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WILDLAND FIRE CONFERENCE
KOREA

지구환경변화 대응 산불방지전략 마련 국제심포지엄

International Symposium on Strategy Development of Forest Fire Policy and Organization

Date January 15 - 17, 2013

Venue Seoul Education Cultural Center,
Seoul, Republic of Korea

Hosted by *kfri*

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Opening Address

Dr. Young-kyoon YOON
Director General
Korea Forest Research Institute

First of all, I'd like to extend my gratitude to distinguished guests, speakers and forest fires experts from home and abroad for attending today's symposium despite your busy schedule.

In particular, it is my great pleasure to be joined by world-renowned forest fire experts,

Dr. Johann G. Goldammer, Director of the Global fire monitoring center under the International strategy for disaster reduction,

Dr. Nikola Nikolov from Ss. Cyril and methodius university in Macedonia,

Dr. Mark Jones, Chief fire officer of the Buckinghamshire Fire & Rescue Service,

Dr. Gavriil Xanthopoulos, Fire Specialist of FAO(Food and agriculture organization) and UNECE(United nations economic commission for Europe),

Dr. Soung-ryoul Ryu from the University of Alberta,

Dr. Gong-ju Na, Director of the Korea National Park Service,

Dr. Yeong-joo Lee, Director of AFoCo, and

Dr. Ji-bum Chung of the Korea Institute of Public Administration.

Also, I would like to thank Dr. Eung-sik kim from Hoseo University who will be today's moderator,

Dr. Si-young Lee from Kangwon National University,

Dr. Pil-sun Lee from Seoul National University,

Dr. Hyeon-cheol Moon from Chodang University and other distinguished participants in charge of forest fire research and administration.

As you are well aware, recently, the world suffers from unprecedented mega fires due to climate change. Forest fires occurred in Greece in 2007, in Australia in 2009, and in Texas, the U.S. on April 15, 2011 burnt more than 400,000 ha of forest lands, killing dozens of people and incurring huge property losses.

Now, forest fire is no longer a problem of a single nation, but a transnational global issue. Korea and other Asian countries are no exception. From tropical forests to frigid forest in far-east Asia, forests in Asian region have become more vulnerable to fires, making mega fires not a matter of distant future, but a challenge of today.

An effective response to forest fire urgently requires international cooperation such as sharing of specialized experiences and forest fire suppression resources among countries.

At this juncture, I believe today's symposium will be very helpful to share forest fire prevention strategies and policies as well as seek international cooperation measures.

In this symposium, prominent experts in forest fire prevention from home and abroad will discuss forest fire response strategies. I hope today's symposium will be useful in establishing effective forest fire prevention strategies through sharing of up-to-date information and practical Q&A session.

Last but not least, I'd like to express my deepest appreciation to all of you who offered great support in preparing today's event.

Welcome Address

Dr. Don Koo LEE

Minister

Korea Forest Service

Dr. Johann Goldammer, Director of Global Fire Monitoring Center,

Mr. Mark Jones, Chief Executive of Buckinghamshire Fire & Rescue Service, United Kingdom,

Dr. Gavriil Xanthopoulos, Researcher of Institute of Mediterranean Forest Ecosystems and Forest Products Technology, Athens, Greece

Dr. Soung Ryoul RYU, Professor of University of Alberta, Canada,

Dr. Nikola Nikolov, Professor of Ss. Cyril and Methodius University, Macedonia,

I would like to take this opportunity to sincerely welcome and express my appreciation for readily accepting invitation to the International Symposium on Strategy Development of Forest Fire Policy and Organization.

Dr. Ji Bum CHUNG, Researcher of Korea Institute of Public Administration,

Dr. Young Joo LEE, ASEAN-Korea Forest Cooperation,

Dr. Hyun Cheol MOON, Professor of Chodang University,

Ms. Gong Joo NA, Director of Korea National Park Service,

It is a great honor and pleasure for me to have you at this symposium as domestic presenters and discussants.

Dr. Eung Sik KIM, Professor of Hoseo University,

Dr. Si Young LEE, Professor of Kangwon National University,

Dr. Pil Seon PARK, Professor of Seoul National University,

I would like to express my appreciation for presiding at this meeting.

I would also like to extend my heartfelt gratitude to distinguished guests and wildland fire experts for participating in the event today all the way from home and abroad.

Ladies and gentlemen,

We all know that the rapid pace of climate change all over the globe brings about more frequent and severe incidents of unintended wildland fires. Wildfires do not only strongly affect ecosystems and forests and but also result in the loss of human lives and valuable assets. It shows a form of vicious cycle by emitting greenhouse gas and thus accelerating global warming.

In Korea, we have a painful experience of losing 23,000 hectares of forests and national treasures and heritages in the East Coast in 2000. The recent news of mega fires in the world including the United States, Australia, and Portugal keep drawing Korean people's attention with worries and concerns.

The damage from wildland fires is not restricted within one country. The smoke and fog arising from vegetation fires transcends national borders and affects the adjacent countries. The massive destruction of ecosystems from mega fires eventually influences the whole environment of the earth in a negative way. On the other hand, many forest fire researchers bring forward their professional advice that well-timed and well-placed fire should be prescribed to prevent mega fires beforehand.

To prevent and minimize the damage from fires and use them in a proper way, international collaboration such as the Global Wildland Fire Network (GWFN) and Regional Wildland Fire Networks should be fostered. Each government and international society need to establish effective cooperation strategies to resolve environmental problems of the world in union.

In this respect, the International Wildland Fire Conference (IWFC) has been held regularly since 1989 to facilitate exchange of expertise and knowledge in wildland

fire management and promote international cooperation. The next conference will be held in 2015, and I feel highly honored and delighted that Korea hosts the conference. For its preparation meeting, the International Liaison Committee will be convened during the latter half of this year to discover conference agenda and make detailed plans. I sincerely hope your constant attention and participation.

Through today's presentation and discussion resulting from in-depth study of experts and researchers, I hope we can seek common interest in wildland fire management and strategy. It will be truly fruitful and valuable time in sharing each country's policy and experience to devise better action plans.

Finally, I would like to express my appreciation to organizers of this symposium. I wish all of your success and luck.

Thank you very much.

Congratulatory Address

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

Director, Global Fire Monitoring Center (GFMC)

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

Freiburg, Germany, fire@fire.uni-freiburg.de

Excellency, Honorable Mr. Minister Dr. Don Koo LEE,

Honourable Director General Dr. Young Kyun Yoon,

Honourable representatives of the Korea Forest Service and

the Korea Forest Research Institute

Honourable international representatives of fire management authorities from

Greece, Macedonia, Canada and the United Kingdom and participants of the International Symposium on Strategy Development of Advanced Forest Fire Policy and Organization

After the end of each year the Global Fire Monitoring Center is summarizing and analyzing the magnitude of forest fires globally, and their impacts on the environment and on society. The year 2012 was another year in which we observed fires in some countries that had extreme dimensions, and resulted in high damages. In Spain, the total area affected by wildfire was close to 200,000 hectares, much more than experienced in the past decades. In the United States of America more than 67,000 fires burned 3.7 million hectares of forests and other lands. Satellite imagery reveals that in the Russian Federation more than 30 million hectares of different vegetation types had been burned. Numerous fatalities around the world are not yet counted. The first evaluation of fatalities and damages caused by wildfires in 2012 around the world reveals that more than 180 people have been killed by wildfires and close to 3000 people injured. The total number of reported losses of houses by wildfires exceeded 2600, with additional several hundred businesses, outbuildings and other infrastructures lost. And globally

we are estimating that more than 116,000 people had to be evacuated in more than 200 incidents.

These numbers are derived from government and media reports and certainly understate the true picture. Many losses in less developed countries are not captured and reported by agencies or the media. We assume that the unreported cases of fatalities, loss of houses and even entire villages in countries, where there are no insurance schemes and therefore limited to none official reports, are much higher. The losses of agricultural crops, livestock, and other private and public assets, the costs of power failure, traffic disruptions, evacuations and reduced economic activities caused by wildfires are probably in the magnitude of billions of dollars every year ¬nreported, unnoticed, not included in the statistics.

The intangible values of environmental and cultural damages are even more difficult to assess. How can the costs of destruction of ecosystems by fire, or the impact of fire emissions on the atmosphere and on climate be quantified? How can social and emotional damages be quantified, damages of cultural assets such as the Naksan Temple destroyed by the Yangyang fire of 2005 in Gangwon Province?

Globally, and here in Korea, the fire management community is taking the challenge and responsibility to address the complexity of issues and problems that determine the susceptibility of natural and cultural landscapes to fire, and the increasing vulnerability of the ecosystems and the global environment to the direct and indirect effects of vegetations fires.

The management of wildfire risk and threats in natural and cultural landscapes, which are determined by the interaction between landscape features, climate and the dwellers in, and the users of the landscapes, require a holistic approach.

Successful fire management needs to address the fire problem at its roots, i.e. the reduction of uncontrolled and undesired ignition of wildfires by people, and the reduction of fire application in rural land-use systems where the desired benign effects of fire are surpassed by adverse effects; and the proper management of forest and non-forest vegetation towards reducing the risk of harmful wildfires.

Land and forest owners and managers need to take prime responsibility in the prevention of wildfires and the proper use of fire. Governmental institutions must cooperate and harmonize their sectoral duties and action. Thus, governments should develop a regulatory framework and incentives to oblige or encourage civil society to take responsibility in wildfire disaster risk reduction.

The very specific knowledge and expertise required for understanding the complex interdependency and interactions between forest and other rural landscape features, land use, climate and fire requires the establishment of an authority, which is mandated, qualified and technically equipped to conduct and supervise fire management, including fire suppression, at landscape level; these are usually the Forest Services and / or other land management authorities.

From the point of view of the Global Fire Monitoring Center (GFMC), the Korea Forest Service, advised by the Korea Forest Research Institute, has developed institutional capacities, personnel and technical resources that are a lead example for the organization of fire management in neighboring countries of Eastern Eurasia. When developing more comprehensive approaches in fire management at landscape level ⁻ncluding rural lands outside of forested lands ⁻he experience of KFS should be considered, and KFS be entrusted and take responsibility to work with stakeholders at all levels to manage the rural landscape fires.

Excellency, honourable participants of this symposium!

May I take the opportunity of this event to reflect about the role of international cooperation in developing fire management capabilities in the nations concerning with wildland fire problems. It is exactly ten years ago when the first International Wildland Fire Summit was held in Sydney, Australia, in 2003. This event happened at a time when the Global Wildland Fire Network was in its early stage of establishment and received a push of recognition and endorsement by the International Wildland Fire Summit. The Korean delegation in 2003 offered to take responsibility in the Global Wildland Fire Network. This was realized by the foundation of the Regional Northeast Asia Wildland Fire Network under the auspices of the United Nations International Strategy for Disaster Reduction (UNISDR) and the Global Fire Monitoring Center. The Network is hosted and coordinated by the Korea Forest Research Institute. In the following years intensive regional exchange was realized with the support of the Korea Forest Research Institute and its partners in the region. In 2009 it was recognized that the four UNISDR Regional Wildland Fire Networks in Asia ⁻he networks in Northeast Asia, Southeast Asia, South Asia and Central Asia ⁻hould strengthen synergies and cooperation in a cluster of networks, called "Pan-Asia Wildland Fire Network", under the auspices of the UNISDR. Sharing experience and human and

technical resources is not only the aim of "economizing" fire management in a region. It is also an inter-cultural and political arena in which countries are coming close to each other, taking advantage of common spirit of the forest management and fire management community in the region, and also addressing fires and fire effects, such as smoke pollution, crossing national borders.

The commitments of the Republic of Korea in regional cooperation in fire management, however, was only the beginning of a larger international engagement.

In 2011 the Government of the Republic of Korea declared its availability to host the 6th International Wildland Fire Conference in 2015. This conference, the unique global platform for all countries and regions addressing wildland fire issues, will be held under the slogan "Fires of the Past ⁻ire in Future".

With the success in national development in fire management, the regional Asian neighbourhood engagement, and with the upcoming global conference in 2015 the Government of Korea, represented by the Korea Forest Service and the Korea Forest Research Institute, has proven engagement, competency and visions to address the fire problems at home, in the neighbourhood and globally.

May I congratulate you for the achievements reached, and may I encourage the participants of this Symposium to continue your engaged work in the future. Speaking on behalf of the international participants of the Symposium I would like to express our confidence and support to work with you in the coming years in the spirit of international cooperation. I am citing the Secretary General of the United Nations, Mr. Ban Ki-moon, who stated in 2011 that

The United Nations welcome the efforts of fire specialists to build a culture of prevention and to develop a spirit of global cooperation...⋯ I encourage you to identify real solutions that will help communities and nations to better handle the adverse impacts of fires and to build safer, more sustainable societies for all.

