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SOIL EROSION PROCESSES EFFECTS ON ENVIRONMENT QUALITY IN UPPER BEGA RIVER HYDROGRAPHIC BASIN

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Abstract: *Linkages between soil erosion and environment quality are manifold. Soil erosion is a major cause of pollution of water, air and soil. Discrepancies between the water need, i.e. its quality, and existing resources have reached an alarming level in many parts of Europe, as a result of climate change and dangerous hydrological phenomena (floods, droughts, pollution). Agricultural development has led to increasing use of fertilizers and pesticides, and an irrational use of these substances degrade water quality in rivers, lakes and thus destroying aquatic organisms due to increased soil erosion by water. Through this phenomenon, chemicals in soil are washed down the surface runoff, and particles which form fertile soil horizons are entrainment by surface runoff and reach surface waters. The interdependence between water quality and sediment should be analyzed taking into account that the sediment is a physical entity and has influence on the physical-chemical / biological characteristics of water, respectively that sediment is a part of the water - sediment - dissolved chemical load. Also, wind erosion of the soil, a phenomenon that follows massive deforestation, contributes to increase the amount of dust in the atmosphere. Bega River Upper Basin includes several torentializate sub-basins that were highlighted erosion. Soil erosion changes in time the configuration of sub-basins and surface water quality by increasing the solid loads (particularly suspended load) and water charging with chemicals washed off the hillslopes. These phenomena results determine difficulties in the water treatment for public water supply, especially for Timisoara, Bega River being the most important source of water for the inhabitants of the municipality .This paper aims to analyze the effects of soil erosion on the environment quality in Upper Bega River hydrographic basin, particularly on water quality of the River Bega. Also, the paper proposed several measures to reduce soil erosion intensity in the area and for resulted solid loads management.*

Key words: *soil erosion, environment quality, water quality, measures.*

INTRODUCTION

Linkages between soil erosion and environment quality are manifold. Soil erosion is a major cause of pollution of water, air and soil. Discrepancies between the water need, i.e. its quality, and existing resources have reached an alarming level in many parts of Europe, as a result of climate change and dangerous hydrological phenomena (floods, droughts, pollution). Agricultural development has led to increasing use of fertilizers and pesticides, and an irrational use of these substances degrade water quality in rivers, lakes and thus destroying aquatic organisms due to increased soil erosion by water. Through this phenomenon, chemicals in soil are washed down the surface runoff, and particles which form fertile soil horizons are entrainment by surface runoff and reach surface waters. The interdependence between water quality and sediment should be analyzed taking into account that the sediment is a physical entity and has influence on the physical-chemical / biological characteristics of water, respectively that sediment is a part of the water - sediment - dissolved chemical load. Also, wind erosion of the soil, a phenomenon that follows massive deforestation, contributes to increase the amount of dust in the atmosphere.

Figure 1 shows the water erosion risk of world soils, baseline projection to 2030 (http://www.eea.europa.eu/data-and-maps/figures/water-erosion-risk.-baseline-projection) and Figure 2 the stage of soil erosion in Romania. (MOTOC, 1983; ROMANIAN GOVERNMENT, 2007)

