DEVELOPMENT OF THE SMALL CARPATHIAN CATCHMENTS FOR THEIR RETAINING CAPACITY INCREASE

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Introduction

In the recent years the significant increase of amplitude of extreme events like floods and draughts are observed, they are due to the climate changes but as well to the human activities in the river basins. In the Polish Carpathians recently we observe the abandon of traditional agriculture in consequence disappearance of the field borders, mechanical methods of the forest exploitation, the increase of impervious surfaces as urbanization, roads and etc, provoked land, gully , torrent erosion and land slides, accompanied by increase of the surface runoff and in consequence flood peaks increase. The same occurred in the torrents beds where were situated hydraulic control structures like sediment check dams , sills and often accompanied by concrete canals.

Catchment management

Traditionally flood problems were mono-objective and turn to the local flood protection, and often they disturbed river dynamics and ecosystems. With growing attention of ecology as well as flood protection arose the "Dynamic Slow Down" concept (Le Ralentissement…, 2004). DSD aims at solving flood and erosion issues in the scale of the whole catchment by the increase of its retaining capacity, wherever possible. The DSD was applied to the lowland water basins but up till now there are a few attempts to study its feasibility in the mountainous ones.

In the mountainous area there are possibilities to change the agriculture use of lands – meadows with hedges on the field borders, to introduce following types of small structures –small temporary ponds called "water traps", transferring trenches to re-direct overflows to the safe thalwegs, water infiltration trenches, construction of existing forest roads by introduction of the transverse slope opposite to the hill slope, to cut the gullies by transversal barriers

In the river bed the increase of the storage could be obtained by construction of dry reservoirs and where it is not harmful for the river corridor (Figure1).

Case studies

The authors made a feasibility study for DSD works in 7 Polish Carpathian torrents catchments: two catchments in Beskid .Trzemeśnianka (1) and Kamieniczanka (2), 4 in Podhale Region – commune Poronin (3): Suchy, Bustryczański, Nosków and Florków Torrents and the last one in Beskid Żywiecki Isepnica Torrent (4) (Figure 2).

The authors tried to asses the effect of different combinations of the hill slopes works. The all catchments are ungauged and number of data is limited, therefore the choice of mathematical models to use for the study was limited (Figure 3)