Background and Objectives

Background

According to recent forest fire reports and some cases such as Moscow in Russia, California in U.S.A., Australia and Greece, forest fire is the main drivers of forest destruction and degradation and contributes severely to the emission of gGreenhouse gases. Many research reports pointed out that the large fire risk of occurrence of large and severe wildfires has been increased by as a concequenceconsequence of climate change, population shift into wildland, and land use change.

A global assessment of recent large fires suggests the application of more balanced and comprehensive forest fire management approaches that better integrate fire-related considerations into natural resource management strategies at the landscape scale.

Lessons from the catastropheic firesremind also that fire suppression should be considered as one of the several fire fields such as fire prevention, safe fire use, forest fire preparedness, suppression, and restoration of damaged area. And simple and clear jurisdiction is needed for avoiding and decreasing the unwanted fire effects.

This symposium may wish to discuss how to enhance the integration of fire management to broader sustainable forest-use, how to establish long-term strategy for forest fire policy and organization and how to achieve the goal of simple and clear jurisdiction.

Objectives

The objectives of the symposium include:
- To discuss global and national level issues and concerns of forest fire paradigms and management, especially future forest fire strategy considering global change
- To share knowledgesand experiences in building enhanced forest fire capacity and inter-agency cooperation in fire management, in order to develop effective forest fire mitigation and response.

Time table

Oral Presentation, January 15, 2013

- In Gayageum Hall B -

Time	Title	Speakers	Affiliation
09:00~10:00	Participants registration		
Moderator : Dr. Kyongha, Kim (Korea Forest Research Institute)			
10:00~10:10	Opening address	Dr. Young-kyoon, YOON	Korea Forest Research Institute
10:10~10:20	Welcome address	Dr. Don Koo, Lee	Korea Forest Service
10:20~10:30	Congratulatory address	Prof. Johann G. Goldammer	Global Fire Monitoring Center (GFMC)
10:30~10:50	Photo Time & Coffee Break		
10:50~11:25	Fire Management Policies and Implementation Strategies in Countries of Eastern Eurasia: Towards Development of Integrated Solutions in Landscape Fire Management	Prof. Johann G. Goldammer	Global Fire Monitoring Center (GFMC)
11:25~12:00	Merging Land Management with Emergency Management – practical steps and challenges	Mr. Mark S. Jones	Buckinghamshire Fire and Rescue Service (United Kingdom)
12:00~13:00	Lunch		
Chair : Prof. Eung Sik, Kim (Hoseo University)			
13:00~13:30	Experiences and lessons learnt of fire management organization, practice and performance in Greece	Dr. Gavriil Xanthopoulos	Institute of Mediterranean Forest Ecosystems and Forest Products Technology (Greece)
13:30~14:00	Disaster Management in Korea	Dr. Ji Bum, Chung	Korea Institute of Public Administration

Time	Title	Speakers	Affiliation
14:00~14:30	Organisation of the forest fire protection in the Southeast European/Caucasus Region	Prof. Nikola Nikolov	Ss. Cyril and Methodius University (Macedonia)
14:30~15:00	Poster Presentation & Coffee Break		
Chair : Prof. Si Young, Lee (Kangwon National University)			
15:00~15:30	Forest Fire Prevention Policy of Korea	Mr. Song Hee, Nam	Forest Fire Control Division, Korea Forest Service
15:30~16:00	Fire management of Korea National Park Service	Mr. Gong Ju, Na	Korea National Park Service
16:00~16:30	Canadian Forest Fire Strategy	Prof. Soung Ryoul, Ryu	University of Alberta (Canada)
16:30~17:00	Towards Regional Cooperation in The Fields of Mitigating Forest Fire in Asia through AFoCO	Dr. Yeong Joo, Lee	Asian Forest Cooperation Organization (AFoCo)
17:00~17:10	Coffee Break		
Chair : Prof. Pil Sun, Park (Seoul National University)			
17:10~17:50	Question and Discussion (All foreign Speakers, Prof. Hyeon Cheol, Moon and Director of Forest Fire Control Division, Korea Forest Service)		
17:50~18:00	Closing Comment		

Posters Presentation & Exhibition, January 15, 2013

Time	Posters Presentation / Exhibition
All day	Poster Display & Exhibition
14:30~15:00	Poster Presentation

Field Trip, January 16, 2013

❍ Subjects : Visit forest fire prevention facilities and field discussion
❍ Places : East Regional Forest Office, Gangneung Forest Aviation Station,
　　　　　Public Information Center for Forest Fire Prevention

Time		Detail	Remark
08:30~11:00	180	The-K Seoul Hotel → East Regional Forest Office	Gangneung, Gangwon-Do
11:00~11:50	50	Introduction of Forest Fire Prevention Strategies in East Region	Interview and Briefing
11:50~12:00	10	East Regional Forest Office → Seonkyojang	
12:00~13:00	60	Lunch	
13:00~13:20	20	Seonkyojang → Public Information Center for Forest Fire Prevention	
13:20~13:50	30	Visit Public Information Center for Forest Fire Prevention	
13:50~14:20	30	Public Information Center for Forest Fire Prevention → Gangneung Forest Aviation Station	Gangneung, Gangwon-Do
14:20~15:00	40	Visit Forest Aviation Station	Interview and Briefing
15:00~18:00	180	Gangneung → The-K Seoul Hotel	Seoul

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1. Fire Management Policies and Implementation Strategies in Countries of Eastern Eurasia: Towards Development of Integrated Solutions in Landscape Fire Management

2. Merging Land Management with Emergency Management – practical steps and challenges

Fire Management Policies and Implementation Strategies in Countries of Eastern Eurasia:

Towards Development of Integrated Solutions in Landscape Fire Management

Prof. Dr. Dr. h.c. 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

Most wildfires affecting the landscapes of Eastern Eurasia occur as a consequence of human activities. Agricultural burnings, accidental fires starting by forest users, including collectors of non-timber forest products such as medical and eatable plants, industrialization accompanied by recent economic growth, recreation, tourism, etc. are the main causes of wildfires affecting forests and other vegetation types. The currently observed trend of global warming involves a change of regional climate patterns. According to climate models and the recent weather records an increase of temperatures as well as an occurrence of prolonged droughts has been observed in many parts of the world including Eastern Eurasia. As a consequence of climate change and fire effects the sustainability of forest and non-forest ecosystems in the region, including discontinuous and continuous permafrost sites and peatlands, will be increasingly threatened. Already now the countries of Eastern Eurasia are experiencing a growing occurrence of wildfires in forests and other vegetation (wildland fires), which are impacting the natural environment and society. Fires contribute to the degradation of the soil, water resources and the atmosphere, endangering the sustainability and biodiversity of ecosystems, and threatening human health and security. Eastern Eurasian countries and the international community are increasing their efforts to manage the fires and to reduce their negative impacts.

There is strong consensus that fire and land management should follow the principle of an integrated approach, i.e. the need to work with land owners, land managers, peasants and other rural dwellers to prevent wildfires, to capacitate land managers to safely apply land-use fires where appropriate and needed by prescribed burning, and to actively participate in the suppression of unwanted and destructive fires. Clear jurisdictions are needed to efficiently implement the principles of "Integrated Fire Management" and to reduce the risk of wildfires at landscape level. Forest and other rural land management services should be entrusted to lead these tasks.

INTRODUCTION: CURRENT FIRE ISSUES IN EASTERN EURASIA

In May 2011 the representatives of countries from Asia met at the 5th International Wildland Fire Conference in South Africa. In a dedicated Regional Session the fire situation in Asia was analyzed and summarized as follows (complete report: see Annex I):

- In equatorial Asia the use of fire in converting native primary or secondary vegetation is highest in the region. Main current burning activities are related to conversion of peatlands to plantations, notably biofuel plantations, clearing agriculture land and slash-and-burn agriculture. Wildfires spreading from land-use fires are favoured by dry spells or extended droughts during El Nino-Southern Oscillation (ENSO) events. Increasing severity and frequency of ENSO events are a consequence of global climate change.
- In the seasonal forests of mainland South and Southeast Asia regular seasonal smoke pollution caused by wildland fires are aggravated by industrial pollution and other burning activities such as trash burning. The so-called *Asian Brown Cloud* or the seasonal smoke pollution in Northern Thailand and southern range of Hindu Kush Himalayan region are a consequence of multiple sources of fire. Wildfire-generated smoke pollution at local level but also in remote locations due to long-range transport is also regularly observed in Central and Northeast Asia, with negative consequences on human health and security.
- In the mountain regions of the Himalayas regional warming linked to climate

change is predicted to alter the snow and ice regimes in high-altitude ecosystems. Rapidly melting glaciers will not only impact the drinking water supply of around one billion people but also may affect regional vegetation dryness and fire regimes.

− In Northeast Asia, notably in the Far East of Russia, mixed forest ecosystems are becoming increasingly vulnerable to fire as a consequence of regional climate change, careless fire use and reduced institutional capacities to manage fires.

− In Central Asia the accumulating effects of land-use change, widespread non-sustainable forest use including illegal logging, regional climate change and wildfires are resulting in an expansion of grassland / steppe ecosystems at the expense of forest cover.

Similarly to Central and Western Eurasia several key issues have been identified, which are affecting the risk of wildfire occurrence and the impacts of wildfires on the environment and on human security:

− In many countries, including the Republic of Korea, an acceleration of rural exodus is observed, i.e. migration of rural populations to urban centers, resulting in abandonment of traditional land cultivation (agriculture, pastoralism, forestry). In some places abandonment of land use is leading to formation of fallow lands characterized by a high wildfire hazard.

− As a consequence of urbanization, especially young people moving from villages to towns and cities, the rural work force is reduced. This is also affecting the availability of rural voluntary and professional firefighters and leaving behind elderly village or hamlet populations, who cannot cope with the increasing fire hazards and risks.

− The re-privatization of formerly nationalized forests in some countries has resulted in smallholder forest estates which are often not managed properly because the owners are living far away from their properties, mostly in urban areas. Thus in such private forests there are often limited to none forest and fire management activities.

− Increasing occurrence of wildfires affecting the perimeters of metropolitan areas, settlements and developments dispersed throughout wildlands, either

directly, or indirectly through smoke pollution which is dangerous to human health and security.

- Secondary problems arising from wildfires burning on territories contaminated by pesticides, landfills, other industrial waste and structures containing hazardous materials, especially at the urban / residential perimeters.

- Increasing vulnerability of some ecosystems to wildfires, e.g. formerly drained peat lands (or peatlands desiccated due to climate change) in the temperate-boreal and subtropical-tropical vegetation zones of Eastern Eurasia; or high-altitude mountain ecosystems, such as the Himalaya-Hindu Kush region.

IMPLICATIONS FOR FIRE MANAGEMENT POLICIES AND IMPLEMENTATION STRATEGIES

Addressing the Fire Risk at its Roots

Altogether it is evident that all over Eurasia, like elsewhere in most regions of the world, human activities determine or alter landscape fire regimes. At the same time society is becoming more vulnerable to fires burning in natural and cultural landscapes. This implies that people-centred approaches in fire management are required to meet these changes.

In the Regional Report of Asia elaborated at the 5th International Wildland Fire Conference it was stated that "there is increasing interest and proactive action in Community-based Forest Fire Management (CBFiM) approaches in most of the countries in this region." This statement is reflecting the recognized approach that successful management of fire needs to be realized primarily with or through:

- Users of land-use fires and originators of wildfires: Those who using fire in land and forest management (traditional or advanced, science-based prescribed burning practices), or causing wildfires (accidental, negligent).

- People affected by fire: Those who are directly affected by wildfire (private and public land users, forest and other rural land managers and / or owners; people living at the interface between vegetation lands and peri-urban residential areas or interspersed in fire-prone landscapes); and those who are

indirectly affected by long-range or secondary impacts (e.g., smoke pollution, post-fire landslides or floods).

− Fire managers: Those who are responsible for fire management (public and private owners of forests and other rural lands, and forest and rural land managers)

Integrated and Community-based Fire Management

To address the users of fire, the causative agents of wildfires and those affected by wildfires the approach of "Integrated Fire Management" has been conceptualized in the early 1990s. This is reflected by a definition laid down in the FAO / GFMC Multilingual Wildland Fire Management Terminology (GFMC, 1999):

Integrated Forest Fire Management (IFFM)

Designation of fire management systems which include one or both of the following concepts of integration: (1) Integration of prescribed natural or human-caused wildfires and/or planned application of fire in forestry and other land-use systems in accordance with the objectives of prescribed burning; (2) Integration of the activities and the use of the capabilities of the rural populations (communities, individual land users) to meet the overall objectives of land management, vegetation (forest) protection, and smoke management (Community-Based Fire Management). Note: In case of absence of forests in the area concerned the term Integrated Fire Management (IFM) is used instead.

