatial Analyst. Application and analyses of factors is done through Geographical Information System (GIS) refering to soil type data and its composing elements, climate, topography and land cover.

Results and discussion

General evaluations of the territory where the study was conducted.

Bovilla watershed has a water surface area of 456 ha, length of line around 33750 ml of water and it is located right in the bottom of the catchment basin, up to quote 319 m (with a maximum depth of 60 m).

Water capacity is 80 million m^3. The water source is rainfall streams through surface water and groundwater.

Albania in Europe

Bovilla watershed

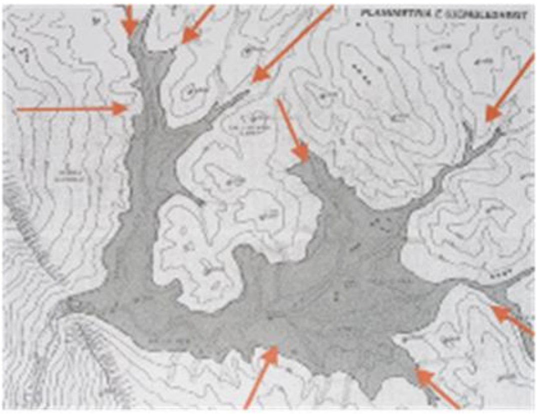

Fig No. 1 - Bovilla watershed Map

Watershed was initially planned for containing 12 million m^3 of water for agriculture, then ideas led to the creation of this basin with a capacity of 80 million m^3 of water, changing the original intention to the needs of city residents Tirana.
Volume of drinking water taken from the reservoir and used for Tirana is about 55 million m^3 of water per year. The remaining 30 million m^3 serves for irrigation.
Symmetric shapes, almost circular catchment basin on the receiving section creates powerful full bow organized in short periods, from 8 to 10 hours. Pure beauty of the landscape of the watershed basin Bovilla, located just a few kilometers from the old city of Kruja and the capital of Albania, and the ability to influence the microclimate of the area makes it attractive for foreign tourists.
Watershed is realized through the construction of the dam that interrupts the flow of river Terkuze, at the point where it enters the mountain chain of the Kruja - Dajt, 15 km north east of the city of Tirana.

Geological framework of the catchment basin.

Bovilla catchment basin within which is built Bovilla reservoir, lies in an area of 9800 ha. Maximum capacity is 80 million m^3 aquifers and processing capability of 105 million m^3 of water per year.
Basin catchment basin and watershed lie in the complex that belongs to the geological flishoid - paleogenic in whose composition are virtually impervious surfaces.
Spots cited above are located on the east side of the anticlinare structure Kruja - Dajt, in the carbonate series contained between the Upper Cretaceous and Paleocene. Shkupi, D., Alia, Sh., Muco, B., Lleshi, B., Mylius, G., and Toloczyki, M. 2000. (“*Harta e rrezikut gjeologjik të Shqipërisë”).*
The entire water basin is characterized by carbonate rocks of the upper Cretaceous (Cr 20) and lower and middle Paleocene Pg1-2. *(Harta Hidrologjike e Shqiperise 1:200 000. 1984.)*

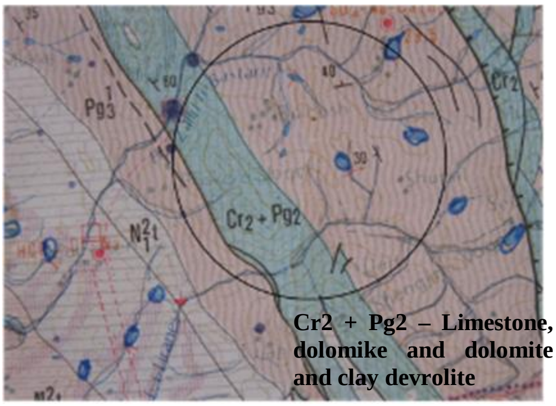

Fig No. 2 Hydrological Map of the Bovilla

Land formations are represented by the exchange of microcrystalline organogenic limestone Dolomites which underlie the entire basin.

Groundwater circulation is carried out through the soil deep cracks as a result of stratification and carstic extensions. The average value of the filtration coefficient of carbonate formation is 42 to 39 units Lugeon.

Morphological characteristics, pedo-climatic, hydrographic and biodiversity

Catchment basin and Bovilla reservoir lies in a field of steep and very steep and often with large land deformations. The slope of the terrain ranges from 8% slope in the sand near the Old Stone, up 40% slope to the Bruzi river source. The soils are different from the composition and belong granulometric types: Gleit (clay), Clay - Loam (clay) and Silt (floodplain). Zdruli. P et al Soil Region. Soils map of Albania INTEREG II.

