Управление делами Президента Республики Казахстан
Государственный национальный природный парк «Бурабай»
Комитет лесного хозяйства и животного мира Министерства экологии,
геологии и природных ресурсов Республики Казахстан
Международный научный комплекс «Астана»
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«Бурабай» мемлекеттік ұлттық табиғи паркінің
құрылуына 20 жыл толуына арналған
«ОРМАН ЭКОЖҮЙЕСІН САҚТАУДАҒЫ ЖӘНЕ
ОНЫ ТҰРАҚТЫ ДАМЫТУДАҒЫ ИННОВАЦИЯЛАР»
халықаралық ғылыми-техникалық конференцияның

МАТЕРИАЛДАРЫ

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М А Т Е Р И А Л Ы

международной научно-практической конференции,
приуроченной к 20-летию создания
Государственного национального природного парка «Бурабай»
«ИННОВАЦИИ В СОХРАНЕНИИ И
УСТОЙЧИВОМ РАЗВИТИИ ЛЕСНЫХ ЭКОСИСТЕМ»

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M A T E R I A L S

of international scientific and practical conference, dedicated
to the 20th anniversary of State national natural Park «Burabay» creation
«INNOVATIONS IN THE CONSERVATION AND
SUSTAINABLE DEVELOPMENT OF FOREST ECOSYSTEMS»

Пос. Бурабай, Акмолинская область, Казахстан
2020

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Жинаққа «Бурабай» мемлекеттік ұлттық табиғи паркі құрылғанына 20 жыл толуына орай халықаралық ғылыми-практикалық конференция материалдары енгізілді. Конференцияның материалдары оның жалпы бағдарламасы бойынша алфавитті ретте авторлардың тізімімен берілген.

Жинақ орманшыларға, географтарға, экологтарға және демографтарға, сондай-ақ жоғары оқу орындарының оқытушыларына, студенттеріне және орман экожүйесін сақтаудағы және тұрақты дамудағы инновацияларына қызығушылықпен айланысатын көпшілік оқырман қауымға арналған.

В сборник включены материалы Международной научно-практической конференции, приуроченной к 20-летию создания Государственного национального природного парка «Бурабай». Материалы конференции в соответствии с ее общей программой приведены по алфавитному списку авторов.

Сборник предназначен для лесоводов, географов, экологов и демографов, а также для преподавателей, студентов высших учебных заведений и широкого круга читателей, интересующихся инновациями в сохранении и устойчивом развитии лесных экосистем.

Collected articles include materials of the international scientific and practical conference, dedicated to the 20th anniversary of State national natural Park «Burabay» creation. Materials of the conference are given in the list of authors according to the general program.

The collection is intended for foresters, geographers, ecologists and demographers, as well as for teachers, students of higher educational institutions and for the broad audience interested in the innovations in the conservation and sustainable development of forest ecosystems.

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Уважаемые коллеги!

Перед вами сборник материалов Международной научно-практической конференции «Инновации в сохранении и устойчивом развитии лесных экосистем», посвящённой 20-летию образования Государственного национального природного парка «Бурабай».

Проведение нашей Международной научно-практической коференции в пос. Бурабай планировалось провести со 2 по 5 сентября 2020 года. Мы с большой ответственностью и радостью готовились в этому значимому для нас событию, рассчитывали на плодотворную работу участников, интересные доклады, а также планировали проведение интересной практической части и ознакомительные экскурсии по нашим прекрасным местам. К сожалению, осуществление очной встречи стало невозможным из-за объявленной ВОЗ пандемии COVID-19.

Материалы сборника сгруппированы в соответствии с основными научными направлениями конференции:

Инновационные подходы и решения для снижения уязвимости лесных экосистем.

Природные и антропогенные риски уязвимости лесных экосистем.

Защита леса на особо охраняемых природных территориях.

Водные ресурсы, их роль в условиях изменения климата для лесных экосистем.

Современное состояние экосистем национального парка и биоразнообразие.

Статьи представлены на казахском, русском и английском языках.

Сборник материалов Международной научно-практической конференции «Инновации в сохранении и устойчивом развитии лесных экосистем» опубликован при поддержке Управления делами Президента Республики Казахстан.

Желаем всем авторам статей плодотворной научной и практической деятельности в будущем и благодарим за проделаную работу во благо нашей природы.

Всего доброго.

Организационный комитет конференции

ИСТОРИЯ ОБРАЗОВАНИЯ НАЦИОНАЛЬНОГО ПАРКА

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Лесное хозяйство в Боровском горно-лесном оазисе имеет длительную историю.

В зимнее время леса Борового служили пристанищем для кочевников, которые с табунами зимовали в лесных урочищах, выпасая скот в течение всей зимы в лесах. Эксплуатация лесов в те далекие времена носила стихийный характер и заключалась в пользовании древесиной по мере надобности, без каких-либо ограничений.

При заселении края русскими переселенцами рубка леса превратилась в настоящее лесоистребление. Много леса было вырублено на строительство таких крупных поселений, как станицы Котуркульская и Щучинская, и других населенных пунктов. Неумеренные рубки в это время привели к образованию пустырей и прогалин, особенно многочисленных на территории теперешнего Мирного и Золотоборского лесничеств.

Очень сильно в те времена леса страдали от пожаров, которые были подлинным бичом для лесов и нередко приводили к опустошению огромных лесных площадей. В очень сильной степени леса подвергались повреждениям энтомовредителями и грибными болезнями. Угроза полного истребления лесов в степной местности заставила лесной департамент Министерства земледелия и государственных имуществ царской России приступить к отчуждению лесов в казну и организации в них государственного (казенного) лесного хозяйства. На организацию и упорядочивание лесного хозяйства большое влияние оказала открытая в 1898 году Боровская лесная школа (рисунок 1).

