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THE ROLE OF LAND USE FROM THE HYDROGRAPHICAL BASIN SIRET IN PRODUCTION AND TRANSPORTATION OF THE SEDIMENTS

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Abstract
In the hydrographical basin of Siret river land use types are varied and differentially affects water flow regime, production and transport of the sediments. The largest areas are occupied by agricultural land at a rate of 43% (29% – arable land, 10% - agricultural land heterogeneous, 1,4% – vineyards and orchards, 2,8 – pastures and others) and forests in a ratio of about 37%. Analyzing the dataset CORINE Land Cover (www.eea.europa.eu) for the study region, between 1990 and 2006, we can say that deforestation prevailed from afforestation. Each main tributaries rivers from the hydrographical basin Siret lost between 1 and 5% of the forest cover. The exception was Putna River Basin which gained 3.6% plus in 16 years reforestation and Buzau where wooded areas did not change in the period considered. At the local level (the basins), the evolution of the wooded areas proved to be more prominent in much higher values. The result of this situation was felt in the production of silt: increases in river basins affected by deforestation and decreases the production of sediments in relation to leaking ponds where the forest area increased.

Keywords: Siret hydrolographical basin, afforestation, deforestation, silt

1. INTRODUCTION

The role of anthropogenic interventions on changing the natural environment has been evaluated on several subdomains thereof, but none is so sensitive to human impact and transportation of sediments (Ichim et al., 1998; Rădoane et al., 2002). This is because any significant intervention in the area of production of sediments (hydrographical river basin) is felt after a very short time in amount of sediment in transit and discharged from that basin.

Overall the transportation of sediments in a river basin is lower in the case of high land with vegetation cover. Numerous studies have shown a negative relationship between the land coverage with vegetation and transportation of sediments (Vanacker et al., 2007).

Although the exact form of this relationship varies depending on the type of vegetation and other characteristics of the catchment, these studies clearly indicate that vegetation has a great deal of control over the transport of sediments in a river basin. This control can be attributed to several factors. A high degree of land vegetation cover provides better protection of soil against raindrop, a higher resistance against surface erosion and sediment eroded more likely to settle quickly (Vanmaercke, 2012).

In addition to coverage of land, plant roots contribute having a strong impact. The roots increase in the soil resistance and erosion on surfaces and liner or the ravination processes (Vanmaercke, 2012), and also against landslides, cave-ins and subsidence. Furthermore, the roots of the plants in general, may improve soil structure and increase the rate of penetration, resulting in a reduction of liquid leakage and erosion of the soil.

From the above we can say that the most important land use types they represent categories of vegetation cover protects the soil. Thus for the Siret hydrological basin these types of land cover refers to forest area and the type of agricultural use, particularly in the share of arable land .

2.STUDY AREA

The Siret river is the largest river inside Romania. It rises in the paleogene flysch Carpathians Forest (Ukraine) at a height of 1238 m and drains through its catchment area, the central-eastern part of the Eastern Carpathians and Carpathian Curvature, Moldavian Subcarpathians and northern sector of the curvature , Moldova Plateau and lower Siret Plain. The total area of the Siret basin is 44 871 km^2 of which 42 890 km^2 are in Romania. The lenght of the Siret river in Romania is 548 km, and at the entry from the Ukrainian border has 110 km (ABAS, 2011).

