

Gavardashvili, Givi; Schaefer, Michael; King, Lorenz

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Debris Flows at the River Mletis Khevi (Greater Caucasus Mountains, Georgia) and its Assessment Methods

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Zentrum für internationale Entwicklungs- und Umweltforschung
der Justus-Liebig-Universität Giessen

**Debris Flows at the River Mletis Khevi
(Greater Caucasus Mountains, Georgia)
and its Assessment Methods**

by

Givi Gavardashvili^{*}, Michael Schaefer^{**}, Lorenz King^{***}

No. 32, Giessen, August 2007

^{*} Georgia LPPL Institute of Water Management,
0162 Tbilisi, 60 Ave. Chavchavadze, Georgia.
E-mail: givi.gava@mail.ru

^{**} Center for international Development and Environmental Research (ZEU)
of the Justus Liebig University Giessen, Germany.
E-mail: Michael.C.Schaefer@zeu.uni-giessen.de

^{***} Institute of Geography and Center for International Development and Environmental
Research (ZEU) of the Justus Liebig University Giessen, Germany.
E-mail: Lorenz.King@geogr.uni-giessen.de

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Abstract

The erosional debris flow processes on the right side of the riverbed of Mletis-Khevi, a tributary of the Tetri Aragvi, are assessed on the basis of field and laboratory studies. The values of the mountain slope erosion in the Mletis-Khevi catchment area have been determined on the basis of field studies, taking into account the time factor and the extent of slope damage. Dependences are derived by means of the maximum discharge of debris flow of various intensities. Furthermore the volume of transported debris flow mass is calculated. A physical-mechanical and chemical analysis of the debris flow mass has been carried out in the laboratory. The results can be used at a subsequent stage for predicting the various basic characteristics of debris flows.

Key-words: debris flow; discharge; erosion coefficient; catchment area.

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1. Natural disasters in Georgia

At the end of the 20th- and the beginning of the 21st century, an increase in the frequency of natural disasters has been recorded on our planet, in Europe as well as in Asia (**Lorenz King, Martin Metzler and Tong Jiang, 2000**), America or Australia (**Osipov V.I., 2003**), causing great damage to the world economy, and the population. Unfortunately, human losses are considerable too. Catastrophic hazards include floods and tsunamis, droughts, storms in tropical as well as mid-latitude regions and mass-wasting processes, e.g. avalanches, mudflows and rock-falls.

Georgia in the South Caucasus is no exception, as the frequency of natural calamities has also been attested there. The principal reasons are both the global climate change and the wrong reclamation of areas in mountains and foothill landscapes (**Mirtskhoulava Ts.E., 1998**). In Georgia mountain landscapes occupy 68 % of the country's territory, the total area is 69.7 thousand km². In mountain landscapes, 87 % of the mountain slopes are characterized by water resources which constitute approximately 100 km³. The annual runoff of 26-thousand large and small rivers of Georgia is 56.4 km³, and the water runoff from other countries (Armenia, Turkey) is 8.7 km³, with the total summary index of 65.1 km³. The remaining 35 km³ comprise glaciers, lakes, reservoirs and swamps (**Svanidze G.G., Gagua V.P., Sukhishvili E.P., 1987**).