Рисунок 1 – Боровская лесная школа

Со времени организации Боровского казенного лесничества органы управления лесами претерпели множество всевозможных изменений и реорганизаций.

С территорией национального парка «Бурабай» связаны жизни и поэтическое наследие Биржана, Акан-сери, Балуан-Шолака, Ибрая Сандыбаева, Сакена Сейфуллина, вошедшие в золотой фонд казахской культуры.

В 1849 году была основана Котыркольская станица (ныне Катарколь), а через год образован поселок Щучье (ныне город Щучинск).

В 1870 году казак Зубов построил водяную мельницу на речке Громатухе между озерами Боровое и Большое Чебачье. Так возникло поселение, будущая станица Боровская (рисунок 2).

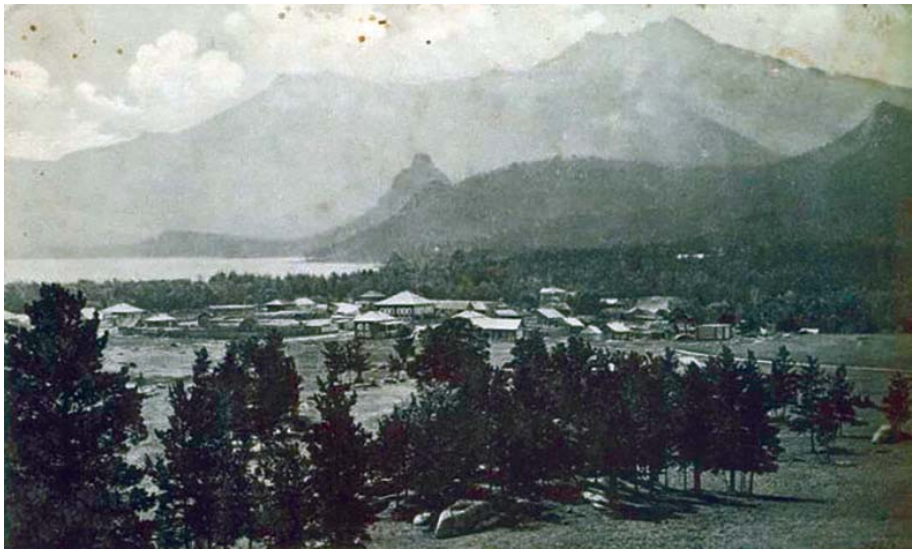

Рисунок 2 – Станица Боровская

В былое время водная система Боровской группы озер выглядела следующим образом: озеро Щучье имело сток в южной части через р. Кылшакты в озеро Копа, из озера Катарколь вытекала речка Сары-Булак и впадала в озеро Боровое, лежащее значительно ниже его. По этой речке можно было проехать на лодке. На реке Громотухе, соединяющей озеро Боровое с озером Большое Чебачье, был водопад и стояли 4 мельницы. Озеро Большое Чебачье соединялось с озером Малое Чебачье двумя протоками, на месте одного из которых позднее образовалось озеро Майбалык. Излишек воды из озера Большое Чебачье изливался через проток в озеро Акколь (Беленькое) и далее в Чебак-Куль и другие степные озерца.

В конце XIX столетия прекратилась связь озер Большое Чебачье и Малое Чебачье и отшнуровалось озеро Майбалык. По словам переселенцев (Пиотровский и Лембек, 1923 г.) произошло это после 1878 г., когда значительно понизился уровень воды в озерах. Примерно в это же время уровень озера Щучье понизился настолько, что речка Кылшакты, вытекавшая в южном конце, потеряла с ним связь (сток прекратился в 1920 г., но до 1930 г. поддерживался искусственно для работы стоявших на речке мельниц.

И. Я. Словцов в 1878 г. отмечал, что «Катарколь, Боровое и Щучье давно известны как превосходные курорты для слабо грудных и чахоточных …», однако лишь в 1910 г. доктор Емельянов открывает в Боровом первый санаторий и кумысолечебницу. К 1913 г. здесь собирались на лечение до 2 тыс. человек в год, приезжая из отдельных уголков Западной Сибири и Приуралья.

Появились летние санатории, магазины, столовые, кинотеатр. В 1920 году курорт был национализирован. В 1920–1930 годы курорт Боровое получил высокую известность, в 1938 году фотографии с его изображением были представлены на всемирной выставке в Нью-Йорке.

Со времени образования Боровского лесничества и Боровской лесной школы возрастает внимание к Боровому со стороны омских естествоиспытателей и поборников охраны природы. Среди них одним из первых заслуженно считается ученый-лесовод В. Б. Барышевцев, которому принадлежала первая мысль создания в Боровом заповедника. По его инициативе состоялось постановление Лесного совета по управлению землями и государственными имуществами Акмолинской, Семипалатинской областей, который в декабре 1915 года вынес решение «О выделении в памятники природы кряжа Кокшетау, горы Синюхи и скалы с озером Аулье-куль, находящихся в Боровском лесничестве». Однако это постановление не было выполнено. В полной мере эта идея осуществилась после 1925 года, когда в Боровом был создан государственный курорт «Боровое».

Также по инициативе В. В. Барышевцева в 1900–1917 гг. был проведен ряд работ по благоустройству Борового, построены дороги по северному берегу озера Боровое и восточному склону горы Кокшетау («Байкальская дорога»), каменный мост через речку Громотуху.

Госзаповедник «Боровое»

В конце 1920-х начале 1930 годов комплексная экспедиция. Ф. Ф. Шиллингера предложила создать в Боровском массиве государственный заповедник.

Организация заповедника «Боровое» началась в 1935 году (Постановление ВЦИК от 01.06.1935 г.). В мае 1938 года заповедник был закрыт, на всей его территории создан лесхоз, однако уже 27.06.1938 года Совнарком КазССР и ЦК КП(б) вновь восстановили его (см. карту-схему).

