

# Soil management practices in the Alps

*A selection of good practices - Case Study 11*



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## CS11.

# Integrating soil protection in forest management planning, Pokljuka, Slovenia

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<b>Country, Region:</b>	<i>Slovenia, Triglav National Park, Pokljuka</i>
<b>Organisation:</b>	<i>Slovenia Forest Service</i>
<b>Sector:</b>	<i>forestry – forest harvesting operations</i>
<b>Land uses:</b>	<i>forest</i>
<b>Main soil threat:</b>	<i>soil compaction, soil contamination, erosion</i>
<b>Key soil ecosystem services:</b>	<i>wood production, biodiversity, water filtration, recreation and tourism, carbon sequestration</i>
<b>Summary:</b>	<i>Unplanned use of modern forest harvesting operations (FHO) can lead to soil degradation and consequently to the reduction of forest productivity. Thus, integration of soil protection in forest management taking into account soil characteristics, climate conditions and the best available forest harvesting operations is needed. The available soil data and soil map for Pokljuka plateau were used to elaborate a derived map showing suitability of FHO use. The used approach is explained, and its applicability is discussed.</i>
<b>Keywords:</b>	<i>forest management, harvesting technology, soil compaction, Pokljuka, Triglav National Park</i>



## Background and description of the problem

With its 6,300 ha of forests, the Pokljuka plateau is the biggest forest complex in Triglav National Park, Slovenia. The forests provide many ecosystem services (ESS) including forest biomass production, global climate regulation (carbon cycle), recreation and spiritual services, habitat provision (biodiversity), water retention, filtration and purification, as well as local climate regulation. High-valued Norway spruce forests require qualitative sustainable forest management and provide economic benefits for forests owners while respecting other ESS.

Pokljuka forests in basic figures: average growing stock is 492 m<sup>3</sup>/ha, annual increment totals 8.15 m<sup>3</sup>/ha, annual felling in managed forests totals 8.4 m<sup>3</sup>/ha.

Modern forest harvesting operations (FHO) in use have several advantages and disadvantages. Heavy machinery effects are substantial, especially on soils, but on the other hand they are very economically efficient, safer for workers and useful, particularly in cases of salvage cutting and natural disasters. Regardless of the high efficiency of FHO, unplanned use of FHO can lead to soil compaction, destruction of soil structure, loss of soil biodiversity, erosion, poor soil aeration and consequently to the reduction of soil fertility and forest productivity. The soil compaction is regarded as a major problem because it can be permanent, which means that the soil porosity and related soil ecosystem services cannot be restored. There had been conflicts and disagreements about the (non-critical) use of MHT between owners, contractors, forest service and other stakeholders (e.g. tourism and recreational activities).

To avoid the above listed problems, the SFS is integrating soil protection in forest management planning taking into account soil characteristics, climate conditions and the best available forest harvesting operations.

## Expected improvements / contribution to better soil management

Sustainable use of FHO is an important subject for SFS. SFS work is based on the following guidelines: Instruction for work preparation in stands, relevant for FHO and guidance for FHO practice, where limitations, advantages, technical details and impact on forest soils are discussed. Workshops concerning FHO topic ranging from technical details to soil protection have been organised.

For the Pokljuka plateau, FHO suitability map was created taking into account soil characteristics, climate conditions and the best available harvesting techniques. The map was integrated into the forest management plan for Pokljuka as additional guidelines for FHO use. Although the map was compiled using scientific data, it is very applicable, understandable and therefore useful for field operatives (Figure 3). Therefore, it is an expert base decision tool to reduce soil degradation and minimise conflicts with contractors and other stakeholders.

## Stakeholders and knowledge transfer

The attitude of different stakeholders towards FHO has been and still is diverse. To overcome differences in attitude and find appropriate solutions, a participatory process consisting of several workshops (WS) has been introduced in 2002 and has been repeated several times (2010 and 2018). Such uniform approach enabled us to get a systematic view on participants' attitude towards the use of FHO over the last two decades. The results show that soil damage caused by FHO is one of the most important issues. Thus, several activities for better integration of soil protection in forest harvesting operations were performed within the Links4Soils project. Maps showing risks of harvesting operations for soil degradation based on existing soil data were prepared and guidelines for forest operations were upgraded. Important part of the activities was WS (2018) on soil protection for forest experts and practitioners, organised as a continuation of the participatory process. Participants from different fields discussed sustainable use of FHO with special emphasis on soil degradation prevention. The participants' opinion, suggestions and disagreements were further used to improve guidelines for planning and use of FHO.

## Data and methods

Expertise about forest soils including soil description, soil sample analyses and the soil map was performed in forests of Bohinj valley, Pokljuka and Mežakla (Pavšner, 1967) plateaus. The fundamental analysed soil parameters are pH, the depth of horizons, soil organic matter (humus) content, C, N, C/N ratio,  $K_2O$ , CaO,  $P_2O_5$ , physiological activity of  $P_2O_5$ ,  $K_2O$ , soil skeleton, texture, humidity and porosity. From soil data, the soil experts estimated soil productivity, acidity, nutrients availability, soil water holding capacity, and soil parent material (geological substrate) for 42 identified different forest soil types and complexes of Pokljuka plateau area. Furthermore, the soil types and complexes were mapped at a scale 1:10,000 that is most applicable for the decision making at local level. The report and the map were designed to get better understanding of soil capacities, threats and soil ecosystem services and thus to improve forest management in the area.