Clay, sand, and conglomerates represented by type (Neogene), limestone Dolomitizuar (Cretaceo superior), calcareous marl (Triassic to Palaeogene Inf.e medio of up to flysch clay - sandstone (Triassic to Palaeogene superior). *(Gjoka, F., and Cara, K. 2003. Broshure “Tokat e Shqipërisë)*

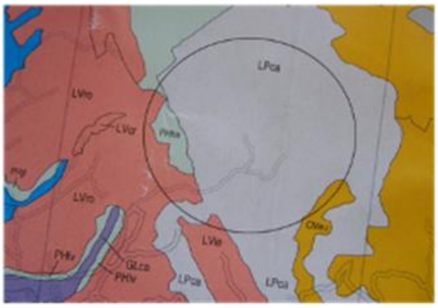

Fig No. 3 Pedological maps of the Bovilla river basin.
LPca – Calcarit Leptosol

The climate in the catchment basin Bovilla is characterized by Mediterranean - Hilly – Central climate zone indicators. Average annual temperatures range from 11° C to 13° C, while the average rainfall perennial range from 1500 mm to 2000 mm/year

Data shows that the average annual rainfall ranges from 1500 mm to 2000 mm of which 600 to 700 mm falling during the period from April to September. Absolute maximum in 24 hours it is reached in 06/18/1964 and 12/30/1962 respectively 155 mm and 170 mm. Average number of rainfall days with above 10 mm is 45 to 65 days, while the number of days with snow layer is 20 to 40 days a year. The average annual temperature is 10° to 14° C *(Instituti i Hidrometerologjisë 1981. “Atlasi Klimatik i Shqiperise”).*

Hydro technical characteristics of the Bovilla catchment basin are: catchment basin has 33 small streams which carry constantly about 3.3 m^3/sec of water, with a maximum capacity of up to 105 million m^3, while the maximum plots provided with frequency 1 in 1000 years, the first in 100 years 1 to 10 years, range from 3 to 11 million m^3 of water. Plant terrestrial coverage is different, with great variety of vegetation growing tendencies. The vegetation of the "floor" of medium and high, represented by oak, shrubs, and rarely mixed forest of beech trees, pine and acacia. Herbaceous vegetation or the lowest "floor", is represented by plants which and legumes. In 3 to 5 % of the territory of the plant cover is missing. *(Dhima, S., Grazhdani. S., Kovaci, V., Gjoka, L., and Laze. P. 1998. “Vlerësimi i faktorit të menaxhimit bimor C në kushtet klimatike dhe tokësore të zonës Jug - Lindore të Shqiperisë” BBSH.Nr 2).*

Human activity

Human activity is diverse. The low zone has a very intensive human activity especially in agriculture. While, high zone has a limited agriculture and livestock as a result of the economical and social changes as well as migration on the other parts of Albania.

In both low and high zones, land fragmentation has reduced significantly effectivity of use of mechanics in agriculture. As a result, normal agriculture works are mainly soil digging, drainage and irrigation system. An important activity remains mountain tourism which despite its weakness is extended along all the area.

Depending on the development process of relieve-formation and intensity of erosion, the area for which we are talking about is part of the youth cycle (early stage), that dominates the severe erosion The form how erosion is shown, the consequences and problems that arise are different and have environmental, social and economic character. Through assessment of the erosion risk of the catchment basin of Bovilla is determined the action to minimize it. Determination of measures for the protection and preservation of soil can contribute to the prevention of physical, physico-chemical and chemical pollution of it and water in the lake basin, improving the environment, increase sustainable agricultural production, capacity of livestock and tourism in this area.

Fig No. 5 Images of good management and bad land in water basins(Kerrabe, Tirane)

Analyses of Soil, Reliefs, Climate and Vegetation Indicators.

For the completion of the research it took to pass in several phases: The first phase monitoring were composed by identification of indicators of soil, hydrography, climate indicators, and land cover of the watershed basin. The second phase - determine the causes and forms of erosion as the main factor that causes water pollution in the Bovilla watershed basin. Third phase – Collecting data for risk assessment *(Giordano, A., Bonfils, P., Karmoss, I., Roquero, C., Sequeira, E., and Yassoglou N. 1992. Published by the Commission of the European Communities. "CORINE soil erosion risk and important land resources in the southern regions of the European Community"p.7-92)*

Fourth-stage - draft measurement of their biological nature, engineering and agronomic and prioritizing them.

To monitor the Bovilla catchment basin area with a relatively large surface and apparent variability, were defined five micro basins as catchment features, relatively different from each other. For the definitions of these micro basins we used the 1:250 000 topographic maps, pedological indicators of the current state of climate and land cover. Through the first phase were identified and materialized indicators necessary to provide with data the software of the assessment of soil erosion caused by water.

