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ARCTIC PEATLANDS DIVERSITY AND NATURAL FEATURES – THE GAPS IN KNOWLEDGE

Minayeva T., Wetlands International, P.O.Box 471, 6700 AL, Wageningen, The Netherlands, +31318660952, E-mail: tatiana.minaeva@wetlands.org

Sirin A., Institute of Forest Science Russian Academy of Sciences

SUMMARY

Peatlands are the dominant type of Arctic terrestrial wetlands. They are the key landscapes in Arctic and the most of those types depend on permafrost. Arctic peatlands provide a different ecosystem services, including crucial regulation functions for the permafrost protection, flood control, carbon accumulation, habitat maintenance and others. Peatlands are significant for the biodiversity in the Arctic and the worldwide through bird migration routes or flyways. Arctic peatlands are highly-integrated ecosystems being extremely fragile to the both natural and human-induced perturbations. They are not well studied, but certain trends are already clearly evident. Rapid industrial development in the Arctic causes effects that are additional to those caused by climate change. Even the traditional land use (e.g. reindeer herding) is becoming more intensive. The higher intensity of the land use increases the land degradation and the loss of peaty soils, contributes to the melting of the permafrost, and feedback the climate change through increased methane emissions from peaty soils and melting ground, and removal of organic matter by erosion. Peatland conservation needs and an adequate ecosystem management are not fully appreciated due to significant gaps in basic information, especially on peatland values, diversity, distribution, and ecosystem services.

KEYWORDS: peatlands, Arctic, permafrost, human impacts, land degradation

INTRODUCTION

Peatlands are the dominant type of Arctic terrestrial wetland. Peatlands are presented very widely in all Arctic biogeographical zones, including tundra and forest tundra. This fact is not taken into consideration in land management planning, including conservation planning. There is an obvious lack of basic information on Arctic peatlands and the information flow from core science to decision making is weak. In this paper we make an attempt to review the status of information on peatlands and highlight the main gaps and connected practical problems.

INFORMATION GAP ANALYSIS

Diversity and distribution

Peatlands in the Arctic are the key landscapes and include the shallow peat tundra on coastal and highland plateaus, polygon and palsa mires, patterned string fens and patches of raised bogs, valley sedge fens, thermokarst, kettle hole peatlands and a high variety of riverine sedge and shrub-sedge fens. Many of these peatlands depend on permafrost. The key studies on peatland diversity in the Arctic were carried out between 1950-1980 in Russia (Katz, 1973; Pyavchenko, 1956) and Canada (Zoltai et al., 1973; Tarnocai and Zoltai, 1988). Although the approaches were slightly different, the key mire massif types and peat covered landscapes were defined in similar way.

What usually is defined as “tundra” is in most cases comprised of paludified shallow peatlands. This is the most widespread terrestrial wetland type on watershed areas in the Eurasian Arctic, forming vast areas of shallow peatlands overlying sandy or loamy ground. This type occurs more sporadically in North America, where it is often replaced by plateau peatlands. The peat layer may be partly degraded or decomposed, and the profile can contain alternating layers of peat and mineral material, indicating that this type of peatland is sometimes recovered by mineral soil.

There are two classical permafrost mire massif types: polygonal and palsa mires. They cover the largest area of the Arctic. In Russia they represent over 20% of all peatlands in the country (Vompersky et al., 2005; Minayeva et al. (eds.), 2009). In Canada and Alaska the “frozen” peatland coverage is even more – up to 30% of all peatlands (Tarnocai and Zoltai, 1988).

Polygon mire landscapes arise as a consequence of thermokarst processes, i.e. the seasonal alternation of thawing and freezing near the upper limit of permafrost. The description of the morphology for the two main type of the polygon mires – low-centered (concave) and high-centered (mounded) – is provided by Tarnocai and Zoltai (1988). It is clear that successful functioning of these mire systems depend upon a complex of construction of different peat types, permafrost and mineral soil. Thus, the key message for this mire type is that it is an integrated dynamic system driven by structural and permafrost processes, so that even partial physical disturbance or destruction can unpredictably shift the equilibrium of the whole dynamic system.

The palsa mires make up the second group of peatlands whose genesis and maintenance is related to the permafrost. The key points for the development of such type of the mires are: the mounds are not created by peat formation, but by heaving of the underlying mineral ground; the hummocks compiled by the fen peat (formed from mesotrophic plant communities), but their vegetation cover is oligotrophic; the underlying mound of the mineral material contains ice lenses; and the upper limit of the permafrost is close to the ground surface in palsa mounds and deeper or absent in intervening depressions. Numerous authors have suggested mechanisms for palsa formation on the basis of their own analyses of this general structure.

Aapa mires and raised bogs occur in the Arctic, Subarctic and Boreal zones and are not directly connected with the permafrost, although permafrost can play a role in certain stages of their formation. At the first glance the patterns of hummock-hollow complexes in raised bogs look similar to those in patterned string fens. However, there are important differences between them in terms of structure and depth of the peat deposit, which leads to differences in hydrology and vegetation patterns. In patterned string fens, the dominant peat type is the fen peat, with the bog peat being found only on the hummocks. Patterned string fens are generally more sensitive to surface impacts than raised bogs, insofar as their microtopographical structure does not regenerate readily. Raised bogs are ecosystems with high resistance to the surface damage, with the key driver being shallow water flow.

Thermokarst kettle hole peatlands or alases are typical Arctic wetland ecosystems. A kettle hole is a distinctive steep-sided depression formed by the thawing of permafrost, which may contain a thermokarst lake or an ecosystem in the lake succession – floating mat, true peatland, etc. The type of vegetation depends on the stage of development and may consist of sedges, hypnaceous mosses or *Juncus*.