Using the available soil data, the sensitivity to compaction, water retention and soil erosion was assessed for each of the 42 forest soil types and complexes. The soil types and complexes were further classified in three categories according to suitability for FHO use. The classification and soil map were then used to elaborate a derived map showing suitability of FHO use at the Pokljuka plateau.

## Results

Table 7: Classification of soil types into FHO categories

SOIL TYPE	MAJOR SOIL PROPERTIES	FHO CATEGORIES	CONDITIONS
No soil, very shallow drained soil on compact parent material	Depth (shallow soil), drainage (drained soil)	1	No restrictions
All other soil types: histosols, leptosols, gleysols, cambisols, stagnosols, luvisols	Soil development stage (developed soil), organic and mineral horizons, depth, texture	2	Frozen soil or snow cover is higher than 0.5 m or suitably dry soil
Podzols, peat bogs	Rare soil types, organic soil	3	Not allowed in any condition

## Transferability and applicability to best soil management practice

The approach is widely applicable in areas where soil maps exist and the basic data for soil types are available. Foresters with help of soil specialists could classify soil types in categories showing suitability for FHO. Such maps are an important basis for better decision making on FHO at local level and thus improve forest management and soil protection, which is especially important in mountainous areas.

## Environmental and climate change impact

Soil acts as a storage of greenhouse gases and represents important terrestrial pool of carbon. Providing nutrient cycling and filtering services, soil regulates greenhouse gas fluxes. Soil compaction has a negative impact on virtually all physical, chemical and biological soil properties and, consequently, on the provision of soil ecosystem services. Soil compaction is causing modified soil physical properties, poor soil aeration, lower biological activity that can decrease availability of macro and micro nutrients, nitrogen fixation and carbon cycles in favour of more emissions of greenhouse gases under wet conditions (Nawaz et al. 2013) to preserve forest soil quality and retain forest productivity. Therefore, the use of FHO in forests should be carefully planned. The FHO suitability map helps in regulating the use of FHO and is a fundamental step in sustainable management of forest soil.

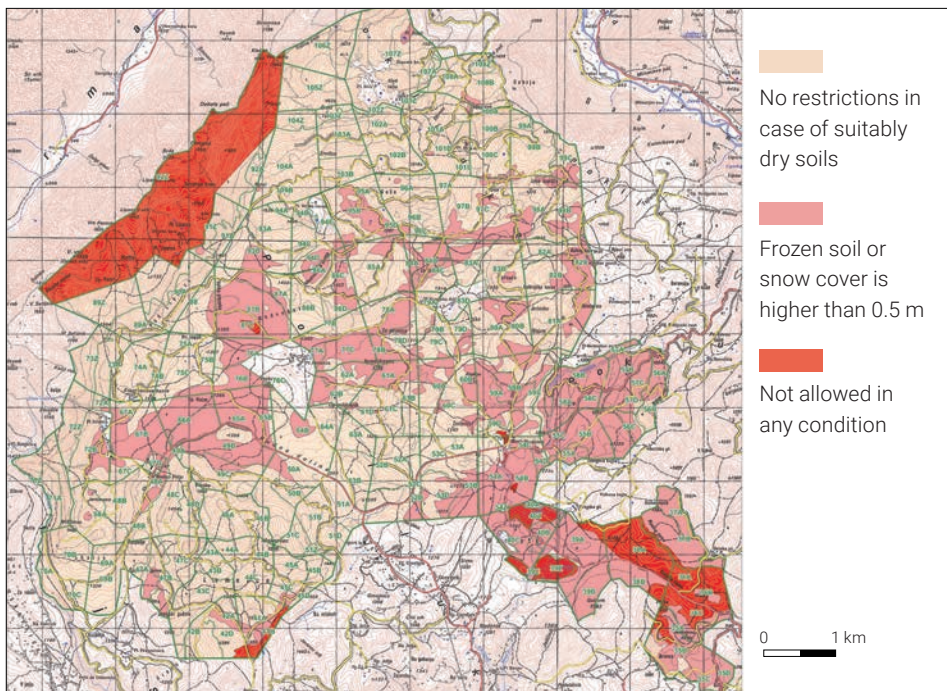


**Figure 40:** Modern harvesting technologies are used on a daily basis in Slovenia. Without them, we cannot imagine the performance of forest works, especially in forests that have been damaged by natural disasters (Photo: Jože Primožič).





**Figure 41:** Heavy machinery used in inappropriate conditions may damage soils; consequently, the provision of ecosystem services is reduced (Photo: Andreja Nève Repe).



**Figure 42:** FHO suitability map for Pokljuka plateau (Slovenia Forest Service).



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**References and further reading**

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