

МЕЖДУНАРОДНОЕ СОТРУДНИЧЕСТВО

THE NEED FOR DEVELOPMENT OF PRAGMATIC AND SCIENCE-BASED SOLUTIONS FOR FOREST MANAGEMENT AND FIRE MANAGEMENT FOR THE RUSSIAN FEDERATION

Sustainable management and protection of forest resources are key elements of the forest policy of the Russian Federation. For more than a century the prevention and control of all forest fires has been primary task of agencies responsible for forest management and fire protection. However, scientific evidence reveals that some forest types in the different ecoregions of Russia's territory have co-evolved with natural fires (lightning fires) and even human-set fires. The effects of fire disturbances include removal of dead and live accumulated biomass, recycling of nutrients, stand thinning and regeneration of forest stands. In some temperate-boreal forest types of Russia fire disturbances may create habitats for valuable biodiversity. Recurrent surface fires of low intensity remove combustible materials and result in an overall reduction of the risk of severe and large destructive fires, which are considered threat to sustainable forest management and utilization, and may lead to large, uncontrollable outbreaks of pests and diseases (Fire..., 1996).

With the presence of natural fires over millennia some forest types can be classified as fire-tolerant, fire-adapted or even fire dependent. Thus, a complete exclusion of fire from some forest ecosystems is neither ecologically desirable, nor economically feasible. Considering the consequences of climate change on forest and non-forest ecosystems in temperate-boreal Eurasia the country is challenged to maintain and properly manage long-term stable forest cover with management objectives that may differ from the past. Apart of the continuing goal of managing highly productive forest new priorities should be set, e. g. creation of forests of high resilience against climate extremes, biodiversity conservation and – related to climate change – terrestrial carbon sequestration. Thus, a future forest and fire management policy of Russia shall consider these challenges. New forest management and silvicultural practices must include the integration of planned and prescribed natural and accidental wildfires, as well as prescribed management fires (Prescribed burning..., 2013; Valendik et al., 2013).

The scientific knowledge on the basics of forest and fire ecology and on the projections of the consequences of climate change on the future of forest ecosystems in temperate-boreal Eurasia is very rich. Much of the research results have been published by the Russian scientists of the Sukachev Institute for Forest in cooperation with their international partners.

Some of these research and development activities have been jointly planned and organized between the Global Fire Monitoring Center (GFMC), the Aerial Forest Fire Center *Avialesookhrana* and the Sukachev Institute of Forest. With the aim to bring the communities of scientists, practitioners and decision makers together some of the significant milestones were realized between 1991 and 2010.

1991 – Start of cooperation between Soviet fire management personnel and scientists in international technical and scientific networks.

1993 – First East-West scientific conference «Fire in Ecosystems of Boreal Eurasia» (Fire..., 1996) at the Academy of Sciences, Siberian Branch, Krasnoyarsk, followed by the Fire Research Campaign Asia-North (FIRESKAN): The Bor Forest Island Fire Experiment.

1996 – UNECE Conference «Forest, Fire and Global Change» in Shushenskoe.

2000 – International fire expert meeting and exercise «Baltic Exercise on Fire Information and Resources Exchange – BALTEX FIRE 2000» in Finland.

2008 – First International Central Asian Wildland Fire Joint Conference and Consultation «Wildland Fires in Natural Ecosystems of the Central Asian Region: Ecology and Management Implications», associated with the First Central Asian Forest Fire Experiment in Mongolia.

2010 – Regional Consultation on Transboundary Cooperation in Fire Management in Irkutsk.

Between 2012 and 2014 several national and regional consultations and international conferences addressed the theme of integrated fire man-

agement from national (Russia) level to the global level (Vegetation fires..., 2013). In the frame of the scientific-technical cooperation between Russia and the Global Wildland Fire Network the results of cooperative science programs have been evaluated. The results show that the scientific basis for decision making is available but has not been used sufficiently for introducing practical management solutions or strategic approaches in forest and fire management that would address the consequences of climate change. This paper summarizes the steps taken to discuss these issues at the science-policy interface. It starts with the «First International Fire Management Week» in Krasnoyarsk in 2012 and end with the World Climate Treaty agreed upon 2015 in Paris, France, and signed at the United Nations in New York in early 2016. At the end it is proposed that the results of the scientific-technical consultations and the political decisions – the World Climate Treaty – are calling for decisive and pragmatic management solutions.