За время существования заповедника численность животных, особенно косули и сурка, значительно возросла. В 1937 г. в березовых колках появился заяц-русак. В 1938 г. в лесах заповедника была успешно акклиматизирована белка-телеутка. Из рыб в 1946 г. в оз. Боровое был выпущен балхашский сазан. Гнездились такие редкие птицы, как чернозобая гагара, серый журавль, черный аист, журавль-красавка. В степях стаями встречались дрофы и стрепеты. Широко был представлен мир хищных птиц – это беркут, орел-могильник, большой подорлик и др.

В годы войны в пос. Боровое были эвакуированы многие сотрудники Академии наук СССР. Здесь жили и работали крупнейшие ученые – как В. И. Вернадский, В. Н. Сукаев, Н. Ф. Гамалея, С. А. Бернштейн, Г. С. Струмилин, В. М. Алексеев, Н. Д. Зелинский. академик В. Н. Сукачев ознакомился с лесорастительными условиями и опубликовал о них две статьи.

К сожалению, поиски гармоничного сочетания природоохранной и рекреационной деятельности были прерваны в 1951 году. Как и многие другие, заповедник «Боровое» был ликвидирован. На его территории в 1952 г. были образованы лесхоз и опытное охотничье хозяйство (рисунок 3), и с этого момента природоохранная деятельность и развитие курорта проводились автономно и несогласованно.

Рисунок 3 –
Боровское лесоохотничье хозяйство, 1962 г.

Рисунок 4 – Завоз козерогов

В этот период большую известность получил опыт по акклиматизации и реакклиматизации животных. Были завезены в 1960 г. в порядке реакклиматизации маралы, 10 козерогов (рисунок 4), в 1961–1963 годах – 17 архаров. В порядке реакклиматизации в 1964 году были завезены 10 особей бурого медведя. В порядке акклиматизации были завезены глухарь в 1965–1968 годах,

европейский благородный олень в 1966 году, кабан в 1972 году, которые сейчас свободно обитают на территории национального парка.

В этот же период в озера Боровской группы были акклиматизированы несколько ценных видов рыб: рипус, пелядь, сиг, линь, лещ, сазан, карп, толстолобик, белый амур, судак.

К середине XX века в результате изменений климата и негативного влияния антропогенных факторов (распашка целинных земель, сведение лесов, перевыпас, увеличение водозабора, интенсивная охота) исчезли бобр, архар, марал, росомаха, сибирский козерог, бурый медведь, дрофа, стрепет, чернозобая гагара, краснозобая казарка, кудрявый пеликан, черный аист, журавль-красавка, скопа, белоглазый нырок, савка, лебедь-кликун, сибирская клуша, черный турпан. Ключевая роль в истории научного изучения и освоения природы Северного Казахстана, в организации здесь первых природоохранных и рекреационных учреждений принадлежит Боровому.

Основные вехи истории лесного хозяйства в Боровом таковы:

1898 г. –образование Боровского казенного лесничества и Боровской лесной школы;

1902 г. – первое лесоустройство Боровского лесничества;

1903 г. – лесоустройство Акылбайской лесной дачи;

1918 г. – организация Боровского учебного лесничества;

1919 г. – организация Золотоборского лесничества;

1924 г. – открытие Боровского лесного техникума;

1935 г. – организация Боровского государственного заповедника;

1952 г. – ликвидация Боровского государственного заповедника;

1952 г. – организация Боровского лесхоза;

1953 г. – ликвидация Котуркульского лесхоза с передачей территории Боровскому лесхозу;

1953 г. – организация Котуркульского лесничества;

1957 г. – организация Боровского охотхозяйства на базе Боровского, Акылбайского и Учебного лесничеств;

1957 г. – организация Золотоборского лесхоза;

1957 г. – организация Мирного и Приозерного лесничеств в составе Золотоборского лесхоза;

1959 г. – организация Бармашинского опытного лесного хозяйства КазНИИЛХ на базе Учебного лесничества;

1962 г. – организация опытно-показательного лесоохотничьего хозяйства «Золотой бор» на базе Золотоборского лесхоза и Боровского охотхозяйства;

1968 г. – организация Боровского лесоохотничьего хозяйства;

1997 г. – образование Природно-оздоровительного лесного комплекса «Бурабай»;

2000 г. – создан Государственный национальный природный парк «Бурабай».

Национальный парк является природоохранным государственным учреждением, входящим в систему особо охраняемых природных территорий республиканского значения и находится в ведении Управления делами Президента РК.

Основные задачи национального парка «Бурабай»: сохранение целостности экосистем, эталонных и уникальных природных комплексов и объектов, памятников истории, культуры и других объектов исторического наследия; восстановление нарушенных природных и историко-культурных комплексов и объектов.

В настоящее время общая площадь национального парка составляет 129 299 га.

За 20 лет образования парка мы достигли многого:

проведена реконструкция центрального офиса ГНПП «Бурабай»;

построена новая производственная база;

построены 3 новых кордона;

построены пешеходная и велосипедная дорожки с мостиками и переходами которая защищает растения и почву от вытаптывания и деградации, эта дорожка вносит весомый вклад в сохранение биоразнообразия;

проведена реконструкция питомника с созданием оросительной системы;

проведено функциональное зонирование территории ГНПП «Бурабай»;

установлена охранная зона вокруг национального парка общей площадью 377 166 га, куда включено множество населенных пунктов, среди которых наиболее крупные г. Щучинск, пос. Бурабай, села Катарколь, Акылбай и другие;

установлена водоохранная зона для 8 озер национального парка;

осуществлено расширение территории национального парка путем присоединения земель ГУ ЛХ «Буландинский»;

