Consideration of geological and ecological factors in tourist trail planning: Case study of the Suchá Belá Gorge (Slovakia)

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ABSTRACT

The environmental degradation in the strictly protected nature area of Suchá Belá (National Park Slovenský raj - Slovak Paradise) is from a considerable part caused by a problematic outline of the tourist trail leading through the gorge. Frequent flooding of the trail supports off-trail movement, and many trail sections are placed in areas with ongoing geohazard activities. This study therefore investigates possibilities for alternative trail planning including trail design, maintenance and monitoring. An effective trail planning is generally recognised to be vital for nature protection, and as such has in recent decade been given much attention from academics and professionals. The internationally accepted guiding manuals can provide valuable knowledge, which this study reviews and compares to current trail planning in the Suchá Belá Gorge, in aspect of the site-specific geological and ecological factors. The considered trails should serve as educational tourist paths.

Key words: tourist trail planning, protected nature area, geological and ecological factors

INTRODUCTION

Several natural localities in National Park Slovenský raj are from aspects of safety and nature protection left in a critical state by inappropriate tourist load (e.g. Suchá Belá, Košariská pri Podlesku, Kyseľ) (National Park Slovenský raj Administration, 2008). A major reason seems to be an inability of tourist trails to suitably distribute tourism impacts (Rybár et al., 2010) and minimise off-trail movement (Janočková, Jablonská, 2012). Tourist trails in protected areas of Slovakia should be designed and maintained according to a formal environmental impact assessment. However, the key process in developing a master plan – the design, construction and maintenance of trails, lack an unified scheme and often does not involve biologists, engineer geologists, recreation planners and other professionals whose knowledge is vital to environmentally and user friendly trails (Forest service technology and development program, 2007). Attention should also be paid to the internationally accepted methods of trail planning, and consider the complex factors affecting a tourist trail and its natural surroundings.

This study outlines the complex aspects to consider in trail planning, and investigates possibilities for improvement of trail design, construction and maintenance on the example of Suchá Belá Gorge.

STUDY AREA

The gorge Suchá Belá is located in the National Park Slovenský raj, which covers an area of 197, 63 km^2 situated in the eastern Slovakia (Fig. 1). Geologically, it is a part of the Silicicum palaeoalpine tectonic unit. The essential part of the area is built up by Triassic (Ladinian - Cordevolian) wetterstein limestones (Mello et al., 2000). Given the natural characteristics, the Suchá Belá Gorge is a considerably problematic site when it comes to trail planning. The one-way trail leading through the gorge prevailingly leads on a stony stream bed