Community-Based Fire Management (CBFiM) is a type of land and forest management in which a locally resident community (with or without the collaboration of other stakeholders) has substantial involvement in deciding the objectives and practices involved in preventing, controlling or utilising fires.

The CBFiM approach is based on the principles of including local communities in the proper application of land-use fires (managed beneficial fires for controlling

weeds, reducing the impact of pests and diseases, generating income from non-timber forest products, creating forage and hunting, etc.), wildfire prevention, and in preparedness and suppression of wildfires. CBFiM approaches can play a significant role in fire management, especially in those parts of the world where human-based ignitions are the primary source of wildfires that affect livelihood, health and security of people. The activities and knowledge communities generally practiced are primarily those associated with prevention. They include planning and supervision of activities, joint action for prescribed fire and fire monitoring and response, applying sanctions, and providing support to individuals to enhance their fire management tasks. Communities can be an important, perhaps pivotal, component in large-scale fire suppression, but should not be expected to shoulder the entire burden (GFMC, 1999).

Faced with increasing fire occurrence and decreasing public budgets, government departments, local organizations, and forest users must consider a range of fire management options and experiences from around the world. Increasingly the solutions to the fire problems and the persistence of them year after year is suggesting that the reaction to fires to date in many countries needs to be reviewed. An active role of communities as proactive actors in fire management ⁻n particular those which recognize the responsibility of civil society to plan and perform fire management activities ⁻ay avoid pitfalls and mistakes of the past. These approaches are seen as more effective, less costly, and more sustainable over the long term.

High−Level Recognition and Endorsement of Principles of Fire Prevention by UN Secretary General Ban Ki−moon

In his opening address at the last International Wildland Fire Conference in South Africa (May 2011) the UN Secretary General Ban Ki-moon stressed:

"Wildland fires destabilize ecosystems and the global atmosphere, and have clear implications for human health and security. Unlike other natural hazards, wildland fires are primarily caused by human activities. Measures to prevent them −uch as education, awareness-raising and capacity-building −re well

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known and within reach. Community-Based Fire Management is particularly important."

 The transboundary effects of wildland fires associated with long-range smoke transport and emissions are prompting the international community to strengthen cooperation in fire management. International organizations and civil society groups are working to build capacity, develop advanced technologies and promote sustainable land-use practices.

The UN system is strongly committed to this effort. Our work encompasses many aspects of fire management, including agriculture, forestry, health, science, the environment, emergency response and weather forecasting and monitoring.

We welcome the efforts of fire specialists to build a culture of prevention and to develop a spirit of global cooperation...... I encourage you to identify real solutions that will help communities and nations to better handle the adverse impacts of fires and to build safer, more sustainable societies for all.

At present, some countries of the Asia-Pacific region are initiating community-based approaches to wildland fire management.

This is happening at a time, as stated above, when many countries of the Asia-Pacific region are noting an increase of forest fires and other vegetation fires. The increasing occurrence of extreme dry spells and heat waves currently observed, as well as climate modeling-based predictions (general circulation models), suggest that extreme weather periods favoring the recurrence of more frequent and larger wildfires and higher associated damages will aggravate in the coming years and decades in the Asia-Pacific region.

Wildfires, if not well managed, might pose not only immediate risk to the sustainability of forest and non-forest ecosystems, threat to biodiversity and the recreational, scenic, environmental and cultural value of forests. Populations of the surrounding areas may become seriously affected by injuries, death, and losses in

properties. Post-fire secondary disasters such as landslides, mudflows or floods are additional threats to human populations, especially in the mountain terrains of the Asia-Pacific region.

Integrating the Management of Wildfire-related Risks in Rural Land and Forest Management Legislation and Policies

On behalf of the for the Australia-New Zealand Forest Fire Management Group (FFMG) Dudfield (2012) urged to understand "the connections between fire, rural land use and the associated legal, regulatory, policy and institutional frameworks dealing with these matters need" and to consider connections in the development national policies and implementation strategies in integrated fire management.

The concept paper "Integrating the Management of Wildfire-related Risks in Rural Land and Forest Management Legislation and Policies" was developed on behalf of the Australia-New Zealand Forest Fire Management Group (FFMG), presented jointly by New Zealand Ministry of Primary Industries and the Australia Department of Agriculture and Forestry representatives at the 24th Meeting of the Asia-Pacific Forestry Commission (APFC), discussed and endorsed by the UNISDR Wildland Fire Advisory Group (WFAG) at its biennial meeting in 2012 and at the 21st session of the FAO Commission on Forestry (2012). This paper is framed around four propositions:

- Forest wildfire management should be based on the application of contemporary risk management principles, policies and practices.
- Management of fire, including its use as a management tool, should be integrated into forest and rural land management policy, legal and regulatory frameworks.
- Laws, regulations, policies and practices related to fire, forest and rural land management should be coordinated nationally across the most relevant institutions in transparent and participatory approaches with formal input by local key forest and land management stakeholder groups, including communities.
- An international standard for managing wildfire-related risks based on the

existing International Organisation for Standardization (ISO) standard for risk management, and drawing on the existing UN Fire Management Voluntary Guidelines (2006) can provide an effective basis for an international guideline towards integrating national and sub-national wildfire-related risks into forest and rural land management principles, policies and practices.

The paper postulates further that "Wildfire risk management is invariably the responsibility of those who "own" the risk and should be included as an integral part of forest and rural land management, contrary to the situation where fire "response" accountabilities are contained under separate legislation in some countries. Linking wildfire and rural land and forest management objectives under a common statutory framework will enable the relevant agencies to simultaneously address fire both as a source of risk and as a risk treatment, while also considering the risk inherent in the treatment itself. Possible examples of the latter could include:

- Minimising the exposure of sensitive adjoining land when using fire to reduce fuel hazards; or
- Reducing the risk of increased erosion or loss of species following a planned fuel reduction burn.

The proposal further states that

- The inclusion of wildfire management in rural land and forest management decisions involves considering risks related to wildfire along with other forms of risks as an integral part of the overall process of assessing land and forest management objectives. Effectively this requires rural land and forest managers or owners to "take ownership" of the fire risk elements."
- Consultation across all agencies with rural land and forest management responsibilities is crucial for good policy, standards and practices formulation. In this respect it is important that the views of the different fire response capabilities are sought. Often times, as is the case in parts of Australia and in New Zealand, there is a separate rural fire force responsible for land outside communities where there is "urban" fire response capability. Rural and urban response agencies are configured differently and have different sets of skills and methods of approach. After considering human safety, in urban

areas the response agencies have the primary role of structure protection. Whereas response agencies from rural areas are mainly concerned with limiting spread of fire, protecting forested and other rural lands and protecting infrastructure and assets.

A New Zealand case study below illustrates how a fire management administration puts into practice many of the concepts discussed above.

In conclusion, the paper states that currently "there is limited reference to fire management in national laws, regulations policies and the institutional frameworks for fire management and some time these are not always clear. At the same time, there is no internationally agreed risk management standard for managing the risks associated with wildfire. In order to assist the integration of wildfire-risk management within rural land and forest management policies, an international standard or guideline needs to be developed on managing the wildfire-related risks. Such a standard would benefit from being based on existing international risk management frameworks which could assist in the adoption of fire risk management policies within countries that are consistent with other forms of risk management. This will ensure that common approaches are used internationally, leading to best-practice fire management policies and practices and ultimately enhanced protection of rural lands, forests, natural ecosystems and communities."

New Zealand Case Study

In New Zealand, the Fire Service Commission (the Commission) is the statutory agency responsible for all urban fire forces (paid and volunteer) and for the general promotion of national fire safety including funding research. Within the Commission is the National Rural Fire Authority (NRFA) which is responsible for coordinating rural fire authorities throughout New Zealand and can fund fire suppression on private land where this cannot be cost recovered from the property owner.

The rural fire force capability relies largely on resources drawn from organisations involved in land management activities. These organisations include forest owners and management contractors, local government authorities, the national conservation agency administering protected lands, aviation firms operating in rural areas, companies involved in road construction, forest harvesting, silviculture and control of pests and weeds and volunteers. Coordinating the community-based groups ensure that there are common wildfire management policies and processes as well as common standards for technical competency, safety and specialist fire fighting equipment. National coordination, consistent approaches and a fire danger rating system also underpin both fire prevention (e.g. public education, restrictions around fire use) and fire suppression activities.

The legislation that establishes and empowers the roles of the Commission and NRFA is explicitly dovetailed with other legislation, particularly, the Forest and Rural Fires Act. This statute allocates powers and responsibilities for aspects of land and forest management and places obligations on land owners. Not only is this integrated approach efficient, but it ensures the involvement of land managers and foresters with their expertise and practical knowledge in responding to wildfire, in land management policies and strategies that take account of fire risk and it incorporates their understanding of the use of fire (as 'prescribed burns') to achieve the land and forest management objectives.

Self-Defence of Local Communities against Wildfires

The realization of approaches in Integrated Fire Management, the involvement of local rural communities in fire management and the establishment of a legal and regulatory framework for the integration of management of wildfire-related risks in rural land and forest management will require a political dialogue at national level, with the participation of all stakeholders of civil society and the agencies concerned. Pragmatic building of local capacities to defend rural assets against destruction by wildfires must receive highest priority and shall not wait until the larger picture is addressed by innovative legal frameworks. Guidelines are needed that will provide

information to local inhabitants (farmers, community leaders, local fire service units, volunteer firefighters and village defence committees) with state-of-the-art information on wildfire damage prevention measures, and pragmatic measures for the defence of settlements and rural assets threatened by wildfires. With such guidelines local communities will be capacitated to apply all fire safety regulations for protecting the structures of the community (clearing vegetation, provide extra sources of water, application of appropriate building codes and use of appropriate materials, etc.) and for the protection of rural populations against the adverse effects of vegetation fire smoke pollution on human health and security. Also, the problem of fires burning on terrain altered by human activities, such as fires affecting dispersed, sometimes abandoned structures, waste deposits / garbage dumps and otherwise contaminated lands, needs to be addressed due to the highly toxic emissions generated by co-burning of natural vegetation and technical / chemical produce.
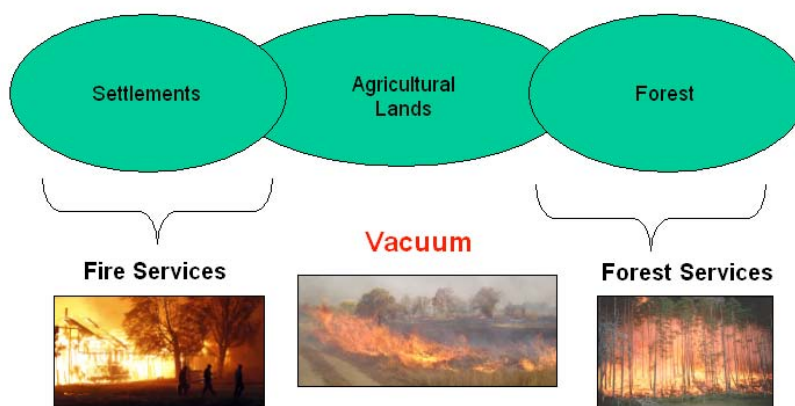
Figure 1. Fires burning in the open rural landscapes (actively managed and abandoned agricultural lands, pastures and other non-forest vegetation) are the primary sources of forest fires. In many countries there are legal gaps and technical deficits to address these fires. Forest Services and the owners and managers of private forests and other rural lands should be entrusted in the authority of fire management in the rural space and develop participatory approaches with land-use planning authorities, land users and other local populations in reducing wildfire risk at landscape level.

To empower local communities in managing fire and to defend their assets and security of rural inhabitants against wildfires, the UNISDR Pan-Asia Wildland Fire Network, a cluster of the four Asian UNISDR Regional Wildland Fire Networks (Northeast Asia, Southeast Asia, South Asia and Central Asia) and the UNISDR Regional Eurasia and Southeast Europe Caucasus Wildland Fire Networks have initiated activities to address the issue. In 2012 the Korean Forest Research Institute (KFRI) sponsored the realization of the regional Pan-Asia / Pacific consultation "Building Advanced National and Regional Capacities in Integrated Fire Management based on Participatory Involvement of Local Communities", which was held under the auspices of the Ministry of Forests and Soil Conservation (MFSC), Government of Nepal, the Korean Forest Research Institute (KFRI) and the Global Fire Monitoring Center (GFMC) representing the UNISDR Global Wildland Fire Network (Lalitpur, Nepal, 20-22 November 2012). The main objectives of the meeting were:

- To share knowledge and experiences of good practices in Community-based Fire Management (CBFiM) among countries of the Asia-Pacific region and outside of Asia
- To discuss global, regional as well as national level issues and concerns of wildland fire paradigms and management of wildland fire involving local communities
- To develop the concept of a regional activity in community-based fire management in the Asia-Pacific region
- To develop a draft concept of building a pilot activity in Nepal and at regional level to promote CBFiM approaches by establishing a Regional Fire Management Resource Center for monitoring, capacity building and advisory services in fire management.