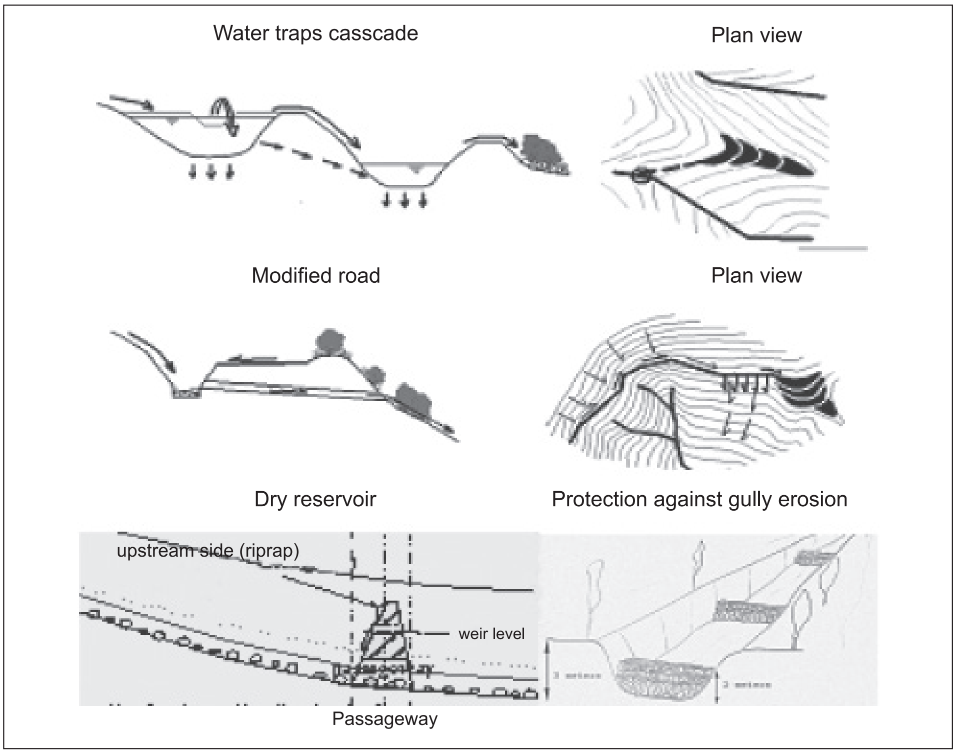

Figure 1. DSD cachment structures

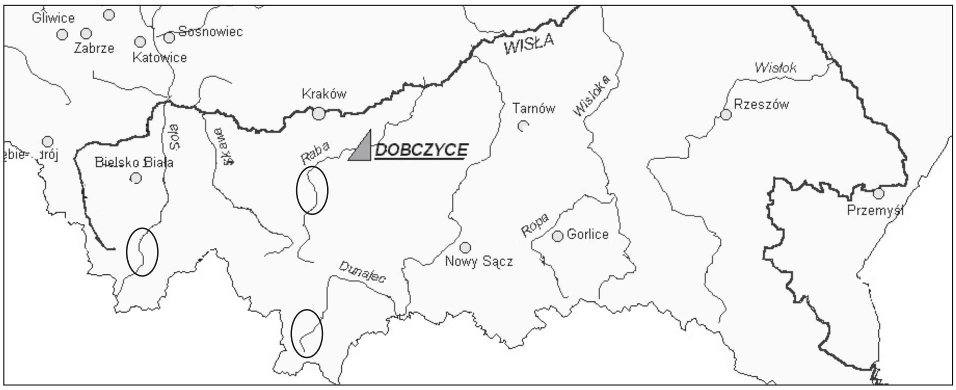

Figure 2. Location of the studied catchments

Development of models Roof and Pipe and OneSecond

The review of existing hydrological models precipitation-runoff showed that it was difficult to find suitable one for our assumptions and rather easy to apply for the forecast goals. The complex hydrological models demanded too many data which are unattainable in the ungauged catchment. Therefore we developed relatively simple models for that purpose- Roof and Pipe and OneSecond (Poulard *et al.*, 2004). We assumed the most disadvantageous condition like catchment completely unable of any seepage (soil saturation and wet surface) and the intensive - storm type precipitations. In the models the complex topography of the slopes was covered by very dense irregular computation net (fixed in R&P depending of topography in OnrSecond) which allows to locate the small retention structures. The both models are distributed parameter models, the difference is that the Roof&Pipe model is very quick (ten minutes for one run) and the introduction of the new management scenarios is very easy, OneSecond represents more exactly the physical nature of the runoff but takes more computer time).

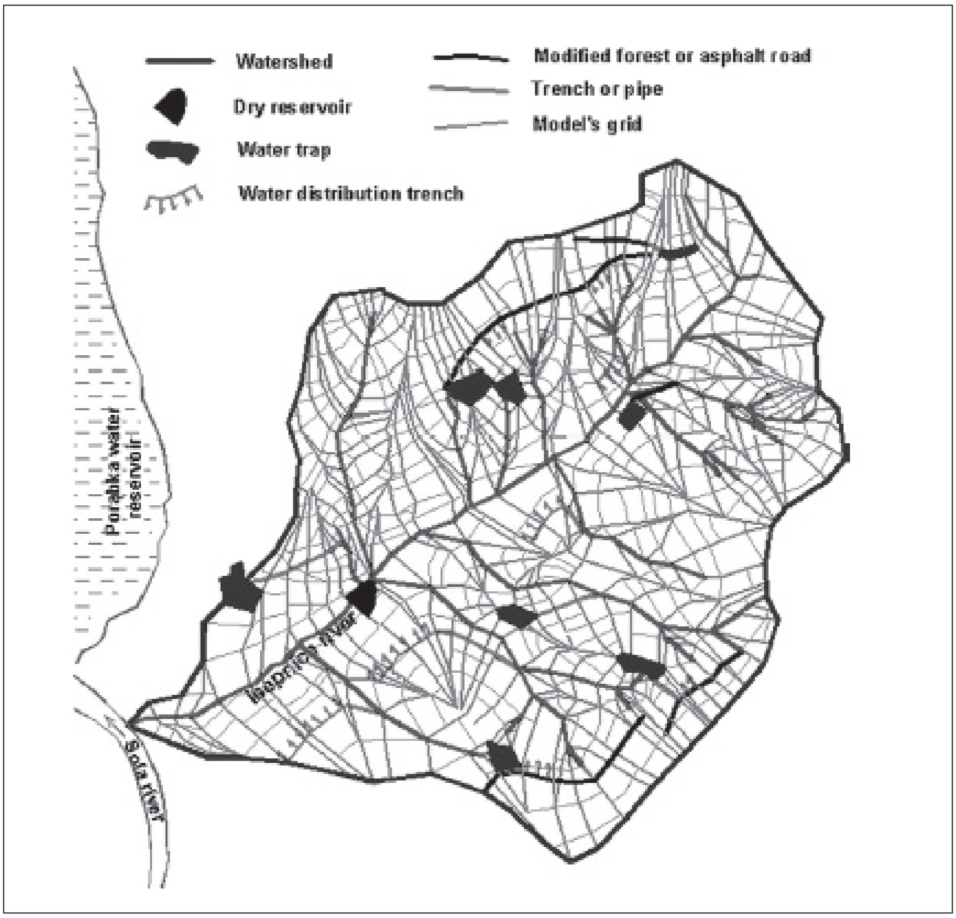

Figure 3. The Isepnica Torrent catchment with computation net and proposed SlowDown structures.

