2015 세계산불총회
INTERNATIONAL
WILDLAND FIRE CONFERENCE
KOREA

PROCEEDINGS

아시아산불네트워크 창립 기념 국제산불심포지엄

International Symposium on Commemorating Establishment of the Pan-Asia Wildland Fire Network

Date October 24, 2013

Venue Korea Forest Research Institute, Seoul, Republic of Korea

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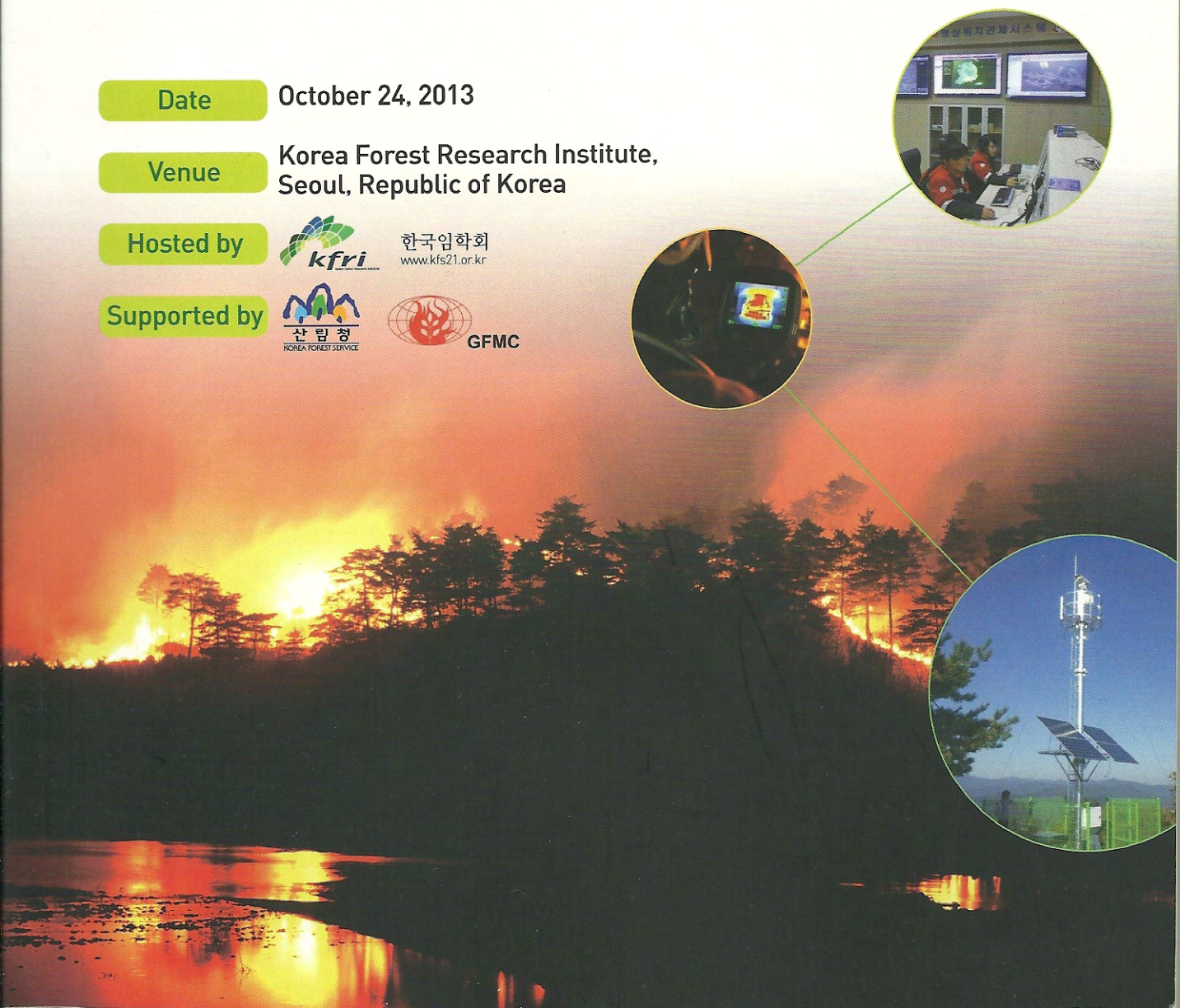

Opening Address

- 2013. 10. 24, Forest Science Exhibition Hall, KFRI -

Yoon Young-Kyoon, Ph. D.
Director General of the Korea Forest Research Institute

I would like to express my deep gratitude to the Minister of the Korea Forest Service, distinguished guests, speakers, forest fire experts from home and abroad to join today's symposium celebrating the establishment of the 「Asia Wildland Fire Network」.

My special thanks go to Dr. Johann G. Goldammer, Director of the Global Fire Monitoring Center under UNISDR, Dr. Bambang H. Saharjo, Chair of the Regional Southeast Asia Wildland Fire Network, Dr. Sundar P. Sharma, Chair of the Regional South Asia Wildland Fire Network, Andrey M. Eritsov, Chair of the Regional Central Asia Wildland Fire Network, representatives from Northeast Wildland Fire Asia Network, China, Japan, Mongolia and other countries, Dr. Park Pil-Sun from Seoul National University, Dr. Lee Yong-Hee from the National Institute of Meteorological Research and other prominent forest fire experts.

I also especially recognize today's moderators, Dr. Lim Gyu-Ho from Seoul National University and Dr. Kim Eung-Sik from Hoseo University and appreciate other participants working for wildland fire research and administration.

As you may be aware, recently, the world is suffering from unprecedented massive forest fires. A large-scale forest fire occurred in this June, in Arizona, the U.S. claimed lives of 19 fire fighters. Another forest fire in California in August burnt Yosemite National Park and other forest areas 1.7 times the size of Seoul to ashes.

Also, a huge wildland fire in Indonesia spread fog and smog into neighboring countries, causing enormous damages. As such, the scope and pattern of forest fires have become greater and more extensive, and subsequent damages such as smog goes beyond a national border. As a result, forest fires are no longer a problem of a single nation, but an important global issue.

In order to effectively address forest fires, countries around the globe need to make concerted efforts in sharing specialized knowledge, experiences and suppression resources.

Against this backdrop, today's symposium to establish and celebrate the 「Asia Wildland Fire Network」 is all the more timely and significant. I am confident that this symposium would be a useful venue where participants can learn fire prevention strategies and policies from each other and devise measures for international cooperation.

It is my sincere hope that we will come up with effective forest prevention strategies through up-to-date information and policies of each network and practical discussion among participants.

Once again, let me thank all of you who have shown great support in preparing this event.

Welcome Address

Shin Won-Sop, Ph. D
Minister of Korea Forest Service

Ladies and gentlemen,

First of all, let me whole-heartedly welcome distinguished guests to the 'International Symposium on Wildland Fire' celebrating the founding of the Asia Wildland Fire Network. I am especially grateful to Dr. Johann G. Goldammer, Director of the Global Forest Fires Monitoring Center, representatives from Regional Asia Wildland Fire Networks, and other forest fire experts who have come a long way to attend this event.

Now, we are living in a world where the risk of massive forest fire increases due to climate change, population growth and drastic land use conversion. Also, the impact of forest fire is not limited to the affected nation, but widely spread to neighboring countries. At this juncture, the establishment of 『Asia Wildland Fire Network』 and the international symposium marking this occasion is very important and timely.

In every spring, forest fire frequently occurs in Korea. This year as well, fires started in Pohang, Ulsan and other urban areas caused massive human and property losses. The Korean government makes various efforts to prevent and suppress forest fire at early stage. We set up 10 forest aviation offices nationwide so that fire extinguishing helicopters are mobilized to the fire site within 30 minutes. Also, about 22,000 personnel in charge of forest fire monitoring and suppression is on call during the period of high forest fire risks. Furthermore, KFS operates 'forest fire control system' for real time fire monitoring and early response, 'real time image information system' for sharing information about fire situation real time, and

‘forest extinguishment facility’ for protecting traditional temples and cultural assets from wildland fire.

A huge forest fire in the Yosemite National Park in Arizona, the U.S., in this June inflicted disastrous damages, killing 10 fire fighters, destroying extensive forest areas and even threatening the lives of giant sequoia trees which have grown there over thousands years. Smog and fog from forest fire started in Riau province, Sumatra, Indonesia seriously affected neighboring countries such as Malaysia and Singapore. As such, we witness large forest fires cause immense damages to countries across the world.

As you are well aware, forest fire is one of the most dangerous disasters affecting forests, a place for people’s lives, work and rest. It is true that cause and characteristic of each wildland fire are different and nations take different control policies accordingly. Nevertheless, if countries around the world share information, experiences, resources for fire suppression, we can respond to wildland fire more effectively.

In this sense, I expect that「Asia Wildland Fire Network」combining regional networks in Asia would greatly help us share forest fire information and effectively respond to transnational disasters such as fire-caused smog and fog.

Let me appreciate all of you who have worked hard to prepare this symposium, and I believe that this event will yield fruitful outcomes. Once again, I want to thank today’s participants for your gracious presence, and especially for foreign participants, I hope you enjoy beautiful autumn weather during your stay in Korea. I am looking forward to seeing you again in the 6th International Wildland Fire Conference in 2015.

Thank you.

Congratulatory Address

Prof. Dr. Dr.h.c.mult. Johann Georg Goldammer
Director, Global Fire Monitoring Center (GFMC)
Freiburg, Germany, fire@fire.uni-freiburg.de

Excellency, Honorable Minister Dr. Won-sop SHIN,

Honourable Director General Dr. Young-kyoon YOON

Honourable representatives of the Korea Forest Service and the Korea Forest Research Institute,

Honourable international representatives of Regional Wildland Fire Networks from China, Indonesia, Japan, Mongolia, Nepal, and the Russian Federation!

It is for the second time in 2013 that I have the privilege to attend and contribute to consultations on forest fire management hosted by the Korean forestry authorities, the Korea Forest Service and the Korea Forest Research Institute.

In January 2013 the "International Symposium on Strategy Development of Advanced Forest Fire Policy and Organization" convened leading national and international fire management specialists from the Republic of Korea, from GFMC, Greece, Macedonia, and the United Kingdom. The Symposium participants exchanged views, experiences and future needs of developing national policies and implementation strategies in fire management, and recommended to follow the principles of Integrated Fire Management. These principles would include cooperative approaches and work with land owners, land managers, peasants and other rural dwellers to prevent wildfires, to capacitate land managers to safely apply, where appropriate, prescribed burning, and to actively participate in the preparedness and response of unwanted and destructive fires. It was agreed that clear jurisdictions are needed to efficiently implement the principles of Integrated Fire Management and to reduce the risk of wildfires at landscape level. Forest

services and other rural land management services should be entrusted to lead these tasks.

While this Symposium in January 2013 addressed national-level policies and implementation strategies, we are now coming together and discuss how to continue and enhance the dialogue and exchange of fire management expertise and resources in the Asian region.

The overarching theme of the 2013 meeting of the UNISDR Pan-Asia Wildland Fire Network is "Setting up the Secretariat and Regional Fire Management Resource Centers in the Region".

What are the desirable means to continue the process of building up and enhancing the effectiveness of the framework for the Regional Networks under the umbrella of the Pan-Asian Wildland Fire Network? How can we strengthen efficient cooperation in wildland fire management among the Asian countries, notably by sharing experience, knowledge and resources?

The main topics of today's International Symposium and the Network Meeting on the following day include several steps that may be considered towards achieving this goal.

First of all the cooperative work between the Regional Wildland Fire Networks may require the establishment of a Secretariat for the Pan-Asian Wildland Fire Network. While the Korea Forest Research Institute, supported by the Korea Forest Service, has already taken the initiative by founding and convening a cluster of Regional Wildland Fire Networks, it may take only moderate additional resources to continue, but also formalize, this cooperative approach.

In this regard, a Secretariat for the Pan-Asian Wildland Fire Network would provide a sound institutional facilitation mechanism under which the forest services of neighbouring countries, apart of the founding members and initiators of the Regional Wildland Fire Networks, would increasingly become involved. A strong institutional cooperation among the neighbouring countries is required to bring the initial strategic views to implementation.

This is also a theme of the upcoming "UNECE Regional Forum on Crossboundary Fire Management" in end of November 2013, which will be held at the United Nations in Geneva and to which the Korea Forest Service has been invited. The intent of the Geneva Forum is to develop a UNECE-wide proposal to

establish mechanism to facilitate and enhance efficiency and efficacy of regional cooperation in fire management. However, the concept of the Forum has now been extended and other regions of the world are invited to provide their view, contribute and benefit from the first official UN Forum on International Cooperation in Fire Management.

Another important item to be discussed during the Symposium and the Network Meeting will be the establishment of Regional Fire Management Resource Centers in Northeast Asia, Southeast Asia, South Asia and Central Asia. Such Centers are needed to respond to the increasing demand on collection and distribution of data and information relevant to fire management among regional neighbourhoods, to facilitate capacity building in fire management at regional level and to exchange human and technical resources where needed.

In order to reach this goal it is necessary to agree on a common understanding of the themes to be addressed, a continuous flow of information both at institutional and at expert level, based on a common terminology. While most countries in West Europe, North America, Latin America and the Caribbean, Australasia and Africa are Indo-European languages and thus have common roots - this is entirely different in Asia. Asian languages like Korean, Japanese, Chinese, Russian, Nepalese, Burmese, Indonesian, Thai or Vietnamese, just to name a few, are entirely different. Fire managers in the Asian are used to be educated, trained and work in their native languages. A common fire management terminology in Asian languages cannot be a "simple translation" from English. Terms must be paraphrased and in some cases expressed by terms that may be unique in one language and may not have a corresponding term in another language. This is not easy − as we have experienced when adding the Russian and Mongolian language to the International Wildland Fire Management Glossary.

But we need to take these challenges and push ourselves to establish sound foundations for our cooperative endeavour to protect forests and other vegetation from the adverse impacts of fire.

In this regard the achievements of the Asian Regional Wildland Fire Networks Group are an important step, maybe a decisive step, for the preparation and finally the results of the 6th International Wildland Fire Conference, which will be hosted by the Republic of Korea in 2015.

Excellency, honourable participants of this symposium!

May I congratulate you for the endeavour of convening this International Symposium and the Pan-Asian Regional Network Meeting.

I wish the organizers, contributors and the audience a fruitful discussion and a successful way ahead for enhancing cooperation in fire management between countries of Asia and for the preparation and success of the 6th International Wildland Fire Conference in 2015.

UNISDR Pan-Asia Wildland Fire Network Meeting 2013 Setting up the Secretariat and Regional Fire Resource Centers in the Region

Background

All over the Asian region the frequency and impacts of wildfires have increased as a consequence of climate change, population shift into wildlands in some regions, the application of fire in land-use change, but also as a consequence of rural exodus and land abandonment in other regions of Asia. Wildfires often do not affect individual countries only, since they are often crossing borders or have other transboundary impacts such as long-distance smoke transport. This is calling for trans-boundary cooperation in fire management.

The establishment of a Pan-Asian Wildland Fire Network to support international cooperation in wildland fire management in the Asia region has been suggested by the Korea Forest Service in 2007 at the 4th International Wildland Fire Conference (IWFC) in Spain. At the meetings of the Pan-Asian in 2009 and 2011, the establishment of the Pan-Asia Network was agreed upon by the four coordinators of the Regional Wildland Fire Networks of the Asian region. They concluded that:

- The character of the Pan-Asia Wildland Fire Network is a network of the Regional Wildland Fire Networks of Northeast Asia, Southeast Asia, South Asia and Central Asia, representing 21 countries in the Asian region.
- The Secretariat will be created at the first Korea Pan-Asian Wildland Fire Conference in 2013 in Republic of Korea. Future conferences will take place in 4-yearly intervals scheduled half-way between the IWFCs. Note: The current schedule and host nations of the IWFCs are 2011 (South Africa); 2015 (Republic of Korea); 2019 to be determined.

At the 5th IWFC in South Africa the network members underscored the

need that Asian countries should take advantage of the accumulated expertise in fire management and international cooperation by international community with the goals to

1. Foster the bilateral and multilateral cooperation in wildland fire management, realization of joint research and practical projects advancing the knowledge on wildland fires;
2. Promote inter-regional cooperation, including joint investigations, joint fire management demonstration projects, consultations, and conferences.
3. Strengthen the pan-Asian endeavor to provide technological and financial support by donors to economically disadvantage countries to build capacities in wildland fire management.

Objectives

The 2013 meeting will be held at the Korea Forest Research Institute, Seoul, Republic of Korea, 23-25 October 2013. The conveners of the meeting are the Korea Forest Research Institute (KFRI) and the Korean Forest Society. The meeting will be sponsored by the Korea Forest Service (KFS) and the Global Fire Monitoring Center (GFMC).

Participants from the four Regional Wildland Fire Networks of the Asian region will discuss how to enhance international cooperation in fire management in the Asian countries:

- Building up a strong and effective framework for the Regional Networks under the umbrella of the Pan-Asian Wildland Fire Network aimed at strengthening efficient cooperation in wildland fire management among the Asian countries, notably by sharing experience, knowledge and resources
- Establishment of a Secretariat for the Pan-Asian Wildland Fire Network
- Establishment of Regional Fire Resource Centers in NE Asia, SE Asia, South Asia and Central Asia

- Addition of new languages (Korean, Chinese, Japanese) to the International Wildland Fire Terminology (current languages: English, Russian, Mongolian, German)
- Preparation of contributions of the Pan-Asian Wildland Fire Network to the to the 6th IWFC

Draft Agenda

Overview 22-26 October 2013

Date	Program	Location	Remarks
22 October (Tuesday)	Arrival of Participants	Seoul	Reception Dinner (Host : Korea Forest Service Minister)
23 October (Wednesday)	Field Trip	2015 International Wildland Fire Conference Venue	Together with ILC members
24 October (Thursday)	International Symposium	Korea Forest Research Institute	Presentations Reception Dinner (Host : Korea Forest Research Institue, Director General)
25 October (Friday)	Setting-up the Pan-Asia Wildland Fire Network Secretariat and Regional Fire Management Resource Centers	Korea Forest Research Institute	
26 October (Saturday)	Departure of Participants	Seoul	

Time table

International Symposium: Oral Presentations (24 October 2013)

Time	Title	Speakers/Chair	Affiliation
09:00~10:00	Participants registration (Moderator: Dr. Ho-joong YOUN)		
10:00~10:10	Opening address	Dr. Young-kyoon YOON	Director General, KFRI
10:10~10:20	Welcome address	Dr. Won-sop SHIN	Minister, KFS
10:20~10:30	Congratulatory address	Dr. Johann G. Goldammer	Director, Global Fire Monitoring Center
10:30~10:50	Photo time & Coffee Break		
10:50~11:30	Enhancing the Dialogue and Efficiency of Cooperation in Wildland Fire Management in the Asian Region: An Action Plan for 2014-2015	Dr. Johann G. Goldammer	Director, Global Fire Monitoring Center
11:30~12:00	The Strategies of Forest Fire Research in Korea	Dr. Myoung-soo WON	Researcher, Forest Disaster Management Division, KFRI
12:00~13:00	Lunch		
13:00~13:30	Transboundary Effects of Wildland Fire Emissions in the Pan-Asia Region	Dr. Bambang H. Saharjo	Professor and Dean, Bogor Agricultural University
13:30~14:00	Experiences and Prospects of Community Participation in Fire Management	Sundar P. Sharma	Soil Conservation Officer, Department of Water Induced Disaster Prevention

Time	Title	Speakers/Chair	Affiliation
14:00~14:30	Regional Fire Management Activities 2010-2013	Andrey M. Eritsov	Deputy Chief, Aerial Forest Fire Center Avialesookhrana
14:30~15:00	Wildland Fire Research in the Past and Wildland Fire Management in Recent Era	Dr. Pil-sun PARK	Professor, Seoul National University
15:00~15:30	Poster Session & Coffee Break		
15:30~16:00	Future Challenges for Wildland Fires Science in China	Dr. Shu Lifu	Leader, Institute of Forest Protection, Chinese of Academy of Forestry
16:00~16:30	Multilingual Wildland Fire Terminology: Challenges for Adding Japanese Language	Dr. Kazuya Uezu	Professor, The University of Kitakyushu
16:30~17:00	Objectives and Principles of Regional Wildland Fire Management Resource Centers: Transiting from Informal Networking to Sharing of Scientific, Technical and Human Resources	Dr. Oyunsanaa Byambasuren	Senior Scientist, National University of Mongolia
17:00~17:30	Mountain and Forest Weather	Dr. Yong-hee LEE	Senior Researcher, National Institute of Meteorological Research
17:30~18:00	Questions and Discussions		All participants
18:00~20:00	Dinner		

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October 24, 2013

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2. The Strategies of Forest Fire Research in Korea

Enhancing the Dialogue and Efficiency of Cooperation in Wildland Fire Management in the Asian Region: An Action Plan for 2014-2015

Prof. Dr. Dr.h.c.mult. Johann Georg Goldammer

Director, Global Fire Monitoring Center (GFMC)

Coordinator, UNISDR Global Wildland Fire Network and Wildland Fire Advisory Group

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Abstract

The main theme of the 2013 meeting of the UNISDR Pan-Asia Wildland Fire Network is "Setting up the Secretariat and Regional Fire Resource Centers inthe Region". These two main topics will not only be the key for the success of the cooperation between the active members of the UNISDR Regional Wildland Fire Networks, but most importantly for realizing the cooperative efforts between participating countries at operational level. A Secretariat for the Pan-Asian Wildland Fire Network would provide a sound institutional facilitation mechanism under which the forest services of neighbouring countries, apart of the founding members and initiators of the Regional Wildland Fire Networks, would increasingly become involved. A strong institutional cooperation among the neighbouring countries is required to bring the initial strategic views to implementation.

A more demanding task is the proposed establishment of Regional Fire Management Resource Centers in NE Asia, SE Asia, South Asia and Central Asia. Such Centers are needed to address the increasing demand on collection and distribution of data and information relevant to fire management with the regional neighbourhoods, the facilitation in capacity building in fire management at regional level and the exchange of human and technical resources where needed.

In order to do so the common understanding of the themes to be addressed within the greater Asian region a continuous flow of information both at institutional and at expert level is required by developing a terminology in which Asian languages should be included in the existing multilingual fire management

glossary, in which currently the only Asian languages Russian and Mongolian are included.

INTRODUCTION

Following the recommendations of the UNECE/FAO/ILO Seminar *Forest, Fire and Global Change* (Russia 1996) and a number of international conferences, among other the Second International Wildland Fire Conference (Vancouver, Canada, 1996), the UNECE/FAO *Team of Specialists on Forest Fire* proposed the establishment of an institution which at that time was preliminarily designated as a *Global Fire Management Facility*. On the basis of these recommendations the Government of Germany through the Ministry of Foreign Affairs, Office for the Coordination of Humanitarian Assistance, in June 1998 provided initial funding for the establishment of the entity which was designated *Global Fire Monitoring Center* (GFMC), which initially operated in the 1990s as a contribution to the International Decade for Natural Hazard Reduction (IDNDR) and later transited to the successor arrangement, the UN International Strategy for Disaster Reduction (UNISDR). The GFMC was founded in 1998 and publicly inaugurated at the FAO Meeting on *Public Policies Affecting Forest Fires* (Rome, October 1998).

The Global Fire Monitoring Center (GFMC) is an institution of the Max Planck Institute for Chemistry, Max Planck Society for the Advancement of Science, located on the campus of Freiburg University, Germany. Since 2005 GFMC is an Associated Institute of the United Nations University (UNU).

GFMC provides a global portal for wildland fire documentation, information and monitoring and is publicly accessible through the Internet[1)]. The regularly updated national to global wildland fire products of the GFMC are generated by a worldwide network of cooperating institutions. Web-based information and GFMC services include:

- Early warning of fire danger and near-real time monitoring of fire events (this includes the currently developing Global Wildland Fire Early Warning System and a global portal to existing national, regional and global fire

1) http://www.fire.uni-freiburg.de

weather and fire danger rating systems)
- Interpretation, synthesis and archive of global fire information
- Support of nations and international organizations to develop long-term strategies or policies for wildland fire management, including community-based fire management approaches and advanced wildland fire management training for decision makers, especially in the prevention and preparedness of wildfire disasters
- Support of countries in capacity building at all levels
- Serve as advisory body to the UN system through the coordination of the UNISDR Wildland Fire Advisory Group and the UNISDR Global Wildland Fire Network
- Emergency hotline and liaison capabilities for providing assistance for rapid assessment and decision support in response to wildland fire emergencies under cooperative agreements with UNOCHA, Emergency Services Branch.

Working at the interface between the science community and the user community the research and development work of the GFMC is targeted at providing capacity building and delivering problem-oriented products and solutions. The contribution of the GFMC to the UNU mandate includes applied research for the development of concepts for capacity building in wildland fire management. Depending on projects and requests the GFMC services are covering:

- Methods of science and technology transfer for application in local fire management (wildland fire prevention, preparedness, suppression, rehabilitation) under different cultural, socio-economic and ecological environments
- Methods and application of people-centered participatory (local-community focused) fire management
- Development of national strategies and policies for wildland fire management, including legislation
- Development of standards for international cooperation in wildland fire management (fire management guidelines, common terminology, standard procedures for cooperation in wildland fire emergencies)
- Training courses for international wildland fire management specialists,

including experts for assessment and intervention missions
- Global wildland fire assessments (e.g., for FAO in 2000 and 2006)

- GFMC is participating in a number of initiatives and projects led by UN agencies and other international organizations, e.g.

- The wildfire emergency preparedness and response through the UNEP/OCHA Joint Environment Unit (JEU), Emergency Services Branch
- The UNFCCC Nairobi Work Programme
- The UNISDR-led Partnership for Environment and Disaster Risk Reduction (PEDRR), with main emphasis of outreach work in fire management in developing countries
- GFMC has signed a Letter of Agreement with the WHO and a Memorandum of Understanding on collaborative work with the FAO
- UNESCO was main sponsor at the foundation of GFMC in 1998 and is a partner of activities to protect cultural and natural heritage assets against destruction by wildfires
- Cooperative work with the International Tropical Timber Organization (ITTO) since the 1990s
- GFMC is member of the Network of Specialised Euro-Mediterranean Centres of the European and Mediterranean Major Hazards Agreement (EUR-OPA), Council of Europe
- Policy advisor and field implementation for the Environment and Security Initiative (ENVSEC), in cooperation with OSCE and UNEP

ENHANCING GLOBAL COOPERATION IN FIRE MANAGEMENT: CENTRAL AND DECENTRALIZED STRUCTURES

Two years after the establishment of the GFMC the World Conservation Union (IUCN), the GFMC and the UN-FAO/ECE/ILO Team of Specialists on Forest Fire in 2000 suggested to the Inter-Agency Task Force for Disaster Reduction (IATF) of the UNISDR,to create an interagency "Working Group on Wildland Fire". At its second meeting the IATF on 11 October 2000 agreed to establish the Working Group on Wildland Fire (Working Group 4 [WG-4]).

Through the Working Group it was envisaged to establish an interagency and inter-sectoral forum of UN and other international agencies and programmes, and mechanisms of information and task sharing in the field of reducing the negative impacts of fire on the environment and humanity. One of the priority fields of activity to be addressed by WG-4 was:

- Establishment of, and operational procedures for, a global network of regional- to national-level focal points for early warning of wildland fire, fire monitoring and impact assessment, aimed at enhancing existing global fire monitoring capabilities and facilitating the functioning of a global fire management working programme or network.

At the 2nd meeting of WG-4 (3-4 December 2001) it was decided to prioritizethe establishment of the "Global Network of Regional Wildland Fire Networks", which later was designated "Global Wildland Fire Network" (GWFN). The GWFN would provide the platform for cooperation between Regional Networks. Since only a few networking structures at regional level were in place in 2001, it was aimed to support the creation of new networks where needed. The GWFN constitutes a global voluntary network that provides policy advice, and facilitates science and technology transfer to enable nations to:

- Reduce the negative impacts of vegetation fires ("wildland fires") on the environment and humanity; and
- Advance the knowledge and application of the ecologically and environmentally benign role of natural fire in fire-dependent ecosystems, and sustainable application of fire in land-use systems.

The work of the GWFN is facilitated / coordinated by the GFMC. One of the key function of coordination is the work of the UNISDR Wildland Fire Advisory Group (WFAG). Members of the Regional Wildland Fire Networks and those UN agencies and programmes, as well as other international organizations, that are mandated or otherwise addressing wildland fire, are members of WFAG. WFAG serves as an advisory body to the UN system.

Since 2008 the GFMC is also serving as Secretariat of the International Fire Aviation Working Group (IFAWG), a consortium of countries with major aerial firefighting assets working under theumbrella of the UNISDR Wildland Fire Advisory Group.

With the transition of the work of the IATF to the UNISDR Global Platform for Disaster Risk Reduction the GWFN is now serving as a "Thematic Platform".[2)]

The GFMC, which had been founded out of the experiences and perspectives of collaborative approaches in the UNECE Region, has worked successfully over the past 15 years as an independent global center of excellence, but is becoming more and more overwhelmed with increasing tasks and work loads.

It was therefore decided to decentralize the responsibilities to the regional level and to create "Regional Fire Monitoring Centers" or "Regional Fire Management Resource Centers". These Centers would intensify the collection and distribution of data and information relevant to fire management with the regional neighbourhoods, facilitate capacity building in fire management at regional level and the exchange of human and technical resources where needed.

THE ROLES AND MANDATES OF REGIONAL FIRE MANAGEMENT RESOURCE CENTERS

After the establishment of the first Regional Fire Monitoring Centers for the South East Europe / Caucasus Region (located in Skopje, FYR Macedonia, 2010) and for the Eastern European Region (located in Kiev, Ukraine, 2013), both sponsored by GFMC and co-financed by the European and Mediterranean Major Hazards Agreement (EUR-OPA), the Central Asia Fire Management Resource Center is currently under construction (in Ulaanbaatar, Mongolia, formal inauguration in 2014). There is the intent to create similar centers in South Asia (Nepal) and possibly South America. It is also suggested to establish a Regional Northeast Asia Fire Management Resource Center in the Republic of Korea.

In the following reflections are given about the experience gained during the last 15 years in building regional networks, out of which regional centers of excellence are now emerging.

2) http://www.unisdr.org/partners/thematic-platforms

Designation of Regional Centers: Various Options

There are considerations to replace the term 'Regional Fire Monitoring Center" in some regions by a different term. The following designations are in use or have been proposed:

"Regional Fire Monitoring Center": This designation may create the impression that the center would do "monitoring / observing only". As described in the previous section, however, the scope of work of GFMC and the first Regional Fire Monitoring Centers in SE Europe and Eastern Europe, go far beyond "monitoring" of wildland fires only.

"Regional Fire Management Center": This designation may create the impression that the center has operational tasks, e.g., having a legal mandate to manage or support managing wildland fires in the region (i.e. in the "participating" countries). There is no such center at regional or global level, which has the task or mandate to manage fires on territories of sovereign countries.

"Regional Fire Coordination Center": This designation may create the impression thata regional center would coordinate firefighting resources between countries. There is hardly any such center in the world. The European Union's 'Monitoring and Information Center" (MIC), which is operating under the Civil Protection Mechanism (CPM), is coming close. But even the CPM / MIC does not have a 'coordination and command"function. CPM / MIC are serving as 'broker" between emergency assistance requests (requests by countries in need) and offers (from countries willing to assist by providing human and technological resources).

"Regional Fire Management Resource Center": This is a new term that has been discussed recently. "Resources" may encompass:

- ***Information***: Information and data are "resources", i.e. a Regional Center would collect, share and provide all wildland fire-related information to the participating countries for enhancing fire management capabilities, including wildfire disaster preparedness and response.
- ***Human resources***: A Regional Center would play a role in joint regional capacity building in fire management

- ***Scientific-Technical***: A Regional Center would involve participating states in developing or benefiting from state-of-the-art scientific knowledge and fire management technologies
- ***Operational***: The Center would have an supporting role in operational response to wildfire emergencies.

Currently the GFMC and the first two Regional Fire Monitoring Centers in SE Europe/Caucasus and Eastern Europe are using the term "Monitoring". However, it is now recommended to apply in future the term "Regional Fire Management Resource Centers" since these centers would focus in joint regional capacity building of human resources in integrated fire management, wildfire crisis preparedness and, if responsibilities of these centers would be further developed by consent of participating states, wildfire emergency support.

Functions of a Regional Fire Management Resource Center (RFMRC)

Basically a RFMRC would be a Center of Excellence which have or will have the following functions:

Regional fire information repositories

The RFMRC stores and makes available regional information and data relevant to wildland fire (vegetation fire), ranging from conventional databases, statistics, literature, narratives and reports. Some information may be freely available online, some information and data may be provided upon targeted requests.

In many countries there is a wealth of knowledge of the fire ecology and experience in fire management. While this is increasingly documented in peer-reviewed printed and online scientific publications, which however are not necessarily available to the stakeholders concerned with wildland fire, there is abundant "grey" literature, which include numerous reports of projects, that have never been published, produced in limited amount of copies, and thus not easily available.

Regional centers should serve as documentation repository, library, access point of this wealth of information, preferably online. But not all can be put online, e.g.

personal expert knowledge. Thus, expert advisory resources need to be part of the repository.

Monitoring and information dissemination

In addition a RFMRC would have either own capabilities or partner institutions providing near-real time information on

- Fire precursors (fire early warning, fire danger rating)
- Active fires (ongoing fires, current situation)
- Fire impacts (area burned, fire damage / impact assessment)

This can be done either online (internet) for public access, and also restricted access (intranet) for participating partners only.

Capacity building: Building and enhancing national and regional fire management capacities

Neighbouring countries are often sharing common ecological, cultural, lingual, socio-economic and political features. Sharing of expertise and learning from each other between neighbouring countries is desirable not only from the point of view of economizing, but also for maintaining sound neighbourhood relationships. Thus, one of the key tasks of a RFMRC is to serve as center of excellence for capacity building and outreach by conducting national and regional training courses, continuous education, seminars, workshops, conferences, bringing different stakeholders together, at the interface between wildland fire science, management and politics / policies.

As a Center of Excellence the RFMRC encourages participating countries of the region to develop national fire management policies, where not yet existing (the vast majority of countries globally do not have a fire management policy). The RFMRC will serve countries on request and will provide advice to governments to develop and implement fire management policies, with multi-resource scope and participation of all relevant actors / donors (national, regional and international). The establishment of National Round Tables on Fire Management, with participation of

all national agencies concerned, including local and non-government stakeholders, and the establishment of inter-agency mechanisms, e.g. National Inter-Agency Fire Management Boards (or Task Forces, Working Groups, Advisory Boards) have proven successful to develop a coordinated cross-sectoral approach addressing fire management.

Participating countries of the region are encouraged to develop bilateral formal agreements / protocols for cross-boundary cooperation in fire management (which will include, capacity building, joint regional trainings, common language and 'systems" where needed, etc.).

Science–technology interface

An important role of the RFMRC is to define research needs and to initiate cooperative, inter-disciplinary research with active participation of the national, regional and international community of wildland fire scientists and other disciplines (social sciences….). Fire science is a backbone of building competency in fire management in the region, especially considering the specific ecological, social and economic conditions of the region.

International nexus

The RFMRC is an entry point to the international processes and facilitates the participation in international agendas. RFMRCs are invited to work with the Global Fire Monitoring Center (GFMC) in its functions as a global fire management clearing house and Secretariat of the Global Wildland Fire Network (GWFN), the UNISDR Wildland Fire Advisory Group (WFAG), the International Fire Aviation Working Group (WFAG) and other functions to participate in international dialogues.

International consultations and conferences require participation and inputs from countries globally. Besides a number of topical international forums in the wildland fire arena (dedicated groups and more or less regular conferences and workshops addressing e.g. satellite remote sensing, early warning, ecology, fuel management, economics fire safety, aerial firefighting, community-based fire management, etc.) there are the International Wildland Fire Conferences, which are the 4-annual global

platforms to meet, report, exchange & consult and raise the voice of the wildland fire community.

Other processes may be related to the agendas of international legally binding agreements or conventions, in which the role of fire is addressed or will be addressed increasingly, e.g. in the frame of UNFCCC, UNCBD and UNCCD.

Or other examples include the role of GFMC and the Regional Wildland Fire Networks to provide the regional fire analyses and expertise to global fire assessments, such as the Global Fire Assessment in the frame of the FAO "Global Forest Fire Assessment 1990-2000", the "Global Forest Resources Assessment 2005 – Regional Fire Reports" (2006), the "Fire Management Global Assessment 2006", or the UN Fire Management Voluntary Guidelines (2006).

Regional and global networking

Regional Wildland Fire Networks are existing in 14 regions globally. Each network has its own, often quite different history. In some regions RFMRCs are now under construction (often a slow process as finances are critical). In some regions the Regional Wildland Fire Networks are still in the stage of emerging from academic or other "*proto networks*"towards officially recognized and agencies-supported networks. Here it makes absolute sense that an RFMC would also have the lead or at least co-lead in the Regional Wildland Fire Network. Thisis because the above-listed tasks are actually implemented by the Regional Wildland Fire Networks.

Modus operandi

Each Regional Network and each RFMRC determines its mandate and *modus operandi*. Most important is the principle of sustainability.

The strength of activities within the Regional Wildland Fire Networks during the past decade is the involvement of stable, sustainable partners.

The project scope of many international donors such as international organizations or development agencies or programmes of industrial (donor) nations, are limited to the lifetime of a project. After the termination of a project there are usually no sustainable structures or processes left behind. Thus, the responsibility to utilize,

continue and make "project" results elements of sustainable development and include them in the institutional and documentary "memory" is an important task of a RFMRC.

INCLUSION OF ASIAN LANGUAGES INTO THE INTERNATIONAL WILDLAND FIRE MANAGEMENT GLOSSARY

In order to improve the dialogue and cooperation in fire management between the countries of Asia we need to agree on a common understanding of the themes to be addressed, a continuous flow of information both at institutional and at expert level.

In order to reach this goal it is necessary to agree on a common understanding of the themes to be addressed, a continuous flow of information both at institutional and at expert level, based on a common terminology. While most countries in West Europe, North America, Latin America and the Caribbean, Australasia and Africa are Indo-European languages and thus have common roots – this is entirely different in Asia. Asian languages like Korean, Japanese, Chinese, Russian, Nepalese, Burmese, Indonesian, Thai or Vietnamese, just to name a few, are entirely different. Fire managers in the Asian are used to be educated, trained and work in their native languages. A common fire management terminology in Asian languages cannot be a "simple translation" from English. Terms must be paraphrased and in some cases expressed by terms that may be unique in one language and may not have a corresponding term in another language. This is not easy –as we have experienced when adding the Russian and Mongolian language to the International Wildland Fire Management Glossary (GFMC, 2010).

PREPARATION OF CONTRIBUTIONS OF THE PAN-ASIAN WILDLAND FIRE NETWORK TO THE 6TH INTERNATIONAL WILDLAND FIRE CONFERENCE 2015

Apart of the above-mentioned activities –the establishment of Regional Fire Management Resource Centers and the completion of the regional languages to the International Wildland Fire Management Glossary –the Regional Wildland Fire Networks and its member countries shall take the necessary steps to prepare

contributions to the 6th IWFC in Republic of Korea in 2015.

The conference theme is "Fire of the Past –Fire in Future". The conference will address both the history of fire and the future of fire on Earth.

The first sub-theme "Global Natural and Cultural Fire Heritage" shall address the facts of how natural fires and fires used by humans have shaped the ecosystems of the world. Fire history analysis will include the ecology and the role of fire in cultivating planet Earth. This includes also the destructive fires, which have contributed to ecosystem degradation or destruction.