Seventy-two participants from 10 countries attended and contributed to the meeting. They assessed that within the four regions of Asia that are belonging to the UNISDR Global Wildland Fire Network and the Pan-Asia Wildland Fire Network, forest fires and other vegetation fires are increasingly impacting the environment and societies and agreed upon recommendations to the governments of countries in the Asia-Pacific Region to develop appropriate policies and enhance national to local capacities in participatory fire management.

The UNISDR Eurasia Wildland Fire Network and the Southeast Europe / Caucasus Wildland Fire Network are working closely with the Pan-Asia Network to develop the "Guidelines for the Defence of Rural Populations, Settlements and Other Assets against Wildfires and Smoke Pollution". The Guidelines are currently prepared with the support from the European and Mediterranean Major Hazards Agreement (EUR-OPA) and its collaborating European Forest Fire Center (Greece), the Global Fire Monitoring Center (Germany), the Regional Southeast Europe / Caucasus Fire Monitoring Center (Republic of Macedonia) and the Eastern European Fire Monitoring Center (Ukraine). Members of the UNECE/FAO Team of Specialists on Forest Fire and the UNISDR Regional Eurasian and SE Europe / Caucasus Wildland Fire Networks will contribute to the development of the guidelines.

CONCLUSIONS AND OUTLOOK

From the review of the current wildland fire problems and the possible future wildland fire threats in Eastern Eurasia some conclusions and recommendations are given for the development of fire management policies and the organizational structures responsible for integrated fire management in Eastern Eurasia including the Republic of Korea:

- The demographic and socio-economic changes in many countries of Eastern Eurasia, associated with rural land-use change, changing natural and cultural fire regimes, and coupled with the effects of climate change, are resulting in an increasing occurrence and destructivity of wildfires, and in increasing vulnerability of society to fire effects.

- The management of wildfire risk and threats in natural and cultural landscapes, which are determined by the interaction between landscape features, climate and the dwellers in and the users of the landscapes, require a holistic approach.

- Successful fire management needs to address the fire problem at its roots, i.e. the reduction of uncontrolled and undesired ignition of wildfires by people, and the reduction of fire application in rural land-use systems where the desired benign effects of fire are surpassed by adverse effects; and the proper

management of forest and non-forest vegetation towards reducing the risk of harmful wildfires.

‒ Land and forest owners and managers need to take prime responsibility in the prevention of wildfires and the proper use of fire

‒ Governmental institutions must cooperate and harmonize their sectoral duties and action (inter-agency cooperation).

‒ Governments should develop a regulatory framework and incentives to oblige or encourage civil society to take responsibility in wildfire disaster risk reduction.

‒ The very specific knowledge and expertise required for understanding the complex interdependency and interactions between forest and other rural landscape features, land use, climate and fire requires the establishment of an authority, which is mandated, qualified and technically equipped to conduct and supervise fire management, including fire suppression, at landscape level; these are usually the Forest Services and / or other land management authorities.

‒ Urban Search and Rescue Services, Fire Services and Civil Protection Services shall receive appropriate training to qualify them to assist in fighting large fires and in fire emergency situations.

From the point of view of the Global Fire Monitoring Center, the Korea Forest Service, advised by the Korea Forest Research Institute, has developed institutional capacities, personnel and technical resources that are considered to be example for the organization of fire management in neighboring countries of Eastern Eurasia. When developing more comprehensive approaches in fire management at landscape level the experience of KFS should be considered, and KFS be entrusted and take responsibility to work with stakeholders at all levels to manage the rural landscape fires. Laws, regulations, policies and practices related to fire, forest and rural land management should be coordinated nationally across the most relevant institutions in transparent and participatory approaches with inputs by local key forest and land management stakeholder groups, including communities.

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ANNEX I

Regional Session III: Asia Cluster: The Pan-Asia Wildland Fire Network −ortheast, Southeast, Central and South Asia

11 May 2011, 15:50 −8:00

Conclusions and Recommendations

General Fire Assessment

Ecosystems throughout the Asian region are undergoing changes in wildland fire regimes. These changes are primarily induced by humans and aggravated by climate extremes. In equatorial Asia the use of fire in converting native primary or secondary vegetation is highest in the region. Main current burning activities are related to conversion of peatlands to plantations, notably biofuel plantations, clearing agriculture land and slash-and-burn agriculture. Wildfires spreading from land-use fires are favoured by dry spells or extended droughts during El Nino-Southern Oscillation (ENSO) events. Increasing severity and frequency of ENSO events are a consequence of global climate change.

In the seasonal forests of mainland South and Southeast Asia regular seasonal smoke pollution caused by wildland fires are aggravated by industrial pollution and other burning activities such as trash burning. The so-called *Asian Brown Cloud* or the seasonal smoke pollution in Northern Thailand and southern range of Hindu Kush Himalayan region are a consequence of multiple sources of fire. Wildfire-generated smoke pollution at local level but also in remote locations due to long-range transport is also regularly observed in Central and Northeast Asia, with negative consequences on human health and security.

In the mountain regions of the Himalayas regional warming linked to climate change is predicted to alter the snow and ice regimes in high-altitude ecosystems. Rapidly melting glaciers will not only impact the drinking water supply of around one billion people but also may affect regional vegetation dryness and fire regimes.

There is increasing interest and proactive actions in Community-based Forest Fire Management (CBFiM) Approach in most of the countries in this region.

In Northeast Asia, notably in the Far East of Russia, mixed forest ecosystems are becoming increasingly vulnerable to fire as a consequence of regional climate change, careless fire use and reduced institutional capacities to manage fires.

In Central Asia (which due to technical and thematic reasons participated in Regional Session V (Eurasia, Southeast Europe / Caucasus and Central Asia) the accumulating effects of land-use change, widespread non-sustainable forest use including illegal logging, regional climate change and wildfires are resulting in an expansion of grassland / steppe ecosystems at the expense of forest cover.

Conclusions and Recommendations:

Being aware that in most countries the problems associated with excessive application of fire in land use and the humanitarian and security consequences of fires and fire emissions are not yet solved, the participants of the Regional Session "III" recommend authorities in all levels and international organizations:

South Asia

To support countries to conduct national fire and fire management assessments, formulate legal frameworks and strategies, build sustainable fire management capabilities and institutions, develop fire management plans and human resources;
To develop National Fire Management Guidelines;
To give emphasis to improvement of participatory / community-based fire management approaches and institutional and technological capabilities at all levels;

To promote education and awareness-raising programmes on wildland fires;

To support countries in developing/ providing fire fighting tools and equipments

To enhance cooperation among countries in the Asia region aimed at sharing technology, expertise and data in fire management;

To implement the objectives of work of the UN-ISDR Wildland Fire Advisory Group / Global Wildland Fire Network and Global Fire Monitoring Center (GFMC) and to support implementation of building fire management capability at both local and national levels, as well as through bilateral and multilateral cooperation agreements;

To establish a regional South Asian Fire Monitoring Center, which in future may also serve as a regional coordination centre for wildfire disaster response;

To create an enabling environment from all possible donors including national, international, bilateral, multi-lateral and private foundations for financial, technical and other resource support for sustainable fire management;

To develop the non-legally binding bilateral and multilateral agreements on cooperation in wildland fire management including Global Strategy of Cooperation.

Southeast Asia

To strengthen forest fire research work conducted in the region by providing funding, exchange between forest fire scientist and periodical meetings with scientist within the region

To promote inter-regional cooperation in disaster reduction through ASEAN, GOFC/GOLD Regional Network, UN-ISDR Wildland Fire Advisory Group / Global Wildland Fire Network and Global Fire Monitoring Center (GFMC) network.

To integrate forest fire management in the REDD++ projects hence lowering the risk of fire occurrences in long-term projects

To develop mitigation and adaptation strategies of the anticipated higher fires frequency in future climate scenario

To encourage and support community in organising forest fire management organisation in the community. Experiences of successful community-based fire management can be shared throughout the region.

To develop rehabilitation techniques in degraded burnt peat swamp forest and

forest lands.

To share and transfer of technology which can help in detecting, monitoring and controlling wildland fires.

Northeast Asia

To establish a UNISDR-Pan-Asian Wildland Fire Network representing four regional Networks consisting 21 countries in the region. The secretariat of the Network shall be established in South Korea.

To hold a 4-yearly series of Pan-Asian Wildland Fire Conference and the first in 2013 in South Korea.

Translate Fire Management Dictionary also into Korean language.

Hold a consultative inter-regional meeting among the networks of South Asia, Southeast Asia, Northeast Asia and Central Asia, by inviting the Sub-Sahara Africa Wildland Fire Network for sharing knowledge on Community-based Fire Management (CBFiM) approaches in 2012.

The participants of the Regional Session III urge authorities and international organizations to provide the financial and technical assistance to the Global Wildland Fire Network, and in particular to the three regional networks represented in this session. In order to realize this, a strategic plan including a timetable of concrete actions in fostering international cooperation must be developed. One of the important steps is the organization of the follow-up work at national level in each country. The major steps in cooperation must be carried out on the national level, including annual meetings of the Regional Wildland Fire Networks, and joint projects of implementation:

The network members should take advantage of the accumulated expertise in fire management and international cooperation by international community;

To foster the bilateral and multilateral cooperation in wildland fire management, realization of joint research and practical projects advancing the knowledge on wildland fires;

Member countries should also promote inter-regional cooperation, including joint

investigations, joint fire management demonstration projects, consultations, and conferences.

To strengthen the UNISDR Pan-Asia Wildland Fire Network;

Technological and financial support must be provided by donor communities to financially disadvantaged countries in building capability in wildland fire management.

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Merging Land Management with Emergency Management - practical steps and challenges

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Abstract

Developing policies to cope with Forest Fires is a challenge faced by many nations. The key issues which affect policy development are ever-changing and policy-makers must be nimble and ready to review their plans as new evidence and occurrences are apparent. In observing the objectives of this symposium, I propose to focus on the key issues affecting wildfire preparation from a Fire Chief's perspective. After describing my assessment of the key challenges, I will offer some examples of successful strategies from the United Kingdom and will discuss my view that prevention and preparation for fires in forests is best undertaken by those agencies which manage the forests.

The three largest global influences upon plans to manage forests are Climate, People and Economics. I understand that the contribution of Professor Goldammer will focus on People - therefore I am focusing on Climate and Economics.

Climate

Globally, as well as predicting (and now observing) shifts in temperatures and precipitation, there seems to be a trend towards less predictability and greater extremes. This creates very specific challenges for emergency planners (and perhaps even more so for long term planners such as foresters). In my experience, planning assumptions are not often proactively tested to the point of failure during the rehearsal stages and this may have serious implications when large scale events do occur.

When reading South Korean climate predictions and the IPCC reports for climate change prediction in temperate coastal areas of Asia, the change of climate may present many other risks to the forests than fire. These are well noted within the KFS's National Forest Plan but it occurs to me that many of those challenges may be more prevalent, costly if realised, of greater public concern and (consequently) more politically influential than fire risk. Examples include pests which damage forests and changing natural tolerance of species in certain areas.

These two extracts serve to further emphasise the wider possible impacts:

"Almost all forest trees would grow better under a warmer climate, but increases in diseases, insect damages, and other meteorological hazards (e.g., severe storm damage) also may result in a shortened life for forest trees" (Tsunekawa et al., 1996a).

"When the original species in a forest decline, other species from neighbouring forest zones more suitable for warmer conditions would grow. If there were an afforested region or broad cultivated area between natural forests, such changes would not occur. The impact of warming would occur noticeably on a time scale of decades to centuries, in areas where the distribution of plant communities is continuous". (IPCC 1997)

To give a local example, in the United Kingdom, climate change has affected many iconic tree species over the last 10 years and the most recent national outcry was at the loss of many of the Ash trees (*Fraxinus excelsior*) which suffered *sudden die back* due to the fungus *Chalara fraxinea*. These losses considerably outweigh those sustained by a bad fire season in commercial terms.

These considerations also force us to think outside our immediate area of interest. Other climate change related effects (which are not directly affecting forests) will also be of great and constant concern to citizens, such as Human diseases borne by parasites such as malaria or flooding. Both of these are readily identifiable and can affect urban areas. I note the growing Malaria rates within South Korea and would contend that, when seeking relevance and influence at high levels, matters such as these will take precedence. Summarising, I contend that all agencies tasked with fire preparation and prevention will have to be ready to compete for relevance and funding with other, competing, political fields of influence.

