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THE STOŽE LANDSLIDE AND PREDELICA TORRENT DEBRIS FLOW

Consequences and Response to the Disaster

STOŽE RUTSCHUNG UND PREDELICA MURGANG

Konsequenzen und Katastrophenmanagement

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SUMMARY

Autumn 2000 was extremely wet in Slovenia. A number of severe disasters occurred in November 2000. The event that caused the most significant damage was the landslide Stože that provoked the torrent Predelica debris flow. As the triggering area was very steep, the landslide immediately changed into a debris flow. The debris flow destroyed the part of the village Log pod Mangrtom, two small hydropower stations and two bridges on the state road to Italy (Bovec-Predel - Tarvisio). The important tourist road towards Mangart Col was cut off and destroyed in the length of ca 1km. There was great damage caused to electricity supplies and telephone connections. The local economy, such as tourism and farming, suffered great losses. The disaster in Log pod Mangartom was a severe test for the Slovene Civil Protection forces, which until then had not yet confronted a similar phenomenon of such vast dimensions. Protection, rescue and relief activities in the affected area were conducted by the municipal civil protection unit with the support of the regional and national civil protection units. The conditions below the landslide area were gradually returning to normal. The article focuses on lessons learnt from intervention measures taken by the Slovene Civil Protection forces in extremely difficult (geographical, technical, social, psychological,...) conditions.

Key words: Natural disasters, Landslides, Debris flow, Intervention, Civil Protection, Crisis Management, Public relations

ZUSAMMENFASSUNG

Das Novembertgewitter 2000 führte an mehreren Standorten Sloweniens zahlreiche Zerstörungen herbei. Die weit ausdrucksvollste war das Abgleiten des Wildbachbettes Materials verbunden mit

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gleichzeitigem rechtsseitigem Bergabrutsch am Anfang des Abgleitens, und anderthalb Tage später ein zweiter Bergabrutsch im Gebiet unter dem Stože-Gipfel. Wegen großer Hangneigungen des Auslösungsbereiches niederdonnerten die Massen des zweiten Bergbrutsch als ein Murgang in das Tal und beschädigten die 4 km entfernte Ortschaft Log pod Mangartom. Es war einer von den größten Naturereignissen in Slowenien, mit katastrophalen Folgen. Unmittelbar nach den ersten Ereignissen aktivierte man zuständige Dienste, die Maßnahmen wurden aber von dem Zivilschutzdienste im Rahmen der Verwaltungsstelle Republik Slowenien für Schutz- und Rettungsmaßnahmen koordiniert. Die Erfahrungen aus allen drei Perioden, aus der Zeit, in der es zur Katastrophe kam und unmittelbar danach, aus der Zeit der ersten Eingriffe und aus der Zeit der dauerhaften Sanierungsmaßnahmen im betroffenen bzw. einflussreichen Gebiete werden auch bei eventuellen ähnlichen Ereignissen für die Vorgehensvorbereitungen wertvoll sein.

Schlagewört: Naturkatastrophen, Bergabrutsch, Murgang, Intervention, Zivilschutz, Katastrophenmanagement, Sanierungsmaßnahmen, Öffentlichkeitsarbeit

INTRODUCTION

Autumn 2000 was extremely wet in Slovenia. A number of severe disasters occurred in November 2000. The event that caused the most significant damage was the landslide Stože that provoked the torrent Predelica debris flow. It happened between the 15th – 18th of November 2000 in the village Log pod Mangartom, commune Bovec, Slovenia.

The landslide occurred in the Stože area (1.340-1.580 m.a.s.l., close to the Mangart mountain, 2.679 m, in the Julian Alps. The land use was mostly mixed mountain forest.

The endangered settlements were situated around the Koritnica valley. It is an alpine valley lying in the direction SW-NE, which was transformed by glaciers. In November 2000 140 inhabitants lived in the village Log pod Mangartom and 11 in the village Strmec.



Fig.1., 2: The village Log pod Mangartom before and after the debris flow (Photo: Ž. Mlekuž, A. Horvat)

Abb. 1, 2: Dorf Log pod Mangartom vor- und nach- Murgangereignis (Foto: Ž. Mlekuž, A. Horvat)

The disaster in Log pod Mangartom was a severe test for the Slovene Civil Protection forces, which until then had not yet confronted a similar phenomenon of such vast dimensions. The article describes the events that caused the devastation with 7 victims and gives special stress to the protection, rescue and relief activities in the affected area.