The second sub-theme "Managing the Global Natural and Cultural Fire Heritage" encourages contributors to present concepts and visions how to protect the natural and cultural heritage from destructive fires and consider the use of management fire (prescribed fire, both caused by nature and set by management).

The third sub-theme "Towards a cohesive global fire management strategy" will focus on how to develop an agreed cohesive international strategy in fire management. This strategy would look beyond the "heritage"of fire, because the future of planet Earth will be subjected to extreme environmental changes, which are caused by humans, and which will determine future fire regimes and fire threats. And these may be different from the history, and different from today.

Clearly, a range of other themes will be addressed by the 2015 conference, among other the role of community participation in fire management – an important theme to be addressed in the regions.

The coordinators and / or representatives of the Regional Wildland Fire Networks of the Asian Region are encouraged to actively address these themes in their regions by calling for dedicated workshops, conferences and consultations.

One successful example of last years was the Regional Pan-Asia / Pacific Consultation on Building Advanced National and Regional Capacities in Integrated Fire Management based on Participatory Involvement of Local Communities, which was held in November 2012 in Nepal, financed by the Korean Forest Research Institute (KFRI) and organized / hosted by the Regional South Asia Wildland Fire Network and the GFMC.

Another example is the upcoming "International Congress and Trade Fair on Forest Fire and Climate Change: Challenges for Fire Management in Natural and Cultural Landscapes of Eurasia". This congress will be hosted by the Russian

Federation in partnership with the Global Fire Monitoring Center (GFMC) in Novosibirsk, Russia, 11-13 November 2013, and will address the most pressing issues arising from changes of climate and socio-economic conditions in the greater Eurasian Region. In this conference the leaders of the Eastern European, South European, Eurasian and Northeast Asian Wildland Fire Networks will contribute and discuss solutions for fire management in future.[3] One of the deliverables of the Congress will be an input to the upcoming UNECE Regional Forum on Cross-boundary Fire Management at the United Nations, Geneva, 28-29 November 2013).[4]

The Secretariat of the Pan-Asia Cluster of Regional Wildland Networks will attend and contribute to the Eurasian consultations and report about the conclusions from this meeting concerning the establishment of Regional Fire Management Resource Centers.

CONCLUSIONS

The Action Plan 2014-2015 for the Pan-Asia Cluster of Regional Wildland Fire Networks comprises a set of demanding tasks. However, the need for action is clear: With the continuation of damaging fires burning in the mountains of the South Asian Himalayas, the lowland tropical rainforests and peatlands of Southeast Asia, the extreme fires in the continental regions of Eurasia, notably in Russia where in 2012 alone more than 30 million hectares of vegetated lands, including forests, had been burned (Goldammer et al., 2013), the Regional Wildland Fire Networks are now challenged to act.

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3) http://www.fire.uni-freiburg.de/course/meeting/2013/meet2013_11.htm

4) http://www.fire.uni-freiburg.de/intro/UNECE-Fire-Forum-2013-Draft-Outline.pdf

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The Strategies of Forest Fire Research in Korea

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Contents

- O Forest Fire Statistics and Policy in Korea
- O Forest Fire Management Systems based on IT
- O Future Plan of Forest Fire Prevention
- O International Cooperation

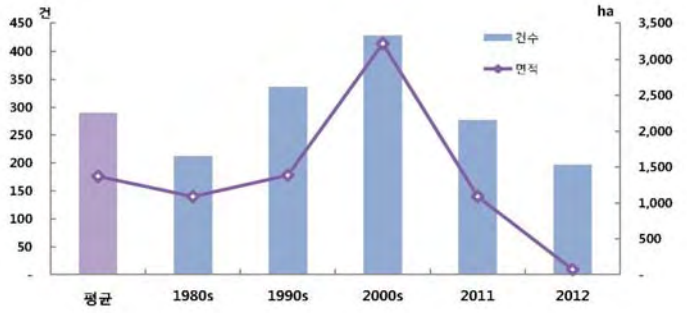
O Forest Fire Statistics and Policy in Korea

Ⅰ. Status of Forest Fires

Annual Fires

- **387 fires of annual average, 734ha of Burned area** (Trifling occurrences are 2500 fires)
- **Irregular fire occurrences and scales depending on weather conditions**

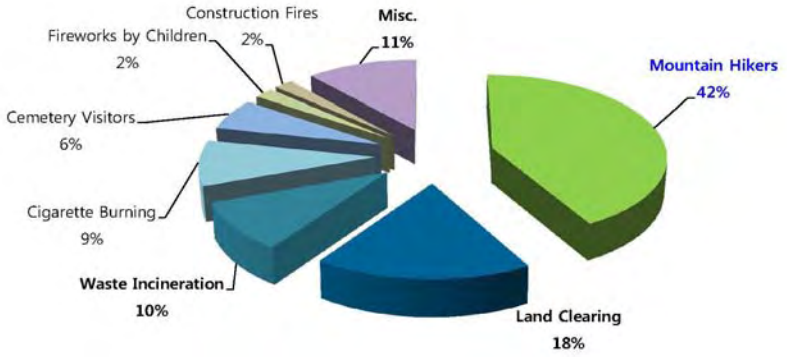
* Forest fires continuously increased until 2000s, but the occurrences have been decreasing thanks to operational optimization of expanded resources since 2010.



Ⅰ. Status of Forest Fires

The Causes of Forest Fire ('03-'12)

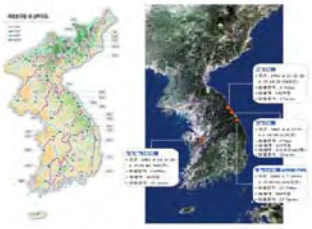
- **Most fires are caused through carelessness of people**



Ⅰ. Status of Forest Fires

Topography

- **Forest covers 64% of the land** (6.37 mil. ha)
- **Forest land is mountainous, curved, and steep**



Forest

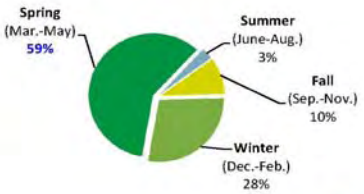
- **44% of pine forests that are highly flammable**
- **Dense forests composed of 59% of more than 30-year-old trees**

※ **Changes in Growing Stock:** ('80) **22㎥/ha** → ('90) 38㎥/ha → ('00) 63㎥/ha → ('10) **126㎥/ha**

Weather

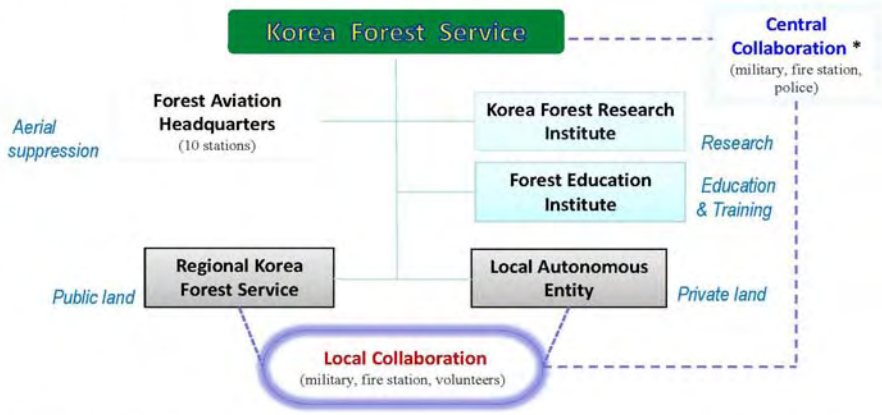
- **Forest fire caution period: November to May**
- **The most dangerous season: March to May**

※ **9% of Annual rainfall**(1,328 mm), **strong seasonal wind**



Ⅱ. Development of Fire Response

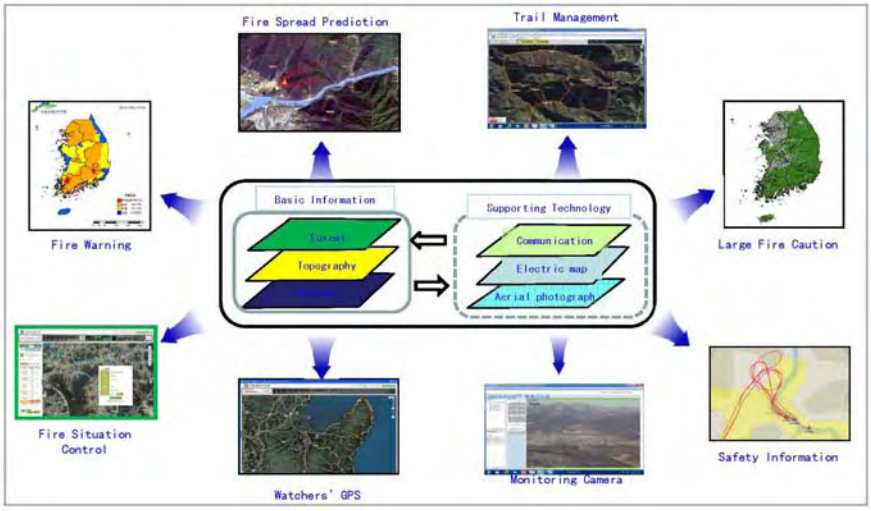
Organization for Forest Fire Control



*** 7 Related Government Departments administering Joint Regulations:** Korea Forest Service, Ministry of National Defense, Korea National Park Service, Cultural Heritage Administration, National Emergency Management Agency, National Police Agency

Ⅱ. Development of Fire Response

1. Fire Management Systems



Ⅱ. Development of Fire Response

2. Early Detection

- **Cameras for surveillance within 10km** (896)
- **Hikers checkpoint guides** (2,600) **, Surveillance towers** (900)



3. Aerial Attack Resources

- **Forest Aviation Headquarters was established in 1971 with 3 helicopters.**
  → 47 helicopters in 9 aircraft stations as of 2012.

Ⅱ. Development of Fire Response

4. Ground Forces

(Man power)

- **3,000 persons of specialized forest fire prevention and suppression forces were introduced in 2003.**
  → Expanded to 9,950 persons in 2012.

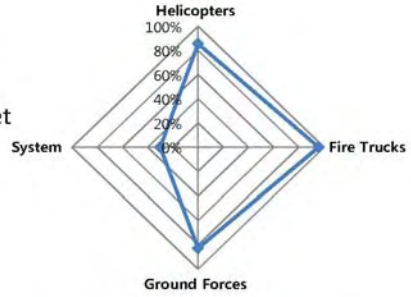
(Equipment)

- **Forest fire trucks were supplied in 1995** (→ 1,148)
- **Small-sized pumps with high pressure in 2007** (→ 1,940)
- **Medium-sized pumps with middle pressure in 2010** (→ 480)
- **Korean Mountain Pumping System(KMPS) in 2010** (→ 30%)

Ⅱ. Development of Fire Response

Assessment and Future policy

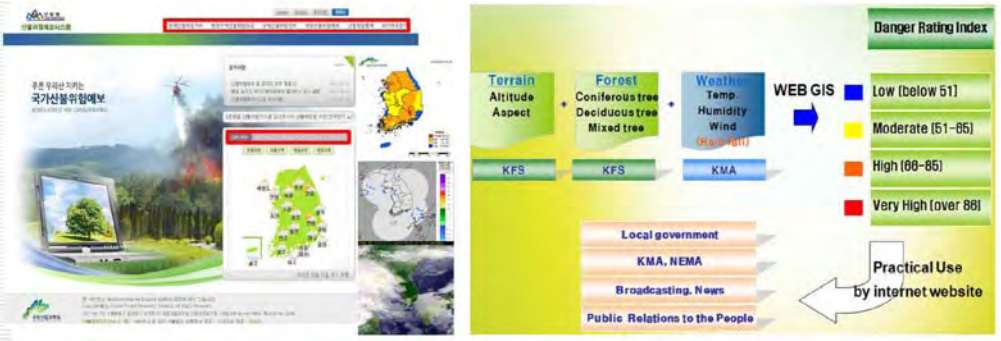
- **Resources expansion 'until 2012'**: Helicopters, fire trucks, and Ground Forces are reinforced continuously and achieved 80-90% of the target
- **System upgrade 'after 2012'**: Supporting IT system settlement and upgrade to use expanded resources effectively



	Helicopters	Fire Trucks	Ground Forces	System
Target	55	1,200	12,000	300
Present State	47	1,148	9,950	90
Present/Target Ratio	85%	96%	83%	30%

O Forest Fire Management Systems based on IT

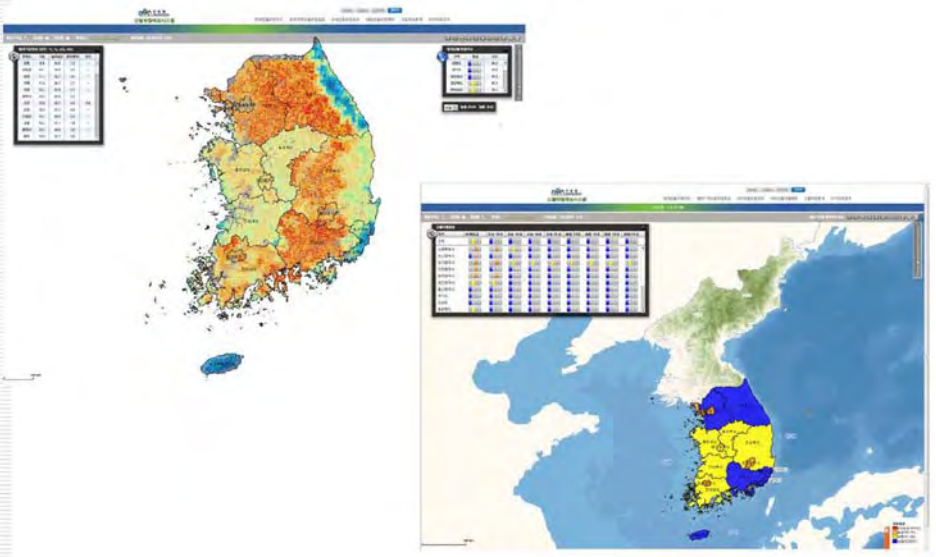
I. Korea Forest Fire Danger Rating Systems



Forest fire danger index | Vegetation map | Weather information

I. Korea Forest Fire Danger Rating Systems

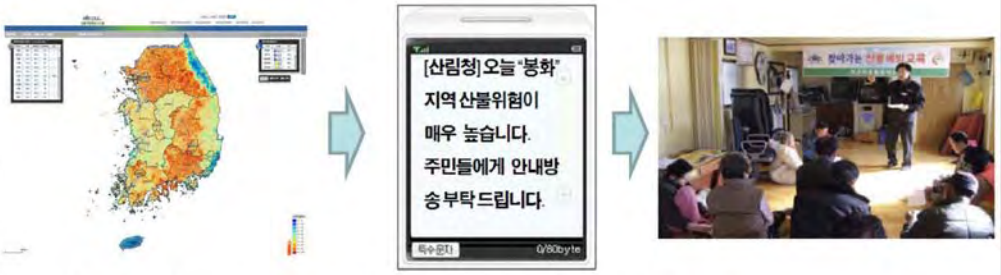
The present forest fire danger rating index



II. Fire Weather Information System

III. SMS Delivery System for Fire Early Warning

To strengthen the fire information delivery system to the local residents



- If the fire danger index is high in the special areas, the warning message from the fire danger rating index system is transferred, automatically, to a head of a village
- He will notify the people of fire danger, also informs the prohibited act such as waste burning, camp fire in the near mountain area.

IV. Fire Ignition Reporting System based on ICT

The participation of local people in the prevention and suppression fire

<Forest fire prevention by a local resident>

- The local people are employed as the firefighters.
- More 25,000 local residents are taking part in the activities of fire prevention and initial suppression across the nation.
- The fire ignition reporting assistant is provided to these people for the accurate and quick reporting from field to fire control headquarters

IV. Fire Ignition Reporting System based on ICT

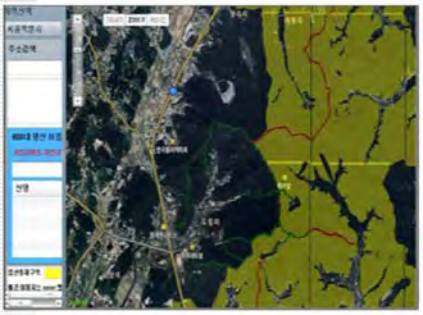
Firefighters location

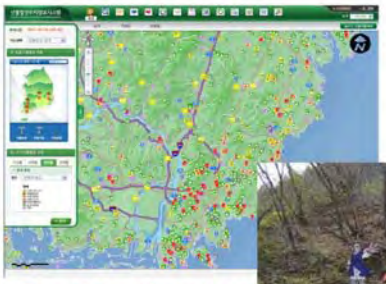
Fire ignition point and Acquisition of suppression information

❖ Smart phone Application for reporting

V. FOLIS based on GIS

Fire occurrence location information system(FOLIS) sharing using web-site



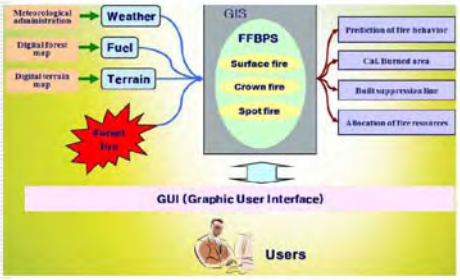


Forest fire Database

Web-based service of trail closure and restricted mountain area for fire prevention

- Information of restricted mountain area and trail closure is serviced by Korea Forest Service web-site.
- Local peoples work in patrol in this area.

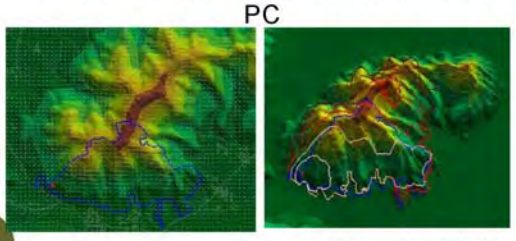
VI. Forest Fire Behavior Prediction Systems (FFBPS)



Fire behavior prediction based on Tablet PC

Google map

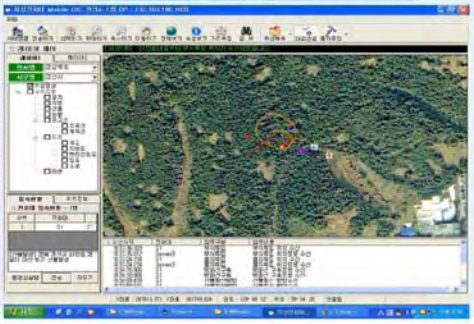
High resolution (50cm) aerial photo



Fire behavior prediction using wind Field

VII. Forest Fire Mobile GIS System for Firefighter

Commander Center



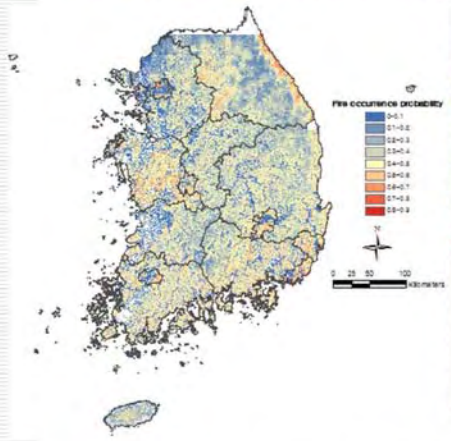
Wireless Mobile Telecommunication (WCDMA, HSDPA)

Forest Fire Field (Firefighter)

Fire Alert | Forest Fire Line | Fire Break Line | Fire Spread Prediction | Escape Route

VIII. Cartography for Fire Mapping

Analysis of forest fire hot-spot



➢ After analysis of fire hot-spot, fuel reduction activities will be carried out by local people with support of local government.

국립산림과학원

VIII. Cartography for Fire Mapping

Analysis of blind spot by detection facilities

➢ After analysis of blind spot, local people in these areas.

국립산림과학원

O Future Plan of Forest Fire Prevention

Future Plan of Forest Fire Prevention

Goal

To minimize fire damage by practical prevention, early detection, and initial suppression

Strategy

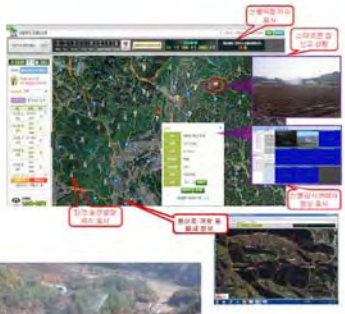
- To reduce fire occurrences by practical preventions
- To detect fires early by using high-tech IT system
- Initial attack by KIICS, 30 min.' AH and KMPS

* KIICS : Korea Integrated Incident Command System, AH : Arriving by Helicopter, KMPS : Korea Mountain Pumping System

Future Plan of Forest Fire Prevention

1. System Upgrade

- Web-based systems including fire risk forecast, trekking courses opening and closure, and patrol management will be integrated into Fire Situation Management System using smart phones.



2. Water Sprinkler Establishment

- Water sprinkler system will be established to protect valuable natural and cultural heritages.

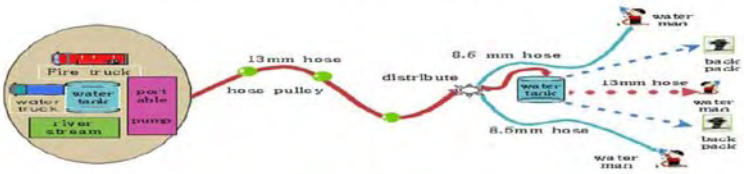
3. Aerial Attack

- Helicopters increase: ('12) 47 → ('17) 50
- Helicopters operation to arrival at the spot within 30 minutes nation
  ※ Including Jeju Island until 2017
- Operation of Aerial Navigation System to prevent safety accidents

Future Plan of Forest Fire Prevention

4. Ground Suppression

- Mechanized units organization using KMPS to supply water the fire spot.
- To Strengthen man power by operating visiting training and education system.



O International Cooperation

I. History of Pan-Asia Wildland Fire Network

- 4th IWFC (May 2007, Spain)
  - Establishment of Pan Asia network for international cooperation in Asia region
    - Suggested by Korea Forest Service
- 6th NEA Network and Pan-Asia Forest Fire Consultation meeting (February 2-7, 2009, Korea)
  - *NEA Countries : China, Russian Federation*
  - *South , North East , South East, Central Asia Network*
- 7th NEA Network and 2nd Pan-Asia Network meeting (June 7-8, 2011, Korea)
  - *NEA Countries : China, Japan, Mongolia*
  - *Indonesia(South East), Nepal (South)*

I. History of Pan-Asia Wildland Fire Network

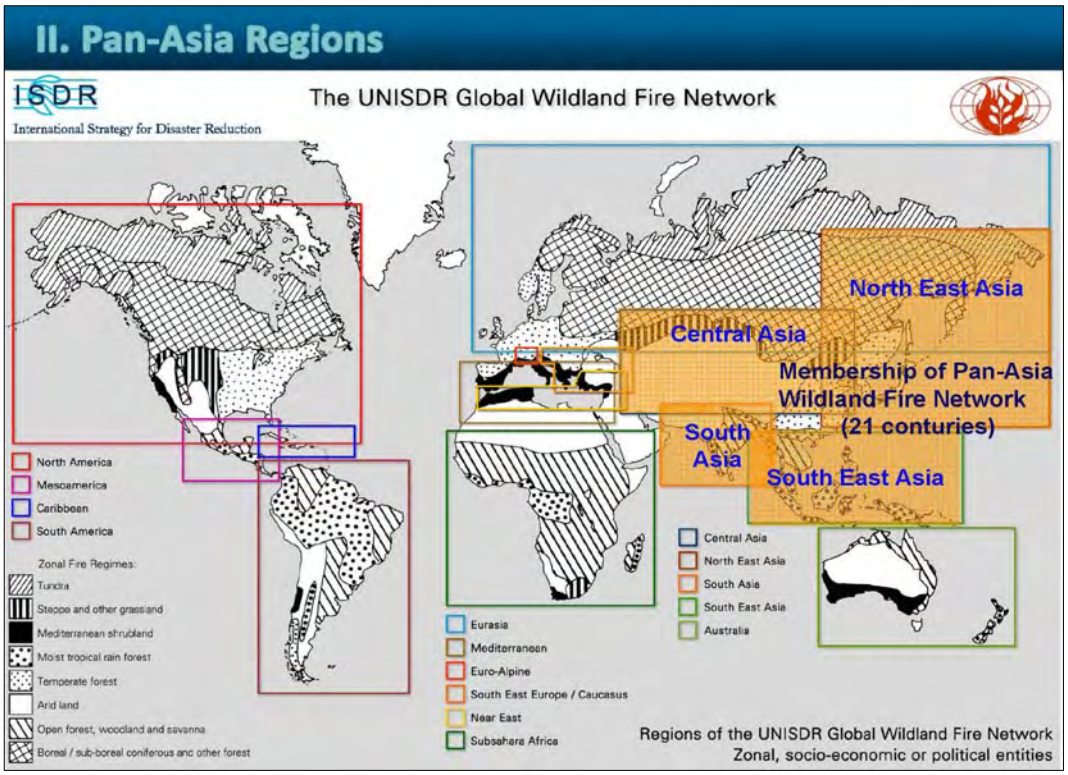
- Major Determinations
  - ➢ To establish a Pan-Asian Wildland Fire Network
    - Network of networks representing 21 countries in the region
    - Installation of the secretariat in Korea
    - To hold a 4-yearly series of pan-Asian wildland fire conference and the first in 2013 in Republic of Korea

I. History of Pan-Asia Wildland Fire Network

- Determinations and Recommendations

(5th IWFC Regional Session III)

1. The network members should take advantage of the accumulated expertise in fire management and international cooperation by international community;
2. To foster the bilateral and multilateral cooperation in wildland fire management, realization of joint research and practical projects advancing the knowledge on wildland fires;
3. Member countries should also promote inter-regional cooperation, including joint investigations, joint fire management demonstration projects, consultations, and conferences.
4. To strengthen the UNISDR Pan-Asia Wildland Fire Network;
5. Technological and financial support must be provided by donor communities to financially disadvantage countries in building capability to wildland fire management.



II. Pan-Asia Regions

Member countries of Pan-Asia Network

Continent	Region	Countries
Asia	*North East Asia*	Republic of Korea, Russia, China, Japan, Mongolia
	Central Asia	Russia, China, Mongolia, Kazakhstan
	South East Asia	Indonesia, Republic of the Union of Myanmar, Brunei, Philippines, Cambodia, Singapore, Vietnam, Laos, Thailand, Malaysia
	South Asia	Indonesia, Bhutan, Pakistan, Sri Lanka ,Nepal

III. The 6th International Wildland Fire Conference (IWFC)

- **The 6th International Wildland Fire Conference (IWFC) will be held in 2015 in Korea.**
  - **Slogan: Fire of the Past, Fire in Future**
  - **Date: 12-16 Oct. 2015**

※ Wed site – http://www.wildfire2015.kr

※ Logo

2015 세계산불총회
INTERNATIONAL
WILDLAND FIRE CONFERENCE
KOREA
Fire of the Past
Fire in Future

Thank You !

www.wildfire2015.kr

Sesson 1

October 24, 2013

1. Transboundary Effects of Wildland Fire Emission in the Pan-Asia Region
2. Experiences and Prospect of Community Participation in Fire Management: A case from Nepal
3. Regional Fire Management Activities 2010-2013
4. Wildland Fire Research in the Past and Wildland Fire Management in Recent Era

Transboundary Effects of Wildland Fire Emission in the Pan-Asia Region

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Abstract

It had been well recognized that land preparation with fire is responsible for the haze that blanket not only at the local area, but also to the regional where it transboundary across the boundary. It increases the greenhouse gas emission, affects the air quality, health, transportation, economic, ecologies, and the relation between countries in the region. The collaboration between the countries affected by the haze rooted from fire will be one of the best solution.

Keywords: Transboundary, wildland fire, emission, Pan-Asia, Indonesia

INTRODUCTION

Indonesian forest and land fire that occurred in June period of 2013 and then followed couples months later until October 2013 have shown that it affects not only in the local area but also to other region especially in the Southeast Asia region. Fire is a significant source of gases and particulate to the atmosphere: environmentally important gases produce by fire includes carbon dioxide, carbon monoxide, methane, non-methane hydrocarbons and oxides of nitrogen. Fire also produces large amounts of small, solid particles or "particulate matter", which absorb and scatter incoming solar radiation, and hence the impact of our planet as well as provoking a variety of human health problems (Levine, 1996). Fire can therefore be considered one of the local points of the multiple relationships between humans and the environmental changes in fire patterns can be taken as indicator of change in land-use patterns and overall environmental conditions (Malingreau and Gregorie, 1996). From the perspective of the International Decade of Natural Disaster Reduction (IDNDR), wildland fires may affect two basic environmental

problem areas: (i) atmospheric pollution (direct impact of smoke on human health and economies; influence of gaseous and particle emissions on the composition of the atmosphere); and (ii) biodiversity, ecosystem performance, and landscape stability (Goldammer, 1999). Both these areas can have deleterious consequences for the severity of other hazards. Smoke reduces visibility, provoking transportation accidents and airport shutdowns. This often leads to transboundary smoke pollution, which provokes international indignation (ADB, 2009).

WEATHER REGIONAL IN SOUTHEEAST ASIAN REGION

Weak Inter-Monsoon conditions prevailed over the southern ASEAN region during the first week of June 2013 before giving way to Southwest Monsoon conditions in the second week of the month (ASEAN, 2013). The intensification of the sub-tropical high pressure system in the southern hemisphere led to the establishment of Southwesterly winds in the region north of the equator. Two tropical storms and one typhoon affected the region during the month of June 2013. On 18 June 2013, tropical storm “Leepi” developed in the Philippines Sea and tracked northwards towards Japan. At the same time, another tropical storm named “Bebinas” developed in the South China Sea and tracked west-northwest before making landfall over Hainan Island on 22 June 2013 (ASEAN, 2013). Towards the end of the month, Typhoon “Rumbia” which developed as a tropical depression in the Philippines Sea on 28 June 2013, tracked northwestwards across the central parts of Philippines, and made landfall near Zhanjiang, Guangdong at around 2nd July 2013 (ASEAN, 2013). With the inter-tropical convergence rain belt established firmly away from the equator in the second half of the month, most of the southern ASEAN region experienced drier weather. The dry weather conditions over the Sumatra, Peninsular Malaysia and Singapore exacerbated the transboundary smoke haze situation which caused hazy conditions to affect Singapore and Peninsular Malaysia for several days. In the northern ASEAN region, the rainy season continued to prevail over Cambodia, Lao PDR, Myanmar, Thailand, Vietnam and the Philippines. For the month of June, the ASEAN region was generally drier than normal (ASEAN, 2013). Most parts of the ASEAN region received less than 75% of the normal rainfall except for central Thailand and the Philippines where more than 150% average

rainfall was received. The rainfall received for most of the southern ASEAN region was also below normal with less than 75% of the normal rainfall recorded in Peninsular Malaysia, Sumatra, Borneo and northern part of Sulawesi (ASEAN, 2013).

TRANSBOUNDARY OF INDONESIAN FIRES

With the traditional rainy season prevailing in the northern ASEAN region, hotspot activities have remained subdued except for occasional scattered hotspots in Myanmar and Cambodia (ASEAN, 2013). In the southern ASEAN region, shower activities have helped to subdue hotspot activities in the first week of June 2013. However, dry weather conditions followed shortly and resulted in a surge in hotspot activities in Sumatra during the middle of the month. Scattered hotspots with moderate to dense smoke were detected mostly in Riau province (ASEAN, 2013). The thick haze blanketed Dumai City in Riau and caused the visibility to drop below 500 metres. The prevailing low level winds over the Riau area transported moderate to thick smoke haze to affect Peninsular Malaysia, Singapore, southern Thailand and parts of South China Sea. Between 19 and 23 June 2013, the air quality in Singapore was within the range of unhealthy to very unhealthy (ASEAN, 2013). Whereas in Malaysia, the Air Pollution Index reached a high of 746 on 23 June 2013 which resulted in the state of emergency declaration in Muar and Ledang. The smoke haze situation in the region eased towards the end of the month with the return of the shower activities (ASEAN, 2013).

The 2013 Southeast Asian haze affects several countries in the Southeast Asian region, including Brunei, Indonesia, Malaysia, Singapore and Southern Thailand, occurring from 13 June 2013 (Wilkipedia, 2013). On 19 June 2013, NASA's Terra and Aqua satellites captured images of smoke from illegal wildfires on the Indonesian island of Sumatra blowing east toward southern Malaysia and Singapore, causing thick clouds of haze in the region.As stated by a local Indonesian official, the source of the haze might be a 3,000 hectare peatland in Bengkalis Regency, Riau Province, which was set ablaze by an unknown party on 9 June. As many as 187 hotspots were picked up by satellites on 18 June, down to 85 on 20 June. On 21 June 2013, a total of 437 hotspots were detected in Sumatra. Two days later,

the number was down to 119. On 24 June, 159 hotspots were detected in Riau, out of a total of 227 detected in Sumatra. An air force officer explained that the low number of hotspots detected on some days was due to heavy cloud cover, which prevented the satellite from detecting some of the hotspots (Wilkipedia, 2013). Malaysia declared a state of emergency on June 23 in a district where the haze triggered one of the country's worst pollution levels, while Singapore has urged citizens to remain indoors because of hazardous levels of pollution. The Malaysia Department of Environment said that 173 hotspots were detected in Malaysia on 24 June, with 1 in Negeri Sembilan, 1 in Terengganu, 3 in Sabah, and 168 in Sarawak. Many of the hotspots are owned by palm oil companies or smallholder farmers who supply palm oil to these companies and use traditional slash-and-burn methods to clear their land for the next planting season(Wilkipedia, 2013). However, Singapore's Prime Minister, Lee Hsien Loong, has said that the fires were most likely started by errant companies, instead of slash-and-burn by smallholders. On 25 June, Indonesia's president Susilo Bambang Yudhoyono issued a formal apology to Malaysia and Singapore for the hazardous smog. As of 29 June, a total of 2,800 military personnel, as well as helicopters and aircraft, have been deployed to fight the fires. About 3,000 civilians are also helping with the firefighting. The fires have also been reduced from an area of 16,500ha to 4,081ha (Wilkipedia, 2013).

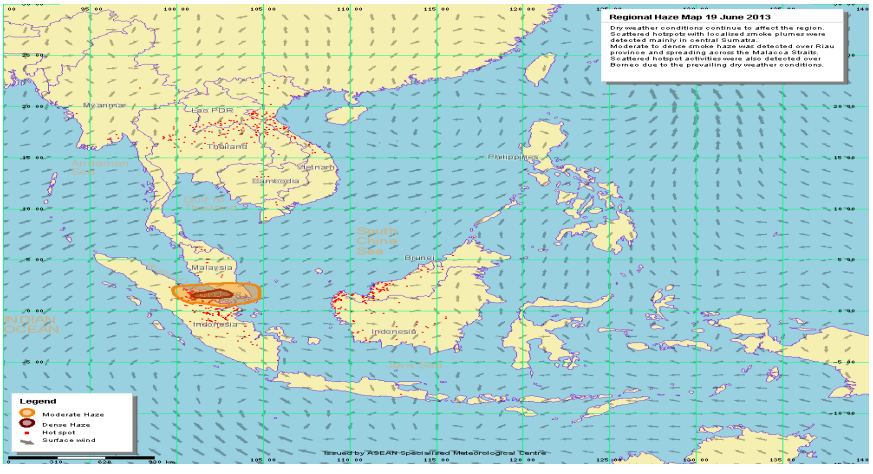

Figure 1. 19 June 2013 condition in Souteast Asia region (ASMC, 2013)

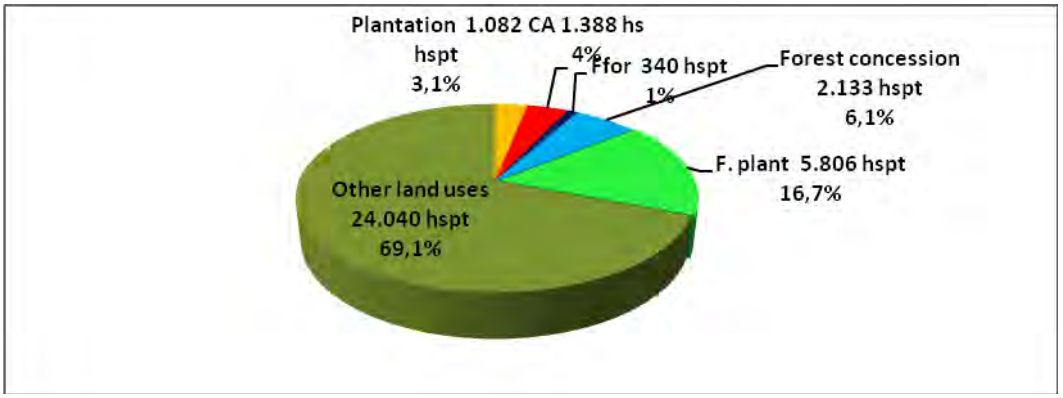

Figure 2. The source of fire in Indonesia 2012

Unfortunately the fire is still exist until October 2013, not only in Sumatra islands such as in Riau, Jambi, South Sumatra, Aceh, but also to the Kalimantan islands such as in West Kalimantan and Central Kalimantan. It means that fire prevention should be conducted seriously and through scientific based and involving the community through community based fire management. Biomass burning is considered a major source of trace gas species and aerosol particles (Logan et al, 1981) which play a vital role in tropospheric chemistry and climate (Crutzen and Andreae, 1996). Transboundary haze pollution due to the smoke from land preparation using fire has become a big problem in Indonesia every year, especially when the dry season comes, since ten years ago. It has been found that most of the smoke originates from illegal land preparation fires in oil palm and industrial forest plantations (60%-80%) as well as from shifting cultivation, which, unfortunately, is usually blamed for the smoke (Saharjo, 2007).

In 2000, Southeast Asia contributed 12% of global GHG emissions, amounting to 5,187.2 $MtCO^2$-eq, including emissions from LUCF (ADB 2009). The region's total emissions increased 27% during 1990–2000, faster than the global average. On a per capita basis, the region's emissions are considerably higher than the global average, but are still relatively low when compared to developed countries. The land use and forestry sector has been the largest source of GHG emissions from the region, contributing 75% of the total in 2000. The region in 2000 accounted for about half of global LUCF GHG emissions. Sources included the decrease in biomass stocks of forestland through deforestation, logging, fuel wood collection;

and the conversion of forestland to other uses such as cropland, grassland or pasture, and settlements (ADB 2009).

Table 1. Southeast Asian hotspot condition in the period 2000-2012 using NOAA-18

No.	Country	Hotspots 2010	Hotspots 2011	Hotspots 2012 (20 Nov.)
1	**INDONESIA**	**9,880**	**28,474**	**34.481**
2	MALAYSIA (semenanjung, sarawak, sabah)	2,346	2,262	3.340
3	BRUNEI	23	18	23
4	PHILIPINES	2,605	730	943
5	**THAILAND**	**17,578**	**12,722**	**24.059**
6	**CAMBODIA**	**14,013**	**13,774**	**12.831**
7	**LAOS**	**21,304**	**11,742**	**15.239**
8	**MYANMAR**	**36,748**	**26,988**	**48.860**
9	**VIETNAM**	**11,950**	**8,522**	**12.343**
10	SINGAPORE	0	0	0

CONCLUSION

Forest and land fires that could not stop and prevent clearly and seriously will cause the potency to make big fire occurs and un controlled. This situation become difficult to control as it occur especially in peat land which produce more haze and increase high greenhouse gas emission accompanied with other negative effects that well recognized such as air quality, health, education, economic, ecologic, transportation, and finally to the country relationship.