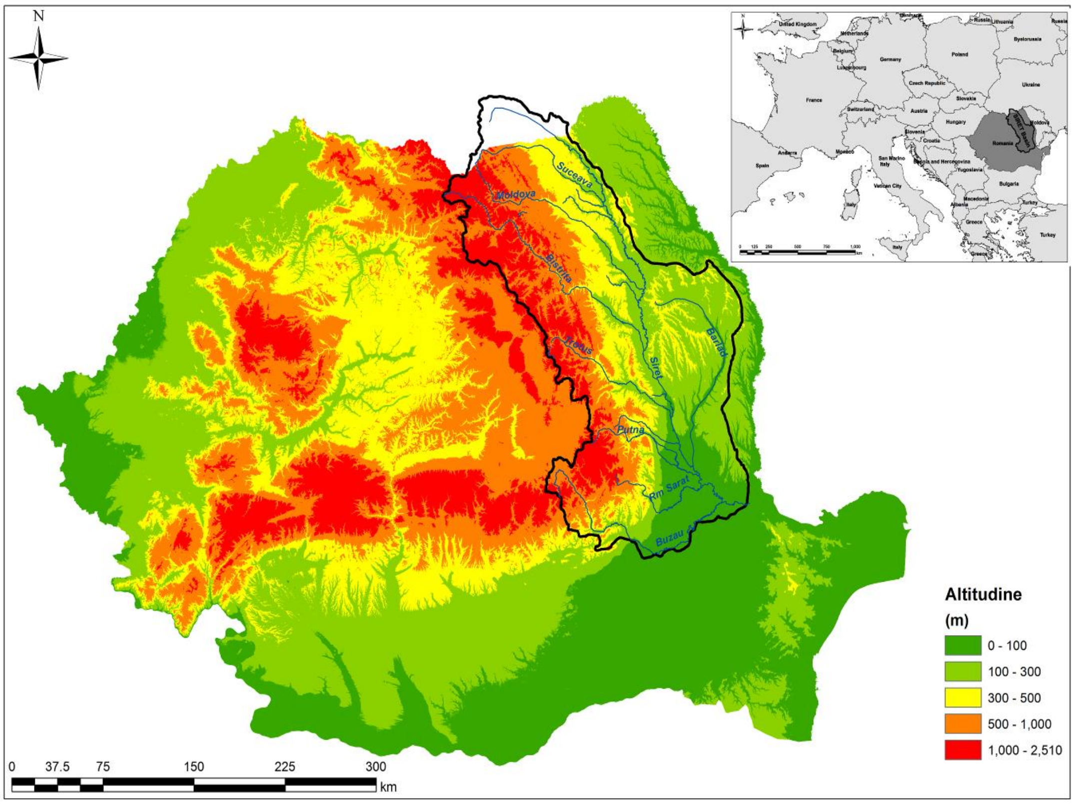

Figure 1. The Siret basin geographical position map in Romania and Europe

Since the springs it is blazing a typical cross mountain valley with slopes average about 10 ‰, which is maintained until the entering the in the SubCarpathian basin at Berhometului (Ukraine). Further down, after turning range southeast, the Siret has a wide valley, a true color with a typical course submontane to shedding (Ujvari, 1970).

In the Siret river basin, the land cover situation is very complex. The largest areas are occupied by agricultural land at a rate of 43% (29% – arable land, 10% - agricultural land heterogeneous, 1,4% – vineyards and orchards, 2,8 – pastures and others) and forests in a ratio of about 37%.

Other types of uses occupy each lower surfaces but all aggregate represent approximately 20% of the Siret river basin located in Romania.

Using CORINE Land Cover database (www.eea.europa.eu) for 1990 and 2006 we realized a situation of the wooded areas Siret river basin in 2006 (Figure 1).

3. DATABASE AND METHODS

To perform a detailed analysis of the problem studied, it was necessary to build a database. This database contains information on developments spill liquid and solid elements and the evolution of the use of land.

The hydrological data were obtained from the archives of the Department of Hydrology Water Basin Administration "SIRET" Bacau. These consist of monthly and annual averages of solid and liquid flow from 66 measurement points in the Siret river basin (gauging stations). The time period for which data were available is 1950 - 2010. Since two of the main tributaries of the Siret - Barlad and Buzau belong to other Basin of Administration, these data were obtained from the respective institutions (Prut Water Basin Administration for the Barlad river and Water Basin Administration Buzau-Ialomita for the Buzau river).