Recommendations of the First International Fire Management Week (2012). Between 2 and 8 September 2012 the «International Fire Management Week» was organized under the joint umbrella of the Federal Forestry Agency of Russia *Rosleskhoz* and GFMC, with financial support of the German Federal Ministry for Food and Agriculture (BMEL). Both countries are cooperating partners under the bilateral Russian-German Agreement on Cooperation in Sustainable Forest Management and under the framework of the UN International Strategy for Disaster Reduction (UNISDR) and the UN Economic Commission for Europe (UNECE).

During this event the latest and up-to-date state of the art of fire ecology and advanced fire management methods on the use of prescribed fire for wild-fire hazard reduction in temperate-boreal Eurasia were presented and discussed between scientists of the V. N. Sukachev Institute of Forest, practitioners and policy makers at national level of the Russian Federation, and with representatives of the administrations of Krasnoyarsk Krai.

For the first time a field demonstration on prescribed burning under canopy of a pine stand nearby Krasnoyarsk was conducted for the public and media representatives were briefed about the objectives of prescribed sub-canopy burning in pine forests. Attendees of this demonstration witnessed for the first time that a prescribed low-intensity surface fire can be set in a forest to safely reduce surface fuels without damaging the stand. An expedition to the site of Bor Forest Island Fire Ex-

periment of 1993, located between the settlements Yartsevo and Bor, demonstrated the concept of a long-term research project of the consequences of a severe, high-intensity fire (FIRESKAN Science Team, 2013). The experiment, scheduled for the 200-years research period 1992–2192, investigates the consequences of a high-intensity forest fire, followed by secondary pests, on the regeneration of a natural forest. A Round Table on the final day of the International Fire Management Week evaluated the seminar, the prescribed burning experiment and the visit of the Bor Forest Island Fire Experiment (Recommendations..., 2013a).

The Krasnoyarsk 10-Point Programme on the Future of Fire Management in Russia. The Round Table concluded that there is an urgent need to revise the policy and practice of fire management in the Russian Federation, and agreed upon 10 recommendations:

1. Legal and other normative documents that are regulating forest management and forest fire protection need to be complemented concerning the use of prescribed fires and prophylactic burning under forest canopy.

2. Methodological guidelines for prescribed burning under forest canopy need to be developed at federal level.

3. Educational programs for the training of forest firefighters and fire management specialists at different educational levels need to be developed and approved at Federal level.

4. Programs of advanced continuous professional education for foresters on prescribed burning need to be developed and approved.

5. Create the occupation categories «Forest Fire Fighter» and Fire Crew Leader in the tariff-classification reference book.

6. Further scientific research concerning prescribed fires needs to be supported at Federal level.

7. The Order of the Federal Forestry Agency № 174 of 27 April 2012 «Approval of the normative for forest fire management plans» need to be changed in the section on planning the prophylactic burnings at forest district unit level and to determine the normatives for fire prevention operation plans in the 1-km zone around settlements.

8. Concepts for the use of fire on agricultural and other non-forested lands of the Russian Federation need to be developed.

9. A new system of statistical accounting and classification of types of forest and other vegetation fires and their consequences needs to be developed,

and appropriate changes to be made in the GOST № 17.6.1.01–83 (approved by Decree of the State Committee on Standards, 19 December 1983).

10. International expertise in the field of fire management needs to be used, including the system of statistical accounting and classification of vegetation fires proposed by GFMC.

Recommendations of the Second International Fire Management Week (2013). Between 17 and 22 June 2013 50 scientists specialized in forest protection and regeneration from Russia, Germany, Kazakhstan, Mongolia and Ukraine attended the International Scientific Conference and Field Experiment entitled «Second International Fire Management Week – 2013: Post-Fire Natural Regeneration of Forests in Siberia and 20 Years Bor Forest Island Fire Experiment (1993–2013)».

The participants presented the results of scientific research on the fire ecology of forests in Siberia and other regions of the world. Main attention was given to the role of natural and prescribed management fires on the dynamics of forest development, with emphasis on the regeneration of forests and other ecosystems after fire. The specialists in their presentations emphasized the role of fire as an ecological factor influencing the growth, composition and regeneration of forest stands. It was pointed out that fire may influence the stability of forests and enhance productivity, but also may have negative impacts on the condition and the sustainability of forests.

