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Global Forest Resources Assessment 2005 – Report on fires in the Baltic Region and adjacent countries

by
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The purpose of these papers is to provide early information on on-going activities and programmes, and to stimulate discussion.

Comments and feedback are welcome.

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FOREWORD

Fires impact upon livelihoods, ecosystems and landscapes. Despite incomplete and inconsistent data, it is estimated that 350 million hectares burn each year; however, the nature of fires determines whether their social, cultural, environmental and economic impacts are negative or positive. Up to 90 percent of wildland fires are caused by human activities primarily through uncontrolled use of fire for clearing forest and woodland for agriculture, maintaining grasslands for livestock management, extraction of non-wood forest products, industrial development, resettlement, hunting and arson - thus any proactive fire management needs to adopt integrated, inter-sectoral, multi-stakeholder and holistic approaches. The situation varies markedly in different regions of the world.

As a supplement and complement to the Global Forest Resources Assessment, 2005, this working paper is one of a series of twelve prepared by regional and country contributing authors to provide a greater depth of data and information on fire incidence, impact, and management issues relating to the twelve UN-ISDR Regional Wildland Fire Networks around the world.

The working paper series assesses the fire situation in each wildland fire region, including the area extent, number and types of fires and their causes. The positive and negative social, economic and environmental impacts are outlined. Prediction, preparedness and prevention as key elements in reduction of the negative impacts of fire, rapid response to extinguish fire incidents and restoration following fires are addressed.

The working paper series also addresses institutional capacity and capability in wildland fire management, including the roles and responsibilities of different stakeholder groups for prevention and suppression, particularly the unique role of community-based fire management.

From these working papers, a FAO Forestry Paper on Fire Management will synthesize the highlights from each region, but also provide a global summary of important lessons that can be used in fire management in the future. These papers are a valuable resource in the process to prepare the Fire Management Code, the Global Strategy to Enhance International Cooperation in Implementing the Fire Management Code and associated capacity building.

ACKNOWLEDGEMENTS

This working paper is the product of a global team of dedicated people willingly giving of their time and specialist expertise within each of the twelve UN-ISDR Regional Wildland Fire Networks.

Ilkka Vanha-Majamaa, as the author, obtained key information and data for this working paper from Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Slovakia, Sweden, Switzerland and United Kingdom, and from the Republic of Karelia in the Russian Federation.

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1. Background

Following the release of the Global Forest Resources Assessment 2000 (FRA 2000) report in 2001, the global FRA process has now entered its next reporting cycle. FAO's Committee on Forestry (COFO) 2003 confirmed the directions of global FRA's that the Kotka IV Expert Consultation recommended in July 2002. Recommendations included the preparation of an update of the global FRA-data in year 2005 and to increasingly involve countries directly in the assessment and reporting, in particular to submit national reports on the status and trends of a range of forestry parameters. More information about FRA 2005 is available at www.fao.org/forestry/fra.

FRA 2005 also included thematic studies, including e.g. one on forest fire, forests and water, and mangroves. The thematic study on wildland and forest fire in 2005 is built on regional reviews on forest fire management in the United Nations International Strategy for Disaster Reduction (UNISDR) Global Wildland Fire Networks (GWFN). The current report is a contribution and makes a review of the UNISDR Baltic region and adjacent countries.

Working Paper FM/7/E has been written by Mr Ilkka Vanha-Majamaa and does not reflect any official position of FAO. All data given in this report has been collected from national representatives of each country. Several Institutes and organizations provided information for this report.

2. Introduction

The Baltic Region area and adjacent countries cover the Benelux countries, United Kingdom, Sweden, Denmark, Germany, Poland, Lithuania, Latvia, Estonia, Finland, Russian Karelia, Switzerland, Austria, Czech Republic and Slovakia. The aim of the report is to give a regional review of forest fire management, fire prevention, and to discuss fire management related issues, meetings, conferences etc., with some aspects on current fire research in this region.

During the process of writing this report, a request for reporting was sent to the above-mentioned countries and their contact persons. Country reports of various levels were provided from Finland, Estonia, Lithuania, Germany, Russian Karelia, Switzerland and United Kingdom. Information on the fire situation from Austria, Czech Republic, Latvia, Slovakia and Sweden was available from other sources. For the remaining countries included in the report, a brief description of the situation is based on information coming especially from a report on Forest Fires in Europe, the 2003 fire campaign, Report No. 4 by the European Commission, earlier reports published in the UN-ECE/FAO International Forest Fire News (IFFN) and other sources available, in particular personal comments. Missing information is mainly from countries not having forest fires problems. Their fire situation is covered by a short description.

Since the release of the last report in 2001, a Regional Baltic Wildland Fire Meeting was held in 2004 in Helsinki, organized by the Finnish Ministry of Interior and the Finnish Forest Research Institute. For this meeting, country reports were already provided by Estonia, Finland and Lithuania, and these are also used for this report, as well as other publications originating from this meeting and published in IFFN (Niklasson and Granström, 2004, Vanha-Majamaa *et al.*, 2004). During the Baltic meeting, the "Helsinki Declaration on Cooperation in Wildland Fire Management in the Baltic Region" was released and later published on the website of the Global Fire Monitoring Center (GFMC) (GFMC, 2004).

This report is based on all the above-mentioned material aiming at analyzing current regional trends and needs in fire management. Current research trends in fire-related issues are also discussed, since much has already been achieved during the last couple of years in fire-related research issues, and many new needs have emerged in this region due to changes in land-use and climate.

3. Fire Situation in the Region

Central European countries belong to temperate vegetation zone, where mesic and more fertile forests are generally dominated by broadleaf trees. Fire-prone forest ecosystems in this region are often sites dominated by pine (predominantly Scots pine – *Pinus sylvestris* L.) on dry and dryish forest types, mainly plantations. In the region of Alps and non-Mediterranean South-eastern Europe, vegetation at fire risk areas is determined by the characteristics of mountain mixed coniferous-deciduous, forest or by lowland broadleaf forests. The countries bordering the Southern Baltic Sea also belong to the temperate vegetation zone. Most fire-prone ecosystems in this area are also pine-dominated forests favoured by continental climate. Nordic countries mainly belong to the boreal and hemi-boreal vegetation zone. For example in Sweden, of the total forested area of 23 million hectares (ha), only few hundred thousand ha belong to the temperate deciduous vegetation zone, dominated by *Fagus, Quercus, Fraxinus, Ulmus, Tilia* and *Acer* spp. (Niklasson and Granström, 2004). Also in this region, the most fire-prone ecosystems are in pine dominated (mainly Scots pine) forests, in dry and dryish site-types. In the United Kingdom, especially in Scotland, the most fire-prone ecosystems are the heathlands. The annually burned area in the studied region is generally rather low as compared to Southern Europe due to climatological reasons. However, within the region, fires generally occur more often in Central Europe than Northern Europe.

Fire impacts on forest ecosystems can be considered to vary from detrimental to beneficial, depending on many reasons. Fires always cause social, economic and environmental effects, which are generally regarded as negative - especially in fire-prone ecosystems. However, at European scale, especially in boreal ecosystems in Northern countries, fire is currently reintroduced to forest ecosystems after a long no-burn policy period. Fire is now also used as a restoration and management tool for forest regeneration and biodiversity management. It can therefore be regarded to also have positive impacts on ecosystems.

In the Baltic region and adjacent countries, the number of fires and the annually burned area has varied depending mainly on weather conditions; but basically during the last decade it has been on the same level. Exceptions can be found in some countries, such as in Poland, where a clear increase in the number of fires and burned area can be observed. In the southern part of the region, most of the fires occur in spring time, from February to April. Towards north, as spring starts later, the highest fire frequency is in May-June. Another peak in the number of fires and burned area occurs in most of the countries in August. The number of fires varies generally in the region due to weather conditions. The average size of a fire in the region is generally very small, often below 1 ha, showing the effectiveness of fire management. An exception is the Republic of Karelia, where the average size of fire is 4 ha, and Estonia with 4.9 ha. This can be explained by sparser road network, lower population density in remote areas, and lower fire suppression capacity locally. Out of the types of most fire-prone forests are the pine forests and other coniferous forests, often plantations. Meadows and grasslands, especially in the spring, are other major vegetation types having biggest problems with wildland fire.

Within the region, some gaps, deficits and problems in fire management fires can be defined. The following fields need to be strengthened like: (i) standardization of data collection; (ii) fire prevention measures; (iii) wildfire management; and (iv) international co-operation.

The collection of fire statistics and reporting varies in the countries of the studied region, which makes comparison between areas and countries rather difficult. Lack of fire reporting systems or their defectiveness, for example in aspects of both socio-economic and ecological consequences of fire, i.e. size and origin of fires in different vegetation types, various degrees of damages or benefits caused by fires, are restricting regional fire risk estimation and fire management. Clear differences in for example classifying fire causes, such as arson, are obvious and therefore partly misleading. Generally the aim should be to achieve similar data collection in different regions and to organize a common international data base on forest fires.

Arson, as an important and increasing cause of forest fires, is shown to be a problem, especially in Poland where arson is reported as a cause in 44% of fires. The reason for this seems to be the high unemployment, which has lead to deliberately set fires to cause at least temporary jobs in fire fighting and forestry. Arson is also a rather common cause for fires in Lithuania (16%) and Estonia (13%).

In southern regions and in Baltic countries, grass burning during spring is still often practised, and a common reason for spread of fires. This seems to be a problem, especially in many Eastern countries of the region. A clear peak in the number of fires can in fact be observed in the spring. The habit of agricultural grass burning has ceased in Fennoscandia, but fires occurring in dry grass are still a common cause during spring time.

The changes in land-tenure and ownership, especially in the Baltic countries, where a high number of new private small forest owners has emerged, have clearly led to problems in taking necessary precautionary measures in forest fire management. Also the migration from country-side to cities and abandonment of rural lands have resulted in fuel loads, changes in vegetation composition and succession, leading to higher wildfire hazard. The area of abandoned agricultural ground has in many countries of the region significantly increased since the beginning of transition towards the market economy. This new situation has resulted in an enormous increase in the number of fires observed on such lands annually; for example in Poland: from approximately 5 000 in 1994 to 53 000 in 2003. Also the magnitude of burned area in Poland has increased from about 13 000 ha in 1995 to 95 000 ha in 2003.