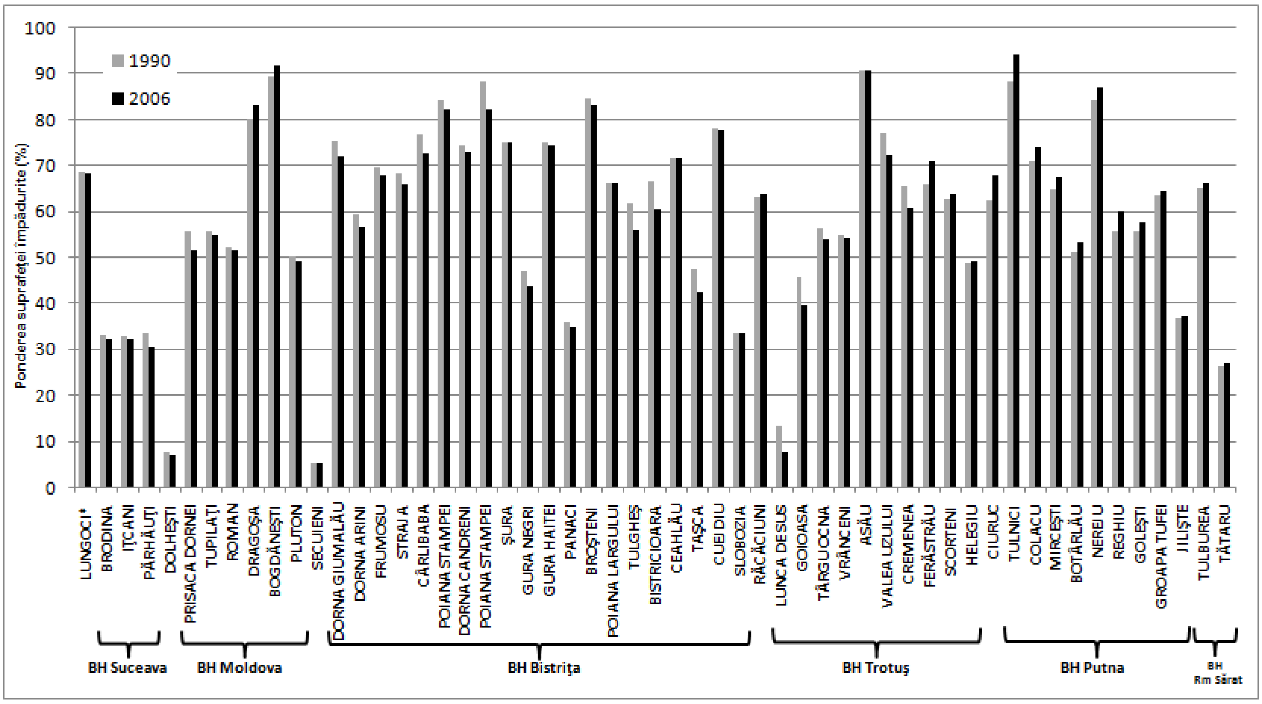

Figure 2. The evolution of forested areas in the hydrographical basin of the Siret river during 1990-2006 (processing after CORINE Land Cover 1990, 2006, www.eea.europa.eu)

Issues relating to the use of land were extracted from the data set CORINE Land Cover for the years 1990, 2000 and 2006 of the European Commission (http://www.eea.europa.eu/data-and-maps/data).

To identify the role of land use in the production and transportation of sediments was used a statistical method similar to those used by many previous specialist works (Walling 1997, 2006, 2009; Xu Jiangxin, 2003; Zhenmei et al., 2008; Rădoane et al., 2013).

Double mass curves - DMC. It is a method commonly used in hydrology applied in analyzing the relationship between two parameters to identify the particular hydrological changes caused by human activity. This method is a graphical representation of the cumulative values of two variables for the same period of time (Searcy & Hardison, 1966).