PRECIPITATION

According to the data of the Hydrologic prognostic forecasting service at the Hydrometeorological Institute of the Republic of Slovenia (Hidrometeorološki zavod Republike Slovenije, HMZ) and the Notification Centre of the Republic of Slovenia (Center za obveščanje Republike Slovenije, CORS) for the year 2000, the rivers and torrents over flow banks in the form of bigger floods in the autumn (October and November) in almost all the characteristic flood areas. Autumn 2000 was extremely wet in Slovenia. In September and October there was very high precipitation that significantly increased in November. Western Slovenian hills and mountains were exposed to amounts from 250 mm to 500mm of rainfall in October and from 600mm to 1400 mm in November. Rainfall in November was up to 400% above the 30-year average (Komac, 2001).

Tab. 1: Monthly precipitation sum – November 2000

Tab. 1: Monatliche Niederschlagssumme – November 2000

Meteorological station in Posočje	Monthly precipitation sum (mm)
Log pod Mangartom	1.234,3
Trenta	880,8
Soča	1.493,9
Žaga	1.450,7
Kobarid	1.200,0

Strong precipitation began on the 6th and 8th of November 2000 in Western and Northern Slovenia and then spread to other parts of the country, causing flooding of many rivers, streams and torrents. The rivers and torrents in Western and Central Slovenia started to flood first and then many others in the Eastern and Southern part of the country.

During the extended period of rainfall in November 6 cold fronts passed through Slovenia. All of them were accompanied by very strong and wet south-westerly winds in high altitudes, which caused strong precipitation in the western mountainous region Posočje.

Tab. 2: The five-day precipitation sum between the 14th and the 18th November 2000

Tab. 2: Fünftägige- Niederschlagssumme in zwischen Zeitraum von 14. bis 18. November

Meteorological station in Posočje	Five-day precipitation sum (mm)
Log pod Mangartom	479,6
Trenta	316,8
Soča	555,1
Žaga	486,9
Kobarid	369,2

In the period between the 14 and the 18 November the five-day precipitation sum was very high. The precipitation of such a high intensity on previously saturated soil were a very important cause for the triggering of the landslides in the Stože area.

DESCRIPTION OF THE EVENT

The first landslide

The first landslide occurred on 15th of November 2000 at around 1 p.m. in the bed of the Mangartski potok torrent. The maximum inclination of the torrent bed is 15%. The bed rests on glacier and torrent deposits. Such material, even if it is totally wet, can not slide if the inclination is only 15%. The most probable cause of the landslide was a tremor that also occurred on the 15th of November. The tremor caused the liquefaction of the waterlogged material. The length of the landslide was 1 km, the width approximately 0,1 km, the volume approximately 600.000 m³. The speed of the landslide was less than 1 m/s. The landslide destroyed the Mangart hydropower plant ca 0,8 km downstream from the landslide source (Figure 3, 4) and the bridge on the road to the Predil boarder crossing ca 1,0 km downstream from the landslide source. In the Mangartski potok torrent gorge, due to a very steep inclination, the landslide changed the mode of movement into a debris flow. The debris flow stopped on the deposition area in the gorge of the torrent Predelica near the confluence with the torrent Mangartski potok. The debris consolidated and the mode of transport turned back to free flow of sediment (Horvat, 2001).



Fig. 3., 4: The hydropower plant object in the torrent Mangartski potok before and after the debris flow (Photo: archives of the PGD Log pod Mangartom)

Abb. 3, 4: Kleinwasserkraftwerk im Wildbach Mangartski potok vor- und nach- der Murgang (Foto: PGD Log)

The second landslide

The second landslide (landslide area 200.000 m², landslide volume 1.000.000 m³) was released on the 17th of November on the Stože area, about 130 to 150 meters above the torrent bed of Mangartski potok (Figure 5). The triggering of the second landslide was not in direct connection with that of the first landslide. As the source area was very steep, the landslide immediately changed into a debris flow with an estimated speed of 8 – 10 m/s. (Majes, 2001). After about 500m the debris flow reached the bed of the Mangartski potok torrent (Figure 6).