Regionally, large exotic plantations, especially with coniferous trees such as *Pinus contorta*, have lead to an increased fire risk. In countries such as Poland, preventive actions to reduce fire risk, for example by changing tree species composition, from coniferous to deciduous species, are being carried out.

Uncontrolled fire use, especially in agriculture, and occasionally prescribed burning in forestry, has been a cause of escaped fires into wildlands and occasionally into forests. These fire hazards are strongly interdependent with the level of local public fire awareness and knowledge of principles of fire ecology and fire management. In some countries, as for example in Estonia, public attitude and especially that of the national authorities is negative towards prescribed burning and policies encouraging its use in managing fuels. This approach together with an effective fire suppression policy has lead to an increased amount of fuels and unnatural accumulation, especially in conservation areas, and thereby to an increased fire risk.

Economic costs of fires constitute direct and indirect losses and vary a lot inside the region and between countries. However, the economic losses can generally be estimated to be rather low as compared to regions where fires are much more common and have much more drastic effects, such as in the Mediterranean area. Ecological damages are rather rare, but occasionally avalanches occur after fires, especially in the Alps. Health effects due to fire are also rare, as the average size of fires in the region is generally below 1 ha.

Financial support and restrictions for fire management vary inside the region and the lack of resources causes difficulties in fire management, especially in Baltic countries. For example, most countries lack adequate fire suppression equipment and protective clothing. Likewise, aerial assets may not necessarily be available due to competing demands. Shared responsibilities between the authorities and organizations, such as in Germany, can occasionally cause problems as well.

Training for wildland and forest fire management, fire suppression and even in use of prescribed burning, is inadequate in most countries of the region, especially concerning the ability to respond to large and long-lasting forest fire situations. Decision-support systems need further development for large fire situations as well as for specialized training in wildland fire management.

Increasingly fire management is no longer the responsibility of forestry staff, but has become the responsibility of national Fire & Rescue Services (F&RS). More often than not, these F&RS people totally lack training in wildland fire management; and specifically on aspects of fire behaviour, including techniques in how to use fire to “kill” an approaching fire (backfiring). Therefore, exchange in training programmes and international training courses should be promoted in the region.

For solving regional problems, there is also a need to establish bilateral and multilateral agreements on co-operation in wildland fire management. The Incident Command System (ICS) as an international standard for all wildland incident management should be introduced in interested countries. Community involvement in fire management is also needed because local people have an intimate knowledge of the terrain in their home area, and can thus better suppress fires locally. Regional

bilateral and multilateral wildland fire emergency exercises, as has been done e.g. among Baltic countries, need to be arranged also in future. Exchange visits and programmes need to be promoted regionally. Specific attention should be put on developing online information systems through websites. Special regional mobile airborne fire response units should be created. Regional Baltic Wildland Fire meetings should be arranged on a regular basis with even a larger participation than so far.

As the role of fire varies between the countries in the region, there are needs to develop regional and national strategies for fire use and management. There are clear needs to improve fire management by preparing strategic fire suppression plans at local and regional level in many countries. Increasing public awareness of fire risks, more careful attitude towards fire use, etc., should be promoted. For example, in the new European Union (EU) member states, several tasks will still have to be accomplished in order to meet the present EU standards in fire management.

Current European fire research projects aim, for example, at developing fuel type maps covering the whole of Europe. This would in future help to estimate fire risk in various European regions in relation to different vegetation types in different climatic conditions, and thereby in developing fire management methods and fire prevention strategies. Further development is also needed in upgrading fire danger rating systems and improving the fire weather index (FWI). Fire research at the European level in this region will continue as an integrated project in the “6th Regional Co-operation in Fire-related Research Projects”, and similar programmes should also be promoted in the future as fire issues are seemingly quite similar in neighbouring countries.

Based on all the above information, it can be concluded that the majority of countries in the region are not facing major problems with forest fires, and are able to establish and strengthen regional dialogue on co-operation in wildland fire management. Preventive measures can clearly be improved, as in the case of spring fires. Financial restrictions, especially in the Baltic region, are one of the main problems.

4. Activities during the last years

In May 2004 a Regional Baltic Wildland Fire Meeting was held in Helsinki, Finland, hosted by the Finnish Ministry of Interior and Finnish Forest Research Institute (FFRI). A side meeting to promote Baltic co-operation in fire research was held after the meeting. Representatives – fire managers and scientists – from ten countries attended the meeting: Finland, Norway, Sweden, Estonia, Latvia, Lithuania, Russia, United Kingdom, France and Germany. Also present were representatives from international organizations such as the United Nations Food and Agriculture Organization (FAO), Economic Commission for Europe (ECE)/FAO Team of Specialists on Forest Fires, UNISDR Wildland Fire Advisory Group, the UNISDR Global Wildland Fire Network, the Global Fire Monitoring Center (GFMC) and the International Technical Committee on the Prevention and Extinction of Fire (CTIF), Forest Fire Commission (Anonymous, 2004).

At the meeting, current trends in fire management in the Baltic region were studied and a special Helsinki Declaration was prepared. This “Helsinki Declaration on Cooperation in Wildland Fire Management in the Baltic Region” included the basic idea to harmonize and strengthen the efforts by the UN International Strategy for Disaster Reduction (UNISDR) and its Wildland Fire Advisory Group, United Nations agencies and programmes, to reduce the negative impacts of wildland fires on the environment, but also to support and promote the knowledge and techniques to utilize the beneficial role of fire in ecosystem management, including the application of prescribed burning for the benefit of ecosystem stability and sustainability, with special emphasis on biodiversity. The preparation of the Baltic Declaration aimed at achieving an international co-operation agreement in wildland fire management, promote and strengthen multilateral and bilateral agreements for co-operation in fire management and follow and support the recommendations given by the ECE/FAO Team of Specialists on Forest Fires, BALTEX FIRE 2000 (Baltic Exercise for Fire Information and Resources Exchange), and the International Wildland Fire Summit (Sydney, Australia, October 2003), and also to refer to the objectives of the Forest Sector of Agenda 21 for the Baltic Sea Region as well as Article 15 of the Helsinki Convention concerning nature conservation and biodiversity of the coastal ecosystems.

In the research field, fire was one of the key topics also in a couple of regional conferences organized after year 2000. In 2000, the 3rd Disturbance Dynamics Conference was organized in Kuhmo, Finland,

(Korpilahti and Kuuluvainen, 2002) and in 2004, the 5th Disturbance Dynamics Conference was held in Dubna, Russia (Maslov, 2004). In both conferences, several fire research papers from the Baltic region were presented, especially in the latter, where three of the keynote talks were dealing with fire effects in the Baltic area, and many of other discussed fire issues in the region as well. In 2004, a Conference on Disturbance was held in Tartu, Estonia (http://www.eau.ee/~ecosyst/), and nearly half of the presentations were dealing with fire effects in the Baltic area (Kangur, 2004; Jogiste *et al.*, 2005).

During the last 5-year period, fire research in the region has increased and also northern countries started to participate in EU-funded research projects, such as FIRESTAR, SPREAD (2001-2004) and EUFIRELAB (2003-2006). Regional co-operation in the field of fire research has also started between some countries in the region, such as the co-operation between the Baltic countries themselves.

In December 2004 the UNISDR Wildland Fire Advisory Group and Global Wildland Fire Network met at the GFMC. The meeting, attended by 20-25 participants from different international organizations and countries representing the Regional Wildland Fire Networks, started by highlighting the obligations deriving from the World Summit on Sustainable Development (WSSD) (Johannesburg, South Africa, September 2002) and from the International Wildland Fire Summit; to strengthen international co-operation in forest fire management by supporting UNISDR and other related units in their work to reduce the negative effects of forest fires. The role and position of UNISDR Wildland Fire Advisory Group (WFAG) and Global Wildland Fire Network (GWFN) in UN organizations was discussed. The participants agreed unanimously that the role and activities of these working units should be strengthened inside the United Nations.

Some basic points were highlighted by FAO: anthropogenic fires constitute globally the majority of fire causes. According to statistics, in most countries, 80-90 % of fire management funds are used for fire detection and suppression activities. By changing the focus towards fire prevention at the national level, the reduction in the number of fires could be expected. The role of fire as a useful tool in land management was also pointed out.

The global fire situation and future aspects were presented by representatives from different ISDR Regional Wildland Fire Networks. Nine regional reports were presented out of eleven networks in operation globally. Discussions were carried out on the need to harmonize international reporting on fire and a decision was made to recommend the use of a reporting format prepared by the GFMC, because the present available global fire information is rather restricted and not compatible. Current developments in fire management activities were also discussed by representatives of other international organizations.

Other issues discussed were climate change; existing data pointed towards increased drought conditions globally and thereby the fire risk, for example in temperate and boreal vegetation zones. The Representative from the World Meteorological Organization (WMO) showed the results of several ongoing research projects dealing with climate change and smoke dispersal from fire. The satellite system developed for fire detection and monitoring was presented at the meeting. Preliminary results show that the use of this test satellite is promising, though further development is still on its way. Cooperation and funding for perfecting global fire monitoring are needed and required support for further development and funding was suggested.

At FAO, an International Ministerial Meeting on Forests, attended by 39 ministers, was held in Rome, in March 2005, and global and regional fire management issues were one of the two items of deliberations. The ministerial meeting and the associated meeting of FAO's Committee on Forestry (COFO) recommended FAO to develop international voluntary guidelines on fire management and a strategy for international cooperation in wildland fire management.[1]

[1] For details on the UNISDR Global Wildland Fire Network/Wildland Fire Advisory Group and FAO's wildland fire management activities, see this GFMC website:
http://www.fire.uni-freiburg.de/GlobalNetworks/RationaleandIntroduction.html

5. Analyses by Countries

5.1 United Kingdom

The United Kingdom has a maritime climate with moderate temperatures and regular rainfall. The forest in the northern half of Scotland belongs to the boreal vegetation zone, further south forests belong to the temperate and deciduous forest zones. Only 11% of the landscape is covered by forests. With a moderate climate and rather low forest cover, forest fires in the United Kingdom are not very common. However, wildfires including grass, heath, scrub and peat fires are quite common. There are also regional differences in climate between the north and west, which are generally wet, and the east and south of the country that can be quite dry.