проведены лесовосстановительные работы на площади 851 га, покрытые лесом площади за 20 лет увеличились более чем на 65%;

численность диких копытных животных возросла более чем на 60%;

обнаружен новый вид земноводной амфибии, ранее нигде не упомянутый;

разработан и утвержден план управления ГНПП «Бурабай»;

разработан паспорт ГНПП «Бурабай»;

разработана символика ГНПП «Бурабай»;

проведен инициативный экологический аудит на территории национального парка;

проведена инвентаризация флоры национального парка;

получена аккредитация субъекта научной и (или) научно-технической деятельности;

из числа подведомственных организаций Управления делами Президента РК и особо охраняемых природных территорий республики ГНПП «Бурабай» одним из первых прошло добровольную сертификацию в части системы управления качеством, системы менеджмента окружающей среды, контроля охраны труда и здоровья персонала, системы энергетического управления;

для работников национального парка созданы все условия для продуктивного труда: все подразделения оснащены компьютерной техникой, подключены к Интернету и электронной почте;

постоянно обновляется материально-техническая база, оснащение соответствующих подразделений пожарной техникой, транспортными и плавсредствами, современными средствами связи;

инспекторский состав увеличен более чем на 50% и полностью обеспечен форменным обмундированием;

разработаны и утверждены 29 турмаршрута;

внедряется система раннего распознавания пожаров Smart National Park Burabay;

проведена инвентаризация постороннего землепользования по границам ГНПП «Бурабай»;

на 6 озерах оборудованы гидрологические посты, метеостанции.

1. ПРИРОДНЫЕ И АНТРОПОГЕННЫЕ РИСКИ УЯЗВИМОСТИ ЛЕСНЫХ ЭКОСИСТЕМ, ИННОВАЦИОННЫЕ ПОДХОДЫ

УДК 630.43

NEED FOR THE DEVELOPMENT OF PRAGMATIC AND SCIENCE-BASED SOLUTIONS FOR FOREST MANAGEMENT AND FIRE MANAGEMENT IN CENTRAL EURASIA

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Summary. The article reviews the scientific and technical activities undertaken jointly by the Global Fire Monitoring Center (Germany), the Sukachev Institute of Forest, SB RAS (Russia) and its Regional Central Eurasia Fire Monitoring Center (RCEFMC), the Aerial Forest Fire Center Avialesookhrana (Russia), the Kazakh Institute for Forest Resources Research and Burabai State National Natural Park, the Fire Management Resource Center – Central Asia Region (FMRC-CAR) (Mongolia) and the Eastern Europe Fire Monitoring Center (REEFMC) (Ukraine). It is stated 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. The paper summarizes the activities and discussions at the science-policy-practitioners interface. It starts with the first scientific cooperation of boreal countries in the former Soviet Union and the Russian Federation in 1991, reflects the process of scientific and technical consultations since then, and ends at the launch of a research and development project entitled "Nature-based silvicultural and fire management methods for increasing the resilience of pine stands to drought and wildfire" (RESILPINE) in 2020. The results of the scientific-technical consultations are calling for decisive political decisions and pragmatic management solutions.

Keywords: forest fire management, prescribed burning, climate change.

Introduction. Sustainable management and protection of forest resources are key elements of the forest policies of the countries temperate-boreal Eurasia. In the largest country of the region – the Russian Federation, which hosts more than 1.3 billion hectares (ha) of forests – 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. 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 a threat to sustainable forest management and utilization, and may lead to large, uncontrollable outbreaks of pests and diseases (Goldammer and Furyaev, 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 (Goldammer, 2013a; 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 of 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 (FIRESCAN): 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.

2012-2014: Several national and regional consultations and international conferences addressed the theme of integrated fire management from national (Russia) level to the global level (Goldammer, 2013b). 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 ends with the launch of a project entitled "Nature-based silvicultural and fire management methods for increasing the resilience of pine stands to drought and wildfire" (RESILPINE), a cooperative research and development project by German and Ukrainian scientists.

1. The First International Fire Management Week – Russian Federation 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 the Global Fire Monitoring Center (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).

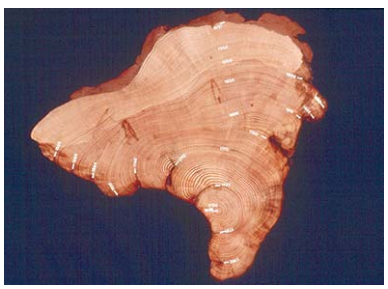
During this event the latest and up-to-date state of the art of fire ecology and advanced fire management methods on the use of prescribed fire for wildfire hazard reduction in temperate-boreal Eurasia were presented and discussed between scientists of the V.N. Sukachev Institute of Forest, practitioners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



Figures 1–3 – The structure of forests and the amount of combustible materials (fuels) determine fire behavior and fire impacts. For instance, non-utilized materials of thinning operations or naturally accumulated fuels provide the energy potential for destructive crown fires






Figures 4–10 – Open natural pine and larch forests of Central Eurasia have been shaped by natural fires: Recurrent short- to medium-interval surface fires (caused by lightning) historically shaped open, wide-spaced forests characterized by a low potential of crown fires.
Evidence is given by dendrochronological (tree ring) analyses, which show the historic frequency of fires.
Example: The Bor Forest Island Fire Experiment, Krasnoyarsk Krai, Russian Federation

Figures 11–12 – Surface fires in Burabai National Park (14 May 2020) and in Mongolia (16 April 2020): If recurrent surface fire have kept the fuel loads at a low level, the severity of fires may not be sufficient to damage or kill the stand. However, during extreme drought and deep burning humus layers the fires may weaken the trees and attract secondary pests and diseases

Figures 13–15 – Prescribed burning for reducing fuel loads in pine forests of Russia (2012) (left), Mongolia (2008) (middle) and Ukraine (2015) (right) – this technique simulates recurrent natural surface fires and reduces the risk of crown fires and ground fires burning deep in the organic layers and potentially weaken or kill trees

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 Experiment 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 (FIRESCAN 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 (GFMC, 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.