Climate change seems to indicate that, for almost all temperate areas, there will

be an increased consequent risk of fires developing. This interpretation is too simplistic however. When assessing the times at which the risks are high and what they might actually be, it is important to make certain distinctions. Firstly, the risks of large fire events occurring seem to be more infrequent and less predictable: essentially, the risks may not be realised in all years and never in all areas. Politically, this presents difficulties in making the case for fully funded preparations.

I note that, in South Korea, about 65% of forest fires occurred during the dry season of 3 consecutive months, March through to May. Some great work abounds within your own Forest Service which analyses the frequencies and severities of fires in South Korea. These two measures are the basis of a risk assessment matrix which can assist with planning.

Economics

Studying the reports from various disasters and large forest fires internationally, I can find some examples of estimates of the costs of the damage and the costs of dealing with the incident. I can see almost no such assessment being used at the pre-planning stages to make balanced risk assessments to decide upon the best methodologies to give protection. As a fire engineer with an urban firefighting background and training, I find this approach unusual. Put bluntly, why would we seek to expend valuable resources to protect any asset without knowing what value we were trying to maintain? It is clear that not all forests might have quantifiable commercial value but some estimation of what other values they have gives clarity to protective strategies.

The costs of preparing for fires can be high. That is why all preparatory actions must be economically justifiable and demonstrably tied to mitigation of identified risks. Some simple economic statements can help to define the challenges we face:

The timber assets we protect have varying asset values

The amenity value is usually not estimated

Generally, effective risk assessments, based upon data and accurate predictions are rare

The multiplicity of interests on forest fires also combines to create tensions -Agencies such as mine tend to adopt an intolerant and fixed fire suppression/

extinguishment attitude but, in working closely with land managers, it is possible for firefighters to comprehend the concept of "Sacrificial areas" and fires which are beneficial to certain environments.

What is the real problem?

Wildfire is not a new phenomenon and is recorded in all countries throughout human history. This causes us to ask - what is changing? It seems to me as a fire manager that most of the modern attitudes to wildfire have developed over the last 50 years and, contrary to what science might suggest is required, there seems to be a growing intolerance of its use as a land management tool in developed countries. This same societal attitude gives little cognisance to what the real threats posed by forest fires might be - they simply want them not to happen and to be extinguished efficiently when they do.

Without a detailed and considered assessment of which activities are likely to be most affected by fires, including recreational use, associated agriculture, forest management, and timber asset values, it seems difficult to inform policy wisely.

Similarly, the broader societal threats which might exist? e.g. threats to Human Health, loss of Carbon storage should at least be investigated. Another key consideration for the definition of the true problems is what impacts recent fires might have had on attitudes - Will the fires (or prevention of them) have the impact of changing citizen attitudes or intended land uses?

By being able to answer the questions posed, fire managers can start to plan a strategy which will be appropriate. Those answers seem to require a large amount of research and the Korean Forest Service is recognised as being prominent in leading such research.

In defining the problem in a country or region, the number or size of fires is often quoted but they in themselves only quantify frequency and magnitude. The impact had by any fire may not be solely correlated simply to those factors. As in South Korea, in the United Kingdom, fires tend to be of small size, readily detected and attacked quickly. Very rarely do they burn for more than a part of one day. Their impact can be very severe however - the comparative similarities with South Korea are clear.

Table 1. Comparisons between the United Kingdom and South Korea

Comparisons	United Kingdom	South Korea
Area	243,610 square Km	100,210 Square Km
Population	around 63 million	around 50 Million
Climate	Temperate	Humid Continental
Fire Response	Local Government	Local Government and Forest Service
Forest ownership	82% private	Over 60% private
Main Wildfire Season	March- June	March - May

Another key similarity between our countries is that few people are killed by forest fires.

Because of the high comparative population density, a fire does not need to be large or of long duration to adversely impact upon transport infrastructure or urban and populated areas. This "infrastructure fragility" is the reason that requires fire responders to be able to efficiently deal with fires. There is also the possibility in the United Kingdom that dealing with wildfires at peak periods can distract from national security and cause some vulnerability to terrorism. This was even a small consideration during the planning stages for London's Olympics. In May 2011 for example, a relatively medium sized (in global terms) wildfire (around 200 hectares) totally distracted a number of Fire Services for almost a week in an area of Southern England.

In many countries, the impacts of the global recession and the consequent reductions in public expenditure and land management activities by private landowners have also combined to reduce the potential firefighting resources available in both public and private ownership. I really welcome the Korean Forest Service's focus on fire causation which will allow prevention strategies to be informed thus allowing the visible and effective range of strategies that has been developed.

It also seems apparent that, given the very specific calendar period in which high risk occurs in countries such as South Korea, some of the resources maintained could be marketed as being of utility to other nations who have differing fire

seasons. In this way, costs can be shared or income generated.

Demands upon Governmental Resources

I am often mindful of the fact that, in many countries, those who deal with large forest fires are not always those who will bear the costs if things go wrong. Whatever national arrangements are chosen, it seems vital that those who will prepare to deal with fires are aware of the ramifications of not doing so effectively. The value of timber has varied much over the years and just as with any other commodity, its market value will be volatile. The true costs of catastrophic wildfires are rarely assessed or truly presented. Both of these facts make it difficult for governments to commit tax receipts to preventative and protective strategies.

All over the world, societies are changing - as they get more urban in nature, the desire of people to spend recreational time in the forests has grown and in most countries, this has had the effect of raising fire risks. I often use a humorous argument that, in the United Kingdom, there are only 3 causes of fires - "Men, Women and Children". In wildfire terms however, it may be true and South Korea's own causation statistics are similarly attributed.

There is always a tension between local preparation and response to fire management and the desire of national governments to rationalize resources and gain efficiencies. A real risk exists however that when large scale or critical fires do occur the "expertise" required to deal with them may have to be imported from other areas. If such actions are required, much of the good work that has been done in planning locally can be lost and valuable local connections missed. Even in those countries in which central leadership is imposed for certain large scale disasters, it is recognised that government edict cannot manage incidents at local level and, in the USA for example, the use of state and federal "declarations of emergency" are actually the method by which funds are released and committed for use by local agencies.

In countries with a mixed profile of forest ownership, there is always a real need for cohesion between land owners, forest managers, land users, emergency responders and funders at the risk assessment, planning and preparatory stages. Coupled with these requirements is the need for cohesive policies which blend Risk

Reduction, Community Education (including managing political and media expectations), environmental interests, citizen expectations, emergency response, and land management practices.

Central governments must realise that, whilst planning and preparatory actions are best conducted at local levels, they have a key role to play in providing interdepartmental cohesion and information sharing. This is particularly relevant in countries such as ours in which some form of devolved autonomy is granted regionally. We must all also recognise that the scale of disasters is not linear but as they grow in magnitude, they tend to undergo more of a *step change* process in terms of costs and impacts. The need for good interaction between government and other agencies is offered by Byoung Il Yoo:

"……..in future, systematic cooperation among the central government, local government and communities will be required to improve natural resource management".

Another limiting belief is that "Fire" agencies tend to have a culture which provides a tone of reassurance. Whilst the need to be seen to be able to cope is quite understandable, our tendency to rise up to challenges as they appear can have a "masking" effect upon under-resourcing or inadequate planning - this is often reinforced by reviews and debriefs in which we celebrate the fact that the fire is out without necessarily truly reporting all of the problems encountered.

One good learning outcome from closer working with foresters and land mangers is a developing understanding of their perspectives - Many other stakeholders, including my own professional fire agencies may not understand the concept of "good fires" i.e. those which may be conferring benefits upon the forest.

Defining who has ownership of the problem

Often, those affected most by wildfires are not those tasked with preparing for them - this creates natural dissonance. The fact that over 60% of forests in both the UK and South Korea are not in public ownership means that we have a limited ability to influence planning and risk management in those areas.

The value of simple and clear jurisdiction should not be underestimated:

－ For the preparatory and planning stages, I propose that all governing

    legislation should define responsibilities for active management and prevention,

  − For the emergency response stages, adoption of the environmental "the polluter pays"[1] principle in the aftermath of wildfires might have a positive impact. Despite the difficulty in bringing those who start fires to justice, land managers who had not properly prepared could be penalized in this way.

Policy Development

I have observed throughout my career, regulation making and the publication of new guidance after almost every large scale emergency which occurred. I have concluded that the best time to make policies to deal with and mitigate emergencies is not directly after (or even sometime during!) the catastrophe.

In the English language, there is an old maxim (which dates back to the trade of blacksmiths) which states "strike whilst the iron is hot". It essentially describes the need to grasp opportunities when they present themselves. In my experience however, this reactive form of behaviour does not translate to good governmental policy development. Many European agencies and bodies have tried to develop forest fire policy in the aftermath of serious fires and catastrophes. Whilst the lessons learned must be incorporated, I would advocate that the time to develop policies is when the fires are neither burning nor imminently anticipated.

In noting the content of the KFS's 5th National Forest Plan, I am very impressed. It represents a genuine intention to integrate fire management into a much broader sustainable forest management system. The way in which the same agency which manages the forests is responsible for all such planning at both local and national level will allow for successful responses to emergencies and provides a useful reference template for all parties to observe. Of course, with all plans, what is written is less important than how it achieves its strategic aims and its success will be judged by history.

Having openly criticised my own country's historic methods of policy development, things have improved in recent years. For example, in England, around 10 years ago, after a polarised debate about the merits, rights and benefits of private landowners and public recreation, in 2000 the Government legislated to introduce a limited *right to roam*, without compensation for landowners. The

Countryside and Rights of Way Act 2000 was gradually implemented to give the general public the conditional right to walk in certain areas of the English and Welsh countryside: principally moorland, heathland and coastal land. Following concerns being expressed by Fire Managers (who were concerned about increased risks of fires due to greater access), the legislation was drafted so that the only specific justifiable reason that access can be refused by landowners is that high fire risks prevail. Given the frequency with which people are accredited with the causation of fires in South Korea, such an exclusion method may be of interest.

Having stated the importance of developing policy outside the "emergency season", I would conversely argue for the preparation and maintenance of "ready-made lobbying strategies". I believe that all emergency managers should develop what sort of lobbying approaches an organisation might take if a catastrophe were to occur. The absence of good policy advice in the immediate aftermath of a national level disaster has marred governmental policy development in some countries in the past and the risk of repetition remains high. To develop these is not difficult - All that is required is for senior teams to imagine events having occurred and then prepare what they might seek to influence in the aftermath.

The United Kingdom – some practical strategies

Many countries, such as my own, have struggled to get the local landowners and managers to engage and work in cohesion because of the absence of simple and clear jurisdiction. Essentially, in the United Kingdom, fire responders only truly have primacy during the period of the emergency. This can present planning challenges.

In the late 1990's in some of Scotland's most rural areas, fires in the February to June period were becoming almost unmanageable for both the landowners and Scotland's Fire Services. Most of the lands in question were in private ownership and engagement with the owners was proving testing. The local government fire agencies undertook to make partnerships between all of the landowners in an area and the local emergency services. The resulting "Wildfire groups" allowed neighbouring landowners to make mutual assistance agreements in conjunction with

the fire service and fire plans were developed which even incorporated pre-agreements to pay for the rental of private helicopter resources if fire service officers thought they were required. The effect was to localise the planning stages to those most affected by the outcomes and those most likely to bear costs.

By 2004, a further gap in policy was identified at national level. Many large government departments, charity and non-governmental agencies had differing perspectives on fire management. It was therefore decided by the government to create a forum at which discussion and pre-planning could take place. The Scottish Wildfire Forum was founded in 2004. www.scottishwildfireforum.org.uk

England and Wales followed and the English Wildfire Forum was founded in 2008

http://wildfireforum.ning.com

From personal experience, I can describe the outcomes of the successful engagement from the fire groups. In 1997, the owner of a large private estate in the Highlands of Scotland consulted me as a local Fire Commander. He intended to plant another 1000 Hectares of conifers and wanted to pre-plan fire precautions without extensive road building. Working together, we planned to created new ponds for helicopters to fill their bombing buckets and new jetties at which Fire Trucks could pump water from a lake which was to be made by building a small dam. Those trees are now 20 years old and probably at their most vulnerable stage in fire risk terms. The foresight shown in planning for their future will keep them safe from fire for all of their growth cycle.

In closing, I would commend South Korea on its achievements. It demonstrates all of the hallmarks of a nation which has considered the importance of its forests both ecologically and culturally and the accomplishments of the Korean Forest Service are impressive. Its international image is very prolific and positive in this context and the Memoranda of Understanding which have been created give the impression of a responsible and internationally influential nation.

