THE ROLE AND CONTRIBUTION OF THE FOREST RESEARCH AND MANAGEMENT INSTITUTE IN THE ESTABLISHMENT OF THE ROMANIAN SCHOOL FOR TORRENTIAL WATERSHED MANAGEMENT

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ABSTRACT

The forestry research conducted by the Forest Research and Management Institute specialists accomplished the conception of torrential watershed management due to four directions achievements:
1. The afforestation of the eroded terrains caused by water, sloughing terrains or/and the degraded terrains produced by the mining exploitations.
2. The forestry hydrology: determination of both the forest capacity for precipitations retention and the reduction of the overland flow.
3. The technical methods of torrent control: realization of economic dams.
4. The hydrology of small torrential watersheds: elaboration of the prediction methods for net storm rain, maximum discharge and for the sediment production.

Key words: torrent control, management of torrential waterheds (MTW), degraded land

Romanian scientific research in the management of torrential watersheds (MTW) has started in 1933, once the Forest Research Institute was established, and was developed and diversified in parallel with the evolution of the MTW concept, with its outline at the end of the 6th in the last century as a result of the cooperation of the Institute for Forest Research and Forest Planning and the Brasov University.

The concept of MTW presented in the Design instructions in 1959 (Gaspar and Apostol) and then, in the Norms from 1964-1967, has represented, as compared with the previous concept, a series of qualitative steps forward. Therefore, it was experienced a transition from the territorial working unit, improvement perimeter established based on administrative-conventional criteria, to the torrential watershed (TW), natural, morphological-hydrological unit; from the degraded land forestation (DLF) to the more

complex hydrological and antierosion organization of the territory, which is substantiated on hydrological studies and aims, beside the restoration of the forest vegetation on eroded lands, at the enhancement of the hydrologic potential of the other area in the watershed, including forestlands; transition from the attempt to consolidate the gullies and ravines with easy works, most of them temporary to the management planning of the entire network of degraded bedrocks through solid highly stable works. Beside the rehabilitation of the degraded lands it was considered the protection of the environment and of the social-economic objectives threatened by high flood waves, etc.

The researches on the management of torrential watersheds had four main directions, as it follows:

FORESTATION OF LANDS ERODED BY WATER AND SLIDING, DEGRADED BY CONSTRUCTION, MINING AND INDUSTRY

These lands, beside their low or inexistent productivity, represent the main sources of alluviums polluting the rivers.

The results of scientific research for the forestation of these lands are mostly the following:

- Creation of a high number of experimental plantations, under various site conditions, where many forest species were used for research sake (to validate or not the experimented solutions) and for demonstration sake (to be used as models in production), in areas highly affected by erosion processes, like: Vrancea, Macin Mountains, seaside, Southern Carpathians, Apuseni Mountains, Bistrita watershed (C. Traci, E. Costin, E. Untaru, N. Bogdan, etc.);
- The development of a site mapping method for lands eroded by water (Traci, 1985) and affected by sliding (Untaru, 1979). The various site units can be integrated in a system that considers the main features of the relief, the soil lythological substratum, including the potential trophicity and the erosion status (for eroded soils), respectively the manner in which the ground moves and its structure (for sliding), by series of site types, from steppe and forest-steppe to sub-Alpine area. Each site type has a symbol that is connected to the entire technology for creating the forest vegetation:
- Establishing several consolidation operations for lands affected by a high mobility, in order to install the forest vegetation (fences, benches, vegetally reinforced terraces, etc.), retaining the water on slopes (ditches, cone-shaped holes), for collecting and evacuating the excess water from the slopes;
- Application of technologies for land preparation before forestation (plowing, terracing, shaping) and of planting technologies including in nutritive pots or polyethylene bags, as well as seedling production in different containers;
- Establishing the suitable forest species, regeneration compositions, thickness cultures, tending operations, by different site types and management methods for the stands created there;
- Evaluating the impact of forest plantations in the improvement of site condi-

tions by developing the humus stratum and the consolidation of the instable lands bz the root network

 Assessment of the direct economic impact on the stands set up on degraded lands by evaluating their wood volume (C.Traci, E. Untaru).