2. The Second International Fire Management Week – Russian Federation 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 townships. 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 (GFMC, 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 clearcuts;

– 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.

3. International Congress "Forest Fire and Climate Change: Challenges for Fire Management in Natural and Cultural Landscapes of Eurasia" – Russian Federation 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 United Nations International Strategy for Disaster Reduction (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;

Global Fire Monitoring Center (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:

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.

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

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.

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 impact 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 Eastern Europe and Central Asia they are either unknown or cannot 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 (GFMC, 2013c):

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).

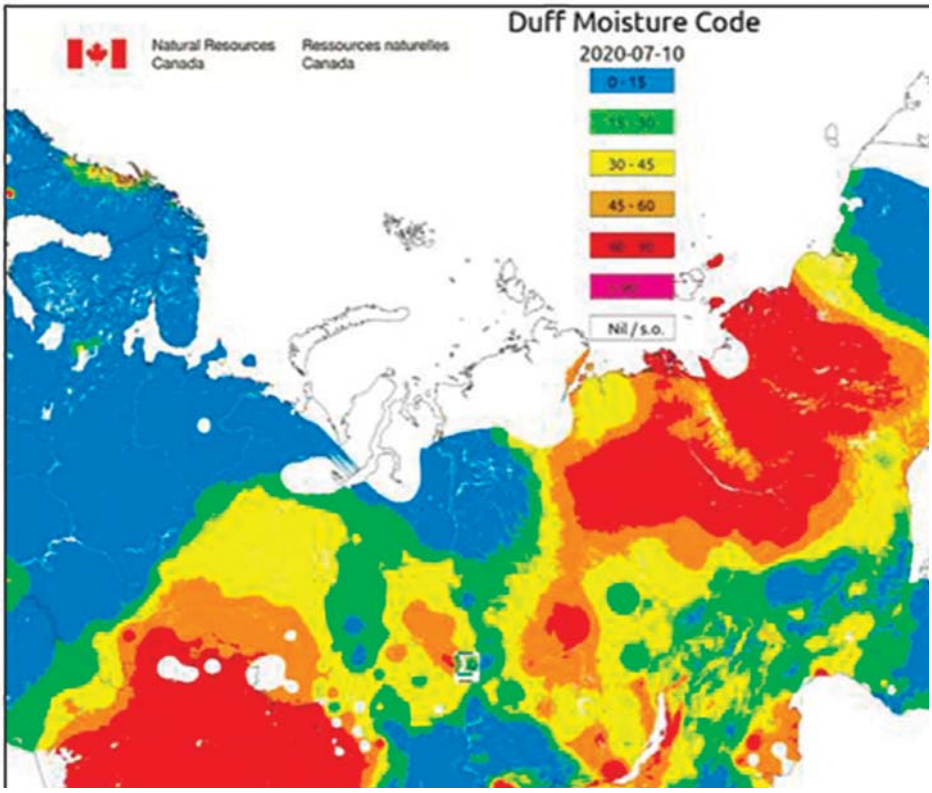
8. A dialogue must be established at regional level between relevant agencies that encourages participatory approaches by inviting representatives of civil society to define fire management solutions at landscape levels (including forests, agricultural lands, abandoned agricultural lands, other lands).

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 German Federal Ministry of Food and Agriculture (BMEL).

Reality 2020. The years after issuing the Novosibirsk Warning revealed an acceleration of the consequences of climate change on wildfire risk. The fire danger warning systems of the Russian Federation and the Eurasia Experimental Fire Weather Information System show the situation in July 2020. The meteorological fire danger in the Northern Latitudes – in the subarctic belt of Eurasia – is increasing (figures 13 and 14).



Figures 16–17 – Fire danger warning maps of the Russian Federation and the Eurasia Experimental Fire Weather Information System predicting the wildfire risk for late June and early July 2020