Walling (1997) used this method to identify possible changes for the transport of the sediments in relation to leakage. The author has used the method in many studies (1997, 2006, 2009) analysis of annual leakage (mil m^3) and silt in suspension (mil t) from different gauging stations. The graphs results (Figure 3) produced by this method can be extremely useful as it indicates a number of issues that other representations do not. Here are some of them:

-breaking the slope of the line drawn in the graph by the values accumulated in the upper part of the graph suggests that the ratio control factors in the basin has changed with effect in increasing of the silt transport or in decreasing of liquid spill.

-breaking the slope of the line drawn in the graph by the values accumulated in the bottom of the chart suggests that the ratio control factors in the basin has changed with effect decreased production / transport of sediments or spill liquids growth.

- straight or nearly straight suggests that both variables - transportation of sediments and leaking - respond to the same factors control without major modifications to one side or the other.

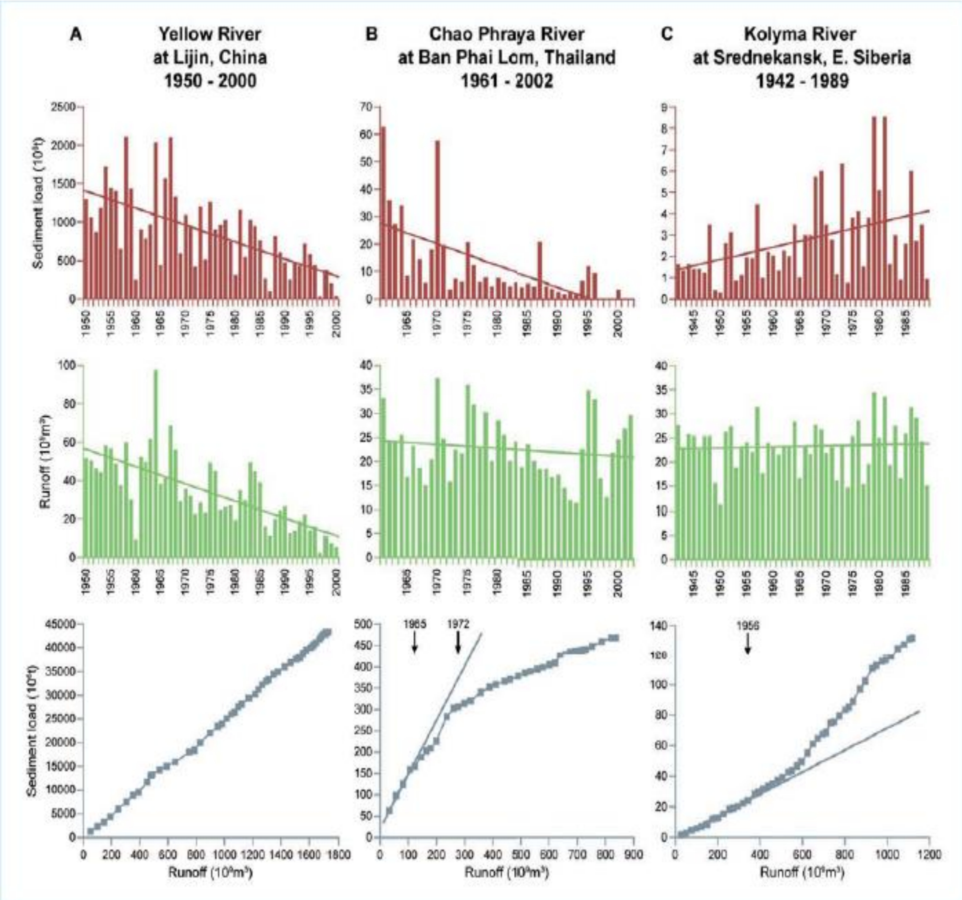

Figure 3. Cumulative curves between leakage and production of alluvial 3 gauging stations in Asia (after taking Walling, 2009)

4. RESULTS AND DISCUSSION

4.1. Evolution of forest areas

The data presented in Table 1, on the evolution forested areas during 1990-2006 indicates the following aspects:

- in Suceava River Basin forest areas decreased percentage values of catchment area between 2.4 to 9.2%;

