A Quick Scan of Peatlands in Central and Eastern Europe

WETLANDS INTERNATIONAL

A QUICK SCAN OF PEATLANDS IN CENTRAL AND EASTERN EUROPE

Compiled and edited by:
Tatiana Minayeva and Andrey Sirin

Language and technical editing:
Olivia Bragg

Project leaders:
Tatiana Minayeva and Marcel Silvius

Authors:
National chapters were contributed by:
Karen Jenderejan (Armenia), Nikolay Bambalov, Nina Tanovitskaya and Alexander Kozulin (Belarus), Janus Paal (Estonia), Izolda Matchutadze (Georgia), Mara Pakalne (Latvia), Ilona Jukoniene, Valerijus Rašomavičius and Romas Pakalnis (Lithuania), Tatiana Minayeva and Andrey Sirin (Russian Federation), Predrag Lazarevic (Serbia), Serhan Çağirankaya (Turkey)
The remaining national chapters were compiled from materials contributed by:
Anna Ganeva (Bulgaria), Jasenka Topic (Croatia), Tatiana Belous (Moldova), Jasminka Milosevic (Serbia), Volodymar Tytar and Grygori Parchuk (Ukraine), Hans Joosten (IMCG)

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– the UK Darwin Initiative Peatland Biodiversity Programme *Sharing Expertise for the Conservation of Peatlands in Central and Eastern Europe* (1998–2001);

– the IMCG *European Mires* project; and

– the collaboration of Vienna University and the Regional Museum of Austria that produced the volume *Moore — von Sibirien bis Feuerland* (*Mires — from Siberia to Tierra del Fuego*), edited by G.M. Steiner (Stapfia 85, zugleich Kataloge der OÖ, Landesmuseen Neue Serie 35, Linz).

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Executive Summary

A Quick Scan of Peatlands in Central and Eastern Europe reviews the status, conservation and use of peatlands in the countries participating in the BBI-Matra Programme (Belarus, Russian Federation, Ukraine, Moldova, Georgia, Armenia, Romania, Bulgaria, Serbia, Croatia and Turkey). Geographically, it covers central and eastern Europe together with the non-European part of the Russian Federation.

This document was prepared at the request of the Dutch Ministry of Agriculture, Nature and Food Quality (LNV), in order to inform the assessment of projects seeking financial support from the BBI-Matra Programme and evaluate the impact (ecological footprint) of trade in peat products with The Netherlands.

The LNV required, for each country, the fullest possible coverage of the following aspects: peatland status, distribution, location and habitat/species diversity in the context of (a) the regional extent and variety of peatlands and (b) the global distribution and status of peatlands; volume of peat and the total area of disturbed peatlands in the context of the impacts of mining, trade and other types of disturbance; the relative areas of impacted, primary and protected peatland; national policies on the management of peatlands; the locations of the most important of the peatlands that are currently or potentially threatened; the areas or activities for which special responsibility falls on The Netherlands, in terms of ecological footprint; the most important unanswered questions; and the actions required within the framework of bilateral co-operation between The Netherlands and the countries of the CEE region.

This document provides initial background information relating to the issues listed above, which has been extracted from the results of a comprehensive review. It presents a series of sketches describing the peatlands within each country, followed by general conclusions. The order in which the countries are introduced roughly reflects their geographical sequence from north to south. The data are as up-to-date as possible, the most recent originating from 01 January 2008 and the oldest referring to the 1990s.

The key findings of the review are summarised below.

Coverage and distribution. Peatlands account for more than 8% of Russia's territory and, when combined with paludified lands with shallow (<0.3 m) peat, they cover about 370 million hectares or over 20% of the country. Their distribution is clearly related to bioclimatic zones and subzones, and in some boreal regions more than 50% of the land surface is peat-covered. Boreal conditions extend into Belarus, Estonia and Latvia, which also have high rates of paludification and are, respectively, 7.9%, 7.2% and 4.9% peat-covered. The land surfaces of Lithuania, Georgia, Bulgaria and Armenia are more than 2% peat-covered, and the other BBI countries less than 1% with a minimum of 0.01% for Moldova.

Regionality. The territory of Russia, the world's largest country, encompasses all possible combinations of geomorphological, climatic and paleogeographical factors and thus supports a great diversity of mire types, characteristic of all bioclimatic zones from the Arctic to the sub-tropics including semi-deserts. Ukraine straddles three of these natural zones (broad-leaved forest, steppe and sub-tropical); and the lowland part of every other BBI country belongs to just a single zone.

Peatland diversity. More than 20% of Russia's peatlands are classified as permafrost (polygonal and palsa) types, which do not occur in the other BBI countries and are extremely vulnerable. The remainder of the country's peatland area is made up of oligotrophic mires (mainly raised bogs) (19%), mesotrophic mires (30%), eutrophic swamps and fens (18%), and ridge-hollow and ridge-pool complexes (about 13%). Peatlands near the southern edge of their distribution in the forest-steppe and steppe zones are particularly vulnerable to modern climate change, and are found in the European part of Russia, Ukraine, Moldova, Bulgaria, Romania and Turkey. Russia, Ukraine, Bulgaria, Romania, Croatia, Serbia, Turkey, Georgia and Armenia have mountain peatlands which, although small, perform very significant natural functions and are under-represented as foci for nature conservation and scientific studies. All of the BBI countries except Estonia and Croatia have extensive river floodplains which originally supported valley fens and swamps. In the largest river valleys, natural peatlands now survive only in the least accessible locations, such as deltas; whilst in the valleys of medium-sized and small rivers, except for forested types (mainly black-alder swamps), most peatlands have been almost totally destroyed by long-term human use.

Information status. Good information on peatlands, and especially on peat resources, is available for most of the countries under consideration. For all of the former Soviet Republics (Russian Federation, Estonia, Latvia, Lithuania, Belarus, Ukraine, Moldova, Georgia, Armenia) and socialist countries (Bulgaria, Croatia, Romania, Serbia), there are systematic inventories of peat deposits which were compiled using the comprehensive and globally well-known SU methodology, and the geological information is supported by land cadastre and forest inventories which are also methodologically uniform. Nowadays, this information is under-used, due to both sectorial access difficulties and the negative attitude to data accumulated during the Soviet period that prevails in FSU and East European countries.

Availability of information. Information on peat resources and distribution is available from the routine peat inventories that have been carried out in all of the target countries except Turkey. This information focuses mainly on potential sources of raw peat, but can be used in other ways. The peat resource of Russia is estimated at over 186,027 million tonnes; and the resources of Belarus, Estonia, Ukraine, Latvia and Lithuania at 4,000, 2,165, 2,900, 1,500 and 937 million tonnes respectively. Peat is a key fuel for all of these countries except Ukraine and, in part, Lithuania. The other target countries have several hundred million tonnes of peat or less.

Regulation functions of peatlands. Peatlands are key environment-forming ecosystems in the Russian Federation. Russian peatlands store approximately 3,000 km^3 of fresh water, they exert considerable influence on the relationships between surface water and groundwater and the generation of river discharge, and are important for water protection and regulation. Peatlands may also have a strong impact on global climate. Russia's peatlands store 113.5–200 x 109 tonnes of carbon, which is the largest national contribution to the world's peatland carbon store, and are major sources and sinks of the greenhouse gases carbon dioxide, methane and nitrous oxide. Active peatlands are the most important terrestrial sinks of atmospheric carbon, and thus mitigate greenhouse warming. Land uses that are under consideration by UN FCCC are actively pursued on peatlands in Russia, Belarus, the Baltic countries and Ukraine, with further implications for climate change mitigation. Peatlands also provide thermal insulation for permafrost and are thus critical for tundra regions undergoing climatic warming. Often, they make local climates milder and work as natural filters which remove many pollutants from the environment.

Peatlands as habitats. Peatlands offer a broad spectrum of habitats that help to support biological diversity. They provide many terrestrial species with temporary habitats, food, shelter, breeding grounds and stepping-stones for migration; and their importance as permanent refugia increases in line with human pressure. Their specific environmental conditions and (with some exceptions) relative resilience to climate change enable them to host numerous azonal and intrazonal species, and this is especially evident under conditions of environmental change, whether due to anthropic transformation of the surrounding landscapes, climate change or other causes.

Most of the characteristic species are confined to peatlands due to ecological specialisation, and for many of these, peatlands offer the only suitable habitat within the biogeographical region or even globally. Moreover, their isolation creates an "island effect" and related polymorphism, promoting intra-specific biodiversity. Despite their relatively low species diversity, peatlands host and become the last refuges of a high proportion of the rare and endangered species in many areas. Thus, most of orchids listed in the vascular plant flora of the temperate zone are found in transition mires. Peatlands are also a unique source of information on biodiversity because the remains of their plant and animal inhabitants, as well as the pollen and spores of plants growing in the wider vicinity, are preserved in their peat deposits.

Peatland-related bird populations. Many bird species are partially dependent on peatlands, e.g. for breeding or feeding. In the forest zone of European Russia, Black Stork, Greater Spotted Eagle, Common Crane and Spotted Crake use fens only; Wood Sandpiper, Greenshank and Curlew are found in bogs and fens; whilst Whimbrel, Golden Plover, Willow grouse, Golden Eagle, Short-toed Eagle, Peregrine Falcon, Merlin, Osprey, Great Grey Shrike and Capercaillie use only bogs. Bird species that depend on peatlands throughout their life cycles include Black-throated Diver, Black Grouse and Greylag Goose. Practically all of the endangered crane species in Russia (White Siberian Crane, Hooded Crane, Japanese Crane) are associated with peatlands, which are also the safest habitats for rare raptors such as White-tailed Eagle, Golden Eagle and Black Kite. Floodplain peatlands — the most threatened peatland landscapes — play a key role for many birds, providing safe migration corridors along rivers with convenient feeding and staging sites. The best-known floodplain peatlands are the Ramsar sites in West and East Siberia and Central European Russia.

Peat extraction. In the Russian Federation, peat is regarded as a mineral resource and managed by the authorities of the subjects of the Federation. In all other target countries except Belarus, Latvia and Estonia, peat is not a strategic resource, and its management (including extraction and conservation) is decentralised and influenced by the socio-economic demands of the particular area. In Ukraine, where peatlands are already rare, no special permission is needed to begin extracting peat. This makes it difficult to ensure that peatlands are being used sustainably. During the Soviet period, centralised planning ensured that peat extraction was concentrated in regions with significant peat resources, whereas nowadays the locations where it is carried out are determined by economic demand. The high cost of transport means that peat is often extracted for local use as fuel, in agriculture (fertilisers, growing media) and for chemical processing, and it is only in the most accessible regions (e.g. western Russia, Lithuania, Latvia and Estonia) that it is extracted for export. Any increase in the external demand for raw peat or its derivatives can cause problems in these regions by pushing extraction rates beyond sustainable levels. For example, the amount of peat extracted annually in Estonia has, in recent years, exceeded the rate of peat formation in the country as a whole.

Peatlands in agriculture. Peatlands — mostly fens in river valleys — have traditionally been drained for agriculture in all of the target countries. The most suitable peatlands for agricultural development were converted over century ago and are still under traditional use. For mainly political reasons, further vast areas of peatland were drained for agriculture, and extracted peatlands converted to arable land, during the Soviet period. The general trend of arable land extension onto peatlands was also seen in East European countries. Peatlands that have been drained for agriculture, and especially those with polder systems, require permanent maintenance. When much of this land was abandoned after the economic changes of the 1990s, secondary paludification occurred in only some areas, and most are now developing shrub and forest vegetation which often catches fire. Whilst agriculture can no longer be profitable on a considerable proportion of the abandoned land, it is essential that sustainable agricultural uses such as haymaking or grazing of livestock are re-established on some of it in order to ensure both socio-economic and environmental security, primarily by reducing fire risk. Early action is needed because the vigorous invasion by scrub and trees constitutes a serious and increasing obstacle to any attempts to recover this land.

Peatland forestry. There are long traditions of peatland forestry in Russia, Belarus, the Baltic countries and Ukraine. Except in Ukraine, these countries' forests are extensively paludified so that drainage has a rational basis and is mostly cost-effective. Until the 1920s, most projects had sound economic and scientific foundations, and many highly productive forest stands were established. On the other hand, by the 1960s — 1980s, forest drainage had become industrialised and was moving in the wrong direction. In Russia and other republics of the FSU, it was mostly carried out by technically well-equipped 'melioration enterprises' which were established specifically for the task and paid on the basis of the area drained. As a result, many projects were economically ineffective and ecologically damaging, even in the southern republics of the FSU and East European countries. Much of the land was not effectively managed after drainage, and forest improvement measures that reduced profitability were applied. A large part of the drained forest land is now undergoing secondary paludification, facilitated by the increasing beaver population. The productive tree stands that were established on some of the drained land are now approaching harvest, and this raises the question of how the land should be managed afterwards. In order to determine this, a range of forestry, hydrological and ecological questions must be addressed, and appropriate management and technological procedures formulated and applied.

Peatlands and infrastructure. One of the primary current threats to mires is the development of infrastructure. Specifically in the highly paludified regions of Russia, peatlands represent obstacles to the construction of roads and infrastructure for the oil and gas industry, especially pipelines. Continuing pressure on peatlands is expected because road development is strategically important for Russia, and in future this must be achieved by ecologically and technically appropriate methods.

Peatlands and development. In many regions, natural mires are rapidly disappearing and being destroyed due to building developments for different purposes. The problem is most acute in regions close to large settlements with rising land prices, and where peatlands are almost the last vacant areas available for state, municipal or business projects. It is especially destructive for ecology and environment where floodplain peatlands are affected, because these are extremely valuable for water protection and regulation as well as biodiversity conservation and education. This issue now creates urgent requirements for peatland protection in most of the target countries.

Peatland protection. In most of the countries under consideration except Estonia, peatlands were rarely mentioned as specific targets for conservation before the 1960s. Mires were usually protected indirectly, either as parts of specially protected areas or within the general framework established for regulation of nature use. They were protected directly only where they occurred as rare and atypical habitats in southern regions of both the FSU and other East European countries. In Russia, peatlands are mainly protected as 'other landscape types' occurring within the boundaries of Specially Protected Nature Areas (SPNA). The total area of peatlands thus protected in European Russia is approximately 700,000 ha, and in Siberia *ca*. 3.5 million ha. Peatlands cover 25–50% of several SPNAs, and more than 70% of the few that were established specifically to protect this habitat. Amongst the 35 Russian Ramsar sites, not a single example was established to protect mire ecosystems only, but more than 9% of their 950,000 ha total area is peat-covered. A few peatlands are also protected within local and regional SPNAs, and some regions introduced the "protected natural mire" SPNA type in order to implement sectorial resource conservation programmes. Peatlands are actively protected in the regions (mostly in north-western European Russia and Western Siberia) where they are abundant and therefore play a major socio-economic role. Research is often in progress here, and this promotes awareness about peatland management and conservation amongst the local population, authorities and other stakeholders. Smaller percentages of peatlands are protected in regions where they are naturally rare or have been substantially impacted by human activities; typically in central European Russia, the steppe and forest-steppe regions of southern European Russia, Cisuralia, the mountainous regions of the Caucasus *etc.* Watershed raised bogs have traditionally been prioritised for conservation, whereas fens (including floodplain mires) have often been undervalued in terms of their hydrological role and importance for floral and faunal biodiversity. This tendency is also apparent in Belarus and Ukraine.

Peatland restoration. In the FSU, rehabilitation of extracted peatlands was compulsory. Although legislation and standards provided for agriculture, forestry, fishing ponds and mire restoration to be considered as after-uses, arable land was usually favoured for political reasons. Nowadays, mire restoration is becoming the principal choice for rehabilitation of these sites.

Partly extracted peatlands that have been abandoned are a key problem in Russia and Belarus, and to some extent an issue for the Baltic countries and Ukraine, primarily because they contain tremendous quantities of flammable dry peat which often catches fire when left unmanaged. This problem has very serious ecological and socio-economic repercussions, and for regions with concentrations of such sites requires integrated intervention at federal and regional levels. Re-wetting for mire restoration requires technological support, but the involvement of local people and other initiative groups could be effective and positive in terms of ecology, local economy, awareness-raising and longevity of the benefits. Fire protection is a comprehensible and welcome objective for all stakeholders, and could be used as a focus for achieving the restoration of biodiversity and environmental functions of mire ecosystems.

The damming of ditches on abandoned agricultural land or in drained forests is not a particularly important issue for Russia and most other FSU countries. However, there is some need in Russia and other countries for restoration of damaged peatlands near cities and other settlements, where mires are already rare and thus valuable for education and awareness-raising.

Knowledge and awareness of peatlands. Raising public awareness of peatlands is a key problem for all BBI countries, as there is a universal lack of basic knowledge about them and their environmental functions are often under-valued. Their negative features were long emphasised in order to promote large-scale reclamation, and now there is a tendency for peatland use to be condemned without any attempt to improve the common appreciation of mire ecology, values and services. In most BBI countries except Estonia, Belarus, and regions of Russia with traditions in mire studies, hardly any special attention is paid to peatlands within either school or university courses. Popular literature about peatlands is lacking, and there is little coverage by the mass media. Filling these gaps and introducing new activities to raise awareness of peatlands amongst different social groups and stakeholders is key issue for the wise use of peatlands in Russia and most of the other countries under consideration.

The footprint of the Netherlands. The Dutch "footprint" on eastern and central European peatlands has both negative and positive aspects.

The use of peatland-related resources by The Netherlands and other West European countries creates a demand that is stimulating the growth of peat-winning in the Baltic countries and the western regions of Russia. This trend will continue until commercially viable alternatives to horticultural peat products become available. The development of a mechanism to minimise the ecological losses arising from these activities — such as peat certification — is urgently required. The tradition of using peat in horticulture is also being exported to BBI countries, and it is fortunate that they cannot compete effectively with The Netherlands in industrial horticulture so that their domestic use of horticultural peat remains at low levels.

The growing density of infrastructure in Siberia and the Russian Arctic is a direct result of the diversification of gas and oil transport routes to The Netherlands and western Europe. Each new pipeline laid in this peatland-dominated landscape is placed in a new corridor, which can be up to 200 metres wide and causes hydrological disturbance over a much larger area.

On the other hand, The Netherlands has contributed a great deal of experience in peatland wise use and restoration to central and eastern Europe.

The Central European Peatland Project (CEPP) was funded jointly by the Dutch and Danish governments through Wetlands International. Eight central European countries participated, including the BBI countries Belarus, Estonia, Latvia, Lithuania and Ukraine (also Czechia, Poland and Slovakia). The main goal was to prepare the *Strategy and Action Plan for Peatland Conservation in Central Europe*, which was targeted at policy makers and funding agencies. It described the importance of central European peatlands in relation to biodiversity, carbon sequestration, water purification *etc.* and included overviews of priority actions at national as well as regional scale.

The Ukrainian Embassy of the Kingdom of the Netherlands supported the publication of results from a multi-disciplinary field survey of the Liubche Lake wetland ecosystems in Ukraine.

Peatland agriculture has been considered in a number of Dutch-funded projects. Work funded by The Netherlands in several regions of Russia has demonstrated Dutch methods of sustainable agriculture on peatlands that support a certain level of environmental quality and the conservation of bird habitats. Dutch expertise has also been applied in the assessment of carbon balances for abandoned meadows on peat in Poland (a non-BBI country).

The Netherlands government funded a study of the ecohydrology of calcareous fens in Slovakia (non-BBI country) as a basis for restoration. The exchange of experience on ecohydrology and soil science with the University of Groningen and Alterra was a very important objective of the project.

A number of specialists from BBI countries have attended the RIZA Wetland Restoration Course in The Netherlands. Dutch specialists also promote the idea of restoring cutover peatlands in eastern and central Europe. Russia and Belarus have benefited from Dutch expertise in peatland restoration through seminars, information exchange and a pilot project in Belarus and the Russian regions Tver, Vladimir, Moscow and Novgorod supported by funding from The Netherlands. The experience of this project was summarised in several Russian publications, and adapted guidelines for peatland restoration were tested and used in a number of model projects. Dutch-funded projects on peatland restoration have also been implemented in the non-BBI countries Poland and Slovenia.

A Dutch Matra project in Vladimir Oblast (Russia) trialled the integration of peatlands into ecological networks using the Larch method developed by experts at Wageningen-Alterra University. This project promoted the use of invertebrates (butterflies) as indicators of peatland status according to a technique developed in The Netherlands, which was a new approach for Russia.

The Wetlands International PIN Matra peatland conservation project piloted the ecological-economic valuation of peatland ecosystem services as a collaboration between experts from the Institute for Environmental Studies (IVM) in Amsterdam (The Netherlands) and Russia. Guidelines on this topic, adapted to the technical conditions of Russia, were prepared, tested on a model site in Moscow Region, and ultimately endorsed by the regional Ministry of Environment and Nature Management.

Many highly constructive innovations concerning peatlands have been introduced to Russia through the Peatland Conservation Project of the Wetlands International Russia Programme. This has been supported by the government of The Netherlands since 1999 and serves as an efficient long-term channel for bilateral co-operation on peatland conservation and wise use between Russia and The Netherlands. The most productive future direction for this collaboration might be the further implementation of new approaches to integrated nature management, in which Dutch expertise in spatial planning could play a decisive role.

The key uses to be addressed in bilateral co-operation with BBI countries. The analyses of the current status, use, conservation and related problems of peatlands has highlighted the following first priorities for attention and action:

- problems in peatland management and conservation arising from recent and ongoing changes in legislation;
- peatlands and national obligations to key international conventions in the field of environmental conservation;
- peatlands and the issues of climate-change mitigation and adaptation;
- high-priority issues relating to the conservation of peatlands at the extremes of their distribution ranges (in the Arctic, steppe and forest-steppe zones), in the context of climate change and human pressure;
- conservation of typical representive peatlands in the regions of their regular distribution;
- total protection of all remaining peatlands in urban and highly developed regions;

– impact assessment of peat extraction techniques;
– restoration of peatlands, peatland fire problems and wise use;
– peat, the energy industry and wise use — especially in the context of the new energy strategy of the Russian Federation;
– infrastructure development and peatlands;
– wise use of peatlands that have been reclaimed for agriculture and forestry;
– the problems of transboundary peatland management;
– the role of peatlands as habitats, especially in supporting migrating species;
– awareness of the role of peatlands in river catchment management and water quality;
– peatlands in education and public awareness; and
– alternative sustainable "green" uses of peatlands including recreation, "wet" farming *etc.*

The Quick Scan presents a rough overview of peatland status and related activities which is suitable for use, in conjunction with national peatland strategies when available, as a tool for planning and evaluation of projects on peatland conservation and wise use within the international co-operation programme of The Netherlands.

Ten Strategic Priorities for Action on Peatland Management Based on the Results of the Quick Scan of Peatlands in Central and Eastern Europe

1. Strengthening inter-sectoral co-operation and public involvement in the integrated management of peatlands.

2. Enhancing the knowledge base and raising awareness of peatland functions and values, including the potential for wise use of peatlands.

3. Ensuring that peatland management and conservation practice are closely linked to the latest changes in legislation, and that lessons learned feed back into policy.

4. Peatland management in relation to climate change, with attention to both mitigation and adaptation measures. Incorporation of peatlands into UNFCCC and Kyoto Protocol activities.

5. Promotion of peatland values for biodiversity conservation, including their disproportionally high value in ecological networks and on the flyways of migratory bird species.

6. Development and implementation of a strategy for the conservation of: peatlands that are typical or representative for biogeographical regions; rare and disappearing peatland habitats; peatlands that are vulnerable to climate change and human activities; transboundary peatlands; and peatlands in urban and highly developed regions.

7. Introducing environmentally friendly and sustainable land use practices for peatland users in all sectors (e.g. energy, agriculture, forestry, road and infrastructure construction); peatland use certification.

8. Peatland restoration for fire control and environmental security.

9. Integration of peatlands into River Basin Management.

10. Fulfillment of the obligations of individual countries to international environmental conventions including the Global Action Plan on Peatlands adopted by the Ramsar Convention, paying particular attention to peatland conservation.

Immediate Actions Required to Meet the Ten Strategic Priorities

1. Analyse and identify needs and opportunities for promoting sustained inter-sectoral co-operation and integrated peatland management under the new legislation.

2. Identify the highest-priority peatlands for conservation action, especially rare or particularly threatened and vulnerable peatland habitats, considering in particular their roles in ecological networks and flyways .

3. Identify priority actions addressing the key sectors that impact peatlands, particularly peat mining, forestry, agriculture, infrastructure development and tourism, including options for certification mechanisms, as well as needs for information and training.

4. Identify and promote the wise use of peatlands as a key requirement for the UNFCCC and the Kyoto Protocol.

5. Review the status and adaptation issues of arctic, mountain and steppe peatlands in relation to their vulnerability to climate change.

6. Develop a strategy for peatland education and awareness-raising and an accompanying set of electronic and other education and awareness programs on peatland values and functions (for schools and higher education).

7. Implement a review of the role of peatlands in river basin management and how this is taken into account in planning.

Introducion

In September 2006, Wetlands International received a request from the Dutch Ministry of Agriculture, Nature and Food Quality (LNV) to submit a proposal for a "Quick Scan" of peatlands in central and eastern Europe (CEE) including the non-European part of the Russian Federation. This would inform the assessment of projects seeking financial support from the BBI-Matra Programme, and evaluate the impact of trade in peat products with the Netherlands (ecological footprint). LNV indicated their requirement for the fullest possible coverage of the aspects listed below.

– For each CEE country, the total area of peatlands and information about peatland status. For each country participating in the BBI-Matra Programme (Belarus, Russian Federation, Ukraine, Moldova, Georgia, Armenia, Romania, Bulgaria, Serbia, Montenegro, Croatia and Turkey), the distribution of peatlands should be described and a location map provided. The focus should be on peat-rich countries, but the habitats and species diversity of peatlands in neighbouring countries should also be covered.

– The country information should be placed in the contexts of (a) the regional extent and variation of peatlands; and (b) the global distribution and status of peatlands.

– The total volume of peat and the total area of disturbed peatlands within each country, in sufficient detail to enable an evaluation of the impacts of mining, trade and other types of disturbance.

– An account of each country's policies on the management of peatlands (peat mining, agriculture, forestry *etc.*, as well as reclamation and nature conservation), including policies that relate to degradation by fire and other impacts.

– The relative areas of impacted, primary and protected peatland in the relevant countries.

– An estimate of the total area that can still be regarded as primary peatland, together with an account of the potential for restoration and its relevance in relation to the total area that remains in primary state or is protected.

– The amount of peat that is being mined in each country annually, and the quantity being traded internationally according to country of origin and destination.

– The locations of the most important of the peatlands that are currently or potentially threatened.

– The areas or activities for which special responsibility falls on The Netherlands, in terms of ecological footprint.

– The most important unanswered questions, and the actions required within the framework of bilateral co-operation between The Netherlands and the countries of the CEE region.

This document provides initial background information relating to the issues listed above, which has been extracted from the results of a comprehensive review. It presents a series of sketches describing the peatlands within each country, followed by general conclusions. The order in which the countries are introduced reflects roughly their geographical sequence from north to south. Only very general literature sources are listed for most countries, but detailed references are given for Russia.

Contributions to the peatland status review and the identification of key problems and co-operation channels between eastern European countries were gathered using several large networks, namely: the

International Mire Conservation Group (IMCG), which connects around 500 experts in mire science and conservation from more than 60 countries; the International Peat Society (IPS), which is an umbrella organisation for professional specialists in peat and peatland management, use, research and conservation; the Darwin Initiative peatland network developed during a training programme for CEE personnel (Peatland Biodiversity Programme) co-ordinated by Dr. Olivia Bragg; the Ramsar Convention STRP; and regional networks including the Russian Peatlands Expert Network. The authors and contributors listed on the title page are all members of one or more of these networks.

Further information was obtained from the outputs of various Wetlands International projects, including the Central European Peatland Project (CEPP, 1999–2002), a joint project with WWF-Germany on the peatlands of the Baltic countries (2005) and Project on Peatland Conservation in Russia of Wetlands International Russian Programme (1999 onward)". Information collected under the auspices of the Darwin Initiative Peatland Biodiversity Programme (see above) was also used. Other significant sources were the book *Moore — von Sibirien bis Feuerland* (*Mires — from Siberia to Tierra del Fuego*) edited by Professor G.M. Steiner (Stapfia 85, zugleich Kataloge der OÖ, Landesmuseen Neue Serie 35, Linz) and sections from the book *European Mires* which is being prepared for publication by the IMCG.

Especially important sources for data on the distribution and diversity of mires in Russia were the GIS "Peatlands of Russia", which is under development at the Russian Academy of Sciences Institute of Forest Science; and the data archives of the All-Union (currently All-Russian) Geological Depository, which stores the results of peat deposit inventories for all republics of the former USSR and many other eastern European countries. The archived materials contain detailed statistical information from the early 1990s up until 2007. For Russia, the primary data have been analysed; whereas for the other countries, existing published reviews based on the archive data (Markov *et al* 1988) have been used.

The results of long-term activities undertaken within the framework of Project on Peatland Conservation in Russia (www.peatlands.ru) (part of the Wetlands International Russia Programme) became the main information source for this review as far as the Russian Federation is concerned. Since its launch in 1997, the Programme has given much attention to peatlands, and in particular to the development of guidelines for mire conservation and the application of wise use principles. This ongoing project has helped to provide continuity between a range of related projects and initiatives, and the large volume of information collected is now successfully used in expert evaluations relating to peatland conservation and management at all administrative levels, from local to federal. It has also contributed significantly to the development of legislation. In particular, peatlands have been integrated into Russian state policy in the form of the Russian Peatland Action Plan — a co-ordinated intersectoral framework document on the conservation and wise use of peatlands, which was developed by all interested stakeholder authorities and organisations under the supervision of the Ministry of Nature Resources (now the Ministry of Nature Resources and Ecology) of the Russian Federation, which endorsed it in 2003.

The results of the first stage of implementation of the Russian Peatland Action Plan were analysed and summarised in September 2005 at the workshop 'Problems of peatland wise use in Russia' at the RF Ministry of Natural Resources in Moscow and in Tver. This workshop confirmed the pertinence of the problems that were raised, and developed action plans to address these at national and international levels. One issue arising was that, given changes in legislation and socio-economic conditions (in particular, the recovery of agriculture and forestry), endorsement of the new federal energy strategy, the recent increase in peatland fires, and some of the latest decisions at international level, it would be necessary to revise the action priorities for the conservation and wise use of peatlands. From an analysis of the information collected and the outputs of the discussions, we compiled a preliminary review (Quick Scan) of the status of Russia's peatlands as a basis for development of a new set of priorities derived from the most acute problems.

Possible priorities for bilateral collaboration between The Netherlands and the Russian Federation were suggested and examined at the joint workshop 'Problems of peatland conservation and wise use: results of joint projects and prospects for co-operation', which was held in January 2007 at the Ministry of Natural Resources of the Russian Federation in Moscow. The discussion identified integral planning and complex nature management on peatlands as a potential main area of focus for the future. We have used these ideas and deliverables in the present document.

In view of the diversity of our information sources and the potentially crucial influence of peatland wise use issues on national economies, Wetlands International has approached each of the countries officially, *via* the appropriate Government Minister, in order to confirm the data presented in the national chapters and to check the key messages of the conclusion. For most of countries we get written confirmation of endorsement. While, the information for Belarus, Croatia, Lithuania, Moldova, Serbia and Turkey has been verified by direct communication with a Ministry representative. We did not receive official replies from Georgia and Romania, and we found no information at all on Montenegro. Thus we are aware that, although we have taken into account the information from all of the national chapters available, the outcome cannot be assumed to reflect the official positions of these states.

The main outcomes of the "Quick Scan of peatlands in central and eastern Europe" — such as the list of emerging issues in peatland conservation and wise use, the recommendations for actions, and the priorities for national and regional policies — are included in the chapter of general conclusions. On this basis, "Ten Strategic Priorities for Action on Peatland Management" and "Immediate actions required to meet the Ten Strategic Priorities" have been formulated. We invite International Conventions — as well as international, regional and national NGOs and environmental agencies — to use these as a foundation for optimising their planning and improving the effectiveness of their project design and implementation. The Quick Scan can be regarded as the feasibility study, and thus one further step towards implementation within the European region of the Global Action Plan on Peatlands, which was endorsed by the Ramsar Convention (8th Conference of Contracting Parties) in 2003.

Russian Federation

General Information

The total area of the country is 17,075,400 km^2 and the population was 143.47 million in 2005 (8.4 inhabitants ha^{-1}). Population density ranges from over 25 people ha 1 in the European part of the country (more than 350 ha^{-1} in Moscow region) to less then 0.05 ha^{-1} in the north of Siberia. 73% of the population is concentrated in the European part of Russia[1] , which constitutes less than one-quarter of the country's territory.

Russia covers more that one-eighth of the Earth. It is the largest country in the world, and it hosts a larger area of peat-covered land than any other nation. Existing statistical and scientific data estimate the area of peatland at 1.4 x 10^6 km^2, or more than 8% of the country's territory. Adding paludified land with shallow (<30 cm thick) peat gives an estimate for the total mire area of about 3.7 million km^2, or more than 20% of Russia.

Russia is a transcontinental country which stretches for 8,000 km from west to east and 6,600 km from north to south. It extends across the whole northern edge of Asia and 40% of Europe, encompassing a broad range of environments and landscapes which provide widely contrasting conditions for mire development. Peatlands are the dominant ecosystem type in some regions, such as West Siberia (the world's largest peatland area), but in others they are present only as exotic biotopes. The regions differ greatly in their economic structure and level of development, as well as in their histories of traditional use, utilisation, management and

[1]This means the subjects of the Russian Federation which refer to the European part of the country, some of which extend across the Ural Mountains into the Asian part. Geographically, the boundary between Europe and Asia follows the main ridge of the Ural Mountains and bisects several federal subjects; indeed, the Urals are often considered separately from both the European and the Asian parts of the country. The Russian Federation comprises 83 federal subjects (at 01 March 2008), which differ in degree of autonomy but are statistically similar. The subjects include 21 republics, 9 krais (territories), 48 oblasts (provinces), 1 autonomous oblast, 5 autonomous okrugs (autonomous districts) of which one is a separate entity and the remaining four are entities within oblasts, and 2 federal cities. The federal subjects are grouped into seven federal districts (okrugs), namely: Central, North-West, South and Povolzsky for the European part of Russia, and Uralsky, Siberian and Far East for non-European part of Russia. The federal district is not a sub-national level of government, but it is a level of administration which provides some valuable statistics including information on land use.

Figure 1: Peatlands in Russia (peat thickness >30 cm), percent coverage (Vompersky *et al* 1999, 2005)

protection of peatland. As a result, it is impossible to make any general statement about Russian peatlands, except that they encompass huge contrasts and their geographical variation must be taken into account. "Regionality" is the key factor, and this must already be invoked when considering the European part of the country alone, or even its sub-divisions into central, north-western *etc.* parts.

Peatland Status, Ownership, Inventory and Information

Russian peatlands have traditionally been assigned to a wide range of different land categories with different legislative status and ownership. Peatlands and paludified land with shallow peat occur within areas designated as forest, agricultural and industrial land, settlements, the Water Fund, State Reserve land, and specially protected nature areas (SPNAs; Fig. 2). The State Forest Fund, Water Fund, State Reserve land and Federal SPNAs belong to the Russian Federation and are governed by various authorities. According to the latest Forest Code, federal state forest land is managed by the subjects of the Russian Federation, who are also responsible for regional SPNAs. State Reserve land is managed by regional and local administrations. Industrial land, which includes peat workings, may have different ownership. In many cases it is temporarily transferred from another land category, such as forest or state reserve, and rented to a company by the state. Land that is allocated to settlements is managed by municipal administrations; whilst most of the agricultural land was privatised after the 1990s and now belongs to individual farmers, companies *etc.* Peatlands belonging to various land categories may be subject to additional state requirements which significantly modify their use and management.