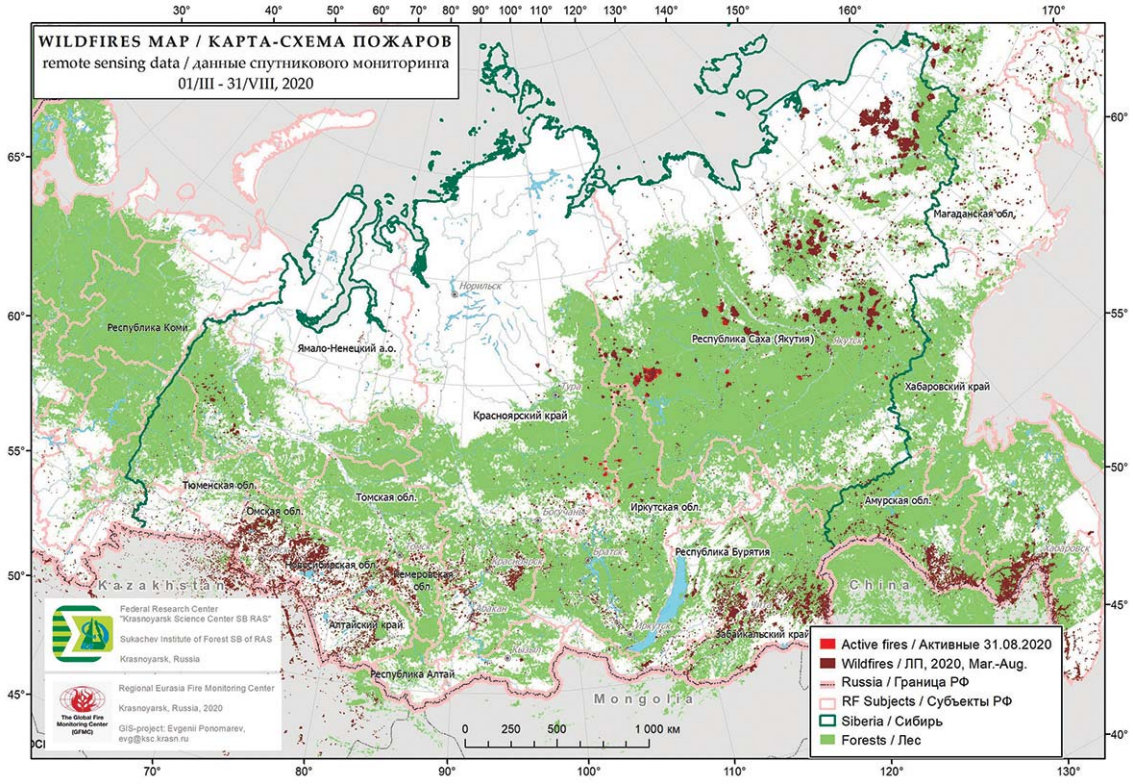


Figure 18 – Locations of wildfires in the Russian Federation derived from satellite sensors and processed by the Regional Central Eurasia Fire Monitoring Center (RCEFMC), Forest Fire Research Laboratory, V. N. Sukachev Institute of Forest, SB RAS. The map shows high fire activity in the Northeast of the country, both in forests and subarctic tundra ecosystems. The map mirrors the high meteorological fire danger in the Northeast as forecasted (exemplarily) for end of June / early July 2020 (figures 16 and 17)

4. UNECE Regional Forum on Cross-boundary Fire Management (2013) – Recommendations. The results of the two Round Tables and the Novosibirsk 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. 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 Long-Range Transboundary Air Pollution (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.

5. Launch of the "International Wildfire Preparedness Mechanism" (IWPM) in Kazan, Tatarstan (2014) and the follow-up. 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. A message, based on the aforementioned cooperative global analysis "Vegetation Fires and Global Change" (GFMC, 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. The message to the international community was entitled:

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 hectares) globally every year. Other studies push this figure further estimating the total annual global area burned at more than 600 million hectares.

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.

In 2013 the UNECE decided to phase out the UNECE/FAO Team of Specialists on Forest Fire by 31 July 2014 after it had successfully completed its mission. In the rationale for this decision the UNECE stated: *The Regional Wildland Fire Networks covering the UNECE Region would continue to represent the interests of UNECE Member States in the Global Wildland Fire Network and the Wildland Fire Advisory Group and its associated bodies and activities.* 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.

Two years later, fire management experts working for the Council of Europe (through its European and Mediterranean Major Hazards Agreement) and the Organization for Security and Cooperation in Europe (OSCE) to re-establish a Regional Team, which would serve the Member States of the Council of Europe – in continuation of the mission of the former UNECE/FAO Team. It was also proposed that such a newly established Team would work in close cooperation with the UN Office for Disaster Risk Reduction (UNISDR) and the UNISDR *Global Wildland Fire Network / Wildland Fire Advisory Group*, as well as with the OSCE participating States through the OSCE Secretariat. On 30 October 2017, the GFMC proposed the establishment of a *Eurasian Team of Specialists on Landscape Fire Management* and to discuss and decide this proposal at the Joint Meeting of Directors of Specialised Centres and Permanent Correspondents of the EUR-OPA Agreement (Paris, 6-7 November 2017). The Team would be tasked to enlarging its scope of work from addressing *Forest Fires* to deal with the increasing complexity and interaction of fires affecting the intermix of natural landscapes, cultural landscapes and the industrial/urban landscapes of Europe that are becoming increasingly vulnerable to wildfires. The *Eurasian Team of Specialists on Landscape Fire Management* would work under the auspices of the GFMC in its function of the GFMC as a Specialized Euro-Mediterranean Centre under EUR-OPA and in continuation of its regional work under the OSCE and the global agenda of the UNISDR, currently and specifically addressing and supporting the implementation of the *Sendai Framework for Disaster Risk Reduction 2015-2030*.

The proposal was endorsed by the Joint Meeting of Directors of the Specialised Centres and Permanent Correspondents of the EUR-OPA Agreement and the participants of the International Conference "Protection of Human Settlements and Social Infrastructure from Wildfires" jointly organized by EMERCOM of Russia and UNISDR in Moscow, 14-15 November 2017. The inauguration meeting of the Team took place at the GFMC in 2018. The Team is coordinated and facilitated by the GFMC and the four Regional Fire Monitoring Centers / Regional Fire Management Resource Centers in the Regions of Southeast Europe / Caucasus, Eastern Europe, Central Asia, and Central Eurasia (covering central-eastern part of Russia and all neighboring Central Asian countries) which have been set up between 2010 and 2019 by the GFMC and seed funding of the Council of Europe / EUR-OPA and the OSCE, i.e. the:

– Regional Fire Monitoring Center for SE Europe / Caucasus (RFMC) (Skopje, the former Yugoslav Republic of Macedonia);

– Regional Eastern European Fire Monitoring Center (REEFMC) (Kyiv, Ukraine);

– Fire Management Resource Center – Central Asia Region (FMRC-CAR) (Ulaanbaatar, Mongolia);

– Regional Central Eurasia Fire Monitoring Center (REFMC) (Krasnoyarsk, Russia).

The main tasks of the Team will include:

– Provision of scientific-technical expert advice and guidance of governments and specialized agencies of Europe, with emphasis on the regions of Eastern Europe, South Caucasus and Central Asia, in developing national fire management policies and derived implementation strategies and action plans;

– Provision of expert advice in the development of cross-sectoral / inter-agency collaboration mechanisms in landscape fire management;

– Provision of scientific advice in transdisciplinary landscape fire research;

– Provision of expert advice and inputs in capacity building for specialized agencies and civil society, notably at community and volunteer levels, both at national and regional levels;

– Facilitation of enhancing inter-operability, effectiveness and efficiency of transboundary, regional and cross-regional cooperation in fire management.