Most land, including forest, is privately owned but the Forestry Commission, the state forest service, is the largest single landowner in the United Kingdom. Most of the forest resource consists of either plantations of species like Sitka Spruce (*Picea sitchensis* (Bong.) Carr.) and Douglas Fir (*Pseudotsuga menziesii* (Mirbel) Franco) or broadleaf trees. One difference found in Scottish forests from some of the drier parts of the boreal zone is the presence of a vigorous shrub layer in the forest, largely consisting of heather and blueberry. There is also often a deep organic soil layer. In dry conditions, a large amount of fuel, both surface fuel and peat, can become available. The presence of a continuous high water table also stimulates root development close to the soil surface. So when there is a drought and a forest fire occurs, fires tend to be stand replacement fires. Heather and associated vegetation cover some 27% of Scotland's land area and 3.8% of the land area of England and Wales.

Information on wildfires in the United Kingdom is poor. There is currently no systematic method established for recording wildfire events in the country and there are no reliable statistics on numbers, sizes or causes of fire. Usually the large fires are moorland fires. The Forestry Commission published information on fires in its own forests only until 1989. The average area of Forestry Commission forest burned by wildfire between 1973-1983 and 1985-1989 has been estimated at 710 ha and 497 ha per annum, respectively. The area of forest burned on private land is likely to exceed these figures. Overall, available statistics are likely to under-estimate both the number and area of wildfires in the United Kingdom. The trend in the number and size of fires is largely related to the weather both in spring, the main prescribed burning season, and in summer. Large heather fires can happen in any year because of the short drying time of the fuel. Wildfires are also common in lowland heathland, especially where these are close to urban sites. Fires within forests are uncommon, but they occur either in young plantations of conifers, especially where adjacent to heather or grass-dominated vegetation, or where heather has re-invaded older stands after thinning. Statistics published by the Home Office Statistical Bulletin (ODPM, 2005), for example, include intentional straw and stubble burning as well as wildland fires, but only include fires attended by the Fire and Rescue Services and do not include management fires or wildfires that were dealt with by the land owners. However, the statistics do show that 2003 was a particularly bad year for wildland fires with 15 700 fires reported, second only to 174 600 fires in the 1995 dry summer. Interestingly, many of the 2003 fires (twice the monthly average) occurred during a particularly dry spell in March and April, rather than during the hotter summer months. Some of these fires were very severe, burning many square kilometres and, in some cases igniting peat and burning for many days. A very high proportion of wildland fires in the United Kingdom are anthropogenic in origin, though lightning fires do occur on rare occasions.

Prescribed burning is used extensively for habitat management for Red Grouse, an upland game bird that lives in heather (*Calluna vulgaris*). Fire is also used extensively to regenerate grazing land for cattle, sheep and deer. In the forests, fire is used to clear branches or heather from sites as a ground preparation tool prior to forest establishment by planting or natural regeneration. Firebreaks are sometimes created alongside forests by burning. Fire is used occasionally on farmland in Scotland to burn straw, a practice that has been stopped in England and Wales. Prescribed burning is used more frequently on private land than on publicly-owned land.

All wildfires are the responsibility of the county or regional fire brigade. Fire brigades are generally split between full-time firemen in city-based stations and part-timers in the rural stations. Wildfires were traditionally put out by large number of people using fire beaters. The traditional tools used for extinguishing heather fires were long handled fire beaters or scrubbers with wire mesh or metal heads. More recently "pump and roll" techniques using very high-pressure fire fogging units has proved to be popular. This system was very effective with heather, shrub and peat fires. Generally helicopters are

only used when either a fire is completely out of control or is threatening a forest. From the 1980s, helicopters were added using underslung dipper buckets. However there are increasing problems of resources in terms of manpower and helicopter use due to financial pressures. There are no helicopters or fixed-wing aircraft in the United Kingdom dedicated to fire fighting. This means that commercial helicopters have to be called in when required and availability is usually limited and dependent on other work. On rare occasions helicopters have been placed on standby during periods of extreme risk, though this is expensive (around 1 500 pounds sterling per day on standby, plus 1 000 pounds per hour flying time).[2] The cost of helicopters is usually borne by the land-owner or insurance companies.

The MetOffice Fire Severity Index is a web-based predictor of fire weather conditions and fire risk that has recently been produced for England and Wales (MetOffice, 2005). This system provides a five-point fire risk index that has been designed specifically in response to the new countryside access legislation (CROW Act), which provides for National Park Authorities to close public access to parts of the countryside during periods of extreme fire risk.

A number of Fire Groups have been established throughout the country. These are agreements between a number of neighbouring estates within a region and the local Fire Brigade to coordinate efforts at fire control. Their primary aims are to provide access to labour and equipment at short notice, to improve effectiveness, efficiency and communication on the fire ground, and to improve safety, training, cost sharing and general mutual assistance. Of particular value is the communication between the estate managers and the Fire and Rescue Services as the estate workers have local knowledge and equipment for working in remote and rough terrain, not available to the professional fire fighters who are trained and equipped for structural fires.

The Scottish Wildfire Forum was proposed at a Wildfire Conference in Aberdeen 2004 and first met the same year. The Forum arose largely from the large number of severe wildfires in 2003. The aims of the forum are to bring together the fire services, land managers, and relevant agencies in Scotland that will develop and communicate wildfire protection strategies to ministers and stakeholders. One of the first tasks of the Forum is to identify key issues and priorities for partner agencies and to stimulate research and development where necessary. To this end the Forum has identified the need for more precise data on the incidence and nature of wildfires and is discussing suitable formats for collecting statistics that will be of value planning and in managing wildfires in the future. There is discussion of the extension of the MetOffice Fire Severity Index to Scotland and the development of a related Fire Behaviour Prediction System through collaboration between the MetOffice and the University of Edinburgh. The Forum has also highlighted the need for Fire and Rescue Services to have access to equipment (PPE) that is more appropriate for fighting wildfires. The Scottish Wildfire Forum has recently been recognized by the Scottish Executive as a national forum. The Welsh Forum for the Control of Countryside Fires is a similar forum recently established by the Countryside Council for Wales with the objective to prevent, reduce and control illegal fires in the countryside. This Forum comprises the fire and police services and the major agencies responsible for countryside management in Wales.

Recent legislation has also widened public access to the countryside both in Scotland (Land Reform (Scotland) Act 2003) and in England and Wales (Countryside and Rights of Way Act 2000, the so-called CROW Act). It is widely expected that this could increase the frequency of accidental ignition in some areas. Fire hazard is also increasing in some areas where there is insufficient heather burning. Heather is ideally burned in prescribed (controlled) burns on an 8-15 year cycle. There has also been a reduction in staff available for heather burning operations due to economic pressures.

A recent questionnaire sent by the Game Conservancy Trust and the Scottish Gamekeepers Association to private estates showed that 17 wildfires were reported by 13 estates during 2003, averaging about 150 ha. Four estates used helicopters to extinguish the fires, though most used a combination of hand tools and water carried on all-terrain vehicles. The Fire Brigade were only called to six of these fires, though six required help from at least 50 people to extinguish, usually workers from neighbouring estates. The cause of fires was mostly escaped management fires in between February and April (eight fires); one was started by crofters (graziers), three were recorded as accidental, two as arson and one unknown. It is important that these wildfires are put into the context

[2] 1000 Pounds Sterling = ca. US$ 1 700.

of normal prescribed burning. Twenty of the 42 responders reported active management by burning during 2003 with an estimated 4 300 fires; one estate estimated that they had burned 900-1 000 fires during the season. However, this rather small sample of estates is likely to be biased towards those who have experienced wildfires as they are perhaps more likely to respond; however, it does give an indication of the scale of the problem. It also concentrates on the moorland estates managed for game and does not include information on the many wildfires that occurred on public land or land managed for other purposes.

The environmental and economic cost of these fires cannot be estimated but is considerable. The economic costs include the loss to property (forestry, fencing, etc.) and of income of up to 70 pounds sterling per ha per year from grouse moors. The environmental costs can also be considerable, as fires lead to change in ecosystem function, destruction of the seed bank, and high risk of erosion.

Wildland fire research in the United Kingdom has mostly concentrated on the ecological effects of fires and the post-fire succession of vegetation. Current fire research includes studies on fire intensity and fire effects of traditional burning practices, estimation of heather biomass from satellite images, heather fuel loads together with fire behaviour etc. Data on fire behaviour from these recent and previous studies will be used to begin the process of testing, ground-truthing and calibrating existing fire behaviour models including BEHAVEPlus and the Canadian Forest Fire Behaviour Prediction System.

Two very successful conferences ('Wildfire 2003' and 'Wildfire 2005') organized by Northwoods have brought together people from the Fire and Rescue Services, National Parks and countryside agencies from across the United Kingdom. A questionnaire survey of some of the participants at Wildfire 2005 showed the value of the recently developed MetOffice Fire Severity Index, but also the need to develop other tools for predicting fire behaviour and fire spread. An essential task in order to achieve this will be the development of a fuel moisture model for heather (Bruce, 2000; Legg *et al.*, 2005).

5.2 Benelux countries

Belgium, the Netherlands and Luxembourg form a rather uniform geographical area, where climate is oceanic and weather rather rainy throughout the year. Of the land area of the Netherlands, nearly half is artificially kept dry for agriculture. Data on forest fires for the Netherlands were, until 1995, available from the administration system of forest fires. However, this registration system was stopped. Basically, forest fires occur on a very small scale in the Netherlands, approximately less than 300 ha are burned annually, which is less than 1% of the Dutch forest area (information based on data available until 1995). No systematic monitoring system is currently in use. Data on forest fires are inventoried occasionally when substantial damage occurs, but since no systematic data collection is in use, no recent fire statistics are either available currently. Burning is almost abolished in the Netherlands, but it has always been a traditional management tool to sustain and regenerate heather. Interestingly, due to military use of training areas - shooting ranges - prescribed burning is currently used in some heathlands as a management tool. Due to unexploded ammunition, sod-cutting or mowing is not possible, so prescribed fire has to be used. The local communities in conjunction with the fire brigades can permit prescribed burnings, which are done in winter only. New research results show that in military areas treated by regular burning, rare and endangered plant species are found, not existing in other parts of the country (van der Zee, 2004).

