# Mudflows in Aini Jamoat (Khuroson District) in Spring 2009

## Short geological report

*Figure 1: Uyali after second mudflow event on May 15th, 2009.*

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Author: Felix Bussmann, CAMP Kuhiston

## Introduction

The spring season 2009 in Tajikistan was characterized by a series of exceptionally heavy rainfall events in April and May, causing disastrous events such as floods, landslides, and mudflows almost all over the country. A total of 40 districts throughout Tajikistan were prone to disastrous events with worst affected districts in Khatlon province. According to government estimates, more than 2'000 buildings (houses & social facilities) have been destroyed or severely damaged and 12'000 people directly affected. At least 26 people are reported to be killed by these disasters including 10 children. The damage to transport and agricultural infrastructure includes completely or partially damaged over 500 km of roads, 83 bridges and 260 km of irrigational canals. Government estimates the damage at $100 million with major losses in agricultural, infrastructure and residential sector.

In terms of damages, the probably most devastating event occurred in Khuroson district (Khatlon Province), where a series of two mudflows severely hit the settlements of 18th Parts'ezdi Bolo, Uyali town, and 18th Parts'ezdi Poyon (Jamoat of Aini). According to the Rapid Emergency Assessment and Coordination Team (REACT), a total of 110 houses were completely destroyed and additional 230 houses were damaged to the state where they became uninhabitable, leaving 414 families in need of shelter and affecting more than 2'500 people in terms of land, harvest, and food[1].

Regarding the catastrophic impact of the event, the Khuroson case has to be considered as a major natural disaster that will absorb a considerable amount of financial resources to properly deal with the consequences the affected communities are facing. This short technical report thereby aims to deliver general rather technical information on the occurred disasters in order to provide involved stakeholders with the necessary background to efficiently assist the affected communities in during the recovery phase.

## Geography / Morphology / Geology

The Jamoat of Aini lies approximately 65 km SSE of Tajikistan's capital Dushanbe and belongs to the Khuroson district of northern Khatlon province. The mudflow affected villages are situated on the northern tip of the river plain occupied by the Vakhsh river and its numerous tributaries, side streams, and channels at an altitude of approximate 420 m a.s.l. To the west, the villages are bordered by a clearly developed topographical step that gains around 60 m in altitude and leads to a flat plateau occupied by large irrigated fields (cotton and wheat) (Fig. 2). Further to the west the topography becomes hilly and seems to be used for pasture and smaller-scale cultivations.

The above described topographical step is the predominant regional morphological feature as it can be followed for several kilometres to the south. On its whole length, it exposes fine-grained non-glacial loess deposits that are characteristic for many regions in Central Asia and China. Loess deposits are aeolian (i.e. wind blown) sediments consisting mainly of silty and partially clayey particles of angular size. Due to the high angularity of the grains, loess deposits often exhibit steep slopes, as observable to the west of Uyali.

Since loess deposits are only marginally compacted, their susceptibility to erosion by wind or water is exceptionally high. Especially the utilisation of the soil beyond its capacity leads to irreversible damages due to large scale washing out of substrate material. However, the fertility of soils formed on a loess substratum is known to be very high leading to exceptional yields. Thus loess soils are widely used for agricultural purposes throughout the world.

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[1] REACT Situation Report # 8 on mudflow in Khuroson district, Khatlon Province, Tajikistan dated to May 28, 2009.

*Figure 2: View from the northern tip of Uyali town towards southwest. The topographical step that separates the mudflow affected towns from the agricultural plateau is clearly visible. Moreover, the deposits of the second mudflow of May14th 2009 are easily recognizable on the picture. Picture taken on May 15th 2009.*

The loess deposits above the affected towns exhibit the whole range of loess-typical erosion features pointing towards ongoing and highly active erosion processes. The villages are located at the end of a deeply incised erosion channel, through which the devastating mudflows where channelled towards the populated area. Similar channels can be found along the whole loess plateau towards the north and the south, often reaching considerable size, both, in wide and depth. Furthermore, so-called pseudo-carstic features as crevasses and funnels are very common and contribute to the ongoing erosion of the soil by facilitating the channelled inflow of surface runoff into the subsurface (Fig. 3).

