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EU Civil Protection Mission Georgia 2014 – Debris Flow Mt. Kazbegi/Caucasus Early Warning System Report

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1. Introduction & Mission background

This report has been compiled Bernd Noggler, Team leader of an European Civil Protection Team (EUCPT) deployed through the (European) Union Civil Protection Mechanism in response to the Government of Georgia request for assistance. Georgia has been currently affected by a **large landslide** (**debris flow**) which occurred on 17 May.

The mission objective was to undertake a rapid assessment of the situation in the area. The above considerations should be combined into an overall assessment identifying any possible immediate or potential threats to local population and the environment. Recommendations for appropriate immediate and mid-term action were provided on 2nd of June 2014 as well as recommendations to the national authorities, including disaster management and environmental authorities.

EU Civil Protection Mechanism:
In 2001, the **EU Civil Protection Mechanism** was established, fostering cooperation among national civil protection authorities across Europe. The operational hub of the Mechanism is the Emergency Response Coordination Centre (ERCC) which monitors emergencies around the globe 24/7, and coordinates the response of the participating countries in case of a crisis. Thanks to its pre-positioned and self-sufficient civil protection modules, the ERCC teams are ready to intervene at short notice both within and outside the EU. *Any country in the world can call on the EU Civil Protection Mechanism for help.* Since its launch in 2001, the EU Civil Protection Mechanism has monitored over 300 disasters and has received more than 180 requests for assistance (ec.europa.eu/echo).

The author has been deployed to nine EU mission including Haiti hurricanes (2008) Chile earthquake (2010), Pakistan floods (2010), Arabian spring humanitarian crisis (2011, 2012, 2013).

1.1 Background

A rock/ice/snow mass collapsed in the Dariali Gorge on 17 May, blocking the Tergi River. The disaster was a result of intensive movement of the Devdoraki glacier located at the 5047 meter-high peak. The collapsed material blocked the river Tergi and created a temporary dam flooding the surrounding area. According to the Emergency Management Department of the Ministry of Internal Affairs (as of 28 May), seven people are reported missing and one dead; about 200 people were evacuated by helicopter from the border crossing checkpoint and its nearby areas. The landslide caused substantial damage to the infrastructure; North-South Pipeline, running through the area, has been affected, suspending transit of Russian gas to Armenia via Georgia. Catastrophic, glacier related events at Devdoraki glacier have been reported during the last 120 years.

***Fig. 1**: Ice demolition / Devdoraki Glacier – Mt. Kazbegi (Georgie) / B. Noggler (27.05.14)*

Mt. Kazbegi has a long record of extreme ice-rock avalanches. The largest ice-rock avalanche recorded, occurred in 2002 on the Russian side of the mountain. On the north-eastern face of Mt. Kazbegi, 10-200 million cubic meters of rock and ice failed and fell onto Kolka glacier, triggering an ice-rock-debris flow down the valley with speeds up to 80m/second. More than 100 people were killed (source: EOS, Vol. 89, Nr. 47, Nov. 2008).

Debris flow warning systems can be classified into two main classes: *advance warning* and *event warning*. *Advance warning systems* predict the possible occurrence of a debris flow event before its occurrence by monitoring predisposing conditions (M. Arattano and L. Marchi, 2008).

Event warning systems or *event-triggered warning systems* detect a debris flow while it is already in progress and provides an alarm; eventually a public warning is issued.

Current event early warning system

The Emergency Management Department (EMD) in cooperation with National Environment Agency (NEA) and others (e.g. Georgian Border Police) are currently running an event warning system by monitoring the situation via two observation posts (highest at 2.284m (former met/glaciological station), lowest at 1.7715m). The observation points are connected with different communication systems (radio) to alert specialists and working personal on-site (reconstruction, measurements, etc.). Alerting is done via sirens, special rocket lights and radio within approx. 4min 50 sec maximum (average landslide conditions) – see “time map” below.

This first non-automatic early warning and alert system is running 7/24. Specialists from NEA (Geologists, Hydrologist, and Glaciologists) are watching the glacier constantly (during daylight and visible weather condition, noise/sound at night or bad weather).

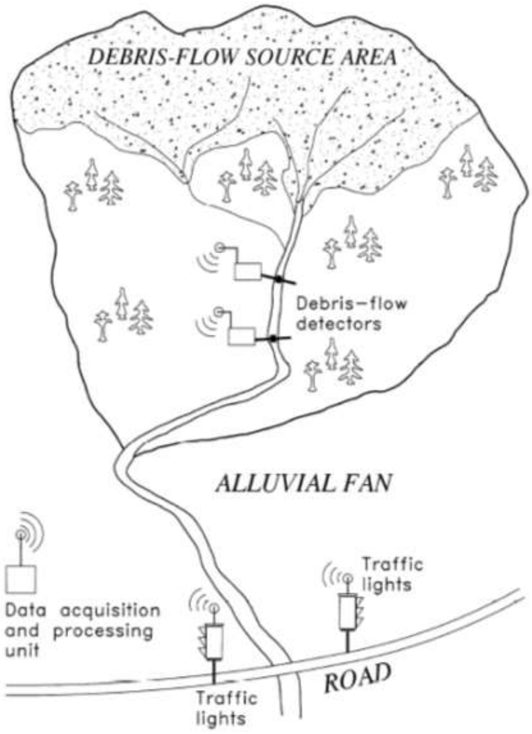
***Fig. 2**: Observation point and Command & Control Center (EWS) / Noggler (28.05.14)*

This staff intensive warning system has to be replaced by a permanent early warning system based on automatic/sensor measurement systems.