6. The 6th International Wildland Fire Conference and 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 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), 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 (GFMC, 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.

7. The 7th International Wildland Fire Conference, Campo Grande, Brazil, November 2019: Call for Building Sustainable and Fire-Resilient Societies and Landscapes. The 7th International Wildland Fire Conference "Facing Fire in a Changing World: Reducing Vulnerability of People and Landscapes by Integrated Fire Management" took place in Campo Grande, Mato Grosso do Sul, Brazil, between 28 October and 1 November 2019. The conference was attended by more than a thousand government officials, scientists, practitioners, the private sector and civil society from 37 countries, and by UN agencies and other international and regional organizations. The 7th conference in Brazil evaluated three decades of international cooperation facilitated by these conferences, their aim to create a global science-policy-practitioners interface, the achievements and the gaps in fire management globally. The Campo Grande Statement sent out another alert to the public and to policy makers, very much in with the outcomes of the Novosibirsk Conference of 2013. The conference participants concluded (GFMC, 2019):

In response to fire and smoke episodes, people around the world are becoming concerned about wildfires. The participants of the conference confirmed that in many regions of the world, wildfires are a growing threat to communities and to natural, cultural, rural, urban and industrial landscapes. The problem is increasing due to the consequences of social, economic and ecological change (land-use change, demographic change, ecosystem degradation), as well as climate change. This is impacting human health and security and resulting in the loss of public and private assets, including critical infrastructure. Current risk governance and institutional arrangements are inadequate to cope with this growing trend. Cross-sectoral approaches are required.

The paradigm of addressing the problem through individual and disconnected services and actions in fire prevention or suppression should be reframed. Unified and integral planning must ensure and strengthen societal, environmental and economic resilience to landscape fires by addressing:

– Risk governance and ownership;
– Dialogue of knowledge, including traditional and indigenous knowledge;
– Gender, diversity and inclusion;
– Socioeconomic innovation in rural landscapes, favoring nature-based solutions;
– Strengthening local action;
– Creation of resilient ecosystems and communities.

Decision-making must be evidence-based and supported by monitoring and evaluation systems. Implementation should be coherent, cohesive and coordinated.

The integrated cross-sectoral approach described above supports the Sustainable Development Goals, the goals of the Paris Agreement and the Sendai Framework for Disaster Risk Reduction 2015-2030. This approach would be further strengthened by an appropriate United Nations instrument.

8. Nature-based silvicultural and fire management methods for increasing the resilience of pine stands to drought and wildfire in Ukraine – the RESILPINE project. The consequences of regional climate change on the future of Ukrainian Forests is uncertain. The uncertainty refers to the impact of climate variability on the natural potential vegetation (including forest) types to evolve, the species composition of forests and their resilience to biotic and abiotic stress factors, such as pests and

disease, extreme wind events and wildfires. The project "Nature-based silvicultural and fire management methods for increasing the resilience of pine stands to drought and wildfire in Ukraine" (RESILPINE), which was initiated in 2020, aims at testing two nature-based solutions aimed at enhancing wildfire resilience of natural and planted Scotch pine (*Pinus sylvestris* L.) forests. In addition, the conservation and restoration of non-forest (open land) ecosystems of high conservation value, which are threatened by invasion / encroachment of tree cover, will be included.

Under these circumstances, testing nature-based solutions aimed at enhancing wildfire resilience of natural and planted Scotch pine (*Pinus sylvestris* L.) forests are important. In addition, the conservation and restoration of non-forest (open land) ecosystems of high conservation value, which are threatened by invasion / encroachment of tree cover need additional attention as well. We consider following methodologies to be tested during over the project period of two years:

Wildfire risk reduction of pine forest by enrichment with broadleaved species

Pine forest plantations established in Central Europe during the 19th and 20th centuries have resulted in the formation of stands that are highly susceptible to fire, i.e. characterized by high wildfire hazard (due to high fuel loads / high loads of easily combustible materials), characteristics of microclimate (rapid desiccation / fuel moisture reduction in periods of precipitation deficits / drought). Experience in Germany reveals that underplanting (under canopy) / enrichment of pure pine stands with broadleaved species such as beech (*Fagus sylvatica* L.) results in an understory microclimate of higher humidity and a shaded understory characterized by a litter and humus layer of reduced flammability. The experiences gained in Germany could be evaluated and experimental stands in Ukraine established.

Wildfire risk reduction of pine forest by applying nature-based integration of prescribed burning

In Ukraine extended areas of lands have been afforested by Scotch pine (*Pinus sylvestris* L.). These stands are located within the natural range of this species (stretching from Scotland in Western Europe to the Far East of the Russian Federation). Similar to Central Europe these forest plantations have been established with up to 30,000 to 40.000 seedlings / ha historically, more recently between 7,000 and 8,000 seedlings / ha, and subsequent silvicultural treatment aiming at producing limbless high-quality lumber. Consequently, these stands are characterized by high fuel loads including ladder-fuels, allowing the development of surface fires and crowning fires of high intensities, especially in the young and middle age classes. In addition to the high wildfire risk these stands are prone to windthrow and windbreak due to the crown shape in higher age classes.

In the natural range of *Pinus sylvestris* in Central Asia (Siberia and adjoining regions of Mongolia, Kazakhstan and Northern China), natural pine forest ecosystem of the "light taiga" have been shaped by recurrent natural (lightning-caused) wildfires. Dendrochronology and stand analyses have revealed that these fires have significantly shaped the formation of open, park-like stands, characterized by solitaire-type of tree stands with low fuel loads and crown shapes. Reduced numbers of individual trees per ha also result in reduced water competition. These features make these open pine stands resilient to wildfires, extreme wind events and drought, especially under continental climate conditions and poor sites.