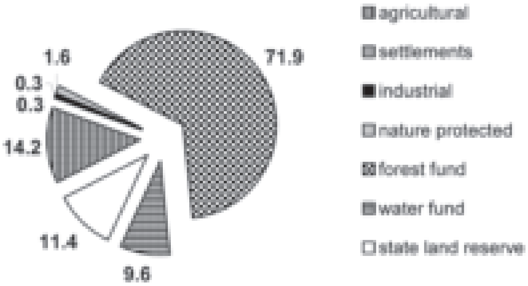

Figure 2: Relative areas (%) of Russian peatland allocated to different land categories (State Land Cadastre, 01 January 2000) (Sirin & Minayeva 2001).

The administration of peatlands by the state has not yet been finalised in Russia. The recently adopted federal Acts such as the Water Code, Forest Code, Land Code *etc.* have significantly changed the legislation that relates to peatlands; for example, the new Water Code of the Russian Federation (2006) treats mires as special water objects. Changes in other federal laws are also likely to affect peatlands. Of particular concern is the division of responsibility for peatlands and their management between federal, provincial and local government. Thus there is an urgent need for further development of the Action Plan for Peatland Conservation and Use in Russia, which is the framework document produced collaboratively by experts from different sectors that was adopted by the Ministry of Natural Resources of the Russian Federation in 2003.

Multisectorial interests have strongly influenced peatland inventory. A national policy for inventory of peatlands (as peat deposits) was established just after the Revolution in October 1917. This was driven by a critical interest in peat as the main fuel resource remaining available to the new state when most of the country was occupied during the Civil War and Foreign Intervention; and supported by the fact that Vladimir Lenin, the leader of the first government of Soviet Russia, was acquainted with the scientific literature relating to peatlands such as Sukatchev (1914); Dokturovski (1915) (Sirin & Minayeva 2001, 2002). Peatland inventory was launched in Russia when the government established the State Peat Committee in the spring of 1918, and field surveys of peat deposits in the central part of the country were subsequently carried out. A special decree "On peatlands" was issued in 1922, and this promoted the standardisation of peatland inventory and monitoring methods. A special depositary for information about peat was established in 1940, and in 1980 it was integrated into the geological depositary.

The geological peat depository is now a unique database encompassing the great majority of Russian peatlands, and all of those which can be regarded as peat deposits. The main criterion for inclusion of a site was the presence of an "industrial peat layer", whose thickness varied from 0.7 m (0.5 m for drained sites) to 1.2 m at different times and for different peatlands (Sirin & Minayeva 2001). Thus it is the most comprehensive, transparent and accessible database on peatlands in Russia. It contains standardised and formalised information including maps, data on peat characteristics, and sketches of vegetation and hydrology. The regular inventories and publications based on standardised national surveys have in turn provided wide opportunities for studies of peatlands, and the data have been used as the basis of medium-scale maps of peat deposits for all republics of the Soviet Union and all provinces of the Russian Federation, as well as for the Peat Atlas of the USSR published in 1968.

The sectors of industry with peatland interests, and related branches of science, have also each developed their own systems for collecting, storing and presenting data on the distribution and diversity of peatlands. Particularly worthy of mention in this respect are topographic maps, forest inventory and soil inventory. Topographic maps at all scales (1:10,000, 1:25,000, 1:50,000, 1:100,000, 1:300,000 and 1:500,000) show peatlands according to standard formats, which distinguish mire from paludified land at most scales and give direct or indirect information about peat depth, wetness and vegetation to indicate the ground conditions for cross-country walkers and vehicles (Sirin & Minayeva 2001). Forest and soil inventory work is related to the standard topographic maps which, in combination with aerial photographs, provide most of the spatial information for the surveys.

Forest inventory data are restricted to land assigned to the State Forest Fund, which makes up about 70% of the country and lies mostly within the boreal zone. Forest Fund land where tree growth is limited by waterlogging and capable of improvement by drainage has been allocated to the so-called "hydro-forest-amelioration fund", for which an inventory derived from existing forest evaluation data and a special survey was finalised in 1975. This includes areas with peat, shallow peat and wet mineral soils (Sirin & Minayeva 2001).

Forest inventory work has paid closer attention to highly productive sites than to peatland forests with limited tree growth, and soil surveyors have similarly regarded economically low-value peaty soils as unimportant. However, detailed soil mapping is compulsory for all agricultural enterprises, regardless of status, and is thus available mostly for agricultural land. Special medium-scale (*ca.* 1:400,000 – 1:1,000,000) soil maps have been developed for most of the federal subjects by combining the detailed local soil maps with forest inventory data. The state land cadastre is based on the same combined information, but also takes into account land use and economic factors (Sirin & Minayeva 2001). Land cover and land use data are combined at local (administrative district) level, then for each federal subject, and finally incorporated into the State Land Report that is presented annually to the Federal Government. In recent years, the amount of land cover data included in the State Land Report has been reduced in favour of information on status, property and economic aspects.

Regional soil maps and related information were integrated to create the Soil Map of Russia at scale 1:2,500,000 (1989), and are now being used in the preparation of soil map sheets at 1:1,000,000 scale, some of which have already been finalised. Vompersky *et al* (1994, 1999) considered soil to be the most consistent landscape characteristic of peatland, and therefore derived their general estimates of peat and shallow peat areas from the 1:2,500,000 Soil Map of Russia. The principal layers of the GIS "Peatlands of Russia" which has been developed at the Institute of Forest Science (Russian Academy of Sciences) were also derived from this map (Vompersky *et al* 2005); whilst the database "Land Resources of Russia" (2002) used a reduced set of information from the same map with the Russian soil types translated into United Nations Food and Agriculture Organisation (FAO) soil classes.

GIS provides an opportunity to combine spatial information from the various existing vegetation, landscape and special maps for different regions of the country, as well as Earth Observation (EO) data. The GIS "Peatlands of Russia" was developed to integrate (mainly spatially referenced) information on peatlands and paludified land with shallow peat. The emphasis is on distribution, diversity, use, condition and regulation functions (carbon storage, fluxes of greenhouse gases, hydrological characteristics *etc.*).

The wide-ranging data arising from the long history of Russian mire science, which traditionally focused on special aspects (e.g. geobotany, hydrology, landscape ecology) of the natural functions and components of mires, provides a substantial information base for peatland management. The landscape complex approach of the Russian school, developed by I. Bogdanovskaya (1969), E. Galkina (1946), V. Masing (1974) and others, is well known amongst mire specialists and highly applicable in this context; whilst the Russian school of mire hydrology, developed by A. Dubach (1936, 1944), K. Ivanov (1953, 1957, 1975, 1981), V. Romanov (1961, 1968 a, b) and others, is regarded as the foundation of mire hydrology all over the world.

From the 1930s, the distribution and zonation of mire types became a focus for regular mire surveys, and the well-known reviews by Y. Zinserling (1938) and N. Katz (1948, 1971) have become classical works for mire specialists in Russia and abroad. Published in 1940, and later revised and republished in 1949 and 1976, the book by S. Tyuremnov has become a standard reference for new and experienced mire scientists alike. There were numerous expeditions to study mires in different regions of the country during the second half of the 20th century, and a comprehensive description of regional mire types was prepared by N. Pyavchenko (1955, 1958) and later summarised (1963, 1985). The latest review of mire diversity in Russia that is available to foreign readers was prepared by M. Botch & V. Masing (1983) from their Russian book of 1979. T. Yurkovskaya (1992) reviewed the subject in the light of more recent studies and presented it in a number of maps which were published in Russia and abroad.

Over the last two decades, a number of collaborative studies have also been published. These include an analysis and clarification of the peat cover of Russia (Vompersky *et al* 1994, 1999), peatland diversity (Abramova *et al* 1974, Pyavchenko 1972) investigations of mires in several individual regions (e.g. Kuvayev 2001), and analyses of available information (e.g. Sirin & Minayeva 2001). Collective discussions of issues such as the wise use of peatlands (Vompersky & Sirin 1999) and the role of mires in the carbon cycle and climate change (Elina *et al* 1998, Vasiliev *et al* … 2001) have also been organised. The Action Plan for Peatland Conservation and Use in Russia (2003) was compiled and approved as a result of collaboration between experts from different sectors; and information exchange on problems relating to mire research, use and conservation has been promoted through the website www.peatlands.ru.

Peatland Distribution and Diversity

According to the State Land Cadastre (Sirin & Minayeva 2001), mires cover more than 8% of Russia. This figure agrees well with current scientific and expert estimates. The total area with a peat layer more than 50 cm thick has been estimated at 975,000 km^2 or 5.7% of the country, but Russian standards define areas with peat soil as those where peat thickness exceeds 30 cm. On the basis of soil mapping, the area of peat has been estimated at 1.39 million km^2 or 8.1% of the area of Russia (Vompersky *et al* 1994, 1999). Areas with a peat layer less than 30 cm thick are classified as paludified (shallow-peat) land, or as forest if they occur on Forest Fund land, and their total extent is estimated at 2.3 million km^2. The total area of deep (>30 cm) and shallow (<30 cm) peat is *ca.* 3.69 million km^2, which accounts for 21.6% of the area of Russia excluding large lakes (Vompersky *et al* 1994, 1999). Most of the errors and uncertainties in these estimates of peat area relate to forested and sparsely wooded peatlands, paludified land and the vast tundra zone. A large fraction of the deep (>30 cm thick) peat is attributed to tundra sites, and it is probable that some of this is in fact shallow peat or mineral soil, especially as it is very difficult or impossible to distinguish between polygon tundra and polygon mire on the basis of remote sensing or EO imagery alone.

The distribution of mires is clearly related to bioclimatic zones and subzones. The most favourable conditions for paludification arise at the point of optimum balance between those that promote primary production (high humidity and high temperature) on the one hand, and those that inhibit decomposition (high humidity but low temperature) on the other. Such conditions are highly typical for Russia's boreal zone where, in some regions, mires cover up to half of the land surface (Fig. 3). They are most extensive in West Siberia, where peat cover reaches 38.5% in Khanty-Mansiysk Autonomous Okrug and 29 % in Tomsk and Tumen Oblasts. They are also extensive in the Far East, especially in the Amur River basin, where the Jewish Autonomous Oblast is 25% peat covered (Sirin & Minayeva 2001). High (15–20%) peat cover is also typical for the northern part of European Russia, and reaches a maximum of 37.5% in Murmansk oblast (Fig. 4).

Figure 3: Peatlands in Russia, percent cover for each administrative region (Sirin & Minayeva 2001)

Figure 4: Peatland area within administrative regions of the European part of Russia (© Project on peatland conservation in Russia).

All possible combinations of geomorphological, climatic and paleogeographical factors occur within the territory of Russia, the world's largest country, and the result is a great diversity of mire types. Peatlands that are characteristic of bioclimatic zones from the Arctic to the subtropics, including semi-deserts, are present (Fig. 5). Moving from the tundra towards the southern limit of the taiga, polygonal mires, palsa mires, ribbed fens (aapa mires) and raised bogs give way sequentially to one another. Herbaceous and herbaceous-moss fens occur in all zones and regions, although they vary from north to south in their community structure, species composition and syntaxonomical composition. Forest swamps are distributed throughout the boreal and nemoral regions only. The distribution ranges of the regional mire types overlap, and several of them can be found within each bioclimatic zone.

There are very few general estimates of peatland diversity for Russia as a whole; although the peat inventory includes information about types of peat deposits (oligotrophic, mesotrophic, eutrophic and complex) and the forest evaluation data gives some information about the trophic status of forest land assigned to the hydro-forest-amelioration fund. Botch *et al* (1994, 1995) describe the typological diversity of peatlands within the former Soviet Union, but their interpretations seem rather questionable. General estimates of peatland diversity in terms of very broad type groups have now been derived from the GIS "Peatlands of Russia" (Fig. 6) which, as already discussed, is based on data from the Soil Map

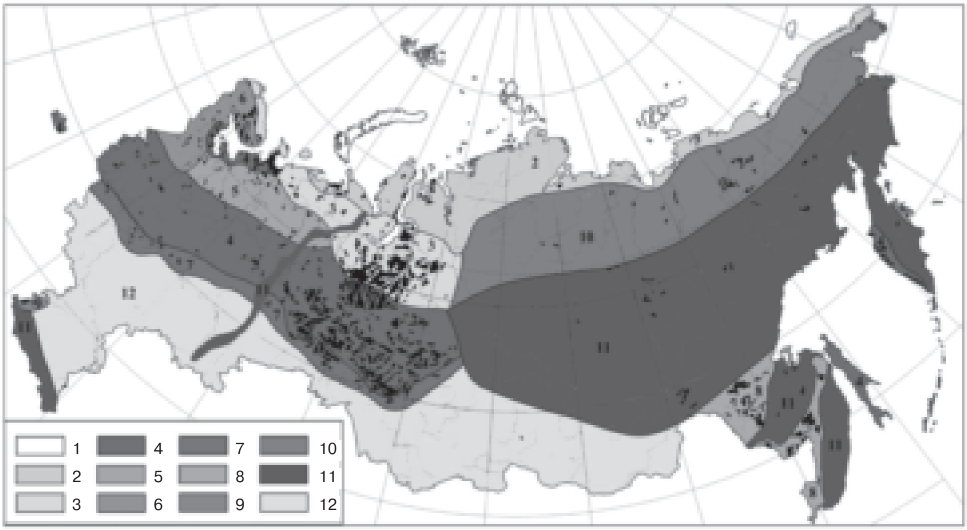

Figure 5: Mire Distribution in Russia (after Yurkovskaya, 2005). 1: herbaceous-moss fens; 2: polygonal mires and herbaceous-moss fens; 3: palsa mires with associated ribbed fens and unpatterned fens; raised bogs (4), with association (5) and prevalence (6) of ribbed fens and fens (7); 8: herbaceous-sedge fens with raised bogs and occasional palsa; 9: reed fens; 10: mires in mountains, muskeg and palsa; 11: mires in highlands; 12: occasional presence of mires.

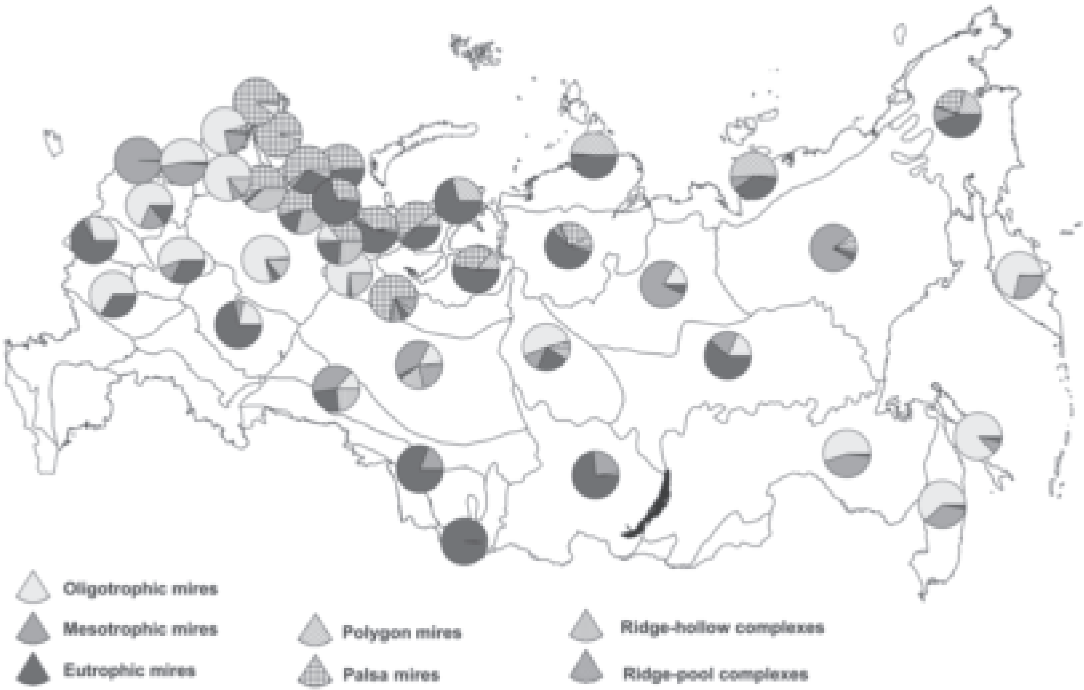

Figure 6: Proportions of peatland belonging to each of the main types within each of the Russian mire regions defined by N. Kats (1971) (Vompersky *et al.* 2005).

of Russia (Vompersky *et al* 2005). So far, the estimates are rather crude and need further clarification, but they can be used to give a general overview of the typology and diversity of peatlands in Russia.

The GIS analysis indicates that, of the country's 1.39 million km^2 total peatland area, polygon mires account for 5.3% and palsa mires for 14.6%; oligotrophic mires (mainly raised bogs), mesotrophic mires, and eutrophic swamps and fens for 19%, 30% and 18% respectively; and ridge-hollow (7.2%) and ridge-pool (5.8%) complexes, which occur mostly in the Asian part of the country and especially in West Siberia, for about 13%. Of the 2.3 million km^2 of shallow (<30 cm) peat, 69% occurs on forest land with dense and sparse tree cover, 26.3% is tundra and forest tundra, and the remaining 4.7% consists of meadows and river valleys (Vompersky *et al* 2005).

Thus, more than 20% of the Russian peatland area consists of permafrost (polygonal and palsa) mires, which are the most vulnerable peatland types to environmental change (Vompersky *et al* 2005). In the European part of Russia, forest-steppe and steppe zone peatlands are located close to the southern limit for mires, and are thus also especially vulnerable to modern climate change in combination with human impacts. Being relatively insignificant in size, they retain very significant natural functions, but are insufficiently spotlighted by nature conservation and scientific studies. Valley fens and swamps are often present on the floodplains of large rivers, but remain in natural condition only in less accessible locations such as deltas. Most peatlands in the valleys of medium-sized and small rivers, except forested (mainly black alder) swamps, have been almost totally destroyed through long use by man.

According to estimates based on existing GIS and EO-derived data (Salnikov *et al* 2008), trees are present on 38% of Russia's peatland area, of which more than half (21%) has sparse tree cover. Similar percentages of the shallow (<30 cm) peatland area are occupied by forest (23%) and sparse trees (24%). Thus, the dominant fraction (62% and 53% by area) in both cases is open peatland. Overall, however, 56% of all peat-covered land with deep and shallow peat layers now has trees.

Ecological Value of Peatlands

Peatlands are important natural ecosystems for water and climate regulation, biodiversity conservation and human welfare (Assessment on Peatlands, Biodiversity and Climate Change, 2008). Their ecological role for the Russian Federation in general is extremely valuable on account of their vast distribution and broad spectrum of natural diversity, which can vary profoundly between different regions of the country and under different natural conditions.

The total volume of fresh water stored by Russian peatlands is estimated at more than 3000 km^3. Peatlands are important for landscape hydrology, runoff formation and regulation, flood and erosion control, water protection and water purification. They act as sponges in the landscape, storing water and maintaining water levels in adjacent areas. Especially in mountainous regions, they act as water towers which sustain permanent flow in river headwaters. The indirect ecological influence of peatlands thus operates across large areas, because river catchments support significant biodiversity at all levels.

Like large water bodies, mires mitigate droughts and hard frosts, cool the air in summer and warm it in winter, and thus contribute to the regulation of climate at regional, local and adjacent-ecosystem scales. In the 19th century, one of the main arguments for developing an ambitious state peatland drainage program for the European part of the Russian Empire was that the reduction of fog would make local climates healthier. Under modern conditions, with extensive drained peatlands and warming climate, the microclimatic effects associated with mires are becoming increasingly positive.

Russian peatlands contribute significantly to the global role of peatlands for climate. They comprise the world's largest national peatland carbon store, estimated by Vompersky *et al* (1996) at 113.5 $x10^9$ tonnes and by Botch *et al* (1995) at more than $200x10^9$ tonnes, and are major sources and sinks of the greenhouse gases carbon dioxide, methane and nitrous oxide. The peatlands of West Siberia (Bleuten & Lapshina 2001) — the planet's largest peatland region — are especially important. Peatlands also help to protect permafrost by providing thermal insulation. The presence of peatlands in the Arctic and tundra zones of Russia is critical for maintenance of the current climatic situation and all of its related biodiversity.

The special and often unique role of peatlands in supporting biological diversity at genetic, species, and ecosystem levels arises from their peculiar ecological features, and their environment-forming functions also help to support biological diversity in their surroundings.

Peatlands mitigate habitat fragmentation and its consequences by providing temporary habitats, stepping-stones for migration, and even permanent refugia for a number of species. They are also important temporary habitats for many non-peatland terrestrial species, providing them with food, shelter, and breeding grounds. This role is increasingly important in landscapes under escalating anthropic pressure. In Central European Russia alone, 8 fish, 8 reptile and amphibian, 220 bird and 17 mammal species whose main habitats lie in adjacent areas use peatlands as temporary niches for feeding, hiding and breeding (Nikolayev 2006).

The specific environmental conditions and (with some exceptions) the relative resilience to climate change of peatlands enables them to host numerous azonal and intrazonal species. These include many relict species which found stable habitat conditions in peatlands during previous periods of change resulting from anthropic transformation of landscapes, climate change and related changes in environment *etc.*

The general species diversity of peatlands is not high relative to that of adjacent habitats within the same biogeographical zone. For example, in the Republic of Karelia, which is one of the most extensively peat-covered areas in the north-west of European Russia, only 283 (17.4%) of the Republic's total of 1631 vascular plant species, 31 (8.5%) of 366 butterfly species, 109 (23.2%) of 470 bryophyte species, and 85 (30.5%) of 279 bird species are found in peatlands (Gromtsev *et al* 2003, Kuznetsov 2003). Nevertheless, these species are bound or connected to peatlands by specific adaptations. Most of the characteristic species are ecologically specialised so that, for many of them, peatlands are the only possible habitat type within the biogeographical region or even globally. Examples include the 40 of 109 peatland-related vascular plant species described for the Yamal peninsula in north Siberia which occurred in peatlands only (Rebristaya 2000), the 52 obligatory helophytes amongst the 288 plant species occurring in the mountain peatlands of West Sayan (Chernova 2006), and 33 of the 277 peatland plant species recorded in Kuznetsky Alatau (Volkova 2001).

Despite their relatively low species diversity, peatlands host and have become last refuges for a high proportion of the rare and endangered species in many parts of the Russian Federation. For example, most of the orchids in the vascular plant flora are found in temperate-zone transition mires; peatlands are the safest habitats for rare raptors such as the White-tailed Eagle *Haliaeetus albicilla,* Golden Eagle *Aquila chrysaetos* and Black Kite *Milvus migrans;* and practically all endangered species of crane (White Siberian Crane *Grus leucogeranus,* Hooded Crane *Grus monacha* and Japanese Crane *Grus japonensis*) are associated with peatlands.

Many bird species depend on peatlands during parts of their life cycles, for example for breeding or feeding. In the fens of the forest zone of European Russia, such species include the Black Stork *Ciconia nigra,* Greater Spotted Eagle *Aquila clanga,* Common Crane *Grus grus* and Spotted Crake *Porzana porzana.* The Wood Sandpiper *Tringa glareola,* Greenshank *Tringa nebularia* and Curlew *Numenius arquata* are found both in bogs and fens; whilst the Whimbrel *Numenius phaeopus,* Golden Plover *Pluvialis apricaria,* Willow Grouse *Lagopus l. rossicus,* Golden Eagle *Aquila chrysaetos,* Short-toed Eagle *Circaetus gallicus,* Peregrine Falcon *Falco peregrinus,* Merlin *Falco columbarius,* Osprey *Pandion haliaeetus,* Great Grey Shrike *Lanius excubitor* and Capercaillie *Tetrao urogallus* are found only in bogs. A few bird species, such as the Black-throated Diver *Gavia arctica,* Black Grouse *Lyrurus tetrix* and Greylag Goose *Anser anser,* depend on peatlands throughout their life cycles (Nikolayev 2000).

Peatlands often play a decisive yet indirect (and therefore unappreciated) role in supporting species groups. For example, floodplain peatlands such as the Ramsar sites of the Medium and Lower Dvuobje in West Siberia, those in the Argun' Lowland of Dauria (south of Lake Baikal) and the Dubnensky mire massif in Moscow Oblast support the migrations of many bird species by providing safe corridors along rivers with convenient feeding and staging sites.

Peatlands are still regarded as badlands by most social groups (Plusnin 2006 a, Sirin *et al* 2006) although their ecological role, especially for hydrology and climate, is generally understood by both by stakeholders and ordinary people. But, even amongst environmentalists, this understanding is often based on obsolete and incorrect information, e.g. about the hydrological role of raised bogs. Thus, there is an imperative need to bring to all stakeholders information about the substantial scientific basis and experience of practical applications that was previously developed in Russia, as well as in other countries, taking into consideration the regional differentiation of the Russian Federation.

Peatland Use

Being common in many regions of Russia, especially the heartlands, peatlands traditionally feature in economic activities, playing valuable roles which vary regionally and are sometimes socio-economic in character. Mires provide resources such as peat, timber, medicinal plants, wild berries and mushrooms; and as important (although sometimes ambivalent) regulators of natural processes, can fundamentally influence the economy and the lives of people. Peatlands limit tree growth, impede agricultural development, and obstruct the establishment of transport routes and other infrastructure. In highly paludified areas, they may well govern the socio-economic development of the entire region. Historically, there have been far-reaching changes in the priorities affecting man-mire interactions, and the current status of Russian peatlands is the result of both temporal and regional differences in the level of economic interest that they have attracted.

Biological resources. Mires have always been used by local people for their biological resources (berries, mushrooms, game, medicinal plants and raw materials), but with varying intensity depending on the region and the historical period. Cartularies from the 14th century show that bog berries played a significant role in the monastic diet, and that *Sphagnum* moss was used in building and as bedding, or even fodder, for cattle. Modern sociological studies have shown that people still regard mires as sources of vital biological resources (Plusnin 2006) and, even in industrially developed regions, picking cranberries, hunting moorfowl and collecting moss for construction purposes remain essential parts of village lifestyles.

Mires are traditionally regarded as special hunting grounds. The many game birds that are characteristic of mires in the forest zone include capercaillie, black grouse, willow grouse and some ducks, geese, and waders. Mires also provide seasonal foraging for ungulates, bears and hares; and other species such as beaver, mink and otter are permanent inhabitants. Mires often become refuges for animals (including game species) if the neighbouring areas are intensively used by man. For example, mires and old peat extraction sites are actively colonised by typical meadow species such as grey partridge, quail and corncrake. These fowl are followed by hunters, and this increases anthropic pressure. Hunting often increases rapidly in conjunction with industrial developments such as the oil and gas industry in the north and east of the country, and may upset the balance between peatlands and the activities of indigenous human populations.

The economic climate of the late 1980s and 1990s led to an increase in berry picking, especially in regions with high unemployment rates, but within last decade this pressure has generally declined and become more localised. On the other hand, consumer demand for medicinal plants has increased in recent years, and over-use of the vegetative resources of mires is becoming a problem in some locations.

Peat extraction. Peat cutting for fuel has long been practiced in Russia. Drawing on his experience in Holland, Peter the Great established the first peat-burning factory in southern Russia with his decree of 1697, and recommendations for using peat as a fuel were published in 1766. The famous Russian scientist M. Lomonosov described the macrofossil structure of peat and its characteristics as a fuel in 1784, and N.P. Sokolov developed the first detailed map of a mire in 1798. During this period, peat was already employed as a fertiliser and growing medium (Fomin 1790) and by the early 19th century it was being used widely both as fuel, especially on railways, and as a soil improver. Late in the same century, several peat bedding and fertiliser factories were built in Moscow Province.

During the period of civil war and foreign intervention against the young Soviet state (1917–1923), peat became the strategic fuel resource for Russia because coal and oil fields were inaccessible. Peat was also a key factor in the ambitious project to electrify and promote the industrial development of Soviet Russia established by the Head of Government V. Lenin. Peat extraction increased steadily from that time until the mid-1980s, when it reached 140 million tonnes per year (Fig. 7). Peat-winning methods changed gradually during this period, the early manual and partly mechanical peat-cutting techniques giving way first to "hydropeat" production (which involves pumping-out of wet disintegrated peat, washed off with water under high pressure) and later to peat milling. In addition to indus-

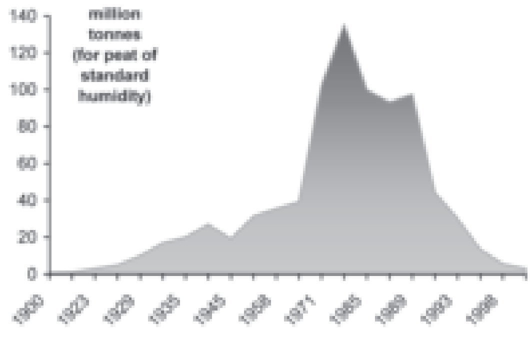

Figure 7: Dynamics of peat extraction in Russia during the 20th century (Sirin & Minayeva 2001).

trial peat-winning for fuel and further processing, large-scale extraction of peat for use as fertiliser was undertaken by both state agricultural enterprises and co-operatives ("kolkhoz"), usually exploiting small fens in depressions and river valleys which were categorised as agricultural land.

The increase in peat extraction promoted both development of the peat industry and studies on peat resources. In the 1960s, research on peat and the inventory of peat deposits became a branch of Geology. This helped to standardise the collection, analysis and storage of data pertaining to the identification, mapping and description of peat deposits. It also made the data more readily available to users and for publications (Peat fund ... 1957, Khoroshev & Kreshtapova 1976, Olenin & Khoroshev 1983, Sokolov 1988).

The total area of peat deposits that have been worked out to date is estimated to be in the range 850,000–1,500,000 hectares. According to the Land Cadastre, however, the total area of worked-out peatland in 2000 was just over 240,000 hectares; the remainder having recovered spontaneously or been re-cultivated and transferred to other land categories (Peatlands of Russia... 2001). Economic changes during the 1990s precipitated a collapse of the peat industry which resulted in the transfer of large areas of partly extracted peat workings and worked-out areas awaiting re-cultivation, without further management, to the so-called "reserve lands", which meant that they became a perennial fire risk.

In recent years, interest in peat extraction has increased again. The rapidly growing demand for peat as a fertiliser and land improver created by domestic and public gardening/landscaping projects, especially near cities and towns, is augmented by a rising interest in fuel peat, primarily for local use. In modern Russia, there are positive ecological arguments for the use of peat as a heating fuel. First, peat could replace the definitely non-renewable fossil fuels and in some cases, like brown coal, be much more environmentally friendly in terms of air pollution. Secondly, the development of industrial fuel

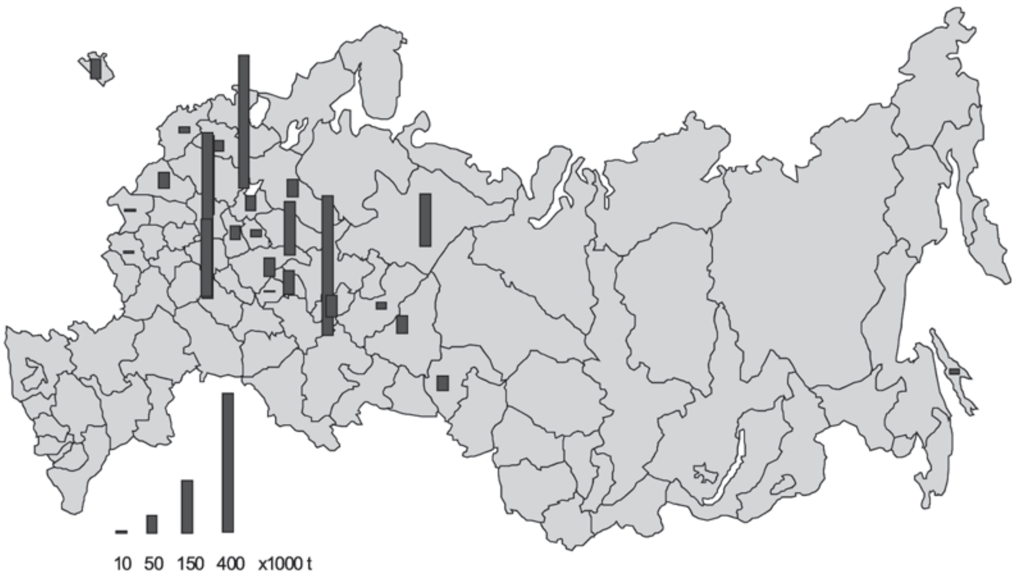

Figure 8: Peat extraction in Russia in 2003 (© Project on peatland conservation in Russia)

Figure 9: Agricultural use of peatlands in European Russia. The extents of drainage and peat extraction for agriculture and horticulture are indicated for each province (© Project on peatland conservation in Russia).

peat extraction should seldom require the exploitation of new peat deposits, but merely the re-opening of abandoned workings, and this would reduce the fire risk presently associated with "reserve lands" peatland.

Peat is now regarded as a communal resource which is managed by the provinces, and extraction is carried out by mainly private enterprises of widely ranging sizes. These factors combine to make the calculation of areas and volumes of peat extraction complicated and difficult. However, Figure 8 illustrates the distribution of activity across the country during one example year, and shows that most peat was extracted in the central European part of Russia, which already has worked-out peatlands.

Agriculture. Agricultural use of peatlands is typical for the central and southern regions of European Russia, the southern parts of

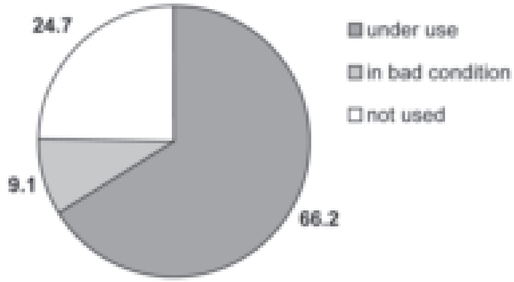

Figure 10: Present-day condition of all agriculturally drained peatland and paludified land in Russia (© Project on peatland conservation in Russia).

Siberia, and the Far East. Development began in the late 18th century, and many intensively used peatlands have since been destroyed by drainage and peat extraction for agriculture.

Large-scale conversion ('improvement') of mires to arable land and hayfields began in the 1880s–1890s, under the authority of two well-known national expeditions. The western expedition was headed by General I.I. Zhilinsky and the northern one by I.K. Avgustinovich. One of their main goals was to promote the general economic development of highly paludified areas and the healthy development of agricultural land. When the expeditions ended, their responsibilities were handed on to provincial departments of agriculture and state agencies. By 1917, drainage and land amelioration had been carried out on at least 3,000,000 hectares of peatland, most of which was destined for agricultural use.

As in the case of peat extraction, peatland agriculture considerably stimulated the development of peat science. Databases grew, research institutions and scientific journals were established, teaching programmes for high school and technical education were set up, and the first thirty years' inventory of peat resources in Soviet Russia was carried out by agricultural institutions.

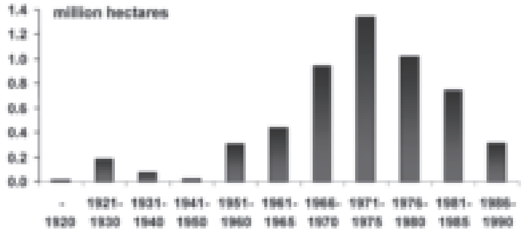

Figure 11: Dynamics of forest drainage in Russia (© Project on peatland conservation in Russia).