The conference was held on the ship «M. Yu. Lermontov» cruising Yenisei River between Krasnoyarsk–Yeniseisk–Yartsevo settlements. The participants of the conference visited forest plots that had been affected by fires in the past to evaluate the dynamics of forest regeneration. Special emphasis was given to a visit of the Bor Forest Island where in 1993 a large fire experiment was conducted to be followed by a 200 years research period (1993–2193). At the conference the monograph entitled «Prescribed Burning in Russia and Neighbouring Temperate-Boreal Eurasia» was presented. The book, which was prepared by an international group of scientists including the Sukachev Institute of Forest, summarizes the last two decades of work in the field of prescribed fire and post-fire forest regeneration. This scientific work demonstrates the profound scientific and technical experience in the use of fire in forests and includes the results of the first two decades of research on Bor Forest Island Experiment (Recommendations..., 2013b).

The conference participants highlighted:

1. Siberian forests have been shaped by wildfires in the past. These forest ecosystems bear rich natural biodiversity and carbon stock and are of potential economic interest.

2. The role and the ecological consequences of wildfires are diverse:

– while a single intense and severe wildfire may result in the destruction of a mature or an over-aged stand, it also initiates regeneration. The subsequent development of a natural (non-managed) forest depends on the fire return intervals and the interactions between fire, insects and diseases;

– some pine and larch forests exist only due to the influence of fire. Light coniferous forests regularly affected by surface fires thus are less sensitive to crown fires.

3. In economically accessible forests a wildfire may cause a partial or total destruction and loss of commercial timber. However, prescribed fire can prevent the outbreak of wildfires and has positive impacts on composition and quality of forest stands.

4. Fire plays an important role in the regeneration of forests depending on the type of fire and effects of fire and fire severity. Post-fire regeneration on Siberian burned areas in general was successful. This has been proved by results of the Bor Forest Island Fire Experiment and sites surveyed by expedition members.

5. Prescribed burning in forestry can be used for:

- reduction of fuel loads;
- cleaning clear-cuts;
- site preparation for regeneration;
- improving forest sanitary conditions.

6. Forest fires burning under specific conditions and proper management could be regarded as a prescribed management fires.

The conference participants endorsed the validity of the recommendations of the First International Fire Management Week of 2012. Taking into consideration the conducted research and the presented reports at the Second International Fire Management Week the participants proposed to:

1. Develop monitoring technologies for post-fire regeneration by enhancing the capabilities of the Satellite Fire Monitoring System of Rosleskhoz.

2. Develop a new methodology to evaluate the necessity of reforestation of burned areas.

3. Develop recommendations to carry out activities for restoration of forests damaged by fires.

4. Develop evaluation criteria of a selective approach towards forest fire suppression taking into

consideration the fire management zoning and forest health conditions.

5. Develop new techniques to evaluate economical losses caused by forest fires.

6. Develop decision-support software for forest fire suppression.

7. Revise the current forest and fire management terminology considering the amendments in the forest legislation and scientific and technical advances.

8. Provide appropriate information to the general public about the positive role of controlled fire in natural regeneration and about the real situation related to reforestation of burned areas.

9. Initiate research concerning post-fire regeneration in burned areas of different ecosystems continue long-term post-fire research in different ecosystems including the Bor Forest Island Fire Experiment site.

10. Ensure involvement of young specialists for continuation of long-term scientific studies in forest conservation, protection and reproduction.

Recommendations of the International Congress «Forest Fire and Climate Change: Challenges for Fire Management in Natural and Cultural Landscapes of Eurasia» (2013). Following the two Fire Management Weeks in Krasnoyarsk an international congress was organized which addressed the consequences of climate change on fire regimes and fire management entitled «Forest Fire and Climate Change: Challenges for Fire Management in Natural and Cultural Landscapes of Eurasia», held in Novosibirsk, Russia, 11–12 November 2013. The rationale for organizing the congress was that recent wildfire episodes in temperate-boreal Eurasia have resulted in severe environmental damages, high economic losses and considerable humanitarian problems. Several key issues affecting wildland fire in the cultural landscapes of temperate-boreal Eurasia have been identified:

increasing rural exodus and urbanization of rural populations, resulting in:

– abandonment of traditional land cultivation (agriculture, pastoralism, forestry);

– subsequent encroachment of weeds, shrubs and forest – resulting in increasing wildfire hazard;