Safeguarding biodiversity of open land ecosystems of high-conservation value against invasion of trees and development of forest

While the protection and securing of forests of Ukraine in a changing climate era will receive high attention, the role of open-land ecosystems, such as grasslands that are providing resting and breeding ground for bird populations, or dwarf shrub ecosystems like heathlands (e.g., *Calluna vulgaris*) that bear floristic and faunistic habitats of high conservation value. These ecosystems have been created by centuries of intensive land use such as grazing, mowing, biofuel utilization and fire application – practices that have been abandoned in Central Europe, notably in Germany, prescribed fire is increasingly applied to maintain and restore open-land habitats, which are not cultivated any longer, and where prescribed fire is used as a substitution tool for maintaining these valuable open ecosystems.

In Germany it has also been proposed and demonstrated that belts of these conservation areas could serve as fuel breaks between forest stands of high wildfire risk. These fuel breaks would avoid to

construct and maintain ploughed firebreaks that will expose the mineral soil and thus becoming subject to wind and water erosion.

Strategic treatment of fuel breaks between forests, agricultural lands and settlements

The concept of creating open, park-like stands that are intensively treated for fuel reduction (= wildfire hazard reduction) would have highest priority at the interface with agricultural lands. Agricultural burnings are a major source of forest fires. The concept of creating open, park-like stands should be concentrated strategically as belts along the agricultural interface and along forest roads used by the public. On these belts specific attention will be given to fuel reduction and intensive thinning / selective cutting by mechanical means and the use of prescribed fire.

An additional option could be tested by creating a silvo-pastoral concept in which these belt would be used as pastures for animal husbandry. In Central and Eastern Europe this concept has been abandoned completely and is generally not accepted by foresters. However, agrosilvo-pastoral land-use concepts are increasingly debated and used in the Mediterranean region (including Southern Europe) and in Western North America. Targeted grazing by livestock (cattle, sheep, goats) would allow a combined land use under canopy shade.

Such open forest belt would also be strategically planned around settlements that are located inside forests, such as weekend / datcha and small farm estates. Here the open forest belts would also serve as protection of the settlements because wildfires would be less intense and could be controlled easier as compared to dense stands.

9. Conclusions: Challenges for the forest and fire science community and policy makers. The scientific-technical cooperation in Central Eurasia have revealed the need for targeted action in forest and landscape management. 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 regard to the theme of the conference "Innovations in the Conservation and Sustainable Development of Forest Ecosystems" organized at the occasion of the 20th anniversary of the establishment of Burabai State National Nature Park, this paper has followed-up activities jointly organized or attended by the authors in the Eurasian region and globally.

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 Eurasia are dramatically affecting fire regimes. More changes are expected, such as the anticipated changes of forest composition, migrations of species and forest zones, thawing of permafrost and the migration of wildfire activities to the subarctic zone – a trend, which has become evident in 2019 and 2020.

Pragmatic solutions are needed to stabilize the forests of Central Eurasia 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 Central Eurasia'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.

With the rapidly changing global and regional climate change, the forest ecosystems of Central Eurasia are at high risk. The consequences of increasing occurrence and severity of droughts include the danger that after wildfires or clearcuts the affected forest ecosystems may not recover and become replaced long-term by steppe ecosystems. Thus, forestry and fire management practices need to adjust to this foreseeable trend by searching solutions for drought- and fire resilient stands in which nature-based silvicultural practices – including the use of close-to nature prescribed burning practices – would allow halting this dangerous trend.

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НЕОБХОДИМОСТЬ РАЗРАБОТКИ ПРАГМАТИЧЕСКИХ И НАУЧНО ОБОСНОВАННЫХ РЕШЕНИЙ ДЛЯ УПРАВЛЕНИЯ ЛЕСАМИ И БОРЬБЫ С ПОЖАРАМИ В ЦЕНТРАЛЬНОЙ ЕВРАЗИИ

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Аннотация. Рассматривается научно-техническая деятельность, осуществляемая Глобальным центром мониторинга пожаров (Германия) совместно с Институтом леса имени Сукачева СО РАН (Россия) и его Региональным центром мониторинга пожаров Центральной Евразии (RCEFMC), Авиационным лесопожарным центром «Авиалесоохрана» (Россия), Казахским институтом исследования лесных ресурсов и Государственным национальным природным парком «Бурабай», Ресурсным центром управления пожарами – регион Центральной Азии (FMRC-CAR) (Монголия) и Центром мониторинга пожаров Восточной Европы (REEFMC) (Украина). Отмечается, что научная основа для принятия решений имеется, но не используется в достаточной степени для внедрения практических управленческих решений или стратегических подходов в области управления лесами и пожарами, которые позволили бы устранить последствия изменения климата. Кратко излагаются мероприятия и результаты обсуждения на стыке наука – политика – практические работы. Она начинается с первого научного сотрудничества бореальных стран бывшего Советского Союза и Российской Федерации в 1991 году, отражает процесс научно-технических консультаций с тех пор и завершается началом в 2020 году научно-исследовательского проекта «Методы лесоводства и борьбы с пожарами на основе природы для повышения устойчивости сосновых насаждений к засухе и лесным пожарам» (RESIDPINE). Результаты научно-технических консультаций требуют решительных политических решений и прагматичных управленческих решений.

Ключевые слова: управление лесными пожарами, предписанное сжигание, изменение климата.

СОДЕРЖАНИЕ

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И УСТОЙЧИВОМ РАЗВИТИИ
ЛЕСНЫХ ЭКОСИСТЕМ

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