

DEGRADATION OF LANDSCAPE IN SERBIAN SKI RESORTS-ASPECTS OF SCALE AND TRANSFER OF IMPACTS

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The environmental impacts in Serbian ski resorts (Kopaonik, Zlatibor, Stara planina, Divčibare) are very strong, leading to degradation of unique mountain landscape, and functionality losses. Processes of urbanization, construction or improvement works, cause hard degradation of topsoil and native vegetation. The logging, large excavation activities, erosion, noise and water pollution constantly impact the habitats of all animal and plant species residing in small areas. The process leads to severe fragmentation of the remaining old-growth forests, endangering future subsistence. Consequences of mismanagement in ski areas are noticeable in downstream sections of river beds, causing floods and bed-load deposition, with high concentration of pollutants, in reservoirs for water supply. Legal nature-protection standards are weakly implemented in regional ski areas. Effective protection of landscape in Serbian ski-areas is based on careful considerations of impact assessment at all levels of planning (spatial and urban planning) and designing activities, which enables application of restoration concept, in accordance with general goals of environmental protection (preserving biodiversity, CO₂ sequestration, attenuation of effects of global climate changes).

Key words: landscape, degradation, impacts, protection, restoration concept.

INTRODUCTION

Construction of new and improvement of existing ski resorts, is very attractive activity in transition societies of Balkan region (Serbia, Montenegro, Bulgaria), but involves numerous environmental violations during and after work (Ristić, 2007; Matto, 2007). The logging and construction works, large excavations, erosion, noise and water pollution constantly impact the habitats of all animal species. The process leads to severe fragmentation of the remaining old-growth forests, endangering future subsistence. The shallow soil coverage on the steep slopes starts to be stripped away with the onset of a short, intensive rainfall, snowmelt or

their coincidence, thus creating a source of sediment that can be easily transported into streams, lakes or wetlands. The large excavation works on the steep slopes cause debris flows and land slides, leading to degradation of the unique mountain landscape, functional and aesthetic problems. At the same time, downstream channel sections became more exposed to flooding.

SKI RESORTS OF SERBIA

In former development of mountain areas a few ski resorts were formed (*Figure 1*). A major and the oldest ski resort in Serbia is located on the Kopaonik mountain, in the area of the National Park. This ski resort offers about 50 km ski slopes for alpine skiing, about 18 km ski slopes for cross-country skiing, interconnected with 24 chairlifts and ski lifts. The total investment in the construction of new ski runs

and chairlifts, between December 2004 and August 2009, amounts to about 20,000,000 € Second largest ski resort is "Brezovica", on the mountain Šara, which is located along the border between Serbia and Macedonia. Ski center comprises about 16 km ski slopes equipped with 5 chairlifts and 5 ski lifts. Ski resort "Stara planina" is being built on the biggest mountain in East Serbia - Stara



Figure 1 – Disposition of main ski resorts in Serbia (1-Kopaonik; 2-Stara Planina; 3-Zlatibor; 4-Divčibare; 5-Goč; 6-Brezovica)

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planina, which runs along the Serbian-Bulgarian border. Three ski slopes of 3,700m in length and appropriate installations (water reservoir for artificial snow making, 10,000m³; pipeline, snow-guns) were completed during the first construction phase. In December 2007, a new detachable quad chair lift and one ski lift were started up. Total value of these investments surpasses 15,000,000 €. Ski-resort „Zlatibor“ was renovated in period 2006–2009, with 4km ski runs and a new detachable six chair lift. Construction of another new ski slope has been started in the proximity of the locality Divčibare, on the Maljen mountain in 2006. By the end of 2006, a construction of one 850 m long ski slope with double chair lift had begun, totaling to approximate 1,500,000 € investment.

Ski resorts in Serbia were formed without conceptual level guidelines for erosion control projects, in accordance with BMP's (Best Management Practices). Construction activities involved numerous environmental violations during and after work, with huge damages. After massive clearings and machine grading of slopes erosion damaged surface soil layer, thus creating a source of sediment that was easily transported into local streams (Macan et al., 1997; Ristić et al., 2005). Disturbances caused functional and aesthetic problems along and around all the newly-built ski runs

(Ristić et al., 2007). The logging, large excavation activities, construction works on steep slopes, caused appearance of furrows, gullies, debris flows and shallow land slides, especially in period April–October. Fast surface runoff starts to strip away the shallow soil coverage on the steep slopes, with the onset of a short, intensive rainfall, snowmelt or their coincidence, thus endangering skiing infrastructure and road system.

