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DEBRIS FLOWS IN KAZANLAK VALLEY, SOUTH SLOPES OF THE BALKAN MOUNTAIN RANGE, BULGARIA

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Abstract: Along the Balkan slope of Kazanlak valley there are active debris flows. They are formed in small basins and increase the relief-dissection rate. Their activity is related with deforestation of this area, especially strong during the end of the Medieval period. The fortification of the streams along the south slope of the Balkan Range was a state policy when a Department of Forestation was founded (as department of the National Agency for Torrents Control) in 1904 in Kaznalak town. This research was taken during archeological excavations, when layers stratification around Thracian moulds showed typical alluvial fan gradation. The aim of this study was to characterize the streams, their type, their deposits and their forms of accumulation (using grain size analysis), and to estimate the forestation as prevention activity. The results showed that debris flows in Kazanlak valley are incoherent, the size of their sediment forms is not large but they were fortified very effectively and in present days they are not active.

Key words: Kazanlak valley, colluvial fan, debris flow, erosion, forestation

Introduction

In 1861, in the northern part of Kazanlak valley, few little streams – Novomagalenska River (IV order Strahler, 1952) and others smaller, which came from the Balkan slope, overflowed. They changed their directions and caused a huge catastrophe to the local economy. Historical chronics are telling about a large quantity of stones, sand and water, which buried houses in Izvorovo and Enina villages, the northern districts of Kazanlak town, orchards and rose gardens. All these streams belong to Tundzha River catchment. They all have torrential character; act as debris flows and the area they affect has 327.6 km2. Since then there has not been recorded such massive catastrophe on Bulgarian territory.

Deforestation of the southern slopes of the Balkan Range started during the Ottoman Empire (for this country - until 1878). Because of the Russian-Turkish

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war and the battles here, deforestation became massive and after that the agricultural cultivation took their part. Because of deforestation stream erosion was a problem and all the rivers on the Balkan slopes were debris flows. Their activity was varying every year but they always been a treat to the local economy. In 1905 a State department for torrents control was established and in concerned localities were organized so called “Erosion and forestation control offices”. The first of them was established in Kazanlak town.

The name of the French engineer Felix Vogeli was involved (he was invited by Bulgarian government in 1904) with the fortification activities of the Erosion and forestation control office in Kazanlak town. He already had experience with erosion control activities in French Alps and he was an expert in this area. He worked in Kazanlak town for six years and he had trained a Bulgarian team. He arranged studying of young Bulgarians in France, where they practiced with him and after their return in Bulgaria (1913-1944), they continued his work.

Since then a large bibliography for erosion control was created but there have not enough geomorphologic sources for debris flows type and deposits, which build the joint debris and alluvial fan.

In our research we have studied the Balkan tributaries of Tundzha River in Kazanlak valley. Their characteristics and erosion control assessment were aims of our researches.

Study area

The following petrographic types, which build the Balkan slope and the valley, are present in the studied area:

– Precambrian migmatites and stripe gneisses, gneiss-schist and amphibolites from Arda group. Spots of them could be observed on the Balkan slope.

– South Bulgarian granites from Ist complex (Hisarja pluton) - Carboniferous, which build the main part of the slope – quartz-diorites, granite-diorites, diorites and granites.

– Pleistocene-Holocene proluvium and diluvium, angular and subangular fragments in clayish-sandy matrix.

– Proluvium – debris fans with subangular fragments and clayish-sandy deposits.

The study area is part of the Continental-Mediterranean climatic zone (Ratchev & Nikolova, 2009). The mean year precipitation is 550 - 600 mm (Kazanlak climatic station) with maximal amounts in May-June-July period, when the catastrophic events usually happen. In catchment area (Shipka peak – 1328,9 m) the main year precipitation is 750-800 mm[5].

This area is part of the hilly (290 - 420 m) and low - mountain (420-800 m) environments (Galabov et. al., 1982). Here the Sub-Balkan fault causes the contemporary seismic activity (Kanev, 1989) and therefore the active erosion processes. All the rivers belong to Tundzha River catchment. Biggest tributary is Eninska (Stara) River (V order Strahler, 1952).