Also in Belgium, most of the original vegetation has been altered in the past, and only some heather and peat-land vegetation remind of the initial vegetation, mainly in Ardennes, where also some original beech forests can be found. Annual average burned area is on the same level as in the Netherlands, although some high fire years have occurred in the past due to climatic variation.

In Luxembourg, only few hectares burn normally yearly and the country can therefore be regarded as having one of the lowest fire risks in Europe. Because of the climate and rather small percentage of forests in Benelux countries, fires are generally not a big problem in the area.

In 2003, Belgium hosted the 4th International Workshop on Remote Sensing and GIS applications to forest fire management. The Workshop was organized by the University of Ghent, EARSeL, a Special Interest Group (SIG) on Forest Fires and the Global Observation of Forest and Land Cover Dynamics

(GOFC-GOLD) Fire Implementation Team. The themes of the meeting were organized around three topics: fuel characterization, fire risk mapping and burned land assessment and recommended to develop global products for fire danger estimation (Chuvieco, 2003).

5.3 Denmark

The topography of Denmark is mainly lowland with an oceanic climate and rather cool summers. Danish forests are mainly dominated by beech and *Calluna* heathers dominate the open areas. Over 60% of the land area is covered by agriculture. Because of the high proportion of agricultural land and oceanic climate, the forests are mainly dominated by temperate broadleaf vegetation types; therefore forest fires are generally not a problem in Denmark. The annual burned area is averaging less than 50 ha.

5.4 Germany

Forests cover almost 30% of Germany. Fire-sensitive intensively managed forest ecosystems and protected forests cover over 11 million ha. Initial temperate deciduous forests (beech, oak) have largely been cut and planted with coniferous trees, pine and spruce. Other wooded lands, which can be described fire-tolerant ecosystems, cover 500 000 ha. Fire frequency in these ecosystems is only five years. Heathlands, which cover 20 000 ha, are fire-maintained ecosystems where prescribed burning is being practiced with a typical 12-year interval.

Most of the fires in Germany are human caused (up to 99%), and lightning only plays a minor role as a fire cause. However, close to 40% of fire causes has been reported to be unknown; and underlying causes are not known. Fires occur between March and September, the highest fire peaks appearing in August, and during spring in April. Prescribed burning is being practiced mainly in spring (February-March), and occasionally in summer (August). However, prescribed burning in forestry is still not yet accepted as a method for fuel reduction. Slash burning on small heaps is practiced occasionally.

Since 1990, the number of forest fires has varied between 1 000-3 000 annually, except in 2001 and 2002, when only 500-600 fires were recorded. The highest number of fires was recorded in years 1992 (>3 000 fires) and 2003 (>2 500 fires). The total area burned varies from 400 to 5 000 ha annually, except 2001 and 2002 with only 120 ha. Average fire size is approximately 1 ha. During past decades, fire frequency, fire size and causes of fires have remained rather the same, despite the unification of the two German states. However, a slight decrease in military-caused fires can be observed. More extreme weather conditions, such as summer 2003, influence the number of fires.

Damages by forest fires are mainly economic, loss in terms of lost timber, increased rehabilitation and site clearing costs, etc. The average economic damage is € 3 million per year. Losses in conservation areas are currently not yet assessed. Ecological damages are rare, and exist only in very exceptional cases, as most burned areas are reforested soon after a fire event. However after fire occasionally land slides occur, and even avalanches in winter in the Alps. Due to effective fire suppression policy, fires represent only a minor area of disturbances in Germany's forest landscapes. Wildfires rarely affect agricultural systems or buildings, infrastructures at the wildland, residential interface. Only in certain areas, where property is placed in or near fire-prone pine forests, damages can occur. Social damages are restricted mainly to emotional reactions. Health effects are minimal because of small size of individual fire (approximately 1 ha).

Fires can be regarded as a natural disturbance, and therefore also have positive impacts on forest ecosystems. Wildfires in ecosystems where prescribed burning is a targeted or a potential management tool can therefore be considered beneficial ecologically and even economically, both in nature conservation and landscape management.

The German Weather Service is providing early fire warning as well as the Forest Service, using ground weather and vegetation data. GWS provides a Forest Fire Index and an Experimental Grassland Fire Index online on a daily basis during the fire season. Access to the daily updated website can be found in the GFMC Wildland Fire Early Warning Portal at: http://www.fire.uni-freiburg.de/fwf/de_fwf.htm. Fire prevention is done by technical means such as by fire danger rating,

fire break preparation, establishment of green belts between pine plantations, closure of forests, preparation of forest maps with information relevant for fire suppression, etc. and falls within the responsibility of the Forest Services. The German Weather Service, which provides a Forest and Grassland Fire Index online, supports this on a voluntary basis. In fire-prone areas, lookout towers and/or cameras are installed to detect and monitor forest fires. In some areas the automatic early warning system for forest fires "FIRE WATCH" has been installed. This is a terrestrial digital remote surveillance system which is capable of observing larger wooded regions, and to analyse, evaluate, link and store the collective data (http://www.fire-watch.de/). In some areas the Fire Services and the State Forest Service operate spotter planes on days with high fire danger index, which patrol and monitor forests. In the rest of the country, fires are detected and reported to the Fire Service by the public. The fire services have the exclusive responsibility of fire suppression. If fire is reported, a so-called forest “fire alarm plan” is activated, and a standard operating procedure how to inform and activate the fire service and the local forestry authorities is applied. In large fire situations, the fire services use a standard organizational system, which resembles the international ICS (Incident Command System). For wildland fire suppression the German Fire Services, Police or the Armed Forces have few helibuckets for helicopters. The standard equipment such as Class A foam etc. is also used for fire fighting. International co-operation in case of disaster fires is a common practice. Specific wildland fire management resources are however limited in Germany. Thus, helicopters are the most common resource type used for cross-border operations. However, pilots are seldom trained and experienced in aerial wildland fire fighting. In August 2005, three German helicopters operated by the Federal Police were sent to Portugal to assist the country in fire fighting.

The fact that the responsibility of wildland fire management is divided among many organizations makes fire management approaches and planning more complicated, and occasionally has further negative consequences, such as lack of information between the units in operation. Some of the main concerns are also the lack of specific training of staff, lack of specific equipment, such as hand tools, vehicles, safety clothes etc. A major need in Germany is the development of curricula for capacity building in wildland fire management for German volunteer and professional fire services. The equipment which is designed for fighting structural fires or HAZMAT events must be complemented by special equipment for wildland fire suppression.

5.5 Switzerland

The climate in southern Switzerland – the most wildfire-endangered region of the country – is characterized by dry and sunny winters with periods of dry north-foehn. This is the main forest fire season. The typical vegetation under the climatic conditions in this region are chestnut forests on acid soils, deciduous broadleaved mixed forests on limestone and beech forests at altitudes between 800 and 1 300 m a.s.l. Lower elevations (600-800 m a.s.l, in the Alps up to 1 400 m a.s.l) are dominated by deciduous forests, higher elevations (1 500-2 400 m a.s.l) are dominated by coniferous forests, forming the oro-boreal vegetation zone.

The fire statistics available from Switzerland refer to Canton Ticino (size 280 000 ha, of which 50% are covered by forests). This region in Southern Switzerland is representing over 50% of the land area of Switzerland. In this canton, usually 60% of wildfires take place and total 90% of all the burned areas of Switzerland.

In 1992, the FNP *Sottostazione Sud delle Alpi* (FNP SdA), a branch station of the Swiss Federal Institute of Forest, Snow and Landscape Research, started its research on forest fires, by creating a wildfire database including all information available on forest fires in southern Switzerland. Since that time, several research topics about forest fires and their management have been under study at the FNP SdA.

The most notable aspect of the development of the fire regime in the last century was the general increase in the occurrence of fires since 1960s, with a marked rise of fire occurrence in summer (May to November) since the 1970s. This was mainly due to rapid changes in the socio-economic conditions on the southern side of the Alps. These changes have led to an acceleration of the increase in the forested areas, an abrupt cessation of litter utilization, and other agricultural activities, as well as a drastic reduction in the exploitation of timber. Consequently, the amount of fuel has increased, and for

example the forest ecosystem of the chestnut belt has gradually changed its succession towards mixed deciduous broadleaved forests.

A remarkable aspect of forest fire behaviour in southern Switzerland is that nearly all forest fires are surface fires. Crown fires very rarely occur. An annual average of 0.4% of the total forest cover burns, in extremely dry years up to 4.1% (1973) can be destroyed by forest fires. In the last 10 years (1994-2003), an annual mean of 55 fires burned 330 ha of forests and pastures. In the whole Switzerland, on the average around 400 ha are burned annually. The main fire season is in spring (March-April), a second peak in July and August. Lightning fires represent 15% of the total number of fires, one of the highest percentages in Europe. The number of lightning-ignited fires is highest in higher elevations. The main damages are due to the erosion and debris flow risk after fire. After a fire, the sandy and acid Haplic Podzols (FAO classification) in the region of the chestnut belt, which are relatively poor in nutrients, are exposed to increased runoff, soil erosion, and nutrient loss.

Fire prevention is done by fuel reduction along the roadsides in particularly sensitive areas. During periods of high fire risk (dry, windy periods), an absolute prohibition of starting domestic fires in the open is declared by the means of the official radio and TV-channels. Fire brigades are usually very efficient in fire extinguishing, in the worse cases with the help of helicopters.

Foresters are responsible for fuel management and planning of technical infrastructures such as water points, helicopter places, etc. Fire brigades are in charge for fire fighting. During the fire event, foresters act as consultants. MeteoSwiss is responsible for declaring the periods of high fire risk and the prohibition of domestic fires in the open. The engagement of helicopters is decided by the head of the fire fighter brigade. Communities in Ticino play a marginal role, but this differs in Switzerland from a canton to the other, because of the federal structure of the country.

In Switzerland, it is currently planned to improve fire management by preparing strategic fire fighting plans at local to regional level. Studies on the ecological aspects of forest fires in southern Switzerland should also be intensified, because the ecological effects, especially of winter fires (December to April), which are dominant in the southern part of Switzerland, are still poorly known.