As the first landslide caused the complete devastation of the middle and lower flow bed of the torrent Mangarstki potok and also of the middle flow bed of the torrent Predelica, there was practically no more place for the energy dissipation or the deposition of the debris. The second debris flow, with its high energy, destroyed the torrential beds of Mangartski potok and Predelica and part of the village of Log pod Mangartom (Figure 4). It also caused huge devastation in the bed of the Koritnica torrent where another small hydropower plant was damaged (Horvat, 2001).



Fig. 5, 6: Second landslide source area and the Mangart potok torrent after the debris flow (Photo: B. Ušeničnik)
 Abb. 5, 6: Rutschungsgebiet und des Wildbachbett von Mangartski potok nach dem Murgangsergebnis (Foto: B.U.)

Human casualties

Seven people lost their lives. Due to the consequences of the debris flow and the possibility of its recurrence the inhabitants of the village were evacuated to Bovec to a hotel, private residences and relatives till spring (Ušeničnik, 2001).

Economic losses

6 houses and 7 farm buildings were destroyed. Another 11 houses and 1 farm building in the village were damaged. The beds of Mangartski potok, Predelica and Koritnica torrents were destroyed on most of their length. Two bridges on the state road to Italy (Bovec-Predel_Tarvisio) were destroyed (Figure 7, 8); the important road connection to Predel was cut off. The important tourist road towards Mangart Col was cut off and destroyed on the length of ca 1km. Two small hydropower plants were damaged. There were great damages to electricity supplies and telephone connections.

The local economy, tourism and farming, suffered great losses (Komac, 2001). The damage caused by the landslide, which was estimated by the National commission on damage assessment (Državna komisija za ocena škode zaradi naravnih nesreč) in 2000, amounted to 36 mio EUR (Ušeničnik, 2001).

PREVENTION MEASURES BEFORE AND AFTER THE FIRST LANDSLIDE

The precipitation and floods in November 2000 were predicted. The Hydro-meteorological Institute of the Republic of Slovenia (Hidrometeorološki zavod Republike Slovenije, HMZ) sent several warnings every day to the Notification Centre of the Republic of Slovenia (Center za obveščanje Republike Slovenije, CORS). The Administration for Civil Protection and Disaster

Relief of the Republic of Slovenia (Uprava Republike Slovenije za zaščito in reševanje, URSZR) announced hazard warnings of to the competent authorities, rescue services and the public, but did not specially mention the hazard of debris flow. Most of the warnings were forwarded down to all 13 regional notification centres. On the 3rd of November this Administration sent a special letter warning against flooding of rivers, streams and sea, including landslides and advisory measures, to regional defence agencies and communities, especially those in the western, southern and central parts of Slovenia. Those warnings were repeated on 6th, 14th, 15th, 16th and 17th November. The mayors of communities were advised to monitor the situation and to ensure the appropriate readiness of the community headquarters of civil protection and other rescue services, including timely warning of the endangered population. They were also reminded to inform their regional notification centres both verbally and in written form.

After the first landslide on the 15th November a local disaster management system was activated in Log pod Mangartom. The system formed the mayor of Bovec, the Enterprise for Torrent and Erosion Control (Podjetje za urejanje hudournikov, PUH), the Enterprise for Road Maintenance (Cestno podjetje Nova Gorica, CP Nova Gorica) geologists and the Administration of the Civil Protection's Regional Headquarters for North Primorska about the situation. On the 15th November the "ad-hoc co-ordination body" was appointed. It consisted of the mayor of Bovec, the representatives from the Civil Protection Local Headquarters from Bovec, the Civil Protection Regional Headquarters for North Primorska, the Police department of Bovec and the local fire brigade from Log pod Mangartom. They concluded that inhabitants of five houses had to be temporary evacuated.

The next day (16th November) the experts and the "ad-hoc co-ordination body" took a thorough examination of the landslide area and they prolonged the previous day's preventive orders that the inhabitants from the most endangered houses should stay further on safe. Due to the very bad weather and safety conditions in the area the landslide was closely monitored only in possible zones. (Ušenicnik, 2001).