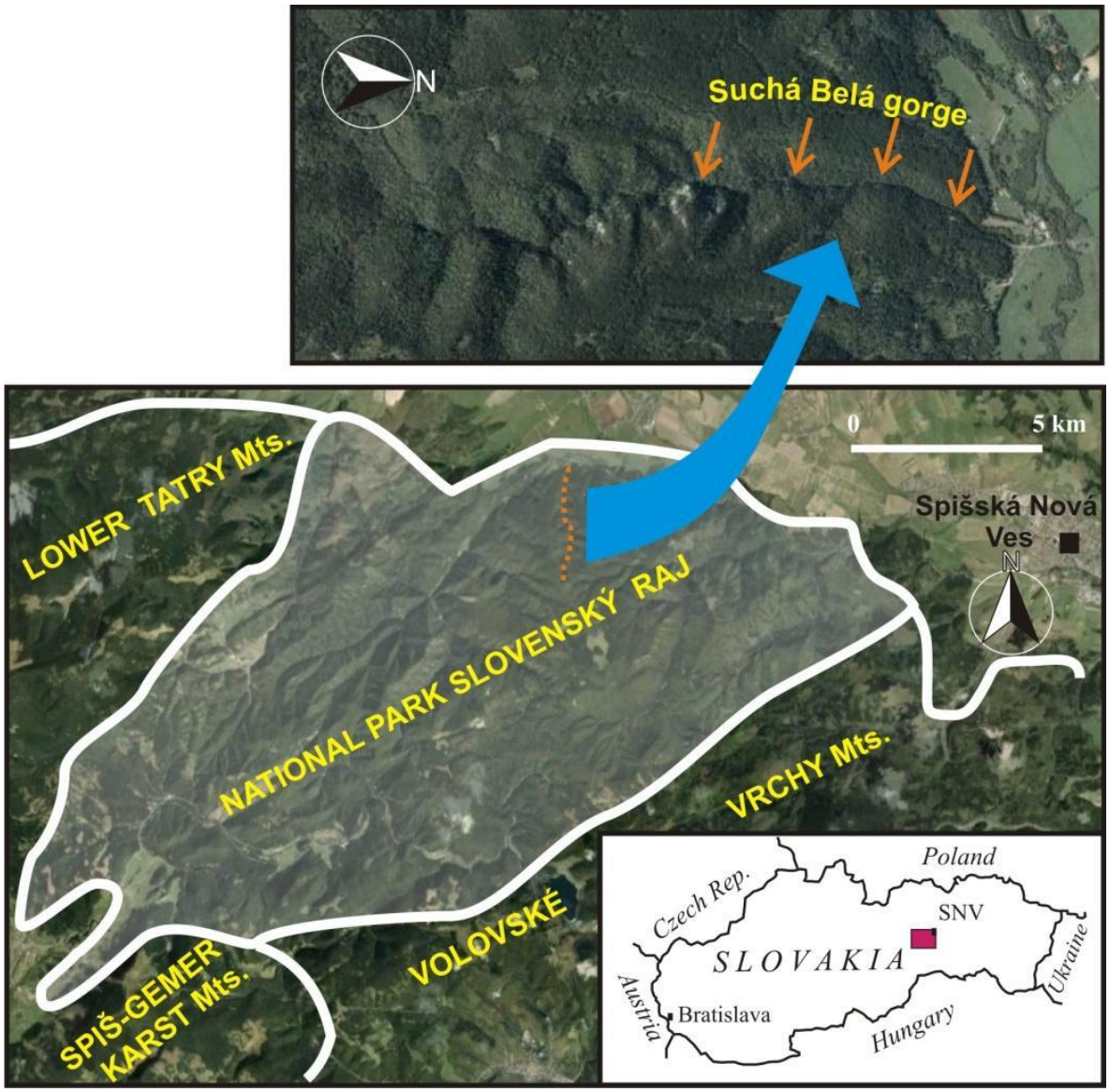


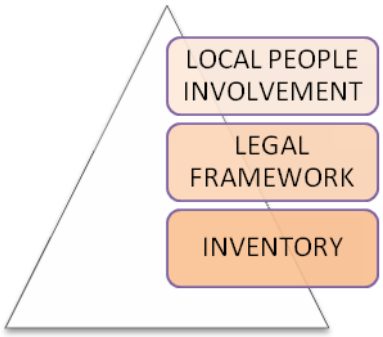
Fig.1 Localization of the study area. Note deeply incised gorge of SucháBelá.

formed in dolomite rock, occasionally covered by wood, tree trunksand gravel depositedbywater. The trail is closely fitting a steep exposed terrain with high relief energy - a typical setting for frequent occurrence of geohazard. The sides of the gorge are composed of loose loam and loam with stones overlying the carbonate bedrock. The cover is only occasionally vegetated by trees that have stabilizing effect.

TRAIL PLANNING

Prior to developing a master plan, the preparatory steps must be tackled to ensure sustainability, and avoid user conflict (Fig. 2). Tourist trails are built for people to enjoy the outdoors and learn to appreciate protection of natural resources. In an area of a national park that primarily aims for nature protection, the idea is to build sustainable trails which among other have negligible effect on soil loss and generation of landslides, do not adversely affect animal life and minimise disturbance of vegetation cover. A suitably designed trail requires minimal long-term maintenance and rerouting, which saves both budgets and time. Every step of the trail development should be specified by a master plan (Fig. 3).

1. Preparatorysteps



Obtain local acceptance

Assure compliance with national and regional plans, laws, regulations, guidelines

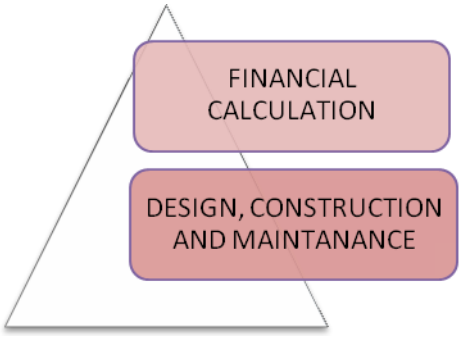
Characterize natural features, environmental protection, existing trails

Determine trail users, number and distribution of visitors throughout the year, expectations of visitors

Analyse activities linked with particular locations

Fig. 2 Summary of aspects to consider prior to developing a master plan for trail planning (based on Ecological Tourism in Europe and UNESCO MaB, 2007, Forest service technology and development program, 2007, InternationalMountainBicyclingAssociation, 2012, Schmidt, 2009, modified).