- in the Moldova river basin overall situation is decreasing forest cover percentage values ranging from 1.4 to 7.8% of the catchment. However in the two tributary basins, respectively Moldova and Râşca, apparently wooded areas increased during 1990-2006 with values between 2.7 to 3.8%;

-in the Bistrita river basin the forest cover surfaces are decreasing with the percentage values up to 10.6% in the Bicaz basin;

-in the Totuși river basin the wooded surfaces decreased with the percentage values to 45% (the springs of Trotuşului). On the two tributaries Trotuşului (Tazlău and Oituz) were the growth of forest areas as follows: 0.8% on Tazlau Basin and 7.6% on Oituz Basin;

-according to CORINE Land Cover database, the Siret tributaries basins in the south indicates increases in forest areas for the period 1990-2006, as follows: Șușița basin – 8,7%, Putna basin 1,1-7,6% and in the Râmnicu Sărat basin 2,0-3,3%.

To identify how this type of development of forest areas have influenced the production and transport of sediments, we applied a method often used by many authors (Walling, 1997, 2006, 2009; Xu Jiongxin, 2003; Zhenmei et al., 2008;). For this purpose we used the cumulative curves (double mass curves - DMC - explained in detail in Chapter 3).

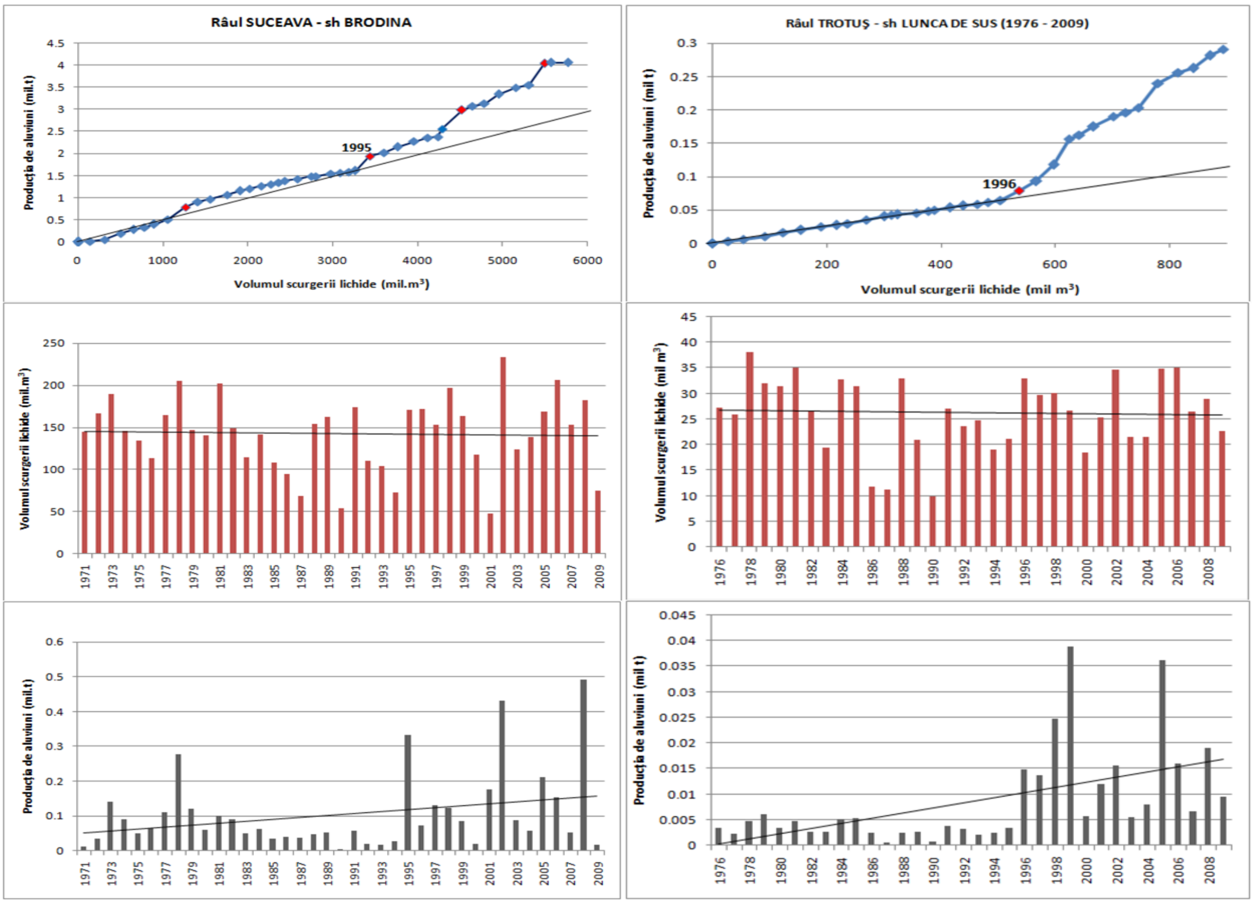

Figure 5. Cumulative curves of silt production and liquid flow at the gauging stations Brodina and Lunca de Sus

Cumulative curves of annual production of silt and liquid flow were performed for all hydrometric stations in Table 3.1. In this study we presented the results to only those gauging stations where analysis of CORINE Land Cover database showed both decreases and increases of forest area (Figures 2 and 3).

Since previous studies have indicated that the influence of coverage of forest land is manifested more strongly in smaller basins (Walling, 1983; Ichim et al., 1998; Rădoane M & Rădoane N, 2007; de Vente et al., 2007) we chosed to study several gauging stations whose catchment area did not exceed 400 km^2.