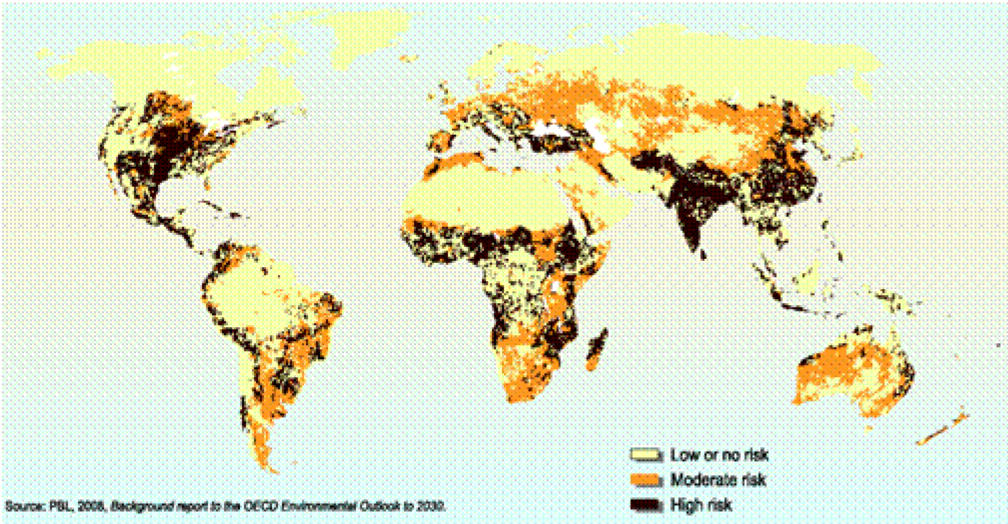

Figure 1: Water erosion risk. Baseline projection to 2030.

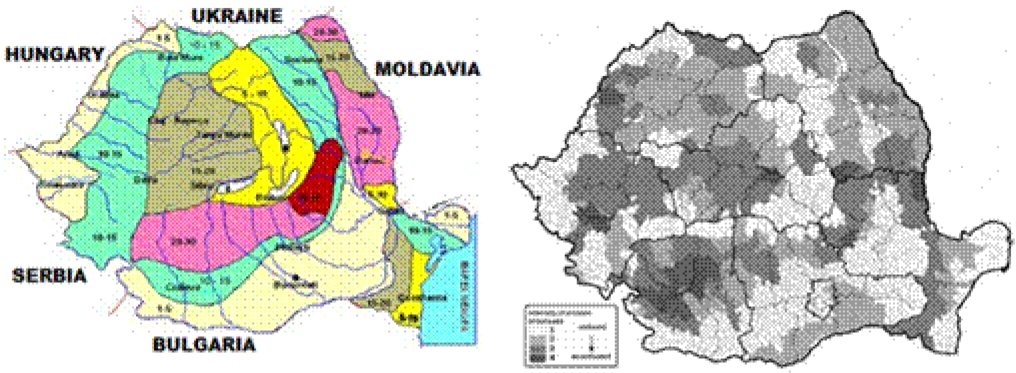

Figure 2: The stage of soil erosion in Romania

From Figure 2 it can be seen that in Bega River Upper Basin the annual average erosion is between 10 to 15 t / ha.an and intensity of soil erosion by water is a 3 on a scale of 1-4. It follows that it is necessary to study very well the evolution and mechanism of this phenomenon, to establish appropriate measures to reduce environmental impacts, especially on the Bega river water quality deterioration. Bega River is the most important source of drinking water for the inhabitants of Timisoara.

MATERIAL AND METHODS

The studied territory (Figure 3) is situated in the depression between Zarandului and Poiana Ruscai Mountains, at the borderline between Lipova Plateau and the Occidental Field. From a genetic perspective, the studied perimeter is characterized by a piemontane accumulative relief; the relief consists of Pliocene river deposits (Figure 4). The morphogenetic processes are particularly subject to the activity of the hydrographical network, which generated a choline hill like relief, with altimetry values between 120 and 1300 m. Relief asymmetry shows how this has evolved, at least during the Quaternary, mostly under the influence of the basic level of Bega River. On the whole, the relief presents a general inclination from the north-east to the south-west, with the following components: piemontan hills on the north, terraces on the south and central part, a river meadow in the central part.