2.Master plan



Trail specifications:

Type of trail flow
Recreational activity for which the trail is intended
Intended amount of use
Physical characteristics of the land
Ecologic considerations
Aesthetic considerations

Fig. 3 The general steps of trail development that are to be defined in a master plan (based on Ecological Tourism in Europe and UNESCO MaB, 2007, Forest service technology and development program, 2007, InternationalMountainBicyclingAssociation, 2012, Schmidt, 2009, modified).

The level of impact on the natural environment directly depends on the design, construction and maintenance of the trail. Among frequent mistakes in trail building is placing the trail on level terrain, not outsloping the trail placed on sideslopes, or placing the trail in problematic terrains with frequent geohazard occurrence. Trails are then along with their built-in infrastructure often damaged by the natural phenomena (Fig. 4), and cause or support erosion and other negative geohazards. As the viability of a tourist trail is greatly influenced by forms of relief, type of rocks forming the trail surface, and the climatic factors (Bielawska and Tsermegas, 2009; Marion and Wimpey, 2007), the following analyses link the physical processes and the current trail outline in SuchéBelá to identify the limitations, and recommend appropriate corrections.

The key issue influencing the trail preservation in Suchá Belá is the ephemeral, intermittently flooded streamleading through the gorge. Avoiding the flooded trail results in developing alternative paths on terrains that are unstable and susceptible to erosion and sliding (Fig. 4).

Fig. 4 Flooded tourist path cause tourists to form alternative paths on an unstable terrain.

Such illegal paths attract additional use by tourists when the water level falls, supporting landslides, widening of trail sides, trampling of vegetation and exposing tree roots. Therefore the most often flooded trail sections should be stabilised by barriers (Fig. 5), redirected, or crossed/passed over by help of technical infrastructure to prevent off-trail movement.

Rerouting or stabilizing of the trail can also be considered in sections that are repeatedly affected by geohazard activities such as landslides or rock fall, e.g. as shown in Figure 6.

Alternatively, the affected trail sections could be rerouted on the adjacent terrain where informal paths have already been permanently trampled. Suitability of any trail altering would depend on specifications of complex abiotic and biotic factors (e.g. type of soil, geological and geomorphologic structures and geodynamic processes, occurrence and type of vegetation). After analyses of these factors, the reconstruction would have to fulfil the below summarised basic conditions of design and construction, resulting in adequate maintenance. In general, the trail design should respect the terrain contours, while the trail construction should assure the sustainability of the trail (Fig. 7).

Trail design tries to copy the existing contours by traversing the hillside. This is because even in case of only a slightly inclined trail, its perpendicular placement to the contours would cause trenching (Schmidt, 2009).

Generally, the tread (travel surface of the trail) is to be build by the ‘half rule’ to assure proper drainage, meaning its grade should be less than half the sideslope grade. The sideslopes in Suchá Belá are for the most part of a gradient of over 25˚,

Fig. 5 Suggested reworking of the trail in the sections exposed to frequent floods. The suggested reworking protects vegetation (see exposed tree roots on the stream bank) and lowers the risk of sliding