Peatlands were drained specifically for agricultural use as hayfields, pastures and arable land, or converted to these uses after partial extraction of their peat deposits. In the 1970s, small peatlands which had been fully or partially extracted were preferentially used for laying out sometimes extensive areas of small private garden plots, especially around the large cities of European Russia.

By 1967, 1,600,000 hectares of Russia's mires had been converted to agriculture; and the total area of peat-covered, paludified shallow-peat and waterlogged mineral land that had been drained for this purpose reached 5,100,000 hectares in 1990 (Sirin & Minayeva 2001). Much of this land is now inefficiently used or abandoned (Fig. 10). In contrast to peatland that was drained for forestry, agricultural land seldom undergoes secondary paludification and the drained peat layer instead continues to mineralise and sporadically catches fire. Often, these peatlands become overgrown by small-leaved bushes and trees after they are abandoned, which makes their future rehabilitation for agricultural use very difficult.

Forestry. Drainage for forestry is concentrated mainly in north-western and central European Russia, in the eastern Polessye at the border with Ukraine and Belarus, in Karelia and, to a lesser extent, in the Volga region and Cisuralia. Forest drainage has also been carried out in south-western Siberia.

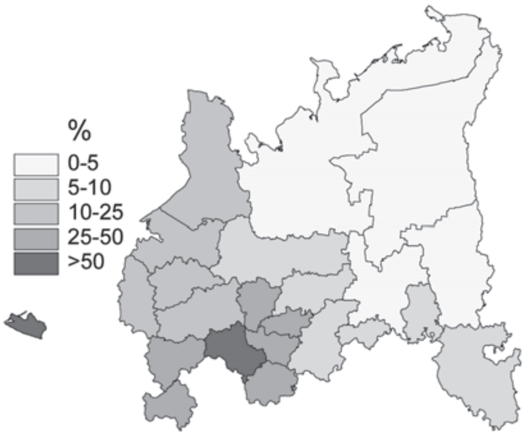

Figure 12: Percentage of State Forest Fund peatland and paludified land for which forest drainage is recommended (Sirin & Minayeva 2001).

Drainage for forestry was first mentioned in official documents in 1820, when a private landowner drained around 340 hectares of peatland covered by dwarf pine and birch trees. More than 65 kilometres of shallow ditches were cut, and this resulted in rapid growth of the trees to more than three times their original height. In 1844 a forest drainage project was implemented on an area of about 2,200 hectares, and in 1853 the practice of draining forested peatlands was endorsed at government level.

During the two late-nineteenth-century expeditions mentioned above, forests were actively drained along with agricultural land and the routes of roads. The expeditions lasted for more than 20 years, covered most of the European part of Russia, and involved the drainage of 615,000 hectares of forested peatland as well as other land. The income from forest amelioration was estimated at 1.06 million roubles, and it was decided that this activity should be developed further. As a result, more than 850,000 hectares of land had been drained for forestry by the time of World War I (50,000 hectares before 1870 and 800,000 hectares during the period 1870–1915) (Konstantinov 1999).

Forest amelioration theory developed rapidly in subsequent years. Practical recommendations were developed on the basis of several background investigations (Dubah 1945), and the numerous scientific studies relating to forest drainage focused on biological background (Vompersky 1968), hydrology (Vompersky *et al* 1988, Vompersky & Sirin 1997), changes in biodiversity, primary production (Nitsenko 1951, Platonov 1967, Grabovik 1989) *etc.* Discussion of the influence of forest drainage on mire regulation functions resulted in a number of publications (The role of peatlands… 1980; Pyavchenko 1985a), and in the 1980s it was concluded that drainage has a positive impact on catchment hydrology.

Forest drainage work peaked during the period 1966–1990, when the area of drained forest — mainly in north-western, western and central European Russia — exceeded 4 million hectares. This was achieved by establishing special state forest improvement enterprises, which were very well equipped technically and had strong engineering support, but were economically motivated to maximise working rates and minimise expenses including transport costs. This did not favour selective drainage and resulted in the creation of distinct concentrations of drained mires which were often capable of supporting only low-efficiency forestry. In general, however, forest drainage helped to improve the management of Russia's forests by making them more accessible to motor vehicles and enhancing fire protection by fragmenting continuous stands of trees and installing ponds.

Unfortunately, no economic benefits have been realised from many of the drained sites because the necessary forest management has not been carried out. This outcome was promoted by the economic changes of the 1990s. According to the latest inventory (1999–2000), there are only about 3 million hectares of drained forest in the European part of Russia. Many of the areas that were previously drained have undergone secondary paludification, often actively assisted by beavers, whose numbers have increased rapidly in recent years. Although ecologically positive in some cases, this can lead to the death of trees, especially spruce, which increases fire risk and has other detrimental consequences. The drainage networks have gradually deteriorated and the reconstruction work which is permanently required, especially at the most fertile and productive sites, is increasingly neglected (Fig. 13). Peatlands that were effectively drained 30–40 years ago have already developed productive forests which are now approaching harvestable condition. As the mature spruce will soon begin to fall over, forest management is urgently needed.

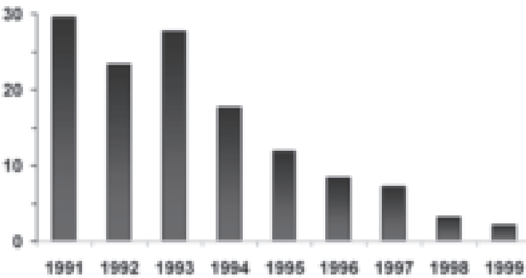

Figure 13: Reconstruction of the forest drainage network in Russia (thousands of hectares) (© Project on peatland conservation in Russia).

Indirect Use and Threats. When surrounded by mires, one has to explore, use and transform them in order to create space in which to eke out a living. In the highly paludified regions of Russia, most of the human impacts on mires can be attributed to so-called 'indirect use', for example the construction of roads and other industrial infrastructure. Indeed, it is difficult (and in many regions impossible) to find a road that does not cross peatland. The standards set for road construction require that spillways should be installed to allow water to move safely from the upstream to the downstream side of the road. As such arrangements are incompatible with the natural flow pattern of mire water, the only practical option is to collect the water in ditches on the upstream side of the road and route these to the spillways. However, digging ditches does not usually meet with the approval of environmentalists. As a result, stretches of flooded and disturbed mire can be seen along most of the roads in Russia's forest zone. Corresponding water-deprived (effectively drained) stretches of mire are present on the downstream sides of these roads, although they are often less obvious. Similar impacts are caused by oil and gas pipelines, which are laid not only near the production areas but also in other regions of the country.

The oil and gas industry imposes many additional impacts on peatlands (Vasiliev 1998). The construction of drilling rigs directly damages the mire surface, which is difficult to repair, and may cause degradation of adjacent areas which thus lose their productivity and natural functions. Oil production can also cause pollution of the mire surface. Wastes that arise during the drilling of oil wells are usually stored in slime chambers, which are dug out of the ground and lined with plastic. These readily become sources of surface pollution by oil and related substances if the plastic linings are punctured or broken. Contamination also results from spills of deep groundwater containing high concentrations of dissolved mineral salts, which destroys the vegetation and promotes rapid degradation of peat. Oil spills from broken pipelines are another cause of direct pollution. In addition to these types of impact pollution, there is also carpet pollution, which is spread by surface runoff or falling precipitation. This may change the trophic level of the mire, cause mineralisation of peat, and affect vegetation communities and biological diversity.

As in other European countries, Russia's peatlands are increasingly being engulfed by building to meet national and municipal needs. This arises because peatland tends to have low commercial value and to be shared between just a few land owners. Peatlands in river valleys are especially vulnerable because they tend to belong to land categories (e.g. agricultural land) that are governed at regional or local level, whereas watershed peatlands are much less accessible because they are mostly classified as Forest Fund land, which has federal status. Building for various purposes is especially intense in densely populated regions close to large cities, but it is to be hoped that the Water Code (2006) will be effective in preventing the conversion of mires to dumping sites for solid municipal waste and wastewater in future.

Peatland Conservation

In Russia, the conservation of mires and paludified land was rarely addressed specifically before the 1960s. Mires were protected only indirectly, either as parts of Specially Protected Natural Areas (SPNAs) or within the general framework for regulation of the use of natural resources. With few exceptions (Dokturovski 1925, Katz 1928), the issue of mire conservation was not even raised in the scientific literature. On the other hand, authors often cited the negative functions of mires and advocated their large-scale reclamation and transformation (Olenin & Markov 1983). In two regions of central European Russia where mires are plentiful and traditionally used by man, sociological investigations have demonstrated that most people still regard them with fear and as obstacles to normal life and development. Opinion polls showed that local inhabitants and summer visitors alike were unanimously cautious: "don't touch mires and they won't touch you". This attitude derives from an intuitively mystical view of mires as impenetrable, uninviting places that are full of devilry. Similar emotions must have dominated in the European countries where, centuries ago, peatlands were destroyed for social reasons and economic gain. Nowadays, the people of these countries, in contrast to those in most of Russia, are willing to incur considerable material and social expense to protect and restore peatlands. However, this attitude cannot simply be exported to countries where peatlands are still important sources of livelihood and direct or indirect economic return (Sirin *et al* 2006; Plusnin 2006a, 2006b).

Specially Protected Nature Areas. The landscape approach has always dominated nature conservation planning for the vast territory of Russia (Borodin 1913). This is reflected in historical conservation designations such as "sacred land" (groves) and "hunting reserves" (menageries *etc.*), whose boundaries often included mires and paludified land; as well as in the current SPNA system. Territorial nature conservation in Russia generally involves establishing SPNAs of the various types listed in the Federal Law On Specially Protected Areas. Federal-level SPNAs include strict nature reserves (zapovedniks), national parks, nature refuges (zakazniks), nature monuments, botanical gardens and recreation areas. Twenty-two zapovedniks and three national parks are also UNESCO biosphere reserves. Some of these SPNA types correspond to IUCN classifications — zapovedniks are equivalent to IUCN Category Ia reserves and national parks fall into IUCN Category II, whilst biosphere reserves and landscape zakazniks fit within Category V. There is no special SPNA category for mire protection at the federal level. Regional SPNAs include zakazniks, nature monuments and nature parks, and additional types may be defined by regional legislation. For example, both the Russian Federation and several of its administrative regions (e.g. the oblasts or provinces) have established SPNA categories such as "valuable wetland" (Krasnoyarsky Krai, Amurskaya Oblast) and "protected water object" (Moscow Oblast).

The scientific foundations for territorial conservation of mire ecosystems were laid in the 1970s and 1980s. Masing (1979) evaluated mires as habitats for rare species, whilst Botch & Masing (1979 organized discussions (Botch 1979, 1991) and carried out analyses of positive functions and threats which were used to develop criteria for identifying mires for conservation (Tanovitsky 1980). Antipin & Tokarev (1991) also presented a method for establishing specially protected areas that focused on mires. The development of principles for integrated management of peatland resources (Vompersky & Prozorov…1989) followed; approaches included a sectorial approach to wise use and restoration (Kuzmin 1993), and integrated spatial planning (Minayeva 1996).

The number of SPNAs and the total area thus protected has grown steadily in recent years, to more than 3% of Russia's total area. Mire ecosystems have been protected within SPNA boundaries, as have other landscape types (Minayeva & Sirin 2001). The zapovedniks and national parks of European Russia include approximately 700,000 hectares of mires, whilst federal SPNAs in Siberia include some 3.5 million hectares of mires.

Many mires are protected within the boundaries of SPNAs that were not established exclusively for mire conservation, such as: Nizhnesvirsky Zapovednik, Leningrad Oblast (41% of the total SPNA area); Kerzhensky Zapovednik, Nizhny Novgorod Oblast (36%); Darvinsky Zapovednik, Yaroslavl Oblast (23%); and Vodlozersky National Park on the border of Karelia and Archangelsk Oblast (42%). Several nature reserves have also been established primarily for the conservation of mire ecosystems and their associated plant and animal species.

Two contiguous nature reserves have been established to protect the Polisto-Lovat mire system, which is one of the largest intact raised bog massifs in north-western Russia. These are Polistovsky Zapovednik in Pskov Oblast (mire area 71% of total) and Rdeysky Zapovednik in Novgorod Oblast

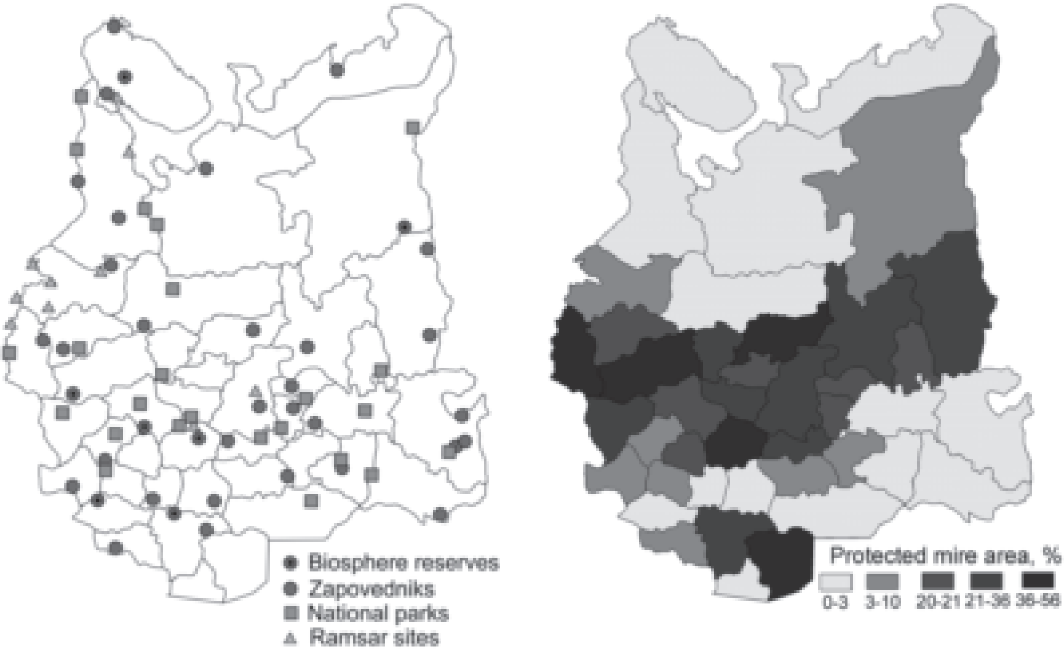

Figure 14: Federal Specially Protected Nature Areas (SPNAs) and Ramsar sites with peatlands (left) and area (%) of mires registered as peat deposits and protected within SPNAs (right) in the European part of Russia (© Project on peatland conservation in Russia)

(mire area 92%). Two reserves have also been designated to protect the unique Polisto-Lovat mire system (Maykov 2005, Galanina 2005), which is the largest raised-bog-dominated mire massif in Europe and the site of some classical scientific investigations (Bogdanovskaya-Guenef 1969). The integrated management that is necessary for each of these mire massifs requires a high level of co-ordination between the two SPNA administrations involved.

Yugansky Zapovednik (mire area 84.7%) was established in Khanty-Mansi Autonomous Area (Western Siberia) to protect the famous Yuganskiye Mires which are, moreover, inhabited by the indigenous Khanty people. Bolonsky Zapovednik in Khabarovsk Krai (province) also comprises more than 80% peatland.

The situation for internationally protected sites resembles that for the federal SPNAs. Although none of the 35 Russian Ramsar sites was established exclusively to protect mire ecosystems, more than 9% (950,000 hectares) of the existing wetlands of international importance consist of mires and paludified land (Wetlands in Russia ... 1999). In view of the importance of these ecosystems for Russia, a Ramsar "shadow list" has also been compiled (Wetlands in Russia ... 2000 a, b). This includes a large number of peatlands. It was prepared on a regional basis, and underlines the special status of mires in conservation planning for Russia's administrative regions.

Significant numbers of mires are protected within local (administrative region) nature parks, zakazniks and, especially, nature monuments. During the 1980s, the administrations of some regions in European Russia introduced the additional SPNA type "protected natural mire" to underpin resource conservation programmes for sectors such as forestry and the peat industry. The protected mires remained available for these land uses, but were excluded from the areas to be felled or extracted for periods that were defined within the users' own business plans. However, this SPNA category has not been perpetuated in the relevant legislation. Many mires and waterlogged areas are located within game reserves (zakazniks), whose boundaries may be varied to accommodate the reproduction needs of the local game fauna. Nonetheless, habitat conservation for game positively affects the status of the mires within these areas.

The Land Code established by Russian law categorises SPNAs of federal and regional importance, along with areas of restricted land use (forests assigned for water protection, recreation, other values *etc.*), as "nature conservation lands". Figure 15 shows the fraction (%) of nature conservation lands occupied by mires within each of Russia's administrative regions.

Mires are actively protected in administrative regions with extensive socially and economically important peatlands, where public awareness of the associated management and conservation issues tends to be high. Often, mires in such regions are also important for research, which further enhances awareness amongst the local population, authorities and other stakeholders. These regions are north-western European Russia (Botch & Smagin 1993), Western Siberia and the Russian Far East. In regions where mires originally covered only small areas and have contracted due to human impacts, the protected proportions are modest. This applies in central European Russia including Moscow Oblast, most of the steppe and forest steppe regions of southern European Russia, Cisuralia, Western Siberia and the upland and mountainous parts of the Caucasus.

Although very few SPNAs have been designated specifically for peatland conservation, the total area of protected peatland is relatively large. However, the selection process takes no account of the diversity of peatland types, or of the need to include typical examples for the full variety of landscape situations and climatic zones. Indeed, the selection of mire systems for conservation has been somewhat subjective. Spatial analysis of the mire types included in SPNAs within European Russia indicates that most of the protected temperate zone mires are raised bogs, and that watershed raised bogs have been selected preferentially (Minayeva 1996, Preobrazhensky 2001). The explanation is that most raised bogs belong to the State Forest land category. This ownership facilitates control and makes changes of status difficult. There is also a long-standing and deeply-seated delusion — in Russia and elsewhere — that raised bogs have especially important hydrological roles as the sources of rivers *etc.* Scientific research has disproved this contention. Fens (including valley and floodplain systems) often have more valuable environmental roles in regulating the discharge of rivers and protecting them from pollution, as well as in supporting floral and faunal biodiversity. They are also the most threatened mire types because they are still regarded as wastelands, mostly classified as agricultural land with diverse non-state ownership, and regulated by local administrations. As a result, many fens have been affected by human activities, and those near big cities have even been displaced by new summer cottages (dachas) and infrastructure during the last 15 years.

According to the analyses undertaken by Orlov & Tishkov (2004), the highest priority should be afforded to protection of:

- mires that are close to their geographical distribution limits (in the Arctic, steppe and forest-steppe zones) and thus especially vulnerable to climate change, especially if they are also subject to human pressure;
- high mountain peatlands;
- typical and representative peatlands for each biogeographical region, for example raised bogs and transitional fens of the temperate forest zone; and

Figure 15: The proportion (%) of land assigned to nature conservation that consists of peatland, for each region of the Russian Federation. Derived from Land Cadastre data (© Project on peatland conservation in Russia).

– all surviving peatlands in the zones of urban and economic development around large cities.

The current SPNA system does not provide an adequate protection mechanism for peatlands in these cateogories, but land use regulation could deliver substantial environmental benefits without significant changes in land use. The steps that would be required to initiate effective conservation measures are as follows:

– inventory of the status of all peatlands in the categories listed above;

– threat analyses;

– compilation of a list of peatlands to be protected;

– public awareness-raising, including work with administrative authorities; and

– development of local and federal legislation to ensure protection of the priority peatland types.

Land Use Regulation. A foundation for regulating the use of Russia's mires was laid long ago. The Grand Prince of Kiev known as Yaroslav the Wise instigated the protection of forests and the habitats of game animals, which are often associated with mires, back in the eleventh century; whilst Peter the First issued royal decrees establishing water protection zones along rivers and around river sources, as well as floodplain conservation (Grave 1993; Reimers & Shtilmark 1978). Thus, the protection of certain mire types was facilitated by rather strict nature management regulations in pre-revolutionary Russia as well as during the Soviet period, and some of these regulations have persisted to the present day.

The post-Soviet national legislation originally incorporated many positive features, but also contradictions and discrepancies reflecting the traditional sectoral approach to mires and their resources (Sirin & Minayeva 2001). However, as in previous periods of history, development of the provisions for protecting mires and controlling their use has continued, and priorities in the field of mire conservation are gradually changing for the better — although perhaps too slowly. The legislative status of mires was rectified in the recently adopted Water Code (2006). This treats mires as special water bodies, and so provides for the establishment of protective shoreline bands and water protection zones around them. It also allows for an integrated approach in cases where changes to part of a mire are expected to affect the whole mire massif, and it includes a special chapter on the protection of mires against pollution and fouling. On the other hand, forests growing on mires are still regulated by forest legislation; peat extraction is regulated by geological legislation; and a few other federal laws on land use, forest management, subsoil assets, nature conservation *etc.* also directly affect mires. Thus, contradictory legislation continues to create some uncertainties in the regulation of construction on mires.

During the Soviet period, the state owned most of Russia's land and natural resources, so that inconsistencies between different laws governing the use and conservation of mires did not dramatically affect their status. Now that more land is in private ownership, such discrepancies can significantly impede the regulation of mire use by generating varying interpretations and errors in practical application of the legislation. For example, there are no clear regulations regarding the use of privately owned mires which are not listed in the water cadastre; and varying interpretations of the water legislation mean that certain types of mires may not be regarded as water bodies. In some parts of Western Siberia, all watershed mires are considered to be water bodies, but forest fens with high species diversity and unquestionable importance for water protection and regulation ("sogra" mires) are not. It is hoped, however, that such difficulties will gradually be eliminated.

Individual sectors dealing with mires have, to some degree, developed their own mechanisms for wise use which include conservation. Since the 1960s, intensive utilisation of the natural resources associated with mires, coupled with general national support for the "wise use" ideology, has promoted work to establish provisions for the restoration of mires after exploitation (Pyavchenko 1985b, Vompersky & Prozorov ... 1989) and to emphasise the importance of conserving their ecosystem diversity (Nitsenko 1962, Botch & Nitsenko 1971). Since the 1970s, the *Torfgeologia* Industrial Geological Association, which is in charge of exploration for peat resources, has assessed the conservation importance of peat deposits in European Russia and on this basis allocated them amongst the "peat funds", which are areas reserved for different uses including conservation (Kuzmin 1993).

Botanical studies carried out by the mire science section of the All-Union Botanical Society and by the Russian branch of the *Telma* Group (mire conservation group under the UNESCO Man and Biosphere Programme umbrella) resulted in a list of valuable mires (Botch & Masing 1979), and a considerable number of these have been placed under protection. The percentage of such peatlands in each of Russia's administrative regions is shown in Figure 14 (right).

The other sector with major peatland interests — the State Forest Service — identified mires for protection somewhat pragmatically by excluding stands of trees with low productivity from the areas to be felled. However, these stands comprise the foundation of the modern network of protected mires.

The traditional sectoral attitudes that prevail in economic and scientific circles within Russia mean that effective planning of mire conservation and wise use requires an integrated approach and broad inter-sectoral collaboration. Adoption by government of the inter-sectoral framework document "Action Plan for Peatland Conservation and Wise Use in Russia" (2003) was an important step in this direction. The Action Plan was developed as part of the implementation at national level of Ramsar Convention decisions relating to the wise use of peatlands (Resolution VIII.17), and a long-term project to pursue some of its major objectives was subsequently launched under the auspices of the Wetlands International — Russia Programme. This project includes work on national policy and legislation issues, international co-operation, the provision of methodological and informational support for mire conservation and wise use, information exchange, awareness raising, model field projects to explore methods and novel approaches, the resolution of 'burning issues', *etc.* (see http://www.peatlands.ru for further details).

Peatland Restoration

The pattern of peatland use in Russia is generally similar to that observed across much of the northern temperate zone, and restoration needs are directly related to the type of use. Most of the drained peatland is used for agriculture, less is used for forestry, and the smallest area is used for peat extraction. The intensity of impact is estimated as visa versa — the worst consequences are caused by peat extraction as far the most of extracted areas have been nor rehabilitated.

Peatlands under agriculture and forestry are notable for the substantial areas of mire that are inefficiently used or unused, some of which are at various stages of secondary paludification. These have arisen from errors in choosing sites, poor drainage design and/or maintenance, and the general social and economic decline that has occurred in some regions with extensive managed peatlands. Restoration by raising the water table is not appropriate for forested peatlands because it causes waterlogging and high mortality of trees; these areas should be left to paludify naturally. On the other hand, re-wetting of peatlands that have been drained for agriculture should effected as a matter of priority on account of the associated widespread risk of peat fires.

The most pressing need for peatland restoration is linked to peat extraction. A preliminary investigation of the distribution of peat workings at all stages of development in 2007 demonstrates that they are concentrated in densely populated areas, and that new workings tend to be located close to existing ones. Thus, the many partly extracted sites that were abandoned when the peat industry declined in the early 1990s now represent concentrated fire hazards.

In Soviet times, worked-out peat deposits were re-cultivated and allocated to other land uses (agriculture, forestry, reserve, human settlements, industry or water fund). This makes it difficult to trace the histories of individual sites, and obscures the very existence of small sites that were extracted by local companies and subsequently converted to predominantly agricultural uses.

Before the 1950s and 1960s, peat was extracted mostly from open pits, by methods such as direct excavation and the 'hydrotorf' technique. The associated disturbance was relatively local and did not substantially alter peatland hydrology. Most of the areas that were exploited in this way are now recovering and have already developed semi-natural mire communities. More recently, peat has been extracted only by milling, which drastically changes local hydrology and so reduces the likelihood that re-paludification will occur spontaneously afterwards. This increases the danger that worked-out areas will become long-term points of origin for peat fires and dust storms, and primary habitats for invasive species. However, the re-cultivation of extracted areas is an obligatory part of the procedure for peatland development, and

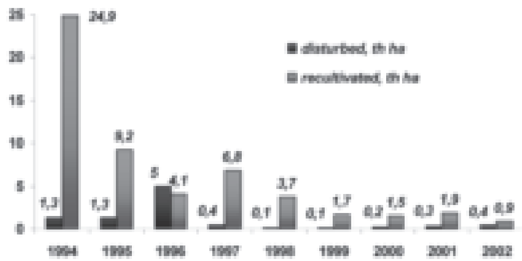

Figure 16: Recent dynamics of peat workings in Russia, illustrated by the areas being newly prepared for peat extraction (disturbed), and recultivated after extraction, in each year from 1994 to 2002 (© Project on peatland conservation in Russia).

the areas of land reclaimed must be documented and submitted by the developer for inclusion in national statistics on the turnover of industrial land (Fig. 16). By analogy with standards set for engineering-technological schemes, the milled peatlands should have been allocated to a range of after-uses including agriculture, forestry, smallholdings, fish farms and secondary paludification; but for political reasons, priority was given to the expansion of agricultural land. It was not until 1998 that secondary paludification was introduced by "The instruction for reclamation of peatlands after peat extraction" (endorsed by the RF Ministry of Natural Resources on 31 March 1998). In order to completely solve the problem, what is required now is a re-alignment of peat industry policy to establish secondary paludification as the priority after-use for extracted sites.

As a result of the situation described above, restoration is most relevant for three types of transformed peatland, namely:

- in the case of agricultural land — unused areas of drained peatland;
- in the case of forestry land — peatland sites with ineffective drainage; and
- in the case of extracted peatland — extracted and worked-out areas that have been abandoned; especially if they adjoin natural peatlands, occur in high concentrations, or are located in densely populated or protected areas.

Restoration also is also important for rare and hydrologically discrete peatland types such as valley and spring fens, karst fens in the steppe regions *etc.*

The legislative and methodological background represents a challenge for peatland restoration, because numerous unco-ordinated changes to both federal and regional laws have exacerbated the legal complexities and uncertainties. The key pieces of federal legislation that are (only indirectly) relevant are the Laws on Melioration, Environmental Impact Assessment (EIA) and Environmental Protection as well as the Land, Water and Forest Codes. The land and the drainage system of a drained peatland may have different owners, which may be forestry or agriculture enterprises or companies specialising in drainage. The procedures that must be completed before restoration can commence vary with the present use and ownership of the land, as well as with the organisation implementing the restoration project, and include: endorsement by the land owner; agreement with the land user; development of project documentation and expertise; input of state expertise; EIA (in the case of a nature conservation area); and evaluation of impacts on neighbouring land where appropriate.

The importance of Russia's peatlands for nature conservation and recreation has not yet been evaluated sufficiently to assess restoration needs for these purposes, and the main driver for peatland restoration at present is fire control. In recent years, various organisations have carried out effective re-wetting work on several cutover peatlands for fire control purposes, whilst also bearing in mind the prospects for their longer-term recovery as fully functional mire ecosystems.

Examination of these projects indicates an urgent need for development of rigorous procedures to integrate the practical work with legislation, land use management and land development plans. The most irregular and "illegal" re-wetting projects have been undertaken by voluntary associations of local stakeholders and NGOs, and include examples of ecologically unsound and legally disputed dam construction on drained forest land. This arises because small projects funded by voluntary investments and foreign sponsors have no capacity to develop project documentation or undertake EIA, no technical expertise, and no means to monitor and maintain water control structures after installation. The projects undertaken by the peat industry are generally the most sound, perhaps because the state is responsible for both developing the economic incentives and ensuring compliance with the regulations in these cases. This issue requires the much closer attention of all stakeholders, from federal government to private businesses.

Analysis of the Russian experience of peatland restoration to date shows that the following steps are required to further develop these activities:

1. analysis of the legislative background for peatland inventory and restoration in the Russian Federation;
2. inventory of degraded peatlands in European Russia;
3. development of economic incentives to encourage peatland restoration by government and private sector organisations;
4. avoidance/prohibition of biofuel production as an after-use for extracted peatlands;
5. awareness-raising focused on peatland restoration;
6. development of methods for peatland restoration;
7. stimulation of the involvement of environmental consultancies in peatland restoration; and
8. focusing attention on restoration as a priority for the following land categories: drained and extracted peatlands within existing protected areas; abandoned drained and extracted peatlands in urban areas; and abandoned extracted peatlands adjoining natural peatland landscapes.

Action Priorities for Russia

The most pressing issues highlighted by the analyses of the current status of peatlands, their use, conservation and related problems are summarised below.

Problems in peatland management and conservation arising from legislative changes. Several of the 2005–2006 changes in federal legislation governing the use of natural resources have significant implications for peatlands. Substantial responsibilities were devolved from federal to regional level, necessitating changes to rules and procedures which are still in progress so that much remains unclear. The new Water Code incorporates peatlands as complex objects, but legislation supporting contradictory sectorial viewpoints has been retained, making it difficult to determine which rules from the Land, Water and Forest legislation take precedence in relation to different peatland uses.

Action points: to analyse the implementation of the new legislation; to develop recommendations for synchronising and minimising contradictions between the different Acts; to develop rules and procedures for peatland management and conservation that comply with the requirements of the new federal legislation; to support subjects of the Federation in developing legislation for aspects of peatland management that are no longer fully regulated by federal legislation.

Peatlands and obligations of the Russian Federation to key international conventions in the field of environmental conservation. During the last decade, several significant decisions relating to peatlands have been taken at international level. The Ramsar Convention adopted the *Global Action Plan on Peatlands* in 2002, whilst the Convention on Biodiversity recognised peatlands as ecosystems requiring a special approach and adopted the *Assessment on Peatlands, Biodiversity and Climate Change* in 2008. Also, in 2006, UNFCCC adopted the *Guidelines for National GHG Inventories,* which take account of peatlands under extraction.

Action point: to develop national documentation to support and promote the recommendations, decisions and guidelines of these international conventions, including those for national reporting.

Russian peatlands and climate change: mitigation and adaptation issues. The natural functions of peatland ecosystems furnish them with enormous potential in relation to climate-change mitigation and adaptation. As Russia's peatlands are extensive, full implementation of the regulations on peatlands and climate change could affect the situation across a large area.

In UNFCCC terms, the mitigation functions of peatlands arise from their capacity to accumulate and store carbon and prevent the subsequent release of greenhouse gases. Special consideration is afforded to peatlands that are prepared for extraction, under extraction, in after-use and abandoned; all of which are common and widely distributed in Russia.

Climate-change adaptation refers to the adjustment of natural and human systems so as to moderate harm or exploit beneficial opportunities arising from actual or expected climatic changes and their effects. This may encompass a wide range of activities which are not exactly defined at international level (e.g. by UNFCCC). The official position of Russia is that the priority activities in this context are monitoring of environmental variables including ecosystem characteristics, and the observation of changing climatic conditions. Mires, as one of the dominant ecosystem types of Russia, are obvious candidates for monitoring and observation. This is needed not only where mires are abundant, as in the boreal zone, but also where peatlands and shallow peatlands are regarded as other ecosystem types (e.g. tundra) and near their natural geographical limits, where they are rare (e.g. in steppe regions and mountains). Adaptation options present a wide range of opportunities for moderating losses of peatland biodiversity, regulation functions and values under changing environmental conditions through environmental policies and wise use management, both in general and operating through specific sectors of the economy such as agriculture, forestry and peat extraction. These approaches should be broadly based, as peatlands provide a wide range of adaptation services: they sustain the hydrology and microclimate of adjacent areas; represent stepping-stones for migrations across fragmented landscapes; and provide refugia for species which are not restricted to peatlands but have been eliminated from their intensively-used surroundings, thus securing habitats for azonal, intrazonal, relict and endangered species.

Action point: to undertake a scientifically-based review of the mitigation and adaptation functions of peatlands, and develop recommendations for land use practices to maintain these functions.

High-priority measures for the direct protection of specific peatlands: at their distribution limits (the Arctic, steppe and forest-steppe zones) in the face of climate change and human pressure;

typical and representative peatlands within their natural distribution ranges; and all remaining peatlands in urban and economically developed regions. The protection of peatlands in these categories will not involve significant changes in land use, but will have a substantial effect on the overall environment.

The main requirements for Arctic peatlands are that they should be protected from surface disturbance including the mechanical destruction of vegetation and soil, and that alterations to surface hydrology and flooding regimes should be avoided in order to avert the melting of permafrost and its catastrophic local, regional and global consequences. A need for management, based on the understanding that peat functions as insulation material for permafrost and is much more sensitive to disturbance than other soils, is indicated. In order to justify this to the relevant authorities, a clear description of the processes that follow peat disturbance, as well as estimates of the consequences for biodiversity based on good inventories of peatland distribution and habitats, will be required.

Steppe, forest steppe and urban peatlands do not cover significant areas, and could be excluded from use without serious socio-economic consequences if the process is managed appropriately from a political point of view. These peatlands are still used to satisfy very local needs which could be covered from other sources, but only if there is a clear political will to protect peatlands.

Public awareness of peatlands is extremely low in the southern regions of Russia. There is also insufficient knowledge about them within the administrations of regions around the large urban areas (especially Moscow), where construction on peatlands is proceeding very rapidly due to the often strongly negative attitudes of the authorities to these ecosystems combined with the high value of land. The alternative of totally excluding peatlands from this use would deliver a significant conservation result, especially for their value as habitats and stepping stones on migration routes.