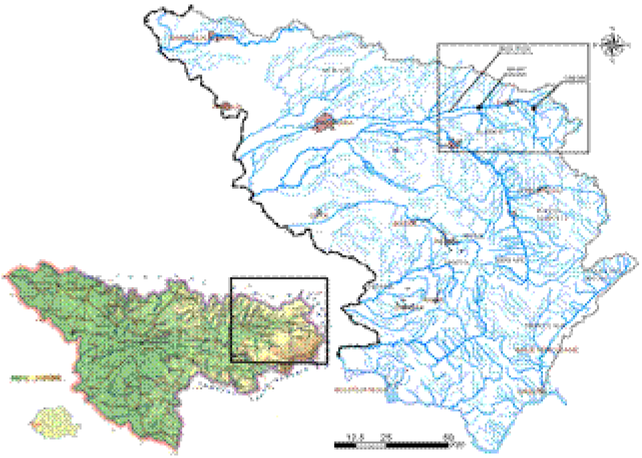

Figure 3: Localization of Upper Bega River hydrographic basin

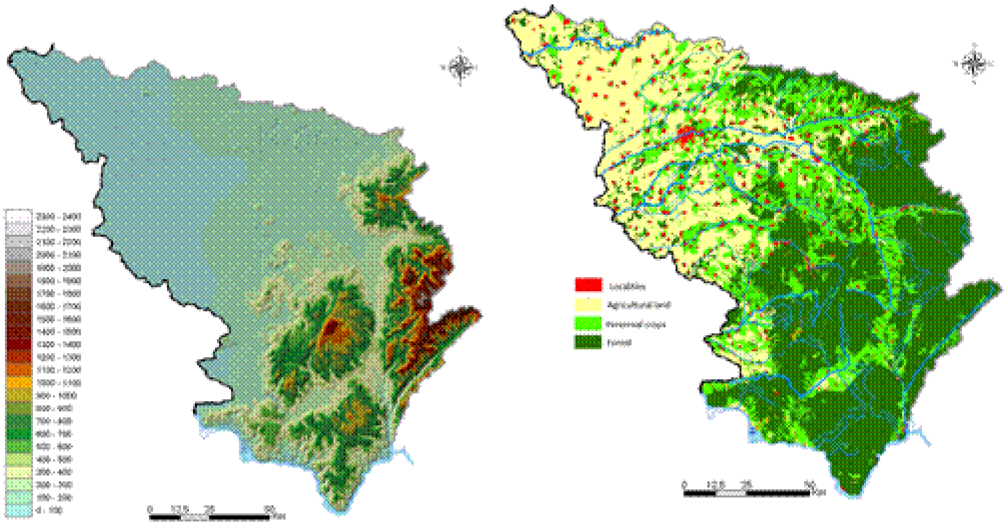

Figure 4: Banat hydrographical space relief and land use (Banat Water Administration)

The hillslopes generally have a complex profile, with slopes between 2 – 50 %. Ravines are frequent on the hillslopes with large and medium slopes, and landslides are isolated, not stretching on large areas.

As regards vegetation, the territory belongs to the area of deciduous tree forests, like the oak tree, with the following forms of vegetation: natural wood vegetation, shrubs, cultivated wood vegetation, natural grass vegetation, leguminous vegetation, herbage and plants in crop. Land uses concern: forests, trees, pastures, hay fields and arable land, the corresponding surfaces not being exactly known (Figure 4, Figure 5).

Figure 5: Upper Bega River hydrographic basin, satellite view (www.google earth.com)

Torrential fluvial erosion as hillslope erosion are factors that have contributed to marking of the main morphological terracing. Bega River tributaries stream have their source in the highest areas and have been able terraces fragmentation and modulation. Valleys were formed as erosion slopes more or less inclined, as many ravines and tranches areas, isolated landslides occur. The erosion valleys are narrow and relatively narrow, temporary with water and clogged with material medium - fine. Passage of terraces is usually narrow lanes generally parallel valleys due to parallel valleys separating them.

Erosion processes are most intensified on hillslopes with south, south-east, east and south-west exposition, and they are also most increased when land is used for agricultural purposes, in comparison with pasture and hay fields. The occurrence of deep hydric erosion forms is also due to the unreasonable human intervention (unjustified fallow and exacerbated deforestation). (OSPA, 1982)

Based on data provided by Banat Water Administration has studied the evolution of Bega River water quality in the two sections upstream Timisoara, Luncani and Balint.

RESULT AND DISCUSIONS

Soil erosion changes in time the configuration of sub-basins and surface water quality by increasing the solid loads (particularly suspended load) and water charging with chemicals washed off the hillslopes. These phenomena results determine difficulties in the water treatment for public water supply, especially for Timisoara, Bega River being the most important source of drinking water for the inhabitants of the municipality.

The intensity of soil erosion processes in respective area can also be noticed in Figure 6 and Figure 7, graphics which show the variation of suspended sediments concentrations in Bega River, in two sections situated upstream of Timisoara: Luncani and Balint. (Data source – Romanian Water Authority, Banat Water Administration).