5.6 Austria

No detailed information about the fire situation in Austria was provided for this report.

Land area of Austria is close to 84 000 km^2, with 2 350 municipalities. Each municipality has on an average two fire brigades - total number of nearly 5 000 voluntary fire brigades. Six of the fire brigades are professional fire brigades. The total number of fire fighters in Austria is 290 000. Average response time for action is less than 10-15 minutes, except in mountains, where response time is much higher.

The number of forest fires in 2003 was 2 562, and burned area totalled 250 ha. Generally the average size of one fire is in lowlands and therefore extremely small – 0.1 ha. The largest fire in 2003 was only 15 ha in size. As compared to year 2002, when 902 forest fires were recorded, the number of forest fires in 2003 was 184% higher than in 2002, but the total burned area and largest fires are still remarkably small.

Special equipment for forest and wildland fire fighting is not in use. In the mountains, Austrian Army helicopters are used such as Alouette, Bell 212 and Black Hawks. The water transport capacity is between 1 000-3 000 litres. Normal equipment is being used in operational use in the field. For international actions, some task force units are available, with 30 fire-fighters and required equipment (Anonymous, 2003).

Based on the statistics available (especially the small size of an average fire), forest fires cause probably no major damages except in years with exceptional fire weather.

5.7 Czech Republic

According to statistics of the period 1998-2003, the average number of forest fires has been around 1 300 fires per year, varying from less than 500 up to 2 563 in 1998. The number of fires exceeded the average also in 1999, 2000 and 2003. The average annually burned area during the same period was 564 ha, resulting in an average of 0.4 ha burned. Even in rather extreme fire years, as in 2003, the average size of fire remained below 1 ha. The annually burned area was highest in 1998 (1 100 ha) and in 2003 (over 1 200 ha). Since 1993, there were only a few fires between the sizes of 30-80 ha. During the fire season, most fires occur in spring and summer, with a slight peak in the number of fires in August, but forest fires occur occasionally also during winter.

Negligence (55%) is the main reason for forest fires in Czech Republic. Arson represents 4% of fires, and 33% of fire events are of unknown reasons. Direct economic losses, for example in 2003, when 1 235 ha were burned, were 33.5 million CZK (approximately € 1.0 million). During the fire season in 2003, one person died and 44 were injured in these wildland and forest fires.

During 2003, air patrolling was done by airplanes of private companies and helicopters of the Police of the Czech Republic. Aerial fire fighting increased substantially during the year 2003. The main reason for this was the prevailing extreme climatic conditions. A total of 464 patrol flights were done and during these flights, 31 forest fires were detected. The number of flights was three times higher in 2003 than in 2000, and the difference was even higher compared to 2001 and 2002. The number of fire extinguished by aerial means was 54 in 2003, many times higher than during previous years.

Considering the rather low amount of forest fires per year, relatively small size of individual fire, and considerably low economic losses, it can be estimated that forest fires are not a big problem in the Czech Republic. However, during extreme weather conditions, fire risk is higher (Anonymous, 2000, 2003).

5.8 Slovakia

The number of forest fires in Slovakia has varied annually between 300 and 1 000, the highest being in 1998, 2000 and 2003. Information of annually burned area has been available since 1999, and it has varied from 300 ha to 1 600 ha, the highest being in 2003. The average size of one fire has generally been very low, less than 1 ha. Annually burned areas clearly correlate with the number of fires, showing that even in more severe fire seasons, the average size of one fire still remains small. The largest fire reported in 2003 was 28 ha. No clear information was available of what kind of forest types were burned, but information on 2003 fires include a description of fires mainly burning in mixed forest stands. While most of the fires have been started by humans, the main reasons being grass and bush cover burning (32.8%) especially in the spring time, and camp fires in nature, fires probably occur in various vegetation types. The largest number of fires occurred in April-March, referring to the high number of grass and bush cover burning in the spring time. Another peak in the number of forest fires was in August.

The total direct economic damage year 2003 was 29 832 350 SKK (approximately € 780 000). One fatal accident occurred, and six people were injured. During the last ten years, eight casualties have been reported. In 2003, fire fighting by Fire and Rescue Corps involved over 6 000 people (Anonymous, 2003).

Based on the above information, it can be estimated that, since most of the fires are human caused and started by careless grass burning, camp fires, waste and garbage burning, etc., fire prevention should concentrate on increasing public awareness of fire risks, more careful attitude to fire use, etc..

5.9 Poland

The total area of Polish forests is 8 865 million ha, which is 28.35% of the land cover. Most of the forests are state owned, 78.4%, which makes fire management easier. However, considering the small average size of 1.3 ha in privately-owned forests, fire protection in private lands is more difficult. About

83% of all forest resources of Poland are potentially threatened by fire (the respective average figure for the whole Europe is 65%). Thus, with an area of 7.4 million ha at risk, the danger is extremely high.

Polish forests are dominated by conifers (76.5% of the forested area) that are especially endangered by fire. Stands dominated by Scots pine (*Pinus sylvestris*) and to a smaller extent larch (*Larix europaea*) are forming 68.2% of the Polish forest area. Besides pine, the most fire-prone species are Norway spruce (*Picea abies*), fir (*Abies alba*), Weymouth pine (*Pinus strobus*), and of broadleaved trees beech (*Fagus sylvatica*), oak (*Quercus* spp.), locust (*Robinia pseudoaccacia*), birch (*Betula* spp.) and alder (*Alnus* spp.). Coniferous forests make up a total of 66.6% forest area, broadleaf forest 15.4%, and mixed forest 18.0%.

Polish forests are being classified into Fire Danger Classes. In each forest area the fire hazard classification is reassessed in 10-year intervals, either in forest management plans (Forest Districts) or in forest protection plans (National Parks). Non-state owned forests do not so far undergo this regular classification. In Poland two methods of forest fire danger assessment are recognized: (a) the method of the Forest Research Institute (IBL method), and (b) the method of Szczygieł's for fire risk determination. At present, the maps of forest fire risk are prepared on a daily basis during the fire season and are publicly available immediately on the internet at:
http://www.ibles.waw.pl/bazy/pozary/mapa.html.

Since 1990, the number of annual forest fires has varied in Poland between 4 500-16 000 and the area burned between 3 500 and 44 000 ha. During the last few years, an increase in fire danger and number of fires and area burned has been observed as a consequence of more frequent occurrence of extreme fire weather conditions during the fire season. The present regional climate warming has, associated with increasing occurrence of relatively warm and snowless winters, moreover also contributed to the prolongation of the fire season. The number of fires is highest in May, but area burned in April. The fire season goes from March to September, but fires occur also during winter. Thus, winter and autumn months are no longer considered free of fire risk. The year 1999 serves as an example: that year the maximum of fires (2 106) was observed in September.

During the last decade, the number of fires has tripled since 1951-1960. The size of the yearly burned area varies a lot, but has generally been higher during the period 1991-2000 than before. The number of forest fires in Poland contributed to between 6 and 16% of the total number of forest fires in the entire Europe. The yearly burned area has varied from 0.8 to 9.7% of Europe's burned forest area.

Most fires are human caused, mainly as a result of carelessness of adults (40.17%). The highest concern, however, is the growing number of arson fires (44.23%). Interestingly, the share purposely set fires has been growing regardless changes in forest ownership. Previously, intentional fire setting was connected to some mental disorders, but currently it has been done with the potential perspective of getting even a temporary job at the burned area. This is especially the case in regions with high structural unemployment. An increase in the number of fires caused by burning of stubble, meadows, near-road ditches or fallow grounds, has also been observed. Burning grasses is dangerous for forests and farms, often involving fatalities, including the perpetrators themselves. Smoke emissions create a danger for drivers by reducing the visibility. In the season of meadow burning, the number of forest fires rapidly grows by up to five times above the average.

Forest fires are causing both direct losses that are connected with destroyed or damaged timber and silviculture and protection costs, on an average of € 61 million yearly, but also indirect losses. The latter can in the long run be six times higher than direct losses. The average economic losses per hectare (the mean value of burned forest) were € 2 879 in 1999 in State Forests. However, these figures do not show the magnitude of far more serious damage posed to the environment and society. In larger fires, losses of human lives have regularly been reported.

Forest area observation systems consist of networks of fire lookout towers (either traditional or since 1970s, partly equipped with TV cameras), since the end of 1980s, aerial patrols and lookout patrols (ground fire detection) have been in operation. Such patrolling is organized by each Forest District or National Park, particularly in the areas with increased fire danger risks, e.g., in regions with high tourism activities, near high-intensity traffic routes and in other places lacking efficient monitoring.

The Polish system of alarm-command communication includes stationary basic radiotelephone with the retransmission system enabling the use of State Fire Service frequencies, radiotelephones working in the forestry frequencies (all service vehicles), and in sub-districts, the use of telephone or radiotelephone, according to the local needs. Another element of the alarm system is the Alarm-Command Points (ACP) of a particular organizational unit of State Forests. Their task is to alarm their own fire units as well as those units of fire services and also to supervise the functioning of the fire protection and preparedness system in their area. The various types of alarm-command points include: regional, established in a regional directorate of State Forests; local, established for a group of Forest Districts; primary, established in a single Forest District or National Park, in units belonging to Fire Danger Classes I or II.

Forest Districts and National Parks are managing a fire base, containing the equipment for forest fire suppression according to the Fire Danger Class. The fire-fighting equipment includes: trailer with a tank and pump to supply water for the fire-fighting team, hand-operated equipment and tools – at least universal extinguishers, spades, shovels, forest hoes for firebreak construction. The equipment bases may also be equipped with additional types of fire suppression equipment, e.g., floating pumps, fire hoses, water pumps and chemical extinguishing agents. The water supply should be sufficient for at least 50 m^3 and the minimum delivery efficiency of 15 dm^3/s (900 l/min), within a radius of 3-5 km, should also be ensured. Forest aeroplane bases are used and developed in accordance with actual needs. For fire suppression; hand tools are used (initial attack equipment), including multiple-use original water-foam extinguishers filled at the action place. Other machinery operated by the Forest Service and useful in fire-fighting actions include, bulldozers, ploughs, wood chippers, four-wheel drive fire-tenders (all-terrain vehicles) equipped with high pressure pump aggregates, air planes and helicopters, mainly M-18 Dromader, Mi-2 and PZL Sokół. In specific conditions, State Forest employees use prescribed fire (broadcast burning) in order to reduce fuel loads on clear-cut areas. Fire (backfiring, counter fire) is occasionally used as a method in fire-fighting.