– reduction of the rural work force, including availability of rural firefighters;

limited fire management capabilities in some countries due to the historic division of responsibilities of public services and land owners;

lack of regulations and responsibilities in fire management on agricultural lands and at the interface between wildlands and residential areas;

re-privatization of formerly nationalized forests resulting in vacuums of forest and fire management in smallholder forest estates;

weakened capacity over forestry and decreased fire management capabilities in many Eastern European and Central Asian countries as a consequence of the transition of national economies, often associated with the uncontrolled or illegal forest use and increase of related wildfires;

increasing occurrence of wildfires affecting the perimeters of metropolitan areas, settlements and developments dispersed throughout rural landscapes;

secondary problems associated with wildfires, e. g. those burning on territories contaminated by radioactivity and remnants from armed conflicts (e. g. unexploded ordnance, land mines, uranium-depleted ammunition); or wildfires affecting agricultural lands treated with pesticides; landfills, other industrial waste and structures containing hazardous materials, especially at the urban / residential perimeters;

impacts of smoke pollution on human health and security;

transboundary consequences of emissions from wildfires and excessive burning in agricultural lands on the atmosphere and terrestrial systems, notably the transport and deposition of black carbon to the Arctic environment;

consequences of climate change resulting in extended periods of extreme drought and heat, with a consequent increase of the risk of occurrence of large, intense and severe wildfires;

increasing ecosystem vulnerability to wildfires, e. g. consequences of climate change will result in the transformation of former fire-free or fire-protected natural ecosystems, such as peat bogs and high-altitude mountain ecosystems, to ecosystems becoming vulnerable to wildfire and increasingly become affected by wildfires.

The assessment of changing fire regimes and the increasing vulnerability of society as well as the responses required by public policies and action by local administrations were discussed at the congress, which was organized under the auspices of the UNISDR, the Global Wildland Fire Network and the UNECE/FAO Team of Specialists on Forest Fire as a cooperative endeavor of the State Duma Committee on Natural Resources, Environment and Ecology; Ministry of Emergency Situations

(EMERCOM); Federal Forest Agency Rosleskhoz, Siberian Federal District; Government of Novosibirsk Oblast; GFMC.

Both the exhibition and the congress brought together four major groups to exchange views and sectoral contributions towards preparing the Eurasian region to the changing climate and environment:

1. Scientists from Russian universities and the Academy of Sciences and their partners from scientific institutions abroad transmitted their messages to the representatives of decision-making authorities.

2. Representatives from non-government organizations provided the views and contributions of civil society to define future solutions to fire problems.

3. Decision-making authorities from Siberian Federal District (regional forest services, institutions belonging to the ministries of emergency situations, aerial firefighting services) reported on the changes occurring in fire regimes and the necessity of establishing transparent monitoring and reporting mechanisms as well as the need to broaden the scope of fire management from the current focus on forests only to a broader, landscape-level approach.

4. The Russian and international industries displayed and demonstrated advanced tools for fire management.

The Congress themes included high-level contributions by scientists and representatives of non-government organizations from the Russian Federation and from neighboring countries of Eurasia and from North America, including Canada, Germany, Kazakhstan, FYR of Macedonia, Mongolia, South Korea, Turkey, Ukraine and the United States of America, who addressed:

regional climate change in Eurasia and North America: observed trends and modeling of the future;

impacts of climate change on Eurasian landscapes (forests, wetlands and peatlands, steppes and grasslands);

challenges and new approaches for forest management and fire management under changing socio-economic and environmental conditions;

fire management in agricultural lands;

participation of civil society in fire management (fire prevention, defense of villages and rural assets against wildfires, volunteers);

public policies and strategic planning in fire management.

The scientific-technical presentations and discussions confirmed the above-mentioned key problems, which were the reason for organizing the congress. The participants addressed the following high-priority problems.

Climate change is reality and already resulting in an increase of wildfire occurrence and area burned. The future of climate change will result in extremely dangerous fire situations in Russia and neighboring countries of Eurasia, as well as to North American forests and other lands.

The protection of some forest ecosystems against destructive fires, however, should not continue to focus on complete fire exclusion only. The traditional approach of prevention and suppression all fires needs to be replaced by fire management systems, in which natural fires and prescribed burning will be integrated if such fires have a positive influence on forest stability and the economic and social functions of forests.

On the other hand, current excessive and unnecessary agricultural burning practices are recognized as one of the main sources of wildfires, which ignite forests and other lands (especially peatlands) and result in severe environmental damages, including air pollution.