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Experiences and Prospect of Community Participation in Fire Management: A case from Nepal

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Abstract

Wildfires are a regular phenomenon during the long and intense dry seasons occurring annually in the Hindu Kush-Himalayas (HKH) region, many of them having a potential to cause major damages; e.g., serious degradation of forests, changes of ecosystem properties, and deterioration of social and economic conditions in some land-use systems and natural vegetation types.

Incidents of forest fires and total burning days are increasing in Nepal with increasing dry and hot season from the recent past and its consequences not only contributing to regional and the overall global problem but also posing a higher risk to the local communities, on economy, culture and ecology and to the secondary disasters, such as landslides and flash floods, that follow disastrous wildfires.

Almost all fires are human induced and impacting the most to the local community people who are relying on forest for their livelihood. This paper highlights some thoughts and experiences of community participation based on 3-level model works from Nepal.

1. INTRODUCTION

Wildfires in high altitude Hindu Kush-Himalayas (HKH) ecosystems are a major driver for destruction of pristine biodiversity, including the habitats of many rare species. During the long and intense dry seasons occurring annually in the region, wildfires are a regular phenomenon, many of them having a potential to cause major damages; e.g., serious degradation of forests, changes of ecosystem properties, and deterioration of social and economic conditions in some land-use systems and natural vegetation types. Observations indicate that the occurrence of wildfires is

increasing as a consequence of regional warming and extended dry spells. The southern slopes of the mountains are primarily affected, since they are generally warmer and drier compared to northern slopes and are therefore exposed to high human pressure. Increasing trend of wildfires in the recent past in the southern stretch of the HKH region not only contributing to regional and the overall global problem but also posing a higher risk to the communities if looked at from the point of view of the fragile Himalayan ecology (SAARC 2009).

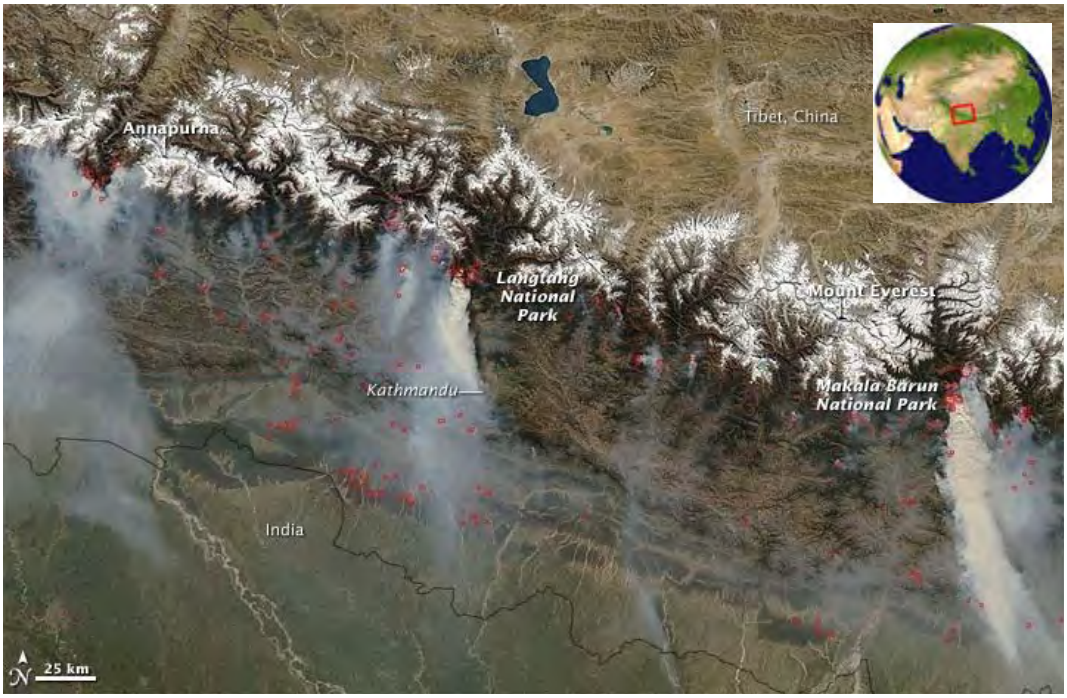


Figure 1. Fire Disaster Episode 2009 in Nepal
(Source: NASA's Earth Observatory (MODIS Aqua), 12 March 2009)

Incidents of forest fires and total burning days are increasing in Nepal with increasing dry and hot season from the recent past and its consequences not only contributing to regional and the overall global problem but also posing a higher risk to the local communities, on economy, culture and ecology.

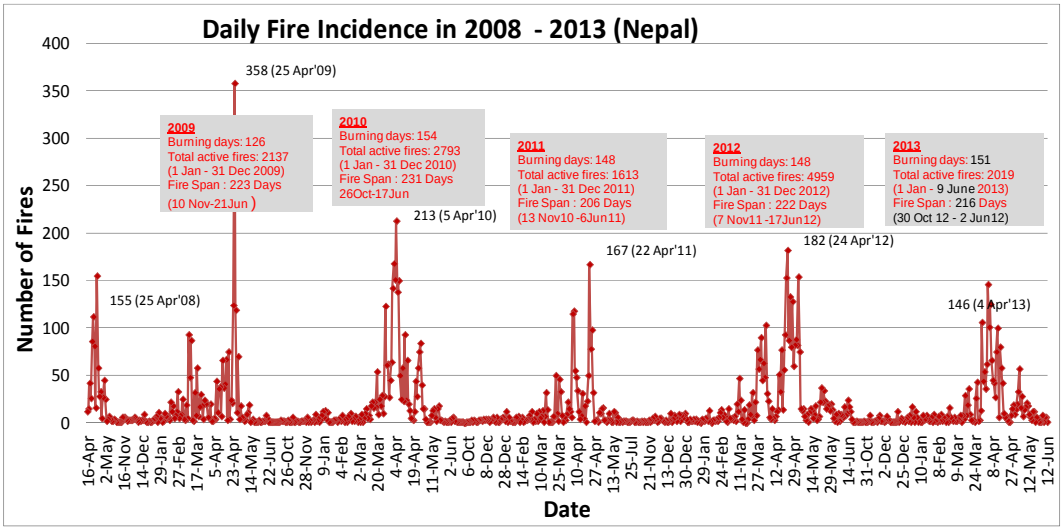
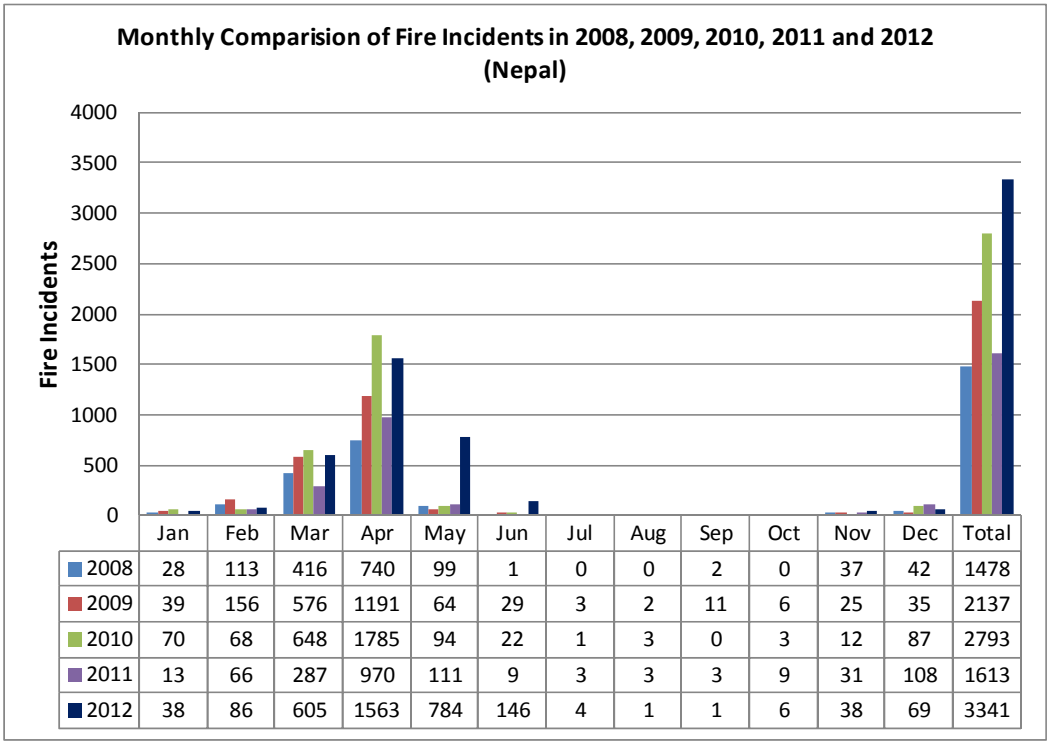


Figure 2. Daily fire incidents in Nepal from 2008 to 2013
(Data source: FIRMS-MODIS/FAO/UMD/NASA)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2008	28	113	416	740	99	1	0	0	2	0	37	42	1478
2009	39	156	576	1191	64	29	3	2	11	6	25	35	2137
2010	70	68	648	1785	94	22	1	3	0	3	12	87	2793
2011	13	66	287	970	111	9	3	3	3	9	31	108	1613
2012	38	86	605	1563	784	146	4	1	1	6	38	69	3341

Figure 3. Monthly fire incidents in Nepal from 2008 to 2012
(Data source: FIRMS-MODIS/FAO/UMD/NASA)

Wildfires in high altitude Hindu Kush-Himalayas (HKH) ecosystems are a major driver for destruction of pristine biodiversity, including the habitats of many rare species. The ecosystems and society are very vulnerable to wildfires, in general, and to the secondary disasters, such as landslides and flash floods, that follow disastrous wildfires. In 2009 alone forest fires claimed 49 lives injured 9 people; about 146,742 hectare of forest destroyed and caused the loss of about Rs 134,415,000. In 2010 fire season, a total of 9 people were reported dead, three people seriously injured, 431 houses were completely destroyed, 92 animals killed and more than 82,000 hectares forests were burnt A proper damage assessment of a fire and systematic fire management is not developed yet in Nepal. Moreover, there is no any record of impacts of fire on wildlife, medicinal plants, secondary disasters (health and water induced disasters) and, regional climate. However, there is recent new development in fire detection, monitoring and response system involving local communities.

There is increasing interest in community participation in fire management and the need for institutional and technological capability development at all levels in Nepal. Some key factors that urge for community-based approach are:

- Fire is used by the rural population as a traditional tool for clearing and managing agricultural and pasture lands. It is also used to facilitate the gathering of Non-Timber Forest Products (NTFPs) and in hunting and herding. Uncontrolled fires are common in the country, with a long and intense dry season. Many of these fires have the potential to cause major damages;
- Consequences of uncontrolled fires in country, inter alia, lead serious degradation of forests, ecological changes, as well as deterioration of social and economical conditions in some land-use systems and regional climate (e.g., the Asian Brown Cloud) and natural vegetation types;
- Nepal has diverse ecosystems, socio-economic and cultural settings and vegetation types resulting from a wide range of land-use systems and climatic conditions, consequently having diverse fire regimes and vulnerabilities;
- Fire management can be an essential part in ecosystem management (not all fires are destructive);

- Sustainable management and protection of vegetation cover, which provides goods and services including non-timber forest products and recreation, maintain biological diversity, mitigates the consequences of climate change, conserves watersheds, improves air quality and helps to reduce poverty through livelihood support to rural populations.

After a successful foundation of Regional South Asia Wildland Fire Network under the United Nations International Strategy for Disaster Reduction (UNISDR) Global Wildland Fire Network in Kathmandu in April 2007, *a 3-level Wildland Fire Management Project for Nepal* was approved and funded by the German Foreign Office, Task Force for Humanitarian Assistance, and was implemented by the Global Fire Monitoring Center (GFMC). The main components of the project were:

- Community Forest Fire Management Planning (CFFMP)
- District Forest Fire Management Planning (DFFMP)
- Round Table (RT) Meeting for the Development of National Strategy for Wildland Fire Management in Nepal

2. THREE LEVELS FIRE MANAGEMENT MODEL: NEPAL

The concept of '3-level Wildland Fire Management 'involved 3 components, i.e. (1) Community Level Fire Management Training and Planning, (2) District level Fire Management Planning, and (3) National Level Strategy Development.

2.1 Community Level Fire Management Training and Planning

It involved the two parts,

ⅰ. Awareness training to local forest user's groups

ⅱ. Model CBFiM planning

2.1.1 Awareness training programme

It deals with tools for community based fire management planning that are intended for use in a process which is as participatory as possible. It has been developed so that it can be applied to any village environment in Nepal. It is aimed at villagers and other members of a Community Forest User´s Group

(CFUG) and will allow to let people develop their own fire management plan and fire risk map.

Nepal is developing a local expertise to take a global leadership in fire management involving local community. There is a 'Volunteer Fire Management Group' well motivated to provide volunteer services to fire fighting and provide instructors to a fire management training programme if requested for in Nepal.

Figure 4. Fire Management Volunteer Group equipped with tools and safety gears

2.1.2 Community-based Fire Management Planning

A model has been developed for CBFiM Planning. The process includes where local people take the key roles in whole project cycle.

The principles are to include the perspectives of all interest groups (inclusive and gender balance) and to recognize indigenous technical knowledge on fire management.

Figure 5. Community people taking the lead during the training session in developing fire management plan

The CBFiMP process aimed at to:

- identify users, expectations (needs) of users and planning area
- identify physical features, conditions, zones, changes and contrasts in the village environment (transect walk)
- present and analyse information on land use, forests, water and other resources

and risk zones (participatory resource mapping)

- prepare 5-years action plan

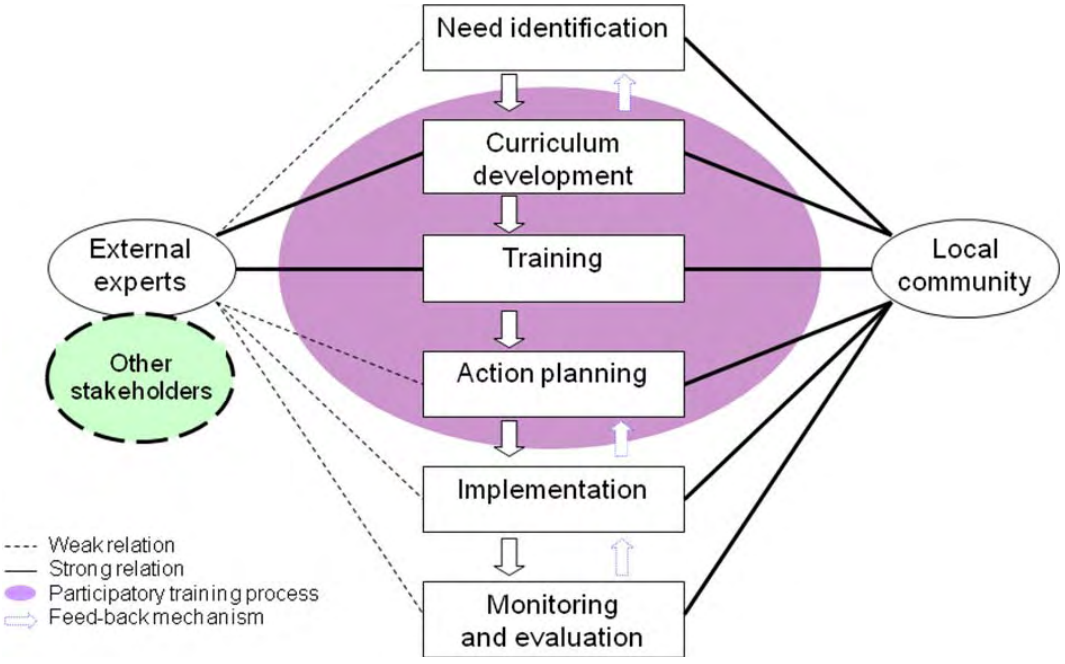


Figure 6. Community-based participatory forest fire management flow diagram

2.2 District (Province) level Fire Management Planning

It is common that forest fire occurs every year in Nepal, particularly in the forests of Terai and Churia hills. Government of Nepal has given less priority in managing forest fire due to limited resources. Nepal has adopted various forest management approaches including community forestry, leasehold forestry, protected forestry and government managed forestry. All categories of forests are affected by fire albeit the magnitude varies. Community forests and leasehold forests are less affected as compared to protected forests and government managed forests. Nevertheless, no comprehensive fire management plan exists in the country till date. The plan aims to fulfill the gap. This fire management plan highlights basic forest fire information, existing practices adopted by local communities in suppressing forest fire, and fire prevention and control strategies to be adopted into community managed, government managed, and protected forests in Makawanpur district.

The district fire management plan intends to prevent and control forest fire with strategies of ensuring people's participation, promoting indigenous knowledge, emphasizing preventive measures, and enhancing multi-stakeholders' networking. The management plan is prepared in the spirit of participatory approach. Various participatory tools including focus group discussion, key-informant interviews and observations were used. In addition, various documents were reviewed while preparing the plan.

Makawanpur district of Nepal was selected for district level planning which aimed to:

- Assess the status, damages and impacts of forest fire;
- Identify fire sensitive areas and causes of forest fire;
- Identify preventive and control measures of forest fire; and
- Prepare a comprehensive five-year work plan for forest fire management.

The district is divided into three fire zones including highly fire sensitive zone, moderately fire sensitive zone and less fire sensitive zone, based on causes and effects of forest fire. The criteria set for zoning include occurrence of forest fire, forest types and availability of fuel loads, distance from settlements, roads and trails, human interferences (charcoal production areas, shifting cultivation areas, forest encroachment areas etc.) and forest management regimes.

Proposed fire preventive measures include risk reduction through increased awareness level of the stakeholders; and hazard reduction through reducing fire fuels, construction of fire lines, and adoption of prescribed burning in highly and moderately fire sensitive zones. Fire control measures proposed in the plan include developing effective fire detection and communication systems; and suppressing fire through developing appropriate institutions and well equipped fire crews with traditional as well as modern fire fighting equipments and tools at various levels. The plan also recommends contingent recovery planning for rehabilitating fire damaged areas. A fire management work plan is prepared for the next five years.

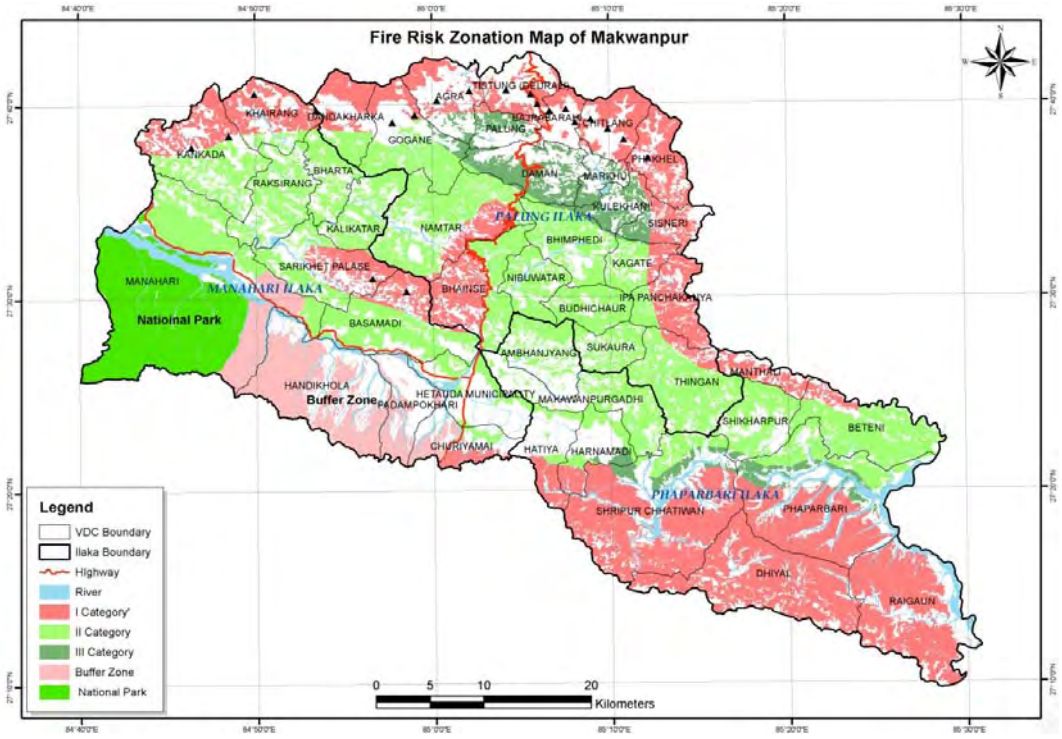


Figure 7. Fire Risk Zonation Map of Makawanpur District (Nepal)

2.3 National Level Fire Management Strategy Development

Forest fire is considered as a major problem in forest degradation in Nepal. About 400,000 hectares forest area burned annually. About 90 percent of the forested area in the plain was burnt annually. Moreover, there are regular winter vegetation burnings in the coniferous forests in high mountains in Nepal. Most of fires are anthropogenic. A study revealed that fire incidents were 58% deliberate, 22 % negligence and 20% accidental. At least one hundred villages are burned annually in Nepal, some of which are definitely destroyed by forest fires where the roofs are made of thatched grass.

Consequently, the uncontrolled fires in the country among others are serious degradation of forests, ecological changes, as well as deterioration of social and economical conditions in some land-use systems and natural vegetation types. It losses in regenerative capacity of the forest (ca. 90% regeneration of *Shorea robusta* is completely damaged by fire). Fire-induced loss of soil cover negatively affects

hydrological regimes and soil properties, leading to severe erosion and loss of productive topsoil. High economic losses are caused by damaging valuable timber and non-timber resources, natural regeneration, and planted forests.

Despite these intimidating scenarios, there was no fire specific strategic measure to address these problems in the country. Therefore, all national key players (including high level bureaucrats, development partners, academicians, NGOs, Civil societies, practitioners and managers etc.) met together and agreed upon the 'Resolutons' in Kathmandu in December 2007. The 'Resolutions' are in line with the 'KTM Declarations' made in the foundation of UNISDR-Regional Wildland Fire Nework in 2007, agreed road maps of the 'Seville Conference' in 2007, ITTO and FAO Fire Management Voluntary Guidelines'.

Figure 8. The participants of the National Round Table meeting within the frame of 3-level Fire Management Project in Nepal in 2007

The '*Resolusions of the Round Table Meeting*' emphasized, among others are:

- Enhance cooperation among countries within the region and at inter-regional levels, aimed at sharing technology, expertise and data in fire management;
- Emphasize on participatory approach to fire management
- Develop legal, institutional and policy frameworks
- Develop human resources
- Create an enabling environment from all possible donors including national, international, bi-lateral, multi-lateral and private foundations for financial, technical and other resource support for sustainable fire management in the country;
- Apply non-legally binding instrument and its implementation through the Multi-Year Programme of Work; as well as the International Strategy to Enhance

International Cooperation in Fire Management, including the Fire Management Voluntary Guidelines.

- Support the UNISDR Global Wildland Fire Network, the Regional South Asia Wildland Fire Network and the Secretariat of the global network, the Global Fire Monitoring Center (GFMC) by national agencies and international donors aimed at fostering international cooperation in fire management, including collecting and disseminating fire information, arranging and enhancing international policy dialogue, and support of projects;

3. Impacts after the 3-level Fire Management Project

After implementation of the 3-level models in Nepal, some impacts have been seen as follows:

3.1 Development of fire management volunteer groups (20-30 persons in each groups) with fire fighting hand tools and safety gears in different forest management regimes in Nepal

- 7 groups in community forest within WWF funded Terai Arc Landscape Project (TAL) and Chitawan-Annapurna Landscape (CHAL) project areas
- 3groups in collaborative forest management areas
- 3 groups in conservation areas including buffer zone community forests
- 1 group in protected area
- 6 groups in District Forest Offices

Rangapur Collaborative Forest, Rangapur, Rautahat, Nepal: Supported by WWF/ USAID/ Hariyo Ban Program, Implemented by Nepal Forest Fire Management Chapter (NFMC), 2012

Halkhoriya Collaborative Forest, Bara, Nepal: Supported by WWF/ USAID/ Hariyo Ban Program, Implemented by Nepal Forest Fire Management Chapter (NFMC), 2012

Baghauda User Committee, Buffer Zone of Chitawan National Park, Chitawan, Nepal: Supported by WWF/ USAID/ Hariyo Ban Program, Implemented by Nepal Forest Fire Management Chapter (NFMC), 2012

Barandabhar Protected Forest, Chitawan, Nepal: Supported by WWF/ USAID/ Hariyo Ban Program, Implemented by Nepal Forest Fire Management Chapter (NFMC), 2012

Sundevi Users Committee, Suklaphanta Wildlife Buffer Zone, Kanchanpur, Nepal: Supported by WWF/ USAID/ Hariyo Ban Program, Implemented by Nepal Forest Fire Management Chapter (NFMC), 2012

Rani Ban Community Forest and Pathari Community Forestry, Kaski, Nepal: Supported by WWF/ USAID/ Hariyo Ban Program, Implemented by Nepal Forest Fire Management Chapter (NFMC), 2012

Baijanath Community Forestry and Barandibhar Community Forestry, Kanchanpur, Nepal: Supported by WWF/ USAID/ Hariyo Ban Program, Implemented by Nepal Forest Fire Management Chapter (NFMC), 2012

Jum Danda Jhhapre Community Forestry, Tanahu, Nepal: Supported by WWF/ USAID/ Hariyo Ban Program, Implemented by Nepal Forest Fire Management Chapter (NFMC), 2012

Tikauli Buffer-zone Community Forest, Tikauli, Chitawan, Nepal - Terai Arc Landscape Project (TAL), Sauraha, Chitawan, Implemented by Nepal Forest Fire Management Chapter (NFMC), 2012

Sunakhari Buffer-zone Community Forest, Subarnapur, Parsa, Nepal, Terai Arc Landscape Project (TAL), Sauraha, Chitawan, Implemented by Nepal Forest Fire Management Chapter (NFMC), 2012

Narti Community Forest Users Coordination Commitee, Lamahi, Dang, Terai Arc Landscape Project (TAL), Dhangadhi, Kailali, Implemented by Nepal Forest Fire Management Chapter (NFMC), 2012

Khata Community Forest Users Coordination Committee, Bardiya, Nepal: Supported by Terai Arc Landscape Project (TAL), Dhangadhi, Kailali, Implemented by Nepal Forest Fire Management Chapter (NFMC), 2012

District Forest Office, Dang, Nepal: Supported by Multi Stakeholder Forestry Programme (MSFP)/Government of Nepal/ UKAid/ Swiss Agency for Development and and Cooperation (SDC)/Ministry for Foreign Affairs of Finland, Implemented by Nepal Forest Fire Management Chapter (NFMC), 2013

District Forest Office, Dailekh, Nepal: Supported by Multi Stakeholder Forestry Programme (MSFP)/Government of Nepal/ UKAid/ Swiss Agency for Development and and Cooperation (SDC)/Ministry for Foreign Affairs of Finland, Implemented by Nepal Forest Fire Management Chapter (NFMC), 2013

District Forest Office, Kapilvastu, Nepal: Supported by Multi Stakeholder Forestry Programme (MSFP)/Government of Nepal/ UKAid/ Swiss Agency for Development and and Cooperation (SDC)/Ministry for Foreign Affairs of Finland, Implemented by Nepal Forest Fire Management Chapter (NFMC), 2013

District Forest Office, Ramechhap, Nepal: Supported by Multi Stakeholder Forestry Programme (MSFP)/Government of Nepal/ UKAid/ Swiss Agency for Development and and Cooperation (SDC)/Ministry for Foreign Affairs of Finland, Implemented by Nepal Forest Fire Management Chapter (NFMC), 2013

District Forest Office, Baglung, Nepal: Supported by Multi Stakeholder Forestry Programme (MSFP)/Government of Nepal/ UKAid/ Swiss Agency for Development and and Cooperation (SDC)/Ministry for Foreign Affairs of Finland, Implemented by Nepal Forest Fire Management Chapter (NFMC), 2013

District Forest Office, Dhankuta, Nepal: Supported by Multi Stakeholder Forestry Programme (MSFP)/Government of Nepal/ UKAid/ Swiss Agency for Development and and Cooperation (SDC)/Ministry for Foreign Affairs of Finland, Implemented by Nepal Forest Fire Management Chapter (NFMC), 2013

Tilaurakot Collaborative Forest Management Committee, Kapilvastu, Nepal: Supported by Terai Arc Landscape Project (TAL)/RIMS-Nepal, Dhangadhi, Kailali, Implemented by Nepal Forest Fire Management Chapter (NFMC), 2013

Fire fighting hand tools and safety gears (arranged and developed by NFMC www.nffmc.org) handed over to each group (most of the cases) are listed below:

S.N.	Types	Unit	Number
1	Swatter	Sets	10
2	Shovel	Sets	5
3	Rake	Sets	5
4	Rake-hoe	Sets	5
5	Axe-hoe	Sets	2
6	First-Aid Kit	Set	1
7	Jump-suit	Sets	10
8	Gloves	Pairs	20
9	Helmet	Sets	10
10	Boot	Pairs	20
11	Torch	Sets	5
12	Socks	Pairs	10
13	Water Bottle	Sets	10
14	Face Mask	Sets	10

3.2 Government and local development partners are initiated to development of 'District Level Forest Fire Management Plans'

The district fire management plan intends to prevent and control forest fire with strategies of ensuring people's participation, promoting indigenous knowledge, emphasizing preventive measures, and enhancing multi-stakeholders' networking. The management plan is prepared in the spirit of participatory approach. Various participatory tools including focus group discussion, key-informant interviews and observations were used. In addition, various documents were reviewed while preparing the plan.

Makawanpur district is divided into three fire zones including highly fire sensitive zone, moderately fire sensitive zone and less fire sensitive zone, based on causes and effects of forest fire. The criteria set for zoning include occurrence of forest fire, forest types and availability of fuel loads, distance from settlements, roads and trails, and forest management regimes.

Figure 9. Forest Fire Management Plan of Makawanpur District (Nepal)

Proposed fire preventive measures include risk reduction through increased awareness level of the stakeholders; and hazard reduction through reducing fire fuels, construction of fire lines, and adoption of prescribed burning in highly and moderately fire sensitive zones. Fire control measures proposed in the plan include developing effective fire detection and communication systems; and suppressing fire through developing appropriate institutions and well equipped fire crews with traditional as well as modern fire fighting equipments and tools at various levels.

The plan also recommends contingent recovery planning for rehabilitating fire

damaged areas. A fire management work plan is prepared for the next five years.

As per the model developed in Makawanpur district, Nepal is now considering this initiative through different programmes and projects.

3.3 Government of Nepal has approved 'Forest Fire Management Strategy of Nepal 2010'

The forest fire management strategy of Nepal has four pillars and is under implementation:

1. Policy, legal and institutional development and improvement;
2. Education, awareness raising, capacity building and technology development;
3. Participatory (involving local community) fire management and research; and
4. Coordination, collaboration, networking, international cooperation, and infrastructure development.

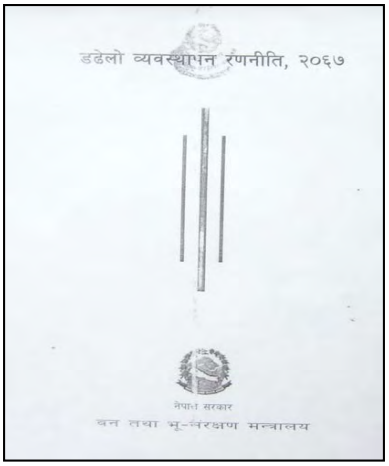


Figure 10. Forest Fire Management Plan of Makawanpur District (Nepal)

The strategy highlights, among others, are:

- Establish 'Fire Management Cell' at the Departments (Forests & National Parks and Wildlife Conservation)
- Prevention and early detection is the best strategy
- Community-based approach supported by modern technology (RS/GIS).

4. CONCLUSION AND RECOMMENDATION

There is a lack of existing local and national capability in fire research and management, including fire fighting, monitoring, early warning and ecological and socio-economic impact assessment, and facilitating international cooperation in fire management in countries in South Asia including Nepal.

Therefore, it has been recommended for:

- Focus on capacity building, awareness raising and education,

- ◦ Conduct Regional Training Courses
- ◦ Conduct Country level FM training courses
  - ■ Mid-level technicians
  - ■ Field level technicians
  - ■ Community level people
- ◦ Education and Awareness Programmes

- Development of curricula for college and school levels
- Conduct regular Regional Consultations
- Develop the multilingual 'Fire Management terminologies' in the languages of South Asian countries'
- Development of a Policy, a Strategy and Building Capacities in Local, National and Transboundary Forest Fire Management
- Development of leadership, cooperation and communication
- Establishment of Regional Fire Management Center in Kathmandu
- Workshops / Trainings / Consultations (Potential Focus – information and capacity building, including Fire Monitoring and Early Warning System, Fire Assessment, Land cover)
- Dissemination of knowledge on people's participation in fire management gained from Nepal through pilot projects
- As the South Asia Regional Network is playing a crucial role in providing platform for policy dialogue and communication, information sharing and technology transfer through project implementation in the region, the Network should be recognized as a key partner and be supported by the UNISDR, KOICA, FAO and other donors.
- It should also be noted that, it is important to encourage the key stakeholders, for instance government organizations, regional organizations/ institutions (e.g. UNECE, SAARC, ASEAN, ICIMOD etc.), in countries in the Pan Asia region to get involved in UNISDR-Pan Asia Wildland Fire Network initiatives.

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Regional Fire Management Activities 2010-2013

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Abstract

Forests in the Russian Federation occupy 69% of the total territory. There are 1183.3 million hectares (ha) of forest, including the State Forest Fund (1144.1 million ha), especially protected natural territories (26.2 million ha), forests of other categories (, belonging to the Ministries for Agriculture or Transport, 6.8 million ha), Forests of the Ministry of Defense (4.8 million ha), and Municipality Forests (1.4 million ha).

Forests constitute a unique ecological system which is one of the most important among all natural systems and a rich genetic resource. For millennia fire was an important factor shaping sustainable forest ecosystems. During the last century, however, forest fires became dramatically destructive because of human activities. Thousands of kilometres of forest roads built up to extended territories in Siberia and Far East for clearcut areas. At the same time it was a national policy to put out every fire not depending the location and economic value. Due to this policy huge amount of fuel accumulated in this areas, and fires cause dramatic damage to forested territories now days.

Among many different problems in the forest sector during the last few years wildfires affecting protected (managed) forests and other lands, e.g. natural peatlands, natural pastures and agricultural lands, have resulted in high economic and environmental damages.

Introduction

The Forest Fund of Russia is subdivided into the following zones of monitoring:

1) **Zone of Ground Monitoring:** Densely populated territories with a developed road network where detection and suppression is made by mainly ground forces, that capable to arrive to a fire within 3 hours from the time of fire detection – 90.4 million ha;

2) **Zone of Aviation Monitoring:** Forests with the low-developed road network, detection is made by aviation methods, suppression of fires is made mainly by teams of paratrooper-firefighters and aviation technologies – 481.2 million ha;

3) **Zone of Space Monitoring (remote territories):** The zone of space monitoring is subdivided into two levels. In the Zone of the 1st level detection of forest fires remote sensing technologies are applied, suppression is carried out only at threat to settlements and objects of economy. In the Zone of the 2nd level control of a fire situation is carried out by remote sensing only – 571.3 million ha.

According to the Forest Code of Russia regional forest authorities are responsible for fire management since 2007.

Fire season 2010

Russia experienced its worst wildfire season ever in European Russia, due to record temperatures (the hottest recorded summer in Russian history) and drought during the period 21 June to 19 August 2010. A severe drought, accompanied by high air temperatures (up to 40℃) and strong winds fanned much of the burning. A total of 2.3 million ha nationwide burned by 32,300 fires. The general burned area was represented by conifer and mixed forests and some areas of peat bogs in Moscow, Ivanovo, Vladimir, Riazan regions. These wildfires were close to populated areas, forcing about 100,000 from their homes, more than 3,000 houses burned in over 100 villages in 19 regions of Russia. Most villages burned out of flame of crown fires due to strong winds – over 20-30 meters per second. 62 people died in the fires including three firefighters. The smoke impacts to Moscow, Nizni Novgorod, Cheboksary cities and in many other towns and villages lingered for weeks and, along with the heat, and caused pulmonary and heart diseases. Most of

the wildfires were the result of human carelessness.

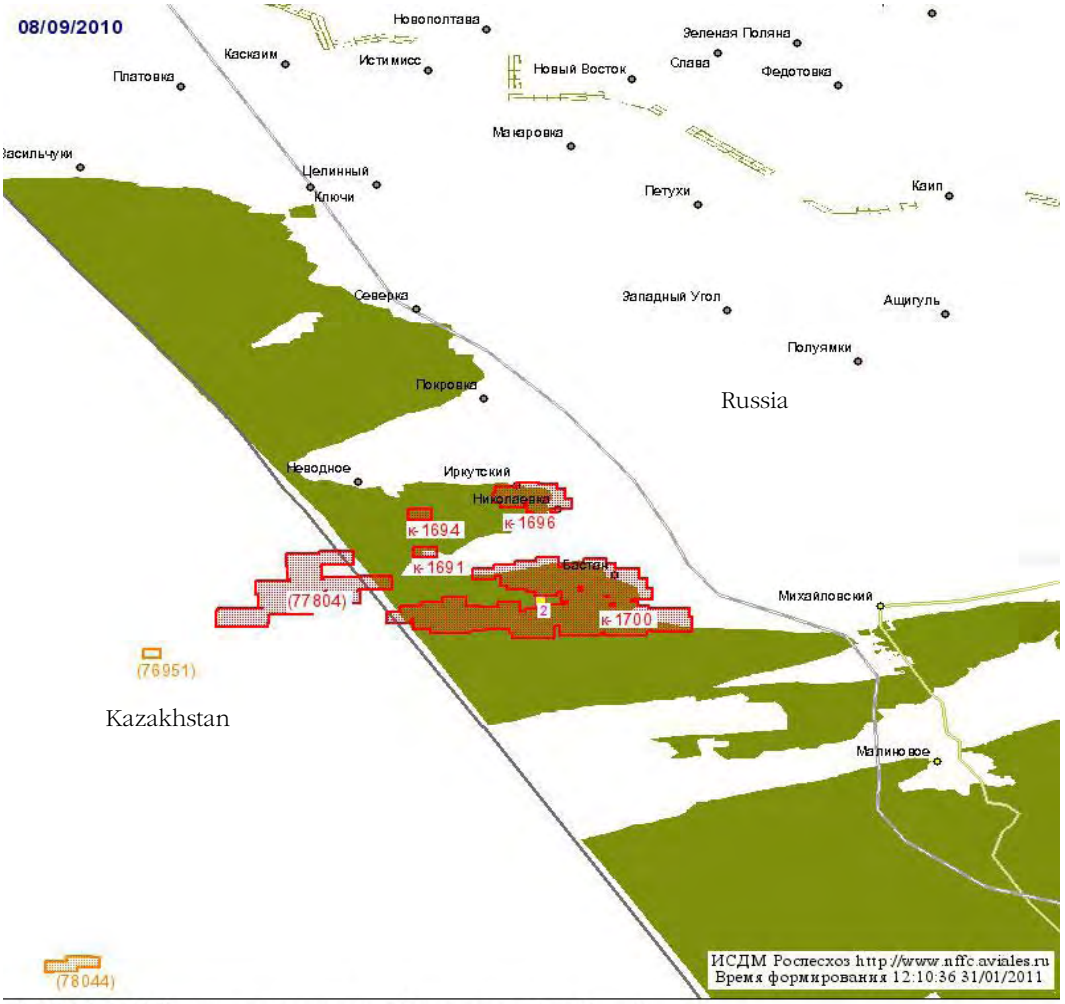
During a short time great number of resources were involved for fire management. Over 200,000 firefighters, 30,000 fire trucks and engines, about 200 aircraft, including 13 aircraft, over 100 engines and 560 firefighters as an assistance from 14 countries. By end of 2010 all villages were reconstructed under a Government program.