It should be noted that for all cumulative curves constructed trend / slope breaking graphs occurring in years when there were major floods. Even if this brings to mind the more climate effect than anthropogenic, regarding the evolution of the silt production it should still be considered in the present study the coincidence reflected in the two figures (Figures 4 and 5): production of silt increased in the river basins affected by deforestation and decreases the production of sediments in relation to leaking ponds where the forest area increased. Even if the factors set in motion alluvial materials are the climate and hydrological, who contributed to decreased resistance to erosion and implicitly to easier availability alluvial material is the way of development of forest areas.

4.2. The evolution of land use in distinct periods

Regarding the evolution of the use of land in Romania we can say that in the last hundred years there have been significant changes in political regimes with effect over the use of land. We refer here to the period after the Second World War until the early collectivization of agriculture by the communist regime, during collectivization itself and the period after 1989, when the regime of the lands has changed. Studies of human and economic geography **(Erdeli & Cucu, 2005)** points to some particularities for each of these periods. If the first and second period show some similarities represented by the fragmentation of agricultural parcels and excessive deforestation in some regions, the collectivization period is marked by the union of large areas of agricultural land, drainage and drainage of land for agriculture, numerous measures to combat soil erosion, afforestation in certain areas affected by erosion (ex. the Putna Vrânceana basin). Thus, given the above, we will try in the following to realize an analysis of the evolution of alluvial production against leakage using the same method of cumulative curves for each period described. Given the database we have, we split the time series of the flow of silt into three periods corresponding to the above, as it follows: 1950-1969, 1970-1989, 1990-2009. Should be noted that all three periods benefited from hydro-climatic events excessive - floods and droughts (Mustățea, 2005; Olariu et al., 2009) and major earthquakes, at least the last two periods (1977, 1986, 1991), with effect in triggering or reactivation of major landslides (Bălteanu et al., 2010; Mărmureanu et al, 2002).