In the second phase, we were focused to the surface erosion, depth erosion, erosion on both sides and the depth of streams, erosion in the form of landslides and erosion caused by frost during the winter period. We took into account the results of the measurements obtained from

direct observation in the field, and the conclusions drawn from the surfaces experimented following the methodology of the universal equation of soil loss (8).
The third phase was the most. Soils indicators are syntheses of the class assessment and the sensitivity that they have to erosion. Soil texture with three classes is named based on fraction content with different measurements (< 0.002mm up to 2.0 mm). Soil depth with three classes is named depend on the soil pit depth (< 25cm, 25 – 75cm and > 75 cm). Percentile content of surface stones with two class is based on percentile of stones in soils (>10% and ≤ 10 %). Assessment of soil erodiblity index is product of textural classes with soil depth and content of stones. Climate indicators taken in consideration are precipitation and temperatures and identified with erosivity. Erosivity is product of assessment to Fournier and Bognous-Gaussen indexes or variability index class and aridity classes. (9) Dependence of the value of product of Erozivity indexes is classified in steeps.(10) A topographic indicator is identified with slope index with four steeps which identified slope angle and length of slope. Assessment of potential erosion risk is the product of soil erodibility index with erosivity indexes. The actual risk depends on land cover and soil erosion risk depends on the land cove and their indexes.
In fourth phase, we have proposed the measures to prevent and minimize erosion and water pollution in the Bovilla watershed basin. Measures depending on the effect that may have been labeled: infrastructure measures, biological and agronomic measures.
Infrastructure preventive measures, depending on the effectiveness of the construction and construction techniques are: embankment expected to be prevent the movement and transport of soil, builded with simple wooden tools (fences). Fig Nr 6 and 7 of simple embankment builded with stone material with or without mortar.

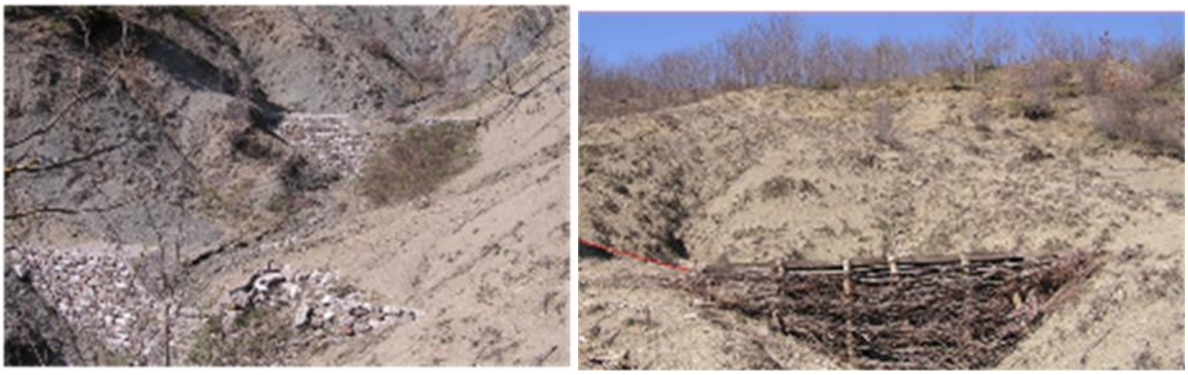

Fig.No.Fig.6 &7

Fig No. 8 Embankment built with concrete

Preventive measures of biological character, consist mainly of implantation of forest trees, shrubs and pastures. Fig 9 and 10 for building overlooking the generation of various protective vegetation.

Fig. No.9 & 10 Protection of water basins

Safeguards of agronomic character are not only highly effective in protecting the land but also they minimize and prevent chemical and physical contamination of surface water, groundwater and water basins. Safeguards of agronomic character most of the time are quite effective. How we manage land, work with it, is very important. However the application of chemicals in agriculture should be evaluated and treated with great caution, especially in the vicinity of streams and lands with high water permeability. However the administration and processing of organic fertilizers, human and animal excrement in the community, has a great importance, especially in those villages where houses are close to watercourses. Handling and processing should be done according to the rules and methodologies provided by competent institutions.

Conclusions

Determination of soil indicators, climate, landscape and vegetation in the catchment basin of Bovilla, are the result of scientific research work and study done in years, from the researcher of our scientific institutions. Application of this methodology, which is certified by many of the Mediterranean and European countries, showed that studied area has high potential and increased erosion risk.

The result indicates that:

Soils with low potential erosion risk occupied about 10%

Soils with moderate potential erosion risk occupied about 15%

Soils with high potential erosion risk occupied about 75%

and

Soils with low actual erosion risk occupied about 12%

Soils with moderate actual erosion risk occupied about 83% and

Soils with high actual erosion risk occupied about 5%

The difference, between the areas of potential and actual erosion risk, indicates the effects of land cover on soil erosion. These areas classified as high erosion risk in the potential erosion risk map were reduced from 75% to 5% in actual soil erosion risk map, after overlapping the vegetation layer. This proved that the areas subject to high erosion risk are mostly covered by forest vegetation. Among the protective measures of soil from water erosion are important primary biological measures, second-order measures hydrotecnic and the third building measures.

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