In the following some of the catastrophic fires of the 2010 fire season are described.

CATASTROPHIC FIRES IN 2010: ASSESSMENT SURVEY AND COMMENTS

Table 1. Fire assessment in Altay region

Fire name	K-1696, k-1700
Location	Altaiski krai
Dates (Detection /contained)	8 September – 11 September 2010
Size	7,400 ha covered by forest, 1,600 not covered by forest, 3,000 ha non forested land, 3000 ha burned by crown fire
Cause	Cross boundary fire from Kazakhstan
Impact summary	334 homes burned in Nikolaevka and Bastan Villages. Over 1000 people forced to leave houses. No lives lost. 300 fire fighters, 60 engines, 21 bulldozers, 5 aircraft involved in fire management. Cost of fire fighting: 9.9 million rubles ($US 330,000)
Land use objectives	Nearly 100% of the area burnt comprised conservation reserves.
Fire regimes / fire history	Variable, over such a large area. Active fire suppression has been practiced, while the use of prescribed fire limited
Fuel description	Primarily pine forest dominated ecosystems.
Climate / weather factors	Many days of Very High to Extreme fire weather supported with strong wind 30 m/sec
Fire protection strategies	Forest Fire management is the responsibility of the Regional Forest Services that is under Regional Government since 2007. Local municipalities are responsible for management of agriculture fields and fire management on this areas.



k-1696, k-1700 (начало, пострадали н.п. Николаевка и н.п. Бастан)

Figure 1. Satellite-derived map of cross-boundary fires between Kazakhstan and the Russian Federation

Table 2. Fire assessment in Mordovia Republic

Fire name	k-360
Location	Republic of Mordovia
Dates (detection / contained)	25 July – 15 August 2010
Size	800 ha covered by forest, 300 ha non forested land, 500 ha burned by crown fire
Cause	Unknown (most likely carelessness)

Impact summary	65 homes burned in Svezhenkaya Village, 3 people died. 46 fire fighters, 6 engines, 2 bulldozers, 2 tractors involved in fire management.
Land use objectives	Exploitation forest
Fire regimes / fire history	Variable, over such a large area. Active fire suppression has been practiced, while the use of prescribed fire limited
Fuel description	Primarily pine and spruce forest dominated ecosystems.
Climate / weather factors	There were no precipitation since 21 June 2010. Many days of very high temperature up to 40°C. Extreme fire weather supported with strong wind over 30 m/sec
Fire protection strategies	Forest Fire management is the responsibility of the Regional Forest Services that is under Regional Government since 2007. Local municipalities are responsible for management of agriculture fields and fire management on this areas.

Table 3. Fire assessment in Riazan region

Fire name	k-369
Location	Riazan oblast
Dates (detection / contained)	24 July – 20 August 2010
Size	36,000 ha covered by forest, 1400 ha non forested land, 15,800 ha burned by crown fire
Cause	Carelessness
Impact summary	95 homes burned in Shemkhino and Kriusha Villages, 1 died. 704 fire fighters, 20 fire engines, 12 bulldozers and 10 tractors were involved in fire management. Damage cost 1.3 billion rub ($US 43.3 million)
Land use objectives	Exploitation forest
Fire regimes / fire history	Variable, over such a large area. Active fire suppression has been practiced, while the use of prescribed fire limited
Fuel description	Primarily conifer plantations.
Climate / weather factors	There were no precipitation since June 20. Many days of Very High temperature up to 40°C. Extreme fire weather supported with strong wind over 30 m/sec
Fire protection strategies	Forest Fire management is the responsibility of the Regional Forest Services that is under Regional Government since 2007. Local municipalities are responsible for management of agriculture fields and fire management on this areas.

Fire Season 2011

As a whole for Russia in 2011 the average amount of precipitation was for 22% more than in 2010.

Forest Fire Danger Rating based on weather conditions in the Russian Federation is determined by the Nesterov Index and is characterized by the corresponding class of fire danger (KPO) on a scale from 1 to 5 (the main criteria: quantity of rainless days, humidity of air, temperature).

The analysis of Fire Danger shows that in comparison with last year High and Extreme fire danger was observed in Far East Federal District (April, August, October), Siberian Federal District (April, May, October), and also in North West Federal District (June). In the majority of other regions average value of KPO was up to standard or decreased.

In 2011 a total of 20,851 forest fires were recorded which burned 1,636,232 ha, on protected territories. According to data of Space Research Institute based on remote sensing area burned is noted about 5 mln ha on extended areas of Russia. Mainly large fires were burning in Siberia, Far East and North West Federal Districts (90%) out of total area burned and are the share of 11 subjects (regions) of the Russian Federation (the Republics of Sakha (Yakutia), Buryatiya, Komi, Zabaykalsky Krai, Krasnoyarsk, Khabarovsk, the Amur, Arkhangelsk, Irkutsk, Sverdlovsk areas, Khanty-Mansi Autonomous Okrug).

The main reason for the raised number of forest fires and area burned in that regions were uncontrollable agricultural burnings that run out of control and abnormal weather conditions.

In total over 17,000 fire engines, tractors and other equipment, over 200 aircraft were mobilized during the season nationwide.

One fire fighter died in Rostov oblast out of crown fire. One pilot died and next injured hardly in Republic of Tyva after crash of Bekas X-32 airplane deployed for aerial monitoring.

Under the Interagency Agreement forces of Emergency Ministry and resources of other agencies were involved during the extreme fire events.

Based on interregional agreements 1600 fire fighters involved in fire fighting assistance in the other regions of the Russian Federation.

In comparison with 2010 the number of fires decreased by 1.6 times, the area affected by forest fires decreased by 471,000 ha on protected territories. The damage caused by forest fires, made up in 2011 more than 20 billion rubles that almost 6 times less in comparison to the previous year.

In the territory of the Moscow region Federal Forest Agency- Rosleskhoz together with the Government of the Moscow region defined sites of peatlands for restoration (rewetting). Also Rosleskhoz together with the Government of the Moscow region coordinated the sites of forest fund for irrigation in 2012 and 2013. In total for 2010-2011 irrigation / restoration of peat lands of forest fund were accomplished on 17,000 ha out of the total of 20,000 ha.

Fire Season 2012

In 2012 in the Russian Federation on protected forest territories of Russia 19,535 wildfires affected 1.9 million ha of forest lands. In comparison with 2011 the number of fires decreased by 6%, while the area affected by the fire, rose up by 22%. Extreme forest fire situations were observed during 2012 in the Ural, Siberian and Far Eastern Federal Districts. Emergency situation declared in 16 regions of Russia. 54% of all fires and 92% of the burned area were in 10 most burning regions: Chelyabinsk Region (34,200 ha, 1.7%), the Amur region (42,400 ha, 2.1%), Yamal-Nenets Autonomous Okrug (63,100 ha, 3.2%), the Republic of Buryatia (130,400 ha, 6.5%), Tomsk region (101,600 ha, 5.1 %), Khanty-Mansisk Autonomous Area (118,700 ha, 5.9%), Republic of Sakha (Yakutia) (188,900 ha, 9.5%), Khabarovsk region (352,800 ha, 17.7%), Amur region (400,200 ha, 20%), Krasnoyarsk region (410,900 ha, 20.6%).

The main reasons of the increasing of forest fires in 2012 are the early beginning of the fire season (the first forest fires were recorded on 26 March 2012 in the Trans-Baikal region), abnormal weather conditions in some regions (average number of extreme fire danger rating days were more than 150 days), and starting of fires in remote areas.

59 teams of fire fighters with a total of 2,454 people were engaged during fire season to the regions with extreme burning conditions under the program of interregional assistance.

The main causes of forest fires included:

- Carelessness – 31.1%, which is 1.4 times less in comparison with 2011 (45%) and 1.6 times less the five-year average data (49.4%)
- Lightning – 21.7%, which is 1.6 times higher compared with 2011 (13.7%) and 2.4 times higher the five-year average data (9%)
- Agricultural burns – 6.6%, which is 1.3 times higher compared to 2011 (4.9%) and 1.1 times less than the five-year average data (7%).
- Not determined – 40.6%, which is 1.1 times more compared with 2011 (36.4%) and 1.2 times higher the five-year average data (34.7%)

Analyzing the causes of unfavorable development of the forest fire situation in the regions of Russia should be noted major shortcomings:

- Lack of controlling the propagation of wildfires
- Lack of preventive measures in forests and in adjoining territories with economic objects and other lands.
- Late detection of forest fires.
- Lack of aerial monitoring and fire fighting operations.

During fire fighting operations in mountainous terrain in Republic of Tiva eight smokejumpers (aerial firefighters) died in a crown fire.

Fire Season 2013

Fire season 2013 started late to compare with previous years and was moderate in general.

Up to 17 October 2013 a total of 10,135 fires burned 1.1 million ha forested and 0.3 million ha non-forested area. The number of forest fires and area burned are less by 50% to compare with long term data. Critical fire situations were only in following regions: Republic of Yakutia (Far East), Krasnoyarski krai (Siberia), Khanti Mansisk and Yamal- Nenetsk autonomus okrugs (Urals) and Komi republic (North West). About 90% out of total area burned during the season in those regions.

The main reason of optimistic fire data to compare with previous years is appropriate weather conditions. However in National and Regional levels taken many actions to improve forest fire protection in general as well including development of joint programs of scientists and practitioners.

In 2012 and 2013 with the assistance of Global Fire Monitoring Center (Prof. Johann G. Goldammer) the First and Second International Fire Management Weeks were organized in Krasnoyarsk region to observe the role of natural fires and prescribed management fires, as well as post-fire natural regeneration of forests in Siberia and the results of 20 Years Bor Forest Island Fire Experiment (1993-2013).

Scientists, Practitioners, Government Authorities and International experts 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.

Scientists and fire management specialists took part in the discussions. Representatives of the media and public organizations expressed substantial interest in the conference.

The Round Table of the Fire Management Week in 2012 concluded that there is an urgent need to revise the policy and practice of fire management in the Russian Federation, and agreed 10 recommendations including:

- 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.
- Methodological guidelines for prescribed burning under forest canopy need to be developed at federal level.
- Educational programs for the training of forest firefighters and fire management specialists at different educational levels (Including programs for

volunteer fire fighters) need to be developed and approved at Federal level.

- Programs of advanced continuous professional education for foresters on prescribed burning need to be developed and approved
- Further scientific research concerning prescribed fires needs to be supported at Federal level.
- 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 level and to determine the normatives for fire prevention operation plans in the 1-km zone around settlements.
- Concepts for the use of fire on agricultural and other non-forested lands of the Russian Federation need to be developed.
- 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).
- 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.

During Fire Management Week in 2013 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.

1. 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.
2. 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.
3. Prescribed burning in forestry can be used for
   - reduction of fuel loads
   - cleaning clearcuts
   - site preparation for regeneration
   - improving forest sanitary conditions
1. 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 Fire Management Weeks of 2012 and 2013 accepted by the Federal Forest Agency and taken for future development.

Figure 2. International and Russian fire scientists and fire management experts prepare the "Krasnoyarsk 10-Point Programme on the Future of Fire Management in Russia" at the First Fire Management Week, September 2012

Figure 3. Prof. Goldammer explaining the role of historic natural fires for Siberian forests to the media at the First Fire Management Week, September 2012

Figure 4. International experts giving presentations during the Second Fire Management Week, June 2013.

Figure 5. Participants of the Second Fire Management week in the field experiment

Figure 6. Bor Forest Island in flames 20 years ago (July 1993)

Figure 7. Natural restoration of Bor Forest Island in 2013 from the air.

Figure 8. Natural restoration of Bor Forest Island in 2013 on the ground.

Conclusions

After the fire season 2010 the Federal and Regional Authorities have taken essential efforts to develop forest protection in Russia.

Funding of forest protected activities doubled in comparison with investments of 2010 and amounted about 5.0 billion rubles annually, including Federal and Regional budgets.

During the period 2011-2013 8.5 billion rubles were provided for acquisitions of fire fighting equipment. Over 3000 engines, tractors and other units were delivered to the firefighting organizations.

Improved fire management rules and regulations were developed to involve additional resources in firefighting operations.

Interregional and Interagency cooperation was further developed and a Federal Reserve of Aerial Fire Fighting Resources was established.

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Wildland Fire Research in the Past and Wildland Fire Management in Recent Era

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Abstract

Scientific, social and political interest in wildland fire is increasing as our knowledge and information sharing over the world are expanding. Analysis of research topics on wildland fire in several journals relevant to wildland fire showed that the major topics have been changed with the social and technical development. Number of papers on wildland fire increased dramatically in late twentieth century. The number of papers on wildland fire in 1970s was almost similar to that until 1970, more than doubled in 1980s, and exploded more than four times in 1990s. Research topics on wildland fire became diverse and more detailed with time. Cooperation in different hierarchical levels, changing environment and fire regimes, community participation in wildland fire management, and technology development are major topics in international wildland management in recent era. Climate change dominates most of issues. Wildland fire management is facing a task to adapt to drastic changes, and that is a big challenge.

WILDLAND FIRE RESEARCH IN THE PAST

1900-1970

Only ca. 200 papers including fire in the title or keywords were published before 1970. The topics could be grouped as wildland fire policy, preparedness, firefighting, fire weather, fire impact and fire statistics. Wildland fire policy included forest fire law, fire management, and resource allocation. Preparedness included danger rating, detection, and behavior of wildland fire. Firefighting included firefighting equipment, aircraft, retardant, and modeling issues. Weather was also a

hot topic in wildland fire research even in the early twentieth century. Fire impact was mostly studied on vegetation and a few studies dealing with wildlife and fire damage were reported. Fire statistics was mostly national reports on wildland fire occurrence and damage.

Most of papers in 1930s were on fire law or the establishment of fire organizations. Fire danger and detection began to be increasing issues in 1930s. Fire control or fire damage issues were discussed and fire danger index was appeared in 1940s. Prevention or control were still top topics in wildland fire issues until 1960s. The impact of fire on soil began to be reported in 1960s.

1970s and 1980s

Number of fire research published in journals increased almost linearly from 1970 t0 1990 and topics became more diverse and detailed with time. Wildland fire effects on vegetation and soil were major topics in 1970s. Number of fire research papers published in 1970s was almost similar to that published until 1970. Journals on hydrology, conservation and soil also delivered papers on wildland fire.

Number of journals including wildland fire research increased drastically from 1980s. Number of papers published in 1980s was more than twice as many as that in 1970s. Effects of fire on plants, mixed-conifer forest, regeneration, soil, nutrition, ash-fertilization, sediment, and catchment were studied. Fire effects on wildlife were also investigated. Prescribed burn, fire history, fire danger, fire frequency, and post-fire effects were actively studied and modeling began to get interest in 1980s. Fire management still occupied major part in wildland fire research.

From 1990 to present

Fire research drastically developed with the development of RS and GIS techniques. 1990s were a monumental period in fire research in that reason. Fire research in 1990s and 2000s could be grouped as fire detection and techniques, modeling, firefighting, fire effect, policy and management, and fire review. Fire detection and technique mostly dealt with RS or GIS techniques. Fire modeling focused on the prediction of fire behavior based on weather, fuel, and other predictors, and danger rating. Climate change became a hot issue affecting wildland

fire. Human impact and restoration became important parts in wildland fire research.

ISSUES IN WILDLAND FIRE MANAGEMENT

Cooperation

Cooperation has been always a major topic in wildland fire management. Different level of cooperation is actively discussed in international meetings. Domestic cooperation between central government and regional government, among regional governments, and among different agencies is diverse in format, regions, and countries. Differences in environment, regional characteristics, cultural, social and political background result in differences in domestic cooperation in wildland fire management among countries.

Regional cooperation is active in wildland fire management. Regional cooperation within the same region that shares similar environment including climate, vegetation, and similar fire regime can deal with wildland fire more efficiently. The ways and tools for regional cooperation are actively discussed in each region, while there are still many issues to be solved such as resource sharing in firefighting.

International cooperation in wildland fire management is required more than any time in history. Climate change, fire suppression, fuel accumulation, and human activities bring increase in mega fire beyond national boundaries. Information sharing and technology transfer are major topics in international cooperation and are active areas where collaborations are processed. Integrated policies, terminology, management, including Incident Command System, and transboundary smoke in wildland fire among countries are topics actively discussed in international cooperation.

Changing environment and fire regimes

Increasing anthropogenic activity such shifting agriculture, forest conversion, monoculture, industrialization, and globalization have changed wildland fire environments, and fire regimes. Big fires are occurring in areas where few fires occurred in the past such as countries of rain forests. Active fire suppression sometimes increases fuel accumulation and changes fire regimes from frequent small

fires to less frequent large fires. Recent researches report climate change or human impact on wildland fire. Policies and management try to include ways to adapt to climate change and changing environments.

Community participation

Community based fire management is important in wildland fire management. A large part of wildland fire management depends on the community, especially in areas with difficult accessibility or communication. Knowledge transfer, information sharing, and fire training are important topics discussed in wildland fire management relevant to community participation together with preparedness and firefighting methods. Application of traditional knowledge to fire management is also discussed with community participation.

Technology development

Recent firefighting and fire detection depend on technology development. Aerial firefighting is preferred in many areas although there are still more areas where ground firefighting is the only way in firefighting. National and international wildland fire policy could be developed along with technology development. Firefighting and fire modeling have been much developed with RS and GIS techniques. Thus, technology development is an important axis in wildland fire management.

CONCLUSIONS

With the development of technology and globalization, information on wildland fire spreads rapidly throughout the world. More topics in wildland fire research came out with time. The areas that had been considered not to be actively connected to wildland fire found to have direct interact with wildland fire. Historical fire regimes are changing due to too much anthropogenic activity, which requires management activity is indispensable in dealing with wildland fires. We are in the globalization and mega fire period that requires scientific data, information sharing, technology development, and cooperation more than before.

Session 2

October 24, 2013

1. Future Challenges for Wildland Fires Science in China
2. Multilingual Wildland Fire Terminology: Challenges for Adding Japanese Language
3. Objectives and Principles of Regional Wildland Fire Management Resource Centers: Transiting from Informal Networking to Sharing of Scientific, Technical and Human Resources
4. Mountain and Forest Weather

Future Challenges for Wildland Fires Science in China

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Abstract

the May 6th ,1987, Forest Fire of Daxinganling mountain area is a critical point in the history of forest fire research in China. Owing to natural and historical factors, forest fires have been long frequenting in China. Forest fire research starts forest fire research in the 1950s. Researchers have make some progress in predicting and forecasting the forest fire causing weather, the cause of fire and fire behavior. Some works have done in the planned fire burning either inside or outside the forest. Monitoring system is composed of the application of Meteorological satellites in monitoring and predicting forest fire and the application of distance satellites for emergency in communication. We have worked out a series of products for the professional fire fighters, portable fire ignition and fire distinguishing tools and equipment designed. The Green-breaks belts in the south have taken their good effects. They have shown great potential for further development. Both planting and management of the trees should become many-faceted. In general forest fire study both at theoretical level and practical level, is mainly focused on the north part of the country while in other areas especially in the south and southwest areas has a relatively short history and backword. It has a good future for China on forest fire research.

Keywords: Forest Fire, Research, Fire Fighting, Fire Prevention, Fire Extinguish

Introduction

It starts forest fire research in the 1950s and the May 5th Forest Fire of Daxinganling mountain area is a critical point in the history of forest fire research in China. To solve a series of problems of technology and method met in fighting

against the May 5th Forest Fire, our government set up the project as a funded program in forest fire prevention and protection– a study of forest fire prevention and protection in Daxinganling mountain area. The study consists of - the study of prediction and forecast technology of the weather liable to cause fire, of forest fire behavior and fire blockage technology, of management of fire fighting, of fire distinguishing outfit and fire fighting equipments for emergency, and of field experiment. In general our study both at theoretical level and practical level, is mainly focused on the north part of the country while in other areas especially in the south and southwest areas including Yunan, Sichuan, hainan, guangdong, guangxi, guizhou and fujian provinces where forest fires have been found frequently, the study of forest fire has a relatively short history and backword. So here we can say that there is an obvious imbalance of the study as far as the whole country is concerned.

The major research progresses of recent years:

The forecast of forest fire and forest fire prevention

We have make some progress in predicting and forecasting the forest fire causing weather, the cause of fire and fire behavior. What's more we have set up a system to forecast and prevent the forest fire behavior and put forward new theories and methods about the cause and behavior of the forest fire. But we have found that these theories and methods are hard to put into practice.

The study of forest fire blocking techniques.

We have done some work in the planned fire burning either inside or outside the forest. We have put forward the technology of geological and climate ignition, and compiled for the Northeast and inner Mongolian forest areas the procedure of using the planned fire, which has been widely adopted in the two areas.

Forest fire monitoring and information transmission

This system is composed of the application of NOAA satellites in monitoring and predicting forest fire and the application of distance satellites for emergency in

communication.

Equipments for Fire fighters

We have worked out a series of products for the professional fire fighters, portable fire ignition and fire distinguishing tools and equipment designed exclusively for the fire fighting force such as the products in alarming, lighting, charging, communicating, commanding and cooking etc. All these products play their parts in fire fighting.

●*Equipments for fire fighting*

The model Squerral helicopter equipped with a fire distinguishing bucket, the model Mic 8 helicopter with its outside equipped with a fire extinguishing automaton, and the model 5 with water to fight fire contribute much to the development of the forest fire protection by air. On the other hand, portable wind powered fire extinguishing series have been widely used in fire fighting. For instance the tire style fire engine and the wheel style field fire engine both have improved the effect of fire fighting on land.

●*Green-breaks belts*

The Green-breaks belts in the south have shown their good effects. They have shown great potential for further development. Here we suggest that the study of the mechanism of the Green-breaks belts should be shifted from the qualitative to the quantitative, the trees planted should be of different type rather than of a single type, should be in a complex structure rather than in a simple structure. Both planting and management of the trees should become many-faceted.

The roles of forest fire research in fire protection

The research contributes to the fire fighting in the past years in the following aspects.

- It makes fire fighters further understand the nature of the forest fire. In the past they thought their job was only to put out it once there is a fire, but

now they have realized that it is more important than putting out the fire that they need to learn to manage the forest and then the fire. It shows that we have changed our strategy of fire fighting.

- It improves the technology of forest fire forecast. Though we haven't set up a fire forecast system around the whole country, we have started doing it in some areas of the country. And we have moved into a new stage of fire behavior prediction rather than the past metreological prediction of fire danger.
- It raises the level of fire monitoring.
  We have successfully built a network of fire monitoring through out the country. The network now has shown it significant effects. Plane's x-ray monitoring technology has been fully and widely adopted.
- It improves the communication in fire fields.
  The application of short-wave networks and ultra-short wave networks, communicative satellites and maritime satellites contributes greatly to the communicative system that governs the fire fighting in fire field..
  It improves the fire extinguishing equipment and technique.

Research institutes and sources of funds

Research institutes

Forest fire protection section of the chinese forestry academy– fire prevention and protection, ecological fire

State funded chief lab of university of science and technology – mechanism of forest fire

Forest fire protection institute of Heilongjiang province– fire extinguishing equipment

The school of resources of forest environment of Northeast university of Forestry- fire ecology

The school of forestry industry of beijing university of forestry- fire extinguishing equipment.

Source of funds

The funds of the forest fire research mainly come from the ministry of science and technology, national committee of natural science fund, national bureau of forestry, and some other organizations at provincial level.

Future Challenges for Wildland Fires Science in China

Forecast of forest fire

forecast is the premise for forest fire prevention, so it has been put much stress in every country. It can make fire prevention work go on in a reasonable way to calculate the possibility of a forest fire. We started doing it in the 1950's. In the past decades we just borrowed from abroad and tried the fire causing weather forecast method though we improved the method somewhat. Now we have some progress in this field. Quite a number of provinces and autonomies are already capable of doing the forecast job successfully. This establishes a strong foundation for the building of the nation wide forecast system. We have done the classification of various burnable substances and given a study to fire behaviors, which is another foundation of our forecast study.

Fire detecting technology

The study in this aspect is to improve the defecting precision by combined use of −, GPS and −. We can set up a database of forest fire messages. Then we put into the database all the information we gather from the forest map, topography map, and the —. After analyzing the data we gain what we need concerning management of the forest, —, — and change of the environment. By using all the data, we greatly raise the level of fire detecting.

Commanding fire fighting through information

The transmission of message on forest fire must make it possible for fire fighters to get messages whenever and wherever they need. (for example when they are fighting the fire, when they want to prevent the fire or when they want to know how to use the fire safely). Especially as soon as defecting the fire, the message should be sent to the commanding center so that the center can arrange to send in time fire fighters and materials it needs to put out the fire to reduce the damage as

much as possible. To achieve this, the message must be transmitted without stop between spots on land, between spots in the air, and between the air and the land. So we need to further the present system of communicative networks, at the same time we need to further develop the communicative technology in the fire field. We need to usse the short wave and ultra short wave to solve the communicative problems in the remote areas where message is difficult to reach.

Fire extinguishers and fire fighting products

It is not enough to have only scientific theories to prevent the forest fire. We need to have the advanced tools also. So we should not neglect the study of fire fighting facilities

Isolating technology and the management of the burnable substances

The management of the forest fire is not simply to prevent the fire passively but to actively prepared ourselves to prevent fire or to put out fire or even to use the fire through the technology of isolating the big fire and by managing the burnable substances. In future we need to do work in designing the fire preventing line and managing the forest by use fire.

Fire fighters' training

Knowing the importance of fire fighters' training is the basis to reduce the casualties and raise the efficiency of fire fighting. At present we badly need to strengthening our skill training of fire fighting and textbook compiling, and adding the number of our fire fighting facilities. In addition, we need to formulate our regulation of fire fighting training. In our training we need to use the multi-media resource, the computer network resource and some other facilities.

Building the system of standardization

Forest fire protection is a complicated system. It covers large content, involves a large area of different places and complicated technology study. It is concerned with the standardization of different fields such as the basic equipment and facilities,

products, forecast, fire prevention, communication, fire-fighters' protecting outfit and fire extinguishing equipment. The standardization in various aspects of the work of forest protection urgently needs to be realized. So we are to start our study in the system of standardization.

Management in fire fighting

We plan to put more efforts in helping the public raise their sense of fire prevention and safety. We are going to make the most of the modern media such as newspapers, radios, televisions and the internet. We are planning to set up our own web site through which we could let the public get our notices, multi-media training software and booklet on forest fire protection.

Conclusion

Forest fire research starts forest fire research in the 1950s and the May 6th ,1987, Forest Fire of Daxinganling mountain area is a critical point in the history of forest fire research in China. Researchers have make some progress in predicting and forecasting the forest fire causing weather, the cause of fire and fire behavior. Some works have done in the planned fire burning either inside or outside the forest.

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Multilingual Wildland Fire Terminology: Challenges for Adding Japanese Language

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Abstract

Class A firefighting foam concentrates, containing surfactants in major proportions, reduce the usage of water for firefighting. Due to the characteristic properties of surfactants, the agents reduce surface tension of water, and create a superior foam blanket when mixed with air. Thus, it allows firefighters to extinguish a fire much faster than water alone. In Japan, however, the firefighters hesitate to use these agents because they show significant toxicity against aquatic organisms. We have been developing a novel firefighting foam concentrate with significantly lower environmental risk, consisting of soaps, chelating agent, and diluents. Soaps are the key major components in our firefighting agent, and possess very high biodegradability and very low toxicity particularly for aquatic organisms such as a fish.

In this presentation, I will talk about the current forest fire situation in Japan, and the progressing condition for adding Japanese language to multilingual wildland fire terminology.

OUR ACTIVITIES

We have worked on "Environmentally Friendly Soap-based Firefighting Foam" with the Kitakyushu City Fire and Disaster Management Bureau, Shabondama Soap Co.,Ltd, and the firefighting enterprises since 2003 (Mizuki et al., 2007; Goto et al., 2007; Mizuki et al., 2010). The novel firefighting foam for structure fire was a commercial reality in 2007. This activity is consistent with policy of Kiakyushu city that has a magnificent heritage of techniques and human resources as a "manufacturing city" and aims to become the "World Capital of Sustainable

Development". The collaboration among industry, academia, and government is useful and powerful, and the teamwork is will be further advanced through the mediation of the new research center.

The Research and Development center of Fire and Environmental Safety (RDFES) was established in April 2008 as a research institute within the Faculty of Environmental Engineering, the University of Kitakyushu. The RDFES is the first academic institute in Japan to contribute to environmental engineering and firefighting technology for social safety, and focuses on the environmental researches to overcome the worldwide serious firefighting problem, for example huge forest fires, and consequently contributes to create the epoch-making products for the environmental conservation and the safety of citizens.

In this project, we have been developing a novel firefighting foam concentrate with significantly lower environmental risk, consisting of soaps, chelating agent, and diluents. Soaps are the key major components in our firefighting agent, and possess very high biodegradability and very low toxicity particularly for aquatic organisms such as a fish. Furthermore, the ecotoxicological evaluation and the environmental risk assessment will be performed. This project had been promoted by the collaboration among Shabondama Soap Co.,Ltd, Morita Holdings Corporation, the University of Kitakyushu, and Kitakyushu City Fire and Disaster Management Bureau under Japan Science and Technology Agency (JST) Project, Adaptable and Seamless Technology Transfer Program through Target-driven R&D (2009-2012). The research in this program is based on fundamental findings from universities, etc., and aimed at developing toward commercialization via regional industry-academia-government collaborative research.

Furthermore, we started the Project by JICA (Japan International Cooperation Agency) Partnership Program “Enhancing Fire Fighting Technology against Peatland and Forest Fires in Balikpapan City, Republic of Indonesia” (2013-2015). The JICA Partnership Program (JPP) was introduced in 2002 to support and cooperate with the implementation of projects formulated by Japanese NGOs, Japanese local governments, and Japanese universities to utilize their accumulated knowledge and experience in assistance activities for developing countries.

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Objectives and Principles of Regional Wildland Fire Management Resource Centers:
Transiting from Informal Networking to Sharing of Scientific, Technical and Human Resources

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Abstract

In this presentation we will discuss cases of wildland fires that cause ecological and economic damages and those that have had trans-national impacts, for example, through smoke pollution, loss of biodiversity or forest degradation at the landscape level. The existing constraints posed by such fire events and the fact that cross-border wildfires cause damage at higher levels than would be otherwise expected signifies that the sharing of scientific, technical and human resources at regional and international levels is a very important and current topic. This will also be discussed. Finally, this presentation will provide information about the current regional networking activities and initiatives and the potential functions of the regional wildland fire resource centers in the central Asian neighbourhood.

RATIONALE AND INTRODUCTION

Over the past several decades, many countries in Asia have witnessed a growing number and average size of wildfires in forest and non-forest ecosystems, predominantly caused by people, but also by lightning in sparsely populated areas. In conjunction with non-sustainable land-use practices, climatic extremes and exploitation of natural resources these fires have caused considerable ecological and economic damages and some have had trans-national impacts, for example, through smoke pollution, loss of biodiversity or forest degradation at the landscape level. The unprecedented examples of interaction between anthropogenic environmental disturbances and wildland fire shows a new dimension of fire problems that may become of increasing importance with the expanding population and shrinking

natural resources – a challenge to environmental management and particularly to wildland fire management. Financial resources for fire management are limited in all countries globally. These constraints and the fact that consequences of destructive wildfires have transnational impacts are calling for sharing of scientific, technical and human resources at regional and international levels. Most important is capacity building of personnel responsible for fire management at landscape level, but also the participation of civil society, notably local rural communities and dwellers, and entering formal agreements between countries that are sharing common borders and common wildfire risks.

REGIONAL NETWORKING ACTIVITIES AND THE FUNCTIONS OF REGIONAL WILDLAND FIRE RESOURCE CENTERS: EXAMPLES FROM CENTRAL ASIA

Recent activities of the UNISDR Global Wildland Fire Network (UNISDR-GWFN) show encouraging results of intensifying international cooperation in wildland fire management. The advances made over the last decades are provided in the contribution of the Director of GFMC to this International Symposium (Goldammer, 2013a; this volume).

In the Central Asian Region we have taken a number of initiatives to establish regional networking, which shall transit to more formal cooperation agreements and activities between neighbouring countries. In the last five years we have made the following progress:

- Establishment of the UNISDR Regional Central Asia Wildland Fire Network[1)]
- The First Central Asian Wildland Fire Joint Conference and Consultation "Wildland Fires in Natural Ecosystems of the Central Asian Region: Ecology and Management Implications" was held in Mongolia associated with the First Central Asian Forest Fire Experiment in 2008 under umbrella of the UNISDR-GWFN (Goldammer, 2013b).[2)]
- As demanded by the Regional Central and Northeast Asia Wildland Fire Networks the International Multi-Lingual Fire Management Terminology has

1) http://www.fire.uni-freiburg.de/GlobalNetworks/CentralAsia/CentralAsia.html

2) See also: http://www.fire.uni-freiburg.de/GlobalNetworks/CentralAsia/CentralAsia_3.html

been expanded to Russian and Mongolian languages in order to facilitate the regional dialogue in fire management in meetings and consultations by common terms and definitions related to fire management (GFMC, 2010).

- The presentation of this expanded terminology at the International Conference on Cross-Border Forest Fires, Irkutsk, Russian Federation, 2010, contributed to the success of this conference in which the Russian Federation and neighbouring countries agreed on enhancing the neighbourhood cooperation in fire management.[3)]

It is also recognized that establishment and continuing functioning of the Regional Fire Management Resource Centers are critically important to make the Network activities more efficient. First regional centers have been established for the Southeast European / Caucasus Region (RFMC) [4)] and for Eastern Europe (REEFMC).[5)] Among their multiple functions these Centers are addressing the increasing demand on collection and distribution of data and information relevant to fire management with the regional neighbourhoods, the facilitation in capacity building in fire management at regional level and the exchange of human and technical resources where needed.

CONCLUSIONS

Capacity building of personnel responsible for fire management and the participation of civil society, notably local rural communities and dwellers, and entering formal agreements between countries that are sharing common borders and common wildfire risks will be an important steps in Central Asia and in other regions of the world. To enhance these activities at the Regional level the establishment and the continuous functioning of the Regional Fire Management Resource Centers will be an important step forward.

3) http://www.fire.uni-freiburg.de/GlobalNetworks/CentralAsia/CentralAsia_6.html
4) http://www.rfmc.mk/
5) http://nubip.edu.ua/en/node/7800 (preliminary website)

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Mountain and Forest Weather

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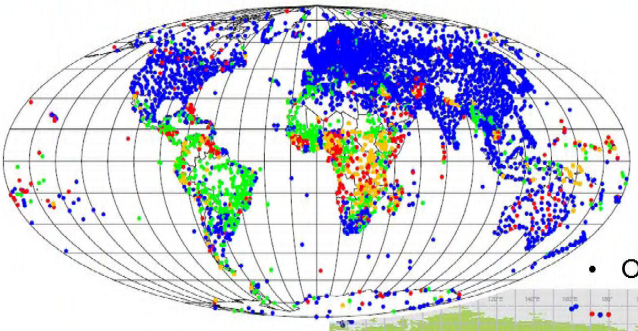
The greatest collaborative invention

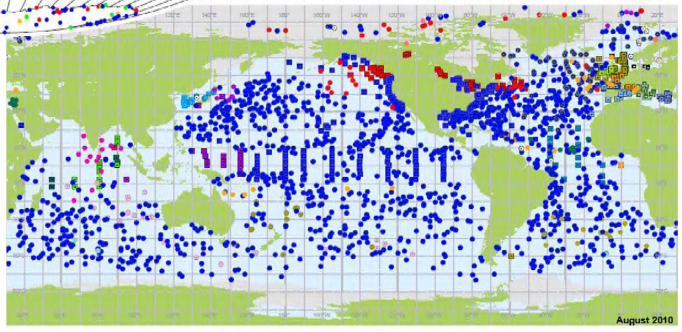
Weather forecasting is the greatest human invention only possible through collaborations of all mankind

World observation Network

- WMO Basic Synoptic Network



- Ocean Drifting & Moored Buoys



Weather service is a life-saving science

Meteorologist is a kind of doctor whose specialty is weather diagnosis and forecast."