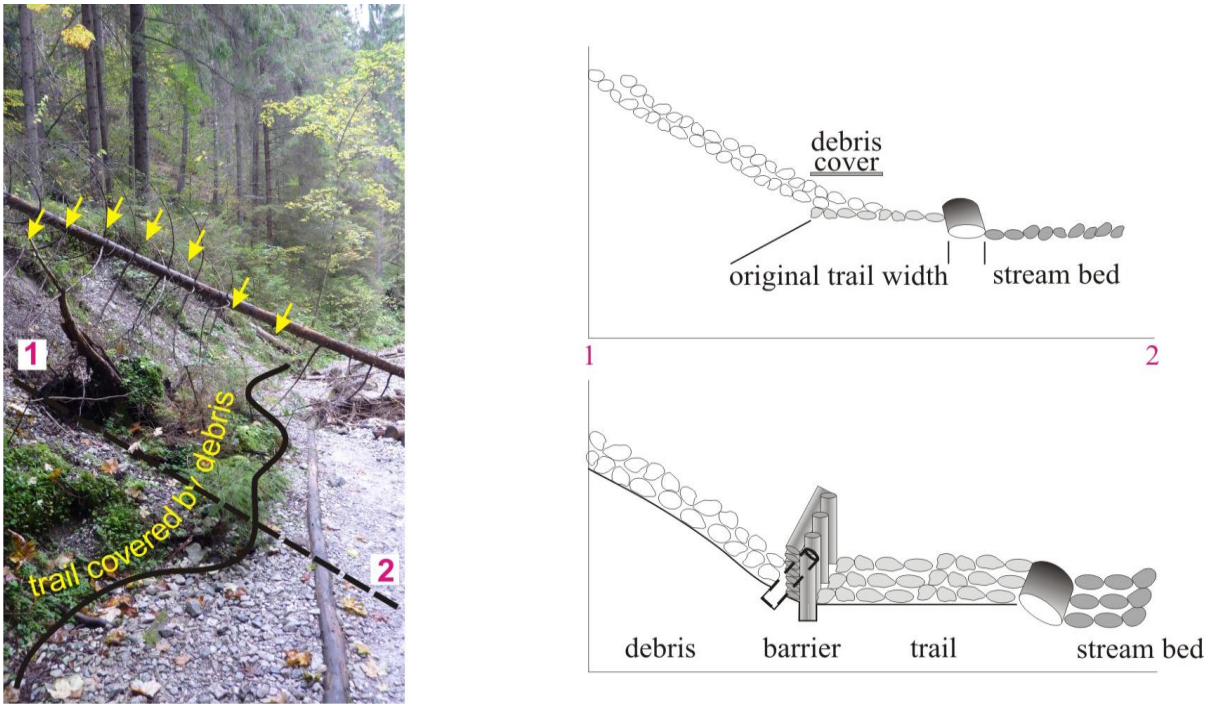


Fig. 6 Suggested protection of the trail against the rock debris sliding from the neighbouring slopes. The barrier is made from tree logs, arranged vertically and horizontally along the trail. A higher stability of the barrier is assured by inclined crossbar. A) The present state of analysed trail section B) Suggestion of stabilizing the trail.

therefore the trail would be of an inclination lesser then 12,5˚. This, however, exceeds the '10 percent rule' of a sustainable trail, that is, the trail incline should reach a maximum of 10°. In such case, it has to be taken into account that an overall trail grade should be kept to 10 percent or less, and should in no trail section be higher than 15°. Exception can be made on solid rock, where the earthen sections between rocks would be secured against loosening by armouring. To reduce trail incline and probability of erosion on steep slopes, built-in infrastructure in form of steps or ladders can be placed on the steep descends and serpentines (Forest service technology and development program, 2007). This also adds the fun-factor to the trail, and keeps the traffic from going off trail. In either case, use of shortcuts should be prevented by placement of barriers of a preferably natural material such as stones or logs.