Conclusion

The ever-shifting and dynamic fields of people, climate and economics create significant challenges for policy-makers intent on devising strategies to best protect

a nation's forests. The best plans are likely to be achieved by using the views of local landowners and managers, scientific research, informed risk assessments which focus on potential impacts and supportive governing and financial frameworks

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Byoung Il Yoo: "Forest Fire Management and Autonomy in the Republic of Korea"

Sesson 1

January 15, 2013

1. Experiences and lessons learnt of fire management organization, practice and performance in Greece

2. Disaster Management in Korea

3. Organisation of the forest fire protection in the Southeast European /Caucasus Region

Experiences and lessons learnt of fire management organization, practice and performance in Greece

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Abstract

Forest fires have become a serious problem in Greece in the last few decades resulting in large burned areas, significant property destruction and even loss of life. This paper examines the evolution of the problem and how the Greek state tried to cope with it. The reasons why the problem worsened and why the measures taken by the Greek governments in response to it failed are discussed. It is concluded that in order to achieve a successful long-term solution decisions must be based on true understanding of the forest fire problem which is more complex than what most non-specialized people think. Forest fire science must be at the base of any such decision. The basic principle should be "if it is not broken don't fix it". Even when there is room or need for improvement, especially in the direction of increasing fire management efficiency, it is best to seek this improvement in the direction of improved fire-aware forest management, increased forest fire prevention, and a balanced cooperation of all state, municipal and private organizations that have the capacity to contribute, under a wisely built cooperation framework.

INTRODUCTION

Greece is a European country with a population of 11 million people, occupying an area of 130,875 km2 in the southern tip of the Balkan Peninsula. About 60% of this area (7.9 million ha) is characterized as forest land. Tall forests constitute 2.5 million ha of this land, the rest being evergreen shrublands and partially forested areas (3.2 million ha) or degraded lands with low vegetation of mostly thorny spiny

shrubs (phrygana) (1.9 million ha). These shrublands and grasslands are mainly used for animal grazing. Less than half of the tall forests are timber producing forests, mainly growing at high elevations. The rest consists of "low" or coppice forests that produce mostly fuelwood, and of low elevation pine forests (mainly *Pinus halepensis* and *Pinus brutia*) with little timber production but high aesthetic value. The climate over most of Greece is typically Mediterranean, with relatively mild winters and a hot and dry summer period (Xanthopoulos 2000a).

About 2/3 of all forest lands are state owned and are managed by the Greek Forest Service (GFS) which is a state organization with a long history and very important work in the past, especially in the post 2nd World War era, when it helped develop infrastructures such as roads and flood control works in the country, providing jobs and resources to rural populations. Forest management, and through that timber production, was an important task of the GFS through the second half of the 20th century as it strived to restore and improve the forests. However, its efforts were mostly centered in the mountainous areas, mainly in northern Greece, where productive forests of true-fir (*Abies sp.*), spruce (*Picea abies*), high-elevation pines (*Pinus nigra* and *Pinus sylvestris*), beech (*Fagus sp.*) and deciduous oaks (*Quercus sp.*) grow. Low elevation pine forests were for the most part out of scientific management as the funds needed for this task were never available. In practice, there was a management scheme applied mainly by resin collectors who cultivated these forests, securing regeneration and their protection.

In the 1950s and 1960s, after the 2nd World War and the Civil War that followed, Greece was a deeply divided and devastated country. As a result, in that period, approximately 15% of the population, mainly from the villages, immigrated abroad to countries such as USA, Canada, Australia, Germany, etc., and another large percentage moved to larger cities. Furthermore, the increase of tourism that started in the 1970s, a strong economic growth and the improvement of living standards gradually drove more young people away from villages and from the hard work in the forests. In the 1980s the country joined the European Union. Subsidies to the resin producers were not among the policies of the EU. Gradually, the low elevation pine forests were practically abandoned.

In the same period, the demand for secondary homes in coastal areas for summer vacations started growing. This trend continued until about 2010, and the same has

been true for the development of urban-wildland interface (WUI) zones in Attica (the region around Athens) and certain other areas, as people try to avoid large crowded cities. Planning for this growth has been very poor. Lack of a complete land cadastre was and still is a problem contributing in this direction.

Forest fires are a phenomenon closely tied to the Greek forests as well as to the forests of all other Mediterranean countries, as they form a basic element in the function of Mediterranean ecosystems. Their occurrence is documented from antiquity. However, the way in which they appear in regard to their frequency, their characteristics and the damages they cause has not always been the same (Fig. 1). In this paper, the evolution of forest fires and their management in Greece and their development into a significant problem is documented and explained, allowing conclusions about the impacts of certain changes. This leads to conclusions some of which may be worthwhile lessons not only for Greece but for other countries as well.

EVOLUTION OF THE FOREST FIRE PROBLEM IN GREECE

As low elevation forests were gradually left unmanaged and villages were abandoned by young people in the 1960s and 1970s, the number of forest fires and especially the yearly burned area started growing steeply by the end of the 1970s. The inhabitants of the villages who had been the main force of forest firefighting until then, guided by GFS personnel, making use of their experience and knowledge of the land and often their own agricultural equipment, gradually became fewer, older and less willing to contribute. The GFS which had the responsibility for forest protection started acquiring ground and aerial firefighting resources to control forest fires. Forest protection from fires and from illegal land occupation or land-use change, gradually became the focus of most GFS offices in southern Greece where these problems were more pronounced. Forest management continued to be the main task in most offices of northern Greece.
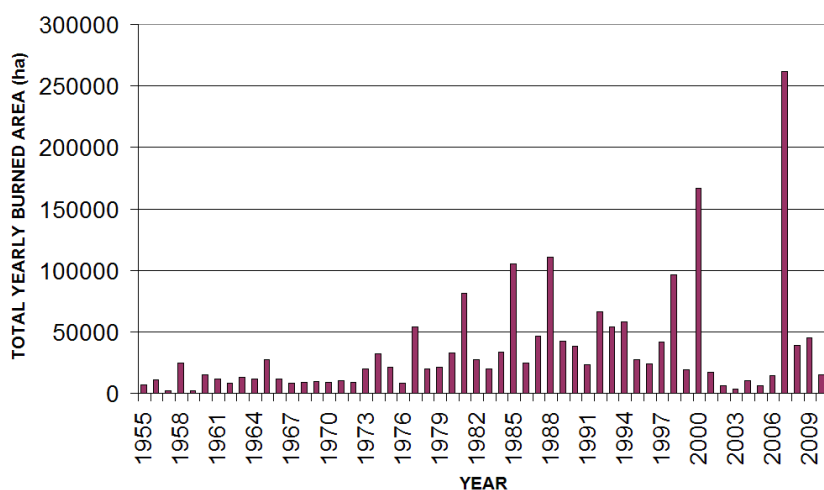
Figure 1. Evolution of the total yearly burned area in Greece in the 1955-2010 period.

In the 1980s the yearly burned area kept increasing, exceeding the 100,000 ha mark twice (1985 and 1988) (Fig. 1). The need to improve the firefighting mechanism was obvious but actions in the 1980s were quite slow and funding was limited. However, starting around 1993, the GFS, with the influx of previously unavailable scientific knowledge and some political support, started getting better organized for fire suppression with only marginally higher funding. Soon there were marked signs of improvement. Then, in 1998, with a rushed decision of the Greek government, the responsibility of forest firefighting passed from the GFS to the Fire Service.

The decision was taken at the end of 1997 and it was mainly a political one. It was prompted by what was considered poor results of the GFS in previous years and did not really consider in depth all the parameters of the undertaking. Actually, it lacked any serious scientific justification or planning. During the winter and spring of 1998 many voices warned about an oncoming disaster including a number of politicians, Forest Service officers, many university professors, and the few forest fire experts in the country who were not given any opportunity to offer their input (Xanthopoulos 1998).

The law about the transfer of responsibility to the Fire Service finally took effect on May 25, 1998. What followed was a very bad fire season with nearly 100,000 ha burned and loss of life of three firefighters and one volunteer firefighter on

Hymettus mountain near Athens, on July 17, 1998. No provision was made for cooperation between the personnel of the GFS and the Fire Service at all levels. The one-sided political decision resulted in strong disagreement and finally resentment on the side of the personnel of the GFS (Xanthopoulos 2008a). The Fire Service officers, who had been contributing in the past to forest firefighting, mainly close to urban areas and most often from paved roads, never having command on forest fire incidents, were not really trained for this job. The significant difference between wildfires and the other types of fires they had been trained for (industrial, ship-fires, home-fires etc.) eluded them. When called to coordinate fighting of large forest fires they failed.

In the following years the Fire Service received generous support and funding from the government. After a disastrous fire season in 2000 which broke all previous records, it started efforts to improve especially with the prospect of the approaching Olympic Games of 2004 that were held in Athens. In the meantime, the GFS was neglected and broken down into a regional structure belonging to the Ministry of Interior while the headquarters in Athens remained under the Ministry of Rural Development and Food. Its funding was cut back severely, and as a result it deteriorated. As the GFS suffered, forest management suffered as well. Fuel loads in the forest kept increasing, forest road maintenance fell to a minimum and fire prevention, which remained partly in the responsibility of the GFS, was practically abandoned. The GFS officers were rarely called to contribute to fire management with their knowledge and experience.
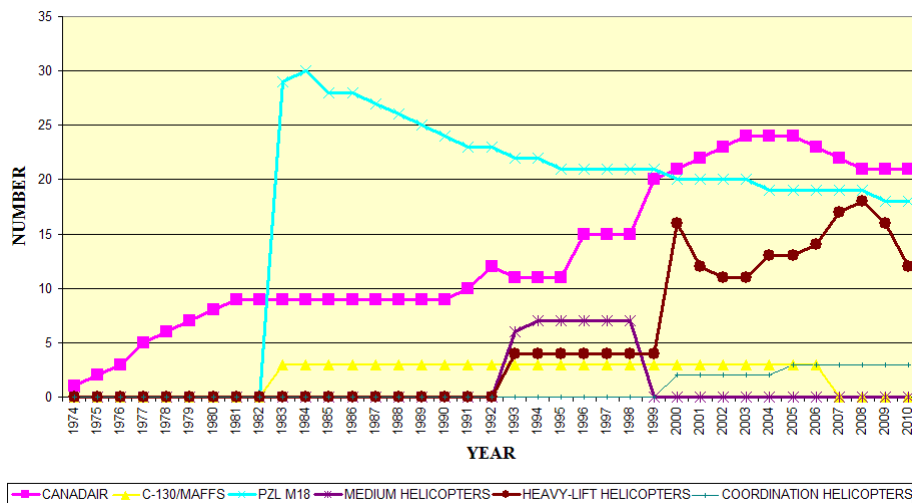
Fig. 2. Evolution of the number of aerial firefighting resources in Greece.

The Fire Service taking advantage of its increased budget, which more than tripled compared to what the GFS received for fire management in the 1990s, and the permission of the government to contract private helicopters from 1999 on, adopted a firefighting strategy that was clearly based on massive aerial attack. As the number of aerial (Fig. 2) and ground resources increased the cost also skyrocketed (Fig. 3). Unfortunately, firefighting tactics on the ground did not improve, largely due to the reliance on the heavy aerial support. In the relatively easy fire seasons between 2001 and 2006 this scheme appeared to work quite well, at least as reflected in the statistics. However, during the extremely difficult fire season of 2007 the firefighting mechanism of the country failed many times. Lack of fire prevention, fuel accumulation in the forests, poor firefighting tactics that practically ignored indirect attack, and an unprepared public, combined with the adverse weather conditions, resulted in the worst fire disaster ever recorded in Greece.
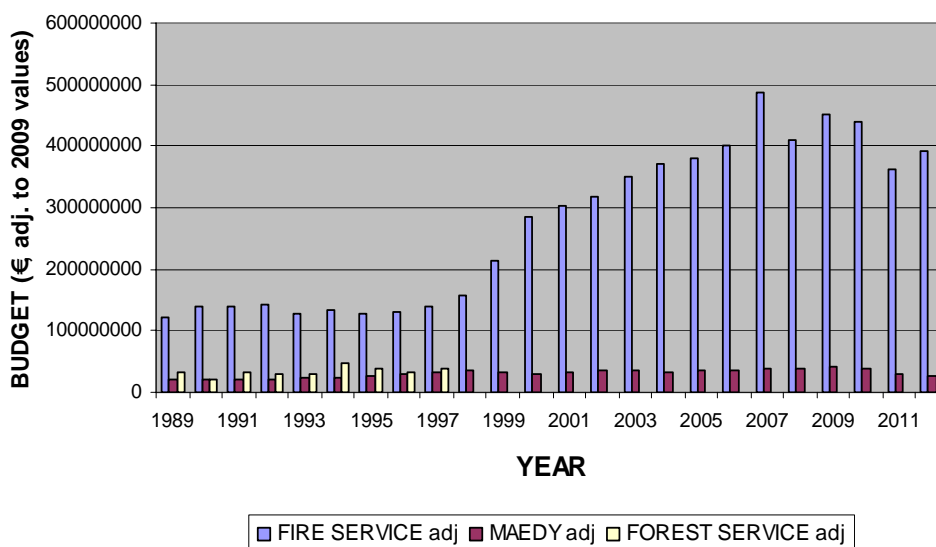
Fig. 3. Evolution of the annual forest firefighting cost of the Greek Forest Service (1989-1997), of the budget of the Special Unit of the Greek Air Force (MAEDY) that operates the fleet of PZL M-18 Dromader aircraft (1989-2012), and of the total budget of the Fire Service (1989-2012) that includes both urban and wildland firefighting, all adjusted in 2009 prices (sources: GFS and the official State budget).