The typical peatlands of the boreal zone could be lost very easily because they are too commonplace to be regarded as valuable. Thus, the situation in Russia could soon come to resemble that in Finland, where most peatlands in highly paludified boreal regions have been disturbed in some way, especially along their edges. Because pre-emptive protection measures can greatly assist the conservation of peatlands in such regions, it is imperative now to make an inventory of protected peatlands and ensure that all of the typical and representative types are included.

Action points: inventory of the status of peatlands in targeted regions and landscape types; threat analyses; list of peatlands to be directly protected; public awareness campaign including work with regional administrations; development of local and federal legislation to ensure the protection of specific peatland types.

Peat industry: the need for a regional approach and complex assessment. The new Russian Federation energy strategy increases the fraction of biofuels in the overall energy mix. For this purpose, peat is regarded as a renewable biofuel. Of course, although it can form more rapidly than coal or gas, it hardly qualifies as a renewable fuel because its regeneration time is much longer than 1–2 human generations. Moreover, the rate of peat growth varies with peatland type and geographical location, and many peatlands are now degrading — i.e. growing at negative rates — due to disturbance exacerbated by climate change. Nonetheless, the use of peat in energy production will increase for economic reasons. The demand for peat as a growing medium and fertiliser is also rising. Peat extraction could have positive as well as negative results. Drained peatlands with milling fields that were abandoned in 1990s are especially prone to fire, and recovery of the peat industry here could be beneficial because owners would thus become responsible for fire prevention. On the other hand, commercial exploitation of hitherto undisturbed peatlands should be discouraged, and forbidden in areas where they are already rare. Comparisons of the rate of peat extraction with peat resource and growth data are often presented for the country as whole, and almost inevitably indicate a very small effect. This approach is misleading because it ignores the fact that the demand for peat is mostly concentrated in regions where little peatland remains. For example, for economic reasons, peat for gardening and landscaping is extracted from the few surviving peatlands near cities and towns, with irreversible negative consequences for the environment.

Action point: to prepare a reference paper on the regional variation of peatland resources and their present condition, values and functions. This would be made available to all decision-makers and stakeholders in order to advocate a regional approach and the careful assessment of peat extraction activities.

Impact assessment on peat extraction techniques. Peat extraction is one of the most destructive peatland uses in terms of its effects on biodiversity and other ecosystem functions. It could not be terminated immediately, and will persist for a long time in many regions of Russia. Thus, high-quality impact assessments will be needed. These should take into account a wide range of processes and be supported by good knowledge of peatland functions and regeneration. All areas from which peat has been extracted without intense drainage (by hydropeat, excavation *etc.* processes) within the last 40–50 years have recovered well, but such "wet" extraction methods are now regarded as less effective than milling, which requires intense drainage, on economic grounds. It seems possible that, if the demonstrated lower costs of recultivation and restoration after "wet" extraction were weighed against the increased fire risk and loss of regulation functions *etc.* associated with milling, the "wet" methods might appear more economically lucrative so that a sound case could be made for their re-adoption.

Action point: to develop a substantiation report on the economic and environmental benefits of "wet" methods of peat extraction.

Restoration of peatlands, the problem of peatland fires, and wise use. Russia does not yet have a clear legislative and methodological basis for peatland restoration, and this makes it difficult to plan and implement restoration work. At the same time, re-wetting is an extremely effective method for the prevention of peatland fires, which is an important national objective. The obvious solution is to establish fire prevention and restoration activities as integral parts of regular practice for both peatland use and peatland conservation. Methodological recommendations have been developed and endorsed by Moscow regional government within a PIN Matra project (2003–2005), but this first step requires reinforcement with further regulations and practical recommendations on restoration activities which take into account regional variety and conservation needs.

Action points: to support the integration of peatland restoration into State policy using fire protection as the main driving force; to bring to the attention of Federal authorities the urgent need for restoration of the abandoned excavated peatlands which have State Reserve Land status; to use the theoretical and practical background for peatland restoration and management which was developed during the Soviet period.

Infrastructure development and peatlands. Technical advances have reduced the strength of arguments against siting new infrastructure on peatlands on account of their unfavourable ground conditions. This is especially true for highly lucrative activities such as pipeline construction and building in the vicinity of megapolices where little free space remains and land prices are high. As a result, vast areas of peatland have been disturbed by linear constructions (roads, pipelines *etc.*) and there have been local but irreversible losses to housing and commercial developments within and near existing settlements.

Land with private or municipal status is more readily available to developers than state land. Because the privately-owned agricultural and industrial land is generally in river valleys rather than on watersheds, and municipal land is near settlements, peatlands in these situations tend to be disproportionately affected. Thus, the few peatlands that remain near big cities — especially those in river valleys — will disappear in the very near future. There is an urgent need to designate them as regional protected territories and raise awareness amongst all stakeholders, including local people and administration, of their extremely valuable role in water regulation and biodiversity support within highly populated regions.

Linear constructions affect peatlands by changing their hydrological regimes, with consequences for biodiversity, greenhouse gas emissions and other functions. The construction of roads and pipelines totally alters the pattern of water flow, which is concentrated in the uppermost 50 cm of the peat layer. Standard road embankments are much less permeable to water than most types of surface peat, and existing technology which could make them compatible is economically non-viable in most cases. Simple culverts could permit water to flow across the line of a road at the natural rate without causing damaging concentrations of flow at their extremities if intercepting ditches were installed, but this is often opposed by environmentalists. Thus, there is a strong need to raise awareness about the problem amongst different groups of specialists so that further damage to peatlands can be avoided by making sensible water management a compulsory part of construction practice. For pipeline construction, similar attention to the hydrological value of the surface peat is required. In this case it will be necessary to devise and apply methods for cutting out and storing the surface layer in undisturbed blocks before the trench is excavated, and replacing it after the pipeline is laid.

Linear constructions are one of the key threats to peatlands in Russia, and collective action is required to solve the problem. Applying good practice at the planning and construction stages may well be more cost-effective than paying for repairs arising from bad design. Hence, there are strong incentives for conservationists and developers to co-operate in devising environmentally safe methods for installing linear constructions on peatlands.

Action points: to raise awareness at different levels and emphasise to all stakeholder groups, especially the developers, the benefits of taking peatlands into consideration when constructing roads; to undertake a detailed review of the impacts, processes and existing experience of road construction in peatlands; to promote implementation of this approach in state-funded projects and to raise funds from the private sector to address the problem.

Wise use of peatlands being reclaimed from agriculture and forestry. A large area of peatland was drained for agriculture and forestry before the 1980s, but there is now less interest in these activities due to the re-structuring of economic sectors that followed the changes in Russia's socio-economic situation. The drainage networks have not been maintained, and the land is no longer managed for economic benefit. The resulting accumulation of unused drained peatlands requires special attention in order to avoid catastrophic consequences such as fires, erosion and loss of biodiversity. An information base is needed to enable adequate planning of the future use of this land.

Action points: inventory of drained land in the key regions, with focus on ecological dynamics; evaluation of the legal possibilities and practical potential for use and restoration of such land; to test the approach in one region, in order to develop standard practical methods and address legislative aspects, and thus create a model for wider implementation.

The problems of transboundary peatland management. A peatland is an ecosystem which functions as a single entity and should not be divided by administrative boundaries. The indivisibility and integrity of peatlands is incorporated in Federal legislation: a special section of the Water Code stresses that any action upon part of a peatland should not affect other parts. The same principle can be applied to paludified catchments and interfluves. Many of the borders of Russia with other countries divide peatlands and catchments. Large lowland peatlands are divided along the borders with Norway, Finland, Estonia, Latvia, Belarus, Ukraine, Kazakhstan, Mongolia and China. This means that peatland could be managed in different ways on the two sides of the border. Moreover, there are no guidelines for transboundary peatland management and no relevant case studies. Many regional borders between the Russian provinces also divide peatlands and catchments. Often, legislation and especially sectorial rules and standards have been applied in different ways in neighboring regions so that the transboundary issue arises also within the country. Under the newest Russian legislation (from 01 January 2007), the subjects of the Russian Federation have acquired extended responsibilities for the management of natural resources, and this makes the problem more urgent.

Action points: to develop an overview of problems relating to transboundary peatland management for pairs of named neighbouring countries; to formulate guidelines for some issues within individual countries.

Role of peatlands as habitats, especially to support migrating species. Peatlands have specific traits and characteristics which are reflected in their biodiversity characteristics at the genetic, phenetic, species and ecosystem scales. The particularities of peatland biodiversity should be considered when planning conservation measures. Peatlands maintain populations of plants, animals and other groups which are adapted to their harsh conditions and could not survive elsewhere. They also host "dryland" species during specific events such as droughts, frosts and crop failures, as well as when they are under anthropic pressure. Different azonal and intrazonal species may also find favourable conditions in peatlands; for example, arctic species are found in the bogs of the temperate zone.

Peatlands maintain migration routes in different regions. Valley peatlands play an extremely valuable role in bird and mammal migrations by maintaining open areas along rivers which widen migration routes and provide food. Many large watershed peatlands are also known as resting places for migrating birds. Peatlands host many rare species (e.g. all nests of the Siberian crane, the frost-bird *Pluvialis apricaria,* the aquatic warbler which is known only from peatlands, and the golden eagle which uses mineral islands within large peatlands).

The role of peatlands for biodiversity, and especially for the maintenance of migration routes, is undervalued in Russia.

Action points: to develop national and regional annotated lists of species that are dependent on peatlands; to compile inventories of the most valuable peatlands for habitats of rare species, and of peatlands that are valuable for sustaining migration routes; to evaluate the status of named peatlands and provide recommendations for their management; to review the biodiversity of peatlands and prepare guidelines for regional inventories and management for species conservation.

Awareness of the role of peatlands in river catchment management and water quality. The hydrological role of peatlands depends very much on the region, the landscape type and the range of anthropic impact, but can be highly complex and provide services such as: water storage; redistribution of water availability between seasons; regulation of flow in rivers and flood control; protection of water from contamination and purification of surface water; and maintenance of water levels and replenishment of groundwater storage in adjoining aquifers. This role can be critical, and peatland protection for water management is a key issue in some regions of Russia. At the same time, awareness of the hydrological role of peatlands is rather low amongst Russian land users, decision makers, local populations and even scientists and experts. Often, naive assumptions about hydrology are applied to peatland issues, even by specialists. 20th century Russian scientists made a major contribution to the study of mire hydrology and their work is well-known all over the world — indeed, rather better than in Russia. From the 1960s to the 1980s, much of their theoretical and practical knowledge was used to develop management guidelines and recommendations for different peatland uses including the control and management of water and river basins, and many of these guidelines still have official sectorial status. The new Water Code (2006) provides a good opportunity to reconsider the hydrological role of peatlands and build a strong foundation for their protection as discrete water objects.

Action point: There is a strong need to use all existing Soviet-Russian knowledge, as well as modern international information on the subject, to raise awareness amongst different stakeholder groups in Russia and to develop comparative information as well as official guidelines and recommendations for water and river basin management, and for decision making.

Peatlands in education and public awareness. Until the 1980s, many popular works on peatlands, their utilisation and value were published in the Soviet Union, in Russian and other official languages, by central publishing houses as well as in the former republics of the USSR. This was a consequence of the wide-ranging Soviet programme to bring information on the problems of economic development, which included the utilisation of peat and peatlands, to the attention of different stakeholders and population groups. Many of these publications were very well produced, are still used, and could be helpful in addressing current problems. Now there is a lack of information for almost all groups of potential users. Only short remarks about peatlands are included in primary and secondary school textbooks, and very few universities still offer the courses on mire science and related subjects which were obligatory for many biological, geographical, forestry and other specialist degrees before the 1990s. The lack of information at all educational levels has led to a lack of knowledge amongst both the general population and key stakeholders, and thus to serious mistakes in peatland management. Since 2003, several leaflets explaining the natural functions and values of peatlands have been published within projects funded by PIN Matra (The Netherlands). There has also been an attempt to integrate information on peatlands into school education. However, the public awareness campaign is only just beginning and much work is still needed.

There is a clear need for the preparation of background information to support the further integration of mire science and knowledge into general courses at different educational levels, from primary school to university. Land users and decision makers should be provided with simple leaflets explaining the special aspects of land use on peatlands. Guidelines for local museums on how to organise a small peatland exhibition, based on national and international experience, would also be helpful.

Sociological studies in several regions of central European Russia have demonstrated that most people regard peatlands as direct sources of commodities such as peat for energy and fertiliser, land for agriculture and forestry, and unlimited supplies of berries, mushrooms and game. Few people see peatlands as places for recreation, as habitat and regeneration zones for many species including game, as ecosystems with complex hydrological functions, or as carbon stores with a role in climate-change mitigation. These functions require explanation and promotion, and there is a general need to explain the complexity and integrity of mires, their natural diversity and their different values and functions. Nowadays, many regions are developing capacity for nature tourism. Special "mire" tourism has just begun in Tver and Tomsk regions; in Tomsk this focuses mainly on scientific meetings, whilst in Tver it aims at a wider clientele including adult nature tourists. Information to support environmental tourism as an alternative ('green') use of peatlands should be developed, and the European example of establishing nature trails on peatlands should be followed in Russia. There is also an urgent need for some simple guidelines containing key information, and even for some training, to create a foundation for further work by local teams on the development of "mire" tourism.

Action point: The key problems and actions identified above could be used as a basis for the development of Federal-level guidelines, recommendations and regulations for nature tourism, as well as for the implementation of pilot activities to test and demonstrate approaches in the most appropriate regions.

Countries of Central and Eastern Europe

Estonia

General Information

The total area of the country is 4,522,763 ha and the population is 1,370,052 (0.30 people per ha). The original extent of mire was 1,009,100 ha (peat deposits), and the current area is 325,000 ha.

Estonia lies within the boreo-nemoral vegetation zone.

Distribution and Diversity

The mire classification system that is most widely used in Estonia is based on developmental stage and trophic conditions. The three classes are: (i) eutrophic mires, which are rich in nutrients and occur in low-lying depressions; (ii) mesotrophic or transitional mires; and (iii) oligotrophic mires (bogs), which are poor in nutrients and located mostly on watersheds.

The most extensive fens are found in the western part of the country, where species-rich examples have developed near the mainland coast and on the calcareous substrata of Saaremaa Island. Poor fens are more common in eastern Estonia, whilst floodplain fens occur widely in the lowermost parts of river valleys, except in the north. Spring fens are distributed sparsely across the country, but most are located on the marginal slopes of the Pandivere and Sakala Uplands and on Saaremaa Island.

Transitional fen communities are found in western, central and north-eastern Estonia. They are rather scattered, but are common around lakes. Transitional bog communities often form wooded belts around the large ombrotrophic bogs, especially in north Estonia.

The larger bogs are in the western, central and north-eastern parts of the mainland.

Depressions between the sand dunes of northern coastal areas host a very rare type of heather moor with, typically, up to 0.5 m of peat overlying pure sand, into which drainage is impeded by an intervening ortstein horizon.

More than 16,500 Estonian peatlands cover areas greater than 1 ha, 1,626 extend to more than 10 ha, and 143 to more than 1,000 ha. In terms of the Estonian vegetation habitat classification, 24 habitat types and 15 subtypes are represented in mires, and 10 mire habitat types are considered to be rare.

Peatland Resources

Rates of peat accumulation vary significantly between the different natural mire types. In fens, peat is formed at an average rate of 0.2–0.6 mm y^{-1}, whilst in ombrotrophic mires the accumulation rate is I.2–2.0 mm y^{-1}. Peat thickness is generally 3–4 m, but can reach 7–9 m in places. There are 1,626 peat deposits (Orru 1955) with a total area of 5,800 km^2. The peat resource is estimated at 15.24 Gm^3 (2.87 Mt), of which 3.62 Gm^3 (0.37 Gt) is classed as horticultural and litter peat, and 11.62 Gm^3 (2.00 Gt) as fuel peat.

Peatland Use

Peat extraction. Peat is Estonia's second most important strategic energy source, the most important being oil shale. Between 1950 and 1990, around 0.35 million tonnes of sod peat was extracted annually, and 15,000 ha of peatland was damaged. Milled peat extraction peaked in the 1970s then declined, but began to increase again in 1994 and now amounts to 0.5 million tonnes per year. Estonia is now the world's third largest exporter of horticultural peat, supplying the Netherlands, Germany, France, Sweden, Finland and the UK; and in recent years 1.2–1.5 million tones of peat have been extracted. The total area of natural peatland lost to this activity is estimated at 30,000 ha, of which 15,000 ha are now abandoned.

About 2,580 km^2 of Estonian peatlands have been drained (Loopmann 1994), and more than 4300 km^2 under pasture, grassland and forestry are influenced by drainage (Ilomets 2005). The area of drained peatland under forestry is 0.5 million hectares, the area under agricultural use is 0.7 million hectares, and another 1.1 million and 0.9 million hectares respectively are regarded as requiring drainage for these two uses. However, the only further drainage that is planned is the drainage of paludified forests for silviculture. The extant drainage systems are in need of investment for maintenance.

According to the geobotanical mapping carried out in 1930–1955, most of the Estonia's floodplains had been converted into grasslands. At that time they covered 83,000 ha and amounted to 7.5% of the total area of semi-natural grasslands in the country (Laasimer 1965). An inventory of grasslands in the late 1970s (Aug & Kokk 1983) indicated that the area of floodplain grasslands was 27,584 ha, which is about 35% of the estimate from the first half of the century. Like other areas of semi-natural vegetation, most of these grasslands have now been abandoned and scrubbing-over is widespread.

There are at least 70 mires, total area about 25,750 ha, whose annual yield of cranberries is more than 50 kg ha^{-1}. Picking cranberries provides extra income for local people, and during the 1970s quantities ranging from 200 to 1,300 tonnes of cranberries were purchased each year by the state.

Visits to mires are increasingly included in environmental holiday packages offered by Estonian tourist agencies.

Some 2,000 ha of mire have been destroyed by opencast mining of the oil shale beneath, and this activity advances across another 100 ha of mire each year. Mires are also displaced by road construction and urban development.

Policies on peatland management

Estonia has ratified five international conventions that relate to the biodiversity and wise use of peatlands, and there ten of the national laws dealing with environmental protection and use of natural resources are relevant to peatland conservation. The country's environmental policy is based on the principles of sustainable development and aims to encourage a shift from the traditional consumptive use of natural resources towards more balanced and ecologically oriented production systems. Article 53 of the new Constitution of the Republic of Estonia (approved on 27 June 1992) sets out this general principle as follows: "Everyone shall be obliged to preserve the human and natural environment and to compensate for damages caused by him or her to the environment. The procedures shall be determined by law."

Since 01 January 2001, environmental impact assessment (EIA) has been required by law for planned new areas of peat extraction exceeding 150 ha. For smaller areas, the Ministry of the Environment and the environmental authorities must decide whether EIA is necessary, on a case-by-case basis. However, auditing has shown that these compulsory assessments have not always been carried out before extraction permits have been granted.

Peatland Natural Value and Conservation

Biodiversity maintenance. All of the key mire types for the Baltic Ecoregion are represented in Estonia. The rare types that are specific to the Baltic Ecoregion are: calcareous rich fens (*ca.* 7,000 ha), spring fens (350 ha), heather-shallow peat mires on sandy soils (*ca.* 300 ha, in the coastal zone and on islands); and fast-growing oceanic ombrotrophic raised bogs with thick peat (*ca.* 158,000 ha, on watersheds, with up to 11 m of peat). Estonian mires host 188 species of bryophytes, 280 species of vascular plants, 300 species of Aranei, more than 1,600 species of Insecta, 4 species of Amphibia, 3 species of Reptilia, more than 200 species of Aves and 11 species of Mammalia. 69 vascular plant species, 25 bryophytes and 22 animals that are found in mires are included in the Red Data Book. Mires provide temporary habitat for 6 bird species as transit migrants, 4 winter visitors and 42 vagrants.

Natural regulation functions. Peatlands prevent damaging floods and eutrophication of inland and coastal waters, and play an important role in improving water quality and in cleaning waste water. Their drainage impacts negatively on the water regimes of surrounding landscapes. They are also an integral part of the circulation systems for nitrogen, sulphur, oxygen, carbon dioxide and methane; and Estonian peatlands store approximately 1.2 million tones of carbon, keeping it locked away from the atmospheric carbon pool for thousands of years.

Protection measures. Specially Protected Natural Areas (SPNAs) The national system of protected areas dates back to the 19th century, when mires were designated as habitats for rare birds. Peatlands are now included in 160 nature conservation areas designated at national or local level. Estonia's 509 existing and proposed Natura 2000 sites include 780 mires with total area 245,160 hectares, representing nine mire habitat types. Peatlands are well integrated into the Estonian Econet, with high ecological network index values.

Although different terms were used, the concept of the Estonian ecological network was effectively established in 1979–1981, as the "Scheme for protection and sustainable use of Estonian natural resources"

Table 1. Natura 2000 mire and mire forest sites in Estonia

Habitats Directive code	Habitat type	Number of sites	Total area (ha)
7110	Active raised bogs	93	142,500
7120	Degraded raised bogs still capable of natural regeneration	26	2,000
7140	Transition mires and quaking bogs	78	15,000
7160	Fennoscandian mineral-rich springs and spring fens	38	7,160
7210	Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*	36	1,100
7220	Petrifying springs with tufa formations (*Cratoneurion*)	16 (53 springs in total)	
7230	Alkaline fens	117	10,700
9080	Fennoscandian deciduous swamp woods	177	31,800
91D0	Bog woodlands	127	34,900
	Totals	708	245,160

(Külvik & Sepp 1998). Little was done to realise these ideas during the Soviet period, however, and it was only in the mid-1990s, after adoption and implementation of several legislative tools, that the Econet concept was put into practice (Sepp *et al* 1999). Wetlands are well integrated into the process of defining the key elements of the network, and the wetland land cover classes attain high ecological network values; on a 6–point scale, bogs score 2.4, wooded fens and bogs 3.4, littoral marshes 3.6 and fens 4.0.

International protected areas. Ten of the twelve Estonian Ramsar sites include peatlands, and there are seven more peatland sites in the 'shadow list' of eleven proposed Ramsar sites. Which mires should be added to the SPNA system will be clear when the detailed results of the Natura 2000 effort have been fully compiled.

Potential for restoration. Even simple reclamation or rehabilitation of cut-over peatland areas is proceeding very slowly in Estonia, so that these areas continue to detract from the aesthetic values of landscapes and emit large quantities of CO_2 to the atmosphere. The 2005 report of the State Audit Office suggested very strongly that deserted opencast peat mining areas on state-owned land, for which there was little practical prospect of further working, should be re-vegetated. What is lacking, however, is a scheme for financing restoration in the event that the peat mining company becomes insolvent. Such a scheme might be developed, for instance, by creating a national guarantee fund or a sub-fund within an existing financial institution. Otherwise the developer might be obliged to guarantee the existence of sufficient funds for restoration as a condition of issue of the extraction permit.

Main Threats

Peat extraction. In the recent years, the amount of peat extracted annually has been $1.2–1.5 \times 10^6$ tonnes, which is 2–3 times the annual growth of peat in Estonia.

Drainage. For the first decade after drainage, the annual loss of organic matter due to mineralisation is 15–20 tonne ha^{-1} yr^{-1}. Later, the rate of loss stabilises at about 10–15 tonne ha^{-1} yr^{-1} on cropland and 5–10 tonne ha^{-1} yr^{-1} on grassland. The leaching of nitrogen may amount to 150–250 kg ha^{-1} yr^{-1} and 100–200 kg N ha^{-1} yr^{-1} under the same respective land uses. On grasslands, subsidence of the drained peat layer will be one metre during the first 20 years, and two metres of the peat will vanish over a century. The peat layer in drained forests diminishes by 6–15 mm per year.

Use of bioresources. Pressure from visitors gathering cranberries and other produce from mires introduces possible threats that include trampling, introduction of invasive and alien species, and an increase in the frequency of fires.

Opencast mining of oil shale. In order to access the oil shale beneath a peatland, all of the peat must be removed. In north-eastern Estonia, about 2,000 ha of mire have been destroyed in this way and a further 100 ha will be destroyed annually in the future.

Air pollution by gas containing Ca, As, Zn, Th, Hf and V arises from power plants burning oil shale in north-eastern Estonia. About 200,000 ha of land in a 30 km radius around each power plant has been affected. It is estimated that 30,000 tons of Ca are deposited in dust falling on this area, resulting in disappearance of the Sphagnum carpet. This has in turn halted the peat-forming process and increased the rate of decomposition in bogs lying within 10–15 km of the pollution source.

Peat fires. The rehabilitation of burned bogs and recovery of the pre-fire community structure takes 50–100 years.

Impact of construction. The expansion of built-up areas influences the condition of mires mostly around the larger towns, especially in the suburbs of Tallinn. Several holiday camps have been built on paludified land, but this is still a comparatively unimportant impact. There are also several places where road construction has affected peatlands, including natural mires.

Threatened peatlands. There are three endangered Natura 2000 sites with peatlands.

In terms of "Natura 2000 in the New EU member states..." (2005), three 'hot issues' can be pointed out (the numbers beginning 'EE' are from the Estonian Natura 2000 sites register).

1) EE0040001 (Väinameri SPA) = EE0040002 (Väinameri pSCI[1]): building of a bridge (instead of a tunnel) between the Estonian mainland and Muhu Island. Impacts: disturbance of waterfowl by cutting through the main migration corridor known as the Baltic Sea — White Sea flyway, which is used by millions of ducks and 30–60,000 divers annually; and bisecting the Estonian population of Ringed Seal (*Phoca hispida botnica*).

2) EE0040432 (Küdema laht pSCI and SPA): building of the new Saaremaa harbour. Impacts: threat to the breeding and wintering waterfowl populations.

3) EE0040203 (Marimetsa — Õmma pSCI and SPA): planned peat extraction in the northwest part of Õmma bog. Impacts: just before the designation deadline for Natura 2000 sites, the regional environmental department of Rapla District excluded the northwestern half of the intact Õmma bog (7110*) from the pSCI and SPA, and allocated this area for peat extraction. Working is expected to start

[1]SPA - Special Protection Area for EU Birds Directive; pSCI - proposed Site of Community Importance for EU Habitats Directive list.

within the next few years, and this will undoubtedly impair the conservation status of the Natura 2000 site.

Hot Issues and Recommendations

The water-related ecological functions of mires should be given due consideration in the future management of Estonian landscapes. The water holding and purification capacity of mires and peaty soils should be given high priority in land use planning. In particular, within the catchments of rivers whose flooding is likely to cause damage, the destruction of wetlands should be avoided; and special care should be given to the protection and appropriate management of wetlands in and adjacent to watercourses with high loads of nutrients and other pollutants. Using natural mires for water purification is much less costly than constructing conventional treatment plants.

Peatland restoration must be made obligatory through legislation.

The wise use approach should be applied in spatial planning and in the improvement of technologies for both the extraction of peat and its conversion to fuel.

Various problems and suggested solutions are summarised below:

Gaps and Problems in legislation

European legislation should embrace and incorporate wise use principles for peatlands, and in particular regulate the rate at which sourcing of peat for west European markets expands eastwards (and farther afield), in order both to ensure maximal sustainability of the peat industry and to avert the danger of simply exporting the environmental problems of western Europe.

If peat is to be regarded as a renewable natural resource, permissible extraction rates should be calculated by government on the basis of annual peat increment (rate of formation) data, rather than from the estimated total size of the reserve. Detailed studies are

Table 2. Various problems and suggested solutions

Problem	Suggested solution
Lack of knowledge	Special education programmes
Lack of awareness of the natural values of peatlands	Campaigns and awareness-raising activities
Peat-consuming technologies in extraction and end uses	Development of new technologies involving intensive extraction and more effective use
Insufficient background knowledge for decision-making regarding peat accumulation and the water cycle and in natural and degraded mires	Research programmes and projects to fill the gaps; develop legally enforced monitoring systems
Lack of established restoration methodologies and supporting legal framework	Pilot projects to fill the gap
No articulation between land tenure and management of the degraded land after working	Development of the appropriate legal background to link the two ('polluter pays')
Peat fires	Development of a legal framework for fire prevention on abandoned land

urgently needed on this so that the permitted annual rate of peat extraction can be designed to arrest the over-exploitation of peat resources.

Drainage and extraction of new intact peatlands should be prohibited until all the current extraction sites have been worked out.

Environmental Impact Assessment (EIA) must be carried out in respect of all new extraction permits, regardless of the size of the proposal (not only for sites larger that 150 ha). The EIA process should take full account of the views of local people.

Peat extraction permits should specify requirements for monitoring the quality and discharge rates of drainage water.

Current legislation is insufficient to provide timely and adequate rehabilitation of exhausted peat-fields.

There is a need for establishing a tax system to promote sustainable use of peat resources.

Investment in drainage systems is required to provide two-way water regulation on peat extraction sites so that drying and mineralisation of peat is minimised.

Latvia

General Information

The total area of the country is 6,463,500 ha and the population is 2,490,000 (0.39 people per ha). The original extent of peatland was 672,204 ha and the current area is 316,712 ha, giving an estimated loss of 53%.

Distribution and Diversity

Peatlands cover 4.9% of the total land area of Latvia. Peat deposits, defined as peatlands larger than 1 ha with more than 0.3 m of peat, cover 10.4% of the country. These include some forest types, drained peatlands and peat extraction sites in addition to peatlands with thick peat layers.

All of the key peatland types for the Baltic eco-region are represented in Latvia, although raised bogs are more common than fens. Black alder swamps occur throughout the country, whilst watershed raised bogs and sedge fens are found only inland. In coastal areas there are vast (more than 1,000 ha) flat ombrotrophic bogs, small inter-dune peatlands, rich fens with the rare species *Schoenus ferrugineus* and *Cladium mariscus,* and poor fens.

The largest raised bogs are located in the East and Middle Latvia Lowland, the North Vidzeme Lowland, and the Tireli Plain in central Latvia.

Fens are also widely distributed, occurring wherever groundwater contributes to maintaining waterlogged conditions. They range in size from small sites of only a few square metres to extensive fen complexes; and have frequently formed as zones around lakes, in waterlogged hollows, at the margins of raised bogs and in river floodplains. Rich fens are found in locations with limestone substrates. One of their distinctive features is that they are very rich in plant species, a number of which are rare and protected.

Reedswamp and tall-sedge communities, e.g. Phragmitetum australis and Caricetum elatae, often occur near lakes. The dominant species here is *Phragmites australis* and its associates are *Scirpus lacustris* and *Typha latifolia*.

Peatland Resources

There are about 6,800 peatlands in Latvia, and the country's total peat resource amounts to 1.5 billion tonnes.

Peatland Use

Extracted peat is used within Latvia as fuel, fertiliser and litter for animals; and it is exported mainly for horticultural use. About 6% of the country's total peat resource has been utilised already, and 536 peatlands are still available to be opened up for peat extraction. These peatlands contain commercial peat reserves amounting to 333 million tonnes (at moisture content 40% by wait). Annual data prepared by the Latvian Environmental, Geological and Meterological Agency show that the total volume of peat extracted varies from year to year, depending on demand and the weather conditions. Thus, one million tonnes were extracted from 65 sites during 2006, whereas only 541,000 tonnes were extracted from 66 sites the following year. About 9% of Latvia's raised bogs (37 bogs with a total area of 70,000 ha) have been affected by peat extraction and 20,000 ha are almost exhausted.

The other major threat to Latvian peatlands is drainage. 14,571 km^2 of peatland have been drained for agriculture, 4,000 km^2 for forestry, and the current total area of drained peat deposits is 1,862 km?. The most intensive drainage projects were conducted between 1960 and 1980, and drainage of wetlands has practically ceased in recent times.

Policies on Peatland Management

Latvia is party to eight international conventions and two regional directives that are relevant to peatland conservation. Nationally, peatland conservation and use is regulated by 16 official documents relating to environmental protection and the use of natural resources. Three documents that relate specifically to peatlands have been endorsed, namely: The Strategy for Peatland Biodiversity Conservation, approved by the Ministry of the Environment; The Strategy for Peat Resource Conservation, which contains specific recommendations for the development of wise use guidelines for extracted peatland; and The Action Plan for Peatland Conservation and Management.

Natural Values and Conservation of Peatlands

Values. The rare and protected species hosted by Latvian peatlands include 34 vascular plants, 25 bryophytes, 15 invertebrates, 2 reptiles, 25 birds and 8 mammals. Also, several peatland plant species meet here at the most eastern (*Myrica gale, Erica tetralix*) and the most western (*Chamaedaphne calyculata*) extremes of their distributions.

Eight of the protected habitat types included in the European Habitats Directive classification are represented in Latvian peatlands. Three of these types are rare and confined to the Baltic Eco-region. They are: calcareous fens and spring sulphur fens; petrifying springs with tufa formation associated with dolomite rocks; and inter-dune peatlands.

Peatlands are also valued in Latvia for their natural regulation roles in relation to water supply, water purification, microclimate maintenance and carbon storage, as well as for their buffer function in preventing damaging floods.

Protection measures. More than half of the peatlands in Latvia are relatively little disturbed by human activities and the remainder have been drained or used for peat cutting. About 12% of them are state protected within 336 Natura 2000 sites, which encompass raised bogs, fens and peatlands near lakes.

The Law On Protected Areas provides seven categories of protected areas, namely: State Strict Nature Reserves (IUCN category I), National Parks (category II), Natural

Monuments (category III), Nature Reserves (category IV), Nature Parks (category V), Protected Landscape Areas (category V) and Biosphere Reserves (category VI).

The list of protected areas accepted by the Latvian Parliament in 1999 includes about 140 peatlands with a total area of 38,000 ha. These are distributed across most of the protected area categories, being located in three Strict Nature Reserves (Grini, Krustkalni and Teici), three National Parks (Gauja, Kemeri and Slitere), six Protected Landscape Areas, the North-Vidzeme Biosphere Reserve, 15 Nature Parks and 140 Nature Reserves.

International protected areas. At present there are six Ramsar sites containing peatlands in Latvia. These are Teici and Pelecare Peatlands, Engure Lake, Kanieris Lake, the Lubana Wetland Complex, Northern Bogs, and Pape Wetland Complex.

Almost 140 nature reserves selected from 336 prospective Natura 2000 sites include all of the country's peatland types.

The European protected habitats (according to the Habitats Directive) that occur in Latvian peatlands are:

– active raised bogs;

– degraded raised bogs still capable of natural regeneration;

– transitional peatlands and quaking bogs;

– Fennoscandian mineral-rich springs and spring fens;

– calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*;

– petrifying springs with tufa formation (*Cratoneurion*);

– alkaline fens; and

– bog woodland.

Latvian legislation distinguishes the following protected peatland habitats:

– mineral-rich springs and spring fens;

– petrifying springs with tufa formation;

– sulphur springs;

– calcareous fens with *Carex davalliana*;

– calcareous fens with *Schoenus ferrugineus*; and

– calcareous fens with *Cladium mariscus*.

Potential for Restoration

Land reform (the privatisation process) has not noticeably affected peatlands because peat resources are, and will continue to be, mainly state-owned. On the other hand, the peat extraction companies are being privatised. This could create future problems in relation to the restoration of worked-out peatlands, because private companies have not yet become interested in financing renaturalisation work and state bodies do not have the necessary instruments for enforcement.

Main Threats

Peatlands have been drained and converted into arable land, meadows and pastures. Drainage alters their ecology and hydrology with detrimental consequences for adjacent areas and water bodies. Drainage also results in the loss of stored carbon, mostly as the greenhouse gas carbon dioxide, thus contributing to climate change. It is estimated, for example, that peat mineralisation in Lithuania results in carbon losses of 1.6–2.5 million tonnes per year.