MANAGEMENT PLANNING FOR TORRENTIAL BEDROCKS

It was inspired by the methods used in the western countries located around the Alpes (France, Austria, etc.) methods adjusted to the natural and social-economic conditions in Romania. Starting with 1958-1960, the use of woodwork (wattlework type) and dry brickwork was restricted, due to their low resistance and efficiency and the use of transversal and longitudinal works made of cement and concrete with mortar became a general. Due to the high number of torrents to be corrected each year, to the high number of objectives to be protected (lakes, roads and railways, human settlements, etc.) the conclusion was that a lot of embankments for torrent correction are needed.

This situation lead to the occurrence of a innovation movement in research, in design and higher teaching, with the aim of reducing the costs for embankment building in the same time increasing its technical efficiency. **Consequently, tens of original embankment types have been conceived together with improved variants of classical types.** There was a transition from big heavy works to slender construction structures. It was expanded the use of prefabricates and the mechanization of several operations on working sites for torrent correction. The emergence of new work types was also possible due to the revision and rationalization of the computation methodology for the constructions by reducing to the minimal limit the safety coefficients to rollover and sliding; by **admitting the stretching efforts in the concrete and mortar brickwork, by removing from the computation the loads occurring in rivers with permanent high flows and high embankments, but which are to be neglected in valleys with temporary or low flows** where torrent correction works are applied and which have a low height; by using soil to increase the stability of embankments and to reduce the hydrostatic pressure, etc. Economic embankment types have been built on many torrential areas. Some of the new embankment types used in Romania were conceived and built by R. Gaspar, C. Avram, N. Gologan, Necula, Voiculescu S., Munteanu, I. Clinciu. The cutback of materials, work costs resulted from the use of the new embankments represen-ted about 30-50% compared to the classical embankment used in 1950.

A permanent concern in research was the survey of the static and functional behaviour of torrent correction works (embankments, channels), especially of the new type during high flood waves and for along time, which allowed the maintenance in design only of the resistant, stable and economic works whose functionality was in accordance with the aim. Therefore, the use of light prefabricates and filtering embankments made of reinforced concrete beams decreased, the use of soil embankments was restricted, structural changes were made in energy dissipaters and other types of channels.

FOREST HIDROLOGY

The main reason of the researches was to establish the importance of forests for hydrology in flood situations and consist in definition of some terms from water balance equation like the retention of the precipitations in the canopy and in litter and the surface runoff.

Storing in canopy (due to the interception by the foliaceous apparatus and by the branches of trees), was determined on the main forest species (spruce, pine, common beech, oak, robinia etc) trough the measurement of the precipitations in open field and under crown of the trees (Arghiriade, 1960 and 1968, Abagiu, 1960 and 1973). As a result the precipitation layer retained during a rain, by the canopy of tree, is rising together with the precipitation layer and tend to a boundary value named the maximum capacity of storing precipitations. This capacity depends on species, the consistency, the age of stand etc. and varies between 8-12 mm on the mature tree and important rain. The **effective storing** can be 3-4 mm if the rain doesn't exceed 10 mm and about 8 mm if the rain totalise 40 mm on a maximum storing capacity about 10 mm (Abagiu, 1973). During the floods, interception is reducing significantly (Gaspar and Untaru, 1973).

The young cultures, till the canopy closure, in downpour and storm situations realise an effective storing very low (just 1 l/m2 , experimentally determined by Arghiriade, 1968).

Storing in pin litter was establish experimentally by Abagiu, 1973 and varies with the dimension of the litter layer (much bigger then other species), has high values but in fact the storing capacity doesn t exceed 1-1,5 cm water to 1 cm litter layer.

Researches over the surface leaking were made inside of the **leaking plots** placed on the slopes with different land use (forest, grassland, arable) the water being collected in tin containers (Arghiriade, Abagiu, 1960) and inside of the **torrential watershed very small** covered by forests and equipped with turnovers (Abagiu, 1967). As a conclusion the water flowed varies with the layer precipitations and is smaller in forest.

