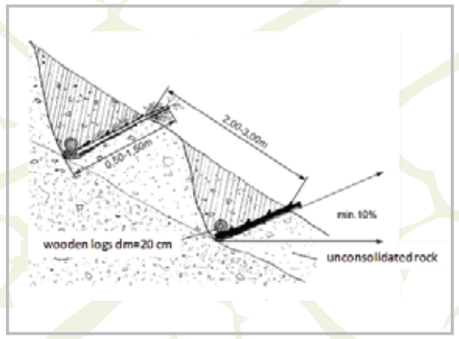
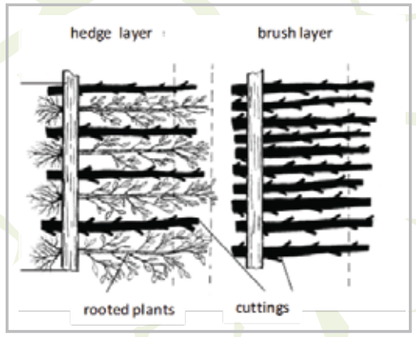
Rounding of overhanging edges

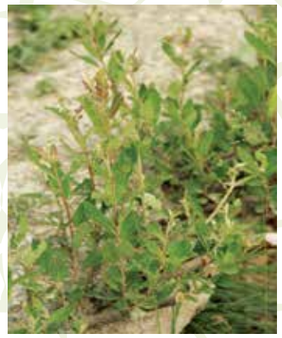
Characteristic of the gully were the overhanging edges, preventing development of vegetation at its steepest parts. Hence, the edges were rounded off on 400 running meters, improving stability of the underlying slope and preparing it for replanting or bioengineering measures.

Hedge brush layer

The hedge brush layering techniques were applied in the upper part of the gully. This technique helps to stabilise unconsolidated rock and to initiate pioneer plant species there, thus supporting and accelerating reforestation of such areas. The willow cuttings, rooted plants and brush layers were placed on terraces at least 50 cm wide, transversely to the wooden logs and with a counter fall to the main slope. The structure was filled up with the excavated material from the terrace above. Not more than 10% of the cuttings may be visible from the outside.







In section A, a total of four rows of the hedge brush layers were constructed: one 12 running meters to the left of the slope and three 10 running meters each to the right of it. Later, local plants cultivated in the nursery were propagated along the whole gully for further stabilization.

Benefits and possibilities

The transverse structures (palisades and check dams) reduce flow velocity and drag force, thus, preventing the gully from deepening. The palisades in the upper part already retain most of the sediment. This protects the settlement from mudslides and floods as well as from further cuts in section C.

The biggest benefit of these structures is, however, that with simple machinery and few resources, effective soil erosion control measures can be taken. The material, except for iron that supports the structure, can be locally sourced and easily transported. The integration of living plants ensures that this barrier is effective, even if the wooden logs are already rotten.

Thus, besides stability as part of the engineering effect, the ecological effect of the measures was manifested through habitat creation. Requiring little energy, bioengineering is also climate-friendly and supports maintenance of the landscape's aesthetical value.

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Integrated Biodiversity Management, South Caucasus (IBiS)

BioTopic

Integrated Erosion Control (IEC) Measures

Authors: Hanns Kirchmeir, Anneliese Fuchs, Natia Kobakhidze,
Christian Goenner & Albina Muzafarova