*Figure 3: Pseudo-carstic crevasse above Uyali. Such erosion features are typical for loess deposits and allow the infiltration of surface runoff into the subsurface. Picture taken on May 15th 2009.*

## Event description

*Causes for the mudflow events*

As mentioned in the previous section, loess deposits as observable to the west of the mudflow affected settlements are by their nature highly susceptible to erosion by either wind or water. In loess areas, mudflows are thus a very common landscape forming factor capable to mobilize large amounts of soil material within short time intervals. To the west of Uyali and along the entire topographical step that separates the river plain from the adjacent hills, deeply incised gullies can be observed, which testify for an ongoing mudflow activity over the past decades.

The intensive agricultural activity to the west of Uyali requests large amounts of water that are provided by a Sovjet-time irrigation system that was reportedly built in 1972. As visible on the overview picture in the Annex, an open irrigation channel runs in N-S direction above the agricultural fields that were partly washed away by the mudflow events. Close to the mudflow source area, the water enters two pipes of 1 m diameter each that run underground for several hundred meters (Fig. 4). However, the capacity of the underground pipes is too small in comparison with the open channel what in combination with exceptional rainfall events can cause backwater and subsequently an overflow of irrigation water downhill towards the agricultural fields.

*Figure 4: Open irrigation channel above the agricultural fields to the west of Uyali. Clearly visible is the beginning of the underground pipes that run several hundred meters downhill. Picture taken on June 17th.*

*Trigger of the mudflow events*

Heavy rainfalls on April 20th and May 14th led to extreme surface runoffs in the hills above the mudflow affected settlements. Thereby, the open irrigation channel was filled over its capacity limit, provoking an overflow of water towards the agricultural fields. Traces of the overflowing water in the agricultural fields confirm the high erosional capacity of the water that caused vast backwards erosion on the top end of the pre-existing mudflow channel (Fig. 5).

*Figure 5: Flow indicators in the agricultural fields above Uyali. The open irrigation channel is situated approximately 100 m behind the camera position. View in flow direction towards the mudflow source area (washed away fields). Picture taken on June 17th.*

*Mudflow events of April 20th and May 14th*

The heavy rainfall together with the overflowing irrigation water caused retrogressive erosion on the top end of the pre-existing mudflow channel (Fig. 6). Thereby, an area of approximately 500 m x 200 m of agricultural fields was washed away to a depth of often more than 8-10 m. This leads to the assumption that during the two mudflow events a minimum of 600’000-700’000 $m^3$ of soil material have been displaced.

*Figure 6: Mudflow source area. At least 600'000-700'000 $m^3$ of loess soil have been washed away. View downslope towards the top end of the mudflow gully. Picture taken on June 17th.*

Notably, the second mudflow event of May 14th had the same source area as the first event of April 20th, extending the area of washed-away agricultural fields further upslope. Causes and Triggers of both events are thus the same.

**Prevention of comparable events in the future**

One must be aware that mudflows are quite common in Tajikistan due to the large amounts of loess deposits that can be found in this area. Hence mudflows are common landscape forming factors in the southern provinces of the country that cannot be mitigated totally. However, the devastating mudflows that destroyed the town Uyali and the adjacent settlements in spring 2009 are partially man-made, as it is highly probable that the large amounts of overflowing irrigation water considerably worsened the situation that already resulted from the heavy rainfalls.

According to villagers, it was the first time since the construction of the irrigation scheme in 1972 that the irrigation channels and pipes had not enough capacity to deal with the accumulating surface runoff. However, considering climate change and its associated accumulation of exceptional hydrological events, such runoff amounts might be observed more often in the future. It is thus advisable to hydrologically assess the existing irrigation scheme in order to come up with a convenient solution that inhibits the channel from overflowing.

Furthermore, authorities as well as villagers must be aware about the potential risks associated with mudflow events in Khuroson district. An awareness rising campaign among the villages adjacent to Uyali should thus be conducted in order to build capacity regarding disaster risks.