The amount of peat extracted each year is closely related to peat exports. In recent years there has been an increase in peat exports, mainly to West European countries and especially to Germany, the Netherlands and Italy. Although located in the same biogeographic region, these countries have lost most or even all of their peatlands. This creates high demand for peat on the international market and particularly on the Baltic countries, which still possess semi-natural peatlands. The products exported are mainly based on little-humified peat, e.g. litter peat. It is predicted that peat exports will continue to increase and that greater quantities of processed and packaged peat will be exported in the future. Moreover, extraction techniques and technology will be modernised in order to raise the quality of the peat to European standards.

In recent years, fires have occurred on some peatlands such as Lielais Kemeru Tirelis in the Kemeri National Park.

Road construction leads to fragmentation of habitats and hydrological shifts in peatlands.

Threatened peatlands. No designated peatlands are threatened.

Hot Issues and Recommendations

An inventory of peatlands, a public awareness campaign, and work towards implementation of The Action Plan for Peatland Conservation and Management are urgently needed in Latvia.

The following activities have been identified as burning priorities:

- projects raising awareness about peatlands amongst the general public, aiming to popularise peatland values and the need for their protection;
- research to assess the biodiversity value of Latvian peatlands;
- research on the status and hydrological functioning of peatlands;
- update of the national peatland inventory with respect to all peatland types; and
- development of guidelines for assessment of the value of peatlands for biodiversity and conservation.

Lithuania

General Information

The total area of the country is 6,530,000 ha and the population is 3.7 million (0.57 people per ha). The original extent of mire was 482,600 ha and the current area is 145,400 ha, reflecting a loss of 70–80%.

Distribution and Diversity of Peatlands

Geobotanically, Lithuania is located in the mixed forest sub-zone and belongs to the boreo-nemoral vegetation zone

Mires covered about 7.3% of Lithuania until the middle of the 20th century. The total number of mires (including the smallest ones) was *ca.* 40,000, but only 30 were larger than 1,000 ha whereas about 1,500 were in the size range 50–1,000 ha. Large mires were concentrated in the transition from upland to lowland, whilst the smaller ones were located mostly in hilly morainic landscapes, where they filled almost every depression. The majority of mires were 5–8 m deep and only rare examples were more than 10 m deep.

The mire classification system that is most widely used in Lithuania is as follows: (1) fens, which occur in low-lying depres-

Table 3. Information about the Lithuanian mire resource in 1994

Area (ha)	Number of mires	Number being exploited, number (%)	Number abandoned, number (%)	Natural or slightly damaged, number, (%)	Fraction of total area, (%)	Fraction of total peat resource, (%)
<1	251	-	-	-	0.05	<0.1
1-10	2780	-	-	-	4.55	3.0
10-50	2603	-	4 (0.04)	183 (1.68)	19.3	13.8
50-100	522	-	12 (0.34)	40 (1.18)	11.5	9.1
100-500	434	14 (1.52)	22 (1.89)	40 (3.33)	26.9	24.6
>500	95	14 (11.37)	7 (2.23)	3 (0.84)	37.7	49.4
Total	6685	28 (12.89)	45 (4.5)	266 (7.03)	100	100

sions, are rich in nutrients and have telluric water supplies (e.g. groundwater, springs, water bodies); (2) transitional mires; and (3) raised bogs, which are mostly situated in elevated watershed areas, are poor in nutrients, and receive water only as precipitation. The surviving mires now cover 2.2 of Lithuania. Before land reclamation, 60–70% of the total mire area was fen, 5–10% was transitional mire and 25–30% was bog.

Fens are typical for the northern and central parts of the country, where most of them have been transformed into grasslands and meadows. Raised bogs are concentrated in the west and include plateau raised bogs, which are typical for oceanic areas but have now almost disappeared from the Baltic ecoregion. Most of the mires are small. It is estimated that 41 of the country's peatlands are smaller than 20 ha and together comprise only 1.7 of the total peatland area. Only nine peatlands extend to more than 3,000 ha, and together these account for 17 of the total peatland area. Amongst these is the famous Augstumale Bog, which lies within the 'Delta of the Nemunas River' Ramsar site. Eleven of the plant communities that occur on mires are included in the Red Data Book of Lithuanian plant communities.

Peatland Resources

Until 1990, the Committee for the Environmental Protection of Lithuania was responsible for Lithuanian peatlands. Their experts surveyed 6,685 individual sites covering a total area of 3,217 km^2 and estimated to contain 5.247 Gm^3 (937 Mt) of peat. 785 (812.6 km^2) of these peatlands are located within protected areas, 334 (579 km^2) are available for extraction and the remainder are under forestry, agriculture and other uses. There are 214 peat deposits whose industrial extraction is regarded as uneconomic. Of these, 69 (200 Mt) are in protected areas and I07 (110 Mt) are on drained agricultural land. There are also 295 uneconomic deposits of local significance. Of these, 44 (11.8 Mt) are in protected areas and 103 (27.6 Mt) on cultivated land.

Peat extraction in Lithuania has been governed by the demand for peat products, the peat resources available, and the capacity of the peat industry. The quantity extracted annually peaked in 1975 (3.2 Mt) and subsequently stabilised at 2.2–2.3 Mt. 54 sites were worked until 1989, after which output declined rapidly as the Lithuanian economy underwent structural changes. Only 0.19 Mt of peat was extracted in 1993, and about 30 previously worked sites are now abandoned.

Peatland Use

64 peatlands covering 235,000 ha and containing 119x10^6 tonnes of peat are included in the mineral reserves of Lithuania, and are thus potential sites for peat extraction. 28 of them (30,600 ha) were worked until 1998 (data from 1999). 368,000 tonnes of peat was extracted in 2004. The Lithuanian Law on Energy regards peat as a primary energy source. Fuel peat is a key issue for Lithuania, especially with the impending final closure of the Ignalina nuclear power plant, which is currently scheduled for 2009. Almost 6 million tonnes of fuel peat was extracted between 1960 and 1990 (1 million tonnes in 1975!), reducing to around 100,000 tonnes per year after 1994. In the same period, 9.2 million tonnes of peat was extracted for use as soil improver and litter (2.2 million tonnes in 1975!); this use has now also declined significantly.

The output of the Lithuanian peat industry in 1975 was seven times the output in 1994. During 1975, 0.23 Mt of peat was used for generating electricity, but by

1985 this use had declined to 0.03 Mt (Ignalina 1 came online in 1983 and subsequently supplied up to 80% of Lithuania's electricity). Small consumers and enterprises producing industrial building materials used less fuel peat in favour of gas and oil, but the use of peat for agricultural purposes (mainly litter) increased and reached approximately 2.0 Mt per year in 1989. Domestic consumption of peat products declined after 1990.

In recent years, Lithuania has started to extract slightly decomposed horticultural peat for export. In 1992, 11,100 tonnes (48.6%) of peat exports were to Germany, 5,900 tonnes to Belgium, 4,200 tonnes to Greece and 2,700 tonnes to France (total 23,900 tonnes). In 1993, 97 000 tonnes; and in 1994, 250,000 tonnes were exported.

During the last 30 years of the twentieth century, 70% of Lithuania's mires were drained for forestry and agriculture. The area of drained peatland is now 185,000 ha.

Harvesting of bioresources – berries and medicinal plants – is a visible part of the local economy in rural areas. In fact, mires provide about 30% of the raw materials required by the Lithuanian pharmaceuticals industry, which uses more than 50 mire species. Fen peat is used for 'mud cure' (balneology) in the health resorts at Druskininkai, Likėnai, Birštonas and Palanga. The total productive area of peatland for cranberries is 10,000 ha, and companies bought up to 3,668.5 tonnes of the harvest from local people in 1997, 2,272 tones in 1998 and 7,035 tonnes in 2004.

Policies on Peatland Management

Lithuania is a Contracting Party to all of the key biodiversity-related international conventions. Seven national laws on nature conservation and use relate to peatlands. The Lithuanian Strategy for Sustainable Development (2003), the Biodiversity Conservation Strategy and Action Plan (1998) and the Master Plan of the Republic of Lithuania till 2020 (2002) call for the conservation of wetland ecosystems by prohibiting the exploitation of new sites, by restoring peatlands, and by setting out measures for the conservation of valuable habitats including establishment of the proposed ecological net "Nature Frame".

The Lithuanian legal system is composed of laws, regulations, rules, government resolutions, standards, norms, methodologies and recommendations. All of these elements are used in mire protection. The Law on Environmental Protection (1992) sets out the legal basis for mire protection. Other aspects of mire protection are covered by many laws adopted by Lithuanian Parliament (Seimas) such as the Law on Protected Areas (1993, 2003), Law on Land (1994), Law on Forests (1994), Law on Territorial Planning (1995), Law on Environmental Impact Assessment (1996), Law on Wildlife (1997), Law on Protected Plant, Animal and Fungi Species and Communities (1997) and others, which are all being progressively revised as the social/economic situation changes.

The national priorities for mire conservation are provided by the Lithuanian Strategy for Sustainable Development, which was approved by the Government of the Republic of Lithuania in 2003, and in the Biodiversity Conservation Strategy and Action Plan prepared by the Ministry of the Environment (1998). In these documents, one of the priority goals at ecosystem level is "to conserve wetland ecosystems by prohibiting exploitation of new wetlands, by restoring peatlands, and by delineating measures for the conservation of valuable habitats". Some national-level documents also anticipate establishment of the ecological net Nature Frame, which will cover more than half of Lithuania. It is defined in the Master Plan of the Republic of Lithuania (to 2020), which was adopted by the parliament in 2002, and will be realised through the combined efforts of all of the Lithuanian institutions, together with population. The Nature Frame will include most protected areas and ecologically significant natural areas including mire systems, lakes, river valleys, forests and meadows.

Other legislative instruments for mire protection and use include the regulations for reserves and nature monuments; the regulations for individual strict nature reserves, national parks and regional parks; the Special Conditions for Land and Forest Use; and the Rules of Forest Protection and Use in Protected Areas.

The Republic of Lithuania is a party to various international agreements and treaties relating to the environment. The most important of these for the protection of wetlands are the Convention on Wetlands (Ramsar 1971) and the EU Habitats (92/43) and Birds (79/409) Directives. Lithuania also participates in Natura 2000.

The system of legally protected areas includes strict nature reserves, national parks, regional parks, managed nature reserves and various protected zones, all of which are used to protect mire ecosystems. Mires dominate in most of the strict nature reserves, but they also occur in the reserve zones of national and regional parks, in managed nature reserves (botanical-zoological, botanical, zoological and hydrographical), in landscape managed nature reserves and in specialised managed nature reserves (telmatological).

The legislative background is sufficient for mire conservation, and what is required now is detailed implementation.

Natural Values and Conservation of Peatlands

Values. About 260 vascular plant, 79 moss and 38 liverwort species occur in Lithuanian mires. The Red Data Book of Lithuania includes 21 birds, 2 mammals, 14 insects, 48 vascular plants and 22 bryophytes that are associated with peatlands. Some insects occur only in mires, for example *Closiana frigga*, *Proclossiana eunomija* and *Clossiana euphrosyne*, f. *lapponica*; whilst the reptile *Emys orbicularis* and the amphibian *Bombina bombina* are restricted to small water bodies in mires. There are also 105 nematode, 8 earthworm and 128 microarthropod species. The natural regulation functions of peatlands and mires include water storage, prevention of damaging floods (buffer role), water purification, microclimate maintenance and carbon storage.

Protected areas. Lithuanian protected areas (state strict nature reserves, national and regional parks, various reserves) include 821 mires with a total area of 78,357 ha (18.9% of the total mire area for Lithuania). The largest protected mires are in the administrative districts of Varėna (104 mires, 9,093 ha), Radviliškis (11 mires, 7,394 ha), Alytus (8 mires, 7,196 ha) and Švenčionys (75 mires, 5,771 ha). There are no protected mires in Jurbarkas, Pakruojis, Pasvalys and Šakiai Districts. The largest mire complexes — Čepkeliai, Kamanos, Žuvintas and Viesvilė — include 11 mires (total area 17,853 ha) and are state strict nature reserves. There are 225 mires (total area 430 ha) in national parks and 422 mires (total area 22,233 ha) in regional parks.

International measures. 13 designated and 95 proposed Natura 2000 sites include mires. Peatlands are also protected within five Ramsar sites, and there are six peatland sites on the Ramsar Shadow List (proposed Ramsar sites).

Potential for restoration. Peatland restoration is identified as a priority of Lithuania's Biodiversity Conservation Strategy and Action Plan, and several proposals for EU-LIFE restoration projects have been developed. However, there is no legal mechanism for restoration to be carried out as an obligatory part of regular land management. Moreover, there are no economic incentives for restoration and no clear technical guidelines for its implementation. Some restoration work has begun on Puščia mire (Zarasai district) and on Aukštumalė Bog; and a new restoration project is being prepared for Amalva Bog in the Dovinė River Basin.

Main Threats

Indirect uses and impacts. Mires are influenced not only by direct drainage, but also by reclamation of the surrounding fields. When mires are drained, fires often ensue. High emissions of SOx, NOx and other substances cause eutrophication and loss of the natural flora and fauna of mires.

Other threats include the absence of national priorities for peatland conservation, coupled with lack of funding; lack of specialists with knowledge of either mires and peatlands or wetland management and restora-

Table 4. Threatened designated and proposed Natura 2000 sites

Number in the list of Natura2000 sites	Site	Threats
3	Adutiškis Bog	Drainage and frequent fires.
12	Balandinė Bog	Drainage and former peat extraction.
38	Konstantinava Bog	Drainage.
41	Laukesa Bog	Drainage and current peat extraction nearby.
44	Tyras Bog within Lužija and Tyras Bog site	Former peat extraction.
45	Mūšos Tyrelis forest	Drainage.
46	Bogs within the Nemunas River Delta site	Most of these bogs are degraded, having previously been drained and used for peat extraction. Aukštumale bog is still used for this purpose.
59	Pleinė Bog	Drainage and former peat extraction.
65	Rėkyva Bog	Current peat extraction.
68	Rūdgiriai Bog	Drainage.
77	Svencelė Bog	Former peat extraction and drainage in the northeastern part of the bog; reclamation of surrounding fields.
95 Zuvintas site	Amalvas bog within and Žuvintas fires.	Changed hydrological regime
62 mire complex	Pravirsulio tyrelis	Changed hydrological regime.
BirdDir mire complex	Birzulis-Stervas	Changed hydrological regime.
BirdDir	Tyruliai	Current peat extraction.
BirdDir	Sulinkiai	Drainage, peat extraction, frequent fires.
BirdDir	Novaraistis ornithological reserve	Changed hydrological regime.

tion; insufficient general knowledge and public awareness of peatland values and functions; lack of management activities in protected peatland areas; and no established research programmes on mire biodiversity, restoration, management and monitoring.

Threatened peatlands. Four designated and 13 proposed Natura 2000 sites that are threatened by current land use are listed below.

The majority of fens in Lithuania are changing (overgrowing) due to management changes.

Hot issues and Recommendations

Peat extraction on "part on mire" approach.

Lack of incentives for restoration.

Market demands for peat.

Accumulation of pollutants. Čepkliai Mire absorbs 64 to 72 kg ha^{-1} of dissolved pollutants from the atmosphere every year, and only 3–7 kg ha^{-1} is carried through the surface and subsurface flow paths to emerge at the edges of mire.

No peat accumulation. Only 63 raised and transitional mires and 73 fens in Lithuania still accumulate peat at a rate of more than 16,000 tonnes of absolute dry matter per year. For all other fens, the annual increase of the peat layer is hardly 4, 800 tonnes of absolute dry peat mass.

Belarus

General Information

The total area of the country is 20,697,000 ha and the population is approximately 10 million (0.48 people per ha). The original extent of mire was 2,939,000 ha, which thus covered 14.2% of the country. There are now 9,192 peatland sites with a total area of 1,434,000 ha (6.9% of the country), giving an estimated loss of 50–60%. The area of drained peatland is 1,505,000 ha, which amounts to 51.2% of the peatland area.

Distribution and Diversity

Belarus lies in the temperate broadleaved forest zone. The dominant mire types are sedge valley fens and black alder fens with spruce. There are small raised mires on watersheds, whilst transitional mires occur on slopes and around the headwaters of rivers. The distributions of the different mire types are related to landscape type and geomorphological zone.

The following geomorphological zones are recognised:

I Hill-lake landscape bog area (Poozerie). 10.6% of the area is peatland, with average peat thickness 2.0 m. The peat often overlies lake deposits. The relative areas of fen, transitional and raised bog peat are 54.5%, 7.0% and 38.2%

II Western end-moraine landscape fen area. 7.7% of the area is peatland, with an average peat thickness of 1.96 m. There are few lakes. Fen peat 94.3%, transitional 3.7%, raised bog peat 2.0%.

III Alluvial plain bog and fen area. 15.5% of the area is peatland, with an average peat thickness of 1.93 m. Fen peat 70.3%, transitional 6.2%, raised bog peat 23.5%.

IV Small bog and fen area set in loess geology. The landscape is predominantly flat with few lakes. 5.5% of the area is peatland, with an average peat thickness of 1.59 m. Fen peat 85.5%, transitional 3.6%, raised bog peat 10.9%.

V Large Polesie fen area. This is a sand/clay plain. 18.3% of the area is peatland, with an average peat thickness of 1.55 m. Fen peat 86.4%, transitional 7.3% and raised bog peat 6.3%.

The open fens of Polesie are of immense importance for European biodiversity conservation. Such fens were widespread in central Europe until recently, but many of them have now been drained. Most of the natural fens that remain within the Polesie area are located in Belarus.

Peatland Resources

Mean peat thickness is 1.9 m, but there is wide regional variation; for example, the average for Brest region is 1.4 m whilst for Vitebsk region it is 2.6 m. The area of thin (<1.0 m) peat with no potential for industrial development is 3,953 km^2 (Bragg & Lindsay 2003). No data are available for peat less than 0.3 m thick.

Early geological surveys estimated the peat reserves of Belarus at 5,707.7 Mt (40% moisture content). Since then, they have been depleted by continuous development for different purposes and at 01 January 1992 they amounted to 4,000 Mt. Peat is used mainly in farming and as fuel.

Peatland Use

The areas of peatland under different land uses are shown in Table 5.

The most intensive period of peat mining was from 1970 to 1988, when 30–40 Mt of peat were extracted each year (Bambalov *et al* l996). Peat has not been used as fuel for power stations since 1986. Over the last five years the quantity of peat extracted annually has fallen to 14–15 Mt, of which about 6 Mt is used to produce peat briquettes for domestic use. Many enterprises market peat for horticulture, vegetable growing and hot-beds; and a small quantity is used for chemical processing and balneology. The remainder is used in farming.

Peatlands play an important role in the economy of Belarus, and 10,851 km^2 of the mire area has been drained and converted into soil for agriculture and forestry, peat extraction sites, or urban and industrial land.

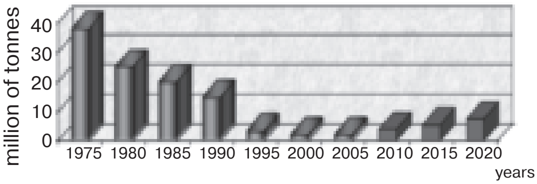

Figure 17. Annual quantities of peat extraction in Belarus since 1975, projected to 2020

Table 5. The total area of peatland in Belarus, divided according to land use (after Bambalov 2005)

Use category	Area (ha)
Drained for agriculture and forestry	1,085,100
Nature protection	317,200
Extracted peatlands, including:	209,500
not recultivated	83,700
rehabilitated	24,000
Peat winning	109,000
Reserves of valuable peat types	30,800
Peatlands for which use has not yet been identified	793,800
Peatlands not included in any land use fund (with area less than 100 ha)	523,800
Total	3,069,200

Policies on Peatland Management

The nature conservation policy of the Republic of Belarus aims to perfect the legislation for nature protection, create a clear basis for regulation of environmental matters, implement economically effective methods for the management and control of nature use, create an integrated system for financing nature protection, perfect management bodies and systems for ecological control, provide nature protection bodies with real and wide-ranging power to implement an ecological training programme for their personnel, promote an ecological culture amongst the general population, and develop international co-operation and more active input of foreign experience towards solving ecological problems in Belarus.

Use of the natural resources of mires and peat deposits is regulated by implementation of the Republic's laws on nature use, which provide for maintenance of an inventory of natural resources, environmental protection, nature reserves, rational use of natural resources and other measures.

The national legislation relating to environmental protection and nature use is based on:

- the Constitution of the Republic of Belarus (Articles 34, 44, 45, 46 and 55), adopted on 15 March 1993, with the additions and changes adopted on 24 November 1996;
- the Conception of state policy on environmental protection, approved by the Supreme Soviet of the Republic of Belarus on 06 September 1995;
- the Law "On protection of environment", adopted 26 November 1992;
- the Law "On state ecological examination", adopted 18 June 1993;
- the Law "On especially protected natural territories and objects", adopted 20 October 1994;
- the Law "On the tax for use of natural resources (ecological tax)", adopted 23 December 1991;
- the Law "On wastes of production and consumption", adopted 25 November 1993;
- the Law "On protection and use of the animal world", adopted 19 September 1996;
- the Law "On protection of atmospheric air", adopted 15 April 1997;
- the Code of the Republic of Belarus on Land, adopted 11 December 1990;
- the Water Code of the Republic of Belarus, adopted 27 December 1972;
- the Code of the Republic of Belarus on subterranean resources, adopted 18 June 1976;
- the Forest Code of the Republic of Belarus, adopted 21 June 1976;
- the Law on Melioration № 423–3, adopted 23 July 2008; and
- the State Programme "Peat" for 2008–2010 and up to 2020, adopted 28 January 2008.

Internationally, Belarus is a Party to the International Convention on Biodiversity and the Ramsar Convention, and fulfils all of the associated obligations.

The legislation is implemented by a number of government organisations. The Council of Ministers is the highest executive body, and answers directly to the President of the Republic of Belarus. It implements state ecological policy, develops and implements financing programmes and nature protection measures, co-ordinates the activities of the ministries and other agencies with responsibilities for environmental protection and nature use, determines budgets, manages the assessment of natural resources and the cadastres, approves ecological standards and limits for nature use and environmental protection, and co-operates internationally in the sphere of environmental protection. The state executive body with principal responsibility for ensuring that policy is implemented with regard to the use of peatlands is the Ministry of Natural Resources and Environmental Protection. A section within this Ministry, known as the Special Inspectorate for the State Control of Lands, Forests, Subsoil and Peat Fund Use and Protection, administers six regional and 123 city and district inspection units for the protection of natural resources and the environment, which directly control the condition and use of mires and peat deposits at local level. The organisation State Concern for Fuel and Gasification (Beltopgas), the Ministry of Agriculture and Food, the Ministry of Forestry, and the Administration for Protected Areas, Forestry and Agriculture also have essential roles in management of the natural resources of peatlands. Some additional relevant functions are provided by the Ministry for Emergencies and Protection of Population from the Consequences of the Accident at the Chernobyl NPS, the Ministry of Health Care and the Ministry of Education.

Nature Value and Conservation of Peatlands

Values. Belarussian wetland vegetation has a rich floristic structure comprising 267 species of flowering plants and ferns including 37 woody and fruit-bearing species, 167 herbal species, 31 *Sphagnum* and 32 green moss species. The country's peatlands host more than 50 valuable medicinal plants such as valerian, Labrador tea, butterbur and buckbean as well as the berry plants cranberry, lingonberry, blueberry and bilberry. A significant proportion of the peatland plants are rare and threatened species. These include the insectivorous sundew (*Drosera*), *Sphagnum* mosses, cottongrass (*Eriophorum angustifolium*), cranberry (*Vaccinium oxycoccus*) and buckbean (*Menyanthes trifoliata*). Species included in the Belarus Red Data Book are: the vascular plants *Osmunda regalis, Hydrocotyle vulgaris, Valeriana dioica, Scabiosa columbaria, Gentiana verna, Swertia perennis, Pinguicula vulgaris, Saxifraga hirculus, Carex buxbaumii, Carex capillaris, Betula nana, Salix myrtilloides, Rhododendron luteum, Drosera intermedia, Rubus chamaemorus, Pedicularis sceptrum carolinum, Pedicularis sylvatica, Senecio fluviatilis, Iris sibrica, Corallorhiza trifida, Listera cordata, Listera ovata, Carex pauciflora, Carex paupercula* and *Viola uliginosa*; and the bryophytes *Gymnocolea inflata, Sphagnum lindbergii, Sphagnum molle and Cinclidium stygium*.

The fauna of bogs and poor fens includes mammals, reptiles and amphibians, and is characterised by low indices of species diversity. The population densities of all the animal groups are very low as a result of the low productivity of peatland ecosystems. However, peatlands are of great importance for the conservation of a number of rare animals and birds, especially as hiding-places which are used either seasonally or throughout the year. The status of many bird species is dependent on the condition of peatland systems because most of their Belarussian populations are confined to these habitats. Birds whose principal habitats are bog and poor fen include: osprey (*Pandion haliaetus*), short-toed eagle (*Circaetus gallicus*), golden eagle (*Aquila chrysaetos*), merlin (*Falco columbarius*), black grouse (*Lyrurus tetrix*), willow grouse (*Lagopus lagopus*), golden plover (*Pluvialis apricaria*), wood sandpiper (*Tringa glareola*), greenshank (*Tringa nebularia*) and whimbrel (*Numenius phaeopus*). Rare bird species that inhabit peatlands and the neighbouring swampy forests include: great grey shrike (*Lanius excubitor*), short-eared owl (*Asio flammeus*), black-throated diver (*Gavia arctica*), herring gull (*Larus argentatus*), common crane (*Grus grus*), short-toed eagle (*Circaetus gallicus*), great grey owl (*Strix nebulosa*) and three-toed woodpecker (*Picoides tridactylus*). Most notably, more than 60% of the presently known world population of aquatic warbler, amounting to 14,000–20,000 ephebic males (and perhaps the same number of females), is resident in Belarus. 34% inhabit the peatland systems of the River Pripyat and its tributaries, and 21% are located in the Yaselda system. This biogeographical region extends for 350 km from northwest to southeast and 100 km from north to south, and the condition of its vast fenlands is also crucial for short-eared owl and common crane.

Protection measures. For the most ecologically important peatlands and mire landscapes, the aims of protection are:

– conservation of unique ecotopes for mire and semi-aquatic species of European, regional and local importance;

– conservation of peatlands as the factor that creates an environment which clears excess carbon dioxide from the atmosphere and enriches it with oxygen, and maintains the water regime and climate across large territories.

Protection of peatlands and mire landscapes is achieved in three ways: first by protecting peatlands and mire landscapes which are already included in nature reserves; secondly by securing new protected areas on mires and peat deposits by transferring them from the unassigned peatland fund into the nature protection fund; and thirdly by re-establishing peat formation and creating new mires on anthropically disturbed peatlands. Also, improved peatland can be transferred from agricultural use to nature reserves and sometimes to National Parks after secondary slumping has occurred.

The following large specially protected territories have been created in Belarus:

– The State National Park 'Belovezhskaya Pushcha" is located in Brest region (Kamenets and Pruzhany districts) and Grodno region (Svislochsky district). Its total area is 98,500 ha. The main aims of the National Park are to conserve biological diversity and carry out detailed research on forest plant communities and their growth processes. Twenty-three peat deposits with a total area of 26,200 ha are included in the Pushcha and its protected zone.

– Berezinsky Biosphere Reserve lies on the watershed between the Dniepr and Western Dvina rivers, in the Borisov district of Minsk region and the Dokshitsy and Lepel districts of Vitebsk region. The area of the reserve is 76,200 ha, of which 20 peat deposits occupy 38,100 ha. The reserve peatlands are used for hydrological, botanical, zoological and other research, as well as research and conservation work on the Belarussian Poozerie vegetation.

– "Pripyatsky" National Park was designated for research on changes in the hydrologically confined Polesie Lowland landscape. It is situated on the Pripyat — Stviga — Ubort interfluve, in the Zhitkovichy, Lelchitsy and Petrikov districts of Gomel region. The area of the National Park is 82,400 ha and this includes a complex of peat deposits with a total area of 38,600 ha. The peat deposits lie in the shared valley of the Pripyat, Stviga and Ubort rivers, and extend from here along the Pripyat valley. The peatlands within the Park have great hydrological importance because they accumulate water during periods of precipitation excess and replenish the three rivers during drought. They also regulate groundwater levels in the surrounding areas.

– "Braslav Lakes" National Park is situated in Vitebsk region. Its total area is 69,100 ha and it includes 12,500 ha of protected peatland.

Botanical zakazniks have protected area status in Belarus. Their total area is 142,700 ha. They include 2,400 ha of peatland in 33 peat deposits which are mainly small, shallow deposits hosting rare and medicinal plants.

Hydrological zakazniks with a total area of 83,000 ha have been created on peatlands for their role in water protection. The largest include Yelnya, Dikoye and Vygonoschanskoye. Every hydrological zakaznik is also important for biodiversity protection. For example, some 2–3 thousand birds visit Yelnya every year, and many rare bird and plant species live on these zakazniks (e.g. Vygonoschanskoye and Zvanets). Berry zakazniks are created for wild berry (cranberry, bilberry, blueberry and lingonberry) conservation. There are now 20 zakazniks for cranberry, which cover a total area of 26,500 ha including 23,500 ha of peatland.

In order to maintain the stability of the environment, at least 7l,l00 ha of undisturbed peatland must be added to the existing the nature protection fund (Table 5). The principal way in which this fund could be augmented is by adding peatlands from the unassigned part of the peatland fund. The peatlands that must be transferred include those which host species that are endangered or protected for biodiversity, those with large populations of medicinal plants, those which lie on the migration flyways of water and mire birds, and those located in the floodplains of rivers and lakes which are important for water protection.

There are also many floodplain mire complexes with alternating small peatlands, river oxbows, swampy meadows and scrub on mineral ground, which are periodically flooded and have high carrying capacity for aquatic and mire species, for which they provide food and protection. These complexes cover large areas, for example in the Pripyat floodplain, and play a very important role in maintaining the European populations of most of the visiting bird species. They must be included in nature reserves.

International protected areas. Work on inventory and organisation of the required biodiversity conservation procedures for the Belarussian areas of international importance began in 2001. Twenty potential areas of international and national importance (Ramsar sites and Key Ornithological Territories or KOT according to IBA Bird Life) were identified by survey. These cover 620,626 ha, which is 2.9% of the area of the Republic. The next steps will be to ensure their national protection status and secure their recognition at international level. This will increase the biogeographical effectiveness of the populations of rare species as well as biodiversity protection in general. Open water, peatlands and floodplains dominate most of these areas. For nine (43%) of them, open water and peatland cover more than half the potential reserve area. Floodplain meadows occupy the same fraction of five (24%) of these areas, and woodlands dominate four (18%). The Ramsar sites in Belarus currently cover a total area of 283,107 ha, and most of this is peatland.

Potential for restoration. Creating nature reserves by re-wetting worked-out peatlands would improve the condition of the natural environment, and could potentially increase the area of mires and mire landscapes in Belarus by 12.3%. Thus ecological rehabilitation, which re-establishes peat-forming mire vegetation and re-activates all of the natural peatland functions, must become the principal after-use for cutover sites. The experience of more than 25 rehabilitation projects covering a total area of 30,000 ha, some of which are still ongoing, has shown that perfect water-mires can be created by secondary swamping of worked-out peat deposits. In these, areas of shallow open water alternate with reedbeds, sedges and other wetland vegetation including woody species; whilst the abandoned road and railway embankments, stockpiling areas and dams, together with naturally better-drained areas, form a system of frequent 'islands' with meadow, scrub and woodland vegetation. The water-filled drainage channels make the sites quite inaccessible to people and thus protect the numerous colonies of peatland and aquatic animals, which include dragonflies, beavers and birds. Such mire landscapes, with high carrying capacity and sanctuary value for mire species as well as high potential for recovery of environmental functions, have now been established on worked-out peatlands in different biogeographical zones across Belarus. Further additions of fully functional mires to the nature protection fund could be secured by similarly re-wetting peatland that has been converted to agricultural use ('ameliorated'), and subsequently lost productivity or become too dry as a result of design errors in the drainage system. Secondary paludification of such areas for ecological purposes is now in progress; for example, on almost 600 ha of the Diky Nikor peatland, which adjoins the Belovezhskaya Pushcha National Park and was ameliorated in 1958. Another re-wetting project has been developed for an ameliorated area of 400 ha on the Mstizh-Makovie peatland, which lies adjacent to the Berezinsky Biosphere Reserve. As of 2008, the total area of re-wetting projects that have been successfully implemented on degraded peatland, as a result of various initiatives, is 24,000 ha (Table 5).

Main Threats

The degradation of mires and peat deposits due to human influences still continues today. Almost all economically-driven activities on peatland involve partial or total loss of peat, destruction of the mire ecosystem and destabilisation of the biosphere functions of the peatland.

The peat industry is one anthropic influence that threatens peatland landscapes. Peat mining for fuel or fertiliser involves partial or complete removal of the peat deposit, and the peatland is artificially isolated from its environs. Peat formation and all of its other natural functions are thus severely impaired or terminated.

Peatland drainage. The conversion of mires and peat deposits to agricultural use by the so-called 'amelioration' procedure is especially destructive to peatland ecosystems. Canals and structures for water control are installed, drastically modifying the relief of the peatland surface and changing the water regime both within and outside the area destined for conversion. Ancient groundwater reserves are rapidly drained away, and as a result the aeration regime of the rooting zone is altered, organic matter which has been stored for even longer than the drained groundwater begins to decompose, and the microclimate changes. Peat accumulation ceases and the peat layer begins to disappear by mineralisation. The wild vegetation is directly destroyed and replaced with cultivated plant communities, the fauna changes, and progressive degradation of the peatland ecosystem continues under the subsequently sustained anthropic influence. As a result of drainage, the organic matter and energy balance of mires becomes negative. This change in the peat formation process means that drained mires tend to become sources rather than sinks for carbon dioxide, and begin to release CO_2 into the atmosphere as a final product of mineralisation. Peat losses from the ameliorated soils of Belarus amount to 9 Mt per year. As a result of peat mineralisation over many years, mineral subsoils have been exposed at many sites. The new anthropically formed soils have poor water regimes. The exact area of these soils has not been determined, but experts believe that it is not less than 1,000 km^2. Over the next 20 years, such soils are expected to appear on another 2,300 km^2 of former peatland as a result of the ongoing effects of drainage and oxidation. Wetlands on mineral soils are also being drained for agriculture. At the time of writing in 2008, the total area of drained peat soils is about 861 km^2, the area of degraded peat soils with organic matter content less than 50% is 224 km^2, including 27.3 km^2 of deeply disturbed soils with organic matter content less than 5% (Tanovitskaya & Kozulin 2008).

Agricultural activity. Most of the mineral islands within Belarussian peatlands have been ploughed. Thus they no longer host the rare plant species that occur under natural conditions, and the agricultural work causes stress to peatland animals. Early hay cutting on fens destroys a significant number of birds' nests including those of the globally threatened aquatic warbler. Intensive cattle husbandry on peatlands adjacent to villages alters the structure and species composition of the vegetation and displaces a number of rare bird species. Burning of fen vegetation in order to improve the growth of grasses has extremely negative consequences for the wild flora and fauna unless their ecological requirements are taken into account. In dry springs without floods, the uppermost layer of peat is burned off with the vegetation so that plant roots, insects and micro-organisms are exposed and dry out. Most bird species, and especially the globally threatened corncrake and aquatic warbler, no longer nest on mires and meadows that are regularly burned.