Legal nature-protection standards are weakly implemented in regional ski areas. Some activities such as clear cuttings in National parks are contradicted two main park management objectives: conservation of ecosystems and preservation of biodiversity (ski resort „Stara planina“ is located in Park of nature; ski resort „Kopaonik“ is located in National Park). However, environmental violations were not so dramatic like in neighboring Bulgaria („For Earth“, 2007), but enough provocative to become object of scientific research (Perović, 2008) and theme for numerous critical articles in daily news.

EROSION PROCESSES AND LANDSCAPE DEGRADATION AT THE SKI RESORT „STARA PLANINA“

Representative (negative) example was the beginning of building of ski resort „Stara planina“, although the numerous negative

impacts have been noticed in another ski resorts. The hardest forms of terrain degradation were recorded in the proximity of locality Babin Zub, in the zone of ski runs, ski lifts and access roads. Destruction of autochthonous beech forest and meadows (over 1600 m.a.s.l.) produced anthropogenic bare land as dominant surface in upper part of Zubska river watershed (Figures 2, 9). Intensive erosion processes caused appearance of furrows and gullies, almost 3.5m deep (Figure 4).

In the region of Stara Planina, sediment yields ranged from 6460 m³km⁻²year⁻¹ on disturbed surfaces (ski run „Konjarnik 1“, Zubska river watershed), to 450 m³km⁻²year⁻¹ on undisturbed surfaces (Repuški stream watershed). Sediment production was calculated using a method of „Erosion Potential“ (method prof. Gavrilović). Sediment yields were nearly 14 times greater from red sand and granite ski-run soils than from undisturbed (native) sites (Ristić et al., 2009). In North America, sediment yields were nearly four times greater from disturbed granite ski-run soils than from native sites (Grismer and Eliss, 2006.). Even thinnings carried out as salvage silvicultural cuttings, increase sediment yields 28–45 times (Macan et al., 1997.).

Zubska river follows ski run „Konjarnik 1“ (K₁), in which inflow ski runs „Konjarnik 2“ (K₂) and



Figure 2 – Anthropogenic bare land on Stara planina



Figure 3 – Network of access roads



Figure 4 – Deep gullies on ski run „Konjarnik 2“ (Stara planina)



Figure 5 – Products of erosion on ski run „Konjarnik“ (Stara planina)



Figure 6 – Torrential flood in Zubska river bed



Figure 7 – Deposition of bed load in Zubska river bed



Figure 8 – Disposition of ski runs on Stara Planina

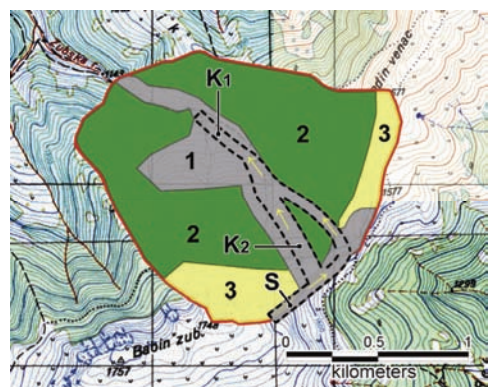


Figure 9 – Composition of surfaces on upper part of Zubska river watershed (1-anthropogenic bare land; 2-forest; 3-meadows)

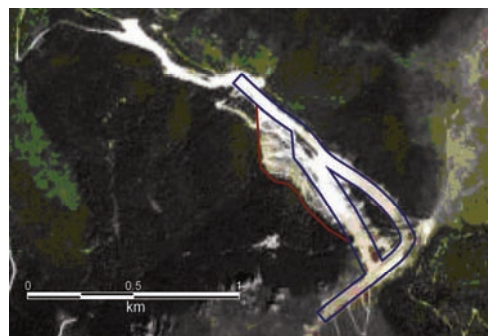


Figure 10 – Immediate zone of ski resort „Stara Planina“

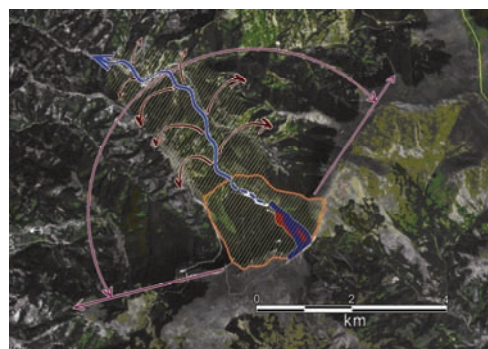


Figure 11 – Wider zone of ski resort „Stara Planina“

gravitates to Zubska river and its tributaries, has expressive slope of terrain ($I_m = 47.57\%$), and erosion products reach ski runs or hydrographic system very easy. Fast surface runoff accelerates transport process. Network of access roads (Figure 3) helps concentration of runoff: roads had been built without asphalt cover and structures for evacuation of water: road culverts and channels. Fast concentration of rainfall water increases frequency of torrential floods, with high content of sediment (Figures 6, 7).