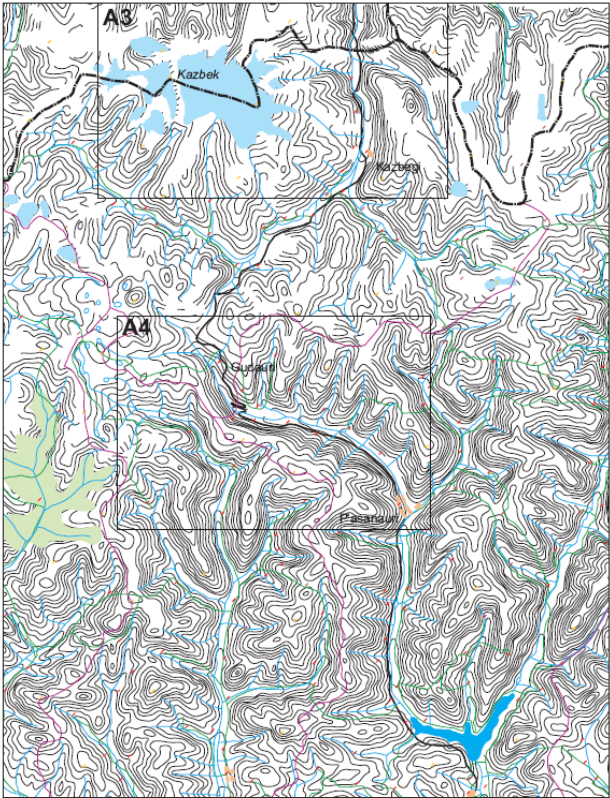
The studies carried out have shown that more than half of Georgia's entire area experiences strong natural disasters. The impact of debris flows (mudflows) constitutes 30 % of the entire territory. In the years 2000-2006, Georgian territory was a catastrophic area in terms of strong action of mudflows, as indicated by the geography of natural disasters. None of Georgia's regions was by-passed by natural disasters which destroyed bridges, dwelled houses, churches and monasteries. Regrettably, there were human casualties and loss of lives stock as well. According to expert estimates, the losses inflicted exceeded several dozens of million USD.

Debris flows have passed at the Pasanauri-Mleta section of the Georgian Military Road which is the catchment area of the river Tetri Aragvi (cf. Figure 1, 2 and 3). In 2003 the road marked its 200th anniversary. It is the shortest automobile highway between Russia and the three South Caucasian states: Georgia, Azerbaijan and Armenia (**Gavardashvili G.V., 2002**).

Figure 1: Physical map of Georgia with location of study area.



Figure 2: Topography of the study area between Jinvali reservoir and Kazbek Mountain.



Draft: M. Schaefer
Cartography: B. Goecke

Figure 3: Satellite picture of the working area between Jinvali reservoir and Kazbek Mountain (Google Earth 2007).



2. The catchment area of the river Mletis - Khevi

The Tetri Aragvi catchment area can be called a natural laboratory, where several debris flows are recorded almost annually. The material presented in this paper is mainly based on the results of field studies carried out over the last decade.

Almost all right-bank tributaries of the Tetri Aragvi have debris flow character, and especially the Mletis-Khevi is hazardous. The statistical number of debris flow occurrence on the latter stream exceeds 150 from 1897 to 2006 inclusive.

Since the year 2000 almost annually 2-3 major debris flows have been recorded on the Mletis-Khevi, causing considerable hazards:

- a) to the normal functioning of the Georgian Military Road;
- b) to the residents of the village of Kvemo Mleta;
- c) to the Mleta church of the St. George, built in 1896, which is on the verge of destruction.

Photo 1 shows the general view of the Mleta church in 2003, while Photo 2 shows the same church in 2006 after the passage of a debris flow.

Photo 1: General view of the Mleta church on May 26, 2003. (Gavardashvili)



Photo 2: General view of the Mleta church on April 23, 2006, the churchyard is totally filled with a 3 m high debris flow mass. (Gavardashvili)



3. Assessment methods of debris flows and results of the field study

The results of the field studies, carried out on the right-bank tributaries of the Tetri Aragvi, are given in Table 1.

Table 1: Data of field investigations in the catchment of the river Tetri Aragvi.