Hydrologic importance of the forest in long rains was determined starting of some researches made in 255 small basins (under 100 km2) from the higher basins of Somes and Mures, marked by the high flood waves in mai 1970 (Gaspar and Abagiu, 1974). On 60% of basins the precipitations totalised between 40-130 mm, lasting 2 days and had a small intensity (under 0,1 mm/min).

The medium flows specific (q, $m^3/s.km^2$) were included between 0,1-9,5 m3/s.km2 being so high with:

- basins surface was smaller
- precipitations amount (h, mm) was bigger: on h<50 mm, q=1,17 $m^3/s.km^2$ and on h>75 mm, q=2,43 $m^3/s.km^2$;
- percent of forest in basin (F/S) was smaller ; on F/S>0,25: q=2,90 $m^3/s.km^2$ and F/S >0,75: q=1,46 $m^3/s.km^2$;
- consistency of stands (D) was smaller; in basins with over 50% forest (F/S>0,5) the result was: D=0,6 :q =1,97$m^3/s.km^2$, D=0,9 : q =1,01 $m^3/s.km^2$
- the afforested area with those occupied by young stands (under 20 years) was

higher

The flood waves had mainly the following causes: the amount of precipitations was over the surface storing capacity and the accumulation power of the water in soil; existence of a snow layer; previous rains; the simultaneity of flood and the minor evacuation capacity in bed of the rivers.

HYDROLOGY OF THE TORRENTIAL WATERSHEDS

The management of torrential watersheds asks knowledge of some hydrologic parameters of basins, which give the volume, and the characteristics of works like:

- precipitation layer from a certain long rain and annually established
- maximum of flow capacity generated by rains
- the amount of alluvial deposits transported and evacuated from the basin and on torrential rains with 1% probability

These parameters are useful for the estimation of hydrological and antierosion effect of MTW works system and should be determined trough the statistics and mathematics methods if there were measurements over 15 years, but this solution is practically impossible. Thus the only solution is the **elaboration of some indirect calculation methods** of these hydrological parameters starting from the dangerous precipitation and the characteristics of basins, these methods are based on **researches in pilot basins.**

In this way were selected about 15 main torrential basins where there were unsilting dams, 9 of these being equipped with pluviometer and hydrometric instruments used for systematic measurements over 12-15 years (Gaspar, 1967-1985).

Starting of these researches was made a system with original methods checked in pilot basins like:

 Method of the accumulation power (Gaspar 1988-1997a) for evaluation of the amount of precipitations storing on topsoil

 Method of active surface (Gaspar 1974-1997b), which give the possibility to evaluate the waterflow

 Method of overloaded (Gaspar 1998-1999) for evaluate the alluvial deposits proceed from bed of the rivers in every rain and annually

At the same time, the other results of researches (Gaspar, Untaru and Cristescu) are:

- the amount of precipitations and the structure of rain have a major role for the siye and the aspect of flows hydrograph, no matter the shape of basin and the percent of forest
- texture of soil is the most important characteristic of basin with a given surface
- in basins from mountain and hill area, covered by forests and grasslands, the network of beds river degraded (which doesn't t represent more than 2-5 % of the surface of basin), contribute with 70-90% to the alluvial deposits, especially if it is affected by land slip and landslides (Gaspar, 1974).

Under the estimation methodology for hydrological and antierosion efficiency of

MTW works (Gaspar 1974) was determined the effect of management watershed works on 7 torrential basins (Traci, Gaspar, Munteanu, 1980) with the following results:

- storing on topsoil of precipitations is increasing with 34%
-the volume of flood having 1% probability is reducing with 15%
- the maxim flow Q_{max} 1% is reducing with 29%
-the specific erosion on slopes has decrease with 41% and the medium erosion on slopes with 38%

The implementation of the researches results requires the involvement beside the planning engineers teachers, administration people, workers and researchers. They had given technical assistance on execution stage.

In this speech I was referring , shortly, to some of the research achievements in this topic. The results of the Romanian school for the management of torrential watershed, were well known on international level and are provided on the results of specialists from research, education, design, administration and construction involved in protection of social and economics local and national objectives.

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