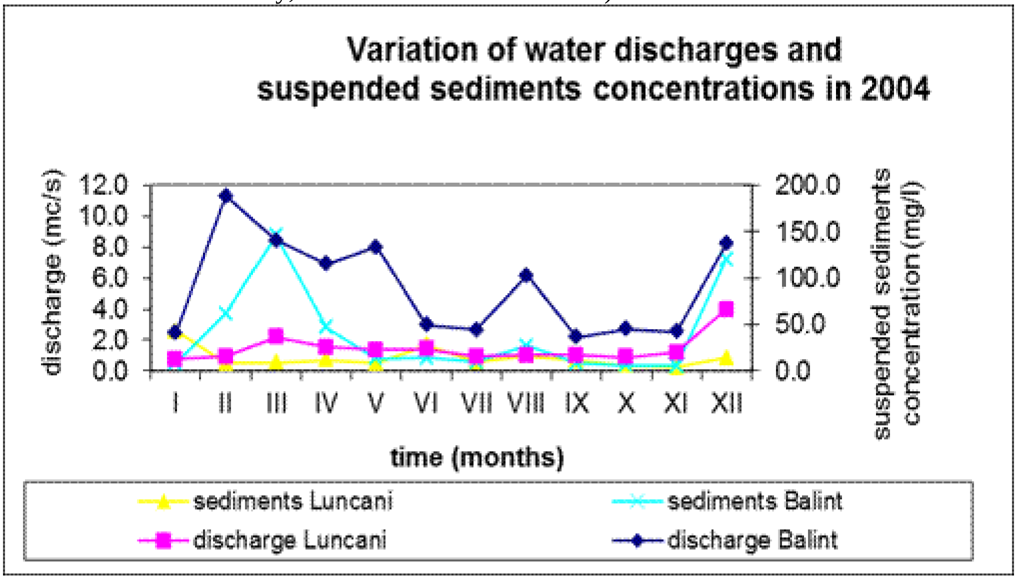

Figure 6: Variation of water discharges and suspended sediments concentrations in 2004

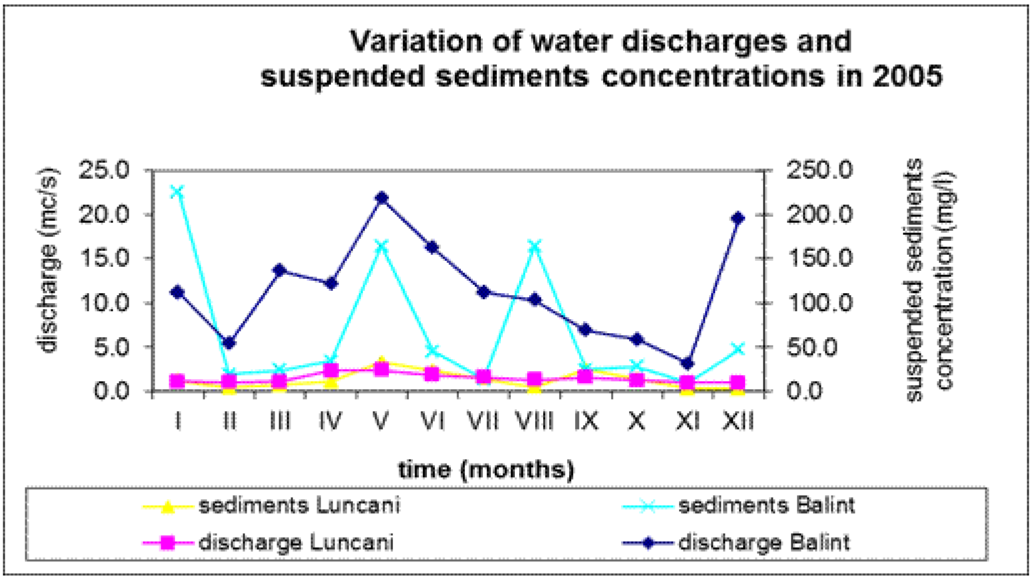

Figure 7: Variation of water discharges and suspended sediments concentrations in 2005

Sediments from soil erosion, arrived in river bed of Bega, have direct effects on water quality. In order to study these effects, were studied the dependence between the concentration of the suspension and the quality characteristics of the water directly influenced by them: N-NH_4, N-NO_2 and N-NO_3 (Figure 8 and Figure 9) and P-PO_4 (Figure 10 and Figure 11), in the two sections upstream Timisoara, Luncani and Balint 2005. (GUTIU et al, 2003)