PROTECTION, RESCUE AND RELIEF ACTIVITIES AFTER THE SECOND LANDSLIDE AND THE DEBRIS FLOW

The second landslide that provoked the debris flow occurred a few minutes after midnight on the 17th of November 2000, approximately 130 to 150 meters higher up on the right side slopes of Stoze in the same torrent watershed as the first one. Unfortunately 7 people lost their lives because they returned to their homes not obeying the warnings. The following morning the local disaster management and the "ad-hoc co-ordination body" system took decisions about rescuing and organising life in the village. The whole village was evacuated and settled in Bovec in hotels, private apartments or at relatives. The road to the village was opened only for authorised persons. The local rescue services from Bovec took all the precautions and actions of rescuing and protection in the area. The Civil Protection Headquarters of the Republic of Slovenia and the Civil Protection Headquarters for North Primorska provided professional logistic and other help to the local disaster management system. Because of the complex situation on the 18th of November a team of experts from various fields related to the problem was formed. The team was split in two groups: one with the experts in engineering geology (Majes, 2000) and the other in hydrotechnics and torrent control (Horvat, 2000).



Fig. 7, 8: Damage in the village Log pod Mangartom – destroyed bridge on the road to Predil (Photo: A. Horvat)
 Abb. 7, 8: Die Schaden im Dorf Log pod Mangartom und zerstörte Brücke nach Predil (Foto: A. Horvat)

On the 25 November 2000 they examined the situation and proposed temporary measures for the affected area. The evacuated inhabitants should stay out of the village Log pod Mangartom until spring. The Municipal protection unit, the local fire brigade and some inhabitants from the village also took care of the animals and the property in the village (Figure 9, 10).

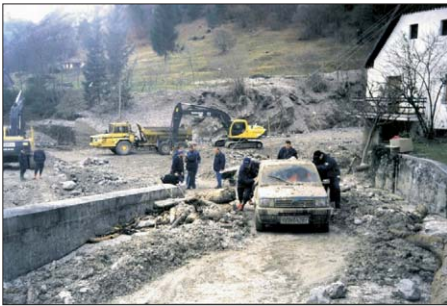


Fig. 9, 10: First intervention measures Care of the animals (Photo: PGD Log pod Mangartom and Bovec)
 Abb. 9, 10: Erste Intervention; Sorge tragen für die Tiere (Foto: PGD Log)

On the 25th November the Civil Protection Headquarters of the Republic of Slovenia according to the prepositions of the experts teams accepted decisions and measures for the following actions:

- Controlled access to the affected area.
- High precautions while working in the area due to the possibility of another possible debris flow,
- Improvement of observation and information services of the affected area,
- Ensuring temporary residence for the evacuated inhabitants during the winter in Bovec,
- Ensuring permanent care for the animals and property
- Draining of the landslide area
- Removal of debris from torrent beds and deposition areas
- Rebuilding new bridges on the regional road,
- Restoration of life in the valley (domestic life, pasture, tourism)
- Ensuring the necessary changes in land use plans.



Fig. 11., 12: The Enterprise for Torrent Control removes debris from deposition area (Photo: A. Horvat)

Abb. 11, 12: Große Geschiebemengen - Unternehmen für Wildbachverbauung räumt die Ablagerungsgebiete

The key national decision-making bodies agreed with these measures and assured the funds for the intervention measures of protection, rescuing and help with approximately 670,000 EUR.

On the 21st December the Slovenian Government discussed the disaster and adopted the proposition of law on ensuring the resources for further activities:

- Observation of the whole area affected by the landslide and the debris flow,
- Urgent landslide consolidation measures,
- Urgent torrent control measures on Predelica, Koritnica and Mangartski potok,
- Reestablishment of the road connections (bridges),
- Assurance of the primary conditions for life and economy in the affected area
- Necessary corrections in land use planning

All of the rescue and protection activities were carried out mostly with municipal resources; only a small part was done with inter-municipal or regional resources. The municipalities are obliged, according to the principle of gradual use of forces and means, to use up their own forces and means first, before requesting outside intervention. Only in the case of their insufficiency, help from other municipalities or state may be requested (Ušeničnik, 2001). Help from other municipalities was requested only in this exceptional case where the local forces lacked equipment or forces (horizontal inter-municipal cooperation).