20. August 2014: A second debris flow has again destroyed infrastructure in the same area and killing two people.

2. Recommendation #1: Establishing a landslide / torrent / avalanche (event) early warning system for Tergi Valley highway

The purpose of an event warning system is to provide an alarm when a debris flow is in progress. The sensors used for event warning systems are often the same adopted in debris-flow channels monitored for research purposes.



The sensors for detecting debris flows are only one component of event warning systems. Further components include a data acquisition and processing unit and devices to spread the alarm. The data acquisition and processing unit, installed in a safe position, receives data from debris-flow sensors, elaborates them and forwards the signals to the alarm devices (sirens, traffic light, etc.).

Fig. 3*: Sketch of the components of a debris flow warning system (M. Arattano and L. Marchi, 2008).*

Alarms are disseminated to address both the public, by means of sirens and traffic lights, and the personnel in charge of disaster management, by means of signals in emergency rooms (*112.ge / border post / trafic police / others*) and short messages on mobile phones.

Debris flows are fast mass movements, as a consequence, warning times for event alarm systems seldom exceed 3-5 minutes (see map below).

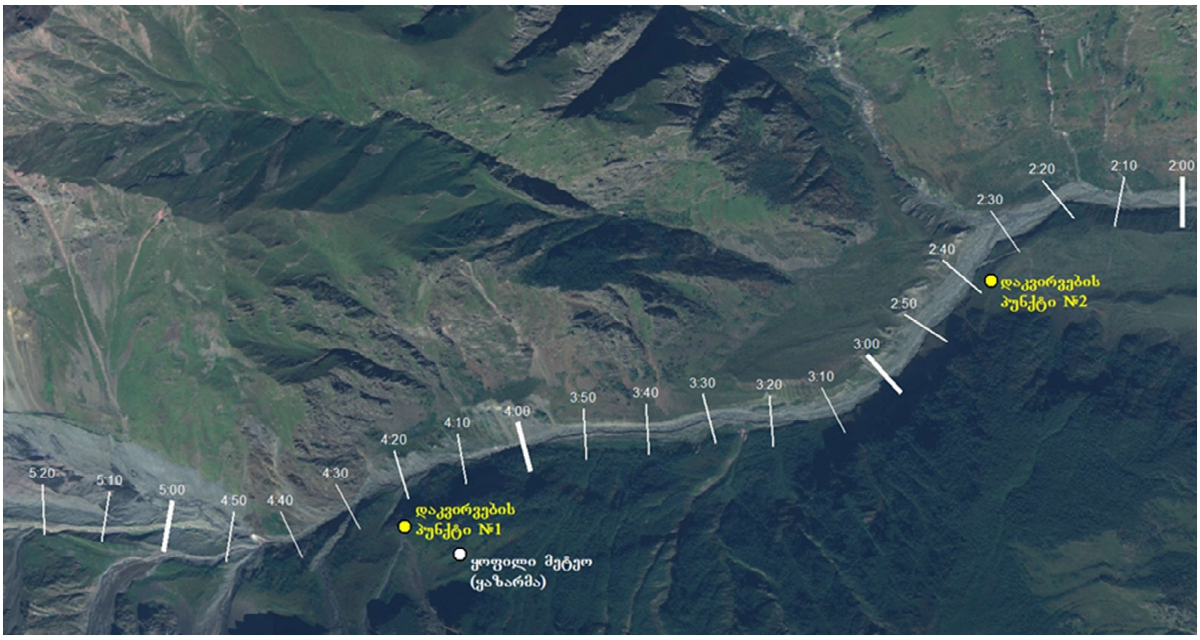


Fig. 4: *Map: Warning Times (Min/Sec), Observation points (left/right point at 2.284m and at Amali/Devdoraki confluence (1.715m) and Warning and Communication point (right).*
Source: Geographic (GIS & RS Consulting Centre)

This causes important limitations in the use of event warning systems, which can be suitable for protecting transportation routes by stopping the traffic, whereas they are normally unfit to effectively protect inhabited areas because warning times are too short to evacuate people from endangered areas (M. Arattano and L. Marchi, 2008).