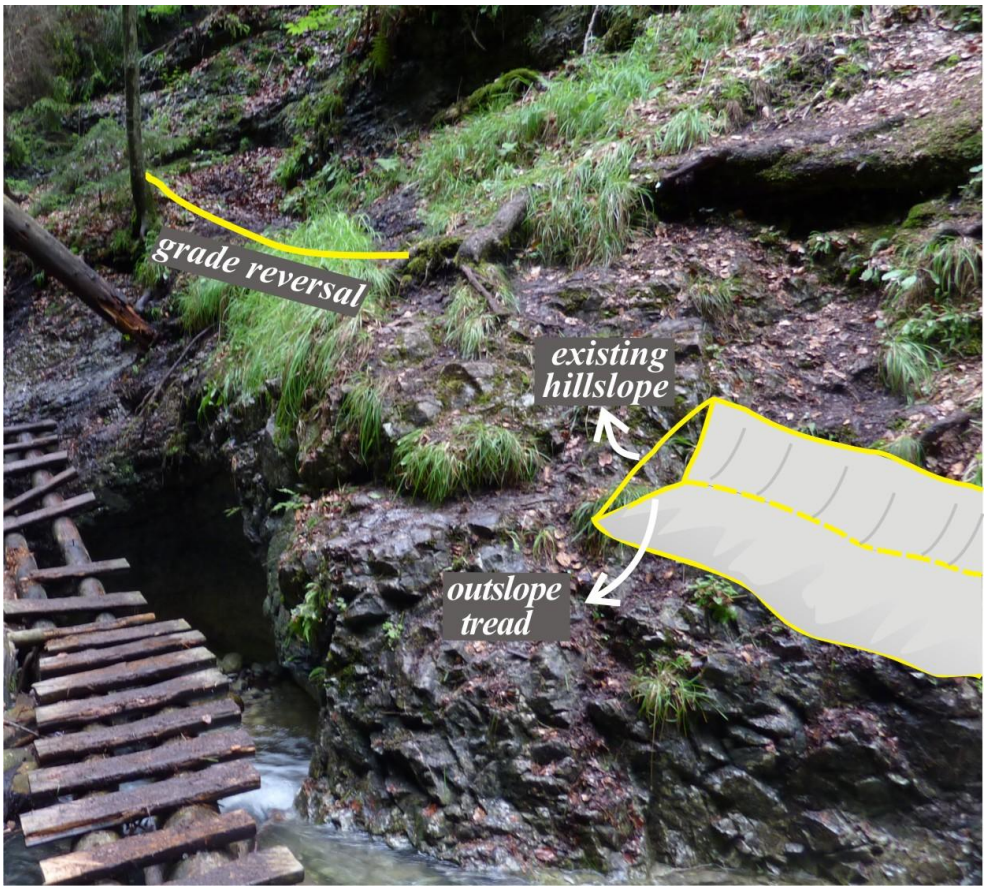


Fig. 7 Example of a contour trail with sustainable trail grades, outsloped trail tread, and water drainage in form of created grade reversals.

To allow for sheet water flow, the tread has to be slightly outsloped by lowering the tread on one side by at least 5 percent (International Mountain Bicycling Association, 2012). A hiking trail should be at least 0,5 m to 1,5 m wide (Forest service technology and development program, 2007).

Keeping in mind the above guidance, a durable trail is to be build by full-bench construction (full tread width is cut into hillside) or partial-bench construction (the tread is supported by fill material). A full-bench construction is in most cases preferred for easier construction and a less demanding maintenance (Riteret al., 2001). The exposed area above the tread called backslope has to be built stable by following the trail specifications; it should be angled until no soil falls down on the tread, ideally equaling the angle of the sideslope repose.

The trail corridor, meaning the tread, the area above the trail and the area to the sides of the tread, is usually cleared of vegetation, fallen trees, boulders etc. A hiking trail corridor in level terrain is normally cleared 1 meter to either sides from the centre, 0,3 meters of tread edge from all plants and debris, and 0,5 meters from trail edge of plants higher then 0,5 meters (Forest service technology and development program, 2007). However as the study area is strictly protected and minimal interference is wanted, only the material directly affecting the tread can be removed.

The key issue in trail design, construction and maintenance is the surface water control. The often mentioned measures that are relevant for Suchá Belá are grade reversals, drainage dips, and installment of water bars. Grade reversals are short changes to the direction of trail grade to redirect water off the trail. They are preferred for an undemanding maintenance and for being aesthetical unobtrusive, and should be placed more often with the

increasing steepness of slopes (Ecological Tourism in Europe and UNESCO MaB, 2007). Another tool to stabilize the trail and prevent erosion is installment of water bars in form of rock or native logs. Preferred options to water bars are drainage dips providing a change in gradient of the trail alignment to dissipate the water flow. Similarly as in case of water bars, the drainage dips are useless without regular maintenance.

Among the priorities of trail maintenance is keeping travelers to the center of the trail. Maintaining the trail solid, outsloped, and to the designated width should be aimed by removing slough (soil, rock, and debris moved to the inside of the tread) and berms (soil built up on outside of the tread) (International Mountain Bicycling Association, 2012). Sloughing narrows the trail and flattens the outer trail edge on which the travellers then walk upon, which eventually leads to eroding of the tread surface. The traffic can be directed to the centre of the tread by placing trailside material that tourist will avoid, such as a log or rocks, on the lower tread edge.

CONCLUSION

An effective trail planning can prevent adverse nature impacts caused by trampling disturbance or interference of the trail to natural environment. The process of tourist trail planning consist of a complex analyzes of the area, and includes cooperation of scientists (biologists, engineering geologists, hydrogeologists, ecologists and building engineers) and recreation managers to build both nature and user friendly trails. The educational purpose of the tourist trail can be enhanced by information boards interpreting the general nature topics including the geological environment (e.g. rock types, geological structure of the specific locations along the trail).

This study has looked at the basic methods of trail design, which, however, can only be viable if all of the other aspects of trail planning process are met. As the current trail outline in Suchá Belá is in many of the trail sections repeatedly affected by the natural process, and increases probability of off-trail movement and geohazard, some trail sections should be rerouted by correct trail planning methods. An alternative is to place the trails on the hillside adjacent to the river bank, where the priority would be to build a trail that would rightly balance recreation needs and soil protection, with minimal maintenance requirements. The key considerations in trail design and construction are to follow the existing contours, construct the trail according to rules of maximal sideslope and trail inclination, outsloping, choosing suitable methods for stabilizing the trail, and assure proper water drainage. The condition of the trail, including deterioration of signs, potential tripping hazards, development of short cuts and other, must be regularly monitored and maintained accordingly.

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