GLOBAL SYMPOSIUM ON SOIL ORGANIC CARBON, Rome, Italy, 21-23 March 2017

Managing Of Karst Peatland Use and Potential Rehabilitation In Dinaric Region

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Abstract
Peatland and wetland sustainable management is one of very important ecological, economical and social issue in the entire Dinaric karst area. As all ecosystems also peatland are exploited to satisfy human needs. In peatlands special relations between water, plants and peat are in force and that makes them very vulnerable. Functions of peatlands exceed plant and raw material production, they important filtering and sink functions as well as many other nonmaterial functions. While their recovering after peat extraction cannot be regarded as a renewable resource and several conventions include statements of their protection.
In this paper some of the suitable measures for the peatland management in the karst field Livanjsko polje (field) in Dinaric Region of Bosnia and Herzegovina (B&H) will be presented and discussed. Livanjsko polje is the largest karst field in B&H, and one of the largest in the world. As of 2008 the field is inscribed in the Ramsar List of Wetlands of International Importance.
Keywords: *karst peatland, peat degradation, peatland rehabilitation,* wetlands*, bogs, fens*

Introduction

Peatlands are a specific type of wetlands where a substantial accumulation of partially decayed plant remains form peat layers. Peatlands in Russia extend over 57 million of hectares, in Finland almost 9 million, Sweden 6.7, Belarus and Ukraine 3.4, Norway 3, Baltic states 2.2, Poland 1.2 and Ireland 1.3. Only 5% of listed areas in those states are used for peat extraction and more than 60% of the areas are still in natural condition where the peat grows about 0.5 to 1 mm per year.

Rather than bog, karst peat formation corresponds to fen type of wetland which is characterized by an impermeable layer which holds in summer season water table in a level which still enables the fen vegetation to grow. Karst peatlands belong either to permanent wetlands either to seasonal wetlands. This depends on hydrological conditions and water drainage system. Drainage is either natural through sinkholes or artificial through trenches, ditches and canals.

In recent time peatlands acquire interest because of their environmental function as a carbon sink and/or source. Peatlands forms only 3% of the world land area their degradation equal 7% of all fossil fuel carbon dioxide emissions (Boreal Peatland Ecosystems, 2006, Springer). In the context of climatic change certain types of peatlands can become a source of methane and NO_x as well.
Peatlands ecosystems contain disproportionately more organic carbon then other terrestrial ecosystems. While covering only 3% of the World's land area, peatland contain at least 550 Gt of carbon in their peat. This is equivalent to 30% of all global soil carbon, 75% of all atmospheric carbon, equal to all terrestrial biomass, and twice the carbon stock in the forest biomass of the world. This makes peatlands the top long-term carbon store in the terrestrial biosphere (UNDP, 2007).
Peatlands used in agriculture and forestry are less threatened, but peat excavation, water drainage and fire are very serious threats for their existence.
Agricultural use of peatlands usually turns the upper peat layer to muck. Mineralization of peat, which simultaneously accompanies the muck formation, decomposes organic carbon compounds which became strong source of carbon dioxide.
Water drainage can lead to similar processes of peat disintegration and muck formation when peat dries out and the surface rewets again even if there is no mechanical influence. Hydrophobic phenomena can

occur as well when rewetting starts again and the result is subsiding of the peat layers above ground water table.
Fire heath destroys organisms and ashes can change the ecological characteristics of peat as a growing media of wetland plants.

From the review of available information sources it is very clear that peatlands protection is a worldwide accepted policy statement. At the moment this seems to be a political priority and there are many examples of reclamation, restoration and rehabilitation projects. General goal of those projects is maintaining biodiversity (Rydin and Sundberg, 2001; Middleton et al., 2006; Stammel et al., 2003; Wheler et al., 2002; Johnson and Valppu, 2003 and many others), preventing greenhouse gasses emissions from peatlands, restoration of peatlands function as a sink of carbon dioxide.
The decisions on management priorities vary of course very much from country to country and depend on environmental, social and economic circumstances of the county.

In B&H there is an outstanding natural phenomenon 46,000 hectares large karst field called Livanjsko polje (Livno field). Since half of its area is regularly flooded, Livno field is actually a combination of wetlands and peatlands and meadows.
Due to presence of carbonates, peatlands of Livanjsko polje belong to extremely rich (peat forming) fen to calcareous tufa-forming fen (Hayek et al., 2006).
Peatlands of karst fields are very fragile. There are actually two separated peatland areas Jagme and Ždralovac. Both are highly degraded. Degradation of Jagme peatland is caused due (too) extensive ameliorations and consequently peat fires. Ždralovac peatland is physically degraded due to peat extraction. Extraction is possible at a lower groundwater table, so peat is dried over the summer time as well. Peat fires have consequently acted as degradation agents in that area too.

Methodology

Considering the importance of Livanjsko polje, sustainable use as well as its protection, research has been conducted within the UNDP project "Mainstreaming Karst Peatlands Conservation into Key Economic Sectors" (KARST, 2007) in order to identify the problem or the key process responsible for the observed changes in the components of the ecosystem and its functioning.

In respect of local conditions the active excavation field Ždralovac is taken into consideration. Three groups of processes has been identified as follows: biological, hydrological and chemical. Appropriate technical measures have been proposed and discussed. Further different principal management strategies for restorations, namely peat excavation area, burned peat areas and of degraded peat due to ameliorations are described.