The organization and execution of fire suppression actions in Poland is a duty of the State Fire Service (SFS). This task is being carried out by the National Firefighting and Rescue System. The system consists of 496 professional rescue-fire units of SFS (these units have about 2 000 professional firemen) and 3 114 voluntary fire service units (which have about 73 000 volunteer firemen). Some Forest Districts have their own volunteer fire services. In addition to the above, the State Forests also have their own fire rescue groups, which are supplied with fire extinguishing equipment. The State Forests also organize the system of aerial patrolling and extinguishing of forest fires. The air resources are, in case of fire extinguish actions, under the command of both the State Fire Service and the Forest Service.

Preventive measures form a part of the fire protection system of Poland. Prevention includes legislative activities, public information and propaganda efforts; fire preparedness by increasing forest accessibility for forest fire protection; construction and maintenance of fire breaks and fire belts; implementation of recommended silvicultural applications; training of staff involved in forest fire management. In silviculture for example, coniferous monocultures are gradually converted to more fire resistant broadleaf stands.

The fact that the absolute majority of Polish forests are under the administration of a single organization, the State Forests, allows both effective management and prevention against fire and firefighting. The financial resources available, however, are still insufficient. The role of financial aid programmes of the EU has been an important help. Funds obtained this way continued to be helpful in financing many projects of technical support, e.g., in fire-danger forecasting and monitoring of forests, and for purchase of fire suppression equipment. These projects are conducted within the cooperation programmes of bordering regions. Another very important topic will be the international collaboration in the field of meteorological services and forest fire forecasting, as recommended by the Second Baltic Conference on Forest Fires (Kuopio, Finland 2000).

5.10 Lithuania

Forests cover up to 2 045 million ha and 31.3% of the whole territory of Lithuania. Average age of forests stand is 53 years. State forests occupy 49.7% of the land area, private forests - 31.4% and forests reserved for privatization - 18.9% of total area of Lithuania. The number of private forest

owners is 209 000, with an average of 4.5 ha sized forest property. Pine stands cover 42%, spruce - 22.8%, and deciduous tree species 4.5% of the total forest area. In state-owned forests, coniferous tree species occupy 67% and deciduous tree species 33%. In private forests and in forests reserved for privatization, coniferous tree species stands cover 52% and deciduous trees 48%.

The Lithuanian forests fall into three combustibility classes (high, medium and low natural combustibility) according to the tree species (coniferous or deciduous), age (more and less than 40 years old), forest site type (soil humidity and nutrient richness). Of the forests, 40% belong to high natural combustibility, 23% to medium combustibility and 37% to low combustibility forests.

Annually, 750 forest fires on an average are registered, and 350 ha burn per year. Fires occur mainly in pine forests. Due to meteorological conditions, 1992, 1999 and 2002 have recently been years of large forest fires. The main reasons for forest fires are careless human behaviour (70%) and burning of dry grass in spring (14%). Arson is the reason for 16% of forest fires.

Fire prevention measures are applied within the forest territories according to the Law of Forestry of Lithuania, regardless of forest ownership. This system includes the measures for forest fire surveillance (forecast and watch), prevention and fire protection. The main objectives of the system is to reduce forest fires hazards, to improve their prevention, increase forest stands' resistance to fires, forecast, watch and extinguish fires. The Lithuanian Directorate General of State Forests has established 42 state forest enterprises, and coordinates the implementation of the integral state system of fire prevention measures. Forest managers and owners are responsible for the fire protection within their forests. Mostly, the implementation of integral state system of fire prevention measures is financed by the funds of the 42 state forest enterprises and from the national budget.

The present Forest Fire Risk Index has 5 classes. The Directorate General of State Forests updates every day the risk index map which can be found at the web page www.gmu.lt. Based on this information, state forest enterprises organize the duty in fire watchtowers and in forests. In Lithuanian forests, there are more than 100 fire watchtowers supplied with watching equipment and radio communication. Video cameras are very rare. During poor weather or high fire risk, state forest enterprises keep an over-ground watch. Fire watchtower distribution has been recently renewed, and also a new radio system has been installed to help communication between authorities.

State forest enterprises pay a lot of attention to forest fire prevention measures and to forest management activities, by for example dividing forests into blocks and firebreaks. Existing mineral fire break lines are maintained or new breaks, as well as belts of broadleaved trees (green breaks), are established. Lithuanian forests encompass 28 500 km of roads that make up approximately 14.4 km for each 1 000 ha of forests. Such network of forest roads enables the Directorate to detect the sites of forest fire breakouts and effectively organize their extinguishing. Not less than 10 000 km of mineral fire breaks lines are renewed and/or established every year.

During the critical fire out-break periods, strict control measures of forests and especially peat-bogs are applied to prevent big and long lasting forest fires. The state forest enterprises have to deal with complicated tasks in extinguishing peat fires, due to the lack of special fire suppression equipment. The Fire and Rescue Department carries out the basic workload in putting out peat fires. In reality, peat fires are stopped by nature - only after long lasting rains.

The recording of forest fires is done by the Directorate General of State Forests (www.gmu.lt.). State forest enterprises are also responsible for establishing the fire brigades responsible for extinguishing all forest fires that occur in Lithuania. Teams must be provided with the means of fire extinguishing, transport and communications. All state forests have provisions for basic forest fire extinguishing measures. State forest enterprises divided into the first forest fire hazard class need to form 2-4 basic fire brigades and 2-3 reserved fire brigades. Basic fire brigades are equipped with fire trucks and water cisterns, and reserved brigades by trucks for transportation of people. State forest enterprises, which are attributed to the second forest fire hazard class, form 1-2 basic fire brigades and 1-2 reserved fire brigades. A basic fire brigade consists of 4-6 members. Every year state forest enterprises prepare specific operative forest fire management plans. These plans are made in coordination with municipality's forest fire rescue and civil protection services. Only in the cases of failure to extinguish a forest fire, the city and county fire and rescue units are called up for assistance.

Economic costs due to forest fires annually amount to around € 150 000, this sum is re-distributed to state forest enterprises from the national budget to compensate the expenditures for forest fire extinguishing and their prevention. Compensated expenses are as follows: construction and restoration of fire watchtowers, repair of radio communication, fire trucks and other mechanisms for forest fire prevention and protection. State forest enterprises make about € 0.85-1.15 million expenses for forest fire protection every year.

In 2003 the Lithuanian Forest Research Institute divided forests managed by state forest enterprises into hazard classes. An analysis of occurred forest fires and evaluation of the status and effectiveness of forest fire protection system was conducted in accordance with the European Union system, and recommendations to improve this system were made. The division of forests by fire hazard classes will serve to apply financial support from the structural funds of the European Union. The funds could be used for improving forest fires prevention measures and for forest regeneration in areas damaged by fire. It is planned that such financial support would be distributed for those state forest enterprises which manage forests in the first and second fire hazard classes.

The main reasons complicating the effectiveness of forest fire suppression, implementation of prevention work and control of the implementation of fire protection requirements are: (i) careless behaviour of inhabitants with fire, including burning of dry grass in spring; (ii) limited financial possibilities to implement newest technology; (iii) slow implementation of preventive fire measures in private forests.

5.11 Latvia

Forests cover 44% of the land area in Latvia and the percentage is currently increasing, mainly due to farmland afforestation. Most wooded regions are situated in Western Latvia. Of the total forest area, 51.8% are owned by the state, 44.2% by private owners, and the rest by other groups. Pine-forests dominate 40% of the forest area, spruce 20%, and broadleaf trees (mainly birch) 38%. About 60% of the coniferous forests are classified as having high fire risk, especially young stands. In dry conditions fires also occur on peatlands.

Normally the fire season starts in mid-April. Negligence constitutes 71% of fires; other reasons are less than 10% each, and arson is 5%. During the past 20 years, the average number of forest fires has clearly increased in Latvia. In 1980s the number of fires was from 200 to 600, but in 1990s the number of fires exceeded 1 000 during several consecutive years. In 2002, the number of fires was the highest so far (1 742 fires). However, the average size of fire is still very small, below 1 ha. Only during extreme fire years the average size exceeds 1 ha. About 78% of fires are extinguished are below 0.5 ha size. In most cases, forest stands survive fire without substantial fire damage.

The forest fire safety and fire control are under the responsibility of the State Forest Service (SFS) in all forests in Latvia and the work is being financed from the state budget. SFS receives information of fire risk on a daily basis from the State Hydro-Meteorological Agency. During the fire season, operative information on forest fires is available at SFS's homepage (http://www.vmd.gov.lv). The execution of fire preventive measures, such as preparing mineralized fire lines, is the responsibility of the forest owner or manager. SFS consists of the Central Office, 26 territorial units and 197 forest districts. In the staff of the central office of each regional forest district, there is an engineer responsible for forest fire control. Each regional forest district has several forest fire stations equipped with a fire truck (or several, the total number in Latvia being 96), and a crew of 3-4 members for each truck. On a seasonal basis, 800 persons are employed in fire fighting. In case of bigger fires (> 10 ha), additional forces (the Fire Safety and Rescue Service of the Ministry of Interior, the National Armed Forces, and the local governments) are used. SFS has made agreements with these entities about co-operation in fire control.

Latvia has a network of 186 watch towers, covering the whole country and each tower is equipped with telephone or radio communication. So far, aerial patrolling or remote sensing, are not considered financially feasible in Latvia. After each fire season, statistical data of forest fires are collected and submitted to the Central Statistical Bureau of Latvia.

Specific problems occur occasionally in dry summers (close to the autumn season) especially in peatlands, because of poor accessibility and generally a shortage of water supply in the vicinity of fire area. Great emphasis is put on training and increase in new fire management equipment. Currently main problems include insufficient funding from the state budget and therefore outdated fire engines, which have been in use for over 15 years. Occupational competence is another problem, mainly resulting from the seasonal nature of the work, which makes recruiting staff more complicated. Authorities are discussing the possibility of handling over the forest fire control responsibility to the Fire Safety and Rescue Service with the aim of creating a single national system on fire safety. SFS is planning to prepare digital fire management maps at the scale of 1:10 000 by the year 2006 (Anonymous, 2003).