UNDERSTANDING THE PROBLEM

The short description above illustrates that, in spite of more resources and higher expenditures in the last few years, forest fires are still a significant problem in Greece. Understanding the reasons for this paradox is necessary for trying to improve the situation in the future. Forest fire statistics are an important tool for this task.

In Greece, the number of fires has gradually increased in the last decades but a change in the way fires are counted by the Fire Service after 1998, do not allow firm conclusions about the level of increase (Fig. 4).

On the other hand, there is undeniable evidence that the average yearly burned area has increased after 1998 in spite of the steep increase in the firefighting budget and resources: the average for the 1984-1997 period, which includes the two worst years in the era of GFS firefighting responsibility, was 49,743 ha; it reached 52,552 for the 1998-2011 period. In addition to larger burned areas the size of

forest fire damages increased steeply including loss of life which was very rare until the late 1970s (Fig. 5) .

Fig. 4. Evolution of the number of forest fires in Greece. Until 1997 the GFS recorded as forest fires only fires that had burned at least some forest area. After 1997, the Fire Service records all fires burning outdoors, including purely agricultural fires.
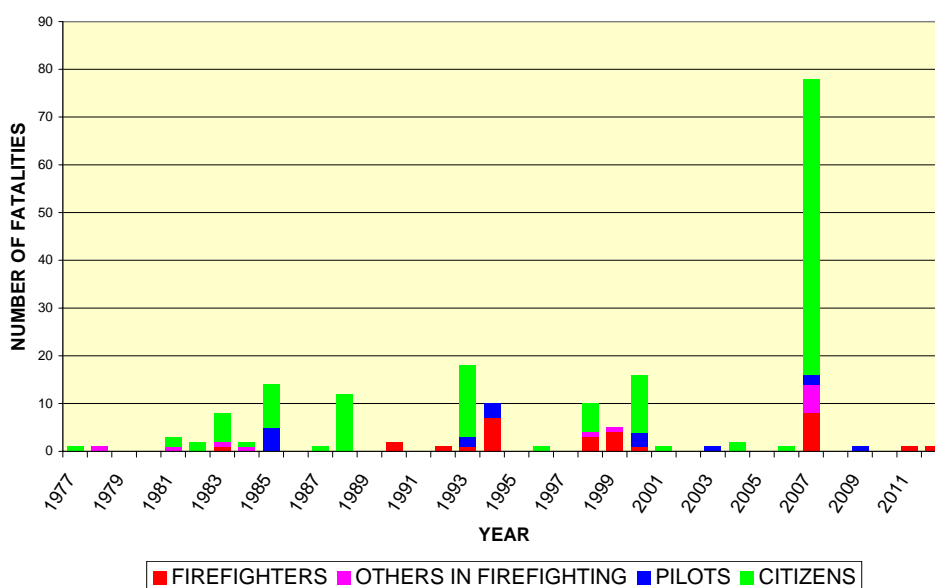
Fig. 5. Number of forest fire related fatalities in Greece in the 1977-2012 period.

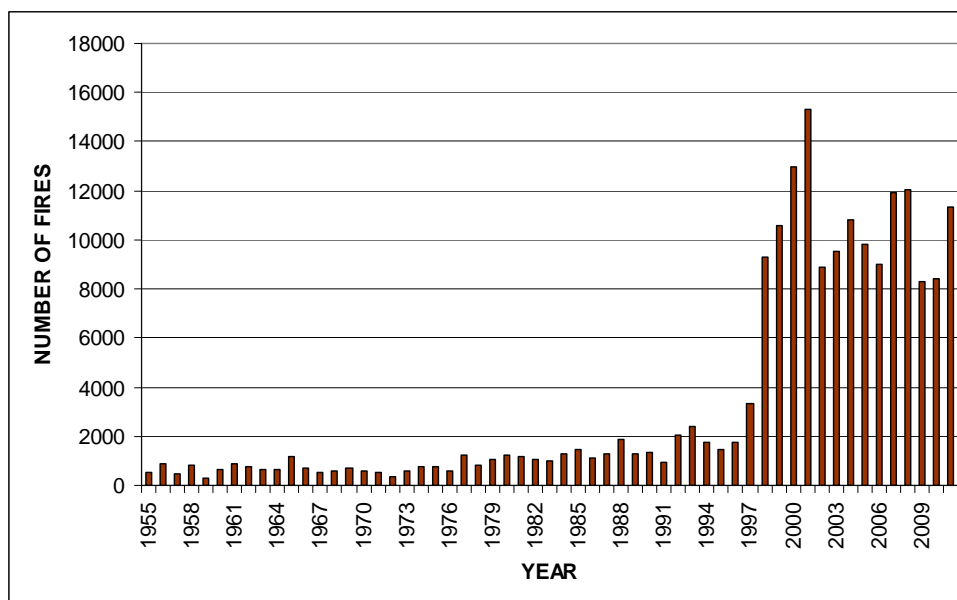The worsening of the problem that is illustrated by the fire statistics can be attributed on one side to an increasing wildfire threat level and on the other to a reduced effectiveness of fire suppression. These two sides and the factors affecting them are examined below.

Wildfire threat

Wildfire threat can be viewed as the resultant of three elements:
- The probability of fire eruption,
- The intensity of fires when they occur, and
- The values at risk.

The factors affecting them include increased fire hazard due to forest fuel build-up which is the result of declining forest management and reduced biomass utilization, higher frequency of extreme fire weather conditions widely attributed to climate change, and development of poorly planned WUI areas.

Fuel build-up results in greater fuel loads and thus higher fire intensities. Vertical fuel continuity allows fires that start at the lower fuel layers (forest litter, grasses and shrubs) to reach the tree crowns more easily resulting in hard-to-control crown fires. Horizontal fuel continuity, resulting from the abandonment of agricultural activities within forests, also makes firefighting more demanding as the firefighting forces do not find easily places with reduced fuels where they can conveniently and safely control the fire.

The effect of changing climate on forest fires is a worldwide concern. So far, there are relatively few studies in the world that have concluded that increasing temperatures already influence the characteristics of forest fires. There is more discussion about an increased frequency of occurrence of fire weather extremes that often lead to what is called mega-fires - meaning wildfires with behavior that makes any firefighting effort futile ⁻hich cause extensive damages and often result in loss of life. However, it is difficult to disassociate the influence of fire weather as the driving force behind these disasters from the contribution of changing landscapes, development of homes in forests and changes in firefighting.

Higher values at risk result in higher fire damages. Such values near or within forest lands have increased steeply in the last three decades in Greece. WUI areas have mushroomed around large cities and in tourist locations near the coast. Villages, now with reduced and aging population, come in contact with agricultural and forest vegetation forming what has been termed a Rural-Urban Interface (RUI). RUIs existed in the past but all dead wood around villages was collected for fuel, practically resulting in the equivalent of a fuel break protecting each village. Nowadays, wild vegetation mostly remains unused so fires often reach into villages threatening homes and other structures. Other infrastructures, such as roads, power lines, telephone lines, etc. which serve all these settlements are also threatened.

All the above can be elaborated further in regard to the changes that have influenced the three elements affecting forest fire threat. Many forest fire scientists have been explaining for a long time now that the causes of the problem are rooted, either directly or indirectly, in the socioeconomic changes which have been taking place in Mediterranean Europe (Goldammer 1992, Rego 1992, Velez 1993, Xanthopoulos 2009):

- − Fire frequency is affected by the presence of people in or near the forests and the corresponding uses (permanent living, vacation, tourism, hiking, hunting, river fishing, etc.), their educational profile, their fire awareness level and their economic interests.
- − Fuel build-up is directly affected by the depopulation of rural areas, the tendency for traditional uses (grazing and firewood) to be relinquished and the tendency for forest use to disappear as a raw material producer, or at least to be reduced noticeably. A decrease of the importance and funding of the national Forest Services in the Mediterranean countries, which is often reflected in reduced forest management, is further contributing to the problem.
- − RUI areas with poorly maintained homes in contact with heavy vegetation are also the result of rural depopulation. On the other hand, the development of huge polluted cities is one of the main reasons behind the development of WUI areas where people try to achieve a better standard of living. The improvement of the financial status of the average citizen is another socioeconomic development that made living in a WUI area and commuting daily to the city a viable option.

Furthermore, Goldammer (1992) who was among the first who identified the development of the WUI problem in Europe, referring to the reduced rates of biomass utilization and the changing fire regimes, concluded that "because of the increasing socio-cultural, ecological, economical and even aesthetic demands on our landscapes, fires become less tolerable. The fire problem is not anymore a phenomenon or a problem to be addressed by a single agency with its particular philosophy".

All these changes have taken place in Greece in the last few decades. Hence, it is not difficult to understand why wildfire threat has increased so much, especially in view of a general inadequacy of parallel fire prevention efforts.

Fire prevention

One of the ways to mitigate wildfire fire threat is to put an emphasis on fire prevention. In Greece, for a long time prevention meant short-lived campaigns on the Mass Media targeted to the people, warning them not to light fires outdoors in the summer. There was no systematic effort to sensitize citizens and to teach them practical things such as what to do in case of fire, how to prepare their home, how to survive, etc.. In spite of occasional well intended efforts such a systematic approach (e.g. through regular lectures at schools) is still non existent.

Currently, prevention efforts, in addition to the TV messages, include understory vegetation treatment along roads, installation of water tanks and fire hydrants in the forests, forest road maintenance, prevention patrols, etc. However, these efforts are broken down between the GFS, the General Secretariat of Civil Protection, local authorities, and the Fire Service, without a truly coordinating authority. Thus, although until 2009, funds for prevention distributed mainly to the local authorities had exceeded 30 million Euro, there was little visible result.

Fire suppression

The evolution of forest fire suppression in Greece has been very interesting and when studied it can help in completing the understanding the current fire problem. In the early days, before 1970, firefighting was done mainly by the people in the

villages. Actually, the law demanded this contribution. The eagerness of the people to help was not only because of the law but because they new that their source of income was in danger. This income included agricultural products (from fruit tree orchards, olive groves, vineyards etc. growing in plots within or adjacent to forests) as well as forest products (timber, honey-bees, resin, etc.). Furthermore, the GFS was an important seasonal employer for the forestry workers who lived mostly in the villages that were close to forests. Thus, those villagers had a strong need of and lots of respect for the GFS and truly tried to help with fire control. The Fire Service would contribute but, with no forest firefighting training and relatively few firetrucks that were inappropriate for unpaved forest roads, their help was limited. In case of large fires, there was occasionally involvement of the Armed Forces.

The people from the villages, especially the resin, collectors were helping greatly in regard to prevention as well. They would keep an eye on who entered the forest and what was the reason for that. In regard to suppression the villagers used mainly agricultural mechanized equipment and handtools with which they were familiar. In addition to motivation they had to their advantage their long experience, an intimate knowledge of the topography, the road network and the condition of vegetation, and a good knowledge of each other. This allowed them immediate action, catching fires small. When this failed, they would try to confront the fires in areas with reduced fuels, such as their agricultural plots, olive groves and vineyards where they had cut and removed the grasses in advance of the fire season, or close to their villages where as a rule all dead biomass had been used for fuel. In case of very large fires they resorted to the use of fire to control fire. This is documented in the writings of Greek forestry authors as early as 1924 (Kontos 1924)).

In 1971, as the population in the mountainous villages was declining, the GFS acquired its first firetrucks and with them hired a few permanent and many seasonal firefighters. They requested training on the use of firetrucks from the Fire Service. They were taught how to operate the firetrucks and the use of water to put out fire but there was no training about forest firefighting tactics. The GFS at the time lacked specialists in the field of forest fires. Knowledge generally passed from mouth to mouth and most of it was learned by example. With time, the use of handtools was nearly forgotten. Fire use in fire control was only exercised by a

few experienced GFS officers. A notable exception of effective firefighting were the groups of forest workers that occasionally helped put out fires mostly in the high-elevation productive forests of Northern Greece.