ASPECTS OF SCALE AND TRANSFER OF IMPACTS

Ski resort „Stara planina“ was formed in upper part of the Zubska river watershed, on very steep terrain, in the area with a few local streams (Figure 8).

Destruction of vegetation cover (forest and meadow stands) caused hard soil degradation (humus-silicate soil; red sand skeleton), thus creating unfavorable composition of surfaces (Figure 9), with 46 hectares of anthropogenic bare land (almost 25% of Zubska river watershed, in relation to profile in the proximity of ski run „Konjarnik 1“, about 1.5 km far away from peak point).

Next forms of degradation were noticed in immediate zone of ski resort (Figure 10):

- destruction of vegetation cover (forest and meadow stands);
- endangering of animal and plant species;
- excessive erosion (network of furrows, deep gullies, shallow land slides, debris flows);
- intensive production of erosive material and fast transport to hydrographic system;
- fast forming of torrential flood waves;
- degradation of visual and aesthetic characteristics of landscape.

Immediate zone of ski resort comprises spatial diameter of about 1.5 km (Figure 10). Elements of degradation are easy noticeable,

negative impacts have strong, synergy intensity, thus creating conditions for extreme spatial destruction (Figures 2-5).

Next forms of degradation were noticed in wider zone of ski resort (Figure 11):

- more frequent appearance of torrential floods;
- increased concentrations of sediment and pollutants in streams;
- endangering of road system and residential objects;
- disturbing of common economy activities of local dwellers.

Wider zone of ski resort (Figure 11), comprises spatial diameter of about 5 km. Elements of degradation are not easy noticeable, negative influences dominate in the zone equivalent to narrow zone of ski resort (source of impacts and starting area for their transfer). Anthropogenic bare land takes less than 5% of Zubska river watershed (in the relation to the profile 4.7 km far away from the peak point), but it is zone of forming torrential flood waves. Transfer of impacts is going on through Zubska river bed, with following effects: demolishing of bridges; fulfillment of road culverts by sediment; destruction of road system. Entire area is very isolated (the nearest small city is Knjaževac, 60 km far away), and in this way becomes additionally marginalized with interruptions of already weak economical activities. Visual degradation of landscape is noticeable from remarkable view points of neighboring relief.

DISCUSSION

The lack of planned and organized erosion control activities during designing, building, maintaining or improvement activities had strong impacts on ski-runs in Serbia. Restoration and erosion control works, carried out during 2008 in ski-resorts „Kopaonik“, „Stara planina“, „Zlatibor“ and „Divčibare“, were the first of that kind in Serbia. Lack of investments for erosion control works

Table 1: Review of expenses for restoration and erosion control works

Ski resort	Ski-run	Expenses for restoration and erosion control works	
		RSD	€
Stara planina	„Konjarnik 1“	85,500,000	900,000
Stara planina	„Konjarnik 2“	9,500,000	100,000
Stara planina	„Sunčana dolina“	28,500,000	300,000
Divčibare	„Crni vrh“	28,500,000	300,000
Zlatibor	„Čigota“	14,250,000	150,000
Zlatibor	„Tornik“	19,000,000	200,000
Zlatibor	„Zmajevac“	33,250,000	350,000
total:		218,500,000	2,300,000

(immediately after basic construction works) produced later expenses (Table 1).

The onset and completion of all activities fell within period May-October, 2008, in accordance with basic restoration (Krautzer et al., 2006) and erosion control works principles (Ristić et al., 2007): technical works were finished until the end of September, biotechnical until the middle of October (Ristić, 2008.).

Restoration and erosion control works were carried out in conditions of hard terrain degradation, after completion of basic construction works (ski lifts, access roads, ski runs). Presented expenses are the most expensive variant. Preventive activities, before and during basic construction works, reduce expenses for 75-80% (in comparison with amounts from Table 1).

CONCLUSIONS

- Construction and improvement works caused hard degradation of topsoil and native vegetation.
- The environmental impacts in ski resorts were very strong, leading to environmental degradation and functionality losses.
- Land degradation on ski-runs (the highest level of destruction) leads to transfer of impacts, usually downstream through beds of local streams.
- Providing of planning and designing documentation, with Environmental Impact Assessment Studies, minimize possible risk.
- Protection and reclamation of disturbed surfaces within same constructing season, in accordance with natural ambiance.
- Maintaining of ski-runs has to be based on determined BMP's (Best Management Practices).

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