5.12 *Estonia*

The total forest area in Estonia is 2.011 million ha. Forests cover 48% of the Estonian territory. In a 5-year period (1999-2003), 846 forest fires were registered, with a total area of 4 137 ha burned. The average size of a forest fire was 4.9 ha. In the year 2002, a total of 2 081 ha of forest burned – which was the biggest area in the last 40 years (in 1963 the total area was 3 755 ha).

Forest fires are caused by the following reasons: human negligence and carelessness – 51%; arson – 13%; natural factors – 1%; reasons unknown – 35%.

Fire prevention is the task of the Ministry of the Environment and the Rescue Board under the jurisdiction of the Ministry of Internal Affairs. Pursuant to the Forest Act, the Ministry of the Environment shall monitor the forest fire situation and implement measures to prevent and suppress extensive and especially dangerous fires. Pursuant to the "Estonian Forestry Development Programme until 2010", approved by the Parliament in 2002, the main attention in forest protection is paid to the prevention of damages. In state forests, forest fire protection systems are built and maintained by the manager of state forests. In private forests, the state supports forest owners in compliance with the All-Estonian Forest Fire Protection Plan – if sufficient funds are available. Progressively, national legislation will be harmonized with international norms on forest fire protection. Each spring the County Rescue Services prepare updated forest fire suppression plans.

Pursuant to the Rescue Act, the suppression of forest fires is the task of the Rescue Board under the jurisdiction of the Ministry of Internal Affairs. The Estonian Rescue Services have 100 professional fire brigades ready to respond 24 hours a day. An agreement concerning response to emergencies has been concluded with the Defence League and a relevant Act provides for the inclusion of the Defence Forces. The subdivisions of the Rescue Board work to improve the technological basis for forest fire suppression; the aim is to create a mobile and rapidly applied water supply system reckoning with the location and density of Estonian lakes and rivers. Fire pumps of various capacities and hose lines have been purchased for this purpose. One helicopter (type MI-8) and one water container (2 000 litres) in the possession of the Border Guard Aviation Group can be used for the suppression of forest fires.

Forest fires are detected from watch-towers and by special patrol flights (started at the third fire risk level). Public observers also report on fires detected. Pursuant to the Forest Act, detection of forest fires from watch towers and on patrol flights is the task of State Forest Management Centre, a profit-making state agency.

Estonia considers a high priority the continued co-ordinated forest fires activities of the countries in the Baltic region. Co-operation with Finland in what concerns the early detection of forest fires from satellites has been quite successful. Estonia has concluded mutual assistance agreements with Finland, Sweden and Latvia in the area of rescue services. These agreements enable the country to receive promptly technical assistance and counselling in case of necessity, applying procedures previously agreed upon.

Opening access to foreign specialists-observers would certainly be a positive development in case of extensive and long-lasting forest fires. The exchange of experience in case of actual disasters would be highly beneficial.

The main problem in Estonia in the area of fire prevention is the awareness of the general public, which is insufficient. Budgetary funds are also insufficient, especially those earmarked for covering expenses related to forest fires. The lack of human and technical resources has been experienced when several major forest fires have to be suppressed simultaneously. It is also hoped in the future to receive fire suppression planes and helicopters equipped with water containers from neighbouring countries, whenever extensive forest fires break out.

5.13 Norway

The climate in Norway is oceanic. The terrestrial ecosystems of Norway are therefore among the most oceanic-influenced on the whole continent. The topography is very rugged with great variation on both regional and local scales. The rugged topography, with its many depressions, valleys, bogs, lakes and wetlands, creates natural fire barriers. Measured on an international scale, relatively small areas are therefore expected to burn in individual fires. Considerable differences in precipitation and climatic conditions over short distances create the ecological basis for large regional differences in vegetation. The coastal area represents the boreo-nemoral vegetation zone, characterized by temperate coastal forests. Boreal coniferous forests extend from the east to the Scandinavian mountain range, and are followed by an alpine ecosystem. The most southern part of Norway belongs to nemoral vegetation zone. The highest fire frequency is in the boreal vegetation zone in the most continental part of Norway. High precipitation and high humidity in the coastal zone prevent mainly ignition, though lightning in this oceanic climate is exceptionally frequent.

Anthropogenic fires seem to have been very important in the Norwegian ecology. For centuries, both intentionally and unintentionally ignited fires burned large areas in the past. Widespread use of fire in burning of pastures along the coast created extensive areas of *Calluna* heathlands. These areas are purely fire-induced by man-made ecosystems, developed for the purpose of year-round animal grazing. Fire has also recently been used in prescribed burning by modern forestry, to regenerate logged clearcuts. However, the practice of such burning in Norway has been rather limited. Due to extreme ecological variability, however, extensive areas of fire refuge may still exist, which have never burned during the post glacial epoch, a phenomenon rather unique in Europe.

In Norway, the Fire and Rescue Services have the main responsibility of fire management. It is organized at municipal level. The Directorate for Civil Protection and Emergency Planning (DSB) is the national authority for supervision and legislation for the local and regional fire services. DSB is subordinate to the Ministry of Justice and the Police. There are 434 municipalities and 375 local Fire and Rescue Services (Brigades), i.e. some Fire Services are inter-municipal. There are 24 emergency control centres located all over Norway covering 24 geographical regions and operating 24 hours a day. The Fire and Rescue Services and Fire Emergency Control Centres are operated and owned by the municipalities. Norwegian Fire Services are run by full-time and part-time personnel. The Fire Services employ all resources used in fire fighting and rescue operations. A fire service is led by a fire chief, who is the lead professional. In municipalities with more than 20 000 inhabitants, there is always a full-time leadership of Fire Agency as well as a full-time Head of the Fire and Rescue Division and the Fire Prevention Division. About 77% of all Fire Service employees are engaged part-time. The resources within the Municipal Fire and Rescue Services are (2003 figures): 3 500 full-time fire fighters, 9 500 part-time fire fighters and 1 300 other resources, such as rescue vehicles, pumpers etc. Helicopters designated for forest fire fighting are available on hire basis.

More aggressive fire fighting has become the core of today management procedure, resulting in a very efficient fire suppression. During the most recent period, the size of burned areas has therefore subsequently considerably decreased. During 2003, a total of 2 160 forest fires occurred, including bush fires. The average number of forest fires has been 300-600 fires per year. Also, the annual average of burned area is rather low - only a few hundred hectares. Due to extensive fire suppression, the average size of fire is currently around 0.5 ha.

Today, however, a view of the importance of fires to flora and fauna is again on the verge of changing practices and attitudes. Fire-adapted species, or so-called pyrophilous species, are integral components of Norwegian flora and fauna. Also the number of invertebrates associated with scorched and charred substrates, dead wood and other resources in burned areas, is considerable. Conservation efforts towards maintaining some of these components in the Norwegian flora and fauna

will rest on a better knowledge about forest fire as a disturbance and ecological factor; therefore fire is currently actively used in research and restoration activities. It is also crucial in research and management, to more precisely identify the fire regime, before extensive new prescribed fire management programmes are eventually introduced into the Norwegian landscape. Thus, fires cannot be regarded as a big problem in Norway, but as in other Fenno-Scandian countries, fire is used as a tool in restoration activities.

5.14 Sweden

Nearly all Sweden lies within the boreal and boreo-nemoral zone, with most of the terrain covered by a fairly flammable vegetation of coniferous trees, ericaceous dwarf-shrubs and pleurocarpous mosses. Out of a total forested area of 23 million ha, only a few hundred thousand ha belong to the temperate deciduous vegetation zone.

At present, only a fraction of the forest land burns annually (0.017-0.0017%), from a few hundred hectares in wet years up to a few thousand hectares in dry ones (Niklasson and Granström, 2004). So fire is not considered as a serious problem today and the area burned annually is rather small, even in comparison with most other boreal regions. Reasons for this are, for example, that high winds are rare during dry summer periods; road network in the forest is very dense and thereby also fire suppression rather efficient.

There is no official collection of forest fire statistics in Sweden, but the present information is collected by voluntary reporting from emergency operations that the municipalities report to the Swedish Rescue Services Agency. These have not been reported in detail yet, but the total burned area has been less than 5 000 ha per year.

Most fires are caused by people, directly or indirectly. In 1994, arson was assumed to have caused 6% of the fires, smokers 2%, carelessness with fire (camp fires, refuse burning, etc) 13%, and various accidents 14%. An additional 30% of the fires were presumably human-caused although the exact agent was unknown. That year lightning accounted for 35% of the fires, which is a very high figure in comparison with statistics from the period 1945-1975. It is probable that the summer of 1994 was unusually conducive to ignitions by lightning. Most of these fires occurred in July, at the height of a long drought.

As late as in the mid-1800s, on an average more than 1% of the forested area in northern Sweden burned per year. The annually burned area dropped steeply over the last decades of the 19th century and during the last 100 years there have not been any really large fire years. The decline in area burned coincides with the expansion of modern forestry. It is assumed that the rural people gradually abandoned old fire practices (such as burning for improving grazing conditions in the forest) and started to attack lightning ignitions aggressively as well. Recently, because of biodiversity reasons, many forest companies have resumed the old tradition of burning logged over areas as an alternative to mechanical soil scarification. Still, the area treated with prescribed burning is small, probably less than 2 000 ha during the last years, but increasing.

During years 2002 and 2003, the number of forest fires was on productive and other wooded land around 3 500. As compared to the number of fires in 2000 and 2001, when around 2 150 fires per year occurred, there was a clear increase, which can be explained by weather conditions. For example in 2003, weather conditions were dry especially in Northern Sweden. Year 2003 also saw a clear increase in number of fires on non-wooded land.

The total burned area on productive and other wooded land was over 2 300 ha in 2003. This was much higher than during previous years, when approximately 1 000 ha less was burned. Also burned area on non-wooded land has been increasing since 2000, and was in 2003 over three times higher than in 2000.