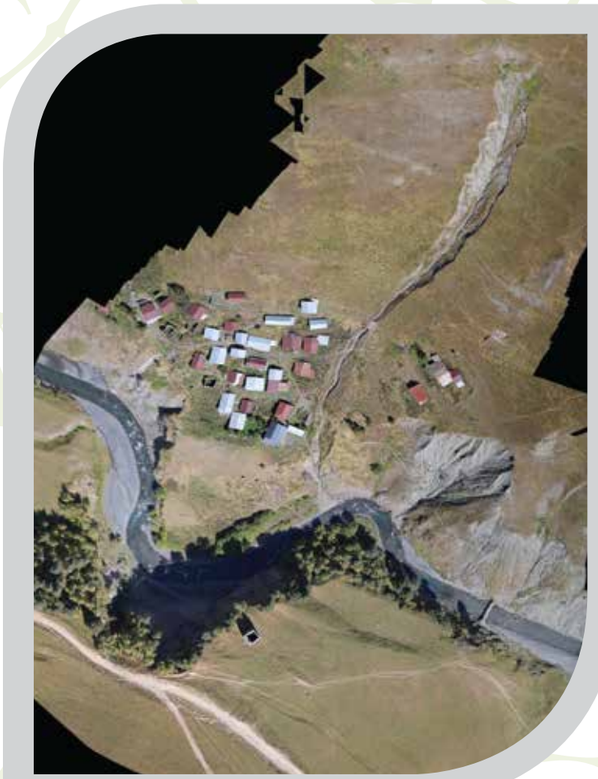


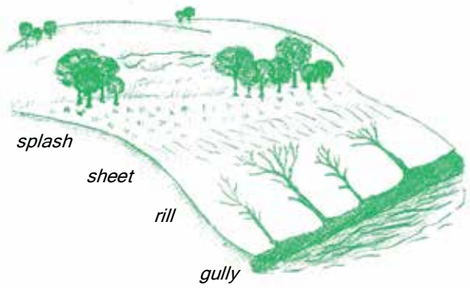
Photo 1: Jvarboseli rill from above (taken with a drone in 2016)

The Programme "Integrated Biodiversity Management, South Caucasus (IBiS)" was financed by the German Federal Ministry for Economic Cooperation and Development (BMZ). One of the objectives of IBiS was to contribute to erosion reduction and rehabilitation of degraded sites in Tusheti by implementing various measures, such as afforestation or bioengineering. In Jvarboseli, several integrated erosion control measures were carried out to stabilise a steep erosion gully.

Soil Erosion

Rainfall and surface runoff which may result from it, produce four main types of soil erosion in the South Caucasus: *splash erosion, sheet erosion, rill erosion, and gully erosion.* Splash erosion is generally seen as the first and least severe stage in the erosion process, followed by sheet erosion, then rill erosion and finally gully erosion (the most severe of the four).

In *splash erosion*, falling raindrops create small craters in soil, ejecting soil particles. If the soil is saturated, or if the rainfall rate is greater than the rate at which water can infiltrate into the soil, surface runoff occurs.



If the runoff has sufficient flow energy, it will transport loosened soil particles (sediment) down the slope (*sheet erosion*).

Rill erosion refers to the development of small, ephemeral concentrated flow paths that function as both sediment source and sediment delivery systems for erosion on hillslopes.

Gully erosion occurs when runoff water accumulates and rapidly flows in narrow channels during or immediately after heavy rains or melting snow, removing soil to a considerable depth.

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Gully erosion in Jvarboseli

The unsustainable use of pastures and forest areas leads to erosion, degradation, desertification and loss of biodiversity in the high mountain regions of the South Caucasus. In the village of Jvarboseli, Tusheti, there is a significant gully directly above the western part of the village. This gully is the result of a severe landslide in 2004. The gully erosion itself starts at an elevation of 2010 m above sea level and extends all the way down to the village at an elevation of 1910 m. The total length of the gully is approximately 300 m.

Methodology

In general, bioengineering measures help to restore the dense vegetation cover and generate soil erosion stabilisation effects by the local vegetation. To this aim, a multidisciplinary assessment of the site was a prerequisite for the soil bioengineering concept. The assessment considered the geomorphology, geotechnical failure processes, hydrological condition, soil texture, and, in particular, existing and potential botany. Based on the results, specific soil bioengineering measures were selected to reduce the enlargement risk of the gully erosion and to prevent damages to the village of Jvarboseli. The following soil bioengineering techniques were selected for different sections of the gully:

- vegetated wooden check dams (section B and C)
- rounding of overhanging edges (section A)
- vegetated palisades (section A)
- hedge brush layer (along the rill)