Surface & Upper observation network

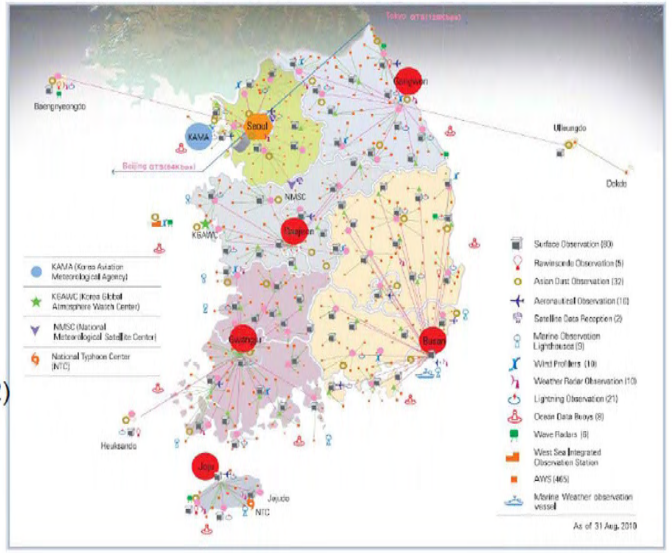
Surface Observation

ASOS : 80(50 staffed)
AWS : 468

Observation Standardization by 2012
: about 3,000 Sts. in 25 organizations

Upper Air Observation

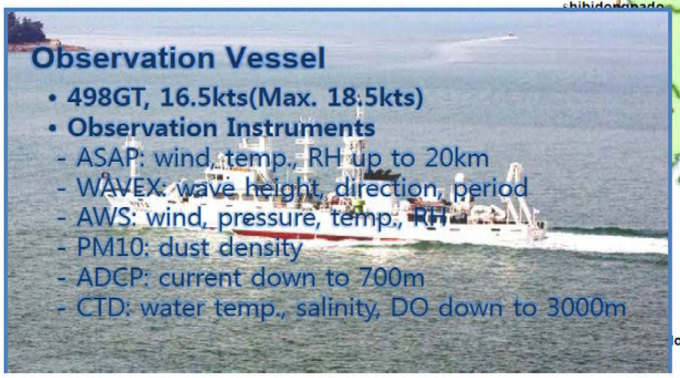
Radiosonde : 5(+1 in 2012)
Wind Profiler : 9 (+3 in 2012)
Radiometer : 9(+3 in 2012)



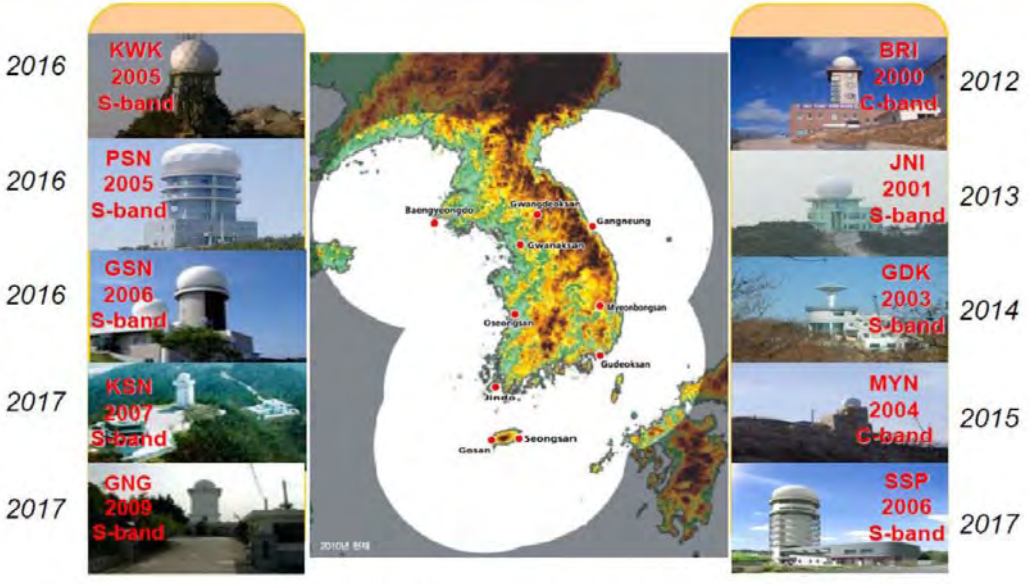
Marine observation network

Observation Network

Ocean Data Buoys : 9
Coastal Wave Buoys : 18
Long Wave Gauges : 11
Wave Radars : 6
Lighthouse AWS : 9
Marine Obs. Station : 1

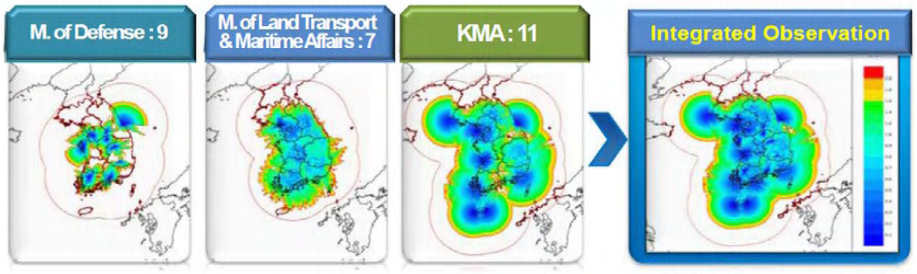


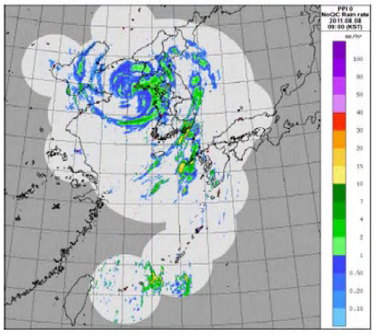
Radar network : 13 sites



S-band dual-polarization Doppler radars by 2017

Integrated Radar Observation





Reduction of blind spots : 53%

Cost cutting : $140 M

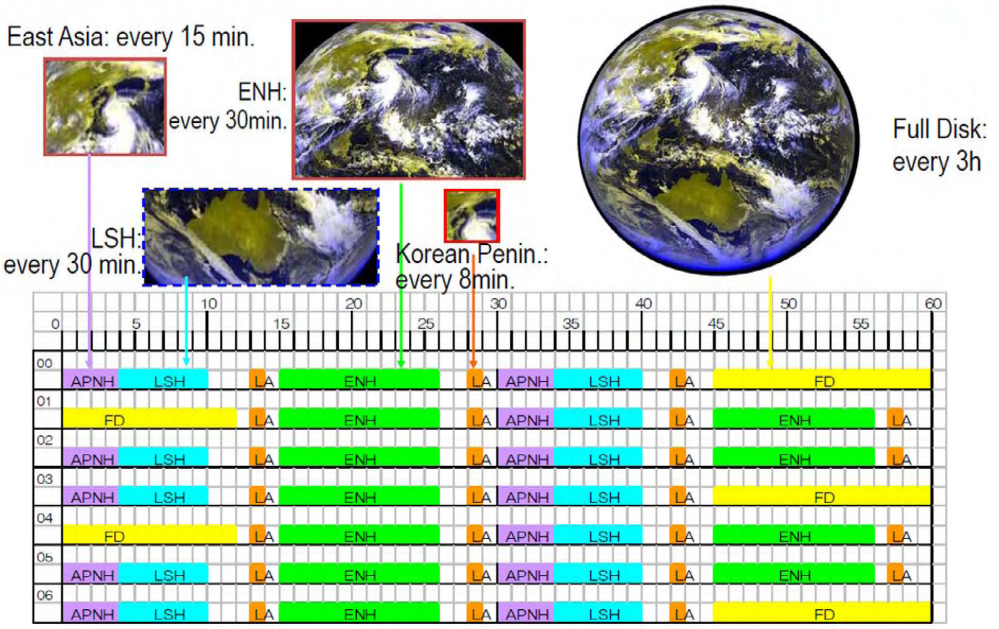
Best Collaborative Administration

Real time exchange of radar image data among China, Japan, and Korea

COMS : Communication, Ocean, & Meteorological Satellite

Orbital Location	128.2 E
Lifetime	7 Years
S/C Stabilization	3-axis
Station-keeping Accuracy	± 0.05 ° in lon/lat
Multiple Payloads	MI(5 channel imager), GOCI, Communication
Data Distribution	HRIT/LRIT within 15 min. after image acquisition

COMS

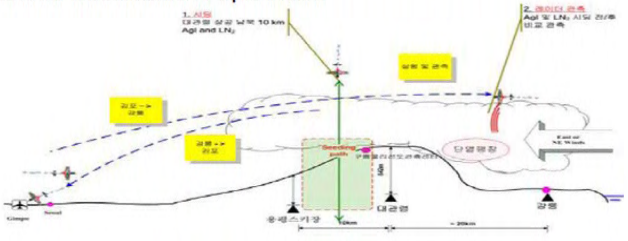


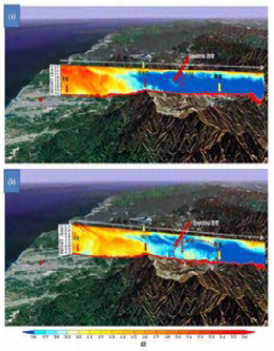
Meteorological Aircraft (2015)

Instruments

- Radar
- Radiometer
- Lidar
- Dropsonde
- Agl Flare
- Aerosol Spectrometer
- Prec. Spectrometer

- ✓ Target Observation (HIW : Typhoon, Heavy Rain, Snow)
- ✓ Climate Change Monitoring (greenhouse gases, aerosol)
- ✓ Weather Modification Experiment





Plan of Infra for Mountain Weather

기상청

▪ Enhancement of OBS density (HQ/KMA)

o Cooperation with interagency (sharing the data)

: Local government, Forest Agency, Agricultural Agency

o Unmanned and cutting edge (VIS, CC/Ceiling, Weight type Rain)

o Adding Upper air site

2013

2012

산악기상관측망 입지선정 결과(강원)

Plan of Infra for Mountain Weather

기상청

▪ Smart Met. Support Project for PyongChang (HQ/KMA)

- In 2012

o Cutting-edge AWS 7, Met. Sensor in Venues 10, Road Obs. 3

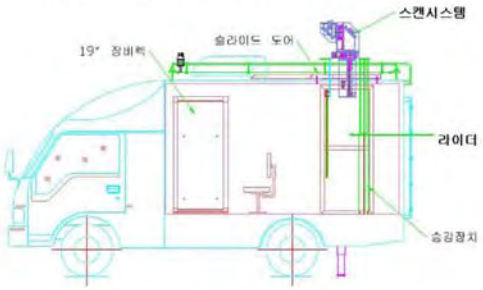
- For 2013~2014

o Horizontal and Vertical Obs. network following Venues Characteristics

(Cutting-edge AWS 7, Met Sensors in Venues15, Road 6, etc)

Plan of Infra for Mountain Weather

- Specialized Met. Support Technology (NIMR/KMA)
  - 2013~2017
    - o Winter Intensive Obs.(Ka-band, X-band, Radio-sonde etc.)
    - o Mobile AWS and Radiosonde
    - o Cloud physics obs.(MRR, Radiometer, 2DVD, Ceilometer etc.
- Aircraft and IOP (2016~2018)



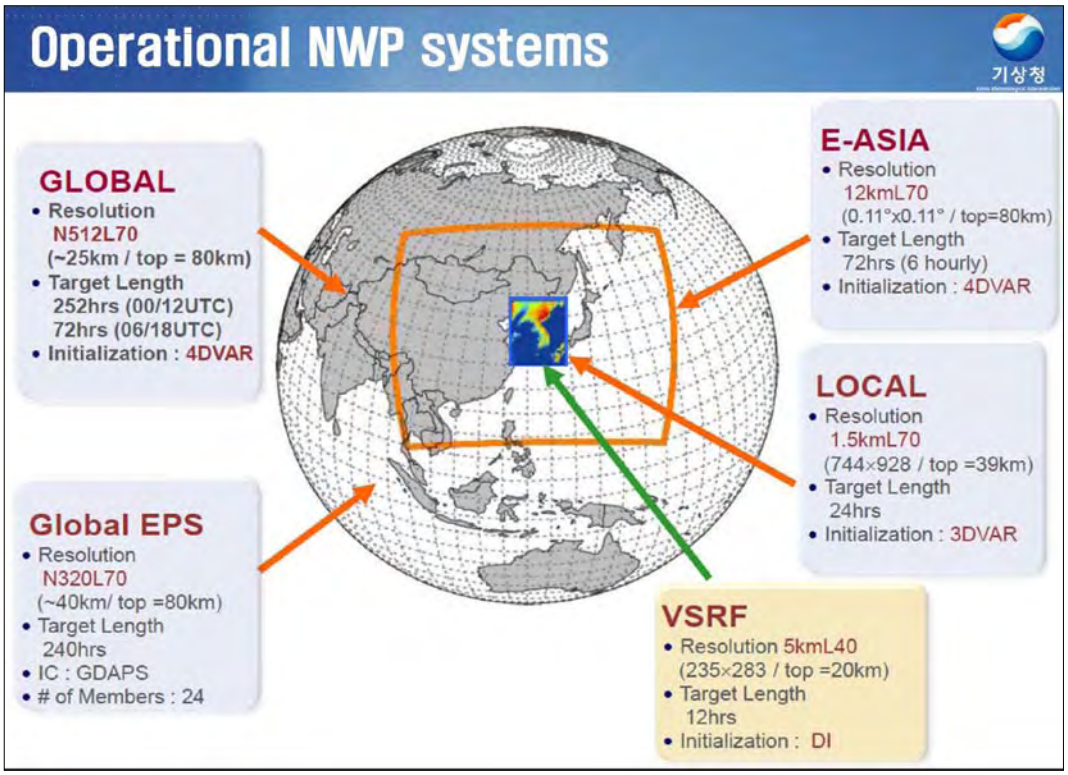
Mobile Scanning Lidar

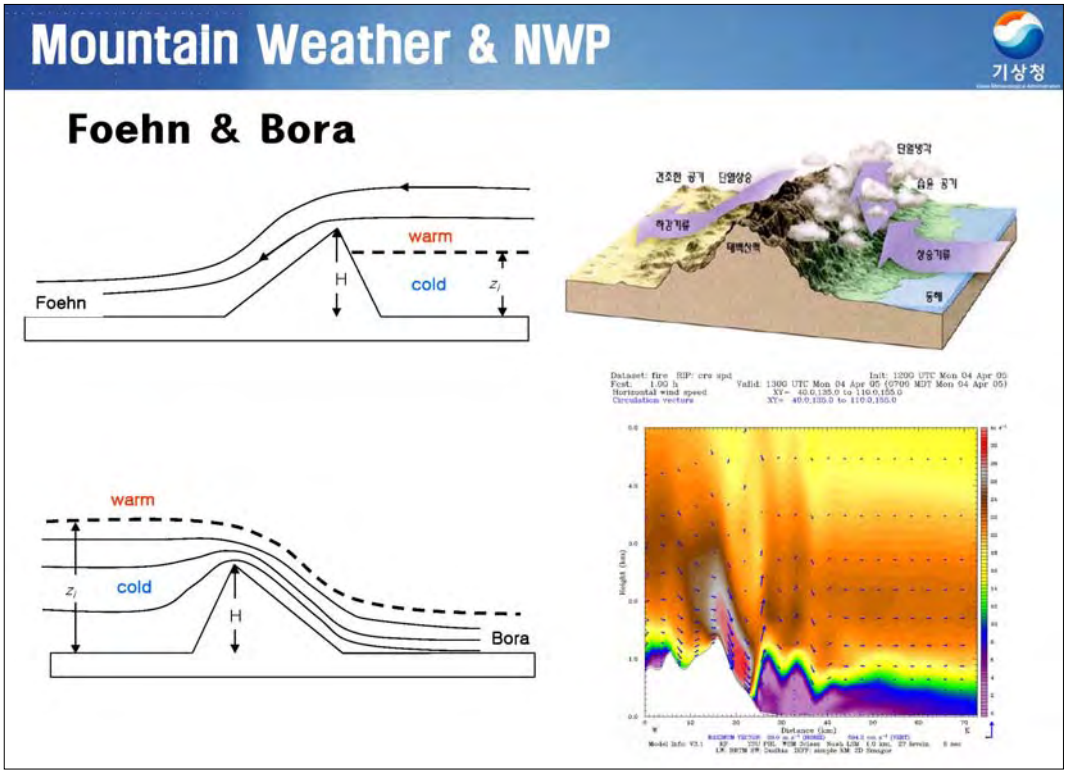
Ka-band cloud radar

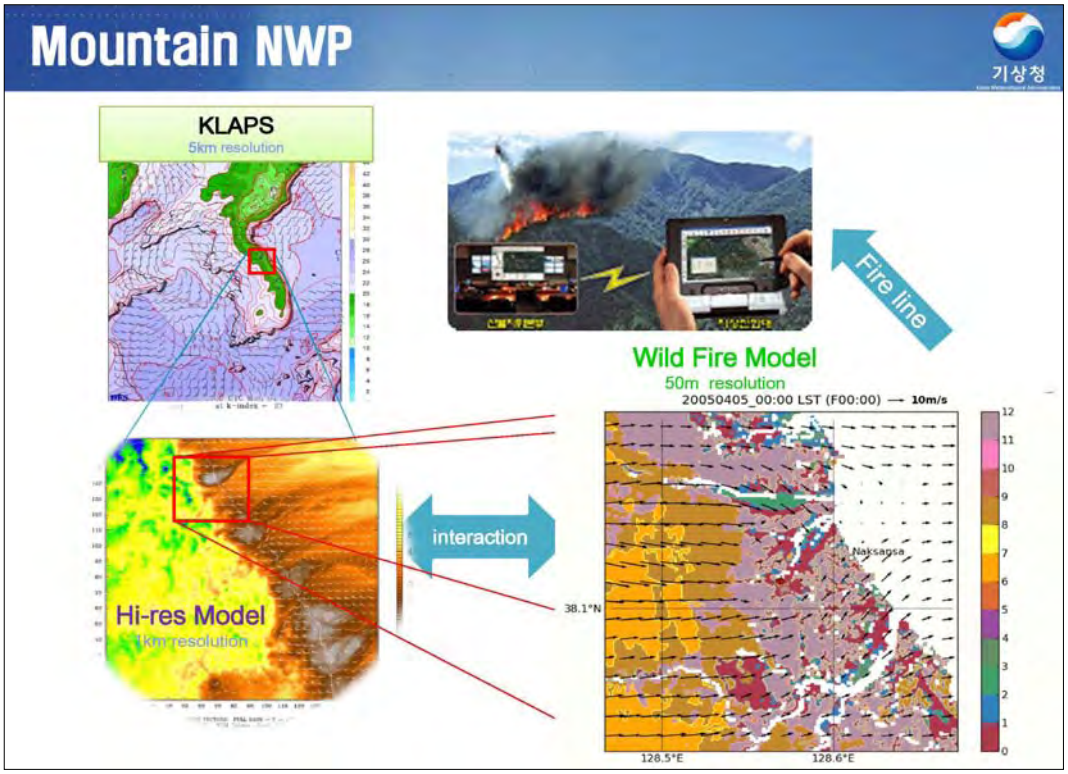
Plan of Infra for Mountain Weather

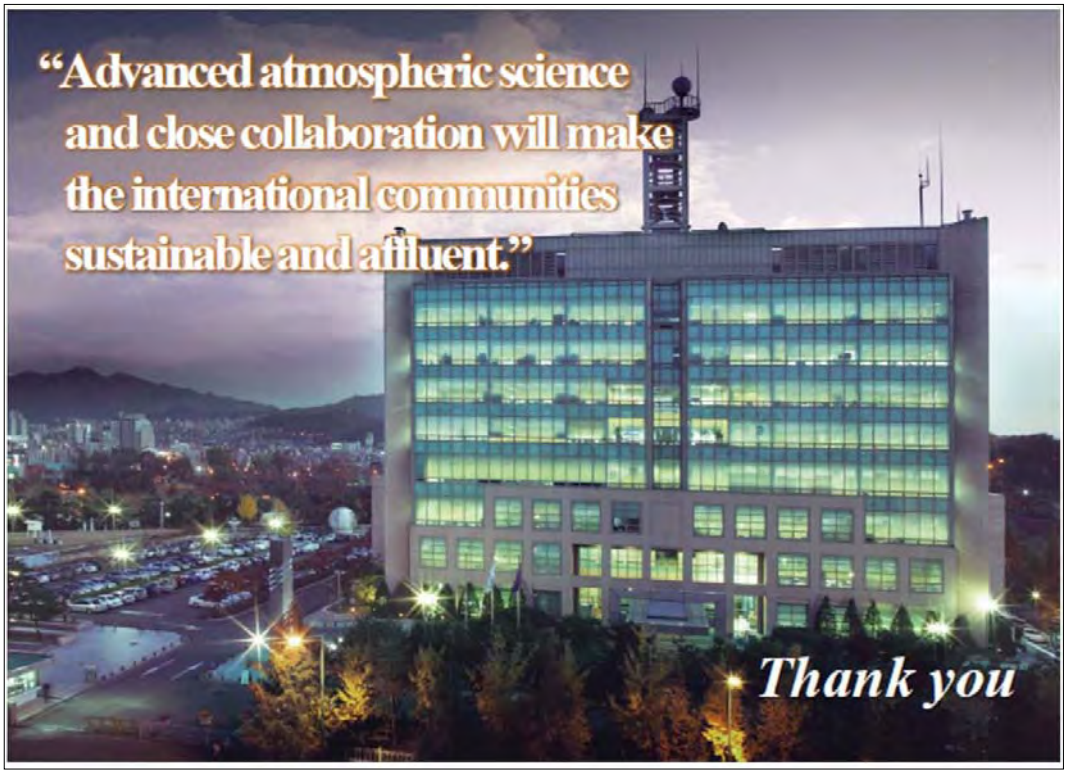
- ✓ Mobile obs. System : Black and White
- ✓ Obs. Component : wind, temp, humidity, precipitable water, sonde

Mobile observation for 2013 Special Olympic games


Operational NWP systems
기상청
GLOBAL
• Resolution
N512L70
(~25km / top = 80km)
• Target Length
252hrs (00/12UTC)
72hrs (06/18UTC)
• Initialization : 4DVAR
E-ASIA
• Resolution
12kmL70
(0.11°x0.11° / top=80km)
• Target Length
72hrs (6 hourly)
• Initialization : 4DVAR
LOCAL
• Resolution
1.5kmL70
(744×928 / top =39km)
• Target Length
24hrs
• Initialization : 3DVAR
Global EPS
• Resolution
N320L70
(~40km/ top =80km)
• Target Length
240hrs
• IC : GDAPS
• # of Members : 24
VSRF
• Resolution 5kmL40
(235×283 / top =20km)
• Target Length
12hrs
• Initialization : DI


Mountain Weather & NWP
기상청
Foehn & Bora
warm
cold
H
Foehn
warm
cold
H
Bora


Mountain NWP
기상청
KLAPS
5km resolution
Fire line
Wild Fire Model
50m resolution
20050405_00:00 LST (F00:00) → 10m/s
interaction
Hi-res Model
1km resolution
Naksansa
38.1°N
128.5°E
128.6°E


"Advanced atmospheric science and close collaboration will make the international communities sustainable and affluent."
Thank you

Poster Presentation

No.	Title	Presenter	Affiliation
P-1	Change of Ant Communities after Forest Fire	Cheol Min Lee	Korea Forest Research Institute
P-2	Economic Measurement on Forest Fire Expansion Prevention Effect by Forest Road Construction	Chulhyun JEON	Korea Forest Research Institute
P-3	Jellyfish (Nemopilema nomurai) Fertilizer Contributes to the Early Establishment of Seedlings Planted in Post-fire Areas	Jung Il Seo	Kongju National University
P-4	Needle nutrient and chlorophyll contents of Pinus densiflora seedlings to different fertilizer compound ratios in a recently burned area	Yong Suk Kim	Korea Forest Research Institute
P-5	Grazing and fire effects on Caragana microphylla density in the Mongolian steppes	Amartuvshin Narantsetseg	Kangwon National University
P-6	A Research on the Forest Fire in DMZ and the need for mutual cooperation between South-North Korea	So-young Park	Korea Forest Research Institute
P-7	Crown Fuel Characteristics and Allometric Equations of Pinus koraiensis Stands in Korea	Sungyong Kim	Kongju National University
P-8	Nomographs for Predicting Crown-Fire Initiation of Pinus densiflora Stands in Central Regions of Korea	Mina Jang	Kongju National University
P-9	Performance of Percentile-based Weibull Diameter Distribution Function for Pinus thunbergii in East Sea, South Korea	Azyleah C. Abino	Kongju National University
P-10	Analysis of CO_2/Non-CO_2 Emissions of Pinusdensiflora in Ahndong, Korea	Mejung Hwang	Professional Graduate school of Disaster prevention in KNU
P-11	The Study on Combustion Characteristic of Smoldering Ground Fire in Forest Fire	JangHwan Kim	Hoseo Uninersity
P-12	The Study on Equipment's Performance Used for Extinguishing of Forest Fire	JeongHun Kim	Hoseo Uninersity
P-13	The Stand Growth of Pinus densiflora Plantation after Forest Fire in Samcheok	Chanwoo Park	Korea Forest Research Institute

No.	Title	Presenter	Affiliation
P-14	Comparison on Early Growth of Quercus mongolica containerized seedling and Quercus spp. Coppice at Burn Area in Samcheok, Korea	Jeonghwan Kim	Korea Forest Research Institute
P-15	Effect of Prescribed Burning on Chirpine-Lemon grass Forest Ecosystem in Eastern Bhutan Himalaya	Mani Ram Moktan	Korea Forest Research Institute
P-16	Comparison of Growth and Distribution of Pinus densiflora in different sites after Goseong forest fires in Korea	Moon-hyun Shin	Korea Forest Research Institute
P-17	Simulation on the Effect of the Extinguishing System for Wild Forest Fire	Gyun-ho Gim	Kunsan National University
P-18	Analysis of Multiple-polarization PALSAR Backscatter for Burn Severity Evaluation in Mountainous Forested Areas	Min-Gee Hong	Kookmin University
P-19	Fuel Consumption Rate and Efficiency of Main Coniferous Species with Fire Severity	Changeun Choi	Taeeun
P-20	Forest Watchmen 'Mandor' incorporating Traditional Knowledge -Forest Fire Management in West Rinjani, Lombok, Indonesia	In-Ae Kim	Korea Forest Research Institute
P-21	A Comparative Analysis of Damage Characteristics of Damaged Facilities caused by Large Forest Fires in Pohang and Ulju	Chun-geun Kwon	Kangwon National University
P-22	A Recognition Analysis on Forest Fire Prevention Education for Residents in the SamCheok region	Chan-ho Yeom	Kangwon National University
P-23	Optimal Spatial Allocation of Initial Attack Resources in the Republic of Korea using a Scenario-based Optimization Model	Yohan Lee	Korea Rural Economic Institute
P-24	Analysis of Burn Severity in Large-fire Area Using Satellite Imagery	Myoungsoo Won	Korea Forest Research Institute
P-25	Effects of Forest Fires on Forest Ecosystems in Eastern Coastal Areas of Korea and Overview of Restoration Projects	Young Sang Ahn	Chonnam National University

No.	Title	Presenter	Affiliation
P-26	Reduced Soil Erosion by Making Contour-Felled Log Erosion Barriers in Burned Areas by Massive Forest Fires in Eastern Coastal Regions of Korea	Young Sang Ahn	Chonnam National University
P-27	Development of Spatial Analysis technique for Evaluating Optimal Location of Forest Fire Suppression Facilities	Gyesun Ryu	Korea Forest Research Institute
P-28	Development of the Checklist for Optimal Location of Forest Fire Suppression Tower	Gyesun Ryu	Korea Forest Research Institute
P-29	Validation of Korean Composit Burn Index(KCBI)	Hyunjoo Lee	Konkuk University
P-30	The Classification of Burn Severity using Rapid Eye image and Estimation of Emissions of Greenhouse Gases According to IPCC and domestic combustion efficiency from Biomass burning at Pohang Korea	Youseung Kim	Korea Forest Research Institute
P-31	Spray characteristics of Water Supply system for forest fire	Yeong Tae Bae	Korea Forest Research Institute
P-32	Effect of Thinning Intensity on Fuel load of Surface and Shrub layer	Yeong Tae Bae	Korea Forest Research Institute
P-33	The Impact of weeding frequency and drainage on seed germination and mortality of red pine (Pinus densiflora) seedlings in Mt. Gariwang	Go Eun Park	Korea Forest Research Institute
P-34	The Forest Climate Monitoring System – The Total Management System of Mountain Weather Information	Myoungsoo Won	Korea Forest Research Institute
P-35	Development of Modeling System for Simulation of High-resolution Wind Fields over Mountain Areas	Yonghan Choi	Seoul National University
P-36	The Flammability of MDF and particleboard using a cone calorimeter	Dongwon Son	Korea Forest Research Institute
P-37	A study on the Development of Standard Diagnostic Table for Chestnut Management and its Applicability	Jungmin Lee	Korea Forest Research Institute

No.	Title	Presenter	Affiliation
P-38	A study on the Development of Standard Diagnostic Table for Oak Mushroom Management and its Applicability	Jungmin Lee	Korea Forest Research Institute
P-39	A Study on the Forest Reserve System of North Korea	So-young Park	Korea Forest Research Institute
P-40	ODA Contents Development for Prevention of Forest Fragmentation -Focusing on Capacity Building in Developing Countries -	Byoung Il Yoo	Korea Forest Research Institute
P-41	Changes for 10 Years of Understory Vegetation Structure of Cold-Temperate Deciduous Broadleaf Forest in Mt. Gyebang Long-Term Ecological Research Site	Kwangil Cheon	Korea Forest Research Institute
P-42	Application of Fluid-Structure Interaction to the Wind Field in a Forest	Jong-Hyun Shin	Kunsan National University
P-43	An Analysis of Cable Logging Operation System with Tower-yarder in Korea	Koo-Hyun Cho	Korea Forest Research Institute
P-44	Estimation of Annual Soil Carbon Emissions/Removals in LULUCF Sector	SunJeoung,Lee	Korea Forest Research Institute
P-45	Estimation of Forest Carbon Stocks of KPHL Rinjani Barat for Assessment of REDD Feasibility in Lombok, Indonesia	Jintaek Kang	Korea Forest Research Institute
P-46	Study of Taper Equation for Cryptomeria Japonica in Jeju Island, South Korea	Yeonok Seo	Warm-Temperate and Subtropical Forest Research Center,KFRI
P-47	Community Structure of Pinus thunbergii Stand in Jeju Island, South Korea	Sungcheol Jung	Warm-Temperate and Subtropical Forest Research Center,KFRI
P-48	A Study of Spatial Suitability of Indicator for Vulnerability Assessment to Climate Change	Raesun Jung	Korea Forest Research Institute
P-49	Effect of Salinity, Irradiance and Temperature in Improvement of Seed Germination in Calystegia soldanella	Chan-Beom Kim	Korea Forest Research Institute
P-50	The Field Experiment and Development of Landslide Early Detecting System for Natural Slope in Korea	Dooyoung Choi	Korea Forest Research Institute

No.	Title	Presenter	Affiliation
P-51	Analysis of Unsaturated Weathered Soils Shear Strength Though Empirical Formula and Laboratory Test	Seonhwan Jeong	Korea Forest Research Institute
P-52	Analysis of Topography Changes in a Dredged and Non-dredged Area of a Debris Barrier by Using Terrestrial LiDAR	Junpyo Seo	Korea Forest Research Institute

Change of Ant Communities after Forest Fire

산불 후 개미군집의 변화

Cheol Min Lee[1], Tae-Sung Kwon[1]

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Abstracts

Forest fires greatly influence the diversity and community structure of insects in forest ecosystems. However, community structure of insects will be restored to its original condition along with restoration of vegetation. This study was carried out to estimate restoration of ant communities according to fire intensity and recovery methods in four burned areas such as Goseong, Gangneung, Samcheok in Gangwon-do and Uljin in Gyeongsangbuk-do. Ants were collected using pitfall trap in 2005 and 2012. Ants were classified into 4 functional guilds: openland forager, forest vegetation forager, forest ground forager, and soil and litter dweller. A total of 3,608 individuals belonging to 36 species were collected. Specie richness was not significantly different according to fire intensities, whereas abundance was significantly different. Species richness of functional guilds was not significantly different according to fire intensities, whereas abundance of functional guilds was significantly different. When ant communities in 2005 and 2012 were compared, ant communities were significantly different, indicating change of ant communities after fire.

요 약

산불은 산림생태계에 서식하는 곤충의 다양성과 군집구조에 큰 영향을 준다. 그러나, 곤충의 군집구조는 식생의 회복에 따라 본래의 모습으로 복원될 것이다. 본 연구는 강원도 고성, 강릉, 삼척과 경상북도 울진의 4개의 산불지에서 산불과 복원 방법에 따른 개미군집의 회복을 평가하기 위해서 수행되었다. 개미는 함정트랩법을 이용하여 2005년과 2012년에 조사되었다. 개미는 4가지 기능군(개활지배회군, 숲식생배회군, 숲지표배회군과 토양낙엽배회군)으로 분류되었다. 총 36종 3,608개체의 개

미가 채집되었다. 산불강도에 따라 종수에서는 유의한 차이가 나타나지 않았지만, 개체수에서 유의한 차이가 나타났다. 지역에 따른 산불강도에서 기능군의 종수는 유의한 차이가 나타나지 않았지만, 기능군의 개체수는 모두 유의한 차이를 나타냈다. 2005년과 2012년의 개미군집을 비교했을 때, 개미군집은 달랐다. 따라서 개미군집은 산불 후 변화되는 것으로 나타났다.

Economic Measurement on Forest Fire Expansion Prevention Effect by Forest Road Construction

임도 건설의 산불확산방지효과에 대한 경제적 평가

Chulhyun JEON[1], Hosang LEE[1], Hyonsun JEON[1], Chulsang KIM[1], Byungdoo LEE[1]

[1]Dept. of Forest economics and management, Korea Forest Research Institute, Seoul 130-712, Korea

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Abstracts

The purpose of the research is to estimate economic measurement of the forest fire expansion prevention effect by forest road construction. The benefits (or effects) of forest road construction are classified into both timber production damage prevention effect and forest public function preservation effect. At first, the benefit of timber production damage prevention effect is represented into 13 minutes reduction of forest fire suppression resource (fireman, pump, vehicles) approach to forest fire site in comparison of with and without(walking approach) forest road. That is, 13 minute effects reduced is between forest fire suppression vehicle speeds of 30km/hr on forest roads and walking speeds of 4km/hr in forests without forest roads, and forest fire would burn 6.75ha/hr of forests in general, so 1.46ha(=6.75ha × 13/60) is possibly protected. The economic benefit of the forest fire expansion prevention effect of forest road construction is ₩7,463,043 (=forest protection area 1.46ha × stumpage price ₩34,742/㎥ × growing stock 125.6㎥). As forest public function protection by preventing the forest fire, that benefit of the protection is ₩233,052,789/ha (=forest protection area 1.46ha*forest public function protection value ₩159,352,334/ha). In summary, total economic benefit of forest fire expansion prevention effect by forest road construction is about ₩2,458,702, the sum of timber production damage prevention (₩7,463,043) and forest public function and forest public function protection value (₩233,052,789) times forest fire ratio 0.017%(=1,090ha÷6,368,843ha) times area of forest road cover 60ha/km.

요 약

본 연구의 목적은 임도 건설로 인한 산불확산방지효과를 경제적으로 평가하는데 있다. 그 편익은 경제적으로 목재생산피해방지효과와 산림공익기능보전효과로 구분될 수 있다. 목재생산피해방지액의 평가는 산불 발생시 임도가 있기 때문에 도보보다 지상진화자원(진화인력, 펌프, 진화차량)의 신속한 도착으로 초기단계에 진화가 신속하게 이루어질 수 있어 현장에 13분 빨리 도착할 수 있는 것에 초점을 두고 있다. 즉, 보행속도와 차량속도를 각각 4km/hr, 30km/hr 기준 시 임도 1km 개설로 13분의 시간을 단축시키는 효과를 가진다. 그리고 산불은 1시간당 6.75ha를 연소시키는데, 13분 빨리 도착하면 그 효과는 1.46ha(=6.75ha×13/60)의 산림면적 보전이 가능하다. 따라서 임도 건설로 인한 목재생산피해방지효과의 경제적 편익은 7,463,043원(=산림보전면적1.46ha×입목평균가34,742원/㎥×임목평균축적125.6㎥)이다. 게다가 산불확산을 방지함으로써 산림공익기능을 보전할 수 있는데, 이에 대한 평가는 산림보전면적과 1ha당 산림공익기능생산액의 곱으로 볼 수 있다. 따라서 산림공익기능보전효과는 233,052,789원/ha(1.46ha×공익기능생산액 159,352,334원/ha)이 된다. 이를 요약하면, 임도 건설의 산불확산방지효과에 대한 경제적 편익은 목재생산피해액과 산림공익기능보전효과의 합계(239,435,563원)에 산불발생비중인 0.017% (=1,090ha ÷ 6,368,843ha)와 60ha/임도1km를 곱하면, 그 편익은 2,458,702원/km이다.

Jellyfish (Nemopilema nomurai) Fertilizer Contributes to the Early Establishment of Seedlings Planted in Post-fire Areas

산불피해지에 있어서 식재목의 조기정착을 위한 해파리 토양개량제의 효과

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Abstracts

The study was performed to examine the effects of jellyfish fertilizer on early establishment of seedlings in post-fire areas. On a recently burned hillslope on Mount Jubong (713.3 m) located in Hoengseong, Gangwondo, we initially planted seedlings of *Pinus thunbergii* and *Quercus palustris*, applied jellyfish fertilizer of 0, 10, 30 and 50 g·tree^{-1} at 10-cm in depth around the roots of seedlings, and finally monitored changes in soil property and subsequent survival and growth rates of seedlings. The overall survival rate of the planted seedlings was higher *P. thunbergii* seedlings than *Q. palustris* seedlings. Particularly, in the plot treated with jellyfish fertilizer of 50 g·tree^{-1}, the survival rate of *Q. palustris* seedlings was less than 50% whereas it of *P. thunbergii* seedlings was greater than 90%. This should be because that the influence of jellyfish fertilizer on survival of the planted seedlings depends on salt resistance. Under the considering their survival rates, the optimum application rates of jellyfish fertilizer were 50 g·tree^{-1} in the plot planted with *P. thunbergii* seedlings and 30 g·tree^{-1} in the plot planted with *Q. palustris* seedlings, respectively. Contents of soil moisture and chemical properties were remarkably increased in the soil treated highly with jellyfish fertilizer. These increments played an important role not only for enhancing the seedling growth but

also for wide distribution of root system. As shown above, the jellyfish fertilizer promotes soil amendment, and has a positive contributor to growths of both shoot and root parts, which is obviously required to secure competitiveness in an early establishment stage. This work was supported by a National Research Foundation of Korea grant funded by the South Korean government (Project No: 2010-0022532).

요 약

이 연구는 강원도 횡성에 위치한 주봉산의 산불피해지를 대상으로 해파리 토양개량제가 곰솔과 대왕참나무 묘목의 조기 활착에 미치는 영향에 대하여 알아보기 위해 진행되었다. 먼저 묘목의 근계둘레의 토양을 10cm 깊이로 굴취한 후 본당 0g, 10g, 30g 및 50g의 해파리 토양개량제를 12그루씩 시비한 후 묘목의 생존율과 생장량 및 토양의 성분변화를 관찰하였다. 그 결과, 곰솔의 생존율이 대왕참나무에 비해 상대적으로 높은 것으로 나타났다. 특히, 50g/본의 해파리 토양개량제를 처리한 조사구의 경우, 대왕참나무의 생존율은 50% 이하인 반면에 곰솔의 생존율은 90% 이상으로 나타났다. 이것은 해파리 토양개량제에 함유되어 있는 염분에 대하여 곰솔과 대왕참나무 묘목의 저항력이 각기 다르기 때문으로 판단된다. 이러한 묘목의 생존율을 고려할 때, 곰솔과 대왕참나무 묘목의 생장에 필요한 최적의 해파리 토양개량제의 시비량은 각각 50g/본과 30g/본으로 나타났다. 이 연구에서 해파리 토양개량제의 시비량이 많을수록 토양의 수분함량 및 화학성분의 농도가 현저하게 증가하는 것으로 나타났는데, 이러한 변화는 지상부의 생장은 물론이거니와 근계 활착에도 중요한 역할을 한다. 이상에서 알 수 있듯이, 해파리 토양개량제는 토양환경을 개선시킴으로써 묘목의 조기활착에 요구되는 줄기 및 근계발달에 긍정적인 영향을 주는 것을 알 수 있었다. 이 연구는 한국연구재단 기본연구지원사업(과제번호: 2010-0022532)의 지원에 의해 실시되었다.

Needle Nutrient and Chlorophyll Contents of Pinus Densiflora Seedlings to Different Fertilizer compound Ratios in a Recently Burned Area

산불피해지내 소나무 묘목의 시비수준별 엽 양분 및 엽록소 함량 변화

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Abstracts

The study was conducted to assess fertilizer compound ratios suitable for soil conditions in a recently burned pine forest in the eastern coast of Korea. In this study, Japanese red pine (*Pinus densiflora* S. et Z.) seedlings planted in burned area were fertilized over four growing seasons with the following NPK compound ratios: unfertilized (CON), 3:4:1, 6:4:1, 3:8:1, and 3:4:2. Fertilization generally increased current-year needle nutrient concentrations of the seedlings. The needle P concentration of the pine seedlings was higher in the 6:4:1 and 3:8:1 treatments than in the 3:4:1, 3:4:2, and CON treatments, but there was no significant difference in needle N concentration of the seedlings among these treatments. Furthermore, fertilization increased needle K concentration of seedlings in all fertilized plots, as compared with CON. There was no significant difference in total chlorophyll contents among treatments, but the chlorophyll a:b ratio in current-year needles was significantly higher in the fertilized plots, particularly 6:4:1 and 3:8:1, than in CON.