Obligatory federal plan on implementation of prophylactic burns has to be excluded from the list of normatives for forest fire management plans as it was pointed out in the «Krasnoyarsk 10-point programme on the future of fire management in Russia» accepted at the First International Fire Management Week held in Krasnoyarsk in 2012. Decisions on the possibility to use prescribed burns, their types and volumes, should be made only by forest district managers. They should take into consideration the necessity to burn, current weather conditions, and level of preparedness of people, finances and equipment needed. Otherwise the planned volume of prescribed burns wouldn't be implemented with proper quality, and works can frequently lead to spontaneous uncontrolled burning.

Smoke pollution generated by agricultural burnings and by wildfires in peat lands and forests nearby settlements and urban centers constitutes a high threat to human health and security.

There are transboundary, global effects of fire emissions, such as the transport of particle emissions to the Arctic environment where the deposition of black carbon accelerates the melting of snow and ice.

Rural exodus and abandonment of agricultural lands contributes to increasing wildfire hazard and

negatively impacts sustainable land and forest management, and the defense of rural assets, including villages, against destruction by wildfires.

Despite the existing legal prohibition of agricultural burning, the reality is that there is limited law enforcement and hence little or no true control over agricultural burnings due to lack of clear institutional responsibilities.

Solutions for alternatives to burning of agricultural residues are practiced internationally. However, throughout East Europe and Russia they are either unknown or can not be implemented due to the weak economic conditions of agricultural enterprises. As a result, burning seems to be the only economically feasible way to dispose of agricultural residues. Existing subsidies for agricultural producers is very small compared to those that are available in the European Union. Agricultural extension and capacity building services in applying alternatives to burning do not exist.

Only now has it been recognized by State authorities that the true number of wildfires and the areas of all ecosystems affected by fire are much higher than previously reported by official sources. A new, transparent monitoring and reporting system using satellite assets needs to be developed.

There is no adequate training of personnel responsible for new approaches of fire management in forests, agricultural lands and village defense.

Governments need to prepare their nations at local to regional levels to cope with the current and the future threats, which are likely to increase. Large, targeted investments are required now to be prepared for a future that will be characterized by climate extremes and extreme wildfires.

RECOMMENDATIONS

By referring to the First and Second International Fire Management Weeks held in Krasnoyarsk in 2012 and 2013 the congress participants recommended the following to the decision making bodies in Russia and suggest neighboring countries of Eastern Europe and Central Eastern Eurasia also review these recommendations and consider their application (Resolution..., 2013):

1. The governments of Russia and the neighboring countries are alerted and warned by the scientific and the professional fire management community that the threat from wildfires in the region will become increasingly dangerous in the coming years as a consequence of climate change and socio-economic and demographic changes.

2. The development and application of advanced technologies of satellite remote sensing systems must be supported to obtain precise and reliable information about the number, size and impacts of fires in all ecosystems (forests, wetlands, agricultural lands, pastures and other vegetation) as well as their secondary consequences such as fire emissions affecting the quality of atmosphere and human health; and provide these data and information to the authorities and the public in a transparent way.

3. In order to reduce the negative effects on environment and human health and in complying with the Gothenburg Protocol to the UNECE Convention on Long-Range Transboundary Air Pollution (LRTAP) the extent of unnecessary burning of agricultural, pasture and steppe ecosystems must be reduced by:

- review and further development of the legislation, law enforcement and management responsibilities of authorities concerning the use of fire on agricultural and pasture lands, as well as on abandoned agricultural lands;

- review and promotion of alternatives to agricultural burning by rural extension services;

- introduction of subsidies for supporting the agricultural sector to apply alternative technologies, following the examples of subsidies in the European Union.

4. Rural communities must be supported in the self-defense of rural assets (farms, villages, recreational sites, infrastructures) against wildfires by the

- establishment of structures for homeland defense against wildfires;

- provision of appropriate training, equipment and insurance of volunteers active in rural wildfire defense.

5. Fire management plans for protected areas, which consider the vulnerability of some ecosystems, and the fire tolerance or fire dependence of other ecosystems, must be developed.

6. Special attention must be given to develop capacities to manage wildfires occurring on vegetated lands that are contaminated by radioactivity, chemical and other industrial deposits or threatened by military assets including unexploded ordnance stemming from armed conflicts or military training.

7. Urban and rural areas must be prepared to protect populations against the adverse effects of wildfire smoke pollution; and publish transparent and open data about people affected by smoke pollution (hospital admissions, premature deaths).

8. A dialogue must be established at regional level between relevant agencies that encourages participatory approaches by inviting representatives of civil society to define fire management solutions at landscape levels (including forests, agricultural lands, abandoned agricultural lands, other lands).