In the main torrent the Roof&Pipe model was coupled to a ID St-Venent hydraulic model RubarBe [3]. This coupling permits introduction the hydraulic control structures in the main stream, and the calculation of supercritical and subcritical flows which occur in the mountain streams, and introduction of distributed runoff flow into the river reach as well as the punctual inputs. The Rubarbe Model permits to calculate a sediment transport.

The results of computation

The most complete computations with the St-Venant' flood routing were used in the case of Isepnica Torrent, for the remaining study cases the simplified routing was applied. Different scenarios of catchment works and reservoirs were studied in the case 1, 2, 3 in the Podhale catchments, very small and steep only the combination of small reservoirs were envisaged.

The results of the small structures efficiency is shown in the Figure 4 and the Table 1. In the case of Isepnica Torrent the study of changing the sediment check dam to a dry reservoir (Łapuszek, Paquier, 2007).

Conclusions

– The SlowDown structure can effectively reduce the danger of the gully erosion and land slides;

– the impact of the small catchment works is significant for the flood mitigation and flattening of the wave peaks and could reduce the use of heavy hydraulic structures in the torrent bed;

– for the protection of urban areas the small SlowDown structure are insufficient and the integrated concept of small works with the dry reservoirs seems to be the best solution.

Table 1. The wave peak reduction in % by DSD structures

Stream	Catchment Area [km^2]	$Q_{max\ 1\%}$ $m^3 \cdot s^{-1}$	Structures of DSD % of Q_{max} reduction	
			Dry reservoir Q_{max}	Water traps
Isepnica	7.8	41	76 61	70
Florków Potok	1.36	27	41	-
Suchy Potok	6.58	64	36	-
Bustryczański Potok	5.05	51	39	-
Nosków Potok	1.41	30	40	-
Kamieniczanka	5.23	18	33	44
Trzemeśnianka	1.59	21	38	48

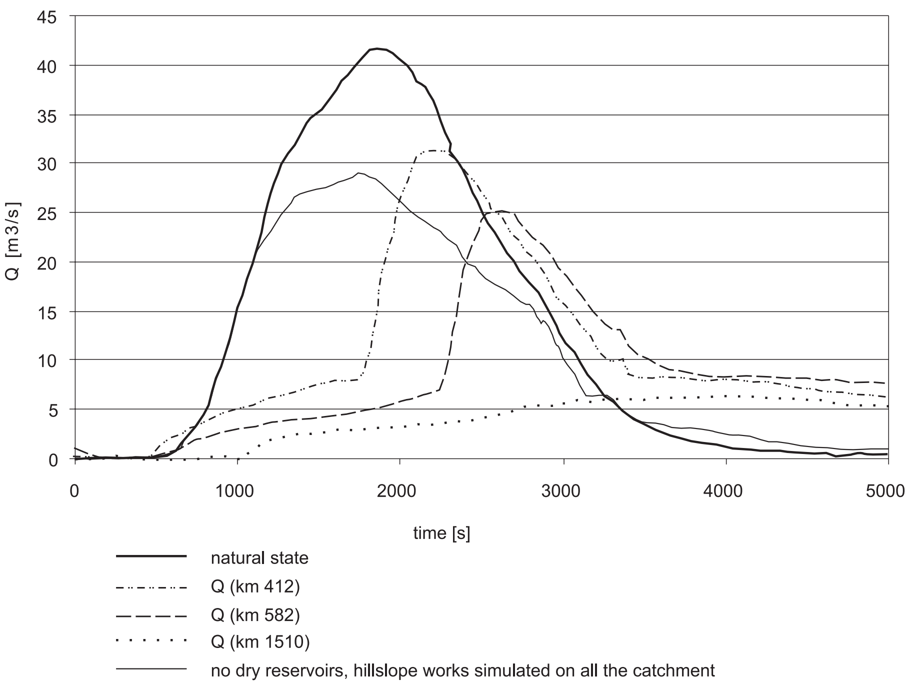

Figure 4. The flood waves hydrograms

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