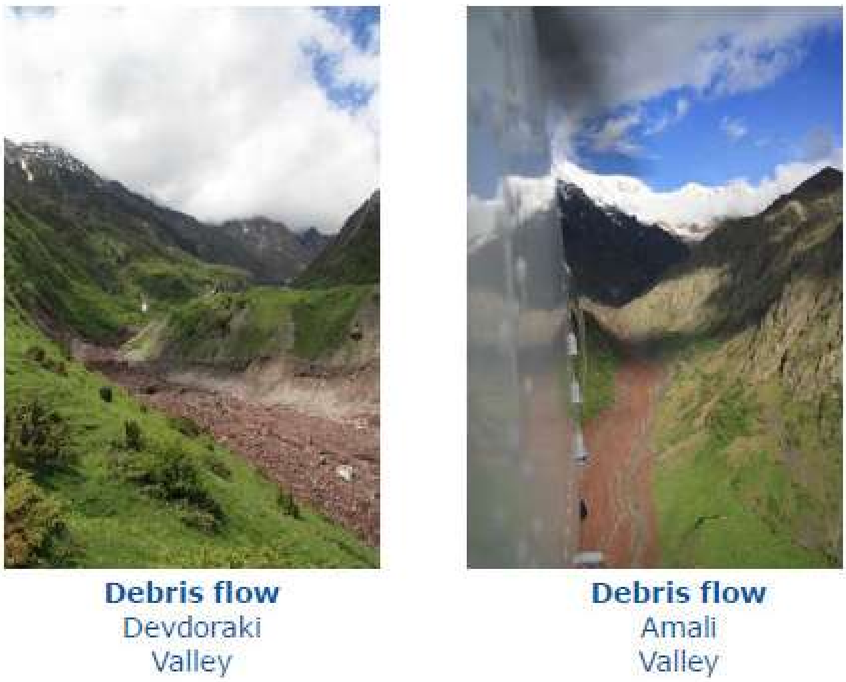


Fig. 5: *Devdoraki & Amali Valley / Noggler 27.05.14*

It is obviously of the utmost importance to minimize the risk of system failure when issuing an alarm in the event of a debris flow. It is then advisable to adopt redundancy criteria into the design of an event warning system for debris-flows; the various components of the system (sensors, powering, data transmission, processing unit) should all be duplicated. At the same time, it is imperative to minimize false alarms; this can be achieved through a wise choice of sensors and installation sites. As previously mentioned, the use of integrated systems might also greatly help (M. Arattano and L. Marchi, 2008).

2.1. On site problems (Mt. Kazbegi)

- No long-term data available (missing weather data, hydrological data, glaciological measurement, etc.)
- Remote area with limited network access (internet, GSM, GSMR)
- Limitation in infrastructure (e.g. electricity)

The mentioned problems may cause restrictions for some measurement systems e.g.

- Video- and radar measurement system (data transmission limitation).
- Geophones (less seismic data for correlation available)

2.2. EWS – System for Tergi Valley (Mt. Kazbegi)

Based on our EUCP field assessment with Georgian experts from *NEA (National Environment Agency)* and *EMD (Emergency Management Department),* experiences in Austria (*Province of Tirol*) and several discussion with colleagues representing all departments operating measurement and warning systems in the province of Tirol and experts from the federal *Ministry of Agriculture, Forestry, Environment and Water Management– Forest Engineering Service in Torrent and Avalanche Control* we could recommend to start with following measurement systems:

ONE LASER MEASUREMENT STATION (LAMS)
ONE OR TWO LEVEL MEASUREMENT STATION(S) (LEMS)
ONE AUTOMATIC WEATHER STATION (AWS)
SOFTWARE FOR DATA COLLECTION, PROCESSING AND ALERTING (ACTION)

In addition to recommendation #1 (event EWS), Mt. Kazbegi area should be used as scientific research area again. All relevant geo-sciences *(Geology, Glaciology, Geomorphology, Meteorology, Volcanology, Seismology, GIS/Mapping/Modelling,…)* should re-establish scientific programmes. This will help to understand processes much better and may help to introduce advanced warning systems in future. Advanced early warning systems predict the possible occurrence of a debris flow event before its occurrence by monitoring predisposing conditions.

Re-establishing or introduction of intensive monitoring and measurement studies for Mt. Kazbegi. Including field studies, measurement programmes (additional AWS e.g. next to Mt. Kazbegi meteorological hut), national and international scientific co-operations.

Possible EU support ***(Copernicus):***

- Satellite images via www.copernicus.eu processing to monitor volcano and its glaciers, slopes (European Earth Observation Programme).
- An intensive data collection programme should include (inputs Government of Tirol/Geology and ILIA State University)
- Analyses of subsurface gas emanations
- Thermal imaging
- Permanent seismic network
- Geochemical analyses of the ground water and hot springs.
- Rock dating for Kazbegi mountain.
- Geophysical field studies to infer massive structure (microgravity measurements, magnetic field measurements; MT measurements);
- Satellite image processing to monitor volcano and its glaciers, slopes
- Tectonic studies of the region.

3. Sources

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