No	Name of the river	Catch-ments basin of river F_0 (km ²)	Gradient of river i	Slope erosion coefficient (E)	Erosion class (by R. Morgan scale)	Erosion rate per year (t/ha)	Maximum charges of debris flow $Q_{\max}$ (m ³ /sec)
1	2	3	4	5	6	7	8
1	Mletis Khevi*	1.28	0.260	1.13	Fourth	10-50	131.0
2	Tsiskvilt Khevi	1.50	0.251	0.89	Third	5-10	87.0
3	Kotoras Khevi	0.62	0.290	1.62	Fifth	50-100	98.0
4	Arakhvetis Khevi	1.45	0.216	0.96	Third	5-10	109.0
5	Kimbarianis Khevi	0.60	0.220	0.95	Third	5-10	70.0
6	Nagvarevis Khevi	6.50	0.247	1.00	Fourth	10-50	387.0
7	Chokhelt Khevi	6.96	0.290	0.95	Third	5-10	550.0
8	Zemo Amirt Khevi	1.87	0.264	0.92	Third	5-10	200.0
9	Kvemo Amirt Khevi	0.96	0.310	0.73	Second	2-5	140.0
10	Chadistsikhis Khevi	1.30	0.360	1.17	Fourth	10-50	141.0

Khevi* - Ravine.

Table 1 includes the values of the erosion coefficient (E) and the maximum discharge ($Q_{\max}$), given in columns 5 and 8, calculated by the following dependence (**Gavardashvili G.V. 1995**):

$$E = [0.58 + 1.40(F_1 / F_0)] \cdot (t / T)^{0.21} \quad (1)$$

where F_1 is the erosional area (km²) in the drainage basin of the river, F_0 is the catchment area of the river basin, t is the interval of the area (year) studied, while T denotes the total period of investigation (year).

$$Q_{\max} = A(34 + 400 \cdot i) \cdot F_0^{0.61}, \quad (\text{m}^3/\text{sec}) \quad (2)$$

where $Q_{\max}$ is the maximum discharge of debris flow (m³/sec); i is the inclination of the debris riverbed, A is the coefficient of debris discharge whose coefficient of percentage provision is given in Table 2 (**Gavardashvili G.V., 2003**).

Table 2: Relation between the coefficient of debris flow discharge and percentage provision.

Provision coefficient (P%)	0.1	1	3	5	10	25	50
Debris flow discharge coefficient (A)	2.4	1.0	0.7	0.6	0.5	0.3	0.2

As to the data in columns 6 and 7 of Table 1, they are estimated according to Professor R. Morgan's scale (**Morgan R.P.C., Hann M.J., 2001**). The erosion classes by R. Morgan are divided by one for very low erosion and seven for exceptional erosion.

Precise determination of the average diameter of the solid fractions transported by the flow is of major importance in ascertaining the rate of debris flow and its impact force.

The average diameter of the sediment ($\bar{d}$) of the transported turbulent flow is calculated on the basis of the next dependence (cf. Table 3):

Table 3: Average diameter of sediment transporting turbulent debris flow.

Inclination angle of the riverbed of Mletis Khevi (α)	4 ⁰	6 ⁰	10 ⁰	13 ⁰	17 ⁰
($\bar{d} / d_{\max}$)	0.218	0.363	0.439	0.508	0.685
$\bar{d}$ (cm)	13.5	22.5	27.2	31.5	42.5
$d_{\max}$ (cm)	62.0				

The debris flow in Mletis-Khevi riverbed in May 2006 moved along for 15 min, with the maximum discharge value of 98.5 m³/sec. The volume of mass transported by the debris flow totaled is 139.768 m³, while the maximum weight of a rock moved by the flow amounted to 1468 kg.

The following empirical dependence has been derived for calculating the volume:

$$W = 0.138 \cdot T^{1.52} \cdot Q_{\max}^{0.73}, \text{ (m}^3\text{)} \quad (3)$$

T – debris flow motion time in the Mleta (second) riverbed,

$Q_{\max}$ - debris flow maximum discharge (m³/sec).