During periods with high danger ratings, an aerial fire detection system is operated. Light private airplanes with a pilot and an observer/navigator fly along fixed routes once (or sometimes twice) a day. All fire suppression is under the responsibility of the communes (townships) through their fire brigades (rescue service). There is no separate organization that especially handles forest fires. The state has

little direct control over the communes and how fire suppression is organized. Communes (including cities) differ in population from 3 000 to 700 000. The large communes have fire brigades that are operated by full-time professional fire fighters. In the smaller communes, fire fighters work part-time and are called in when needed.

Very often fires can be suppressed using the water supply carried in the fire engines arriving at the site. When the distance from the road is too much, lightweight pumps and hoses are carried into the forest. Usually some water source such as a tarn, lake or stream can be found within a few hundred meters from the fire. In later years there has been an increased use of helicopters, particularly if access is difficult or if the fire becomes too important. These are requested by the person in command of the fire. Most often they are from private air companies, but sometimes also naval or army helicopters are called in.

The costs for suppressing a forest fire are covered up to a certain amount by the communes; the amount depends on the population size (actually the amount of taxes supplied). Additional costs are reimbursed by the State. Another problem identified is the lack of experienced persons that can undertake planned prescribed burning operations; therefore special training courses are arranged. According to the Swedish forest certification criteria under the Forest Stewardship Council (FSC), as much as 5% of the annual clear-cut area should be burned. Forest industry companies manage the forests often with very few people who often lack experience in fire management. There is a clear need for training courses. Lack of resources for fire management is another problem (Granström, 1998; Anonymous, 2003; Niklasson and Granström, 2004).

5.15 Finland

Of the land area of Finland, 86% are forested which makes it one of the countries with highest forest cover in the world. Forests belong to the boreal vegetation zone, and main tree species are Scots pine and Norway spruce. Birches and other deciduous tree species cover less than 10%. In Finland, the forestry sector covers 8% of the total economy of the country and is also the highest percentage in the world. However, as fire suppression is efficient and the average size of one fire is currently < 0.5 ha, fires are not regarded as a problem in Finland. Moreover, fire is currently used as a tool in forest management as prescribed burning, due to forest certification criteria, and to some extent also as a restoration tool with and without logging. Because of long period of intensive fire suppression, the role of fire in nature is much lower than in pristine forests and a lot of species are therefore threatened.

After 1970, the largest forest fire has occurred in 1997, 250 ha. During 1990s, around 1 000 forest fires have been recorded annually, except in 1998, when only 231 fires were recorded. On an average, 500-600 ha have been burned annually. Even in 2002, when over 2 500 fires occurred, only 590 ha were burned.

The last casualty in a forest fire was also in 1970s. Under the last 30 years, fires have caused no major damage to forest resources or effects on human health or property, except locally. This is also the case as far as secondary disasters are concerned. Even ecological damages are rare, and due to long non-burning policies, fires can on the contrary have more positive effects on nature.

Twenty-two Regional Rescue Services are responsible for forest fire suppression in their own area. Under Regional Rescue Services, 910 local fire brigades are responsible for forest fire extinguishing. Only 60 of them are professional fire brigades, the others are volunteer or part-time fire brigades. Forest fires form approximately 2–3% of all the accidents wherein fire brigades are alarmed annually. The State Provincial Office (5 provinces) is responsible for arranging efficient forest-fire monitoring in sparsely populated areas. The Finnish Meteorological Institute monitors the weather and establishes a daily forest fire index for different regions. The scale of the index ranges from 1.0 to 6.0. When the forest fire index reaches the value of 4.0, the Meteorological Institute ensures that a forest fire warning is established for that particular region. People are informed about the forest fire warning through media, i.e. TV, radio, internet, newspapers an so on. The Forest and Park Service is liable to provide the rescue authorities with expert assistance in the fighting of forest fires and to make, at its own initiative, plans and preparations how to prevent and fight forest fires in state land, in cooperation with the rescue authorities. Emergency calls in case of fire are dealt with by 15 new emergency response

centres to be taken into operational use in Finland starting in 2006, all equipped with the latest technology.

Until 1970s, the main system for forest fire monitoring in Finland was through the use of lookout towers. There were approximately 150 towers in use at that time. In the 1970s, air patrolling was taken into use and at the end of 1970s the whole Finland was covered by aerial means and lookout towers became obsolete. Currently, air patrolling is the main forest fire monitoring method in Finland. The provincial governments are responsible for organizing air patrolling according to instructions by the Ministry of the Interior. Today, there are altogether 26 air patrolling routes in Finland; handled by local air clubs or air companies. Air patrolling starts when a forest fire warning is issued or whenever it seems to be necessary, e.g. after thunderstorms. Patrolling aircraft are equipped with radios so that they can report fires either to emergency response centre or directly to the local fire officer. In addition, fire patrolling aircraft evaluate how large the fire is and guide the response units to the site. Exact fire location, quick evaluation of the fire size and guidance of the response units to the detected fire, ensure that the burned area remains small. About 10 to15 percent of forest fires are detected from airplanes. Today, more and more fire brigades, as well as emergency response centres, use the GIS-based systems in Finland. In the near future, fires in the whole of Finland will be located by using GIS-based systems.

The Ministry of the Interior, the Technical Research Centre of Finland (VTT) and the Finnish Meteorological Institute (FMI) have developed an operational satellite-based (NOAA AVHRR) system for forest fire monitoring. This system can alarm the closest emergency response centre about a forest fire in less than 30 minutes after the satellite overpass. It also actually works more accurately in Finnish conditions, because the temperature of the surface is not as hot as in the Mediterranean countries, i.e. the false alarm rates can be kept low. The system covers the whole of Scandinavia, Russian Karelia and the Baltic region (Kelhä *et al.*, 2003). After fire observation, the system automatically sends a fax alert to the closest emergency response centre, according to the coordinates of the satellite image. Theoretical minimum detectable fire size is in optimal circumstances 0.1 ha. However, in practice the system detects fires that are larger than 3 ha. Location accuracy is about 1 kilometre and the false alarm rate is less than 10%. The Satellite Monitoring System is also used as part of a monitoring system that detects fires also during night. It also gives useful information about fires in neighbouring countries.

Online Forest Fire Risk assessment is available on the FMI website which is updated regularly and can be used by rescue and other authorities. This application gives output as follows: Forest fire index by counties (actual and +/- 24 hours), lightning (- 6 hours), fires detected by satellite (actual 12 hours, and two weeks), heavy rainfall (radar imagine), forecast (rain, temperature, wind + 24 hours) and relative humidity.

Seventy to eighty percent of the fires are detected and reported by individual people. This is quite logical, given that humans cause most of the forest fires themselves. A number of reports are also given by civil- and military aircraft. Usually these fires are not set on purpose, but because of human negligence. Approximately 13% of fires are caused by lightning

Every municipality should have a long-term forest fire risk assessment prepared for its own area that should include sufficient manpower and equipment to handle forest fires (the Forest Fire Suppression Plan of each municipality). Regional Fire Services should organize a training for local fire brigades and fire fighters. The State Emergency Services College organizes the training of trainers. In general, the most common method in fire suppression is the use of hand tools and water equipments. In Finland there are a lot of water sources available, for instance over 180 000 lakes around the country. In addition there are 4 small aircraft and 5-6 helicopters that can be used for forest fire suppression, i.e. water bombing.

Even though legislation is quite strict, humans cause 60 to 70% of the forest fires. Fire chiefs commonly agree that air patrolling has been an effective tool to reduce the damage caused by forest fires during the last decades in Finland. Due to an effective fire monitoring system, a low number of fires and an effective fire suppression, fire is currently not a problem in Finland.

5.16 Republic of Karelia

Karelia belongs to the boreal vegetation zone and forests dominated by Norway spruce and Scots pine. The share of deciduous tree species is higher than in Finland although ecological conditions are similar and the forest structure in general different, owing to a less intensive forest management history in Russian Karelia.

For this report, fire statistics between 1996-2003 were available. The number of fires in the Republic of Karelia has varied during the last years between 200 and 1 700, the highest number of fires being in 1999 (1 721 fires) and 2002 (1 089 fires). No clear trend in number of fires can be seen, as for example in year 2003, only 564 fires were recorded, but a normal variation is caused by varying weather conditions.

The annual burned area has also varied accordingly, the highest burned area was recorded in 1999 (over 9 000 ha) and 1997 and 2002, when over 4 000 ha were burned. According to last eight year statistics, the average size of a fire is 4.0 ha, which is the second highest reported in the Baltic region. Surprisingly, the average size was largest in 2003 (6.0 ha) and in 2000, when only 470 fires occurred (5.7 ha).

Most of the fires are anthropogenic; during the last years their share has been varying from 83 to over 95%. Information on fires caused by lightning is scarce, the highest recorded year 1999, when 1.3% of fires were reported lightning caused, suggesting the data may not be quite covering.

Economic fire losses in 2003 were over € 0.5 million; this estimation is based on the value of the tree volume destroyed. Information on other economic losses was not available.

The basic fire preventive measures include plans for forest fire prevention, including forest regulations, safety instructions, teaching activities and organizational actions. Territorial monitoring is done by airplanes or helicopters. Basic ways of fire suppression include extinguishing with water or chemicals or mechanical removal of combustible material in front of fire line, etc. At local level, cooperation exists with forest guard and aviation subdivision. In case the forest fire area is large, the divisions of the Ministry of Emergency Measures of Russia and military units take part in fire extinguishing. By the legislation, the Government of the Russian Federation and enforcement authorities of the Republics can involve population in fire suppression, and to provide technical equipment, vehicles and workers from enterprises and organizations and assign them to fire management. Authorities can forbid the visits to forests during high fire hazard period. However, community involvement in protection of forests from fires at a regional level is not applied. International cooperation is restricted to scientific cooperation in defining problems in forest protection.

The basic problem in fire management in the Republic of Karelia is the lack of financial resources. As the average size of a fire is rather large in the region, it can be assumed that it is even higher in most remote and sparsely populated areas of the Republic, where also rather sparse road network makes fire extinguishing more difficult.

In Saint-Petersburg, Russian Federation, an International Symposium on Remote Sensing of Environment was held on 20-24 June 2005. One of the key themes was the reduction of the loss of life and property from natural and human-induced disasters. This theme was mainly related to wildfires/forest fires/burned areas (http://www.niersc.spb.ru/isrse/index.shtml).

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