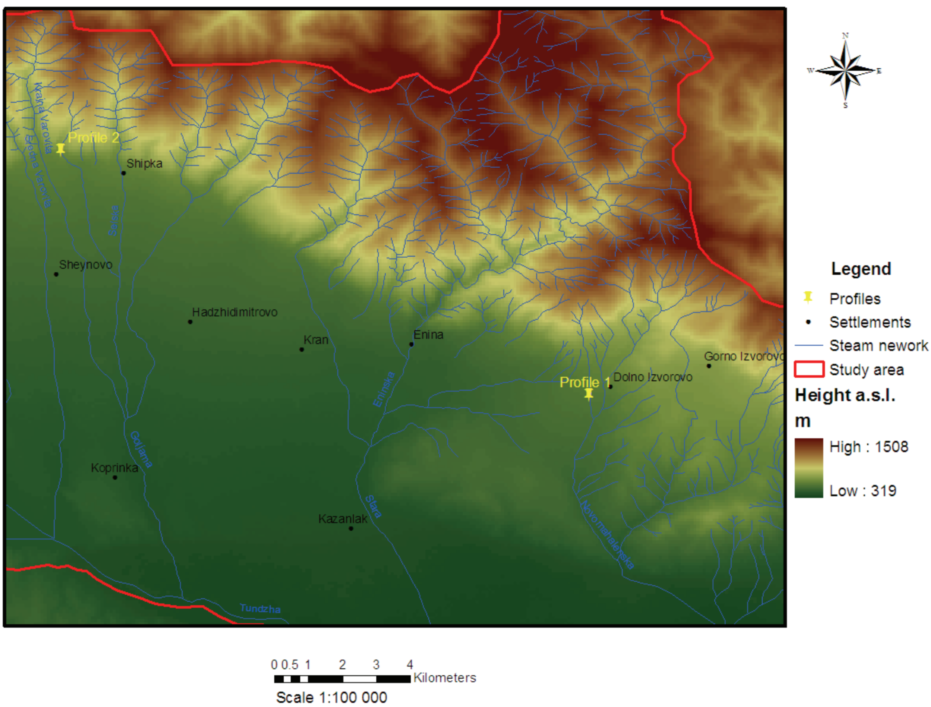

Figure 1. Map of the study area

Materials and methods

Two sites were studied with field observations and sedimentological analyses. The first site is at the stream fan of Novomahalenska River, which was formed in XIX century (Baltakov, 1978). The second one is in the fan of Gratzkoto dere River, which is tributary of Goljama River. There are indications for its torrential regime, but there was no evidence for its channel change. We have analyzed alluvial deposits from streams fans and channels. We used grain size analysis (Pettijohn, Potter & Siever, 1972; Serebrjanij, 1980) for deposits characteristics.

Results

Profile 1 is located in the eastern part of the studied area. Novomahalenska River springs from 1200 m and at this place is of IInd order Strahler, 1952. During its overflowing in 1861 it accumulates deposits at 150-200 m south from present villages Dolno Izvorovo and Sredno Izvorovo. After that, it changes its course to west direction, and after 4.6 km mouths into Eninska River, which devastates agriculture land and settlements until it mouths into Tundzha River. There are data for victims and died cattle (Mandzhukov, 1979).

In the next 20 - 25 years several similar cases were described. According to Mandzhukov (1974) little tributaries were acting together with the bigger ones and they all totally change the landscape of the Balkan fence of Kazanlak valley in a wide belt of 500 - 1500 m. Local people restored the river channel after its overflowing, fortified the river banks with levees and plant poplars on them (Baltakov, 1978). Here was the first erosion control activity, which was taken and funded by state institutions. These activities were the following: river banks fortification with levees construction, stone thresholds construction in the river channels and their forestation with deciduous trees (poplar, acacia, oak) and forestation of the slopes with coniferous trees.

During excavations of a Thracian mould in this area we have found that the sediments deposited from such overflows increased the surface level from 40 cm to over 2-3 m. Present day’s surface is sloping lightly with 3-4o southwards, which means that the surface inclination had been also reduced.

We have described the following deposits types during the field study of this area:

– Coarse materials (over 10-15 cm on short axis), which form piles on the surface and at 1,5-2 m in depth.
– Sandy layers.
– Clayish-sandy layers – usually on the top soil layer, which alternate with thin gravel and granule stripes.
– Clayish layers (over 2 m in depth) are thin (to 20 cm) and have gray and black colour.
– Single gravels (over 50 cm on short axis) of carbonates (mudstones) or granites/gneiss.