요 약

본 연구는 산불피해지의 토양특성에 적합한 비료성분비를 구명하기 위하여 동해안 산불피해지내 소나무 묘목을 식재하고 4년 동안의 생장기에 걸쳐 무시비구(대조구)를 포함해 질소, 인산 및 칼륨의 성분비(3:4:1, 6:4:1, 3:8:1, 3:4:2)를 달리한 비료를 처리하였다. 일반적으로 시비처리는 소나무 묘목의 당년잎내 양분농도를 증가시키는 것으로 나타났다. 특히 6:4:1 및 3:8:1 처리구 묘목의 엽내 인농도가 3:4:1, 3:4:2 및 대조구에 비해 높았으나, 엽내 질소농도는 처리구간에 유의적인 차이가 없는 것으로 나타났다. 또한, 엽내 칼륨농도는 대조구와 비교해 모든 처리구에서 상대적으로 높았다. 엽내 총 엽록소함량은 처리구간에 유의적인 차이가 없는 것으로 나타났으나, 엽록소 a:b비의 경우, 대조구에 비해 6:4:1 및 3:8:1 처리구에서 높은 경향을 보였다.

Grazing and Fire Effects on Caragana Microphylla Density in the Mongolian Steppes

몽골스텝의 Caragana microphylla 밀도에 대한 방목과 산불의 영향

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Abstracts

Though the higher drought resistance of *C. microphylla* is well-recognized, reasons of spatial variability in *C. microphylla* density have not been well-recognized across wide geographic regions of Mongolian steppes. Regional differences in *C. microphylla* density in Mongolian steppes were explained by considering multiple abiotic and biotic factors collectively, including aridity gradients, disturbance regimes of grazing and fire, and inter-specific interaction. In the central and eastern Mongolian steppes, we collected vegetation data from 127 sites. Along 250-m line transects, the hit-frequencies of *C. microphylla* and tall grass species were recorded. Ancillary data were collected, including weather data, livestock population, fire occurrence map data, and herder camp location. Based on the steppe types (i.e., forb, typical, and semi-desert steppes) and disturbance regimes (i.e., natural, grazed, and burned), the sites were classified into 12 sub-groups. Various statistical analyses were conducted at the site, county, and sub-group levels. Natural *C. microphylla* density decreases with climatic aridity from forb to semi-desert steppes, but this decrease was not observed at grazed and burned sites.Livestock grazing suppressed *C. microphylla* density, but this effect was considerably compounded by aridity effects, especially in the central steppes, which made the relations between *C. microphylla* and livestock densities more complex. Though fire appeared to be an important factor in the eastern steppes, the mechanism of the fire effect on *C. microphylla* density is uncertain because the fire -shrub interaction is influenced by the recovery process of tall grass species after

fire disturbances. After investigating the relations of aridity, grazing, fire, and tall grass species density with spatial distribution of *C. microphylla* density, we propose that two different compounding effects (i.e., aridity and grazing vs. fire and inter-specific interaction) play important roles in determining the spatial distribution of *C. microphylla* density in the central and eastern Mongolian steppes, respectively.

요 약

*Caragana microphylla*는 몽골스텝에 광범위하게 분포하며 다양한 생태계 서비스 기능을 제공하는 중요한 관목식물이다. 이 연구에서는 *Caragana* 임분밀도의 공간적 차이를 설명하기 위해, 방목초식압, 산불교란, 건조도, 장초본과의 관계 등을 분석하였다. 결과적으로 몽골중부초지와 동부초지에서 상이한 요인들이 *Caragana* 임분밀도에 영향을 미침을 발견하였다. 산불이 빈번하게 발생하는 몽골동부초지에서는 최근 산불과 장초본과의 관계가 중요한 인자로 판명되었고, 중부초지에서는 건조도와 함께 방목초식압이 *Caragana* 임분밀도에 영향을 미치는 인자로 나타났다.

A Research on the Forest Fire in DMZ and the need for mutual cooperation between South-North Korea

DMZ 내 산불발생과 남북협력의 필요성 연구

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Abstracts

Forest fire steadily breaks out around DMZ about four and five times per year, some of which cause damage to forest located in South Korea as well. Forest fire occurred near DMZ causes an especially huge damage as the processes to deploy the adequate equipment to put out the fire are complex and restricted, which is costly and time consuming and makes it too difficult to put out the fire in an early stage. So there is a growing need to promote a cooperation between the two Koreas to prevent and address the forest fire around DMZ. To achieve this, it is necessary to place a hydrant at the corner of every guard post around DMZ and to build a cooperative system. Also, it is desirable to conduct a joint pilot project of forest fire extinguishment between the two Koreas in the areas that are highly likely to resume tours. Further studies are needed to find a way to build up a channel of communication between the two Koreas in preparation for the forest fire.

요 약

DMZ와 그 주변의 산불은 매해 연평균 4~5회 정도 발생하고 있고, 2012년에는 7건의 산불이 발생하였다. DMZ 주변의 산불은 대부분 군사지역 내 시계확보를 위한 실화에 의해 발생하고 있는 것으로 추정되며, 일부는 북한주민들의 화전에 의한 실화이거나 야생동물 등이 지뢰를 밟아서 발생하는 것으로 알려져 있다.

그중 문제가 되는 것은 DMZ를 타고 남측까지 피해를 주는 중대형 산불이다. DMZ 주변 산불피해가 큰 이유는 DMZ의 특성상 장비투입이 제한되어 초기진화가 어렵고, 규모가 커진 다음에 진화가 시작되면서 많은 시간과 경비가 소요되기 때문이다. 이에 DMZ 산불방지 및 진화를 위한 남북협력의 필요성이 커지고 있다.

먼저 신속한 화재진화를 위해 현재 DMZ 근처 초소 주변 약 10개소에만 있는 소

화전을 휴전선 근처 모든 전방부대 내에 설치·관리하도록 해야 한다. 그리고 초기진화용 산림헬기 투입을 위해 국방부, 통일부, 산림청, 소방방재청 등이 포함된 협력체계를 구축해야 한다, 또한 남북관광이 재개될 가능성이 높은 지역에서는 남북합동 산불진화 시범사업을 진행하고, 시설 및 장비에 대한 지원을 검토할 수 있을 것이다. 한편 DMZ 주변 산불예방과 진화를 위한 남북 대화창구 개설에 대한 연구도 진행되어야 할 것이다.

Crown Fuel Characteristics and Allometric Equations of Pinus koraiensis Stands in Korea

우리나라 잣나무림의 수관연료특성 및 상대생장식 추정

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Abstracts

This study was conducted to analyze the characteristics of crown fuel and to develop allometric equations of each crown component category for the estimation of crown fuel biomass of *Pinus koraiensis* stands in Korea. A total of twenty four representative trees were destructively sampled in Jeongseon, Gapyeong and Hongcheon region. Crown fuel were weighed separately for each fuel category by size class. The results of this study showed that foliar moisture content was 110.1% while the average crown moisture content was 105.5%. The crown fuel/total fuel loading ratio was 33.0%, Whereas needles and twigs with less than 1cm diameter was accounted for the highst crown fuel load category with 55.6%. Adjusted multiple coefficient of determination of suggested allometric equations ranged from 0.887 to 0.972 for crown fuel biomass, 0.984 for crown volume. The results of this study on the biomass estimation and crown fuel characterization are very significant information for the forest managers in estimating the carbon stocks and assessing the crown fire hazard of *Pinus koraiensis* forests in Korea.

요 약

본 연구는 우리나라 잣나무림을 대상으로 수관층 연료특성을 분석하고, 각 부위별 연료량 추정을 위한 상대생장식을 개발하고자 하였다. 연구대상지는 정선군, 가평군, 홍천군을 대상으로 하였으며, 표준지를 선정하여 매목조사를 실시한 후 24본을 표본목을 벌채하였다. 벌채한 잣나무는 수간, 잎, 가지 순으로 분류하였고, 가지는 다시 굵기 별로 분류하여 무게를 측정한 후 분석하였다. 본 연구 결과에 의하면,

생엽의 수분함량은 110.1%, 수관층 수분함량은 105.5%로 나타났다. 전체 연료량에 대한 수관층 연료량 비율은 34%로 나타났으며, 수관화 확산시 연소가능한 연료량의 비율은 55.6%로 나타났다. 본 연구에서 제시된 수관연료 추정식에 대한 조정결정계수(R^2_{adj})의 범위는 0.887-0.97로 높게 나타났으며, 수관체적 추정식에 대한 조정결정계수(R^2_{adj})는 0.984로 나타났다. 본 연구의 바이오매스추정량과 수관연료특성 결과는 우리나라 잣나무림의 수관화 위험성 평가와 관련된 산림경영에 중요한 정보를 제공할 것이다.

Nomographs for Predicting Crown-Fire Initiation of *Pinus densiflora* Stands in Central Regions of Korea

노모그래프를 이용한 중부지방 소나무 임분의 수관화 전이 가능성 예측

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Abstracts

This study was conducted to assess the probability of surface fires transitioning to crown fires in *Pinus densiflora* stands based on crown-fire transition factors, such as surface fuel loads, surface-fire intensity, and surface-fire-flame length. Nomographs were used to determine the critical values of the factors that can lead to crown-fire initiaction, because it can be used to combine several fire model equations. Thirty-six sample plots were established in *P. densiflora* stands and variables such foliar moisture content, crown base height, and surface fuel load were measured in the field. Furthermore, the plots were classified into 6 age classes. Results showed that the surface fuel loads (i.e., shrub, herb, dead leaves, and snags) from age class I to VI were 4.504 t/ha, 8.495 t/ha, 11.694 t/ha, 14.457 t/ha, 16.105 t/ha, 19.974 t/ha, respectively. The critical values for surface-fire intensity from age class II to VI were from 846.81 kW/m to 4,392.21 kW/m, when moisture content of the foliage was 107%. The critical flame lengths of the surface fire for each age class were 1.73 m (class II), 2.38 m (class III), 2.73 m (class IV), 3.57 m (class V), and 3.68 m (class VI). While the fire behavior models used are based on certain assumptions and are constrained by limited testing, the results of this study are considered significant for fire prevention and suppression planning in *P. densiflora* forests in South Korea.

요 약

본 연구에서는 산불발생시 지표화에서 수관화로 전이될 가능성을 판단하고자 소

나무림을 대상으로 수관화 전이를 결정하는 인자인 지표층 연료량, 지표화 강도, 화염길이 등을 추정하고자 하였다. 수관화 전이 결정인자의 추정을 위하여 두 개의 분리된 식을 결합한 노모그래프를 이용하였으며, 변수에는 현장조사의 측정값을 적용하였다. 조사된 소나무림의 개소수는 36plot으로 6개의 영급 (Ⅰ영급～Ⅵ영급)으로 분류하여 매목조사를 실시하였다. 분석결과 추정된 지표층 연료량(관목, 초본, 낙엽, 낙지)은 Ⅰ영급에서 Ⅵ영급까지 각각 4.504 tons/ha, 8.495 tons/ha, 11.694 tons/ha, 14.457 tons/ha, 16.105 tons/ha, 19.974 tons/ha으로 나타났으며, 잎의 수분함량이 107% 일 때 추정된 결정적 지표화 강도는 Ⅱ영급 846.81kW/m에서 Ⅵ영급 4392.21kW/m로 나타났다. 또한 결정적 지표화 화염 길이는 Ⅱ영급 1.73m, Ⅲ영급 2.38m, Ⅳ영급 2.73m, Ⅴ영급 3.57m, Ⅵ영급 3.68m로 나타났다. 본 연구에서 제시된 산불행동모델은 제한된 실험에 의한 특정 가정을 기반으로 하고 있지만, 향후 우리나라 소나무림의 산불 예방 및 진화를 위한 계획 수립에 있어 중요한 정보를 제공할 수 있을 것으로 사료된다.

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Performance of Percentile-based Weibull Diameter Distribution Function for Pinus Thunbergii in East Sea, South Korea

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Abstract

The distribution of diameter is the most potent simple factor in majority of forest management planning tool for predicting stand volume, timber volume and stand growth, among others. Quantification of the diameter distribution and its relationship to stand composition and density plays a critical role for both economic and biological intents. In comparison to other distribution models, the Weibull distribution has been most frequently used in describing diameter distributions because of its flexibility in shape and simplicity of mathematical derivations. In this study, our goal was evaluate the performance of percentile-based Weibull function for *Pinus thunbergii* stands in the eastern coast of Korea. In order to estimate the three parameters of the Weibull model, the parameter recovery technique was used. The performance of the different equations was quantified using evaluation statistics such as fit index (R^2) and root mean square error (*RMSE*). With the percentile based distribution method, the results of the R^2 vary from 0.50125 (minimum diameter) to 0.93211(50^{th} diameter percentiles) and the *RMSE* vary from 0.11158 (quadratic mean diameter) to 3.57211 (minimum diameter). In addition, the mean bias ($\overline{E}$) in trees per ha (TPH) for each diameter class was determined to further evaluate the developed Weibull diameter distribution model. The results showed that the highest over prediction was found in the 20 cm diameter class, and that the highest under prediction was found in the 16 and 24 cm diameter class. Considering the important role of diameter distribution in different aspects of

forestry researches, specifically on yield prediction system, the result of this study is valuable in sustainably managing the forests, most importantly because it is recommended that forest managers should utilize growth and yield models designed and/or calibrated for the region in which the study was undertaken. Using the results of the present study, further research will be carried out to develop a diameter distribution yield prediction system to predict the future yield or total volume of *Pinus thunbergii* stands in Korea.

Analysis of CO_2/Non-CO_2 Emissions of *Pinusdensiflora* in Ahndong, Korea

안동지역 소나무의 CO_2/Non-CO_2 배출가스 분석

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2012 COP held in Doha, Katar, extended the effects of Kyoto Protocol which had to be expired until 2012 and agreed to make a new climate change correspondence system by 2015 which will occur after 2020. After Kyoto Protocol, each country has tried to quantify its non-CO_2 emissions due to forest disturbance such as forest fires, not to get disadvantaged economically. As part of this endeavor, Korea has been developing Tier 2 or 3 emission factor beyond IPCC's Tier 1. For the higher levels, detailed emission factors should be estimated by region, class-age, and tree species. Accordingly, this study conducted a research on non-CO_2 emissions of crown and surface fire level of 2, 4, 6 class-age *Pinusdensifora* in Andong, Korea as an effort for the evaluation of the specific Korean emission factors.

요약

2012년말 카타르 도하에서 열린 당사국총회에서 2012년까지 만료되어야 하는 교토의정서의 효력을 2020년까지 연장하고 2020년 이후에 나타날 새로운 기후변화대응체제를 2015년까지 마련하기로 합의했다. 교토의정서가 발효된 후 각국은 산불등의 산림교란으로 인해 발생하는 non-CO_2 가스의 배출량을 정량화하여 경제적 불이익을 받지 않도록 하고 있다. 우리나라도 이에 대한 노력으로 현재의 IPCC가 제시

하는 가이드라인의 Tier 1에서 좀 더 발전한 Tier 2 혹은 3 수준의 국가고유계수를 가지도록 연구/개발중이다. 이를 위하여 지역별, 영급별, 수종별로 세분화된 배출계수의 사용이 요구된다. 따라서 본 연구는 이러한 추세에 맞춰서 국가고유배출계수 개발의 일환으로 안동지역 2, 4, 6영급 소나무를 대상으로 수관층과 지표층의 non-CO_2 배출에 관한 연구를 수행하였다.

The Study on Combustion Characteristic of Smoldering Ground Fire in Forest Fire

뒷불의 연소특성에 관한 연구

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Smoldering ground fires can be a probable cause of surface re-ignition when transmitted from the fermentation layer to the humus layer that has temperatures higher than that of ignition temperature. The objective of this study is to suggest potential danger of smoldering ground fire. By an experimental methodology about the study of smoldering ground fires with a model of multi-layer surface duff structure similar to real surface fuel beds. The experiment used the coniferous *P. densiflora* and the broad-leaved *Q. variabilis* surface fuel layers as the sample and structured surface layer into litter layer, fermentation layer and humus layer to resemble the real ground fire setting. K-type thermocouple was placed in the litter layer by different depths to measure transition temperature, duration and velocity. The experiment showed varied temperature in each depth of litter layer during smoldering combustion. For example, ignition temperature at litter layer 10cm thick was higher than that in the boundary between fermentation layer and humus layer, thus indicating higher risk of re-ignition. Temperature of boundary surface when moisture content was below 35% was measured at above 300℃ while the same was measured at below 100℃ when FMC was above 44% according to temperature of litter layer measured in different FMC conditions. Hence, critical FMC for re-ignition is judged to be in the range of 35~44% and there appears to be high likelihood of re-ignition triggered by smoldering combustion when FMC at litter layer over 10cm deep is less than 44%. In conclusion, the experiment model proposed potential re-ignition in the multi-structured litter layer caused by smoldering combustion and verified such combustion characteristics as transmission of

smoldering fire from one layer to another, the impact FMC has on ignition, velocity of smoldering fire and temperature changes in the boundary surface by duration.

요 약

산불 형태 중에서 뒷불은 지표층 내부의 발화점 이상 온도가 분해층에서 부식층으로 전이되어 뒷불이 발생 할 수 있는 형태로 잠재적 위험성을 가지고 있다. 본 연구는 뒷불 발생 현장과 유사한 지표층 구조로 뒷불의 잠재적 위험성을 실험을 통하여 규명하는 것을 목적으로 한다. 시료는 침엽수종 소나무 낙엽층과 활엽수종 굴참나무 낙엽층으로, 실제 산림내의 지표층 구조인 낙엽층, 분해층, 부식층로 구분하여 재현하였다. 8개의 열전대(K-type)를 층별 경계면과 그 사이에 배치하여 전이온도, 지속시간, 전파속도를 측정하였다. 유기물층의 뒷불 전이 임계습도는 35~44%사이에 존재하며, 온도는 350℃이상시 뒷불 전이가 일어날 확률이 아주 높다는 결론을 도출하였다.

결론적으로 다층구조의 뒷불 모델을 제시하였으며 이를 사용하여 훈소의 층간 전이현상, 함수율에 따른 발화여부, 훈소 전파속도 및 시간에 따른 경계면의 온도변화 등을 알 수 있었다. 또한 뒷불의 연소특성을 규명할 수 있는 실험방법을 확립하였다.

The Study on Equipment's Performance Used for Extinguishing of Forest Fire

산불 진화장비 성능에 관한 연구

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In order to quantify the performance of the main ground equipments used for extinguishing forest fire, field application tests were conducted for the distance from the source of water to the hose, and the elevation. The comparison group used a fresh water reservoir as the source of water with 40-meter height difference from the source of water through a preliminary test. With regards to field application tests, the water formed the forest valley was used as the source of water and the height difference was 150m, the 3.75 times higher than that used for the preliminary test. Compared with the preliminary experiment that was not largely affected by the height, the performance measured at the same distance for the field application test was reduced by over 50% on average. However, the horizontal and vertical distance indicated the performance reduction within 20%, implying that the horizontal and vertical distances are not a big obstacle to forest fire suppression. Also, the increase of pumping pressure was the biggest for the small-sized pump. Such a test result is due to the difference in the water supply between difference forms of water source, and its causes include reduced stability in supplying water, increased load on pump pressure, and the foreign objects insertion, as well as the effects of the height. In addition, through the test, the appropriate distance used by actual fire fighters, and required number of fire fighters at difference distances could be calculated for different fire-extinguishing equipments.

요 약

산불 진화에 사용되는 지상 주력 장비를 대상으로 수원으로부터 호스 거리 및 고도에 따른 성능을 정량화하기 위한 현장 적용 실험을 실시하였다. 대조군으로는 담수지 형태의 수원을 사용하고 수원으로부터 고도차가 40m 수준인 예비실험을 대상으로 성능값을 비교하였다. 본 현장 적용 실험에서는 산림 내 계곡지를 수원으로 하였으며, 고도차가 150m로 예비 실험의 3.75배인 지형을 선택하였다. 고도에 따른 영향이 크지 않은 예비 실험과 비교하였을 때 고도가 높아질수록 동일 거리에서 측정한 성능값은 평균 50% 이상의 감소를 나타내었다. 그러나 수평 및 수직 거리는 20% 이내 수준의 감소를 나타내어 진화에 큰 장애 요소로는 작용하지 않았으며, 펌프압력은 소형펌프의 압력 상승이 가장 큰 상승률을 나타내었다. 이와 같은 결과는 수원의 형태에 따라 용수 공급차에 기인한 것으로 안정적 용수공급 저하, 펌핑압 부하 증가, 이물질 삽입 등이 원인인 것으로 사료되며, 고도에 따른 영향 인자도 반영된 것으로 해석된다. 또한 실험을 통해 진화장비별 실제 진화대원의 적정 사용거리와 거리별 적정 소요인원을 산출할 수 있었다.

The Stand Growth of Pinus densiflora Plantation after Forest Fire in Samcheok

삼척 산불 후 식재한 소나무 인공림의 임분 생장 연구

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Abstracts

This study was conducted to compare the stand growth of plantation after forest fire with the unburnt forest. The diameter at breast height (DBH) and tree height of 10-year old *Pinus densiflora* stand were measured to estimate the stand growth of post-fire plantation in Samcheok city. The stand biomass of post-fire stand was calculated by growth equation and compared to the biomass of unburnt *P. densiflora* stand described in stand yield table. The mean DBH and tree height of post-fire stand ranged from 3.1 to 3.7 cm (64.1-75.6% of unburnt stand), and from 2.7-2.8 m (65.0-67.5% of unburnt stand), respectively. The stand biomass was 1.8-2.6 ton ha-1, only 11.9-17.3% of biomass in unburnt stand. The results were derived from the low growth rate of container seedlings, and very low stand density of *P. densiflora* due to the narrow growth space caused by the piles of burned trees along topographic contour.

요 약

산불 후 소나무 인공림의 생장 특성을 파악하기 위하여 삼척 산불 후 인공 조림된 10년생 소나무 임분을 대상으로 흉고직경 및 수고를 조사하였다. 기존 개발된 생장식을 바탕으로 바이오매스를 추정한 후, 추정된 바이오매스를 임분 수확표와 비교하여 정상적인 임분과의 차이를 비교하였다. 산불피해지에 조림된 소나무 인공림의 평균 흉고직경은 3.1-3.7cm로서 수확표 대비 64.1-75.6%였으며, 평균 수고는 2.7-2.8m로서 수확표 대비 65.0-67.5%였다. 한편 단위면적 당 바이오매스의 경우, 1.8-2.6 ton/ha로서 수확표 대비 11.9-17.3%에 불과하였다. 이는 용기묘의 초기 생장이 느리다는 점과 소나무 밀도가 매우 낮다는 점에서 기인하는 것으로 판단되며, 소나무의 낮은 밀도는 벌채된 산불 피해목의 조림지 내 수평쌓기로 인해 소나무의 생육공간이 작았기 때문으로 사료된다.

Comparison on Early Growth of *Quercus mongolica* containerized seedling and *Quercus spp*. Coppice at Burn Area in Samcheok, Korea

삼척 산불피해지에서 굴참나무 용기묘와 참나무류 맹아간의 초기 생장비교

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The study was performed to compare the growth variation of *Quercus spp*. on two regeneration methods at eastern costal burn area, burned at 2000 in SamCheok, Korea. We planted containerized *Quercus mongolica* seedling on the east slope of burn area in Apr. 2001. We compared the growth of *Q. mongolica* containerized, *Q. mongolica* coppice regenerated and *Quercus. variabilis* coppice regenerated in Oct. 2013. The plant growth was significantly different between plantation and natural regeneration method ($p<0.05$). The mean tree height presented 1.8 m at plantation and 4.3m at coppice regenerated stand. Mean DBH (diameter at beast height) presented 1.8 cm at plantation and 4.4 cm at coppice regenerated stand. In study area, we concluded that it was desirable to perform natural regeneration method for fire-resisting forest construction instead of plantation.

요 약

본 연구는 삼척시에 위치한 2000년 동해안 산불피해지 동향사면에서 갱신방법에 따른 참나무류의 생장 차이를 비교하기 위해서 수행되었다. 2001년 4월에 굴참나무 용기묘를 식재하였고, 2013년 10월에 굴참나무 용기묘와 맹아갱신한 굴참나무, 그리고 맹아갱신한 신갈나무의 흉고직경과 수고를 측정하여 생장 차이를 비교하였다. 그 결과 굴참나무의 수고는 용기묘를 식재한 경우 1.8m, 맹아갱신한 경우 4.3m로 나타났다. 그리고 흉고직경은 용기묘를 식재한 경우 1.8cm, 맹아갱신한 경우 4.4cm로

나타나, 맹아갱신한 굴참나무의 생장이 용기묘 식재한 굴참나무보다 더 높은 것으로 나타났다($p<0.001$). 따라서, 본 연구대상지에서 굴참나무 내화수림대를 조성하는 경우 용기묘를 식재하기보다는 맹아갱신을 우선적으로 실시하는 것이 바람직한 것으로 판단된다.

Effect of Prescribed Burning on Chirpine-Lemon grass Forest Ecosystem in Eastern Bhutan Himalaya

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Abstracts

Forest fire is one of the major human-induced disturbances, which continue to burn thousands of hectares of forests in Bhutan Himalaya. Fire frequencies are relatively high in seasonally dry forests particularly the fire prone but resilient Chirpine (*Pinus roxburghii*) forest with an undergrowth of commercially important lemon grass (*Cymbopogon flexuosus*) in eastern Bhutan. Repeated burning reportedly increases the biomass and oil content acting as incentive for inducement of forest fires by harvesters and distillers. In order to test this hypothesis, a long-term experiment studies the effect of fire on regeneration, competing ground vegetation and, lemon grass biomass including socio-economic to determine whether prescribed burning is a suitable management tool. The study design compares burned and un-burned plots. Fire promotes natural regeneration of Chirpine stands due to release of nutrients and cone production in seed mother trees in open stands but partially impedes seedling growth. surface fires do not cause mortality of trees over 10 cm dbh. Lemongrass harvesting and distillation is profitable but annul production declines from 1998-2007. Prescribed burning does not reduce lemon grass biomass but promotes non-native invasive herbs. To consolidate the preliminary results, continue monitoring is essential.

요 약

산불은 대표적인 인위적 교란중 하나로서 부탄의 히말라야 지역에서 수천 ha의 산림이 지속적으로 소실되고 있다. 산불 빈도는 하록림에서 상대적으로 높게 나타났으며 특히 부탄 동부 지역의 경제 작물인 레몬그라스(*Cymbopogon flexuosus*)가 하층을 이루고 있는 Chirpine (*Pinus roxburghii*)림이 산불에 취약하지만 산불에 대한 회복력을 가지고 있다. 반복되는 연소는 바이오매스와 오일 함량을 증가시키는 것

으로 알려져 있어 지역주민에 의한 인위적 산불 발생의 원인이 되고 있다. 처방화입이 적절한 관리 수단인지 여부를 판단하기 위해 산불이 레몬그라스 바이오매스량, 지피 식생의 경쟁 및 갱신에 미치는 영향에 대한 장기 실험 연구가 수행되었다. 본 연구에서는 산불 발생 지역과 미발생 지역을 비교 분석 하였다. 산불은 양분을 증가시키고 모수의 구과 생산을 통해 Chirpine의 천연 갱신을 촉진시키지만 부분적으로 치수의 생장을 지연시킨다. 지표화는 흉고직경이 10cm 이상인 수목의 고사율에는 영향을 미치지 못한다. 레몬그라스의 생산량은 1998년부터 2008년까지 감소하였다. 처방화입은 레몬그라스의 바이오메스량을 감소시키지 않지만 외래 침입종을 증가시켰다. 보다 정확한 결과를 위해서는 지속적인 모니터링이 필요하다.

Comparison of Growth and Distribution of *Pinus densiflora* in different sites after Goseong forest fires in Korea

고성 산불 후 자연복원지에서 입지별 소나무 분포와 생장 비교

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This study was conducted to compare the growth and distribution of *Pinus densiflora* in 3 different site types: rocky land, ridge, and slope after the forest fires in 1996 and 2000 occurred in Goseong, Gangwon-do, Korea. After 13-17 years later from the fire, stands and soils in 3 different site types are investigated. *Pinus densiflora* is the dominant species in rocky land and its proportion of tree population was 58%. *Qeurcus* spp. hold a majority at the ridge and slope, and they show 58% and 83% of the proportion respectively. The soil nutrient contents in slope including total nitrogen, K+, and Ca2+ are recovered as they were before the fire, while rocky land and ridge have still showed low contents. The soil moisture content in rocky land shows approximately 10% lower than the others and the coarse texture and lower cover degree of vegetation are considered as the main causes of it. As a result of lower soil nutrients and soil moisture contents, *Pinus densiflora* and *Quercus* spp. in rocky land show lower growth and development.

요 약

본 연구는 1996년 및 2000년 강원도 고성군 산불피해지에서 산불 발생 13-17년이 지난 시점에서 입지별로 소나무의 자연적인 분포와 생장 특성을 살펴보기 위해 수행되었다. 산불 후 국소적으로 자연 복원된 지역을 중심으로 암석지, 능선부, 사면부로 입지를 구분하여 소나무 분포와 생장 특성을 비교하였다. 소나무는 암석지에서 개체수 비율이 58%로 가장 높았다. 능선부와 사면부에서는 참나무류의 개체수 비율

이 각각 58%와 83%로 소나무 보다 높았다. 토양 분석 결과 전질소와 K+, Ca2+ 등 토양 양분 함량이 사면부에서는 산불 이전 수준으로 회복되었으나 암석지와 능선부에서는 낮았다. 특히 암석지는 토성이 양질사토 또는 사양토로서 토양 수분 함량이 대조지역에 비해 약 10% 정도 낮아 식피율도 비교적 낮게 나타났다. 또한 소나무와 참나무류의 수고 생장도 불량하여 관목형 수형을 나타냈다.

Simulation on the Effect of the Extinguishing System for Wild Forest Fire

산불소화시설 효과 시뮬레이션

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Abstracts

In this study, using the appropriate positioning technique and the analysis data of effect on the extinguishing system for wild forest, the terminal objective is to plan for the protection of wooden cultural properties as well as major forest areas from fire. Installing the model of fire extinguishing system around the wind farm in Bieungdo-dong, Gunsan-shi, Jeonbuk, the three nozzle characteristics data and the experimental correlation of wind effect have been induced, and the analysis model using a commercial code, ANSYS-CFX has been completed to study the effect of wind speed on the jet distance of water droplets through the nozzle. In the numerical methods, the steady-state incompressible turbulent two-phase flow is assumed, and the continuity equation, the momentum equation, and the volume fraction are solved for the visualization. A k-omega SST(Shear Stress Transport) turbulence model is used in the present investigation. As a result, nozzles 1 and 3 are found to be similar while the effective radius under the zero wind condition is the largest for the nozzle 3, and the least effected one from wind is nozzle 1 that has the largest discharge flow rate. From the result of simulation, as a conclusion, it is obviously observed that the reaching distance becomes shorter if the wind speed increases against the wind, and, in the jet direction aligned to the favorable wind, the jet distance becomes saturated after increasing.

요 약

본 연구에서는 산불소화시설 적정위치 선정 기법 및 효과 자료를 이용하여 산불

로부터 목조문화재 및 주요 산림지역을 보호하기 위함을 그 최종 목적으로 한다. 전북 군산시 비응도 풍력발전기 인근에 소방시설의 모형을 설치하여 3개의 노즐 특성 데이터 및 바람의 영향 상관식을 도출하였으며, 풍속이 노즐을 통과한 액적의 분사 거리에 미치는 영향을 알아보기 위하여 상용코드인 ANSYS-CFX를 이용하여 해석 모델을 완성하였다. 수치해석 방법으로는 정상 상태의 비압축성, 난류, 이상 유동으로 가정하여 연속 방정식, 운동량 방정식, 부피 분량 등을 풀이하여 도시화 하였다. 난류 모델로는 k-omega SST를 사용하였다. 그 결과 노즐의 특성은 1번과 3번이 유사한 것으로 나타났으며, 바람이 없을 때의 유효 반경은 토출 속도가 큰 3번 노즐이 가장 크고, 바람의 영향을 가장 적게 받는 것은 토출 유량이 가장 큰 1번 노즐로 밝혀졌다. 시뮬레이션 결과, 노즐의 분사 방향과 반대로 풍속이 증가 할 때, 액적의 도달 거리가 짧아 진다는 것을 명백히 알 수 있으며, 풍속의 순방향으로는 분사 거리가 증가를 하다가 어느 정도 풍속이 증가하면 더 이상 증가 효과가 미미해진다는 결론이 도출되었다.

Analysis of Multiple-polarization PALSAR Backscatter for Burn Severity Evaluation in Mountainous Forested Areas

산림지 열화등급 평가를 위한 다중편파 PALSAR 후방산란의 분석

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Abstracts

Currently, operational mapping burn severity and impact evaluation are based mainly on optical images. However, persistent cloud cover and dense haze were occurred active fires impede analysis of burn severity evaluation and forest fire monitoring. Accordingly cloud-penetrating SAR microwave might be useful to supplement existing forest fire monitoring systems. In this study, multiple-polarization PALSAR backscattering coefficients were used to evaluate forest burn severity in Geumryun temple of Yeongcheon-si, where a relatively big forest fire occurred in May, 2010, and a total area of 86ha was burnt. The ALOS PALSAR HH and HV images for the forest burned area were acquired on May 8, 2010(postfire). To analysis the relationship burn severity and PALSAR backscatter, this study compared forest fire areas to different areas(namely, unburned areas) with the same conditions(forest stand volume, tree species and age class) based digital forest map. PALSAR backscatter decreased with burn severity, showed no sensitivity to polarizations. Multi-polarization PALSAR backscatter from burned areas was lower than that from unburned areas.

요 약

현재, 열화피해 등급도 작성 및 영향평가는 주로 광학영상에 기반한다. 그렇지만 활화기간에 발생하는 구름과 연무로 인해 열화등급 평가와 산불탐지 분석에 지연을 받으므로, 구름을 관통하는 SAR 마이크로파는 기존의 산불감시 체계에 보완된다.

본 연구에서는 영천시 금륜사 산불등급을 평가하기 위하여, 다중편파 PALSAR 후방산란계수를 사용하였다. 연구지역은 총 열화면적이 86ha인 만큼 2010년 5월 전국 산불지역 중 비교적 큰 산불에 속하며, ALOS PALSAR HH, HV영상은 산불 후인 2010년 5월 8일에 획득되었다.

열화등급과 PALSAR 후방산란의 관계를 비교하기 위해, 본 연구는 산불지역과 같은 조건, 즉 수치임상도 기반의 입목축적량, 수종 그리고 영급이 동일한 비산불지역을 비교하였다. PALSAR 후방산란은 열화등급 정도에 따라 감소하였고, 편파종류와는 민감성을 보이지 않았다. 또한 열화지역의 다중편파 후방산란은 비열화지역보다 항상 낮은 값으로 분석되었다.

Fuel Consumption Rate and Efficiency of Main Coniferous Species with Fire Severity

주요 침엽수종의 피해강도별 연소량, 연소효율 조사

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요 약

본 연구는 우리나라 주요 침엽수종의 정량적 현장조사를 통해 산불연료모델 개발을 목적으로 하고 있다.

연구내용으로는 산불피해지의 피해강도별 연료량, 연소효율을 조사하기 위해 지표화와 수관화 지역의 관목, 낙엽, 낙지, 가지 등을 샘플링하고, 주요 침엽수인 잣나무, 소나무, 리기다소나무의 배출계수를 개발을 위해 미피해지의 지표층, 수관층을 샘플링 하였다. 연구대상지는 2013년 대형 산불 피해지인 울주군, 봉화군, 포항시를 대상으로 실시하였고, 배출계수를 위한 미피해지 조사는 산불 발생 빈도가 높고, 대형 산불위험이 높은 경북, 강원지역을 대상으로 조사를 실시하였다.

산불피해지는 수관전소, 수관열해, 피해중, 피해경, 미피해지로 구분하여 조사를 실시하였고, 피해지별로 31개소씩 피해조사야장을 작성하고 샘플링을 진행하였다. 연소량 측정을 위해 50㎝×50㎝의 정방형구 틀을 이용하여 샘플을 채취한 후 생중량을 측정하였고, 배출계수 개발을 위한 샘플링은 수관층의 경우 1㎝이하의 잔가지 및 생엽을 채취, 지표층은 10㎝×10㎝×5㎝의 틀을 이용하여 샘플링을 하였다. 미피해지의 대상지는 수종별 분포가 높은 지역으로 대상으로 영급별 시료채취를 해야 하기 때문에 임상도자료를 활용하여 대상지를 선정 후 현장에서 임령을 측정하였다. 잣나무는 1~6영급까지 홍천군 지역에서 조사를 실시하였고, 소나무는 안동시와 의성군에서 리기다소나무는 무주, 장수, 진안에서 영급별로 시료를 채취하였다.

본 연구를 통해 산불온실가스 배출모델을 개발하여 IPCC에 의무적으로 제출해야 할 국가보고서의 자료로 활용가능하고, 산불 온실가스배출량 산정모델 개발을 위한 정량적 현장조사자료 구축이 가능하며, 주요 침엽수종의 연료모델 개발에 따라 산불위험예보, 확산예측, 연소량 산출, 산불 강도 계산, 연무확산 등에 있어서 통일된 자료를 구축하게 될 것으로 기대된다.

Forest Watchmen 'Mandor' incorporating Traditional Knowledge
-Forest Fire Management in West Rinjani, Lombok, Indonesia

전통지식을 활용한 산림감독관 '만도르'
-인도네시아 롬복 산림경영구 산불관리 사례를 통하여

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Abstracts

The purpose of the study is to identify how a Forest Management Unit practices the Forest Fire Watch program in West Rinjani, Lombok, Indonesia. Indonesia implemented a particular forest watch program to control forest fire and illegal logging. We analyzed documents and conducted a focus group discussion and interviews with forestry agents and forest watchmen. The West Rinjani forest management unit has employed forest watchmen, called Mandor, from each village around West Rinjani. The mandor system involves villagers in forest fire management and incorporates traditional knowledge of Sasak people in Lombok. In the region, Mandor plays an influential role in shaping local communities' attitudes toward forest management as a communication channel between the forest management unit and local communities. Forest fire management utilizing Mandor has been effective in terms of minimizing transaction cost and maximizing performance.

요 약

본 연구의 목적은 인도네시아 롬복의 서부 린자니 산림경영구가 산불 감지를 어떻게 하고 있는 지를 파악하는 것이다. 인도네시아는 기초적인 수준에서 산불감독관을 활용한 산불 감독을 시행하고 있으나, 산림관련 전통지식은 다양한 형태로 산림관리에 응용되고 있다. 문헌연구, Focus Group Discussion, 인터뷰를 통하여 서부 린자니 산림경영구와 지역사회가 협력하여 시행하고 있는 산불 감독에 대한 자료를 수집하였다. 서부 린자니 산림경영구에서는 롬복의 전통지식을 활용한 산림감독관

만도르를 각 지역사회에서 선발하여 산불 감독을 시행하고 있다. 만도르는 지역주민들의 산림관리에 대한 태도에 영향을 미치며 산림경영구와의 소통 채널의 역할을 한다. 서부 린자니 산림경영구의 만도르를 활용한 산불관리는 행정 비용을 낮추고 산림 감독의 효율을 높인 사례이다.