Results and Discussion

Total surface of the active excavation field Ždralovac is 3,615 ha. The present management of hydrological conditions is leading to irreversible changes of phytocoenoses of the area. The abiotic parameters of environment have been severely changed due to peat fires as minerals from the ashes influence the chemical properties. At the moment at least fragments of primary vegetation cover exist and enable a seed bank for future rehabilitation. The term fragment is used because, as it can be seen from Picture 1., Ždralovac peatland is physically untouched due to excavation only in about a half of the area and even for that no available data exist about fire damages.

Figure 1 Peatland natural conditions and excavation area tables, UNDP, 2013

Figure 2 Peatland before processing and packing, H., Čustović, 2012

There are several disturbances that have led to a reduction in scope of function of the Ždralovac peatland ecological system:

- Extraction of peat with the purpose of processing it into the substrate for growing plants;
- Ignition of peatlands;
- Drainage of peatlands due to the construction of drainage canal for its exploitation which caused a reduction in the level of groundwater and consequently increased mineralization, subsidence of peat and change of natural vegetation.

Identified processes can be divided into three groups:

- Biological: extraction of peat, succession of vegetation following the ignition of peat;
- Hydrological: reduction in groundwater levels and shift in wetland vegetation on peatlands; enhanced mineralization of peat; drying up of peat prior to fire outbreaks; changes in the physical properties of peat (compaction, subsidence, occurrence of cracks);
- Chemical: changes in water quality; decomposition of peat.

The exploitation of peat at the site of Ždralovac is unplanned. During the mechanical extraction of peat, thickness of the remaining layer is left uneven and in some places reduced to parent substrate. In most cases the entire layer of peat, down to the parent substrate, is removed without leaving a possibility of re-vegetation or restoration of wetlands vegetation such as reed and sedges. This could account for just a sporadic emergence of reed in the first few years after the exploitation, i.e. link this phenomenon with thickness of the left layer of peat.
An important condition for the renewal of exploitation basins after the extraction of peat is leaving a 20-50 cm thick layer of peat at the bottom of the basin which is in line with good practice of exploitation of this type of peat and which allows spontaneous regeneration of reeds.

However, intensification of drainage caused by the construction of a drainage canal in the area of peatlands Ždralovac has led to a general reduction in groundwater levels and creation of conditions conducive to the succession of wetland vegetation by woody plant species. Draining of peatlands also prolongs dry period and drying up of peat thus increasing peat bog fire hazard. After the fire outbreak comes the accelerated succession of vegetation and the emergence of shrub-like and forest vegetation which suppresses reed. The succession of vegetation is then followed by increased intake of water by woody plants which further reduces the groundwater levels. It has to be noted that this process is first and foremost associated with altered hydrological regime and lowering of groundwater levels as well as with the fact that these species could not emerge in wetland conditions. Therefore, solving the problem of changes in the hydrological regime of peatlands would solve this problem as well.

Following all mentioned above, the first recommendation is to quit the peat excavation as soon as possible. It would be worth to try to invalidate the concession contract.
In case the peat excavation continues severe technical measures to protect the preserved peatlands and to reestablish the conditions for peat formation should be applied:

- At excavation area water tight cassettes should be constructed for keeping the water table of not excavated fields as high as possible. The water pumped necessary for excavation should be returned on the field and not in drainage system.
- Drainage ditches of the area, which not necessary for water runoff from excavation fields, should be closed as much as possible. Many materials are used for that purpose around the world so this measure is not costly at all.

Construction of water barriers are very different. For a concrete area a feasibility study is recommended where the locality of barriers should be defined, their number and construction properties. Generally this should be very low cost measure.
A nursery for reed saplings production from rhizomes should be established. From the excavated fields only rare plant stalks are growing on the natural way and the recovery of the dominant plant species is slow. After the excavating the peat the concessionaire should replant the reed saplings.
Reed replanting should be experimentally tested also on the burned peat areas. A minor experimental field should be established as soon as possible.
The water integral management is a crucial political and professional task. The water needs do not exist only for electricity production, but also the essential needs of natural habitats and agriculture should be fulfilled. There is even not possible to establish a natural friendly land use management system if the water management system stays one-sided.

Conclusions

Livanjsko polje is one of the largest karst field in the world in which there is more than 10,000 ha of peatland. The devastation of peatland in Livanjsko polje, in particular in Ždralovac location (3,615 ha north-west) which is a subject of the research, is mainly due to excavation of peatland. This area is covered with peat layers more than 2 meters thick. Damage is caused by the construction and operation of drainage channels built to facilitate the peat extraction.
Also, in the same area the devastation is partly due to the construction of melioration channels in its southeastern part, where the peatland has been converted into agricultural land.
A large part of the peatland gets completely drained during dry periods of year. Therefore, the restoration of the groundwater regime has to be implemented in order to avoid further degradation of the peatland and the loss of biodiversity, especially in case of fire.
In the context of the climate change mitigation the water holding capacity of Livanjsko polje soils and sediments should be raised generally (not only in the way of new retentions) as well as the capacity for carbon dioxide sink. A management of raising the amount of organic matter in soils should be established.

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