Profile 1 (N42°39′13,7″; E25°27′08,3″ - Fig. 2) is in the fan of Novomahalenska River, formed in 1861, in the place where it changed its course to west. There were no sedimentation interruptions along the profile. On Fig. 3 the grain size analysis results are shown.

Figure 2. Field description of Profile 1

– 0-36 cm: contemporary soil layer, clayish-sandy with inclusions of subangular gravel. Gravel's long axis is not in one direction;
– 36-175 cm: sandy with larger inclusions;
– 175-202 cm: sandy, lighter and more orange than the upper one, without large inclusions;
– 202–225 cm: sandy, black 2,5Y4/2 - dark grayish brown, with single gravel;
– 225 – 242 cm: sandy, the same as 175-225cm;
– 242 – 280 cm: sandy.

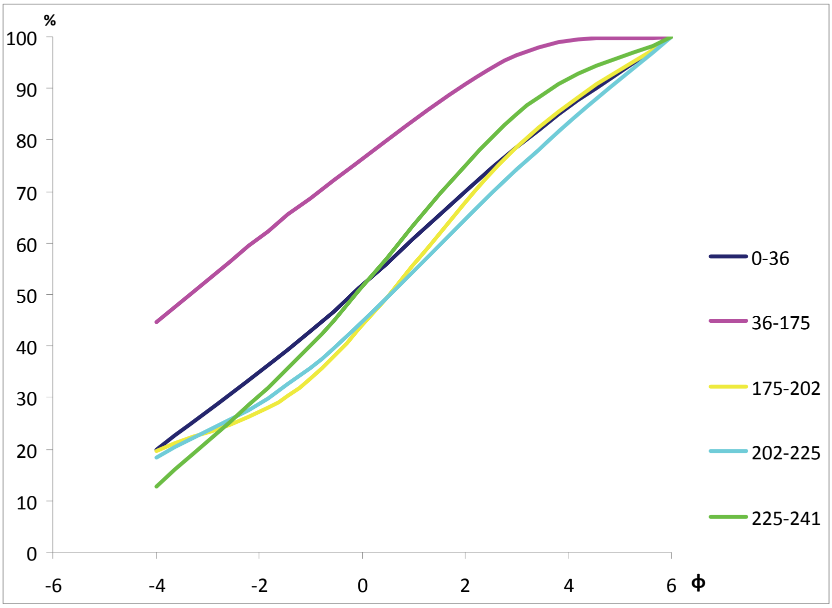

Figure 3. Results from grain size analysis of Profile 1

Alternation of different by thickness layers with different grain size characteristics, with subangular gravel and poor sorting, shows intensive erosion and accumulation of torrential steams. Results from sedimentological analyses show that layer 36-175 cm was accumulated during the overflow in 1861. It is possible part of the upper layer 0-36 cm to become from this overflow, but it was malformed by agriculture treatment (here has a lavender plantation). In the second layer fractions larger than 2 mm are nearly 70% and the sample is extremely poorly sorted. Below 175 cm the layers are part of the debris fan and we take the dark layer as a fan's periphery facies.

– Gravel analysis confirmed crystalline petrographic province (Table 1) and the high percentage of broken pebble – torrential character of the streams. Gravel shape shows that the type of transport was by dragging and by saltation.

– Novomahalenska River did not change its channel recently. Erosion control structures are stable and within them the river formed a new alluvial plain with 10 - 20 m width. Other forms beside the channel and alluvial plain could not be found. Grain size analysis data from the inlet of Novomahalenska into Karadere River showed good sorting and lack of coarse and broken material.

Profile 2 (N42°43′4,7″; E25°19′1,2″ - Fig. 4) is located in the west part of Shipka town. This is the upper edge of the mountain foot and the slope inclination is changing from 20 to 12^{o} from north to south towards the Kazanlak valley. We have studied deposits from the alluvial fan of Gratzkoto Dere River. It drains, together with Varovita River, the south slope of the Shipka passage. Here in July-August 1877 were the hardest fights of the Russian-Turkish war. Chronics are telling about the defense of the passage from the Bulgarian volunteer forces with stones, woods and even dead bodies. Photos from only few years later showed entirely deforested slope.

Gratzkoto Dere was fortified on several places with stone thresholds and forestation with deciduous trees. In the described profile we have found alluvial and debris deposits. Here the river has steep rocky banks with rock falls and taluses. All these forms are currently covered by woods and there hasn’t active slope processes.