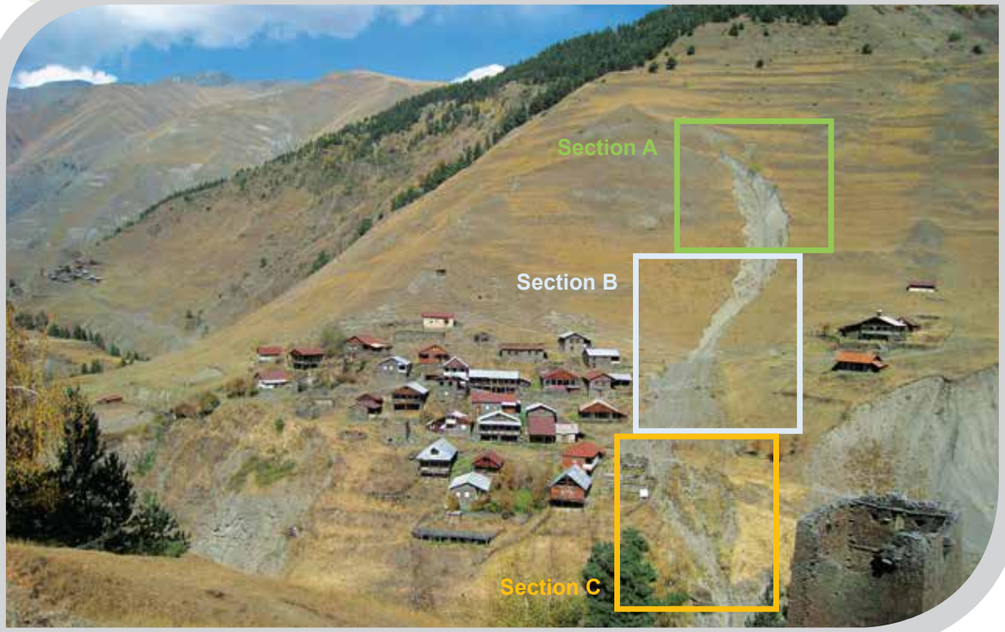


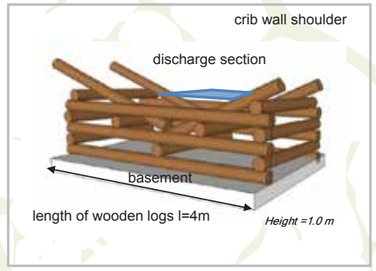
Figure 2: Overview of the implemented bioengineering work in Jvarboseli. Section A includes 13 vegetated palisades, hedge brush layer and rounding overhanging edges. Section B consists of 14 vegetated check dams. Section C comprises 11 vegetated check dams and 3 crib walls (a variation of check dams).

In addition to the bioengineering approach, an electric fence was set up to exclude the animals from grazing around and above the rill (at least for some time). The area above the rill was also afforested with local tree species.

According to the measurements from August 2019, as a result of the bioengineering constructions, the slope of the gully decreased from 35% to 25% in the upper part and from 80% to 30% in the lower part.

Vegetated Wooden Check Dams

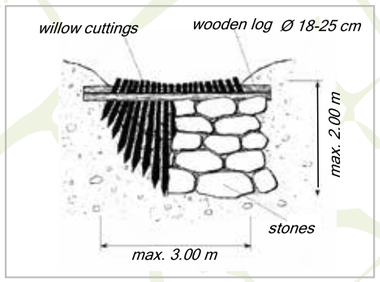
Vegetated wooden check dams are used as transverse structures for slope and bed stabilisation in steep gorges. The construction consists of three horizontal log-layers which were filled with drainage material; living branches or rooted woody plants were inserted into the side walls without blocking the discharge section. Locally available stones were used to prevent erosion of the wooden structure. The flowing water is being concentrated in the discharge section which is enforced by the shoulders of the structure to prevent alongside erosion processes.



In total, 14 vegetated check dams were built in section B and 11 in section C. The slope in section C was significantly steeper compared to the other sections. Therefore, although the general design of the check dams is similar, the structures in section C were built higher to obtain a balance slope. Additionally, three crib walls, check dams without wings, were built.

Vegetated palisades

In the upper part of the gully, 13 vegetated palisades were constructed. These constructions work like the wooden check dams, but the dimensions are smaller. The construction material for one structure consists of a wooden log with a length of around 3.4 m and approximately 50 pieces of cuttings.



First an excavation was carried out to allow the positioning of the horizontal wooden log and its integration into the side areas. Then the willow cuttings were set vertically to reduce the slope. Finally, the vertical cuttings were filled with the excavated soil, and stones are put in front of the structure. The construction is very simple, with a height of around 60 cm, and suitable for smaller gullies with less load and flow.

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