The limits of dependence usage are:

$$\begin{cases} 180 \leq T \leq 2160. & \text{(sec)} \\ 25 \leq Q_{\max} \leq 2000. & \text{(m}^3\text{/sec)} \end{cases} \quad (4)$$

An analysis of field investigations has shown that the discharge of the debris flow formed in the Mletis-Khevi bed amounted to:

$$Q_{3\%} = A(34 + 400 \cdot i) \cdot F_0^{0.61} = 0.7 (34 + 400 \times 0.26) \times 1.28^{0.61} = 112.35 \text{ (m}^3\text{/sec)} \quad (6)$$

As to the volume of the debris flow mass, according to formula (4), it equals:

$$W = 0.138 \times 900^{1.52} \times 112.35^{0.73} = 134043 \text{ (m}^3\text{)}. \quad (7)$$

According to the well-known formula of hydraulics, the volume of mass equals:

$$W_1 = Q_{3\%} \cdot T = 112.35 \cdot 900 = 101115 \quad (\text{m}^3) \quad (8)$$

The difference between the values calculated by means of formulae (7) and (8) does not exceed 24.5 %, while comparison of the value obtained by means of dependence (7) with the natural data yields 4.1 % error, pointing to the reliability of formula (7) derived by the authors.

A comparison of the debris flow discharge ($Q_{\max}$) = 98.5 m³/sec with the value calculated by means of formula (6) has shown the error between them at 0.95 % probability does not exceed 13 %, which is considered a permissible volume for hydrologic calculation.

In order to determine the power of a debris flow special importance attaches to the concentration of flow, the mechanical composition of the solid mass, the chemical content of minerals, etc. Photo 3 presents the automobile bridge destroyed by the Mletis-Khevi debris flow; it was built on the Georgian Military Road, at the village of Kvemo Mleta, spanning the bed of the Tetri Aragvi.

Photo 3: Road bridge destroyed by Mleta debris flow in 2006. (Gavardashvili)



To this end, three samples (1 – conglomerate; 2 – loam; 3 - sediment) were taken from the Mletis-Khevi channel, and laboratory studies were carried out. The results of the study are given in Tables 4, 5 and 6.

Table 4: Cumulative grain size distribution curves for debris flow mass.

a) The Sediments (Sample – 3)

Diameter of sediment (mm)	< 0.05	< 1.0	< 2.0	< 7.0	< 10.0
Percent (%)	24.0	30.0	57.0	94.0	100

b) The Conglomerate (Sample – 1)

Diameter of sediment (mm)	< 0.05	< 1.0	< 2.0	< 7.0	< 10.0	≥ 10.0
Percent (%)	8,49	10,79	23,09	46,94	55,4	100

Table 5: Mechanical analysis of debris flow mass for the river Mletis Khevi.

Sample number	Type of Sample	% Fraction in mm									
		Sums for material smaller 0,05 mm				Distribution					
		<0.05	<0.01	<0.005	<0.0001	1-0.25	0.25-0.05	0.05-0.01	0.01-0.005	0.005-0.001	<0.001
1	Conglomerate	75.18	45.42	29.76	10.37	8.0	16.82	29.76	15.66	19.39	10.37
2	Loam	78.01	40.30	21.54	9.03	7.0	14.99	37.71	18.76	12.51	9.03
3	Sediment	66.16	31.17	15.16	5.17	10	21.84	34.99	16.01	9.99	5.17