Sloping floodplain fens which are dependent on the fluvial regime are also regarded as riparian mires. Sloping floodplain fens, and especially valley-bottom fens, have a homogeneous vegetation structure and highly organic soils, including peat deposits. Vegetation which consists of willows, tall sedges and mosses make them one the most productive of all Arctic ecosystems.

Unfortunately, the generalization above of the available descriptions of Arctic peatlands was not undertaken by the CAFF specialist group while developing the Circumpolar Arctic Vegetation Map (2003). Very similar approach had been applied for Circumboreal Vegetation Map (Talbot, S. S. and Meades, W. J., 2011). As a result, the Arctic peatlands have not been addressed as specific ecosystem types with typical vegetation but rather, they had been distributed among different vegetation mapping units, as designated by the team. Based on this approach, peatlands are overlooked and not addressed in all CAFF related activities and working groups.

Ecosystem services

Arctic peatlands provide different ecosystem services, including crucial regulation functions for the permafrost protection, flood control, carbon accumulation, habitat maintenance and others.
As everywhere, the Arctic peatlands play specific role for biodiversity (Minayeva and Sirin, 2012) and they are significant for the worldwide through bird migration routes or flyways. There are no publications available, focused on the peatlands role on the bird's population and the global flyways maintenance. The situation is the same with respect to the flora and vegetation – no specific peatland related survey has been performed and there is no information for the flora species population maintenance and conservation needs in relation to the peatlands.

The hydrology of Arctic peatlands is presented in a limited number of high quality publications which generalize data for the forest tundra zone of the Arctic in Eurasia (Novikov, 2009) and the tundra zone in North America (Woo and Young, 2006). A large number of publications are available on carbon storage in frozen peatlands and related to permafrost melting greenhouse gas emissions. Nevertheless, there is still not enough data for estimations of uncertainty in such a diverse landscapes and no information on anthropogenic induced emissions and other carbon losses. The information on permafrost is mainly available regarding distribution and distinction. Very little information is available on the mechanisms of the relationship between peat and ice. Specific information on the role of the peat or moss layer in permafrost protection is published in several reviews and technical literature of engineering design of infrastructure.

Climate change induced dynamic

Arctic peatlands are highly-integrated ecosystems that are extremely fragile and sensitive to the both natural and human-induced perturbations. They are not well studied, but certain trends are already clearly evident. Climate change is especially visible in the Arctic (ACIA, 2005; IPCC, 2007). The key findings regarding climate, derived changes in Arctic peatlands are generalized in the Assessment of global peatlands, biodiversity and climate change (Parish et al., 2008) and Arctic biodiversity trends 2010 (Minayeva and Sirin, 2010). The most numerous available studies are related to the mechanisms and consequences of melting of frozen mounds in palsa peatlands or distinction of permafrost related peatland distribution. There is an obvious lack of data on the carbon losses from Arctic peatlands emitting from the hydrological flows, changes in greenhouse gas emission balances and rates, habitat capacity for biodiversity, and productivity. The least data are available on peatlands changes and their consequences at the ecosystem and landscape level.

Peatlands use and livelihoods

Arctic peatlands are the most productive ecosystems in the Arctic. They provide pastures, hay production areas, berries and mushrooms, maintenance habitats for game species. Traditional use of peatlands in the Arctic was sustainable for many years, and in the recent past was still largely within the natural capacity of the ecosystems. A new technology has provided the means to overcome challenges presented by the harsh Arctic environment by providing an easy access to the remote areas, leading to the rapid and widespread development. Apart from expansion of the oil and gas industry, even traditional land use such as reindeer herding are being industrialized. The impact of transport infrastructure has increased substantially and there is a danger that the pursuit of Arctic resources will result in unsustainable development, ignoring the environmental concerns and the livelihood needs of indigenous peoples. Rapid industrial development exacerbates changes in Arctic peatlands resulting from climate change. The development of infrastructure, increased water contamination and air pollution, and direct disturbances increase the degradation of peaty soils, contributes to the melting of permafrost, and feedback to the climate change through increased methane emissions from the peat and the frozen ground, and removal of organic matter by erosion.

There is an obvious lack of studies on Arctic peatland ecosystem services both from the perspective of the carrying capacity of habitats and the socio-economic needs supported by their natural resources and functions. There is an urgent need for studies looking at conflict resulting from the competition for the land in traditional and industrial development. Many more studies are available on the impact of industrial development on the hydrology, carbon storage and greenhouse gas balance of Arctic peatlands, but the results have not been adequately disseminated and transformed through decision making into solutions.

Peatlands protection

The Arctic peatlands are extremely valuable, fragile, and threatened ecosystems, whose high biodiversity value, including global flyways support, warrants much higher attention than they currently receive. Peatlands are not specifically addressed through the protected areas system in Russian Federation, the USA or Canada. The data evaluating the peatlands coverage within protected areas in Russian Arctic show a repetition of the ratio of peat and non-peat lands outside and inside the protected area borders. That is consequence of absence of peatland focused protection areas. Scandinavian countries, Greenland and Iceland, as part of the EU, are following Natura 2000 principles which address mire habitats by their high ranking in the priorities of habitat conservation as required under Council Directive 92/43/EEC on the conservation of natural habitat types and of wild fauna and flora. Peatlands are found at minimum within 12 Natura 2000 habitat types. Nevertheless, there are no substantial studies on the minimal demands for protected peatland acreages within different parts of Arctic biogeographic zones and landscape types.

CONCLUSION

Peatland conservation and wise use needs are not fully appreciated in the Arctic due to a lack of basic information, especially on peatland values, diversity, distribution, and ecosystem services. To protect peatlands effectively, a customised approach to peatland management is required. Long term research and monitoring is needed to define Arctic peatlands ecosystem services and their drivers.

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