9. Fire Management Resource Centers must be established at regional level which will train professionals and volunteers in fire management, disseminate information to the public on early warning and real-time information on ongoing wildfires, and facilitate mutual support between neighbouring regions in wildfire emergency situations.

10. The authorities of the Russian Federation shall acknowledge the recommendations of the International Fire Management Weeks organized in Krasnoyarsk Krai in 2012 and 2013, which addressed the need to reform the approaches in the management of forest fires.

The participants underscored the regional and transboundary significance of the themes addressed by the Congress and the recommendations made by the participants of the Congress. They therefore suggested that these recommendations be forwarded for consideration in the deliberations at the UNECE/FAO Regional Forum on Cross-boundary Fire Management (United Nations, Geneva, 28-29 November 2013), which was sponsored by the BMEL.

Recommendations of the UNECE Regional Forum on Cross-Boundary Fire Management (2013). The results of the two Round Tables and the Novosibirsk meeting were conveyed to the United Nations at the occasion of UNECE/FAO Regional Forum on Cross-boundary Fire Management, which was held at the United Nations in Geneva in November 2013.

After 33 years of work the mission of the UNECE/FAO Team of Specialists on Forest Fire has been accomplished. In this period the work of the Team expanded to global level by creation of the GFMC and the Global Wildland Fire Network and has been effective in advising development of national and regional fire management policies, and implementing capacity building in fire management at all levels. Keeping this in mind, the work of the ToS will continue within the six Regional Wildland Fire Networks covering the UNECE Region, and, by including other regions of the world, support the implementation of the Hyogo Framework for Action 2005–2015: «Building the resilience of Nations and Communities to Disasters» through the Global Wildland Fire Network, the Wildland Fire Advisory

Group and the Global Fire Monitoring Center as its Secretariat.

The forum released – among other – the following recommendations (extracts) (UNECE/FAO..., 2013):

Promote the understanding of and the response to the transboundary effects of fire. The cross-boundary effects of wildfires require jurisdictions at all levels to cooperate in fire management and to define collective solutions. While prime emphasis should be given to cooperation in fire management between jurisdictions sharing common borders, the long-range consequences of fire emissions are calling for strengthening existing and, if necessary, developing additional protocols addressing the reduction of adverse consequences of wildfire at international level. This call is supported by the UNECE Convention on LRTAP and the recommendations from the international congress «Forest Fire and Climate Change» (Novosibirsk, 11–12 November 2013).

Expanding the scope and strengthening of international cooperation in fire management. The formal phasing out of the Team of Specialists coincides with the current and with foreseeable future increase of wildfire problems globally. This combination of factors inspires the call for further development of the voluntary and institutional regulatory framework directly tasked with building resilience of nations and communities within the UNECE region to wildfire emergencies and disasters by enhancing national and collective regional fire management capability through international cooperation. This is calling for the development of a voluntary regulatory institutional and policy framework aimed at building resilience of nations and communities within the UNECE region.

Application of a holistic approach to wildland fire management. Any recommended measures in building resilience of nations and communities to wildfire require a holistic approach to integrated fire management and wildfire risk reduction. This approach must include activities directed at wildland fire prevention, preparedness, response and post-fire recovery and restoration at landscape level including all ecosystem types, land uses and land tenure. Emphasis should be given on people-centered (participatory) approaches.

Adoption and continued development of the International Wildfire Support Mechanism (IWSM). The Forum proposes to establish an International Wildfire Support Mechanism (IWSM) for the UNECE Region and globally, that will assist nations

to improve their capacity and resilience to wildfire. The mechanism will provide a platform / framework from which to cascade improved knowledge, good practice, experience and training throughout the global wildfire community for the benefit of all.

Launch of the «International Wildfire Preparedness Mechanism» (IWPM) in Kazan (2014).

One year later the «International Wildfire Preparedness Mechanism» (IWPM) was presented and launched at the 72nd session of the UNECE Committee on Forest and the Forest Industry, which was held in Kazan, Republic of Tatarstan, Russian Federation (UNECE/FAO..., 2014). A message, based on the aforementioned cooperative global analysis «Vegetation Fires and Global Change» (UNECE/FAO..., 2013), was submitted to the 20th session of the Conference of the Parties of the UNFCCC and the 10th session of the Conference of the Parties (COP) serving as the Meeting of the Parties to the Kyoto Protocol (Lima, Peru, December 2014). This COP was decisive for developing the International Climate Treaty of 2015.