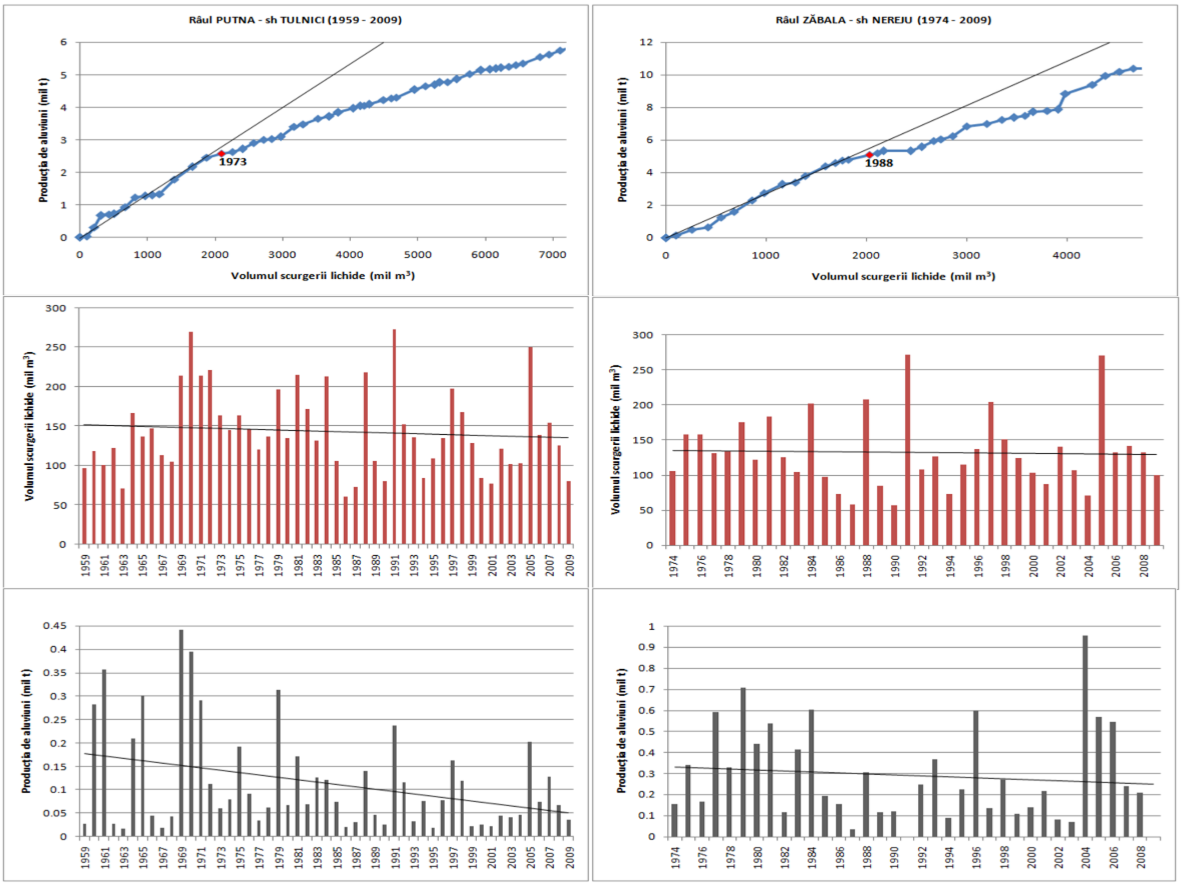

Figure 6. Cumulative curves of silt production and liquid flow at the hydrometric stations Tulnici and Nereju

To analyze in detail these periods, we constructed cumulative curves at hydrometric stations where data streams of time series allowed us this. Figures 5.4 and 5.5 show how the evolution of annual silt production against leakage. Although these figures are only presented results from three gauging stations, we can say that the same results we have seen in over 60% of analyzed hydrometric stations. Thus in Figure 6 it can be seen very clearly how the second period (1970-1989) the production of silt and leakage similar evolved without major changes were part of another for the first period and for the second half of this period of alluvial production began to decline in relation to leakage.

First period and the third is marked by increases in the production of silt against leakage. If for the first period the specific data on the evolution of forest areas were arable are missing, although overall progress is known, for the third period these values could be calculated (Figure 1). The increased production of silt from the third period against leakage coincides with deforestation occurred after 1990 Siret basins tributaries.