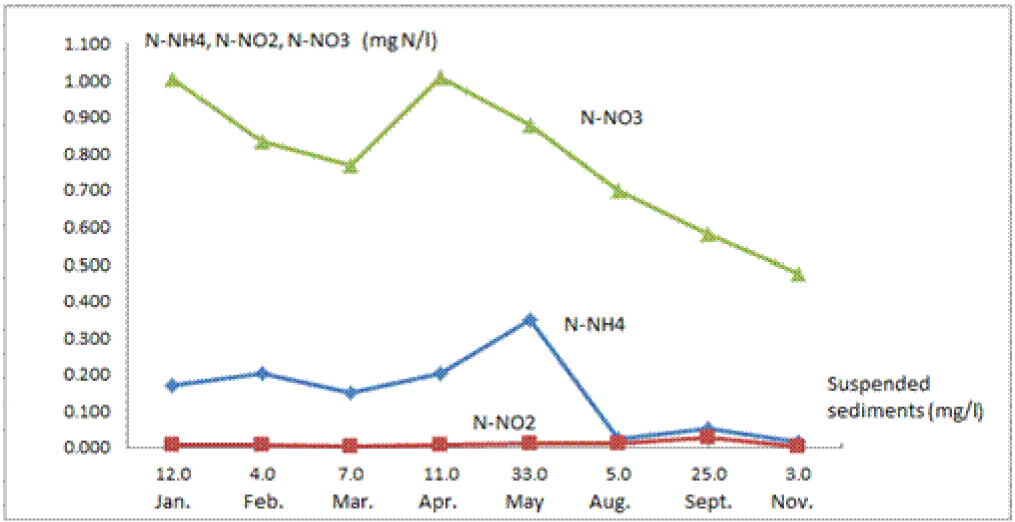

Figure 8: The dependence between suspended sediments concentrations and N-NH_4, N-NO_2 and N-NO_4 at Luncani station, year 2005

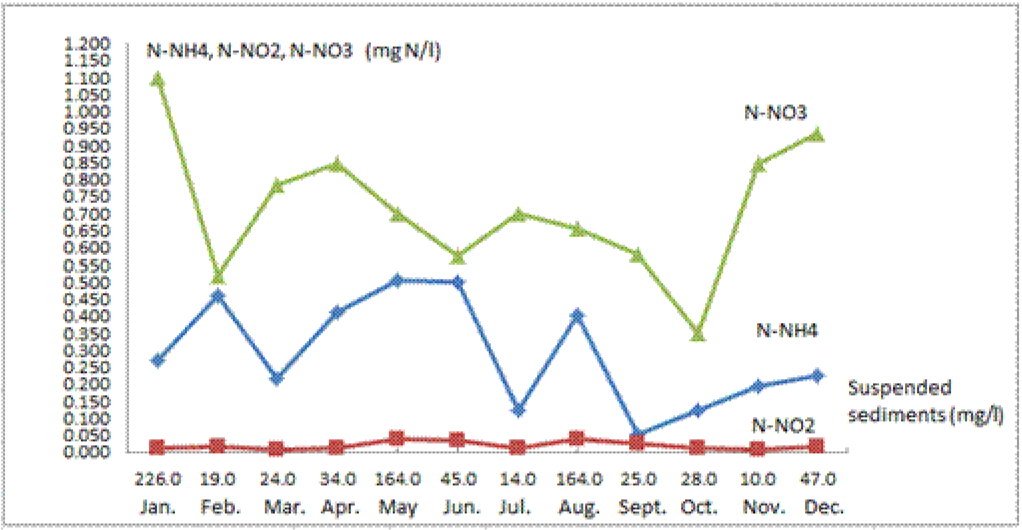

Figure 9: The dependence between suspended sediments concentrations and N-NH_4, N-NO_2 and N-NO_4 at Balint station, year 2005

From the graphs above it is observed that the highest values we find for N-NO3 and lowest for N-NO2. At Luncani section, because afferent sub-basins is mostly forested, the values are quite small. Peaks occur in April-May, period of abundant precipitation.