Forestry. Opportunistic logging of wooded mineral islands causes stress to animal species and can disrupt their population structures. Parts of larger areas of wet woodland were drained during the 1960s and 1970s by excavating shallow ditches which lowered the water table by 30–50 cm. This accelerated mineralisation in the soil layer that had been drained, releasing nutrients which increased timber growth rates, although these returned to pre-drainage levels after just 5–7 years. This procedure is now regarded as ineffective, and the 'improvement' of woodland soils by drainage is no longer practiced in Belarus. The drainage networks disintegrate and fail within approximately 15 years, after which the natural soil water regime is gradually re-established.

Roads, power lines and oil/gas pipelines are laid across mires if it is impossible to route around them. This immediately destroys mire vegetation and displaces most of the birds and other animals. Moreover, these linear constructions essentially slice through the peatland, totally altering its hydrological regime, and whole stands of trees are dying in the vicinities of new road embankments. Once a road has been commissioned, it becomes an ongoing source of pollution for the surrounding mires; and with pipelines there is an additional risk of accidental oil leaks which can spread over considerable areas. On the other hand, reclamation and other uses of peatland are forbidden in areas that are close to power lines and oil/gas pipelines.

Urban and park economy. Cities are now advancing intensively on Belarussian mires. About 20 mires and peat deposits have been annexed by the city of Minsk alone, where they have been built over or converted to parkland. Such mires have been effectively destroyed because they no longer perform their natural functions in relation to the biosphere.

Radioactive and chemical pollution affect peatland ecosystems negatively. Most of the radioactive pollution from the accident at the Chernobyl nuclear power station fell on the south-eastern part of Brest region, the southern and eastern parts of Gomel region and the southern part of Mogilyev region. There are also polluted spots in Minsk and Grodno regions. The total area of zones within the Republic where the caesium-137 land pollution density exceeds 555 kBq/m^2 is more than 6.6 thousand km^2. Half of the polluted area is occupied by woodlands, meadows and mires. In the natural plant communities, the deposited radioactive emissions remain in the uppermost part of the soil profile because they have been adsorbed by the cation exchange complex and are sedentary. Thus the woodland, meadow and mire vegetation is highly radioactive. The caesium radioisotopes are least mobile in peat soils and have remained mostly in the 0–5 cm soil layer, occasionally migrating to depths of no more than 15 cm; whilst strontium isotopes are more mobile and are present throughout the soil profile up to 50 cm depth. Other pollutants are present in the emissions of industrial and domestic enterprises and these pollute mire water, vegetation and peat deposits. Acid rain, exhaust from vehicles and other machinery, and transboundary transfers of contaminants all influence mire ecosystems negatively.

Tourism and recreation. There is little tourism on Belarussian mires and this is not a real threat. Hunting and the gathering of berries, mushrooms and medicinal plants have much greater negative effects on mires and peat deposits. These human activities lead to trampling and breaking of the vegetation cover and impose additional stress on animals and birds. Moreover, people carelessly cause fires which seriously damage the vegetation, disturb animals and destroy the peat deposits.

Threatened peatlands. No data

Hot Issues and Recommendations

The main issues requiring attention are: peat subsidence on agricultural lands; soil degradation in areas that have been abandoned after peat extraction; management of peatlands which have been polluted by radioactivity; over-use of valley peatlands; and the shortfall in the area of protected peatland necessary to avert extinctions. The problems should be researched thoroughly in order to determine the most effective solutions, and these solutions subsequently actioned as a matter of priority.

Ukraine

General Information

The total area of Ukraine is 60,370,000 ha and the population is 46,080,455 (1.31 people per ha). The original extent of mires was around 1,200,000 ha (peat deposits >0.7 m thick) and the current peatland area is 639,500[1] ha (1.059% of the country), giving an estimated loss of 50%.

Distribution and Diversity of Peatlands

Ukraine lies in the middle of Europe and almost entirely (except for Crimea in the south) within the European temperate climate zone. Three vegetation zones are distinguished, namely, from north to south, the Mixed Forest Zone (Polesye), the Forest-steppe Zone and the Steppe Zone. There are two mountainous regions, the Ukrainian Carpathians and the Crimean Mountains.

The occurrence and extent of mires declines, and the dominance of minerotrophic over ombrotrophic systems increases, from north to south. All of the oligotrophic mires — and indeed most (about 700,000 ha) of the total mire resource — are located in Polesye, whose land cover included 6.2% swamp and 4.3% peatland in 1973 (Bragg 2003). In the Forest-Steppe zone (1.5% wetland without peat and 1% peatland), minerotrophic mires predominate. West of the Dnieper River these are principally reed and reed-sedge marshes, whilst to the east there are valley and old-river marshes along with their halophyte variants. Only 0.2% of the Steppe Zone land area is covered by peat (wetlands occupy about 0.3%) and the typically small mires are located in river floodplains and around lakes. The southernmost mire in Ukraine is Kardashinske (Kherson Region).

Peatland Resources

An inventory carried out in 1999 identified 2,474 untransformed peatlands with peat deposits >0.7 m thick, covering a total area of 581,890 ha, and containing 2,165,100,000 tonnes of peat (Bragg & Lindsay 2003).

Peatland Use

Ukraine's peatlands have been affected by drainage and used for peat extraction. Drainage projects started in Polesye

[1]This figure includes peat deposits and areas with organic (peat) soil which have been reclaimed for agriculture.

between 1873 and 1892, when 4,660 km of ditches were constructed; and they were continued between 1895 and 1915 in the Kiev region. During the communist regime, 20,610 km^2 of land were drained, including 5,000 km^2 of peatlands (Balashev *et al* 1982). Peat extraction also increased during this period, reaching 7.5 Mt in 1970 (Bradis *et al* 1973). The peat was used for various purposes in agriculture, for example as fertiliser and cattle bedding (73%), and as fuel (27%). Only 120 km^2 of cut-over peatlands were 'rehabilitated' in any way, some being converted to other land uses such as forestry and agriculture, and others being subjected to re-wetting. Statistical data for 1994 indicates that *ca.* 680 km^2 (63%) of virgin mires remained and that the area previously and currently used by industry was 194 km^2 (19%) (Lappalainen 1996).

Drainage to create pastures and hay meadows began during the 1870s, and by 1917 about 430,000 ha of peatland had been drained. This activity accelerated in the 1950s, increasing the drained area to 613,900 ha (just over 51% of the total area of peat deposits >0.7 m thick) by 1978. The plan for the drained areas involved peat extraction followed by agricultural use of the land. However, drainage proved to have more negative than positive consequences since it resulted in erosion of topsoil and thus a serious threat of water pollution. The 1986 Chernobyl accident caused radioactive contamination of up to 40% of the area, precluding further use of peatland for food production. In 1991, the area of undrained mire was recorded as 693,700 ha. 25,400 ha (0.04%) of the country's peatlands were being used for peat extraction in 1991, but the quantities extracted have declined dramatically since 1990. There have been limited exports of peat to Germany, Greece, Egypt, France, Czechia and Slovakia, but markets are difficult to find because Ukrainian peat is generally of poor quality and some of it is now contaminated with radioactivity (Bragg & Lindsay 2003).

According to the latest available statistics (2003), the current extent of Ukraine's peatlands is 639,500 ha (peat thickness >0.7 m) or *ca.* 1,000,000 ha (> 0 m peat). Included in the first of these totals are: 384 peat deposits (total area 102,696 ha) which have not been drained and remain in natural condition; 46 peat deposits (11,204 ha) which have been transformed into water bodies; 84 peat deposits (71,336 ha) located within nature protection areas, some of which have been drained; 100,000 ha of extracted peatland; and 170,000 ha where peat extraction is currently in progress. The status of the remaining peatland is unknown, and there is no available information about the number or area of drained versus undrained sites. The data for peat deposits indicate that the range of peatland diversity is as follows: 551,000 ha of minerotrophic mire (2,370 sites); 14,200 ha of ombrotrophic mire (57 sites); 12,600 ha of transitional mire (38 sites) and 4,100 ha of mixed mire (9 sites). Again, there is no information about the rest of the peatland area.

Peatland Management Policies

Nature conservation legislation. Ukraine joined the Ramsar Convention in 1991. National law provides for the establishment of Nature Reserves, National Nature Parks, Natural Monuments, Wildlife Reserves, Regional Landscape Parks and Biosphere Reserves as well as zakazniks (small reserves of national and sub-national importance). The Strategy for Conservation of Ukraine's Biological Diversity, which was approved in May 1997, places high priority on the protection of valuable marshland areas, principally in the Polesye region, and the establishment there of a regional ecological network in conjunction with development of the national EECONET (European Ecological Network, proposed in Maastricht, 1993). The purpose of the Resolution of the Ukraine Parliament (1994) "On the Program of Perspective Development of Reserved Affairs in Ukraine" is to maintain and protect representative and unique landscapes as well as biological diversity, to support ecological stability, and to provide a stronger foundation for environmental monitoring, scientific research, and both ecological and patriotic education. This is to be achieved by developing an optimal system of territories for combination with the country's existing Nature Reserve Fund to form the stepping-stones of ECONET.

Legislation on land use planning.

Peat extraction. According to the Code on Minerals (1994), peat is a combustible solid mineral resource of national value. Although special permits are not required, areas of land for peat extraction are granted to users according to conditions set out by Parliament in the Land Code of Ukraine (1992). Land users have the right to mine peat for their own needs, generally up to a depth of two metres. The Resolution of the Cabinet of Ministers of Ukraine (1995, 554) identifies the extraction and processing of peat as one of the ecologically hazardous activities for which it is mandatory to call upon state technical and environmental expertise. Development of peat deposits less than 1m thick is prohibited, but these may be used for fodder and timber (Resolution of the Government of Ukraine 1981, 107). The value of peat deposits is assessed on the basis of differential and absolute rental income. The absolute rental income is calculated every five years, and was 6 Ukrainian Hryvnas (US$ 1.5) per hectare in 1996 (Bragg & Lindsay 2003).

Agricultural use of peatlands. The Resolution of the Cabinet of Ministers of Ukraine sets out scientifically based proposals for peatland use. When land is drained, drainage-irrigation systems with automatic water regulation should be established; and the area of permanent grassland should increase by 30–35% on mineral soils and by 60–70% on peatland.

In Ukraine, the process of change in patterns of land ownership necessitated by post-communist changes in agricultural management structures remains incomplete, and relevant new legislation is currently being established.

The Law of Ukraine "On Amelioration of Lands" (2000) includes some provisions that are relevant to nature protection. During civil engineering and other development works, it is incumbent on the developer to protect the environment within zones of direct and potential impact as well as on neighbouring land, taking into account soils and mineral resources, surface water and groundwater, free air, fauna and flora, fish stocks, natural landscapes and protected sites (e.g. Nature Reserve Fund of Ukraine and Wetlands of International Importance).

Hunting. As natural areas with high potential populations of game, mires will be widely used for hunting, which is regulated. The Law of Ukraine "On Hunting" (2000) defines hunting sites as areas of land and water (forests, meadows, mires, rivers with floodplains, lakes *etc.*) on which there are game animals (distinguishing between wild mammals and birds) and which can be utilised for hunting or procuring (catching, shooting) these animals. On Nature Reserve Fund sites, game animals can be procured under special site-specific orders.

Use of Water Resources. The Water Code of Ukraine (1995), gives an incomplete definition of mire as "excessively wet land with long-term standing water and specialised vegetation". Mires are assigned to the water fund, but forest mires also belong to the forest fund whilst wet hayfields and pastures are also regarded as agricultural land. All land that is occupied by seas, rivers, lakes, water storage basins, other pools, mires and similar islands belongs to the water fund (Article 4), and peatlands are not regarded as a separate category in this context.

Most matters relating to mires are determined by the water fund, because mires are important for water regulation. The users of water fund land are obliged to apply measures to protect it from erosion, flooding, pollution *etc.*

Natural Values and Conservation of Peatlands

Values. Many of the peatland plants species included in the Red Data Book of Ukraine (IUCN1996) reach the southern and eastern limits of their European distributions here. These include the glacial relics *Betula humilis* and *Salix myrtilloides*, together with *Oxycoccos microcarpus, Saxifraga hirculus, Drosera longifolia, Scheuchzeria palustris, Hammarbia paludosa, Pinguicula vulgaris, Tofieldia calyculata, Liparis loeselii, Carex bohemica, Sphagnum wulfianum,* S. *molle, S. subnitens, S. tenellum, Ludwigia polustris, Hydrocotyle vulgaris, Juncus bulbosus, J. subnodulosus* and *Schoenus ferrugineus*; and there are isolated populations of *Cladium mariscus.*

The people of the Polesye and Volyn Regions traditionally lived in harmony with nature and with mires, which feature in their fairy tales, folklore, literature and art. There is even a group known as the Dregovichi, a name derived from the Slavic word "dragovina", meaning mire. They used mires for hunting, grazing and hay. A large part of their diet still consists of mushrooms and berries (*Ribes nigrum, Oxycoccos, Vaccinium, and Rubus* species) collected from mires, they use more than 20 species for medicinal purposes, and they make flour from the seeds and roots of a mixture of wetland plants (Bragg 2003).

Protection measures

The first inventory of 14 peatlands to be preserved was published in 1969, and lobbying by the "Telma" group resulted in the addition of a further 14 peatlands. Another inventory comprising 42 peatlands for conservation was published in 1982 (Balashev *et al* 1982). This multi-regional inventory includes all of the Ukrainian peatland types. So far, 16 peatlands with a total area of 47 km^2 have been protected and it is expected that a further 27, covering an area of 250 km^2, will be designated. 60 km^2 of peatlands are protected within the Polesye National Park (Lappalainen 1996).

Some peatlands are protected within other Nature Reserves (Rivnenskyi, Polesyan, Liubche) (Heluta *et al* 2001), National Nature Parks (Shatskyi, Desniansko-Starogutskyi, Carpathian, Synevyr), the Carpathian Biosphere Reserve and some Regional Landscape Parks. However the most widespread protection instrument for peatlands is the Wildlife Reserve or zakaznyk; there are 88 Wildlife Reserves of National Importance with peatland areas. Wildlife Reserves are isolated wood, steppe, mire *etc.* sites which fulfill certain scientific, nature protection and aesthetic criteria (e.g. naturalness, uniqueness, beauty, presence of rare and endangered species). They may be designated without the agreement of owners, whose activities are nonetheless restricted in order to preserve the natural condition of the sites. Wildlife Reserves are insufficiently protected because responsibility is assigned to users and there is no regulatory body and no compensation mechanism. Land privatisation is a big problem in this context (Bragg & Lindsay 2003).

International protected areas. By 2006, Ukraine had designated 33 Wetlands of International Importance extending to a total area of 744,651 ha. Ramsar sites with significant peatland components (valuable minerotrophic mires) are the Shatsk Lakes, Prypiat River Floodplains and Stokhid River Floodplains (www.ramsar.org).

Potential for Restoration

There is no legislative provision for peatland restoration and although there are potential sites, restoration is not widely practiced. In 1994, a group of scientists prepared a programme for the creation of protected reserves and restoration of wetland complexes in Polesyan Region, at the request of the Ministry of Environment. They proposed several drainage systems for restoration (renaturalisation), so it is expected that these areas will sooner or later be transformed into valuable natural ones. The selection criteria included unsatisfactory status and low effectiveness, important pre-drainage bird habitat, absence of other drained mire massifs nearby, distance from settlements and location close to protected areas (Bragg & Lindsay 2003).

Main Threats

The main threats to peatlands in the Ukraine are: peat extraction with agricultural after-use; drainage followed by intensive agriculture including ploughing, grazing, haymaking, forestry and creation of fish ponds; flooding of peatlands to create reservoirs; radioactive pollution from the Chernobyl accident; flood defence; construction of roads; urban expansion; privatisation of land; organic and inorganic pollution; and changes in ecosystem function due to human activities (Bragg 2003).

Threatened peatlands. Polesye, the Forest Zone of Ukraine, is the richest zone for peatlands. However, many of the peatlands have been drained and peat is still used as fuel. Mires that are degraded through the effects of dams that have been built to protect settlements from floods readily catch fire during summer droughts, especially if they have been drained. Most Polesyan peatlands are contaminated with radioactive fallout. However, there are still many valuable peatlands that urgently need protection. Whereas minerotrophic mires dominate in Polesye, there are many ombrotrophic bogs in the Carpathian Mountains. The greatest threat to mountain bogs is possibly the depletion of forests on slopes, which results in destructive floods such as those that occurred in November 1998. There are peatlands (mostly minerotrophic) in the Forest-steppe Zone of Ukraine. Their peat is often utilised for horticultural purposes. Despite the fact that they play a crucial role in the water cycle, there are plans to drain some of these peatlands and to build on others. Therefore it is very important to make an inventory and to protect them. In the Steppe zone of Ukraine, one of the main problems is drainage of small mires because there are few mires and even fewer peatlands (Bragg 2003).

Hot issues and Recommendations

Promotion of measures to ensure ecological stability (sustainability), including: warning of negative influences on ecosystems and their components (Environmental Impact Assessment); restoration of damaged sites by extractors and others who carry out damaging projects; payment for use of natural resources;

ecological compensation for use; participation of the population in decision making; active ecological education.

Promotion of scientific research and conservation, including: assessing the potential for re-naturalisation of disturbed peatlands; investigating the re-establishment of peat growth (secondary swamping); more research on the ability of peat to "clean" or rehabilitate nature after radioactive pollution; completing the information on developed peatlands, including current state and activity; protecting degraded peatlands that are expected to recover natural values; developing knowledge towards economising on peat use.

Peatland conservation measures, including: protecting all natural peatlands that fulfill the designation criteria for the various categories of protected areas; establishing a nature protection network comprising representative types (groups) of peatland ecosystems; controlling the environmental conditions for all valuable natural peatlands; promoting the development of management plans; establishing a national network of people with peatland conservation interests .

Identification of peatlands that are valuable for biodiversity, including: the Polesyan Region (northern Ukraine) and the Carpathian Mountains; forested minerotrophic mires, usually located near the terraces of river floodplains; ombrotrophic bogs, especially in the high mountains.

Definition of training needs for managers and policy makers, which will better equip them to inform government structures and land users about peatland values.

Moldova

General Information

The total area of the country is 33,740 km^2 and the population is 4.4 million.

Moldova is a lowland country situated adjacent to the Carpathian Mountains at the edge of the Eastern European Plain, where her territory spans the forest, forest-steppe and steppe zones. Most (*ca.* 90%) of Moldova lies on the interfluve of the Rivers Dniester (Nistru) and Prut, with 59% in the Dniester basin, 23% in the Prut basin, 11% in the basins of small tributaries of the River Danube and 7% in the basins of smaller rivers flowing directly into the Black Sea. The topography consists of gentle hills and plains with an average altitude of 147 m a.s.l. The country's lowest point (2 m a.s.l.) is at the confluence of the Prut with the River Danube, and the highest point is at the centre of the Moldova Plain or Balti Steppe (429.5 m a.s.l.).

The relief of the Codru Highland in the centre of the country resembles that of lowlands created by erosional-slide processes. From Codru, the Beltsi Plain rolls northwards towards the Northern Plateau, and the South Moldavian Plain (Budjac Steppe) stretches southwards. The Transnistrian Highland lies along the Dniester and the Tigech Highland is located in the south-western part of the country.

Below 220 m a.s.l., the terraces of the Dniester, Prut and most of their tributaries are covered by loam derived from Quaternary loess, which is soil-forming and succumbs readily to erosion. By contrast, the South Moldovian Plain and its fluvial terraces are practically unaffected by erosion and have the country's most fertile soils, which support Moldova's largest orchards.

The long-term average annual temperature is 8°C, average monthly temperatures range from -3–5°C (January) to 19–22°C (July), and the warm period lasts for 146–180 days per year. Average annual precipitation is 370 mm in the south and 560 mm in the north. The greatest quantities of precipitation (500–550 mm per year) fall in the north-eastern part of the country and on the western slopes of Central Moldova.

Distribution and Diversity

Wetlands have been treated as low-value land and have practically disappeared from the Moldovian part of the Danube basin except for the lower part of the Prut valley. In the Dniester basin there are still several significant wetlands, namely Lake Rosu, the Old Dniester Wetlands, Copanka-Tolmaz, Ataci-Golosnita, Lake Salas, the Cuchurgani Estuary and Goian Creek. The largest remaining wetlands are located in the floodplains of the Prut and the Dniester, where the depth to groundwater ranges from 0 to 2 metres. The spatial distribution of wetlands has been significantly altered by human activities and they are now insufficiently represented in relation to other ecosystems.

The total area of river floodplains in Moldova is 250,000 ha, of which 200,000 ha is now used for intensive agriculture. At the end of the 1950s, *ca.* 74% (155,800 ha) of the wetland area was out of agricultural use but by the end of the 1980s this figure had been reduced to 20%. The area of drained wetland is 155,800 ha.

Peatland Resources

The Moldovan Land Cadastre gives the total paludified area as 17,200 ha, which includes 400 ha in forestry areas, 2,100 ha adjacent to water bodies and 9,400 ha so called "reserved lands" where user is not defined yet. It is very difficult to estimate how much of these areas are peatlands. The most comprehensive and recent (1982) review of peat resources from the Soviet period indicates that there are no "industrial" peatland resources in Moldova.

Peatland Use

All possible measures have been employed to drain Moldova's wetlands and convert them to arable and other economic uses. Peatlands are the most vulnerable wetland type. The majority of small peatlands were drained in the 1960s and 1970s, although large peatlands fared rather better. The areas of drained soils and radically transformed soils are currently 60,000 ha and 33,400 ha respectively.

Policies on Peatland Management

There are no special regulations relating to conservation or wise use of peatlands. There are eight categories of protected areas in Moldova. Strict Nature Reserves now cover about 0.58% of the country (0.17% in 1990). Four of the five strictly protected areas (scientific reserves), including Lower Prut, are currently annexed to Moldova State Forestry Association (Moldsilva) because they are mostly forest zones, and the fifth (Jagorlic) is located on the left bank of the Dniester. Other types of protected areas (natural protected landscapes, fenced-in districts, landscape, natural monuments, garden art monuments, botanic gardens, arboreta and zoological parks) are under local authority management.

Peatland Natural Value and Conservation

Values. Most of the Lower Prut river floodplain comprises aquatic, peatland, wet meadow and forest ecosystems. Their composition and structure are quite diverse and they support more than 300 species of vascular plants, many of which are included in the Red List of the Republic of Moldova. There are some botanical and bio-geographical descriptions of the vegetation of the Manta-Beleu site, including information about the flora that must be protected; but there is no complete inventory of natural habitats and vegetation for the Lower Prut (Postolache 1995).

Protection Measures

Protected areas account for only 1.42% of the total area of Moldova, placing it far behind most other European countries, and there are no National Parks. Altogether there are 25 multifunctional protected areas with floodplain vegetation, within which there is 674.7 ha of peatland vegetation in total (http://www.ecosfera.ournet.md).

International Protected Areas

Moldova hosts three Ramsar sites (total area 94,705 ha), each of which includes some peatland.

Potential for restoration. Each year, 7,000 ha of soils are reconstructed by re-wetting; and 2,500 ha of high-quality soils have been taken out of agricultural use.

Main Threats

Almost all of Moldova's peatlands have been converted to arable use or destroyed, along with their valleys, by river flow regulation activities. The main threat to the remaining peatlands is the lack of information about their distribution and values, the resulting lack of awareness, and the absence of special land management measures to prevent further losses.

Threatened peatlands. No detailed information available.

HotIssues and Recommendations

An inventory and evaluation of peatlands is needed.

Romania

General Information

The total area of Romania is about 237,500 km^2.

This is a country with varied topography. The Transylvanian Basin (or Plateau) in central Romania is mostly very hilly, but also has wide valleys and extensive arable slopes. It is almost completely surrounded by mountains — the Carpathian Mountains to the north and east, the Transylvanian Alps with their highest peak Moldoveanul (2,544 m) to the south, and the Bikhor Mountains to the west. The remainder of Romania is predominantly lowland. The most extensive plains are the lowlands of Walachia, which lie between the Transylvanian Alps and Bulgaria. In the west are the lowlands of the Tisza Plain (the Banat) adjacent to the Serbian border, and of Crisana-Maramures adjacent to Hungary. In the extreme east, a low plateau bordering the Black Sea forms part of Dobruja (Dobrogea) and continues southwards into Bulgaria.

The most important river is the Danube, which defines the eastern part of Romania's border with Serbia and most of the border with Bulgaria.

Distribution and Diversity of Peatlands

There are many small freshwater lakes in the Romanian mountains, and some large saline lagoons on the coast of the Black Sea. The largest lagoon is Lake Razelm. The valley of the lower Danube and the Danube delta are very swampy, the latter having floating vegetation mats which can form peat up to 1.5 m thick. The Danube system includes the country's other important rivers, namely the Mures, Prut, Olt and Siret.

Although peatlands are scarce in Romania, they have been studied since the end of the 18th century and have been thoroughly classified. The most comprehensive investigation was undertaken by Emil Pop, and many of the peatlands that are now protected as Nature Reserves and National Parks were recommended for conservation on the basis of his work. Detailed studies of the flora, fauna, vegetation, peat characteristics and palaeoecology of Romanian peatlands are available in published literature. Most of the publications on peatland vegetation employ the Braun-Blanquet classification.

Romania's peatlands are generally small. Peat deposits are usually classified according to the availability of mineral plant nutrients, i.e.

as eutrophic, mesotrophic or oligotrophic. Peat is classified according to its origin (genesis), as fen (formed by reed, sedge and hypnaceous mosses), transition (sedge-*Sphagnum*, *Polytrichum* and woody) or ombrotrophic (cotton-grass, *Scheuchzeria*, *Pinus*, heather and *Sphagnum*) and allocated to recent (Subatlantic) or ancient (*Sphagnum* peat) categories.

The maximum peat age is 12,000–14,000 years but there are younger peatlands, especially in the mountains. For example, some peatlands developed during the Subatlantic period (after 2500 BP) in the glacial kettle-holes of the Paryng Mountains, and others formed during the Subboreal period (4500–2500 BP). Some deposits dated as late Holocene have been described from the Rora Valley in the foothills of the Eastern Carpathians.

The most significant peat deposits are located near the mouth of the Danube, and in the northwest of the country along the border with Hungary. Reed (*Phragmites communis*) and reed-herb fens are common along the lower Danube, where there are also occasional tussock-sedge mires. Some 70,000–100,000 ha of peatland covers three-quarters of the Danube delta. Vast sedge and herb peatlands occur on more elevated parts of the Danube lowland, as well as on the border with Hungary. Romania's largest peatland is Nad-Lamp, which lies between the Rivers Red and Semesh. This is a transboundary system, of which two-thirds belongs to Hungary.

Fifteen fen districts have been distinguished on the basis of site size and altitude. Fens occur not only in the highlands, but also in other mountain locations. There are flooded fens in the Bikhor Mountains, but most of the mountain fens are in the Carpathians. The relict species *Meesia hexasticha, Paludella squarrosa, Dryopteris cristata, Betula humulis, Salix starkeana, Stellaria longifolia* and *Achillea impatiens* are often found in fens that have developed in Carpathian intermountain depressions. Fens are abundant on the Timish-Beg interfluve in the western foothills of the Southern Carpathians, and the "mire complexes of the Vozloben" are fens on the western edge of the Eastern Carpathians. The most extensively paludified part of the Eastern Carpathians foothills is Khargita, where 28% of all Romanian peatlands are concentrated. In this area there are willow (mainly *Salix cinerea*) and grey alder woodlands with herbs and sedges including *Calamagrostis, Molinia, Carex caespitosa, C.appropinquata, C.dioica, C.diandra,* and some rare species of *Pedicularis* which are regarded as glacial relicts. At the southern limits of their distributions are *Betula humulis, Saxifraga hirculus, Swertia perennis, Ligularia sibirica, Meesia hexapetala* and *Paludella squarrosa*.

Eleven districts have been defined for ombrotrophic peatlands, which are mainly continental and confined to the main Carpathian ridge. The Carpathians host a wide diversity of peatlands, but some of their ombrotrophic mires are unique. These are associated with volcanic deposits (Oush-Hutey-Kharchita), and some occupy volcanic craters. The largest ombrotrophic mires in the country are located in the Drona River basin and the Khargity mountain region. Their flora consists mainly of relict species.

Mountain pine and spruce are usual woody species for both oligotrophic and mesotrophic *Sphagnum* peatlands. The vegetation of mesotrophic peatlands located in the mountains includes pine, spruce, numerous shrubs, sedges, and the moss genera *Sphagnum* and *Hypnum*.

Transitional peatlands with ombrotrophic centres and up to 10–12 m of peat, sometimes underlain by sapropel, occur at approximately 550 m a.s.l. in the Carpathian foothills.

Peatland Resources

There are 436 peat deposits which contain 20.6×10^6 tonnes of peat and cover a total area of 7,100 ha, which amounts to 0.03% of the country. Currently known sites include 171 fens, which cover a total area of 5,727.2 ha and contain 13,900 tonnes of peat; and 265 ombrotrophic mires (bogs), with total area 1,351 ha and 6,700 tonnes of peat. Most of the peatlands (6,286 ha) are located in the Carpathians, and ombrotrophic raised bogs are confined there. Fens are widespread, occurring in both inter-mountain depressions and in the large lowland river valleys, especially those of the Danube and its (left-bank) tributaries.

Peatland use

Pop (1960) mentions that many peatlands have been reclaimed for agriculture, whereas "others are qualified to be used as such in future". Indeed, most of the 400 known Romanian peatlands are currently under agricultural use — mainly as pasture, although some arable crops including hemp and sunflower are grown. In 1988, 20,000–25,000 tonnes of peat were extracted. Some of the extracted peat is used in agriculture and some for balneology, which is now very popular in Romania. Peat also used as industrial and domestic fuel. Both oligotrophic and eutrophic peat types have been used for balneology and as fuel.

Policies on Peatland Management

There is no legislative provision for the sustainable use of peatlands, but political initiatives for direct protection of mires are developing rapidly.

Peatland Natural Value and Conservation

Values. The interesting features of Romanian peatlands include the presence of populations of relict plant species, for example *Pedicularis limnogena* in the Apuseni mountains. The infiltration of certain mires by mineral-rich water contributes to the support of relict plant species. For example, at the Gorge of the Mureg River there are wetlands developed on andesitic lavas in a humid temperate mountain climate. The vascular flora here comprises 1,010 species including 13 Carpathian endemics, namely *Aconitum moldavicum, A. toxicum, Dentaria glandulosa, Centaurea phrygia ssp. carpatica, Cephalaria radiata, Dianthus tenuifolius, Hepatica transsilvanica, Leucanthemum waldsteinii, Melampyrum saxosum, Ranunculus carpaticus, Thlaspi dacicum, Thymus comosus and Viola declinata. Anemone nemorosa* L. *ssp. altaica* (Fischer) Korsh has also been discovered in the gorge. Many boreal and hypoarctic relicts are also to be found in the eutrophic and mesotrophic mires of the Gheorghieni Depression. At Sdncrdieni Botanical Reserve, an area of wet meadow/fen vegetation is fed by mineral waters arising from volcanic springs and the flora is notable for the presence of *Betula humulis* and *Salix rosmarinifolia*. The world's most southerly population of *Betula nana* is to be found in the Harghita Mountains, at the Lucs site studied by Emil Pop; and there is some very deep peat (more than 11 m) in the oligotrophic Mohog Mire, which occupies a volcanic crater.

Protection measures. Romania has a long tradition of peatland conservation. The first Nature Reserve with peatlands (among other ecosystems) was established at Bukovina in 1928, and a number of other nature reserves with peatland interest were founded between 1932 and 1944.

The national system of protected areas includes Natural Parks and National Parks. The total area protected is 1,237,702.42 ha, which amounts to 5.15% of the country. Nonetheless, even at the end of the 20th century, peatlands accounted for a miniscule 0.17% of the total protected area. The situation was revised under Law Number 5, which was passed on 12 April 2000 and brought under statutory protection 21 raised bogs with total area 1,430.7 ha and 20 rich fens with total area 640.85 ha. Five more raised bogs remained under local authority protection. Statutory protection was thus extended to 2,071.55 ha of mire, which amounts to 29.25% of the total peatland area, whilst 266.5 ha (3.67%) remained under the jurisdiction of local authorities. More than 90% of the country's raised bogs now have protected status.

International protected areas. Romania joined the Ramsar Convention on 21 September 1991 and has designated five Ramsar sites of total area 683,628 ha, two of which are dominated by peatlands. Emerald Network sites and CORINE Biotope Reserves have also been established.

Potential for Restoration

No data.

Main Threats

Wetlands in Romania have been reduced to about half of their original extent. Losses have been particularly dramatic along the River Danube, where many wetlands have been converted to agricultural use (www.undp.org/bpsp/nbsap_links/NBSAP_Romania.htm). According to experts, more than 100 km^2 of the histosols in the Danube Delta Biosphere Reserve have already been lost through burning to create arable land in the agricultural polders. Experts also point out that there is an increasing threat to wetlands from the development of infrastructure including recreation facilities, especially for skiing in mountain areas.

Threatened peatlands. Designation of some of the sub-alpine mires in the Fagaras Mountains was overlooked because they happen to lie in an area where the boundaries of three administrative regions meet. Thus they remain unprotected and vulnerable to threats arising from changes in grazing practice and increasing visitor pressure.

Hot Issues and Recommendations

Romanian peatland experts call for increased involvement of local government in wetland protection, improvements in land use legislation, regulation of recreation, and increased public awareness of peatlands (Bragg 2003). A need for restoration work is identified, but some pressing modern peatland issues appear not to have been acknowledged in Romania — such as the global roles of peatlands in climate change mitigation and water management. The involvement of local experts in international networks is important in order that they can share peatland knowledge and experience with the rest of the world.

Republic of Serbia

General Information

Serbia is located on the Balkan Peninsula in southeastern Europe. The Republic of Serbia (Republika Srbija) has a total land area of 88,391 km^2 and the population is estimated at 10,027,000. The capital is Belgrade (Beograd). Bounding the country to the west are the Republic of Bosnia and Herzegovina and the Slavonian region of Croatia. Serbia adjoins Hungary to the north, Romania and Bulgaria to the east, Macedonia and Albania to the south, and Montenegro to the southwest.

The landforms of Serbia, a landlocked country, fall into three regional groupings that roughly parallel the republic's major political divisions. The plains of the northern Vojvodina region generally lie at elevations between 60 and 100 m above sea level. The Fruška Gora hills interrupt these plains in the west, stretching along a triangle of land between the Danube and Sava rivers. Their highest point is 540 m. Much of Vojvodina is blanketed by portions of a former plateau that rose up to 30 m above the territory's floodplains; the remnants are composed of fine particles of loess deposited by winds during the last glacial period in Europe.

The centre of Serbia is characterised by hills and high mountains. Its western margins include sections of the Dinaric Alps and its eastern borderlands are part of the Carpathian and Rhodope mountain systems. Between these flanking mountains lie the Šumadija Hills, the core of the mediaeval Serbian state. The highest mountains of this part are Mt. Kopaonik (2,017 m) and Mt. Stara Planina (2,100 m), whilst the summit heights of the Šumadija Hills range from 600 to 1,100 m a.s.l.

Kosovo, in the south, consists of two intermontane basins whose valley floors lie at altitudes between 460 m and 550 m. The notable mountains are Mt. Prokletije (2,650 m) and Mt. Šar planina (2,500 m).