Vegetation fires increasingly dangerous in an insecure climate. In many ecosystems across the world, fire is a natural and essential force in maintaining the structure and health of ecosystems that are susceptible, tolerant of, adapted to, or dependent on either natural or human-caused fires. In many rural regions fire is an important land management tool embedded in the culture of many societies in the developing world.

However, fire is uncommon and unnatural in many ecosystems, such as fire-sensitive tropical rain forests and peat lands, where its current application is causing widespread vegetation damage and site degradation.

According to some satellite remote sensing studies, wildland fires affect between 3 and 4 million square kilometres (300–400 million ha) globally every year. Other studies push this figure further estimating the total annual global area burned at more than 600 million ha.

Vegetation fires are a significant source of atmospheric pollutants, affecting air quality and human health on a local as well as regional scale. Smoke aerosols perturb regional and global radiation budgets through their light-scattering effects and influence cloud microphysical processes.

For some atmospheric pollutants, vegetation fires rival fossil fuel burning as a source of atmospheric pollution. On a global scale, fire frequency, fire intensity and emissions from burning biomass change according to climate variation and land use.

Several climate model-based studies indicate that future fire activity is likely to increase markedly across most tropical biomes, Mediterranean climate areas, temperate biomes and the boreal zone. The principal driver of this increase will be a combination of reduced rainfall, extended droughts and higher temperatures.

At the 72nd session of the United Nations Economic Commission for Europe (UNECE) Committee on Forest and the Forest Industry, held in November 2014, the Global Fire Monitoring Center (GFMC) presented the conclusions of the work of the UNECE/FAO Team of Specialists on Forest Fire. This Team of experts, representing about half of the 56 UNECE Member States, had been led by the GFMC between 1993 and 2014.

During the 1990s the Team began its work focusing on identifying policy and management options of fires affecting forests and other vegetation types. The work addressed explicitly the transboundary and global nature of fire and fire effects – for example, border-crossing fires, smoke transport, impacts of fire on human health, biodiversity and landscape stability. With the increasing insight in the global interconnectedness of fire and fire effects, it emerged the need to address this problem collectively at global level. As a result it was established, in 2001, the Global Wildland Fire Network (GWFN), a Thematic Platform under the UN International Strategy for Disaster Reduction (UNISDR).

Its representative body, the UNISDR Wildland Fire Advisory Group, in conjunction with the United Nations University, took the initiative of developing a White Paper on Vegetation Fires and Global Change. This paper is aimed at the United Nations and, more generally, at International Organizations, and has been introduced as background and rationale for the «UNECE/FAO Regional Forum on Cross-boundary Fire Management».

In the concluding report of the Forum, and its follow up, the GFMC stressed again the increasing threats posed by destructive wildfires at a global level. Governments within and outside the UNECE region have been alerted by both the scientific community and the professional fire management community that the threat from wildfires will become increasingly dangerous in the coming years due to climate change and socio-economic changes.

Wildfires may become the most important driver of global degradation and destruction of vegetation. To counter this risk, voluntary rules and cooperation mechanisms have been created, such as the «International Wildfire Preparedness Mechanism».

nism» (IWPM) and the «International Fire Aviation Guidelines». However, given the seriousness and cross-country nature of wildfires, voluntary agreements should transit to more formal rules under the UN conventions and, perhaps, towards legally binding instrument on forests.

The 21st Conference of the Parties of the UN Framework Convention for Climate Change (COP 21). The 6th International Wildland Fire Conference held in 2015 in Pyeongchang, Republic of Korea preceded COP 21 and released the «Pyeongchang Declaration on Fire Management and Sustainable Development» (Pyeongchang, Republic of Korea, 16 October 2015).

The 6th International Wildland Fire Conference, which was held under the auspices of the United Nations International Strategy for Disaster Reduction (UNISDR) and the Food and Agriculture Organization of the United Nations (FAO) in Pyeongchang, Gangwon Province, Republic of Korea, 12 to 16 October 2015, was attended by government officials, scientists, professionals from civil society from 73 countries, and by UN agencies and other international organizations. The conference evaluated global wildland fires of the past, the status and achievements of contemporary fire science and fire management, and looked into the future of a changing world and changing fire regimes. Conference participants discussed how science and management could address the challenges ahead, to contribute to the implementation of the Sendai Framework for Disaster Risk Reduction 2015–2030, to assist countries to achieve the Sustainable Development Goal 15 and to deliver inputs to the 21st Conference of the Parties of the UN Framework Convention for Climate Change (COP 21) (December 2015).