At Balint section, maxima are observed in winter period, which shows that there the recommendations on nitrogen fertilization of agricultural land are not respected. Application of nitrogen fertilization under basic plowing is unjustified because they are leachates precipitation during autumn-winter-early spring. Nitrogen has a high solubility in the soil and there is danger of its leaching the soil profile, is applied in several phases, depending on plant requirements.

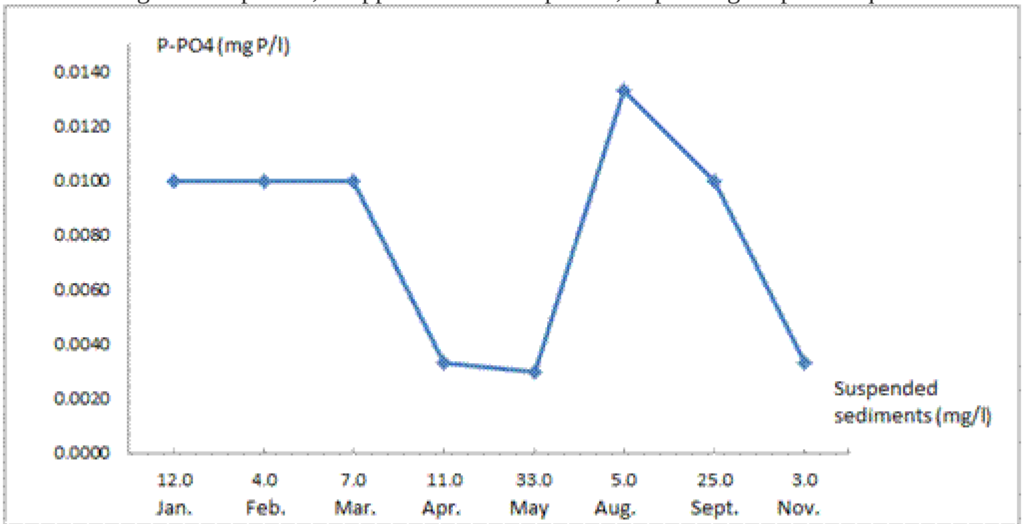

Figure 10: The dependence between suspended sediments concentrations and P-PO_4 at Luncani station, year 2005

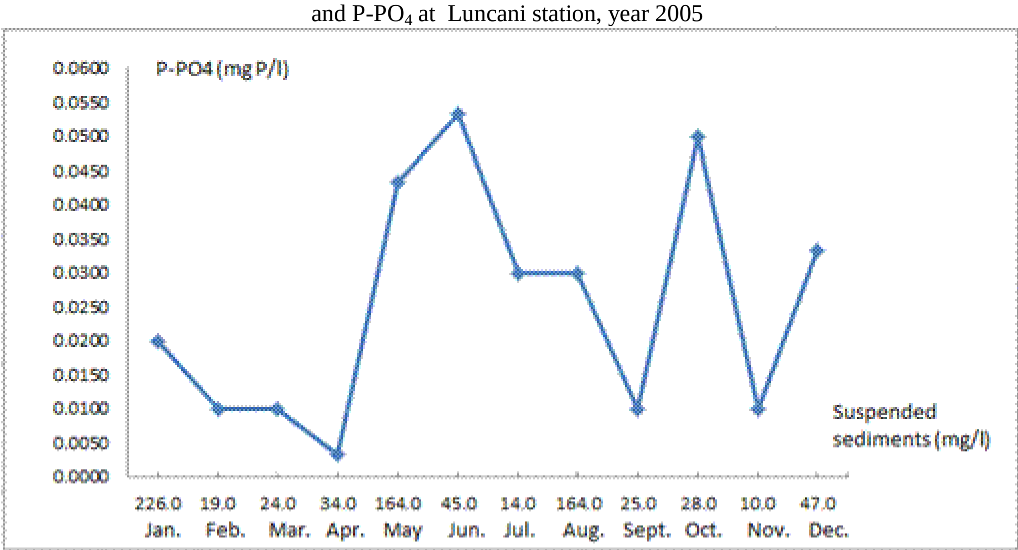

Figure 11: The dependence between suspended sediments concentrations and P-PO_4 at Balint station, year 2005

At Luncani section, because afferent sub-basins is mostly forested, the values are quite small. Peaks occur in April-May-June, period of abundant precipitation.