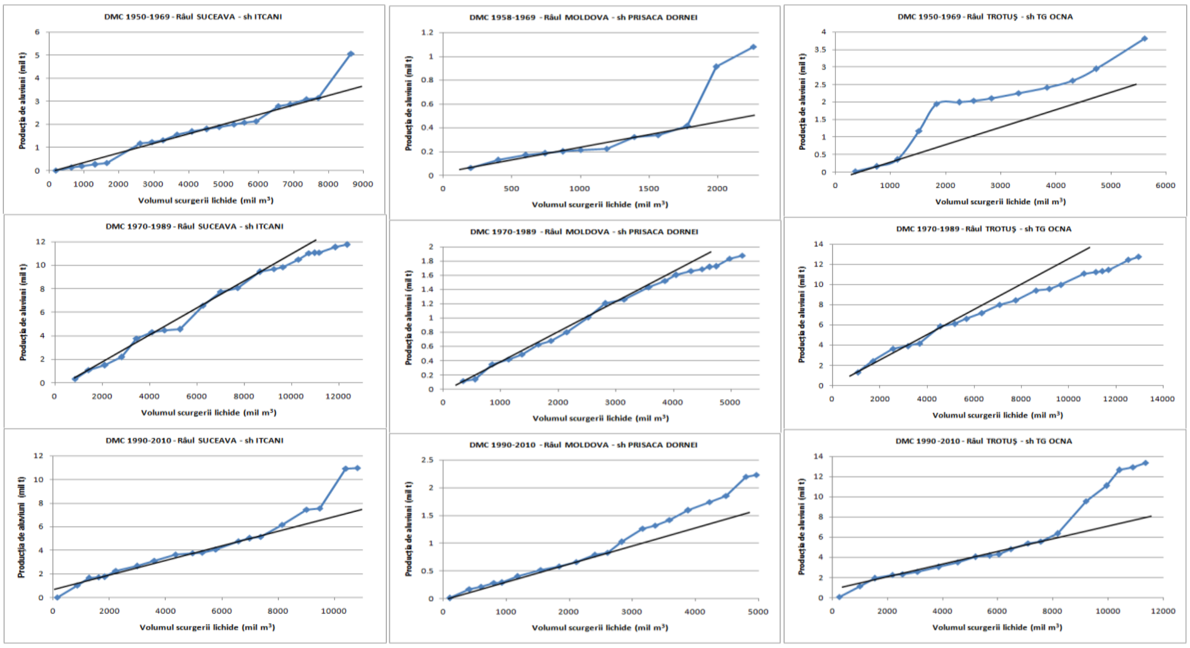

Figure 7. Cumulative curves of silt production and liquid flow in three periods (1950-1969, 1970-1989, 1990-2009) at the hydrometric stations Itcani, Prisaca Dornei and Tg.Ocna

CONCLUSIONS

-The largest areas are occupied by agricultural land at a rate of 43% (29% – arable land, 10% - agricultural land heterogeneous, 1,4% – vineyards and orchards, 2,8 – pastures and others) and forests in a ratio of about 37%. Other types of uses occupy each lower surfaces but all aggregate represent approximately 20% of the Siret river basin located in Romania.

- According to the methodology CORINE LAND COVER (www.eea.europa.eu) applied for the studied region, between 1990 and 2006, deforestation prevailed from afforestation, each selected hydrographical basin lost between 1 and 5% of the area covered by forests. Exception made the Putna River Basin which has acquired additional 3.6% wooded 16 and Buzau where forested areas did not change in the period considered. The result of this situation was felt in the production of silt: increases in river basins affected by deforestation and decreases the production of sediments in relation to leaking ponds that forest area has increased.

- Transportation of sediments along the drainage network shows maximum sensitivity to anthropogenic intervention. This is because any significant intervention in the area of production of sediments (hydrographical basin) is felt after a very short amount of sediment discharged from the basin in transit and that.

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