The key rescue services and measures against this natural disaster were carried out by the local fire brigade, the Enterprise for Road Maintenance and the Enterprise for Torrent and Erosion Control. The latter started with necessary monitoring and torrent control measures (e.g. redirecting the torrent flow of Predelica in the area of Log pod Mangartom, draining of the landslide, etc.) in cooperation with the Slovenian Air Force's helicopters (Figure 13, 14).

Fire-fighting units from the region were fully activated. Their activities could be grouped into three key areas:

- Rescuing and transportation of / and supplying of the necessary resources to the affected people,
- Monitoring of the torrents and the landslide,
- Care for the property and animals left in the village,
- Informing the evacuated inhabitants about the situation in the village.

The day after the debris flow, the Administration for Civil Protection and Disaster Relief of the Republic of Slovenia raised another repeater at fortress Kluže for better radio connections. The observation of the landslide area continued 24 hours a day till the 23rd of December when a special mobile public alerting system was set up in Log pod Mangartom (Figure 15, 16). The Slovenian Air Force also helped with helicopters of 15th brigade. According to the needs and conditions in affected areas, exceptional human solidarity was provided all over Slovenia by people, companies and humanitarian organisations (Red Cross, Caritas, etc).



Fig. 13., 14: The Slovenian Air Force helped with helicopters; Draining of the landslide (Photo: B. Ušeničnik);
 Abb. 13, 14: Slowenische Luftkraft half mit dem Hubschrauber; Dränierung des Hinterlandwasser



Fig. 15., 16: Mobile public alert system (Photo: A. Horvat)
 Abb. 15, 16: Mobile öffentliche Alarmanlage (Foto: A. Horvat)



Fig. 17, 18: The two new bridges - on the road to Predil and in the village Log pod Mangartom (Photo: A. Horvat)
 Abb. 17, 18: Zwei neue Notbrücken auf der Straße Bovec - Predil und im Dorf Log pod Mangartom (Foto: A. H.)

Information supplied to the public

The disaster of the Stoze landslide and the Predelica torrent debris flow that affected the village of Log pod Mangartom in November 2000 triggered a great response by the media, which focused on the process of the rescuing and solving the situation. The analysed documentation shows that the public was regularly and timely informed during the November events on a local, regional and national level. The Administration for Civil Protection and Disaster Relief of the Republic of Slovenia set an experienced representative for public relations who provided all the information and the sources of information. The journalists also reported correctly and objectively from the affected area with an effort of supporting the crisis headquarters (Ušeničnik, 2001).

After the natural disasters in November 2000, the Slovenian media were transmitting information predominantly focused on the damage assessment and reimbursement. The level of critical media attitude towards the floods, landslides, debris flows and crisis management rose significantly in the months after disaster. The dissemination of information to the neighbouring countries (Italy, Austria) was immediate.

CONCLUSIONS AND LESSONS LEARNT

Consecutive flooding and strong precipitation increase the probability of another flooding. Flooding causes also parallel problems in form of landslides that can on steep slopes or torrent beds change into debris flows.

Realistic and accurate natural hazard assessments are the basis for further planning and actions. It is however very difficult to assess the debris flow hazard areas due to the state of knowledge and to the available data, especially when they are connected with earthquakes.

The failures and missed opportunities in the prevention phase, insufficient allocation of financial resources for torrent control and inadequate interventions into the environment (e.g. building settlements and roads in the areas endangered by erosion) have increased the probability of landslide and torrential damages and possible human losses, and contributed to the serious consequences of the November floods in Slovenia.

An effective organisation of the local authorities for disaster management results in a very positive impact on the endangered population. Understaffed, technically inadequately equipped and not sufficiently trained institutions or companies could not perform excellently during the increased labour pressure in the crisis.

The rescue and protection services that became victims in the disaster could not perform as anticipated by the protection and rescue plans. The need for the participation of the armed forces in protection and rescue activities is relative and depends on the needs of municipal authorities. Limited (human and technical) resources of rescue services and other institutions force them to prioritise their activities.

Conditions soon after the disasters are very tense. All information about the accident and further measures are very responsible and sensitive and should be entirely and appropriately transmitted,

The media, as transmitters of information to public, could also be vulnerable to the effects of landslides and debris flows. In such cases, the notification centres must redirect their public messages to other relevant media, covering approximately the same area. Understaffed and technically inadequately equipped notification centres could not inform the public in an appropriate way.

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