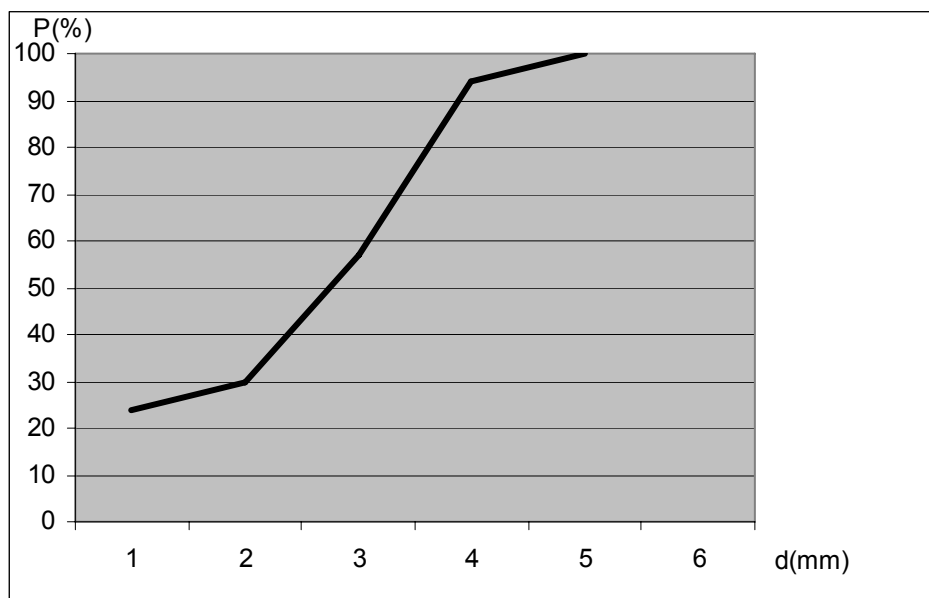
Table 6: Chemical analysis of debris flow mass for the river Mletis Khevi.

Sample number	Type of Sample	Milligram equivalent to 100 gr Sediment				
		P_H	HCO₃	SO₄	Na+K	Ca
1	Conglomerate	7.4	0.426	0.374	0.052	0.748
2	Loam	7.4	0.377	0.416	0.294	0.499
3	Sediment	7.3	0.377	0.436	0.499	0.499

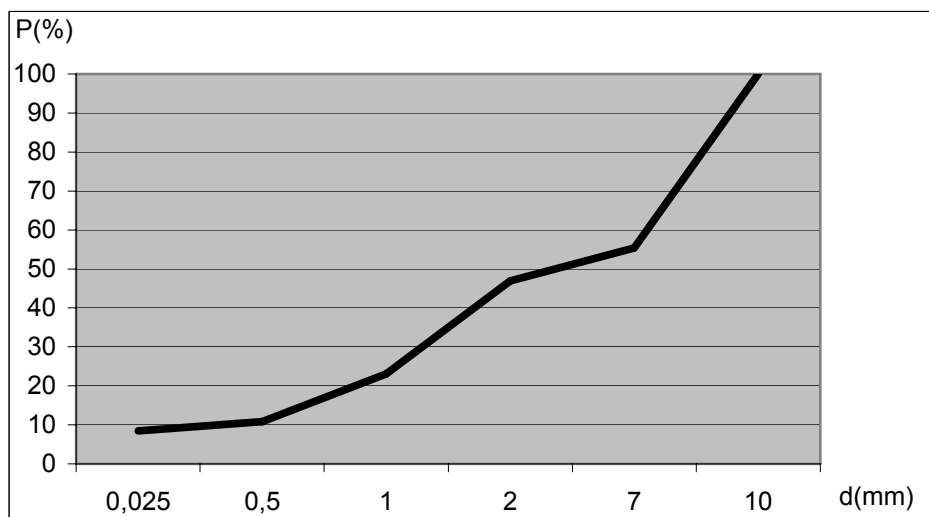
According to the laboratory data, graphs are built for conglomerate and sediment samples, establishing a link between the average diameter, d (mm) of drift and its percentage control P % (cf. Figs. 4 – a, b).

Figure 4: The integral curve of grain size distribution in debris deposition (Gavardashvili).

a) The sediments (Sample - 3).



b) The conglomerate (Sample - 1).



Thus, the scientific studies, carried out and mainly based on field-expedition investigation under natural conditions, have pointed to the formation of debris flows in the Mletis-Khevi riverbed almost every year – several times annually: the value of the maximum discharge of the debris flows changes at the probability of 0.1 %, 1 % and 3 % provision, being indicative of erosional debris flow processes becoming active in the Mletis-Khevi riverbed.