The conference participants expressed strong concerns over the impacts of climate on fire regimes, the contribution of vegetation fire emissions to climate change, the application of fire in land-use change, the accumulating effects of global change on fire regimes, and increasing impacts of fire on society, notably on human health and security. Looking forward, participants suggested increasing international cooperation and response mechanisms, exchange of information and technical and scientific expertise. Based on inputs from the conference participants through regional and thematic statements, a Conference Statement summarized the concerns, the need for action and an envisaged scenario of implementation (Annex to the Declaration). In summary, and in the collective international

interest, the conference appeals to the international community to consider two tiers of response (Pyeongchang Declaration..., 2015):

International policies and concerted action: collective international efforts are needed to address impacts of vegetation fires that are of transboundary nature and currently affecting at an unacceptable level common global assets such as atmosphere and climate, natural and cultural heritage, and human health and security. Systematic application of principles of Integrated Fire Management (IFM), based on the wealth of traditional expertise and advanced fire science, contributes to sustainable land management, ecosystem stability and productivity, maintenance and increase of terrestrial carbon stocks, and reduction of unnecessary emissions of pollutants that affect human health and contribute to climate change. The COP 21 is encouraged to acknowledge the role and endorse the support of IFM as an accountable contribution to reduce greenhouse gas emissions, maintain or increase terrestrial carbon pools in all vegetation types and ensure ecosystem functioning.

Capacitation of nations to address the challenges in fire management: in order to implement IFM there is a demand for capacity building, investments and outreach work at global level. Since traditional and advanced knowledge of IFM principles is available for all vegetation types, the systematic application of IFM, notably community-based fire management approaches, could be promoted by exchange of expertise between countries. The development of regional programmes and / or resource centres for capacity building including training in fire management should be supported by countries and international organizations. Bilateral agreements and multilateral voluntary exchange instruments should also be supported.

This appeal (or recommendation) was explicitly targeted to the 21st Conference of the Parties of the UN Framework Convention for Climate Change (COP 21). The delegation of the Republic of Korea presented these recommendations at the COP 21. The World Climate Agreement, as signed at the UN in 2016, in Decision 55 and Article 5 refers to the need of action to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gases as referred to in Article 4, paragraph 1(d), of the UN Framework Convention on Climate Change (UNFCCC), including forests.

Challenges for the Forest and Fire Science Community and Policy Makers. The scientific-technical round tables and a regional congress con-

ducted in Russia in 2012 and 2013 highlighted the need for targeted measures in forest and landscape management of temperate-boreal Eurasia and notably for the Russian Federation. It is evident that:

- the ecology of forests and fire has been well investigated by the science community;
- the influence of humans on fire regimes of forests and surrounding landscapes is well understood;
- the current and future impacts of climate change on forests and fire regimes are evident;
- agencies responsible for sustainable silviculture, forest economics and disaster risk reduction have developed appropriate policies, response strategies and institutional capacities to prepare the forestry sector to cope with the impact of global change.

With regards to the theme of this conference «Intensification of the Russian Forestry: Problems and Innovative Solutions» this paper has highlighted a process in which the scientific-technical discussions on the role of fire and fire management in the future of forest and fire management have been tied up with the global context.

Indeed, in the past decisions in forest and fire management have often been influenced by emotions and outdated views, which often did not consider the needs of traditional rural / forest communities, the role of natural and anthropogenic fire in these ecosystems and the reality of climate change.

However, time is running away. The impact of climate change and the socio-economic changes in rural Russia are dramatically affecting fire regimes. More changes are to be expected such as the anticipated changes of forest composition, migrations of species and forest zones.

Pragmatic solutions are needed to stabilize the forests of Russia towards an increased resilience against climate extremes and natural and human-caused disturbances. More active investments are needed, swiftly moving from current economics- and emotions-driven forest management decisions to environment- and ecosystem-based solutions.

The role of Siberia's pine and larch forests to cope with climate extremes and fires imply that the two genera of trees *Pinus* spp. and *Larix* spp. are suitable for playing a major future environmental function and an economic role in order to cope with the upcoming changes.

The recommendations of the most significant expert round tables, conferences and political consultations are pointing into the right direction – at

least from the point of view of fire management. Now it is timely that forest planning, silviculture and innovative forest management are coming together and develop solutions that are in line with the World Climate Treaty and the responsibilities of all nations to develop pragmatic and science-based solutions for advanced forest management.

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