Figure 4. Field description of Profile 2

– 0-60 cm: soil, sandy with subangular gravel and granules;
– 60-130 cm: sandy with more gravel quantity;

– 130 – 420 cm: sandy with more gravel;
– 420-560 cm: sandy with more gravel.

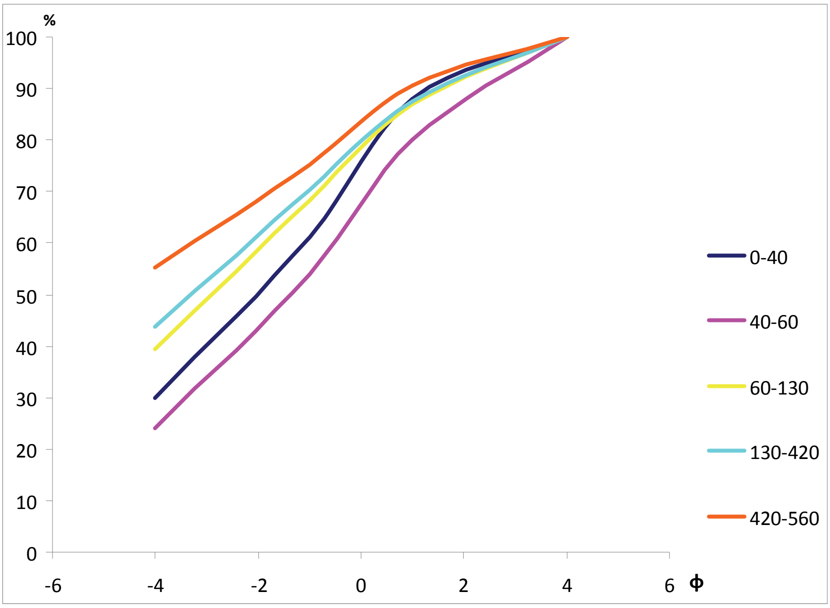

Figure 5. Grain size results from Profile 2

We presume that the uppermost layer was formed after the erosion control activities and the layers below – as a result of the torrential phase. Only from our data and without other evidence we could confirm that here the stream was acting as debris flow. We could not say if it was one overflow with several peaks or several overflows (which is more likely) in close intervals. Like in Profile 1 here we could observe alternation of layers, in which gravel and sand fractions are dominating.

Gravel analysis confirms the metagranite petrographic province, short transport and torrential character (Table 1).

Table 1. Results from gravel analysis in Profile 1 and Profile 2

	Profile 1 36-175 cm	Profile 2 60-420 cm
COUNT	22	64
MIN mm	a-18; b-14; c-12	a-16; b-8; c-2
MAX mm	a-92; b-61; c-41	a-105; b-95; c-47
AVERAGE mm	a-46; b-35; c-24	a-35; b-24; c-12
Petrography	granite	gneiss
Mean roundness	3,5	3,5
Broken pebble %	50	58
Predominate transport	dragging and saltation	dragging

Conclusion

Sedimentological analyses results confirmed the torrential character of the streams of the Balkan slope of Kazanlak valley in the end of 19th century. Quantity and proportion of coarse fractions showed that these debris flows were incoherent - with water, sand and gravel. The extreme gravel quantity caused their destructive effect. Other geographic elements do not suppose such catastrophic events. They were provoked by anthropogenic activities, mostly by deforestation.

The erosion control with stone thresholds is very effective in case of incoherent debris flows. These thresholds are leaking the water and fine materials and stop the coarse materials. They become more effective with forestation of slopes with appropriate to the height species (Baltakov, 1978). This is part of landscape reconstruction activities according to natural vegetation zones: in the upper steepest parts this forestation is with coniferous trees (*Pinus nigra*) and at the mountain foot – with deciduous trees (poplar, acacia and oak). With these erosion control activities almost all the evidences of catastrophic events were covered by woods.

Contemporary land use of the studied area is with technical cultures and most of all – roses for oil production *(Rosa damascena Mill)*. Roses become traditional from the middle of XIX century, when the territory of Kazanlak and Karlovo valleys were called Rose Valley. This tradition has been kept to our days. From the middle of 20^{th} century lavender (*Lavandula angustifolia*) also has been planting here. Both cultures need sandy soil with high gravel contents and little humus.

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