A Comparative Analysis of Damage Characteristics of Damaged Facilities caused by Large Forest Fires in Pohang and Ulju

울주 · 포항 대형산불지역 전소피해 시설물들의 피해특성분석

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Abstracts

We conducted a field researches for a comparative analysis about forest fire damage characteristics of facilities within forest areas in Ulju-Gun. The forest fires in Ulju-Gun damaged 280ha of forest area and 57 facilities, and forest fires in Pohang damaged 79ha of forest area and 110 facilities during March 9th to March 10th, 2013. We investigated 25 facilities including 22 wholly damaged households, 2 vinyl greenhouses, and 1 warehouse from March to May, 2013. We looked at these factors: the geographical characteristics around damaged facilities, forest floor, a distance between forest and facility, whether or not crown fires are formed, and facility. In terms of geographical characteristics, Ulju had simple slope-shaped topography while Pohang had a valley-shaped terrain. Regarding forest floors, there were mainly coniferous forests in both regions. The distance between facilities and forest was 39.7m in Ulju-Gun and 3.1m in Pohang-Si. Crown fires only occurred in Pohang-Si. Facilities were made by slate, assembly-panels, and vinyl. Especially, in the case of Ulju-Gun, even though the distance forest was over 30m, some facilities were damaged from forest fires which were caused by spotting.

요 약

본 연구는 2013년 3월 9일부터 3월 10일 동안 280ha의 산림피해와 57동의 시설

물 피해를 준 울주산불과 79ha의 산림피해, 110동의 시설물 피해를 입힌 포항산불에 대하여 산림 내 시설물들의 산불피해 특성 비교 분석을 위하여 현장조사를 실시하였다. 조사대상물은 전소피해를 입은 주택 22개소, 비닐하우스 2개소, 창고 1개소 등 총 25개소에 대하여 2013년 3월부터 5월까지 현지조사를 실시하였다. 조사항목은 시설물주변의 지형적 특성, 임상 및 이격거리, 수관화 발생여부, 시설물의 재질 등 총 5개 항목에 대하여 피해특성을 분석하였다. 지형적 특성의 경우 울주는 단순사면형 지형이나 포항의 경우 골짜기막장형 지형이며, 주변임상은 울주, 포항 두 지역 모두 침엽수, 산림과의 평균 이격거리는 울주의 경우 39.7m, 포항의 경우 3.1m, 산불의 종류는 포항의 경우만 수관화 발생지역이었으며, 시설물의 재질은 울주, 포항 두 지역 모두 슬레이트, 조립식 판넬, 비닐인 것으로 조사되었다. 특히, 울주의 경우 시설물과 산림과의 이격거리가 30m 이상임에도 전소피해를 입은 곳은 비화에 의한 것으로 나타났다.

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A Recognition Analysis on Forest Fire Prevention Education for Residents in the SamCheok region

삼척 지역주민들의 산불방지교육 인식분석

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Abstracts

This researches were conducted a survey on 90 residents living in the Samcheok region in order to examine the recognition on forest fire prevention education. The questionnaire were consisted with 6 categories including a forest fire prevention education experience, questions about forest fire education, forest fire dangers factors around homes, a necessity of forest fire safety inspections, a recognition of laws related to forest fire, and a recognition of method for management and evacuation in case of a forest fire. 67 residents(74%) have experience with forest fire prevention education, and the most curious question on a forest fire prevention education was “how to evacuate when fire occurred(35 residents, 39%)”. Also, regarding forest fire dangers factors around home, 38 people(42%) answered that the rate of forest fire danger were “dangerous”, but in terms of the necessity for forest fire safety inspections, 55 people(61%) showed negative responses. In addition, in terms of the recognition of laws related to forest fire, only 29 residents(30%) answered a low recognition. Regarding of method fore management and evacuation in case of a forest fire, 20 people(22%) knew the method for management and evacuation.

요 약

본 연구는 산불방지 교육에 대한 인식을 알아보고자 삼척지역 주민 90명을 대상으로 산불방지교육 경험 유무, 산불교육 시 궁금한 점, 집 주변 산불위험성, 산불방

지 안전점검 필요성, 산불관련 법규 인식, 산불발생 시 대피 및 대처방법 등 6개 항목에 대하여 설문조사를 실시하여 분석한 결과 산불방지교육 경험 유무에서는 교육 경험이 “있다”가 67명(74%) 나타났으며, 지역주민들이 산불방지교육 시 가장 궁금한 점은 “주민 대피방법(35명, 39%)”으로 나타났다. 또한 집 주변 산불 위험성은 “위험하다”가 38명(42%)으로 많은 위험성을 인식하고 있었으나, 산불방지 안전점검 필요성 여부는 부정적인 인식이 55명(61%)으로의 산불방지 안전점검 필요성에 대한 인식이 낮은 것으로 조사되었다. 또한, 산불 관련 법규 인식에 대해서는 29명(30%)만이 응답해 산불 관련 법규에 대한 인식이 낮은 것으로 나타났다. 산불 발생 시 대피요령 및 대처방법에서는 20명(22%)이 대피요령 및 대처방법에 대해 알고 있어 대피 및 대처방법에 대한 인식도 낮은 것으로 나타났다.

ACKNOWLEDGEMENT

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Optimal Spatial Allocation of Initial Attack Resources in the Republic of Korea using a Scenario-based Optimization Model

시나리오 기반 최적화 모델을 이용한 초동 산불 진화 자원 배치 방안

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Abstracts

This study explores the optimal spatial allocation of initial attack helicopters in the Republic of Korea. We use spatially explicit GIS-based information on the ecology, fire behavior, and economic characterizations important in Korea. The data include historical fire events in the Republic of Korea during the last two decades, suppression costs, and spatial information of forest fire extent. Interviews with forest managers inform the range of objective functions and policy goals we address in the decision model. Based on this information, we create a modified optimization program to explore the Korean initial attack resource allocation decisions with a range of policy goals. The disparity of optimal fire policy exists between regions depending on their own characteristics (i.e., fire behavior, terrain, budget constraints, and policy goals). We conduct sensitivity analysis by varying parameters systematically. The information about the relative importance of components of the setting helps to identify “rules of thumb” about initial attack resource allocations in particular ecological or policy settings.

요 약

이 연구에서는 국내 산림진화 자원의 최적 배치 알고리즘을 개발하고자 하였다. 산불 진화 효율성 증대를 위해, 산불 발생 시 최초 대응 방안을 정의하였고 발생한 산불이 대형 산불로 확대되기 전에 조기 진압의 효과를 극대화하기 위한 최적 진화 자원 배치 모델을 개발하였다. 이 모델의 목적은 사전 약속 된 산불 진화를 위한

초기 대응 산불진화용 헬기를 최대한 많은 산불 발생 지역에 공급하는 것이다. 이를 위해, GIS 에 기반을 둔 산불 지리 정보 및 지역별 사회 경제적 특성에 대한 자료를 활용하였다. 이러한 산불 진화 자원 배치는 인명·재산 보호 혹은 천연생태구역 보호 등의 산불 진화의 정책 우선순위에 따라 달라질 수 있다. 따라서 이러한 정책 목표에 따른 최적 진화자원 배치 시스템에 대해 연구하였다. 또한, 민감도 분석을 통해 예산 증감 등 주요 정책 변수 값의 변화에 따른 결과 변화를 분석하였다. 산불 진화 자원 배치의 효율성 증대를 위한 최적 방안을 제시함으로써 산불 진화 자원 활용 능력을 현격히 개선할 것으로 기대된다.

Analysis of Burn Severity in Large-fire Area Using Satellite Imagery

위성영상자료를 이용한 대형산불지역의 피해강도 분석

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Forest fire is a dominant large-scale disturbance mechanism in the Korean temperate forest, and it strongly influences both forest structure and function. Moreover, burn severity incorporates both short- and long-term post-fire effects on the local and regional environment. Burn severity is defined as the degree to which an ecosystem has changed owing to the fire. Vegetation rehabilitation may specifically vary according to the burn severity after a fire. To understand burn severity and process of vegetation rehabilitation at the damaged area after large-fire is required a lot of man powers and budgets. However, the analysis of burn severity in the forest area using satellite imagery can acquire rapid information and more objective results remotely in the large-fire area. Space and airbone sensors have been used to map the area burned, assess characteristics of active fires, and characterize post-fire ecological effects. Composite Burn Index(CBI) developed by USDA Forest Service is an index that measures burn severity based on remote sensing techniques.

For classifying fire damaged area and analyzing burn severity of a total of six large-fire area damaged over 100 ha from 2009 to 2012, I utilized supervised classification, unsupervised classification and Normalized Difference Vegetation Index(NDVI) techniques. In this paper, it used post-fire imagery from SPOT, IKONOS, RapidEye imagery to compute the Maximum Likelihood(MLC), Minimum Distance(MDC), ISODATA, K-means, NDVI and evaluate large-scale patterns of burn severity from 1m to 5m spatial resolution. The result of the accuracy

assessment on burn severity from satellite images showed that average overall accuracy was 88.12% and the Kappa coefficient was 0.83.

요 약

본 연구에서는 최근 발생한 100ha 이상의 대형산불 피해지 6지역을 대상으로 하였으며, 대형산불 피해지역의 피해강도를 평가하기 위해 현장조사와 고해상도 위성영상자료 분석을 병행하였다. 위성영상자료 분석 시 산불피해지역의 피해강도를 가장 적절하게 평가할 수 있는 영상분류기법들을 비교 분석하여 최적의 피해강도 평가방법을 선정하였다. 대형산불 피해지역의 최적의 피해강도 평가기법으로는 현장조사에서 획득한 트레이닝 지역의 정보를 이용한 최대우도법(MLC)을 적용하였을 때 가장 좋은 평가결과를 보였다. 대형산불 피해지 6개 지역을 대상으로 추출된 산불피해강도의 정확도 검증 결과, 평균 전체정확도는 88.12%와 Kappa coefficient는 0.83으로 나타났다. 이는 현장조사 자료를 Training site로 반영한 결과이며, 분류정확도는 최대우도법(MLC), 최소거리법(MDC), NDVI 순으로 나타났다. 또한 NDVI 분석결과도 피해강도의 상관성이 높아 현장조사 미 수행으로도 신속하게 산불피해지의 피해강도 평가가 가능할 것으로 판단된다.

Effects of Forest Fires on Forest Ecosystems in Eastern Coastal Areas of Korea and Overview of Restoration Projects

동해안지역 산불이 산림생태계에 미치는 영향과 복원사업 개요

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Large forest fire incidents have recently highlighted the importance of restoring forest ecosystems changed by fire. Restoration principles are based on the integration of ecological, social, and economic factors. Damage from fires in Korea is particularly extensive among pine trees, and trees with thin bark are most severely damaged. In areas where the defenses of fire-damaged trees are weakened, Curculionid beetles are flourishing. In an effort to restore vegetation, natural restoration projects aimed at promoting sprout growth have been conducted in forests where the canopy remains alive, and artificial restoration projects where pine trees are planted at the request of local residents have been undertaken in forests where the canopy is dead. However, because of the high risk of fire occurrence in these pine forests, an ecosystem restoration plan has been implemented in such areas involving the installation of fuel breaks to reduce the risk of fire incidence. These efforts to restore vegetation in burned areas have been evaluated positively.

요 약

최근 대형산불의 발생으로 산림생태계 복원의 중요성이 대두되고 있다. 현재 동해안 지역의 산불피해지 복원 사업은 생태적·사회적·경제적 측면을 고려하여 실시되고 있다. 산불 피해는 불에 잘 타는 소나무림에서 크게 나타났고, 특히 수피가 얇은 개체가 많은 피해를 받았다. 산불피해지에는 쇠약한 나무가 많이 존재하기 때문에 바구미류가 많이 서식하고 있었다. 산불피해지에서는 우선 식생회복을 위해 산불피해가 적은 활엽수림에서는 맹아발생을 촉진하는 자연복원기법과 산불피해가 많은

침엽수림에서는 지역 주민의 요구에 의해 소나무를 조림하는 인공복원기법이 실시되었다. 산불피해지에서 식생회복에 대한 평가는 매우 성공적이라고 평가되고 있다. 그러나 대규모 소나무림 조림지에서는 대형 산불 발생 가능성이 높기 때문에 방화수림대를 조성하여 송이 생산과 더불어 산불 재해를 저감시키기 위한 생태계 관리기법이 시도되었다.

Reduced Soil Erosion by Making Contour-Felled Log Erosion Barriers in Burned Areas by Massive Forest Fires in Eastern Coastal Regions of Korea

동해안 산불피해지에서 벌채목 가로쌓기에 의한 토양침식 저감 효과 분석

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The purpose of this study was to examine the effects of forest fire on physical properties of soil and reduction in soil erosion by making contour-felled log erosion barriers using withered trees in burnt area. It was observed that the bulk densities of surface soil in the burned areas increased due to exposed inorganic material produced by the combustion of litter layer. The loss of colloidal organic matter in surface soil by fire was accompanied by a reduction in mesopore ratio in the surface layers. The destruction of soil structure by forest fire led to an increase in the bulk density with apparent reduction in the porosity of the surface soils, thereby making the soil more vulnerable to post-fire runoff and hill slope erosion. Contour-felled log erosion barriers refers to felling of logs on burned-over hillsides and laying them on the ground along the contour to provide mechanical barriers to water flow, promote infiltration and reduce sediment movement. In making contour-felled log erosion barriers using withered trees in burned areas, there was about 8 times reduction in average sediment yield, which was 133.6 g m^{-2} at the no-treatment site and 17.8 g m^{-2} at the test site.

요 약

본 연구는 산불이 토양물리성에 미치는 영향과 피해목 가로쌓기에 의한 토사침식 저감 효과를 분석하였다. 산불피해지에서는 유기물의 연소로 인하여 표층의 토양밀도는 증가하였고 토양 조공극률은 감소하였다. 이러한 토양물리성 악화는 산불피해 이후 토양의 강우 침투를 악화시켜 토양침식이 발생하기 쉬운 환경을 제공하는 것으로 분석되었다. 그러나 산불피해에 의한 벌채목을 등고선 방향으로 쌓으면(벌채목 가로쌓기) 강우의 지표유출과 토사유출이 감소되는 경향을 보였다. 특히 벌채목 가로쌓기를 실시하지 않은 시험구(n=3)의 평균 토사유출량은 133.6 g m^{-2}인데 반해 가로쌓기 시험구(n=3)는 17.8 g m^{-2}였다.

Development of Spatial Analysis Technique for Evaluating Optimal Location of Forest Fire Suppression Facilities

산불진화시설 적지 선정을 위한 공간분석기법 개발

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Abstracts

Optimal location for forest fire prevention and suppression resources is important to reduce the risk of forest fire damage. In this study, I developed the priority order system for optimal location of forest fire suppression facilities using geographic information system (GIS). Forest fire occurrence probability, density of forest fire from 1991 to 2012, crown fire propagation probability and suppression environmental index are used to calculate the priority order of study area. It has to be high priority order where forest fire is likely to be occurred and propagated. And it is used density of forest fire and forest fire occurrence probability, when the crown fire propagation probability is equal. The result of this, the northern area of the valleys ranging south and north in study area is highest priority area. The southern area of the valleys has low priority. Because it has high suppression environmental index, even though the high crown fire propagation. It could be easy to allocate the forest fire suppression facilities based on this priority order system.

요 약

산불 예방 및 진화 자원의 효율적인 배치는 산불의 조기 진화를 통한 산불 피해의 저감에 기여할 수 있다. 본 연구에서는 공간 분석 기법을 이용하여 산불 진화 시설의 적지를 선정하는 방법을 개발하였다. 이를 위하여 대상지의 산불 발생과 확산 위험성, 진화 환경 지수를 활용한 임상 패치의 순위결정체계를 고안하였다. 순위결정체계는 일차적으로 수관화확산 위험이 높고, 진화 환경이 열악한 곳이 높은 순위를 갖도록 설정되었다. 수관화확산 위험이 같을 경우, 산불 밀도가 높은 곳, 또는 산불 발생 확률이 높은 곳이 우선되도록 동점 처리를 하였다. 경주를 대상으로 우

선 순위를 산출한 결과, 남북을 가르는 구조선을 따라 북부 지역의 순위가 높게 나타났다. 남부 지역의 경우 산불 위험은 비교적 높지만, 진화 환경이 우수하여 상대적으로 낮은 순위가 산출되었다. 연구 결과를 활용하여 보다 합리적인 산불 진화시설의 배치가 가능할 것으로 기대된다.

Development of the Checklist for Optimal Location of Forest Fire Suppression Tower

산불소화시설 설치 후보지 평가표 개발

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Forest fire suppression towers were mounted in Korea by Korea Forest Service(KFS) in 2012. The forest fire suppression tower is to be expected to protect it's facility by spraying over the tree crown. It must be mounted in high forest fire risk area, but it is hard to find which area is dangerous. In this study, we developed the checklist for evaluating the location of forest fire suppression tower. The checklist is generated to consider the conformity with KTS's guideline, forest fires risk, crown fire propagation risk, damage from fire and suppression environment of location. It is consisted of ten factors including forest type, distance to coniferous, wind speed and slope. Each factor is classified several class and has weighted values. We determined the critical value which is could establish the tower using the average and standard deviation of the area mounted in 2012. This checklist could be used for decision making which area is the more conformity, and gives rational reason.

요 약

2012년 산림청은 전국에 20여 개의 산불소화시설을 설치하였다. 산불소화시설은 산불발생시 수관화확산을 억제하여 특정 시설을 보호하는데 목적이 있다. 고가의 장비에 해당하는 산불소화시설은 무엇보다 산불확산의 위험성이 크다고 판단되는 지역에 한하여 설치되어야 하지만, 현장에서 평가할 수 있는 객관적인 방법이 없어 어려움을 겪어왔다. 이에 본 연구에서는 후보지가 적합한지 판단할 수 있는 현장 체크용 평가표를 작성하였다. 평가표는 보호대상의 적합성 여부와 산불발생 위험, 수관화확산 위험성, 피해 위험성, 진화환경 등 산불위험을 비롯하여 주변 환경을 종

합적으로 검토하도록 설계하였다. 평가인자는 주변 임상, 침엽수림과의 거리, 풍속, 사면경사 등을 포함하는 총 10개의 인자로 구성되어 있다. 각 인자는 몇 개의 등급으로 나뉘며, 산불과 관련된 그 동안의 문헌들을 참고하여 등급별 가중치를 결정하였다. 2012년 설치지 7개 지역에 대한 현장 답사 및 평가를 통해, 설치여부 결정의 한계 점수를 평균과 표준편차를 이용하여 정하였다. 개발된 평가표를 활용하여 산불소화시설 설치에 대한 객관적인 근거 제시 및 설치여부의 판단이 가능할 것으로 판단된다.

Validation of Korean Composit Burn Index(KCBI)

한국형 산불피해강도지수(KCBI)의 검증

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KCBI (Korean Composite Burn Index) was developed on the basis of CBI of USDA Forest Service to measure burn severity using remote sensing technique. However, its applicability in Korean environments was not fully verified yet. In this light, this study was conducted to verify the applicability of KCBI. Haemi burned in 2012 were selected as study area, and fifteen sampling plots were assigned for field survey. Burn severity of study areas were estimated by analyzing NDVI from Rapid Eye Images. Applicability of KCBI was verified with correlation analysis between KCBI index values and NDVI values, and their validity was tested with a confusion matrix. The correlation coefficient between KCBI index values and NDVI values were r= 0.841. This result supported that proposed KCBI is adequate index to measure burn severity of fire sites in Korea. However the confusion matrix suggests that there is significant difference between NDVI and KCBI values of low and moderate severity. Despite of this discrepancy, the proposed KCBI showed high potentials for estimating burn severity of fire sites in Korea, and could be improved by considering the limitations in further studies.

요 약

한국형 산불피해강도지수(KCBI, Korean Composite Burn Index)는 미국 산림청(USDA Forest Service)에서 개발한 산불피해강도지수(CBI, Composite Burn Index)를 기초하여 국내 여건에 맞게 개발한 한국 산불피해 현장 조사 지수이다(이현주 등,2012). 본 연구는 개발된 KCBI를 이용한 현장 산불피해강도 등급과 위성영상과

의 검증을 통하여, 국내 산불 피해 지역에 적용 가능성을 확인하기 위하여 수행되었다. 2012년도 산불 피해지 중 상대적으로 피해 규모가 큰 해미지역을 연구 대상지로 선정 후, 15개 지점에서 산불피해강도를 평가하였다. RapidEye영상을 활용하여 NDVI(Normalized Differnce vegetation Index)로 계산된 값과 현장 산불피해강도 등급과의 상관분석, 오류메트릭스(Confusion Matrix)를 이용하여 유효성을 검증하였다. 분석결과 r= 0.841으로 국내 산불 피해 현장에서 적용 가능 한 것으로 나타났지만, 오류매트릭스 결과 피해경과 피해중 지역에서 위성영상 NDVI값과 현장 KCBI등급과의 차이를 보였다. 따라서 이러한 점을 보완하여 향후 보다 많은 한국 산불피해 지역에 적용함으로써, 추후 연구를 진행해야 할 것이다.

The Classification of Burn Severity using Rapid Eye image and Estimation of Emissions of Greenhouse Gases According to IPCC and domestic combustion efficiency from Biomass burning at Pohang Korea

RapidEye 영상을 이용한 포항지역 산불피해등급 구분과 IPCC와 국내 연소효율 비교에 따른 산불로 인한 온실가스 배출량 추정

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Abstracts

The study was performed to estimate the emission of greenhouse gases (GHGs) from biomass burning at a forest fire. The classes of burn severity were extracted from RapidEye image of forest fire site occurred at Pohang on May, 2013. Burn Severity based on field survey data on forest fire damage were classified using the Maximum likelihood method. The combustion efficiency for burn severity was calculated as 0.43 for crown fire where burn severity was 'Extreme' and 'High' as 0.40 for 'Moderate' as 0.15 for 'Low' surface fire and 'Unburn'. Also This study was developed domestic combustion efficiency for burn severity. These indexes were calculated as 0.36 for crown fire where burn severity was 'Extreme', 'High' as 0.34 for 'Moderate' as 0.31 for 'Low' as 0.20 surface fire and 'Unburn'. The emission factors for estimating were separately applied to CO_2 1,580, CO 130, CH_4 9, NO_x 0.7, and N_2O 0.11. To estimate GHGs emission from biomass burning, methodology adopted the IPCC Guideline (2006) equation. Finally, GHGs emissions from biomass burning in Pohang area were estimated to be applied IPCC combustion efficiency CO_2 23,399, CO 1925, CH_4 133, NO_x 10.36, N_2O 1.62 $g/kg^{-1} \cdot ha^{-1}$ and applied domestic combustion efficiency CO_2 25,399, CO 2,125, CH_4 147, NO_x 11.44, N_2O 1.79 $g/kg^{-1} \cdot ha^{-1}$.

요 약

본 연구는 RapidEye 위성영상을 이용하여 산불피해지역을 5등급으로 분류하여 각각의 면적과 산불로 인하여 배출되는 온실가스의 량을 추정을 하기 위함이다. 2013년 3월 9일에 발생한 포항지역의 RapidEye 영상을 활용하여 산불피해등급을 추출하였다. 피해등급 구분은 산불피해지의 현장조사 자료를 기반으로 최대우도법(Maximum Likelihood)을 이용하여 구분하였다. 연소량은 현장조사 자료를 바탕으로 작성된 층위별 연료량 분포지도를 사용하였고 연소효율은 수관전소 '0.43', 수관열해와 피해중 '0.40', 피해경 '0.15' 미피해로 적용하였다. 또한 이번 연구에서는 새로이 국내 연소효율을 개발하여 적용해 보았다. 연소효율은 수관전소 '0.36', 수관열해 '0.34', 피해중 '0.31', 피해경 '0.20' 미피해로 적용하였다. 배출계수는 CO_2 1,580, CO 130, CH_4 9, NOx 0.7, N_2O 0.11을 적용하였다. 온실가스 배출량을 예측하기 위해 IPCC(2006) 에서 권고하는 추정식(L_{fire} = A*B*C*D*10^{-3})을 채택하였다. 포항지역의 온실가스 배출량은 IPCC 연소효율을 적용하였을 때, 각각 CO_2 23,399, CO 1,925, CH_4 133, NOx 10.36, N_2O 1.62 $g/kg^{-1}{\cdot}ha^{-1}$으로 도출되었고, 국내 연소효율을 적용하였을 때, CO_2 25,833, CO 2,125, CH_4 147, NOx 11.44, N_2O 1.79 $g/kg^{-1}{\cdot}ha^{-1}$으로 도출되었다.

Spray Characteristics of Water Supply System for Forest Fire

산불 소화시설의 살수 특성분석

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Abstracts

Yangyang and east coast wildfires, large-scale forest fire gives a great loss to the forest ecosystem, the cultural heritage and architecture. To prevent loss due to a large wildfire was installed the wildfire extinguishing. This study was conducted to analyze the relationship of the pump pressure and the efficiency in the installed wildfire extinguishing area. A field survey conducted the 7 area(goesan, bonghwa, daegu, miryang, hamyang, geochang, yeosu). It was analyzed the average distance, area, effect of wind and output of the pump pressure. The average distance is 30~35m, injection area was 500~1,100㎡ each 1 tower. Under the influence of wind the actual distance was at least 25m, up to 50m range. The output of pump pressure was 2.8~20.0kg/㎡. The wildfire extinguishing was showed a similar trend at the average distance of major axis and minor axis by wind. The difference between the pressure of the injection pump, but did not cause significant differences in the distance. The injection distance was related the topographical and nozzle diameter as well as the pump pressure. The analysis of these factors is considered to be necessary.

요 약

양양산불과 동해안산불과 같은 대형 산불은 산림생태계뿐만이 산에 존재하는 문화재나 건축물에 큰 손실을 준다. 이러한 대형 산불로 인한 손실을 막기 위해 산불 소화시설을 설치하였다. 본 연구는 산불 소화시설을 설치한 지역의 현장조사를 통해

펌프 압력과 성능의 관계를 분석하기 위해 실시하였다. 현장조사는 총 7곳(괴산, 봉화, 대구, 밀양, 함양, 거창, 여수)을 실시하였다. 산불 소화시설에서 분사되는 평균거리와 면적, 바람의 영향, 펌프 출력을 분석하였다. 타워 1개소에서의 평균거리는 30~35m, 분사 면적은 500~1,100㎡이었다. 바람의 영향에 따라 최소 25m, 최대 50m까지 분사거리를 보였다. 펌프의 압력은 2.8~20.0kg/㎡이었다. 산불 소화시설은 바람의 영향으로 장축과 단축이 발생하지만 평균거리에서는 비슷한 경향을 보였다. 펌프의 압력은 차이가 있었으나 분사 거리에서 큰 차이는 발생하지 않았다. 분사 거리는 펌프의 압력뿐만이 아니라 지형적인 요인과 노즐 직경과 관계가 있다. 이러한 요인들에 대한 분석이 필요할 것으로 판단된다.

Effect of Thinning Intensity on Fuel load of Surface and Shrub layer

간벌 강도에 따른 지표와 관목연료의 연료량 변화

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The fuel load of litter and shrub in forest can be transferred from surface fire to crown fire in the wildfire. This study was conducted to analyze changing the fuel load of litter and shrub in accordance with thinning intensity(100tree/ha, 200tree/ha, 300tree/ha, Control) in Gangwon-do Jeongsun-gun, samchuck-city. The analysis of the amount of fuel in 2010 and 2013 were compared. The fuel was calculated by drying After litter in the surface and shrub in the middle layer collect. When the fuel load in 2010 and 2013 were compared, the middle layer was decreased average 60%, the surface was decreased average 70% in jeongsun. When the fuel load in 2010 and 2013 were compared, the middle layer was decreased average 20%, the surface was increased 60% except 100tree/ha in samchuck. The middle layer decreased the fuel load and the potential of the transfer crown fire after thinning treatment in the area. The surface decreased the fuel load and the potential of the transfer surface fire after thinning treatment in the jeongsun, but increased the fuel load and the potential of the transfer surface fire after thinning treatment in the samchuck.

요 약

산림의 지표연료와 관목층은 산불이 발생했을 때 지표화가 수관화로 전이될 수 있는 중간 연료이다. 본 연구에서는 강원 정선, 삼척에서 간벌 강도(100본/ha, 200본/ha, 300본/ha, 대조구)에 따른 지표와 관목연료의 변화를 분석하기 위해 실시하였다. 분석 방법으로 2010년과 2013년의 연료량을 비교하였다. 지표층은 낙엽, 중층은 관목을 채집한 후 건조하여 연료량을 계산하였다. 2010년과 2013년을 비교했을때

정선지역 중층은 평균 60%, 지표층은 평균 70% 감소하였다. 삼척은 관목층은 평균 20%감소, 지표층은 100본/ha만 감소하고 다른 처리구 평균 60% 증가하였다. 간벌 처리를 실시한 후에 중층은 두 지역 모두 연료량이 감소하여 수관화로의 전이 가능성이 감소하였다. 정선지역의 지표층은 연료량이 감소하여 지표화의 확산위험이 감소하였으나 삼척지역의 지표층은 연료량이 증가하여 지표화 확산위험이 증가하였다.

The Impact of Weeding Frequency and Drainage on Seed Germination and Mortality of Red Pine (*Pinus densiflora*) Seedlings in Mt. Gariwang

제초작업 빈도와 배수처리가 소나무 종자 발아와 치수 고사에 미치는 영향

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Abstracts

This study aims to investigate the impact of weeding frequency and drainage on seed germination and mortality of red pine (*Pinus densiflora*). Total 40 subplots were established in open field area in Mt. Gariwang where mother tree treatment was implemented in 2008. On May, seeds were directly sawn in 28 points per a subplot and the distance of each point was about 40cm. For drainage treatment 30-40cm depth-drainage channel were dug along the subplot. Weeding treatments, once (on July), twice (on July and August), thrice (on July, August, and September), were implemented with control, no weeding. Seed germination was observed in every month, from June to Oct. Mortality of seedling were calculated by counting number of dead seedlings among germinated seedlings. Seedling mortality was shown no statistical difference between control and drainage treatment ($p>0.05$) except July. On July, germination ratio of the drained treatment (4.55 ± 0.71 %) was twice higher than that of control (2.60 ± 0.60 %) ($p=0.04$). Among different frequent weeding treatments, the highest mortality was of control (31.00 ± 5.87 %). Mortality of once, twice and thrice was 18.70 ± 3.36 %, 14.20 ± 2.41%, 13.75 ± 2.45 %, respectively ($p=0.006$)

요 약

본 연구의 목적은 소나무림 갱신과 관련하여, 제초작업빈도와 배수처리가 소나무

종자 발아와 치수 고사에 미치는 영향에 대해 밝히고자 함이다. 연구대상지는 2008년 모수작업을 실시한 가리왕산 163임반 소나무림으로 기존 하층식생을 낫으로 모두 제거한 뒤, 40개의 처리구를 설치했고, 한 처리구내에 40cm 간격으로 28개(4줄 x 7칸)의 구멍을 내어 소나무 종자를 점파했다. 배수 처리구에는 깊이 30cm이상의 배수로를 설치하였고, 대조구(파종이후 제초하지 않음)를 제외한 처리구에서는 제초빈도를 1회(7월), 2회(7,8월), 3회(7,8,9월)로 하여 실시했으며, 이때, 발아묘를 손상시키지 않도록 유의하여 제초하였다. 발아율은 6월부터 10월까지 매 월 1회, 고사율은 발아가 확인되었던 치수 중 고사한 것을 7월부터 10월까지 매 월 1회씩 조사하여 산출했다. 7월에는 배수 처리한 곳(4.55±0.71%)과 배수 처리하지 않은 곳(2.60 ± 0.60 %의 발아율이 약 2 배 차이를 보였다($p=0.04$). 제초작업빈도 별 고사율은 대조구가 31.00±5.87%로 가장 높았고, 제초 1회, 2회, 3회 실시 처리구가 각각 18.70±3.36%, 14.20±2.41%, 13.75±2.45%로 그 뒤를 이었다($p=0.006$).

The Forest Climate Monitoring System –
The Total Management System of Mountain Weather Information

산림기후 모니터링 체계 구축 -
산악기상정보 종합관리 시스템 구축

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Abstract

This study was performed to monitor the network of mountain weather station and collect and control the observation data base. As the web based total management system of mountain weather station was built, central and local governments could prepare a countermeasure by analyzing forest disasters correctly with reliable and specified mountain weather information. Also, real time monitoring system could help effective operation and management of mountain weather network. The database schema of this system was designed considering the construction of GIS-based specific mountain climate-weather information supporting system and next extension. The monitoring system watches the reception of observation data and sends the SMS message to the person in charge in case of errors. Furthermore, mobile web is developed to check and monitor the data frequently. In 2012, the mountain weather network was established on 30 stations over Gangwon and Kyongbuk. In 2013, it is being established on 30 stations over Yeongseo section of Gangwon, Chungbuk and Kyungnam.

요 약

본 연구는 산악기상망 구축에 따른 전국 산악기상관측망 운영감시, 관측자료 수집, 자료 관리 등을 하기 위함이다. Web 기반으로 산악기상정보 종합관리 시스템 구축을 통해 고품질의 상세 산악기상기후정보를 제공하고 이를 활용하여 정확한 산림재해정보를 해석함으로써 중앙정부 및 지자체 등에서 대응전략 수립이 가능하다. 또한 실시간 운영상태 모니터링 시스템을 구축하여 효과적인 산악기상관측망 운영

및 관리가 가능하다. 산악기상정보 종합관리 시스템은 GIS 기반 상세 산악기상기후 정보 생산 지원체계 구축을 고려하여 DB schema 및 설계가 되었으며 추후 확장성도 고려되었다. 모니터링 시스템은 관측자료 수신 현황이 파악 가능하도록 구성되었으며 문제 발생시 담당자에게 SMS가 발송된다. 또한 스마트폰의 보급과 더불어 상시 자료 확인 및 모니터링을 위하여 Mobile Web도 개발되었다. 현재 산악기상정보망은 2012년 강원 및 경북지역에 30대, 2013년 강원영서, 충북, 경남지역에 30대가 설치되고 있다.

Development of Modeling System for Simulation of High-resolution Wind Fields over Mountain Areas

산악 지역 고해상도 바람장 모의를 위한 모델링 시스템 개발

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Abstracts

In this study, we developed a modeling system for simulation of mountain micrometeorological fields (e.g., high-resolution wind fields). Accurate prediction of wind, relative humidity, and rainfall is essential for coping with disasters over mountainous areas such as forest fire and landslide. The modeling system is based on the Weather Research and Forecasting (WRF) model, Microscale Urban Climate Model (MUKLIMO), and WRF Data Assimilation (WRFDA). Physics schemes for running the WRF model were determined from sensitivity experiments. Input wind speed/direction for the MUKLIMO model were obtained from the WRF output, and topographic height from Digital Elevation Model (DEM) data, and foliage height/leaf area density from KFRI data archive were also considered. Through dynamic downscaling, the simulated wind fields over two test beds (Gyeongbook and Gangwon) were improved both for forest fire and heavy rainfall cases. Assimilation of surface observations resulted in the improved WRF simulation results and MUKLIMO results.

요 약

본 연구에서는 산악 지역 미기상 요소의 모의를 위한 모델링 시스템을 개발하였다. 바람장, 습도, 강수량과 같은 산악 미기상 요소의 정확한 예측은 산불 혹은 산사태 등 산림 재해 예방 및 대응에 있어 필수적이다. 모델링 시스템은 중규모 모형인 WRF 모형, 미세규모 모형인 MUKLIMO 모형, 그리고 자료 동화 체계인 WRFDA를 기반으로 한다. WRF 모형의 수행을 위한 물리 과정의 조합은 민감도

실험으로부터 결정하였다. MUKLIMO 모형은 원래 진단 모형이지만, WRF 모형의 결과물을 MUKLIMO 모형 수행을 위한 입력 자료로 사용함으로써 예단 모형으로 사용할 수 있다. MUKLIMO 모형 수행을 위한 지형 자료는 DEM 3초 해상도 자료로부터, 그리고 수목 자료는 국립산림과학원의 수종 및 수령 자료로부터 획득하였다. MUKLIMO 모형을 이용하여 역학적 다운 스케일링 과정을 거치면, WRF 모형의 모의 결과에 비해 관측에 가까운 바람장을 얻을 수 있었다. 또한 AWS 관측 자료의 동화를 통해, WRF 모형의 모의 결과가 향상되고 나아가 MUKLIMO 모형의 모의 결과 또한 향상되었다. 본 연구를 통해 개발된 시스템을 통해 약 1 km 해상도의 온도, 습도, 강수량 모의 결과, 그리고 약 100 m 해상도의 바람장 모의 결과를 얻을 수 있다.

The Flammability of MDF and Particleboard using a Cone Calorimeter

콘칼로리미터 의한 MDF와 파티클보드의 연소특성 분석

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Abstracts

The increasing demand for wood based materials in building and interior materials has prompted concerns regarding their combustibility. This study examined the combustion characteristics of MDF and particleboard using a conecalorimeter according to the KS F ISO 5660-1 specifications. The combustion characteristics of the MDF and particleboard were measured such as the time to ignition (TTI), heat release rate (HRR), total heat release (THR), smoke production rate (SPR) under a fire condition. The results demonstrated that TTI affected by coating material on MDF. The HRR and THR showed variations between the wood based materials on construction elements and surface materials.

요 약

건축재와 실내 마감재로서 목질재료의 사용이 증가하면서 이들 재료의 연소 특성에 대한 관심 또한 증가하고 있다. 본 연구는 KS F ISO 5660-1기준에 따른 콘칼로리미터로 실내 사용 MDF 및 파티클보드의 연소특성을 분석하였다. 콘칼로리미터에서 50KW로 30분간 연소하여 점화시간, 열방출률, 총방출열량, 가스발생량 데이터를 비교 분석하였다. 점화시간은 코팅재에 따라 차이를 보였으며 열방출률은 보드의 구성재료의 입자 크기 및 표면재료에 따른 차이를 볼 수 있었다. 총방출열량은 시간의 경과에 따른 재료적 차이가 미미하였으며 열방출율 분석 추이와 같은 경향을 보였다. 가스발생량은 열방출률과 상관관계가 없이 나타나 가스발생량은 연소 시 열량의 크기와 관계없이 구성요소의 연소적 특성과 관계가 있음을 알 수 있었다.

A study on the Development of Standard Diagnostic Table for Chestnut Management and its Applicability

밤나무 경영 표준진단표의 개발 및 적용

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Abstracts

This study aims to develop a standard diagnostic table for chestnut cultivators so that they can check their current level of management and administration, understand and address operational challenges better by themselves utilizing the table. The most important thing in developing the table is to select items and allocate scores to each selected item. It is also significant that the standard diagnostic table should be composed of simple and clear questions that not only respondents can easily understand and answers, but also researchers can easily figure out characteristics of cultivation that the respondents do. After the consultant of the advisory groups including researchers and leading chestnut cultivators, the study developed the standard diagnostic table composed of a questionnaire with 3 categories and 19 subcategories.

Then, to review the field applicability of the table, the study conducted a survey on 245 forestry households throughout more than 8 regions. According to the survey result, the average score was 63.8 with its highest of 86.0 and the lowest point of 27.4, respectively.