4. Conclusions

- A hydro-meteorological investigation, carried out in the Mletis-Khevi riverbed has shown that the value of the mean annual rainfall ranges from 1000 to 1400 (mm/year), while the maximum value of rainfall intensity does not exceed 3.85 mm/sec. The working area around Mletis Khevi is characterised by a snow-forest climate (Schaefer 2003).
- A geological study has shown that sandstone, layers composed of clayey soils, and conglomerate occur predominantly on the left-bank slope of the Mletis-Khevi catchment area, while the right bank is largely represented by a suite of cilium states.
- At erosional points of the Mletis-Khevi basin, the coefficient of erosion of mountain slopes is estimated at the value 1.13, with respective class 4 of erosion, the degree of damage varying from 10 to 50 tons/ha per annum.
- The value of the maximum discharge of debris flow formed in Mletis-Khevi, at 3 % probability of provision, totalled 112.35 m³/sec, while the volume of debris mass transported by a debris flow of corresponding provision totalled 134 004 m³.
- Scientific studies, lasting 20 years, in the Mletis-Khevi catchment area have shown that predominantly floods, freshets, and turbulent-type debris flows are formed in the riverbed; however, occasionally bound-structural type debris flows occur.
- Prediction of turbulent debris flow formed in the Mletis-Khevi bed is carried out by the proposed method, with account of the basic parameters of flow; at the next stage it is feasible to design measures for protecting items from debris flows.

References

- Gavardashvili G.V. (1995)** – The New Mud-Protective Structures and Their Calculation Methodology. Tbilisi, Georgia, 58.
- Gavardashvili G.V. (1999)** – Les Nouvelles Espèces des Construction de Protection de la Nature. Metsniereba, Tbilisi, 42.
- Gavardashvili G.V. (2002)** – Estimation of Ecological Equilibrium of Debris-Flow Riverbeds Along Georgian Military Road Using the Theory of Reliability and the Theory of Risk.//Engineering Ecology. Moscow, #2, 11-17 (In Russian).
- Gavardashvili G.V., Chakhaia G.G. (2002)** – Evaluation of Present Ecological Situation of the River Duruji Drainage Basin. Bull. of the Georgian Academy of Sciences. Vol. 166 #1, 174 – 177.
- Gavardashvili G.V. (2003)** – The Forecast of Erosion-Debris Flow Processes in the Catchment Basin of the River Duruji and New Engineer – Ecological Measures. Tbilisi, Metsniereba, 116 (In Georgian).
- King L., Metzler M., and Jiang T. (2000)** – Flood Risks and Land Use Conflicts in the Yangtze Catchment, China and at the Rhine River, Germany. (Band 2), Peter Lang, Frankfurt am Main, 237.
- Mirtskhoulava Ts.E. (1998)** – An estimation of the frequency of debris flow occurrence of catastrophic character. // Hydraulic construction. Moscow N5., 19-26. (In Russian).
- Morgan R.P.C., Hann M.J. (2001)** – Shah Deniz Gas Export: erosion risk assessment.//Interim Report to PB Kvaerner. Granfield University, UK, Silsoe, 25.
- Osipov V.I. (2003)** – Natural Catastrophes as Global and National Disasters. // Management of Risk. Moscow, N3, 23 - 27 (In Russian).
- Schaefer M. (2003)** – Climate zoning of Georgia: Documentation and critique of existing climate classifications on the basis of longstanding climate data and with a Geographic Information System, published in the GEB, Giessen, <http://geb.uni-giessen.de/geb/volltexte/2005/2541> (In German).
- Schaefer M., Narimanidze E., King, L. (2007)** – Climate zoning of Georgia - a GIS-based regionalization of long-standing precipitation and temperature data. Annals of Agrarian Sciences, Tbilisi.
- Svanidze G.G., Gagua V.P. and Sukhisvili E.P. (1987)** – Renewable Energy Resources of Georgia. Hidrometeoizdat, Leningrad, 174, (In Russian).

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