Differences in altitude, proximity to the sea and exposure to wind lead to significant climatic variations within Serbia. In general, however, the climate is continental with cold, relatively dry winters and warm, humid summers. Vojvodina exhibits most clearly the characteristics of the continental climate. July temperatures average about 22°C and January temperatures hover around -1°C. The mountainous areas of Serbia have noticeably cooler summers, with temperatures averaging about 18°C. Air masses from eastern and northern Europe predominate throughout the year, and it is only occasionally that Mediterranean air masses move in from the southeast or south. Precipitation ranges from 560 to 1,900 mm per year, depending on altitude and exposure (Encyclopædia Britannica 2008).

Distribution and Diversity of Peatlands

The southerly location within Europe means that peatlands, and especially large peatlands, are generally very rare in both Serbia and the Balkan peninsula as a whole. Serbia has fens and transitional fens, but no bogs. In the lowlands, most of the formerly widespread wetland areas (which included mires) have been converted to agricultural use. There are still some remnants of these mires, for example in the Subotica sand, along the Sava river (Zasavica, Obedska Bara) and near the city of Pirot (Krupačko Blato). The occurrence of peatlands increases with altitude, but they become smaller. Numerous small peatlands can be found on the high Serbian mountains like Mt. Stara Planina, Mt. Šar Planina, Mt. Prokletije and Mt. Kopaonik, and the highest mountain mires host different types of transitional fen. The peat types that have been described are: reed, sedge, reed-sedge, reed-sedge-*Hypnum*, sedge-*Menyanthes*, sedge-*Sphagnum* and *Sphagnum*.

Peatland Resources

The detailed peatland inventory for Serbia is not yet complete, but a mires map has been developed (Lazarević 2008). Special peatland surveys have been carried out for agriculture, peatland ecology, vegetation, microbiology, chemical and botanical composition of peat, palaeoecology including spore pollen analyses and radiocarbon dating, nature protection, *etc.*

The total area of peat and semi-peat in Serbia is estimated at about 10,000 ha, which is 0.11% of the area of the country (Tešić *et al* 1979). According to official data held by the Belgrade Soil Institute (www.soilinst.co.yu), the extent of peat soils (histosols) is only around 3,000 ha (0.034% of the country).

Peatland Use

Peatlands are used mainly as pasture, for agriculture, or for extraction of peat for agriculture and horticulture. Some peatland areas are tourism centres.

Policies on Peatland Management

There are no special policies for peatland management in Serbia, but there are management plans for protected peatlands and protected areas that include peatlands.

Peatland Natural Value and Conservation

Values. Serbian mires host rich vegetation. Their small extent (0.034% of the total area of the republic) means that they are very fragile and have extraordinary importance for Serbian biodiversity. They are typically dominated by *Salix cinerea*, *Scirpus* spp., *Phragmites communis, Eriophorum angustifolium* and *E. latifolium*; and their flora includes the sedges *Carex paniculata, C. vulpina, C. acutiformis, C. riparia, C. gracilis, C. vesicaria, C. davalliana, C. echinata C. rostrata* and *C. nigra*. European mire species which reach the southernmost limits of their distributions as boreal relict species in Serbian mires include *Carex nigra, Carex limosa, Eriophorum vaginatum, Potentilla palustris, Vaccinium uliginosum, Betula pubescens, Utricularia minor, Drosera rotundifolia, Menyanthes trifoliata, Pedicularis palustris* and *Sphagnum* species.

Some Balkan and Serbian high mountain mires have special significance for biodiversity, and of course for European mire diversity, because they host endemic plant communities and numerous endemic species including *Narthecium scardicum, Pedicularis brachyodonta, Silene asterias, Barbarea balkana, Alchemilla viridiflora, Pinguicula balcanica, Carex macedonica* and *Dactylorhiza cordigera* ssp. *bosniaca*.

Protection measures. Most Serbian peatlands are valuable for biodiversity conservation, and are therefore protected. Some are protected individually (e.g. Pestersko Polje and Vlasina Lake), whilst others are included in larger protected areas (Mt. Šar planina, Mt. Kopaonik, Mt. Stara planina, Mt. Tara, Mt. Golija, Obedska Bara Marsh and others). In the latter scenario they are usually recognised as the most important sites for conservation and have the highest level of protection within the protected area. The implementation of protection measures is monitored by the Institute for Nature Conservation of Serbia.

International protected areas. Serbia hosts nine *Ramsar* sites. The four that include peatlands are: Peštersko Polje (3455 ha), Vlasina (3209 ha), Obedska Bara (17501 ha) and Zasavica (1913 ha). Only small parts of these areas are mires (see http://www.ramsar.org/profile/profiles_serbia.htm).

Peatlands also occur within the Important Plant Areas (IPAs) Zasavica, Obedska Bara, Subotičko Horgoška Peščara, Mokra Gora I Šargan, Zlatibor, Golija, Peštersko Polje, Š tavalj, Kopaonik, Vlasina, Prokletije, Šara and Stara Planina; the Important Bird Areas (IBAs) Subitička Jezera i Pustare, Zasavica, Obedska Bara, Tara, Kopaonik, Prokletije, Šar Planina, Vlasina and Stara Planina; the Prime Butterfly Areas (PBAs) Šar Planina, Prokletije and Tara; and the EMERALD ecological network.

Potential for Restoration

No information

Main Threats

Over the last few centuries, vast flooded areas near the Rivers Sava, Dunav and Tisa have been drained and taken into agriculture. Wetlands were regarded as wastelands that harboured disease and many, including peatlands, were drained in establishing the necessary system of floodbanks, canals and dams. After the Second World War, the remaining peatlands were researched to determine the potential for peat exploitation, and most of the available data on peatland distribution originates from that time. The largest peatland in Serbia (Vlasinsko Blato) was converted into a lake, and many small peatlands were partly or completely destroyed by local peat extraction or by changing the water regime (e.g. Ćeletaš, Žuta Bara, Gradištanski Rit, Peštersko Polje and peatlands near Vranje). High mountain peatlands were less impacted, but even these have been affected by the development of tourism.

Threatened peatlands. Even today, Peštersko Polje — the largest surviving peatland in Serbia — is being destroyed by peat extraction. Elsewhere, rapid succesion is in progress on small peatlands such as Golija, Divcibare and Jelova Gora due to unfavourable water regime, indirect human impact or lack of restoration. One small but very significant peatland, Šavalj Mire, is disappearing under spoil from a coal mine. Mountain ski centres and other infrastructure for tourism result in continuing damage to mountain peatlands including those at Kopaonik, Golija and Šar Planina, and there are new plans to convert some completly intact mires at Stara Planina and Kopaonik into ski runs and sites for making artificial snow.

Hot Issues and Recommendations

Better information on policy and on the potential and need for peatland conservation and restoration should be available to, and applied by, decision-makers. The most urgent task is to establish mires as one of the most endangered habitat types at national policy level, as current national legislation is neither consistent across its own different sectors nor fully compatible with the international conventions signed by Serbia. Existing management plans lack provisions for mire restoration, and practitioners in the field lack expertise in restoration. Also, both popular and scientific literature in the Serbian language is needed, covering all aspects of mires.

Croatia

General Information

The total area of the country is 56,538 km^2 and the population is about 4,800,000.

The Republic of Croatia is both a Mediterranean and a continental country. The relief varies. The Mediterranean part is characterised by the valleys of the Rivers Sava, Drava, Mura and Danube, whose altitudes range from 80 to 100 m a.s.l. Between these lowlands, the hills and mountains of the continental part reach altitudes of 100–1000 m a.s.l. The ridge of the Dinaric Alps stretches along the Adriatic coast, rising almost directly from the sea to an altitude of 1,800 m a.s.l.

The geographical location and relief of Croatia determine its climate. Precipitation is highest in the western mountains, amounting to *ca.* 3,700 mm per year on Risnjak Mountain (1,400 m a.s.l.) and declines eastwards to about 600 mm per year in Baranja Region. Mean annual temperature ranges from 3.6°C to 16.0°C.

The western part of Croatia is a typical limestone karst area. There are many geomorphological karst features including karstic fields, caves and dolines (ponikve), which have specific microclimatic characteristics such as temperature inversion. There are also "frost pockets", which experience the lowest minimum temperatures in Croatia. Soil pH is mostly in the range 5.0–7.5 and only exceptionally below 5.0.

Distribution and Diversity of Peatlands

The climax vegetation of the Eumediterranean belt is evergreen forest of the association Orno-Quercetum ilicis, but degraded stadiums such as maquis, garigues or stony grasslands are prevalent. In the Submediterranean and Mediterranean-montane belts, deciduous forests of the alliance Carpinion orientalis represent the vegetation climax. The most easterly part of Croatia lies within the transition to forest-steppe vegetation (alliance *Aceri tatarici — Quercion*). The continental part of Croatia belongs to the Illyric province of the Euro Siberian — North American region. There are three altitudinal vegetation belts, namely: lower belt with oak woodland (*Quercus petraea, Quercus robur*); mid-altitude belt with beech woodland (*Fagus sylvatica* in pure stands or mixed with *Abies alba*); and the highest locations with *Pinus mugo*. Only the most exposed tops of the highest mountains have non-forest vegetation types, which include peatlands.

Mires and peatlands once covered 5% of the lowland valleys and their remains have been mapped along the Danube, Savva and Bosna Rivers. All of these are fens. According to Topić & Stančić (2006), peat deposits have been found beneath agricultural fields, suggesting that mires were once more widespread than they are today. Also, place-names in many localities refer to mire habitats, again indicating that they were more widely distributed in the past.

Sphagnum peatlands occupy the deep funnel-like depressions that have formed in intensely karstified areas on limestone and dolomite rocks. Their uppermost layers are very acidic (pH 2.7–4.4) and are made up of the undecomposed remains of *Sphagnum* mosses without mineral inclusions; whilst their lower layers consist of very highly decomposed *Sphagnum*.

Peatlands are mostly confined to higher-altitude locations with humid woodlands in the western and north-western continental part of the country. Even the large quantity of precipitation in the Gorski kotar area (2000–3500 mm per year) is insufficient to support bogs because the summers are too dry (maritime pluviometric regime). There are consequently no true bogs, but only fens and transitional mires, which are fed by both precipitation and mineral water. The ecology and floristics of some twenty small mire sites in the Croatian mountains have been investigated recently, and they have been shown to be still "alive".

In general, there are two types of highland peatlands in Croatia, namely acidophilous transition and quaking bogs (Aliance *Rhynchosporion albae*) and alkaline fens (Aliance *Caricion davallianae*). These are relics from late glacial times and are now dependent on microclimatic conditions. The changes in climate of the postglacial period created warmer and less humid conditions which resulted in progressive vegetation changes and overgrowth of these habitats by forest. Most of the sites are now smaller than 1 ha (with the exception of the 11 ha Blatusa peatland) and these are amongst the most threatened habitats in Croatia.

Peatland Resources

There are no published estimates of the area of peatlands and the volume of peat stored in Croatia, although this information definitely exists. It seems possible that it is held in Belgrade, the capital of former Yugoslavia. There are many published scientific papers on the flora and vegetation of Croatian peatlands.

Peatland Use

Some peatlands (e.g. Blatuša) were used for peat extraction in the past, but there is no current direct peat use. There is no estimation of peatlands area currently used for agriculture.

Policies on Peatland Management

The Strategy for Nature Conservation in Croatia, which was delivered by the Croatian Parliament in 1999, includes recommendations for fen conservation. Peatlands are included in the Croatian National Ecological Network and will be part of the Croatian proposal for the European Natura 2000 network. Action plans for the management of some peatlands (e.g. Dubravica) have been developed and implemented. Some peatlands are also protected as Special Botanical Reserves (Blatusa, Dubravica and Banski Moravci) or within Nature Parks and National Parks.

Peatland Natural Value and Conservation

Values. The largest fen in Croatia is Blatuša, which lies at an altitude of 130 m a.s.l. and extends to about 1000 ha. As early as 1925, Pevalek (1925) discussed the habitat changes and destruction of *Sphagnum* resulting from the installation of drainage ditches on this site. Its vegetation belongs to the association Rynchosporetum albae (alliance Rynchosporion, order Scheuchzerietalia palustris and class Scheuchzerio-Caricetea fuscae). The following plant species have been listed: *Eriophorum latifolium, Lotus uliginosus, Rynchospora alba, Drosera rotundifolia, Ranunculus flammula, Juncus effusus, Potentilla sylvestris, Sphagnum recurvum, Sphagnum subsecundum, Polytrichum* sp., *Carex flava, Prunella vulgaris, Rumex acetosella, Aspidium spinulosum, Menyanthes trifoliata* and *Lycopodium inundatum*; along with some trees and shrubs such as *Alnus glutinosa, Frangula alnus* and *Betula verrucosa. Betula pubescens*, one of the rarest plant species in Croatia, has also been found here. Although the Blatuša fen was a predominantly open site 60 years ago, it is now largely overgrown by shrubs and trees, mostly *Alnus glutinosa*.

There are several smaller fens nearby. It is interesting that these are the only Croatian localities for the fern *Osmunda regalis*.

The small mires in the karstic limestone region of Gorski kotar have developed on restricted areas over water-holding depressions. Most of them belong to the association Drosero-Caricetum stellulatae (alliance Rynchosporion albae). Their characteristic and predominant species include *Drosera rotundifolia, Sphagnum* sp. div., *Eriophorum latifolium, Carex flava, Carex stellulata, Eriophorum angustifolium* and *Molinia caerulea*. The association Carici-Blysmetum compressi occurs sporadically. This community belongs to the basiphilous fens of the alliance Caricion davallianae and includes *Eriophorum latifolia, Parnassia palustris, Epipactis palustris* and other species, in addition to the dominant *Blysmus compressus*.

The boreal species *Eriophorum gracile* was noted in this area within a small fen of the association Drosero-Caricetum stellulatae. This is the only record of this species for Croatia (Ilijanic 1978), where it is on the very southern boundary of its distribution. Also, the only remaining Croatian locality for the boreal species *Calla palustris* in coincidently in the same area of Gorski kotar. This species grows in a small depression within acidophilous forest of the association Blechno-Abietetum. The stand is overgrown by *Sphagnum* spp., *Polytrichum* and *Carex canescens*.

The best known and investigated site is the fen at Dubravica village in Hrvatsko zagorje region. This belongs to the association Rynchosporetum albae, whose characteristic species include *Rynchospora alba, Drosera rotundifolia, Eriophorum angustifolium, Sphagnum subsecundum, Sphagnum cymbifolium, Sphagnum amblyphyllum, Menyanthes trifoliata, Drepanocladus exannulatus, Potentilla erecta, Molinia caerulea, Carex flava, Carex stellulata* and *Carex goodenovii.*

Protection measures. A number of peatlands have been identified as valuable for biodiversity conservation. Some of them, including relic peatlands, are protected within existing nature reserves. The oldest of these is Kopachki Rit. This relatively large area of fen (assocciation Drosero-Caricetum stellulatae) is located in the National Park "Plitvička jezera" (Lika region). There are other fen sites with different plant communities in the same region.

International protected areas. There are four Ramsar sites in Croatia, and these cover a total area of 80,455 ha. Two of them are valley peatlands with a total area of around 70,000 ha, and the other two contain some peatlands.

Potential for Restoration

The Dubravica peatland was chosen as a pilot site for revitalisation. Over the past few years it has been subjected to some active conservation measures, including mowing and the removal of trees and shrubs. As a result, the number of *Drosera rotundifolia* rosettes has increased; and *Rhynchospora alba* and *Eriophorum angustifolium* — two species which had been declared extinct from the site — were found again. An important part of this project was education and work with the local community, and the municipality now manages the Dubravica site. Building on the positive results obtained, a similar project has now been implemented at Blatuša and work at other peatlands is planned.

Main Threats

Peat extraction is not a threat to Croatia's peatlands because they are not large enough ever to be exploited. However, other factors are contributing to their destruction and extinction. The climate has been warming over many centuries during the postglacial period, giving rise to natural vegetation succession. This occurred slowly for a long time, but is now accelerating as the steep part of the S-curve is approached. Some peatlands are now almost completely overgrown. The lack of effective conservation management in the past, combined with climatic changes, has caused the degradation or complete disappearance of peatlands in recent decades, they have become overgrown with shrubs and trees, and their plant species are now endangered or critically endangered. Most peatland species can still be found and only one (*Eriophorum gracile*) is regionally extinct. However, the survival of *Calla palustris* (small population confined to an area of 100 m^2) is in question. Also, the critically endangered species *Osmunda regalis* now occurs in only a few localities in Karlovačka County including the peatland Banski Moravci, which is protected as a Special Botanical Reserve; and it has never been recorded in Blatuša. More information on these species and their distributions can be found in the Flora Croatica Database (http:hirc.botanic.hr/fcd).

Some peatlands have been altered or destroyed by direct human influences. These include Benkovac (Gorski kotar) where there is a large andesite mine, the fen at Fužine (Gorski kotar) which has now been flooded by a hydropower reservoir, and stands of *Caricetum davallianae* in Lika region which have been converted to the grassland community Molinio-Lathyretum pannonici subass. caricetosum davallianae (Gaži-Baskova 1963).

All of these problems are listed in the new Strategy for Nature Conservation, but so far this has not resulted in consistent field management; except at the fen with *Drosera rotundifolia* in Gorski kotar where active management was undertaken only in 1998–1999, when the above-ground parts of *Molinia caerulea* and bushes of *Betula verrucosa* and *Populus tremula* were cut down. One impediment is the unavailability of continuing financial support and the other, very closely related, is that landmines were laid in some of these fens during the war period (1991–1995) and this has made them inaccessible ever since.

Threatened peatlands. Three fens are protected by law as Special Botanical Reserves, although this designation is obviously insufficient to ensure their survival. Despite such "protection", the area of Dubravica Fen was reduced from 2,500 m^2 in 1939 to 605 m^2 in 1994 and its current area is unknown because it is the private property of several unidentified owners. We hope that some of the problems will be solved by the new law on nature protection which is now being prepared.

Hot Issues and Recommendations

The lack of knowledge on peatlands distribution and status may cause mistakes in th eplaning of peatlands use and conservation.

Access is needed to official sectorial data, especially on peat resources from the "Soviet period", to improve the information base for land use planning.

Bulgaria

General Information

The total area of Bulgaria is 110,911.5 km^2, the population is 8.8 million, and the area of peatland is estimated at 30 km^2.

More than half of the country is hilly or mountainous, and the average altitude is *ca.* 480 m a.s.l. The Balkan Mountains cross from the northwestern corner of Bulgaria to the Black Sea, forming the watershed between the River Danube and the Aegean Sea. The northern side of the Balkan range forms the northern Bulgarian plateau, which slopes gradually down to the River Danube. The central portion of the southern side of this range is fringed by a series of narrow plains, notably the Thracian Plain. In southern Bulgaria, the broad and irregular Rhodope Mountains delineate the boundary with Greece. The Rila Mountains lie at the western end of the Rhodopes and culminate in Musala Peak (2,925 m), which is the highest point in the Balkans. There are also several smaller mountain ranges along the country's western border.

The average annual temperature is about 13°C and average annual rainfall *ca.* 635 mm, ranging from around 200 mm in the northeast to 1,900 mm in the Rila Mountains. The wettest period is early summer for most of the country, but autumn or winter in the southern valleys.

Distribution and Diversity of Peatlands

Bulgaria's peatlands are located mostly in river valleys and intermountain depressions. Typical flooded peatlands with reeds, large herbs and *Dryopteris thelypteris* occur in the Maritsa valley, in the central Danube river basin. Sedge fens, and shrub fens with willows and sporadic *Sphagnum* mosses, have also been described in river valleys. Forested peatlands occur mostly in better-drained locations and are represented by ash stands with reeds, black alder and birch forests. Ombrotrophic peatlands with *Eriophorum vaginatum* and *Sphagnum recurvum* are very rare in valleys, but there are some mesotrophic peatlands with *Carex lasiocarpa, Sphagnum recurvum, S. magellanicum, S.centrale* and sparse *Salix cinerea* which have developed peat deposits 1.5–2.0 m thick. Mountain peatlands have been described at around 1,600 m altitude in the Western Rhodopy Mountains. These are mainly mesotrophic mires with *Sphagnum fuscum, S. magellanicum, Drosera rotundifolia, Comarum* *palustre, Viola palustris, S. subsecundum, Eriophorum vaginatum, Pinus sylvestris* and a number of sedges. There are also spring fens characterised by *Philonitis fontana* and *Primula farinosa* with *Sphagnum warnstorfii, S. teres, Carex stellulata*, willows and dwarf shrubs. The associated peat types are sedge and sedge-*Sphagnum.*

Bulgarian peatlands are classified according to geomorphological principles. The high mountain (alpine zone) peatlands of the Rilla and Rhodopy mountains are characterised by their small areas and shallow (up to 0.5 m thick) acid sedge peat. They are used as pastures. Peatlands of intermountain depressions occur at altitudes of 700–900 m a.s.l, extend to several hundred hectares (e.g. the "Baikal" peatland), have relatively deep peat deposits (6–8 m) with medium ash content, and their peat is very often extracted for use as fertiliser. The peatlands of piedmont depressions cover significant areas but are characterised by shallow peat and are thus generally unsuitable for peat extraction. Low valley peatlands occupy old oxbows, extend to several hundreds of hectares, and their peat is 2–3 m deep with high ash content. This peat is used locally as fertiliser. The peatlands of sea lagoons are no more than 100 ha in area, and their peat is 1.5–2.5 m deep with variable ash content.

Peatland Resources

The peat resources of Bulgaria were not studied until recently.

Before 1913, the total area of "blato" (wetland with water level almost constantly above the peat surface, Bragg 2003) along the Danube was 733 km^2. Today it is 23 km^2. The mires/peatlands that have been drained include Straldjansko blato (140 km^2) and Batashko blato (27 km^2), and the second of these has now been converted into a water reservoir. There is no information about mires or peatlands located in the middle and lower courses of rivers.

An inventory of peat resources for agriculture was carried out in 1958–1959. Markov *et al* (1988) report a 1958–59 inventory by soil scientists from the Bulgarian Academy of Sciences which identified 25 peatlands with total area 3,000 ha and peat storage $20x10^6$ m^3 (0.08 Bt). However, the original report presents different figures. Of the 70 mires/peatlands studied, 44 had peat layers 0.5–8 m thick. These covered 21 km^2 and contained about 20 Mt of peat (Bogdanov & Simeonov 1962). There are no data for the extent of mountain peatlands (Stefanova & Ammann 2002).

Lowland peatlands cover a total area of 300–400 ha. Their peat deposits can reach depths of 6–8 m and consist mainly of well-decomposed reed fen peats with high (25–50%) ash content and low acidity, or even neutral reaction. They are saturated with water and include mineral fluvial deposits, which may form a surface layer up to 0.5 m thick. Highland peats are comparatively acid. The age of the deposits has been determined as Atlantic, i.e. around 6,000 years.

Peatland Use

Since the beginning of 20^{th} century, the most important use has been agriculture on drained peatland. Most peatlands are still used directly for agriculture — for arable crops, pasture and hay. Other uses include fisheries, peat extraction and *Phragmites* cutting. A factory built in the town of Silistra in 1954 used 8,000–10,000 tonnes of reed annually for manufacturing everyday necessities (Kochev & Jordanov 1981) until 1976, when this activity diminished. Some of the mires along the Matitza river have been transformed into rice plantations; whilst the aquatic plants *Lemna*, *Spirodela* and *Azolla* are harvested from mires on the Danube for use in poultry (Kochev & Jordanov 1981). Substantial areas of mires with herbaceous vegetation, along with summer-dry mires, were traditionally mowed and grazed; and peatlands in the high mountains, especially in the Balkan, Pirin and Rila ranges, are still grazed in summer. The numerous springs and peatlands of Vitosha Mountain are particularly valuable for drinking water. Extraction of peat, primarily for agricultural needs, began in the 1950s and expanded very rapidly. Some extracted peat is also used for balneological purposes in the Plovdiv and Blagoevgrad areas.

Policies on Peatland Panagement

There is no specific legislation for peatlands, which are protected as one type of wetland; and no available information on land use regulations affecting peatlands.

According to the Constitution of the Republic of Bulgaria, "international agreements ratified in compliance with the Constitution, published and having become effective for the Republic of Bulgaria, are part of the country's internal legislation. They have priority over those legal regulations that contradict them".

This passage of text from the Constitution has a very real meaning in relation to Bulgaria's obligations as a Party to international conventions and treaties concerning biodiversity and habitat conservation, such as the Convention on Conservation of Wetlands as Waterfowl Habitat (Ramsar, 1971), the Convention on Preservation of the World Cultural and Natural Heritage (Paris, 1972), the UN Convention on Biodiversity (Rio de Janeiro, 1992), *etc.* Bulgarian legislation, institutions and practical activities are being developed to achieve consistency with these and other international agreements to which it is a Party. For wetlands, important steps are represented by the National Plan of Priority Actions in the Most Important Wetlands (1993), the National Biodiversity Conservation Strategy (1994), and the National Action Plan for Biodiversity Conservation in Bulgaria (1999), which was later adopted. The Protected Areas Act, which was passed in 1999, incorporates the best features of the now effective conservation legislation and practice of the European Union, and accords fully with the basic requirements and formulations of international conventions and treaties including the Ramsar Convention. One of the requirements of the Protected Areas Act is that the management of protected areas, including wetlands, shall be based on Management Plans adopted (and implemented) after extensive and detailed public discussion with all interested parties, NGOs and local communities. The terms and conditions for development and endorsement of management plans are regulated through specific Acts of the government and its agencies, such as the recently published "Instructions on the Elaboration of Management Plans for Protected Areas" (State Gazette No. 13/2000). The format stipulated closely resembles that for EUROSITE management plans, and is fully compatible with RAMSAR requirements.

Responsibility for the conservation and management of wetlands lies with the Ministry of Environment and Waters (MoEW). The Ministry is legally responsible for the management of national parks, nature reserves, protected sites and nature monuments, as well as for the overall supervision of conservation activities in Bulgaria. The Ministry's strategy and policy are set out in detail in "The National Strategy for Biodiversity Conservation In Bulgaria" — a three-volume publication, accomplished with financial help from the American Agency for International Development (Sakalian & Meini, eds., 1993).

Peatland Natural Value and Conservation

Values. As in all southern countries, Bulgarian peatlands have extremely significant roles for the maintenance of biodiversity, and for climate and the water cycle.

The main justification for mire conservation in Bulgaria is that wetlands provide habitats for wildlife, including some rare plant and animal species that cannot be found elsewhere. The wetland conservation plan emphasises the great importance of coastal basin mires located on the *Via Pontica*, which is the second largest European bird migration route; and of the wetlands along the River Danube which provide prey, together with wintering and nesting habitats, for birds. The value of these sites for bird conservation is reflected by the fact that 15 of the protected areas listed in the Table are included in the Bulgarian Important Bird Areas Network (Kostadinova comp. 1997), and by the fact that the Ministry of Environment and Waters has designated them as priority areas for nature conservation. This, in turn, has attracted two international conservation projects. Since 1995, the Bulgarian-Swiss Biodiversity Conservation Program has focused on coastal wetlands. Management plans are now being prepared, and a visitor centre in Poda Protected Area is another outcome of the project. The "Green Danube" project, conducted by WWF-International, focuses on the wetlands along the Danube.

On the other hand, many shallow peatlands outside these high-profile areas have not yet been documented at all, and a first comprehensive inventory of inland mires is urgently needed. Such an inventory would form a valuable basis for further rehabilitation of mires, especially now that some of the drained lowland peatlands are no longer used for agriculture.

Protection measures. Development of the Bulgarian Protected Areas Network began in 1933, and the designation of Torpheno Branishte (Vitosha Mountain) as a nature reserve in 1935 could be interpreted as the first mire conservation activity. The main purpose of this designation was to preserve a site that provides drinking water. In the decades that followed, more than 280,000 ha of protected areas were established, accounting for about 3.5% of the total area of the country.

The Ministry of Environment and Waters, handsomely supported by the French government and the Ramsar Convention Bureau, has developed "The National Action Plan for the Conservation of the Most Important Wetlands in Bulgaria" (Michev, ed., 1993). The wetlands included in this Plan have been classified according to their importance for the conservation of biodiversity at global, regional and national scales. Priority activities, methods and funding requirements have also been described. The wetland categories defined, and the sites pertaining to each of them, are as follows:

- wetlands of global importance: Nature Reserve Srebarna, Durankulak-Shabla Lake complex, and Bourgas lakes including Atanasovsko Lake;
- wetlands of European importance: Nature Reserve Ropotamo including Arkutino Marsh, Nature Reserve Belene, Nature Reserve Kamchia, and Protected Site 'The Old Oak Tree'; and

– wetlands of national importance: Pomorie Lake, the mouths of the rivers Veleka and Silistar, Malak Preslavets Marsh, and Garvan Marsh.

The wetlands whose names are underlined above have been designated as Ramsar sites (http://www.ramsar.org/wurc/wurc_mgt-plan_bulgaria1a.htm). Peatlands occur within some of these sites, but there is no specific strategy for peatlands.

Bulgaria now has 33 protected areas containing peatlands. These cover a total area of 228,145.8 ha, they include more than 3,367 ha of mires or peatlands, and 22 of them were selected exclusively for their mire interest. It should be emphasised, however, that precise data for mire/peatland areas are not available for some protected areas, especially national parks.

Twenty-one of the CORINE sites for Bulgaria include mires/peatlands, and five of these are designated as internationally important.

Potential for restoration. No information available.

Main threats. Historically, agriculture has been a major factor in the loss and degradation of Bulgarian mires. The total area of natural lakes and mires was more than 200,000 ha at the beginning of 20th century, but today they extend to only 11,000 ha (Michev 1995). Drainage operations began during the 1920s and were intensified in the 1950s in order to enlarge the agricultural and urban areas along the Danube as well as rural lowlands adjacent to other large rivers. As a result, nearly all of the Danubian and inland mires were destroyed and Straldjansko (the largest), Karaboazko and Dragomansko mires disappeared completely. It become evident later that the drained land, especially along the Danube but also elsewhere in the country, was not entirely suitable for agriculture due to salinisation, for which melioration measures were necessary. Nowadays there are insufficient funds to maintain and power the pumps, and a considerable number of them do not work. As a result, some of the wetlands are recovering, for example in the Dragomansko blato area (T. Michev pers. comm.).

Another cause of peatland loss was the conversion of some mire areas into dammed lakes (e.g. Batashko blato and part of the Straldjansko blato) and of others into fish ponds (e.g. Kalimok, Orsoia and others along the Danube and Maritza Rivers).

Autumn burning of common reed (*Phragmites*) is still practiced in Bulgaria, although its purpose is not entirely clear. It might be supposed that people expect it to improve the quality of meadows, but the result is biodiversity loss and changes in soil nutrient composition.

Increasing recreational activities threaten mires mostly along the Black Sea coast. Urban growth here produces increasing quantities of waste, some of which is discharged into mires. Coastal wetlands in particular have also been polluted by toxic pesticides that were used several years ago to control mosquitos.

Ingress of freshwater is a specific threat for touzla systems because it will disrupt this ecosystem's typical hypersalinity and thus cause phyto- and zoocoenotic changes.

Groundwater drawdown near mires can result in their degradation or even extinction (Apostolova *et al* 2001, Dobrev & Dimitrov 1997).

To date, only relatively small-scale extraction of peat for agricultural and horticultural uses has taken place. Although this practice is much restricted at present, it should nonetheless be controlled because the peat reserves are too small to support any expansion.

As everywhere, agricultural and other anthropic pollution is a major causative factor in eutrophication and degradation of mires. In particular, long-term intensive use of fertilisers and pesticides has resulted in N and P contamination (Michev 1995, Kochev & Jordanov 1981, Dobrev & Dimitrov 1997).

Four plant species are extinct and another 41 are threatened because Bulgaria's mires have been reduced to remnants (Velchev 1984). Mire destruction also means that 39 wetland bird species are threatened with extinction.

It should be mentioned, however, that some of the processes of mire change that we observe at present are of natural origin. Vegetation succession and climatic drying — albeit of low intensity — are causing "ageing" of mires, whose future preservation should be ensured by active intervention.

Threatened peatlands. No data

Hot Issues and Recommendations

More attention should be paid to land use regulations and restoration activities. A significant part of the mire resource requires further investigation, reclassification, and reconsideration in terms of protection measures and status.

Turkey

General Information

The total area of the country is 769,630 km^2, the population is 66.6 million, and the total area of peatland is 691 km^2.

Turkey can be divided into seven regions, namely: Thrace and the borderlands of the Sea of Marmara; the Aegean and Mediterranean region; the Black Sea region; western Anatolia; the central Anatolian Plateau; the eastern highlands; and south-eastern Anatolia. Average annual precipitation varies from 350 mm in the central part of the country to 820 mm along the Mediterranean and Aegean coasts.

There are several mountain systems. The eastern highlands region is the most mountainous and rugged part of the country. Less than 10% of this area is cultivated and it includes Mount Ararat (Agri Dagi), which is Turkey's highest peak at 5,122 m, as well as the sources of the rivers Tigris (Dicle) and Euphrates (Firat). South-eastern Anatolia is a rolling plateau enclosed by mountains to the north, east, and west. As part of the so-called Fertile Crescent, this region has been important since antiquity and about 19% of its area is farmed. The surrounding mountains may host peatlands, but there has been no definitive survey.

Distribution and Diversity of Peatlands

There are few peatlands in Turkey but they are distributed throughout the country. Vast herb fens are common in Samsun Bay on the eastern Black Sea coast, along the Dardanelle and Bosporus channels, on the west side of the Sakarya river, in Kuşadasi Bay on the south-west coast, and in the lower reaches of the Ceyhan and Meriç Rivers as they approach Iskenderun Bay in the south. Peatlands are found around some of the lakes, including Isikli, Amik, Yenicaga, Gavur, Hurmetci Marshes and Karakuyu Marshes; and there is a large highland peatland on the plateau east of Hakkari, near the town of Yürekli. Turkey's largest peatland, the Sultan Marshes, lies to the south of the town of Kayseri. Peatlands have also been mapped in the large ravine near the towns of Konya and Kahramanmaras in the southern part of the country. In central and southern Anatolia (Antalya) there are many salty swamps with practically no peat; whilst in north-eastern Anatolia there are valuable large peatlands near Trabzon Province at the eastern end of the Black Sea, which include the important Agacbasi Plateau (17.5 ha).

Peatland Resources

Available accounts of Turkey's peat and peatland resources are inadequate and imprecise. According to an estimate from 1993, the total area of peatlands in Turkey is 691 km^2, of which 130 km^2 have peat more than 0.3 m thick. The rate of peat accumulation is unknown. Detailed surveys, involving peat thickness measurements and laboratory tests on peat samples, have been conducted at only four sites. However, more than 10,000 km^2 of wetlands have so far been catalogued for a new inventory that is now being prepared.

Peatland Use

About 50,000 m^3 of mainly horticultural peat is extracted annually from four or five industrially worked peatlands.

Policies on Peatland Management

Turkey's environmental legislation includes a Regulation on Conservation of Wetlands. This empowers the Ministry of Environment and Forestry to consider applications and grant licences for peat extraction.

Peatland Natural Value and Conservation

Values. Peatlands in mountain areas are valuable for water regulation, as wet pasture, and for maintaining biodiversity; whereas the peatlands of deltas and lagoons have significant roles in water purification and flood control.

Protection measures. Turkish peatlands are protected by legislation that places peat extraction under the control of the Ministry of Environment and Forestry, as described above.

International protected areas. Turkey has twelve Ramsar sites with a total area of 179,482 ha. The Sultan Marshes (17,200 hectares) is a peatland. Seven more of these sites contain peatlands, along with shallow lakes, within delta and lagoon ecosystems.