요 약

본 연구에서는 밤나무 재배 임가의 경영주가 스스로 현재의 경영 상태를 체크하여 어느 정도 수준에 위치해 있는지 파악할 수 있도록 하고 현재보다 상위의 목표를 설정하여 발전해 나갈 수 있도록 밤나무 경영 표준진단표를 개발하여 활용하고자 하였다. 밤나무 경영 표준진단표의 개발에서 가장 중요한 것은 진단항목의 선정과 배점이라고 할 수 있다. 표준진단표는 재배자가 내용을 쉽게 이해할 수 있고 체

크하는데 어려움이 없도록 간단하게 만들어야 하며 동시에 재배자의 경영특성을 정확하게 파악할 수 있는 항목들로 구성해야 한다. 표준진단표의 작성을 위해 밤 관련 연구자와 밤 주산단지의 선도임가를 전문가로 선정하여 자문회의를 거친 후 3개의 대분류 항목과 19개의 중분류 항목으로 구성되는 밤 경영 표준진단표를 개발하였다.

밤나무 경영 표준진단표의 현지적용성 검토를 위하여 8개 지역에서 조사한 245개 임가를 대상으로 결과 분석하였다. 표준진단표의 총점은 각 평가 인자 항목의 점수를 합계하여 산출하였는데 전체 임가의 평균 점수는 63.8점, 최고점은 86.0점, 최저점은 27.4점으로 나타났다.

A study on the Development of Standard Diagnostic Table for Oak Mushroom Management and its Applicability

표고버섯 경영 표준진단표의 개발 및 적용

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Abstracts

This study aims to develop a standard diagnostic table for oak mushroom cultivators so that they can check their current level of management and administration, understand and address operational challenges better by themselves utilizing the table. The table is composed of a questionnaire with 4 categories and 20 subcategories to check the overall status of forestry households, the performance indicators and the management level. These categories are also divided into the four sections of growing environment, vaccination management, cultivation management and administration. To prepare the standard diagnostic table, surveys on 350 forestry households throughout 4 regions – Gyunggi-do, Chungcheong-do, Gyeongsang-do, and Jeolla-do were conducted and utilized in the result analysis. According to the result, the average point was 63.1 with more than half of the respondents, 63.9%, ranging from 60 to 80. Considered by regional group, the average score of Chungcheong-do and Gyunggi-do, 66.7 and 64.9 point respectively, were somewhat higher than that of Gyeongsang-do and Jeolla-do, 59.4 and 60.9 point respectively, which shows a disparity between central and southern region.

요 약

표고버섯 재배 임가가 본인의 경영 수준을 진단하여 문제점이 무엇인지 파악할 수 있도록 하고 이를 개선해 나갈 수 있도록 경영 표준진단표를 개발하여 활용하고자 하였다. 경영 표준진단표는 임가의 일반 현황과 경영성과 지표, 그리고 경영수준

진단을 위한 4개의 대분류 항목 및 20개의 중분류 항목으로 구성하였다. 대분류 항목은 재배환경, 접종관리, 재배관리, 경영관리의 4개 항목으로 구성되어 있다. 표고버섯 경영 표준진단표의 작성을 위해 경영 실태 조사를 실시하였으며 경기도, 충청도, 경상도, 전라도 지역의 350개 임가가 조사에 응답하였다. 전체 임가의 평균 점수는 63.1점으로 나타났으며 조사 임가의 절반 이상인 63.9%가 60점 이상 80점 미만에 해당하는 것으로 나타났다. 지역별로 살펴보면 충청도, 경기도의 평균점수가 각각 66.7점, 64.9점으로 경상도의 59.4점, 전라도의 60.9점과 비교하여 높은 수준으로 나타나 중부 지역과 남부 지역간 다른 모습을 보이는 것을 알 수 있었다.

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A Study on the Forest Reserve System of North Korea

북한의 보호림제도 연구

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Abstracts

So far, North Korea has declared and protected some scenic attractions - Mt. Baek-du, Mt. Geumgang, Mt. Myo-hyang - as forest reserves and biological reserves. Forest reserve refers to an area of forest land designated and maintained by the state, which is worth preserving for its public services. Biological reserve, also designated and managed by the state, means an area containing primitive forest and/or scenic beauty. Seven areas have been selected as biological reserves and two of them, Mt. Baek-du and Mt. Gu-wol were also registered as UNESCO's biosphere reserve areas in 1985 and 2004, respectively. While the authorities ban the public to do certain kinds of personal land uses such as felling, depasture and gathering in forest reserves and biological reserves, they recently have shown efforts to develop these areas by opening resort and camping area for the public and developing tourism complex for foreigners. In this sense, policies for environmental protection and forest fire are further required as the development proceeds at the national level.

요 약

북한은 백두산과 금강산, 묘향산과 같은 명승지를 각종 보호림과 자연보호구로 지정하여 보호하고 있다. 보호림은 산림의 공익기능 유지를 위해 필요하다고 인정하는 산림을 지정·관리하는 것이다. 자연보호구는 원시림이나 경관이 좋은 지역을 지정하여 국가의 직접적으로 관리하는 곳으로 현재 7개가 지정되어 있으며, 백두산과 구월산은 1985년과 2004년 유네스코의 '생물권 보호구'로 등록되었다.

보호림과 자연보호구로 지정된 산림은 벌채와 방목, 채취 등 개인적인 이용을 금지하지만, 휴양소와 야영장을 만들어 주민들의 공공 휴양시설로 이용되고 있다. 또한 최근에는 외국인을 대상으로 한 관광단지를 개발하고 있다. 이처럼 국가적인 산림환경 개발에 따른 환경보호정책과 산불관리정책의 필요성이 요구되고 있다.

ODA Contents Development for Prevention of Forest Fragmentation

-Focusing on Capacity Building in Developing Countries -

산림 파편화 방지를 위한 ODA 컨텐츠 개발

-개발도상국 역량강화사업을 중심으로-

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Abstracts

Forest fragmentation caused by development project not only damages the ecosystem but affects the landscape by its artificial impact. Korea is considered as the only country in the world that led a successful forestation and provides developing countries with official development assistance(ODA) in forestry field focusing on “forestation”. This study aims to develop ODA contents applicable to forestry field beyond the assistance limited to forestation. In particular, this study focused on capacity building for officials and local communities in developing countries to prevent forest fragmentation and suggested the methods of it, based on the definition of “capacity development” presented by UNDP. Capacity development is the process of improving the ability for developing countries to deal with development tasks by themselves at the organizational and social level as well as the transfer of knowledge and technology at the individual level. In this study, capacity building activities for the prevention of forest fragmentation are examined at three levels: individual, organization and enabling environment. As the concept of capacity building in developing countries began to evolve, the sustainability and appropriateness of knowledge and technology transfer became more important and donor countries should play a role as a ‘facilitator’ for the change processes of developing countries rather than the short-term interventionist roles.

요 약

개발사업으로 인한 산림파편화는 생태계를 훼손할 뿐만 아니라 인위적 영향으로 인해 자연 경관에 영향을 미친다. 우리나라는 세계적으로 산림녹화 성공을 거둔 유일한 국가로 산림분야 공적개발원조(ODA)사업에 있어서 “조림” 위주로 개도국에 지원을 하고 있다. 이에 본 연구의 목적은 조림분야에만 국한된 컨텐츠에서 나아가 임업분야에서 적용 가능한 ODA컨텐츠를 개발하는데 있으며 특히 개도국의 산림파편화 최소화를 위한 역량강화 사업에 초점을 맞추었다. 유엔개발계획에서 규명하는 역량개발에 대한 정의를 기반으로 개도국 산림분야 관계자 및 지역사회의 산림파편화 방지 역량 강화를 지원하기 위한 ODA 사업 방안을 제시하고자 한다. 역량개발은 과거 개인 차원에서의 지식 및 기술 전수 형태의 원조사업에서 벗어나 조직 및 사회 전체로서 개발도상국 스스로의 개발과제 대처능력을 제고하는 과정으로, 본 연구에서는 개인, 조직, 외부 환경의 3가지 관점에서 적용할 수 있는 산림 파편화 방지 역량개발 활동에 대해 고찰하였다. 개도국의 역량강화 지원에 대한 개념이 발전하기 시작하면서 기술전수의 지속가능성과 적절성이 더욱 중요해졌으며 공여국은 단기적인 개입보다 수원국 주도의 변화 과정을 촉진하는 역할을 해야 할 필요성이 있다.

Changes for 10 Years of Understory Vegetation Structure of Cold-Temperate Deciduous Broadleaf Forest in Mt. Gyebang Long-Term Ecological Research Site

계방산 장기생태연구지에서 10년간 온대북부 낙엽활엽수림의 하층식생구조 변화

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Abstracts

This study was conducted to investigate the changes understory vegetation composition (shrub and herb layers) in Mt. Gyebang as a northern-temperate deciduous broadleaf forest. This study of the dynamic stat of forest ecosystems (dynamic stat) understand and benefits of forest understory vegetation (nutrient supply to the upper vegetation, wildlife habitat, protection of seedlings and seeds, such as the regulation of the water level etc.) to investigate the primary research was conducted in the future. 10 years of vegetation monitoring (2002～2012) results in study plots would have predicted changes in understory vegetation and Most of these changes affect basal area of upper layer. So, influence vegetation data (upper layer basal area, shrub layer species coverage) were used. Influence on understory vegetation and upper vegetation (basal area) were analyzed by the Mantel-test. As a result, Basal area of upper layer to low layer vegetation change was affected. NMS analysis of shrub layer, strong association with species were reduced time goes by. Increase in basal area of the upper layer reacting species were different. Herb layer plots of the NMS analysis, *Rhododendron schlippenbachii* Maxim. and *Rhododendron mucronulatum* Turcz. Consistently was affected in shrub layer and MRPP-test results for changes in vegetation composition, shrub layer vegetation composition changes in 5～10 years that no significant differences were analyzed. But, 5～10 years of herb layer vegetation composition changes were significantly

analyzed. Herb layer species composition change was larger than a shrub layer composition in understory vegetation.

요 약

본 연구는 계방산 온대북부 낙엽활엽수림에서 하층식생(관목층과 초본층)의 식생조성 변화를 구명하였다. 이러한 연구는 산림생태계가 가지는 동적상태(dynamic stat)를 이해하며 나아가 산림에서 하층식생의 여러 가지 역할들을(상층식생에 양분공급, 야생동물의 서식처, 묘목과 종자의 보호, 지표수의 조절 등) 구명하기 위한 기초연구이다. 10년간(2002～2012)의 모니터링 결과 계방산 장기생태 조사구의 하층식생은 변화하였으며, 그러한 변화는 중 가장 큰 영향을 주는 것은 상층식생의 기저면적이라고 예상했다. 이에, 하층식생에 대한 상층식생영향(기저면적)을 Mantel-test로 분석하였다. 그 결과 상층의 기저면적은 하층의 변화에 영향을 주는 인자 중 하나로 분석되었다. 관목층의 NMS 배열 결과 높은 연관성을 가지는 종은 시간이 경과함에 따라 감소하는 것으로 분석되었으며, 상층의 기저면적 증가에 따라 반응하는 종이 다른 것으로 분석되었다. 초본층 조사구의 NMS 배열 결과 관목층의 철쭉과 진달래가 지속적으로 영향을 미치는 것으로 분석되었다. 그리고 MRPP-test에 대한 식생조성의 변화 결과 관목층은 5년 그리고 10년에 따른 식생조성의 변화가 유의차가 없는 것으로 분석되었다. 하지만 초본층은 5년 그리고 10년에 따른 식생조성의 변화가 유의성 있게 분석되어, 하층식생 중 초본층의 종조성은 관목층 보다 종조성의 변화가 큰 것으로 나타났다.

Application of Fluid-Structure Interaction to the Wind Field in a Forest

산림 바람장에서 유체-구조 연성해석 적용

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Abstracts

Recently, there have been many researches to find the method for minimizing the damage from natural disasters. The disasters in the coast such as typhoon and tsunami are being studied to reduce them, and one of possible methods is to locate some structures for the protection of wind and wave. The most eco-friendly method minimizing the destruction of ecological system is to construct the forest of damage prevention, which has been actively investigated for the last decade. However, we know the fact that the coastal forests can reduce the damage of natural disaster, but the mechanism how they work inside the forest and in the flow field of wake is not yet precisely understood, so there has been no quantitative investigation on the damage prevention effect. The real tree is not rigid but flexible, which means that trees are oscillated with the environmental wind, so this effect is not sufficiently considered in the past researches. In this study, applying FSI(fluid-structure interaction) for a single tree model, the effect of energy dissipation is predicted in the wind field around a forest.

요 약

최근 자연재해로 인하여 발생되는 피해를 최소화하는 방법을 찾는 연구가 많이 진행이 되고 있다. 해안성 자연재해인 태풍, 쓰나미에 의한 피해를 최소화하기 위하여 해안지역에 방재 및 방풍 목적으로 구조물을 배치하는 연구가 진행이 되고 있으며, 친환경적이고 생태계 파괴를 최소화할 수 있는 방재림 조성에 대한 연구가 몇

년 사이에 활발히 진행되고 있다. 그러나 방재림 조성으로 해안성 자연재해의 피해가 감소되는 것은 알고 있지만, 방재림 내부와 후방에서의 유동현상에 대한 확실한 메커니즘을 정밀하게 이해할 수가 없었기 때문에 아직까지 방재림의 피해저감 효과에 대한 정량적인 연구가 없었다. 나무는 강체(rigid body)가 아닌 바람에 따라 흔들리는 연성체(flexible body)이다. 과거 진행된 연구들에서는 이러한 영향이 충분히 고려되지 못했다. 본 연구에서는 단일 수목 모델에 대하여 유체 구조 연성해석(FSI)을 적용하여 산림 바람장에서의 에너지 소산 영향을 예측해보았다.

An Analysis of Cable Logging Operation System with Tower-yarder in Korea

타워야더를 이용한 가선집재작업시스템의 분석

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Abstracts

This study was conducted to investigate the efficiency of the cable logging operation system, the optimum setting-up spacing in order to establish the optimum cable logging operation system with tower-yarder (Koller K300) in Korea. The study area is located Gangneung-Si, Gangwon-Do in the middle of Korea. The forest is artificial forest of *Pinus densiflora*. *Pinus densiflora* is one of the popular species in Korea. In thinning logging operation by tower-yarder (Koller K300), the ratio of choker setting and lateral time was 18% of total cable logging time. An average cable logging productivity of a tower yarder in the thinning operation was 33.6 ㎥/day and 8.4 ㎥/person-day (5.6 ㎥/productive machine hour(PMH)). As the results of the simulation of cable logging operation by tower-yarder (Koller K300), the total cable logging time for one corridor with 4 planting rows of one block and 1 ha took about 1 day and 4 days, respectively

요 약

본 연구는 타워야더 (Koller K300)를 이용한 최적 가선집재시스템을 위한 최적 설치간격과 가선집재시스템의 효율성을 조사하기 위하여 수행되었다. 작업지는 중부지방 강원도 강릉시에 위치하였고, 수종은 한국의 대표수종이라 할 수 있는 소나무 인공림이다. 타워야더 (Koller K300)를 이용한 간벌작업으로 총가선집재작업 시간 중 초커설치와 횡집재시간이 18%를 차지하였다. 간벌작업에서 타워야더의 평균 집재작업생산성은 33.6 ㎥/일 이었고, 1인 작업생산성은 8.4 ㎥/인·일(시간당 5.6 ㎥/시간)이었다. 타워야더 (Koller K300)의 가선집재작업의 시뮬레이션 결과, 1개 블록을 4열로 작업할 때 집재선당 총작업시간은 1일이 소요되었으며, 1ha를 간벌할 때는 4일이 소요되는 것으로 분석되었다.

Estimation of Annual Soil Carbon Emissions/Removals in LULUCF Sector

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According to the Convention of the United Nations Framework Convention on Climate Change, all Parties have to submit the national inventory report. Korea submitted it three times, but soil carbon emissions/removals in land use, land-use change and forestry (LULUCF) sector still do not reported due to the incomplete annual land-use change matrix. This study was conducted to estimate of soil carbon stock in LULUCF sector using the annual national statistics. Basically, soil carbon changes of six land use categories should reported as a mandatory carbon pool but most of parties did not reported the changes for wetland, settlement and other land, because of no methodologies. We have an assumption which is other land use categories do not converted to forest land based on historical statistics. The total soil carbon emissions (t C $year^{-1}$) on the croplands and grasslands converted from other land-use categories was 1024.0, 2199.7 in 2005 and 949.9, 1194.6 in 2010. On the other hand, soil carbon removals (-) and emissions (+) (t C $year^{-1}$) for forest land remaining forest land (FF), cropland remaining cropland (CC), grassland remaining grassland (GG)) were 59,579.6, 50,744.2, -29,859.0 in 2005 and 59,397.3, 56,463.7, -11,895.4 in 2010, respectively. FF and CC were showed emission tendency, but GG is a sink since early 2000. Soil carbon stocks were approximately less than 1% about forest carbon removals in living biomass. Although our study used the incomplete matrix due to the lack of activity data, we will find the way to calculate the annual soil carbon emissions/removals for all land use categories in the near future.

Estimation of Forest Carbon Stocks of KPHL Rinjani Barat for Assessment of REDD Feasibility in Lombok, Indonesia

인도네시아 롬복 KPHL Rinjani Barat의 REDD 타당성 평가를 위한 산림탄소축적량 추정

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Abstracts

The study was performed to estimate forest carbon stock by land use change for assessment of REDD feasibility from REDD study area (40,000ha) in Rinjani Forest Management Unit (Kesatuan Pengelolaan Huntan, KPH) of West Lombok, Indonesia. This study area is classified as 3 forest types (Primary forest, Secondary forest, Shrub land) from Remote Sensing image, Landsat Satellite data of West Lombok. The total number of samples and sampled number by stratum of forest types are calculated by according to the stratified sampling method (Neyman allocation), and the total number of samples was 45 plots. The sampling plot design applying Hairiah method (2007) consists of main plots of 20m × 50m dimension (0.1ha) and four sub plots. We investigated DBH and height of above trees, ground understory vegetation biomass and soil carbon to estimate carbon stock. Allometric equation considering DBH and wood density by Kettering, et al (2001) was used to estimate tree carbon stocks. Understory vegetation and soil samples were processed in laboratory to estimate their biomass. The carbon stocks of above and below ground biomass in tree was 'Primary forest' as average 126.2 tC/ha, 'Secondary forest' as average 124.0 tC/ha, 'Shrubland' as average 18.9 tC/ha. The change of forest carbon stocks of 5 years intervals between 1990 and 2010 decreased 2,889.134 tC/ha in 1990, 2,083,499 tC/ha in 1995, 2,074,703 tC/ha in 2000, 1,994,465 tC/ha in 2005, 1,990,490 tC/ha in 2010 with Primary forest. The carbon stocks of primary forest decreased between 1990 and 1995 in the West Rinjani forest area of REDD

study. The decrease of these carbon stocks was caused by the sharp decline of forest area, deforestation and forest degradation with various factors, including illegal cutting.

요 약

이 연구는 인도네시아 롬복섬 서부 Rinjani KPHL REDD 사업대상지의 REDD 사업 이행 타당성 평가를 위하여 토지이용변화에 따른 산림탄소축적량 추정을 수행하였다. 서부 롬복의 Landsat 인공위성 사진을 이용하여 연구대상지역을 1차림, 2차림 그리고 관목림의 3개 산림유형으로 분류하였다. 전체 조사 표본점수와 산림유형별 표본점수는 층화추출법에 의하여 계산 되어 졌으며, 전체 표본점수는 45 plots이다. 표본점은 20m × 50m (0.1ha) 크기의 주표본조사구과 4개의 부표본조사구로 구성되어 있다. 산림탄소축적량 추정을 위하여 지상부 임목의 흉고직경과 수고, 지상부 하층식생 바이오매스와 토양탄소조사를 수행하였다. 지상부 임목탄소축적량 추정을 위하여 흉고직경(DBH)과 목재밀도(D)의 인자를 고려한 Kettering, et al (2001)의 상대생장식을 이용하였다. 임목탄소축적량은 1차림 ha당 평균 126.2 tC, 2차림 124.0 tC, 관목림 18.9 tC로 나타났다. 1990부터 2010년까지 5년 간격으로 1차림의 산림탄소축적은 1990년 2,889.134 tC, 1995년 2,083,499 tC, 2000년 2,074,703 tC , 2005년 1,994,465 tC, 2010년 1,990,490 tC로 감소하였다. REDD 연구대상지인 서부 Rinjani 산림지역은 1990년과 1995년 사이 1차림의 급격한 감소가 진행되었다. 이러한 산림탄소축적의 감소는 산림전용 및 황폐화, 불법 벌채 등 여러 요인에 의한 산림면적의 급격한 감소에 기인하였다.

Study of Taper Equation for *Cryptomeria japonica* in Jeju Island, South Korea

제주지역 삼나무림의 수간곡선 추정에 관한 연구

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Abstracts

This study was carried out to develop volume equations for *Cryptomeria japonica* in Jeju island, South Korea. The 20 trees were selected in 20m × 30m for stem analysis. This study was used Kozak's model of the estimation for model parameter. The stem taper model using four statistical criteria: Fit index (FI), root mean square error (RMSE), bias ($\bar{E}$), and absolute mean difference (AMD). This results of the model evaluation showed that the taper equation provided the FI at 0.99. The bias showed 0.008 and showed 0.832 of absolute mean difference. This estimation equation was statistically significant. The table of stem volume developed for *Cryptomeria japonica* in jeju region, is very useful in managing in jeju forests.

요 약

본 연구는 제주도 일대의 삼나무 임분을 대상으로 간곡선식을 추정하여 임목의 재적표를 작성하고자 수행하였다. 조사대상지는 제주도 한남시험림에 분포한 삼나무를 대상으로 임분을 대표할 수 있는 지역에 표준지를 선정하여, 직경이 골고루 분포하도록 20그루를 벌채하여 공시목으로 사용하였다. 분석에 사용된 수간곡선식은 Kozak식 모형을 사용하여 모수를 추정하였다. 추정된 모형의 적합성 지수는 99%로 통계적인 유의성이 인정되었으며 오차는 0.008로 나타났다. 또한 절대평균편차는 0.832로 나타나 잔차분석 결과도 양호한 것으로 분석되었다. 이에 따라 삼나무의 간곡선식을 추정하여 수간재적표를 작성하여 제주도 지역에 맞는 지역적 재적표로 이용할 수 있을 것으로 판단된다.

Community Structure of *Pinus thunbergii* Stand in Jeju Island, South Korea

제주지역 해안 곰솔림의 군집구조

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Abstracts

This study was carried out to provide basic data for the effective conservation and management in the *Pinus thunbergii* stand which is located in Jeju island, south korea where the fragmentation of vegetation has been caused by the exploitation and the increase of tourists, and installed the thirty study sites(10m×10m) in the dominant *Pinus thunbergii* stand. The *Pinus thunbergii* stand was classified into two groups(*Pinus thunbergii-Litsea japonica* community, *Pinus thunbergii-Litsea japonica-Elaeagnus macrophylla* community) by a cluster analysis. As a result of MRPP(Multi-Response Permutation Procedures) test, there is significance among the communities. *Eurya japonica*, *Viburnum awabuki*, *Caesalpinia japonica*, *Zanthoxylum piperitum* etc. five species were significant by characteristic species analysis.

요 약

본 연구는 관광객 증가 및 개발로 인한 해안지역 산림이 훼손되고 있어 해안 곰솔림을 대상으로 효율적인 보전과 관리를 위한 자료를 제공하기 위하여 곰솔 우점림에 조사구 30개(10m×10m)를 설치하여 수행하였다. 제주도 지역 해안 곰솔림의 군집분석 결과 곰솔림은 2개의 군집(곰솔-까마귀쪽나무군집, 곰솔-까마귀쪽나무-보리밥나무군집)으로 구분되었으며, Multi-Response Permutation Procedures 검정결과 군집은 유의성 있게 나타났다. 표징종 분석결과 유의한 종은 사스레피나무, 아왜나무, 실거리나무, 초피나무 등 5종이 나타났다.

A Study of Spatial Suitability of Indicator for Vulnerability Assessment to Climate Change

기후변화 취약성 평가 지표의 공간적 적합성 분석

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Abstracts

As a countermeasure of climate change, the importance of adaptation policy is being magnified not only mitigation policy, and need for establishing an adaptive system is continuously increasing for efficiently adapting to climate change through the local level understanding on climate change effects and the establishment of response plan.

But it is an obvious fact that the establishment of adaptive plan by the smallest local government will become a prerequisite for establishing the national level systematic adaptive plan.

However, the lack of effective index on Eup, Myeon, Dong level, which is caused by limitations in acquisition of statistical data of local governments is the biggest problem. and spatial unsuitability of meteorological factors.

In this study, problems of assessment are analyzed and spatial suitability of meteorological, socioeconomic indicators by using spatial autocorrelation analysis and analysis of data status of socioeconomic indicators

As a result of the analysis, there are no differences in climate factors within Eup, Myeon, Dong level, and there is almost 50% of the lack of effective index on Eup, Myeon, Dong level. Vulnerability assessment based solely on lack of data is not reliable. In order to overcome such problems, research is required to be executed on unified index that can efficiently reflect characteristics of each local government.

요 약

기후변화가 우리나라에 미치는 영향은 세계의 다른 나라보다 빠르게 진행되고 있고 영향에 의한 피해 역시 증가됨에 따라 적응 정책의 중요성이 커지고 있다. 기후변화 적응은 지역차원에서의 대응이 중요하며 도출된 적응대책의 실질적 이행을 위해서는 기초지자체 단위의 적응대책 마련이 필요하다.

그러나 기초지자체를 대상으로 시행한 분야별 취약성 평가는 자료구축의 문제점과 기후 지표들의 공간적 부적합성이 가장 큰 한계점으로 나타났다. 본 연구에서는 시범 기초지자체를 대상으로 실시한 취약성 평가 결과의 문제점 및 한계점을 분석하고, 평가 시 사용된 사회경제 지표들의 구축 규모 현황 분석과 기후노출 지표들의 공간자기상관 분석을 통해 지표들의 공간 적합성을 검증하였다. 그 결과, 기상지표는 읍·면·동 뿐만 아니라 상위 행정단위인 시·군·구 내에서도 동일한 값을 갖기 때문에 전국규모로 적용해야 의미가 있는 것으로 나타났다. 또한, 사회경제 지표의 경우 읍·면·동 단위의 자료 구축률이 50%가 넘지 않아 평가에 적합한 수준이 아니라고 판단되었다. 기초지자체 내에서 취약성의 공간적 차별화를 위한 자료가 불완전한 상태에서 실시한 기초지자체 단위의 취약성 평가는 결과의 신뢰도가 떨어진다고 판단되며, 이를 해결하기 위한 기초지자체 규모의 자료구축이 요구되는 것으로 나타났다.

Effect of salinity, Irradiance and Temperature in Improvement of Seed Germination in *Calystegia soldanella*

염분농도, 광조건과 온도 차이가 갯메꽃 종자의 발아에 미치는 영향

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Abstracts

This experiment was conducted to investigate the effect of salinity, irradiance and temperature in improvement of seed germination in *Calystegia soldanella* of central-western coastal. Two temperature conditions(25℃, 35℃), three salinity conditions(untreated, treatment, enrichment), three irradiance conditons(light period 0 hour, 8 hour, 24 hour) were tested under the following conditions. The results, seed germination rate were the highest in light period 8 hour, 25℃conditions. Also, significant differences between irradiance and temperature appeared.

요 약

본 연구는 중부 서해안에서 자생하는 갯메꽃의 종자번식법을 개발하기 위하여 염분, 광조건, 온도에 대한 종자발아 특성을 분석하였다. 염분농도는 무처리구, 일반처리구, 강화처리구 3조건으로 하였으며, 광조건은 명조건과 암조건, 8시간 명/16시간 암조건으로 하였다. 온도는 25℃, 35℃ 두 가지 조건에서 실험 하였다. 그 결과 갯메꽃 발아율은 명조건 8시간, 25℃에서 가장 높게 나타났으며, 광조건과 온도 조건 사이에 유의적 차이를 나타냈으며, 갯메꽃 종자 발아에는 염분농도, 광조건 보다 온도에 민감성을 나타냈다. 따라서 갯메꽃 종자발아를 유도하기위해서는 고온에서보다는 25℃이하에서 발아를 유도해야 될 것으로 생각되며, 앞으로 적절한 발아온도를 찾기 위한 연구가 필요할 것으로 사료된다.

The Field Experiment and Development of Landslide Early Detecting System for Natural Slope in Korea

국내산지에 적합한 산사태 조기감지시스템 개발 및 현장실험

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Abstracts

Since 2011 Woomyunsan landslide, the interest for landslide prevention of the people is increasing. Accordingly, the request for the construction of check dam is increasing in order to landslide prevention. However it is difficult to build check dam on landslide hazard area of all across the country due to budget and construction period. Thus, it is an urgent to prepare of non-structural measures for landslide prevention. In this study, we will develop an early detecting system. This system is used USN(Ubiquitous Sensor Network). And this is consist sensor nodes (tensiometer, soil moisture sensor, temperature sensor, acoustic sensor), networking system using Zigbee and power supply using Solar. This is installed on experimental forest in KFRI (Korea Forest Research Institute). The field experiment was used artificial rainfall device. As a result, the sensor response by position was appeared to react the lower more quickly than the upper. This system is required continuous monitoring in order to verify the result.

요 약

2011년 우면산 산사태 이후로 산사태 피해방지에 대한 국민들의 관심이 높아지고 있다. 산사태 피해방지 수단으로 사방댐의 시공을 요구하는 국민들의 목소리도 커져가는 상황에서 국가적 예산문제와 시공 공사기간의 문제로 인하여 전국의 모든 산사태 위험지역을 사방댐으로 예방하는 것은 어려운 일이다. 따라서 산사태 피해방지를 위하여 비구조적 대책마련이 시급한 상황이다. 이 연구에서는 산사태를 미리 감지하여 주민들을 대피하도록 하는 조기감지시스템을 개발하고자 한다. 본 조기감지

시스템은 USN (Ubiquitous Sensor Network) 방식을 활용한 시스템으로 국내 자연사면을 대상으로 서울시 동대문구 국립산림과학원 내 홍릉 시험림에 설치하였으며, 텐시오미터, 토양수분센서, 기울기센서, 온도센서 음향센서 등 센서노드와 Zigbee 방식의 센서네트워킹 시스템, Solar패널을 이용한 전원장치 등으로 구성되었다. 현장실험은 인공강우장치를 이용하였으며, 그 결과 센서의 반응은 위치 별로 하부가 상부에 비해 더욱 빨리 반응하는 것으로 나타나며, 상부로 침투한 지하수가 하부에 모이면서 급속하게 포화되는 것을 의미한다. 이 현상을 보다 정확하게 확인하기 위해서는 지속적인 현장실험 및 모니터링이 필요하다.

Analysis of Unsaturated Weathered Soils Shear Strength though Empirical Formula and Laboratory Test

경험 방정식과 실내시험을 통한 풍화토의 불포화 전단강도 분석

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Abstracts

It is very important to estimate the shear strength of unsaturated soils for various geotechnical engineering problem, especially for slope stability problem. Unsaturated soil shear strength is presented through the soil-water characteristic curve(SWCC) and triaxial compression test. In this study, three different types of soils(SP, SW, SM are classified as USCS) of weathered soils are carried out for the soil-water characteristic curve(SWCC) test using GCTS pressure plate and Geocomp. triaxial testing system to find out shear strength for saturated soils. Therefore the objective of the study is to predict the shear strength of unsaturated soils by using SWCC and published shear strength equation from the literature.

요 약

기존의 사면안정 해석은 흙의 포화도(degree of saturation)를 고려하지 않은 상태의 전단강도를 이용하는 것이 일반적이며, 지하수위가 낮게 분포 하더라도 지하수위 상승과 강우 시 물의 침투를 고려하여 완전 포화토인 전응력(total stress)상태의 해석이 대부분이다. 이는 불포화상태의 강도정수 보다 포화상태의 강도정수가 일반적으로 작아서 안정성의 문제로 설계되고 있고, 또한 불포화상태의 강도정수를 구하는데 많은 시간과 노력이 요구되기 때문에 적용돼지 못하고 있는 실정이다. 하지만 실제 지반은 대부분 불포화 상태로 존재하고 음의 모관흡수력(matrix suction,)에 의해 겉보기 점착력(c)이 나타나고 내부마찰각이 커지는 등 포화토의 전단강도 특성과 큰 차이를 보이게 된다. 이 때문에 최근 많은 연구자들은 지반의 불포화를 고려한

해석의 필요성을 제기하고 있으며(Cho and Lee, 2001; 김재홍과 황영철 2010), 불포화토의 함수특성곡선(soil-water characteristic curve)을 산정하고 이를 사면안정해석에 적용시키려는 연구들이 진행되어 왔다(김재홍 등, 2002; 유남동 등, 2004; 이규현 등, 2007; 정상섬 등, 2009). 또한 불포화토의 전단강도는 Fredlund and Morgnstern (1978)에 의해 순 수직응력(σ-u_a)과 모관흡수력을 서로 독립적인 상태변수로 사용하여 새로운 전단강도 식을 제안 하였다. 이 식에서는 모관흡수력에 따라 전단강도 증가를 나타내는 겉보기 마찰각(φ^b)을 모관흡수력에 따라 선형적으로 증가하는 것으로 고려하였지만 이후 많은 연구자에 의해 겉보기 마찰각은 낮은 모관흡수력에서 내부마찰각(φ')과 거의 동일하며, 모관 흡수력이 증가함에 따라 비선형적으로 거동하는 특성을 나타냄을 보였다.

본 연구에서는 국내에 분포하고 있는 불포화 풍화토의 함수특성곡선과 불포화 전단강도를 산정하기 위해 먼저 시료를 SP, SW 그리고 SM으로 각각 분류하였으며, GCTS pressure plate 장비를 통해 함수특성곡선을 시험하였다. 또한 삼축압축시험을 포화상태의 강도정수를 얻었으며 함수특성곡선을 이용해 불포화상태의 전단강도를 간접적으로 예측하였으며 입도분포에 따른 불포화토의 전단강도 특성을 분석하였다.

Analysis of Topography Changes in a Dredged and Non-dredged Area of a Debris Barrier by Using Terrestrial LiDAR

지상라이다를 이용한 사방댐 준설지역과 비준설지역의 지형변화 분석

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Abstracts

This research was carried out to determine the impact of dredging on a mountain torrent within a deposit line. The topographical conditions before and after dredging and after the rainy season in the dredged site where a debris barrier was built in were studied.

Terrestrial light detection and ranging (LiDAR) surveys were conducted for both the dredged and non-dredged sites in Gunwi and Seongju. Longitudinal and transverse alignments variations was analyzed by using a geographic information system (GIS) made the following observations.

At the dredged site, longitudinal and transverse alignments showed that general alignment was observed at the lowest point because of dredging. Following the rainy season, mixture of soil and sand accumulations overlaid the alignment, owing to which the area attained a pre-dredged appearance. At the non-dredged site, however, the general alignment of the stream bed was higher, and erosion occurred directly in front of the upstream face. Thus, erosion at the dredged site occurred because of topographical disturbance. Further, natural erosion and sedimentation occurred at the non-dredged site.

요 약

본 연구는 사방댐 준설지에서의 준설전, 후 및 우기후의 지형변화 평가를 통하여 준설작업이 퇴사선내의 계류에 미치는 영향을 알아보기 위해서 준설지(군위, 성주지역)와 비준설지(군위, 성주지역)를 대상으로 지상 LiDAR 측량을 실시하고, GIS를 이용한 종, 횡단선형변화를 평가하였다.

준설지에서의 종, 횡단선형은 준설작업으로 인해서 계상의 전체적인 선형이 낮게 나타났지만, 우기를 지나면서 준설전과 동일하게 만사된 선형을 나타내었다. 그러나 비준설지에서는 계상의 전체적인 선형이 높아졌고, 대수면 바로앞쪽에서는 침식이 일어났다. 이러한 결과로 준설지에서는 지형의 교란이 발생하였기 때문에 침식이 일어났고, 비준설지에서는 자연적인 침식과 퇴적활동이 일어난 것으로 판단된다.

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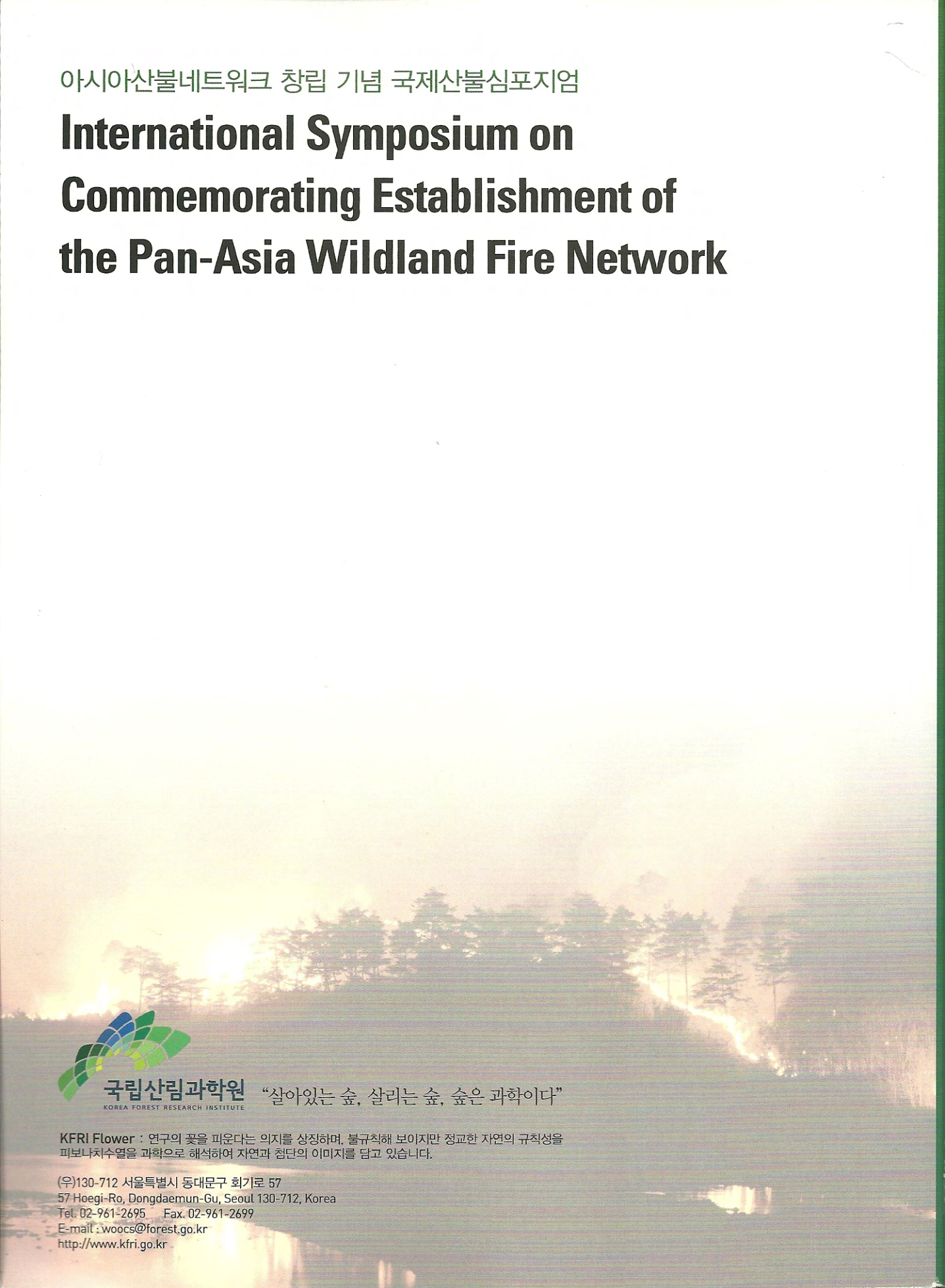

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