At Balint section, the maximum values occur after the spring and autumn crop fertilization. Phosphorus fertilizer application in vegetation period of plants (spring) is totally unwarranted, for fall cereals focus should be increased phosphorus fertilizers, that due to low water solubility and low mobility in soil must be incorporated before sowing, preferably in plowing.

The increasing the concentration of nutrients (N, P, K) in Bega River water leads to favoring eutrophication, which causes difficulties in the treatment of water for drinking.

To reduce the volume and effects on environment quality of soil erosion processes are the following categories of works:

- Works on hillslopes (erosion control works) - organizational works; agro-phytotechnical works; forestry works and measures; hydroameliorative and hydrotechnical works (control works to retain and discharge of runoff and sediments from hillslopes).
- Torrential formations arrangement. By ravines and torrents arrangements seeking to enforce a set of measures for regulating runoff from hillslopes and in drainage network in order to restore the whole area of catchment to corresponding economic and erosion control categories and to remove the damage caused by floods. Figure 12 show the full arrangement of a ravine with all active sectors.

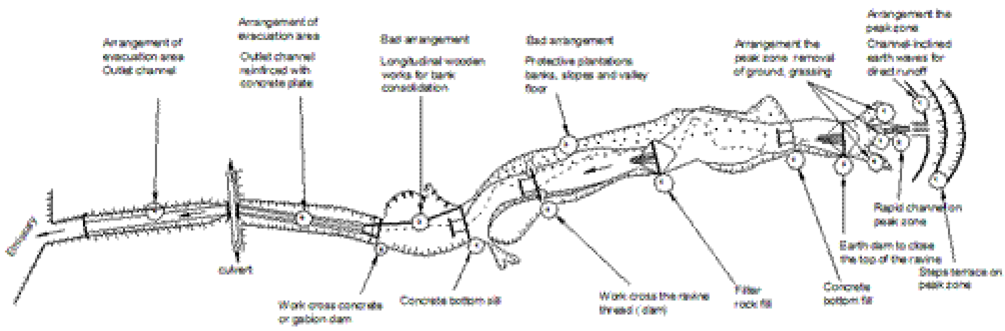

Figure 12: Full arrangement of a ravine with all active sectors. (after POPOVICI, 1991)

- Non-construction measures - implementation and development of the monitoring system of triggers and favoring factors of dangerous phenomena of soil erosion; rethinking hydrotechnical arrangements operating rules; institutional reform; developing or updating of regulations, operational action plans and intervention models for various manufacturing scenarios of dangerous erosion (flash floods, mud flow, landslides); developing risk maps (especially for landslides); placing restrictions on building permits for hazardous areas; activities awareness of decision makers at different levels and population located in areas with dangerous erosion phenomena's risk; developing appropriate economic instruments: the material property insurance through insurance - reinsurance companies, compensation schemes etc.; relocation of settlements and economic objectives from areas with high risk of producing dangerous erosion phenomena's.

In addition to the solution above, works must to be performed and management measures related to the development of strong flow of water management and soil erosion:

- in areas where it provides a progressive lifting of the bottom bed after decreasing transport capacity is necessary to carry out restoration works to ensure that capacity by increasing the slope of the bed;
- if the bottom of the riverbed elevation occurs as a result of the formation of alluvial cones in areas of confluence, it is necessary to carry out improvement works to confluences or works retain of solid tributaries flow.
- in areas where it is likely a general lowering of the bottom of the river bed as a results of a process of gradual erosion (where they are not acceptable, example where buildings are made in bed and could compromise their foundations) should be taken measures to limit these processes by regulating works and bed stabilizations. (BÂCOV, 1996; POPOVICI, 1991, GIURMA, 1997; DI SILVIO, 1998; STĂNESCU et al, 2002)

CONCLUSIONS

It is found that the direct effect of erosion (surface erosion on watersheed hillslopes and deep erosion in their furrow beds) modifying configuration of hillslopes and changing their hydro-physical and hydro-chemical characteristics, through pollution with direct consequences, starting the eutrophication processes.

Measures are required to reduce the intensity of surface erosion by creating a equilibrium profile of ravines, interception and direct discharge of runoff from the hillslopes, enhanced water quality control by minimizing pollution.

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