Potential for Restoration

The restoration of wetlands is encouraged by legislation.

Main Threats

Historically, vast valley peatlands were drained in order to prevent the spread of malaria, and they were subsequently taken into agricultural use. A comparison of old and modern maps indicates that nearly all of Turkey's wetlands have now been drained. Overgrazing may also be regarded as a threat.

Threatened peatlands. No information available.

Hot Issues and Recommendations

A good inventory of Turkish peatlands is urgently needed because it seems that all of them will soon be damaged by agriculture, and especially by pastoral use in the highlands. This should be complemented by a thorough evaluation of their natural functions and conservation status.

Georgia

General Information

The total area of Georgia is 69,700 km^2, the population is 5 million, and the peatland area is 450 km^2.

Georgia contains high mountain ranges as well as extensive coastal lowlands. The Greater Caucasus Mountains form most of the republic's northern boundary, rising ultimately to the peak of Mount Shkhara (5,068 m), which is the highest point in the country. By contrast, the Lesser Caucasus Mountains in the south rarely exceed 3,000 m altitude. The area between these two ranges is generally much lower-lying, especially along river valleys and the Black Sea coast, where altitudes are mostly less than 100 m a.s.l.

The climate ranges from humid subtropical in the Colchis Lowland to drier, more continental conditions in the eastern uplands. The Black Sea coast and the Rioni plains enjoy average temperatures of 5°C in January, 23°C in July and an average annual rainfall of 2,000 mm. The two largest rivers, the Kura and the Rioni, flow in opposite directions. The Kura rises in Turkey and flows generally eastward through Georgia and Azerbaijan into the Caspian Sea, while the Rioni drains westwards into the Black Sea. Numerous other rivers flow across the fertile Colchis Lowland and also discharge into the Black Sea (Microsoft Encarta Encyclopedia 2002).

Distribution and Diversity of Peatlands

Because of its climatic and geographic situation the Kolkheti (Colchis) region represents a centre of biodiversity and human activity on the boundary between Europe and Asia. Kolkheti is unique for its pristine habitats, which have special value for biodiversity conservation. The Kolkheti *Sphagnum* mires and their flora are relicts from the glacial period. The Kolkheti lowlands were not glaciated, and their sheltered location between the Caucasus mountain ranges enabled many species of the warm Tertiary period to survive the Quaternary ice ages. Consequently many relict and endemic species are found here. Glaciation affected Kolkheti only locally, where mountain glaciers extended down to the valley, so that during the last Glacial Maximum, Kolkheti was an important refuge for European flora (Ketshoveli 1960). Because of this, the Kolkheti mires currently harbour, alongside relict tertiary

Table 6. Dominant vegetation of the main mires in Georgia

Name of mire	Open mire (ha)	Forested part (ha)	Dominant vegetation type
Imnati	5,000	17,000	Sphagnetum, with grasses, rich
Anaklia-Churia	1,800	4,500	Sphagnetum; Caricetum
north of Churia		4,000	
Nabada	2,900	6,700	Sphagnetum
Maltakva bog *	300	800	originally Sphagnetum; now secondary vegetation types
Grigoleti *	150	400	partly Sphagnetum; secondary vegetation types
Shavtskala *	500		Caricetum; Juncetum; secondary vegetation types
Ispani II	200	250	Sphagnetum
Ispani I	350	450	dispersed Sphagnetum; secondary vegetation types

* transformed and partly transformed mires.

species, many (sub) Mediterranean, temperate and relict boreal species (Denk 2000). Of special interest is the widespread occurrence of boreal mire species such as *Drosera rotundifolia, Menyanthes trifoliata, Rhynchospora alba* and *Carex lasiocarpa* and the typical Kolkheti "Skeriani" elements such as *Rhododendron ponticum* and *Rhododendron luteum*. Most of the peatlands are concentrated in the Kolkheti lowland and include sedge-*Sphagnum* peatlands, herb and grass fens, forested fens with *Alnus barbata*, Kolkheti relict forest and reedswamps with *Cladium mariscus*. The highland mires are mostly sedge fens located in small river valleys and around lakes.

Fully transformed and degraded mire is found in the northern part of Anaklia Mire, in the southernmost parts of the Nabada and Imnati mires, and in much of the Maltakva and Grigoleti mires. All of these systems have been partly destroyed by peat extraction, construction of drainage channels and other activities.

Peatland Resources

Neishtadt (1946) (in Kazakov 1953) calculated the total area of "peat resources" in Georgia as 250 km^2 with peat reserves of 120 Mt air-dried peat; and three decades later Tyuremnov (1976) gave the total area of "peat deposits" as 200 km^2 (0.3% of the area of the country) with peat resources of 100 Mt. Lappalainen (1996), following Tyuremnov (1976), mentions a "recent peatland" area of 250 km^2 (0.4% of the land area) and total peat resources >100 Mt. On the other hand, Schneider (1976, 1980) and Schneider & Schneider (1990) indicate that the "peatland" area is 1,000 km^2.

The total area of mires ("tchaobi" in Georgian) is *ca.* 450 km^2 (Markov *et al* 1988), with the majority in the 200 km^2 Kolkheti Lowland (Kobulina 1974, Joosten *et al* 2003). Mountain mires can be found at all altitudes between 600 and 3,400 m a.s.l., but cover only a very small fraction of the country (Kimeridze 1960, 1965, Botch & Masing 1983).

Peatland Use

Agriculture has long been an important component of the Georgian economy. Reclamation of peatlands in the coastal lowlands around the mouth of the Rioni has added much fertile land where tea and citrus fruit are produced; and some drained peatlands are used for growing maize and barley.

From natural mires, local people harvest reeds for roofing, cut alder trees for construction timber and firewood, and collect medicinal plants.

Within the Kolkheti National Park (KNP), local people graze cattle and water buffalo throughout the year in wet forest, secondary shrub forest and meadows on peat, and on the edges of bogs. However, it is difficult to judge the impact of grazing because there are no accurate stocking data. The formerly state-owned farms along the rivers Churia, Tsivi, Tsia and Pichori have now been privatised.

Peat has been extracted from the Kolchic mires since 1920–30. Most of it is used as fertiliser and cattle bedding, and a very small quantity as fuel. Peat for local heating is now extracted also from highland peatlands.

The development of infrastructure such as roads, railways, pipelines and military installations on the extensive Kolkheti peatlands makes them into preferred targets for destruction during military conflicts, as was observed during 2008.

Degraded areas and clearings that have developed secondary meadow vegetation are used for dumping.

Peatlands Natural Value and Conservation

Values. Georgian mires are most valuable for their role in water regulation, as well as for their extremely rich biodiversity and the high level of endemism. The natural landscape of Kolkheti, with its unique mires of international importance and its endemic and relict flora and fauna, is particularly notable.

Pristine or almost natural mire is found in the southern part of Anaklia Mire, in the Churia and Pichori mires, in the central and north-eastern parts of Nabada, and in the centre of Imnati Mire.

Swampy alder tree forests retain their original appearance in many peripheral locations within the coastal mires, and are noteworthy. These forests have developed on small islands in the bogs and so are often inaccessible. Although they have not been included in any inventories to date, their origin and present status is of great interest because they have escaped disturbance and so are less altered than most other habitats.

The rivers of the Kolkheti lowlands provide important spawning habitat for migratory fish and are especially crucial for their populations of *Acipenseridae* (sturgeon). Amongst these is the extremely rare species *Acipenser sturio*, which is categorised as being "on the critical verge of extinction" (CR) in the IUCN list for rare and endangered species. In recent decades the Rioni River has been the only location reported for this species throughout its entire range.

The rarity of the ecosystem assemblage of the Kolkheti National Park arises from the fact that the biogeographical conditions once supported abundant tropical and subtropical habitats which, some ten million years ago, stretched in an almost unbroken belt across the vast Eurasian continent. Outside Kolkheti, the only remnants of the associated special ecological communities are to be found southeast of the Black Sea and in Kakheti, Talishi (Azerbaijan) and eastern China; and they are substantially altered in all of these locations.

Protection measures. The Kolkheti Nature Reserve was established in 1935, to protect the sensitive areas of Samegrelo region. It is situated south-east of the town of Poti and to the north of the lower reaches of the River Pichora, and is now part of the newly established Kolkheti National Park.

Kintrishi Nature Reserve, founded in 1956, lies to the south of the Kolkhida or Colchis lowlands, on the western slopes of the Meskhet range — a southern spur of the main Caucasus range — around the Riono valley. It is an area of mountainous relief and deep gorges, with small mires in valleys, and it includes part of the Kobuleti lowland with its mires.

Kolkheti National Park and the Kobuleti Nature Reserve were established in 1999, but these designations do not provide full protection.

Kolkheti National Park covers the western part of the Kolkheti Lowlands. Under "The Law Regarding the Establishment and Management of Kolkheti Protected Areas", the land area of the National Park is set at 28,571 ha and the marine area is 15,742 ha. The mires of Gagidi and Zorgati (between the Enguri and Okumi) have features similar to those of the northern part of Kolkheti Lowlands, but are not included in the National Park because of the current political situation in Georgia. The highly urbanised coastal segments of the Rioni and Khobistskali rivers, as well as some parts of the northeastern and southeastern edges of the Lowland, have been intensively reclaimed for agriculture and so are also excluded. The result is that the National Park is divided into three separate parts, namely Anaklia-Churia, Nabada and Imnati.

International protected areas. Georgia has designated two Ramsar sites with a total area of 34,223 hectares, both in the Kolkheti peatlands.

Potential for Restoration

Pilot projects have been carried out in Ispani. The environmental balance of the project region has been substantially disturbed by the direct and indirect effects of human activities such as drainage of mires, peat extraction and haphazard logging. So far, irreversible damage is limited and the Kolkheti National Park retains its characteristically high natural biodiversity. Almost virgin mire and humid forests can still be found in inaccessible places, and these are of great scientific and aesthetic value. With sound environmental management, most of the degraded ecosystems can probably recover. Possible measures include:

- restoration of the hydrological and hydrobiological conditions of Lake Paliastomi;
- rehabilitation of degraded ecosystems in the northern part of Anaklia and the southernmost part of Nabada, as well as in the Imnati, Maltakva and Grigoleti mires; and
- restoration of the natural relief of sand dunes and of their vegetation, which has been altered to varying degrees.

Main Threats

The precocious agricultural development of Kolkheti under the socialist regime was accompanied by massive deforestation, and the virgin forests were replaced by plantations of tea, citrus and tung tree (*Vernicia fordii*). Large drainage channels were dug through the wetlands, and peat was extracted from Imnati and Ispani I to be used as a soil improver for the plantations. The degraded peatland ecosystems were then invaded by alien plant species.

The plant species *Osmundra regalis, Molinia litoralis* and *Solidago turfosa*, relicts of the Tertiary period, are on the verge of extinction due to impacts from human activities, and *Drosera rotundifolia* is disappearing for the same reason. All of these species are included in the Red Data Book of Georgia. *Hibiscus pontica, Kosteletzkya pentacarpos* and *Salvinia natans* are also on the verge of extinction and should be added.

The wild fauna of the protected areas is rapidly becoming degraded in parallel with the vegetation, and a number of animal species need urgent protection because they are on the verge of extinction. This is demonstrated clearly by the fact that the Atlantic sturgeon (*Acipenser sturio Linne*), banded newt (*Triturus vittatus*) and Aesculapian snake (*Elaphe longissima* Laurenti), which are food species for birds such as the black stork (*Ciconia nigra* Linnaeus), great egret (*Egretta alba* Linnaeus) and whooper swan (*Cygnus cygnus* Linnaeus), are included in both the Red Data Book of Georgia and the List of Endangered Species for Europe.

Despite the high capacity of swamp and wet forest for self-regeneration, virgin areas do not re-establish their original structure after logging and this may lead to biodiversity losses. For instance, the post-logging secondary forest lacks beech (*Fagus*), ash (*Fraxinus*) and maple (*Acer campestre*), whose capacity for self-regeneration is lower than that of alder (*Alnus*).

Demand for timber is now increasing due to high population pressure and socio-economic hardship, causing further damage to forest and in particular devastating the dense and valuable Kolkhic forests. Oak (*Quercus*), beech (*Fagus*), hornbeam (*Carpinus*) and wing-nut (*Pterocarya*) have become rare, surviving only in locations with difficult access, and the fast-growing alder (*Alnus barbata*) has become the dominant tree species. Deforested areas are used for agriculture.

Unfortunately, the present economic crisis has caused further impacts on the biodiversity of wetland ecosystems. The vegetation, birds and fish of the Kolkheti coastal zone have been particular victims, but negative influences from human activities such as woodcutting, mire drainage, peat extraction, uncontrolled hunting and fishing, grazing and the use of fire are reported throughout the National Park. Obviously, the increasing degradation of both terrestrial and marine ecosystems caused by human activities further threatens the biodiversity of the Kolkheti National Park.

At present, the virgin Colchic forest is being felled and drainage canals laid in preparation for construction of the large Kulevi oil terminal on the outskirts of Anaklia-Churia. As a result, local groundwater is no longer replenished and the community has lost its supply of drinking water.

Threatened peatlands. All mires and peatlands in Kolchic Valley are under threat.

Hot Issues and Recommendations

The most urgent needs are to improve land use legislation and conservation practice, and to raise public awareness of the values and protection needs of mires and peatlands.

Armenia

General Information

The total area of the country is 29,743 km^2, the population was estimated in July 2006 as 2,976,372, and the area of peatland is *ca.* 60 km^2 (Jenderedjian 2005).

Armenia is a landlocked country, located 145 km from the Black Sea and 175 km from the Caspian Sea. It is extremely mountainous with an average altitude of 1,850 m a.s.l. The highest peak is Mount Aragats (4,090 m), and the River Debed in the north descends to the country's minimum altitude of 375 m. 9.9 % of the country lies below 1000 m a.s.l., 49.6% between 1,000 and 2,000 m, 37.1% between 2,000 and 3,000 m, and 3.4% above 3,000 m.

Armenia's climate is continental, with wide annual temperature variations. Rainfall varies greatly with location and altitude, and the highest precipitation occurs on mountain slopes. Indeed, the mountainous relief gives rise to a unique variety of natural conditions as, despite its small size, the country includes seven climate zones ranging from dry subtropical to severe alpine.

Armenia has more than 100 lakes, ponds and reservoirs, but water resources are limited because, from the 18.4 km^3 of rainwater received per year, 12.2 km^3 is lost by evaporation. The only river basin is that of the River Kura, which flows into the Caspian Sea. There are, nonetheless, about 10,000 rivers and streams, of which 300 are longer than 10 km, 13 longer than 50 km and only four (Arax, Debed, Hrazdan and Vorotan) longer than 100 km.

Distribution and Diversity

Barseghyan (1990) distinguishes three wetland districts in Armenia on the basis of flora, vegetation, altitude and peat accumulation. These are:

1. The lowland freshwater and saline marshes of the Ararat Valley and the Northern and Southern Regions. These are characterised by hygrohalophytic plants and the absence of mosses and peat. Typical plant species include *Phragmites australis, Scirpus tabernaemontani, Bolboschoenus maritimus, Typha laxmannii, Carex diluta* and *Chara contraria*.
2. The freshwater mires, ponds and river pools which occur at altitudes of 1400–2400 m a.s.l. in the Northern Region, the Sevan Basin and the Southern Region. These have well-developed peat layers. The dominant

plant species are *Phragmites australis, Typha latifolia, T. angustifolia, Scirpus lacustris, Puccinellia sevangensis, P. distans, Scolochloa festucacea, Carex vesicaria, C. gracilis, C. caucasica, Eleocharis palustris* and *E. quinqueflora.* Some species are restricted to this district, namely *Salvinia natans, Nymphaea alba, N. candida, Nymphoides peltata, Utricularia minor, U. intermedia, Potamogeton alpina, P. nodosus, Hippuris vulgaris* and *Elatine alsinastrum*.

3. The ephemeral and hanging marshes of the alpine zone. Peat is absent or almost absent from these wetlands, which are characterised by an abundance of mosses including *Aulacomnium palustre, Desmatodon latifolius, Philonotis caespitosa, P. fontana, Drepanocladus uncinatus* and *Sphagnum girgensohnii. Bryum weigelii* often forms monodominant carpets in lakes above 3,000 m a.s.l. The most typical flowering plants are *Carex dacica, C. canescens, Luzula pseudosudetica, Deschampsia caespitosa, Alopecurus armenus, Callitriche hermaphroditica* and *Limosella aquatica*. As the modern wetland flora formed soon after the glacial epoch, boreal species such as *Menyanthes trifoliata, Scolochloa festucacea, Glyceria plicata, Veronica scutellata* and *Catabrosa aquatica* are best retained in alpine lakes, high mountain river valleys and canyons (Barseghyan 1966).

Peatland Resources

At least 70 peat deposits with a total area of 3,000 ha are known in Armenia. Most of them are smaller than 0.5–1.0 ha but of local importance in that they were used for fuel peat during the difficult war years. Three deposits, with a total peat volume of 50 x 10^6 m^3, have local commercial value. These are Gilli (Sevan Basin, 1,500 ha), Saratovka (Northern Region, 300ha) and Metsavan (Northern Region, 400 ha) (Zakharyan 1960).

Armenian peat is of good quality for agrochemical uses. The pH range is 5.0–7.0, organic matter content 55–82%, total ash content 18–45%, total nitrogen (N) 2.0–2.4%, calcium (CaO) 1.3–3.4%, phosphorus (P_2O_5) 0.12–0.30%, potassium (K_2O) 0.05–0.22% and iron (Fe_2O_3) 0.5–4.2% (Vardanyan 1965).

The highest value of remaining Armenian peatlands is of course for their ecosystem services.

Peatland Use

In the 1980s, peat extraction in Armenia was close to 100,000 m^3 *per annum*. The peat was used mainly as agricultural fertiliser, litter for cattle, and in balneology (mud cure). Nowadays, the low market value of agricultural products often makes the use of peat as a fertiliser unprofitable. Nonetheless, peat extraction is out of control. About 50,000 m^3 is extracted annually from the largest peat deposits, mainly for fuel, and most of the small deposits are completely exhausted.

Armenian peat is mostly highly decomposed, and therefore suitable for soil improvement and cattle bedding. Peat is also used in the developing horticultural industry, as a growing medium for container grown seedlings and in greenhouses.

Flooded meadows are used widely for haymaking, especially in the Northern Region and the Sevan Basin. Although the quality of the hay produced here is lower than that of the surrounding mountain meadows, the productivity is incomparably greater.

Ephemeral and hanging mires are of great importance for grazing, especially during the dry season in the second half of summer and early autumn. The springs feeding hanging mires also provide drinking water for cattle.

Wetlands are a source of pharmacological plants, such as *Althaea officinalis, Bidens tripartita, Gnaphalium uliginosum, Glycyrrhiza glabra, Menyanthes trifoliata, Mentha longifolia, Nuphar luteum, Ononis arvensis, Polygonum hydropiper, Plantago major, Tussilago farfara* and *Valeriana sp.* They also provide edible plants that are used in the Caucasus cuisine, such as *Butomus, Nymphaea, Nasturtium, Rumex, Falcaria and Asparagus.*

In Southern Region, ponds developed after peat extraction areas have been flooded are regionally important for fish breeding and carp fishery (*Cyprinus carpio* and *Carassius auratus*). Rivers crossing flooded meadows and springs feeding hanging marshes are often used for breeding by commercial fish, especially the endemic Sevan barbel (*Barbus goktschaikus*) and Sevan khramulya (*Varicorhinus capoeta sevangi*), and the European chub (*Leuciscus cephalus*) in Northern Region.

Policies on Peatland Management

There is no specific policy on peatland management.

Peatland Natural Value and Conservation

Values. Barseghyan (1990) makes the following points to justify the need for mire/peatland conservation in Armenia:

- mountain mires have a unique ability to retain precipitation during the dry season;
- wetland vegetation supports waterfowl, game and fish;
- peatlands record the history of regional vegetation development;
- wetland fauna and flora are rich in pharmacological, edible, tannin and ether-bearing species;
- wetland vegetation plays an important role in the biological purification of wastewater;
- mires are of great importance for agriculture and balneology; and
- many wetland plant and animal species are endangered.

On this basis, peat-forming wetlands are obviously under-represented within the Armenian nature protection network.

Protection Measures

The Sevan National Park was established in 1978 "to protect Lake Sevan's shoreline, water and aquatic life" (Decree No 125 of the Central Committee of the Communist Party of the Armenian SSR and Board of Ministers dated March 14, 1978). The area of the National Park is 147,456 ha, of which 124,759 ha is open water and 22,697 ha is land. It is divided into three zones – a fully protected "zapovednaya zona", a recreational zone, and an economic zone. There are no peat-forming wetlands in the fully protected zone. The economic zone does include a small part of the former Gilli Lake peatland, but this was drained in 1959 and is now mostly under crops. There will be no special provisions to protect peatlands in the revised zonation of the National Park that is now planned, or in its next management plan.

Of the other areas protected for nature conservation in Armenia, the only one with peatland interest is Dilijan National Park, which includes approximately 2 ha of unique mires surrounding the small forest pond Parz-Litch.

A new project to establish Arpi National Park commenced in 2008, as part of the "Caucasus Initiative" of the German Federal Ministry of

Economic Co-operation and Development (BMZ), funded by the German Bank for Reconstruction and Development (KfW).

International protected areas. There are three Ramsar sites in Armenia, with a total area of 492,291.8 hectares. The total area of peat-forming wetlands (mires) under the Ramsar umbrella is currently about 1,800 ha. There are approximately 1,500 ha of mires in the Lake Sevan Ramsar Site and 200 ha in the Lake Arpi Ramsar Site. There are also mires in Khor Virap Marsh, which was recently declared as a new Ramsar site (Government Decree N 975–N of 25 January 2007).

Potential for Restoration

The restoration and conservation of Lake Gilli is an objective of the national Biodiversity Action Plan (2003). The restoration of Lake Gilli is also a priority of the Lake Sevan Action Programme as established by the national law on "Lake Sevan Rehabilitation Programme" (2001). The total budget for this six-year project is US$ 1,876,308 of which UNDP/GEF will provide US$ 963,708, to be matched by a contribution of US$ 937,600 (the cost of land compensation) from local communities and regional authorities. There will be two outputs, namely (i) a restored Lake Gilli (586 ha) that can serve as an effective wetland habitat for species of international significance and (ii) a co-management plan for the restored Lake Gilli, to be developed jointly by local communities and local authorities, who will also implement it. However, it should be mentioned here that the project launch was initially planned for 2002 and has so far been postponed from year to year.

Main Threats

Whereas forests, steppes and meadows were heavily exploited, Armenian wetlands remained largely undisturbed until the 1930s. During the following 20 years, all of the larger wetlands in the Ararat Valley were dissected by drainage ditches or pipes, and the flow of many rivers was regulated by damming. The main justification for draining wetlands was to combat malaria, dysentery and cholera. The artificial drop in the water level of Lake Sevan had a serious impact on the water balances of all types of wetlands, and of mires in particular.

The total area of lost wetland in Armenia is 20,000 ha, of which some 17,000 ha was peat-forming. 47% of the lost peat-forming wetlands were in Northern Region, 74% in the Sevan Basin, and 92% in Southern Region. As already mentioned, there were no peat-forming wetlands in the Ararat Valley. The causes of wetland loss differed between types and regions. In Northern Region most of the lost wetlands were converted to hay meadows or used for peat extraction; those in the Sevan Basin disappeared due to artificial lowering of Lake Sevan to provide water for irrigation and cheap electricity generation; the Ararat Valley was drained to fight waterborne diseases and to acquire agricultural land; and the Southern Region wetlands disappeared as a result of water regulation enabled by the construction of dams and reservoirs.

Threatened peatlands. The following peat-forming wetlands are important potential additions to the network of protected natural areas (Barseghyan 1990, Jenderedjian *et al* 1999, 2001a,b, 2004):

1. The relict lakes and ponds of Lori, Northern Region (400 ha, 1500 m a.s.l.). This area is a refugium for the boreal wetland flora of the Minor Caucasus, with postglacial relicts such as *Salvinia natans, Nymphaea alba, N. candida, Nymphoides peltata, Carex bohemica, C. vaginata, C. appropinquata, C. elata, Scolochloa festucacea,*

Utricularia intermedia, U. minor, Elatine alsinastrum, Veronica scutellata, Peplis alternifolia, Sparganium minimum and *Scirpus supinus.*

2. Pond Ardenis and the Zhamanakavor Tchahitch 5 km northeast of Lake Arpi, Northern Region (20 ha, 2040–2090 m a.s.l.). This is a small area with a unique abundance of wetland and aquatic vegetation types, which supports many duck and wader species and is the only known breeding site for the Slavonian grebe (*Podiceps auritus*) in Armenia.
3. The remnant mires of Gilli, Tsovinar and Zolakar along the southern shore of Lake Sevan (1,500 ha, 1900–1920 m a.s.l.). This area is important for the conservation of *Puccinellia sevangensis, Peucedanum zedelmeyeranum, Eleocharis transcaucasica, Senecio fluviatilis, Swertia aucheri, Ligularia sibirica, Carex secalina* and *Ranunculus strigilosus*. The Gilli Lakes system was once the most important inland waterfowl area in the Transcaucasus Region, with a total of 60 breeding species (Dal 1954). It is now in urgent need of restoration.
4. The floodplain wet meadow of the River Argichi, Sevan Basin (100 ha, 2100–2150 m a.s.l.). This wetland, and the River Argichi itself, are important for ducks and waders during their spring and autumn migrations. The area is currently threatened by haymaking and heavy grazing.
5. Hanging mire on Mount Tchgnavor, Southern Region (10 ha, 2600–2700 m a.s.l.). This area is important for rare plant species such as *Carex vaginata, C. siegertiana, Juncus alpigenus, J. filiformis, Parnassia palustris, Orchis iberica* and *Sphagnum girgensohnii*.
6. Hanging mire on the eastern slopes of the Zangezur Ridges, Southern Region (0.5 ha, 2400 m a.s.l.). A unique moss-covered mire with *Sphagnum squarrosum, S. fuscum, Calliergon cordifolium, Aulacomnium palustre* and *Brachythecium rivulare*.

Hot Issues and Recommendations

Development of a National Wetland Policy covering all wetland types including peatlands, with an associated Wetland Action Plan and timeframe for implementation.

General Conclusions

The Quick Scan approach was based on sketches prepared for individual central and eastern European (BBI) countries; and involved data synthesis, problem analysis and a review of recommendations. This exercise in turn provided a foundation for the formulation of strategic priorities for action on peatland management, which are summarised below.

Peatland management should be integrated into the general planning schemes for land use and development. This could be achieved by public involvement. Moreover, the complexity of peatlands as natural ecosystems means that their management requires inter-sectoral co-operation. Appropriate mechanisms are not well-developed in most of the countries considered, and need to be strengthened.

Raising public awareness of peatlands is a key problem for all BBI countries because there is a universal lack of basic knowledge about them and, consequently, their environmental functions are often under-valued. Their negative features were long emphasised in order to promote large-scale reclamation; and although peatland use is now condemned, there is a tendency for this to be done without any attempt to improve people's appreciation of the ecology and values of mires or of the services they provide. All of the countries considered should introduce measures to enhance the knowledge base and raise public awareness about peatland functions and values, including the potential for wise use of peatlands.

The dramatic changes in the political systems of all of the countries under consideration have led to serious problems in peatland management and conservation arising from recent and ongoing changes in legislation. Hence, there is a need to ensure that peatland management and conservation practices are closely linked to the latest changes in legislation, and that lessons learned feed back into policy.

The latest scientific findings demonstrate the significance of peatland-related natural processes for climate change. Therefore, each country should study the options for peatland management in relation to climate change, considering both mitigation and adaptation measures. UNFCCC contracting parties and interested players should work towards incorporating peatlands into the provisions of the Kyoto Protocol.

Although peatlands are very often the last remaining intact natural areas within anthropogenic landscapes, their role in biodiversity conservation has not been explicitly confirmed. The BBI countries need to promote the importance of peatlands for biodiversity conservation, including their disproportionately high value in ecological networks and on the flyways of migratory bird species.

There are some peatland types whose conservation requires a special approach involving the development and implementation of type-specific strategies. The types include peatlands which are typical or representative for biogeographical regions, those that are vulnerable to climate change and human activities, those in highly developed and urban regions, rare and disappearing peatland habitats, and transboundary peatlands.

Most of the BBI countries still regard their peatlands as significant natural resources for a wide range of economically lucrative activities. Thus, agendas are required to introduce environmentally friendly and sustainable land use practices and peatland use certification for all relevant sectors (e.g. energy, agriculture, forestry, road and infrastructure construction).

In most cases, current peatland use and after-use practices are detrimental to environmental security. Peatland restoration for fire control is at the top of the agenda for peat users and local authorities alike, and thus the most important theme for specialised research and public awareness-raising.

The role of peatlands in the natural water cycle is generally under-estimated or ignored. A knowledge of peatland hydrology at catchment level is insufficient to support the integration of peatlands into river basin management; and the appropriate scientific basis, regulations and practical recommendations for this are yet to be developed.

Peatlands are still not adequately represented in the international processes which aim to solve global environmental problems. Individual countries should focus on their obligations regarding peatlands, and especially peatland conservation, in the context of key international conventions including the Ramsar Convention's Global Action Plan on Peatlands.

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Contacts of Authors and Contributors

Bambalov, Nikolay
National Academy of Sciences of Belarus
Institute for Nature Managment
Francisk Skaryna 10
Minsk, 220114
Republic of Belarus
E-mail peatland@ecology.basnet.by

Belous, Tatiana
Center for Strategic Environmental
Studies ECOS
58, Hincesti str., of. 77,
Chisinau, 2028
Republic of Moldova
E-mail tatyana_belous@yahoo.com

Bragg, Olivia
School of Social and Environmental Sciences
(Geography)
University of Dundee
Dundee DD1 4HN
Scotland
United Kingdom
E-mail o.m.bragg@dundee.ac.uk

Ganeva, Anna
Department of Phytocoenology and Ecology
Institute of Botany
Bulgarian Academy of Sciences
23 Akad. G. Bonchev str.
Sofia, 1113
Bulgaria
E-mail animoss@bio.bas.bg

Jenderejan, Karen
Division of Animal Resources Management
Agency of Bioresources Management
Ministry of Nature Protection
35 Moskovian Street
Yerevan, 375002
Armenia
E-mail jender@nature.am

Joosten, Hans
IMCG
University of Greifswald
Institute of Botany and Landscape Ecology
Grimmer Strasse 88
Greifswald, 17487
Germany
E-mail: joosten@uni-greifswald.de

Jukoniene, Ilona
Laboratory of Flora and Geobotany
Institute of Botany
Zaliuju Ezeru str. 49
Vilnius, LT-08406
Lithuania
E-mail ilona.jukoniene@botanika.lt

Kozulin, Alexander
National Academy of Sciences of Belarus
Scientific-practical Center of Bioresources
Akademichnaya 27
Minsk, 220072
Republic of Belarus
E-mail kozulin@biobel.bas-net.by

Lazarevic, Predrag
B.Sc. in Biology - Botanist
Institute for Nature Conservation of Serbia
Dr Ivana ribara 91
Belgrade, 11070
Serbia
E-mail lazarevic@zzps.rs

Matchutadze, Izolda
Faculty of Natural Sciences
Rustaveli State University
Ninoshvili av. 35
Batumi Ajara, 60100
Georgia
E-mail tchaobi@yahoo.com

Milosevic, Jasminka
Institute
for Protection
of Nature of Serlia
III Buleva 2106
Belgrad, 11070
Serbia
E-mail Jasminka_M@yahoo.com

Minayeva, Tatiana
Wetlands International
Peatlands project coordinator
and Arctic technical officer
Nikoloyamskaya 19 bd.3
Moscow, 109240
Russian Federation
E-mail tatiana.minaeva@wetlands.org

Paal, Janus
Professor, Senior Research Fellow
University of Tartu Institute
of Ecology and Earts Sciences
Department of Botany
Lai Str. 40
Tartu, 51005
Estonia
E-mail jaanus.paal@ut.ee

Pakalne, Mara
Department of Botany
and Ecology
University of Latvia
Botanical Garden
Kandavas Street 2
Riga, LV-1083
Latvia
E-mail mara@lanet.lv

Pakalnis, Romas
Laboratory of Landscape Ecology
Institute of Botany
Zaliuju Ezeru str. 49
Vilnius, LT-08406
Lithuania
E-mail romas.pakalnis@botanika.lt

Parchuk, Grygori
The State Service for Protected Areas; The Ministry
of the Environment and Natural Resources of Ukraine
1 Tymiryazevska Str.
Kiev, 01014
Ukraine
E-mail parchuk@parks.freenet.kiev.ua

Rašomavičius, Valerijus
Laboratory of Flora and Geobotany
Institute of Botany
Žaliuju Ežeru str. 49
Vilnius, LT-08406
Lithuania
E-mail valerijus.rasomavicius@botanika.lt

Silvius, Marcel
Wetlands
International
PO Box 471
Wageningen, 6700 AL
The Netherlands
E-mail marcel.silvius@wetlands.org

Sirin, Andrey
Russian Academy of Sciences
Institute of Forest Science
Laboratory of Peatland Forestry and Amelioration
Sovetskaya 21, Uspenskoe,
Moscow region, 143030 Russia
Russian Federation
E-mail sirin@ilan.ras.ru

Tanovitskaya, Nina
National Academy of Sciences of Belarus
Institute for Problems of Natural Resources Use and Ecology
Francisk Skaryna 10
Minsk, 220114
Republic of Belarus
E-mail 4tni@mail.ru, peatland@ecology.basnet.by

Topic, Jasenka
Inst. Of Botany, Dept. Biol. Fac. Sci.,
University of Zagreb
Marulicev TRG 20 / II
Zagreb, 10000
Croatia
E-mail Jtopic@Yahoo.com

Tytar, Volodymar
Institute of Zoology
NAS Ukraine
Bogdana Khmelnitskogo, 15
Kiev, 01601
Ukraine
E-mail Vtitar@iptelecom.net.ua

Çağirankaya, Serhan
MoEF Wetlands Division
Engineer,
Ministry of environment protection and forestry.
Department of nature.
Söğütözü cad. No:14/E 14. Kat B Blok
Söğütözü / Ankara
E-mail c.serhan@gmail.com

Mission:

To sustain and restore wetlands, their resources and biodiversity for future generations.

This Quick Scan of Peatlands in Central and Eastern Europe reviews the status, national policy and practice in conservation and use of peatlands in Belarus, Russian Federation, Ukraine, Moldova, Georgia, Armenia, Romania, Bulgaria, Serbia, Croatia and Turkey. Each country sketch presents information on peatland distribution and resources, peatland use and management, national legislation on peatlands, peatland values, threats, conservation and restoration measures. Key actions are suggested to promote the wise use of peatlands.

The review geographically covers central and eastern Europe together with the non-European part of the Russian Federation. More comprehensive information is provided for Russia. The focal countries are participating in the MATRA Programme of the Netherlands (Dutch acronym for "maatschappelijke transformatie") aimed at social transformation and review. This Quick Scan is intended to assist the MATRA programme with the prioritisation of its activities. The national reviews have been prepared by or in consultation with representatives of each country, including scientists, NGOs and politicians and in conjunction with the national Ramsar focal points. The review has been coordinated, compiled and edited by Wetlands International.

Wetlands International
PO Box 471
6700 AL Wageningen
The Netherlands
Phone: +31 (0)318-660910
Fax: +31 (0)0318-660950
Email: post@wetlands.org
Website: www.wetlands.org

WETLANDS INTERNATIONAL