In 1974 the first amphibian water bomber, a Canadair CL-215, able to deliver 5,346 lt of water per drop, arrived in Greece. It was soon followed by more CL-215 (fig. 2). The Air Force created a special unit for operating and maintaining this fleet. A second Air Force unit, called MAEDY, undertook the operation of 30 agricultural single engine PZL M-18 Dromader planes that were purchased in 1983. Also, in 1983, Greece was the first country other than the USA to acquire four modular MAFFS units which, when assembled in an Air Force C-130 cargo plane, can deliver 12 tons of fire retardant per drop. Unfortunately, this increase in resources did not stop the noted increase in burned area through the 1980s. Lacking specialized knowledge on how to best take advantage of these new tools the GFS made poor use of them. They were only deployed in two air-bases (near Athens and Thessaloniki) and they were not used for initial attack. It was considered as prudent to use them only for difficult fires. The GFS officers who were in charge of firefighting in their locality did not receive any special training on how to maximize the effectiveness of the aerial resources. This was especially true for the C-130/MAFFS system which has very different operational characteristics from the CL-215.

By the early 1990s it was evident that improvements were needed. At that time some political support to the GFS, a small increase in funding (fig. 3) and the introduction of new knowledge and technology brought fire suppression a step forward. Initially, instead of opting for more CL-215s, the GFS added 40 new firetrucks and 200 four-wheel drive semi-trucks for initial attack to its fleet that brought the total number to 615. The number of CL-215 and PZL M-18 bases increased for each fire season, and they started being used for initial attack. Many GFS officers attended forest fire management seminars and a fire cause investigation course with USA Forest Service trainers was organized for the first time; the local GFS offices developed presuppression plans; the coordination center in Athens was improved as dispatchers were selected among experienced foresters, were trained, and a simple computerized Decision Support System was introduced to help them with their decisions. In 1993, contracted helicopters were introduced in fire

suppression for the first time, and handcrews, the so called "forest commandos", were trained and transported by the helicopters for initial attack. Later, from 1994 to 1997 military helicopters (Bell 205 "Huey" and Chinook CH-47D) were used for this task. The total personnel of the GFS, manning the headquarters and 102 local offices, reached approximately 4,200 including scientific personnel, fireguards, firefighters and clerical personnel. To these personnel were added approximately 4,500 seasonal firefighters to man the firetrucks and 400 young seasonal firefighters for the helicrews. At the same time, the GFS started putting some emphasis on fire prevention.

The change of firefighting responsibility in 1998 signaled a significant change in fire suppression organization. Initially, the Fire Service tried to adapt fire suppression to its existing military-like structure, thinking that forest fires were the same as the fires they were accustomed to. Actually, they did have some past experience in forest fires, as they had been carrying a supporting role to the GFS, protecting villages etc. but never had to coordinate firefighting on large fires. Among their shortcomings were the abandonment of the yearly assembly and operation of the helicrews, inadequacies in dispatching of aerial resources, lack of understanding of the importance of good coordination by well trained and competent officers, and ignorance about methods of indirect attack.

The 1998 fire season was a bad one and revealed to the Fire Service that forest fires were not as easy to cope with as they thought. As mentioned earlier, they requested and received additional support by the government. Ten (10) new Canadair CL-415 amphibian waterbombers, with a capacity of 6,400 lt per drop, were ordered in 1998 and gradually added to the state fleet. Starting in 1999, a large fleet of heavy-lift helicopters started being contracted every summer. The number of firetrucks, including those taken from the GFS, gradually exceeded 1,500. The permanent personnel increased from approximately 6,500 officers and firefighters to more than 10,000. Currently the personnel consist of 8,000 permanent firefighters, 5,500 seasonal firefighters in the summer and 1,500 volunteer firefighters.

The accumulation of resources unfortunately has not brought the expected results. The pattern of yearly burned area has changed considerably. As mentioned earlier, in easier fire seasons (2001-2006) the large aerial fleet was able to suppress most

fires at their start bringing the total burned area to very low levels. Unfortunately, this brought relaxation to the personnel on the ground who expected to have aerial support even for relatively easy fires. This was not the case however in 2007, a truly difficult fire year. In that hot and dry summer multiple simultaneous fires that escaped initial attack depleted the aerial resources and they were not available everywhere for initial attack. Thus more fires escaped and became true catastrophes resulting in a total loss of 79 lives, in addition to the huge burned area and more than 3000 structures destroyed. Without adequate performance by the forces on the ground, even the huge fleet of international aerial resources that came to Greece to help could not offer much until the conditions changed (Xanthopoulos 2007a, Xanthopoulos et al. 2009).

Furthermore, if the 2007 fires demonstrated the weaknesses of the firefighting mechanism in coping with multiple serious fires, a number of single WUI fires in Attica demonstrated the limitations of the mechanism even when acting at maximum capacity to achieve control and guarantee the safety of WUI areas. Such fires were two parallel fires in the area of Rafina on June 28, 2005 (1,000 ha) (Xanthopoulos 2008b), the fire of Penteli mountain on August 16, 2007 (900 ha) and a very large fire in NE Attica on August 24, 2009 (20,000 ha) that burned through 13 settlements. Even in 2012, a single fire on the island of Chios that started on August 18 and burned for six days passing through many villages, destroyed 14,800 ha in spite of a huge mobilization of resources. Chios boasts a unique in the world product called "masticha", a natural resin produced by the *Pistacia lentiscus* var. *Chia* tree that grows only on this island. It is used as a natural chewing gum, in pharmaceuticals, in cosmetics, and as a cooking spice in the culinary world. Unfortunately, the mobilization did not manage to stop the fire and more than 20% of the masticha production capacity was destroyed.

DISCUSSION

The disappointing situation that has developed in regard to forest fires in Greece in the last decade or so is not so much the result of climate change, as many would conveniently like to conclude, neither the outcome of inadequate firefighting resources. Land-use and population changes in combination with weakened forest

management have resulted in unprecedented fuel accumulation. Successful fire suppression in "easy" fire seasons, further contributed to this. Under adverse conditions, fire behavior is extreme and defies all firefighting efforts.

Under this light it becomes obvious why measures taken by the Greek governments in response to the worsening problem failed. At the political level they lacked an understanding that in environments with Mediterranean climate "we have to live with fire", adapting our land planning and management policies and rethinking the way we build our housing areas in proximity to vegetation. They ignored warnings about the inevitable outcome (Xanthopoulos 1998, 2007b, 2008a) and tried to solve the problem without full knowledge of its nature and of the factors affecting it, promoting a one-sided fire suppression-oriented fire management policy. Giving responsibility for wildland firefighting to a purely suppression mechanism, which tends to be the prevailing trend in today's safety minded world, seems, at least in countries with fire-prone environment, as a recipe for failure (Xanthopoulos 2008a). Greece, where this happened in 1998, is a good, but not the only, example. Since then, the cost of firefighting increased by at least three times. The annual budget for fire prevention after a poorly managed increase in the late 2000s is again very small. The GFS has deteriorated. Forest management has nearly been abandoned. Under such conditions a successful long-term solution is unlikely.

All the above are not surprising to those who have a good understanding of the parameters involved in fire management. Forest fires are not a technical only problem. There are very important biological, social, financial and political aspects as well. If the example of Greece teaches something, is that decisions on how to tackle the wildland fire problem have to be made very carefully, with full scientific support, without preconceived ideas, trying to avoid turf battles between organizations.

In order to mitigate the problem of forest fires in Greece and in other Mediterranean countries in the future it is important to address the factors that have led to the fire threat increase in the last few decades. Policies must aim at reduction of the number of fire starts, reduction of the fierceness of fires, mitigation of the risk and level of damages, improvement of firefighting effectiveness and better post-fire rehabilitation measures.

Minimum requirements for developing and implementing a sound fire prevention

program are:

- Recognition of the need for emphasis on prevention.
- Firm decision on seriously pursuing fire prevention, with a long-term commitment and recognition of all its aspects.
- Assignment of the prevention task to a permanent coordination committee of representatives of the key relevant organizations and of highly qualified expert scientists. The committee should have to work year-round and should have appropriate resources (work-time, funding, office, office support, technical support such as web-site development) available in order to plan and carry-out appropriate actions.
- Understanding that the key for successful prevention is involvement of the public, as individuals and as local forces in communities. Such involvement can increase effectiveness while keeping costs under control. The prevention coordination committee should identify measures that can achieve this, following specific methodologies and providing needed support. An example can be found in the approach developed in Europe by a project called INCA (Xanthopoulos 2010).
- At least a basic level of funding that, used efficiently, will go a long way in support of well planned prevention actions.
- Assessment of the results of prevention efforts and implementation of correction actions.

Even the best level of forest fire prevention cannot totally eliminate fires. A strong and effective firefighting mechanism will always be required although better prevention can mitigate the peak demand for resources that was experienced in extreme fire seasons such as those of 2000 and 2007. The number of personnel and resources available in Greece is quite large, at least at par with the rest of the Mediterranean countries. Further increases are neither advisable nor possible, especially under the current harsh financial conditions of the country. Then, the key to improving the firefighting organization can only be looked for in improvements in the organizational scheme of fire suppression.

The ways for organizing fire suppression are many. Under current conditions emphasis should be put not only on effectiveness but also on efficiency. Reliance

on contracted heavy-lift firefighting helicopters must be reduced. Careful and objective selection of aerial resources will certainly lead to significant cost cuts. Part of the savings must be used for better organization, training and equipment of the ground forces. Training does not only refer to lower level personnel but to the commanding officers as well. Modern technologies that can help with decision making must be adopted. Initial attack must be improved, and organization of helicrews must be introduced again.

Also, the system in the future should foresee official participation of organizations other than the Fire Service in firefighting, especially under extreme conditions. Examples are the GFS, the Armed Forces, the municipalities, and various volunteer groups. Each organization may contribute according to its capacity, provided an appropriate organizational-cooperation scheme is in place and the personnel involved is appropriately trained and equipped. There is no need to re-discover the wheel on how to do this. There exist various examples, the most prevalent being the current National Incident Management System (NIMS) of the USA (http://www.nwcg.gov/pms/pubs/PMS700-1.pdf).

Finally, increased international co-operation should be pursued. As fires are likely to get worse in the future around the Mediterranean Sea, it makes sense for all Mediterranean countries to seek stronger co-operation with each other. In principle, it is not possible and does not make sense financially for a country to try to build and maintain a firefighting organization that will be ready and capable for controlling all fires under the absolutely worst possible conditions. Such an organization would be extremely costly and it would be under-employed most of the time. The European Union has taken initiatives in this direction with the Civil Protection Directorate in Brussels having the task to coordinate supporting efforts for the countries requesting help. This help is assembled in very short time according to pre-arranged protocols.

CONCLUSIONS

The history narrated above, is certainly not detailed and some of the views offered may be controversial. However, the statistics cannot be disputed and they make it evident that in spite of serious investment in firefighting in the last 14

years the situation has not improved in Greece. The main lesson to be learned from this failure is that decisions should be based on true understanding of the forest fire problem which is more complex than what most non-specialized people think. Forest fire science must be at the base of any such decision. The basic principle should be "if it is not broken don't fix it". Even when there is room or need for improvement, especially in the direction of increasing fire management efficiency, it is best to seek this improvement in the direction of improved fire-aware forest management, increased forest fire prevention, and a balanced cooperation of all state, municipal and private organizations that have the capacity to contribute, under a wisely built cooperation framework.

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Disaster Management in Korea

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RISK PROFILE OF KOREA

The Korean Peninsula

Republic of Korea
(South Korea)

Total Land Area:
100,033 sq km

Population:
49.8 million

Geography and Climate

Mountainous Country
Mountain cover 70% of Korea

Mean Temperature(°C)
(Yearly normal)

Precipitation (mm)
(Yearly normal)
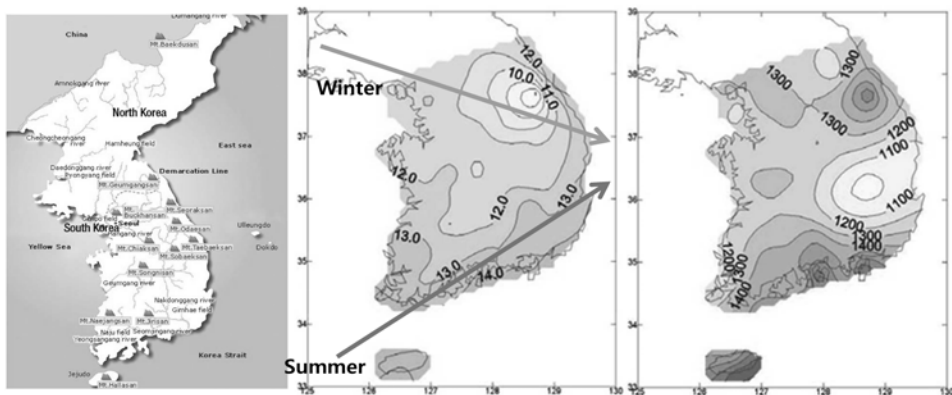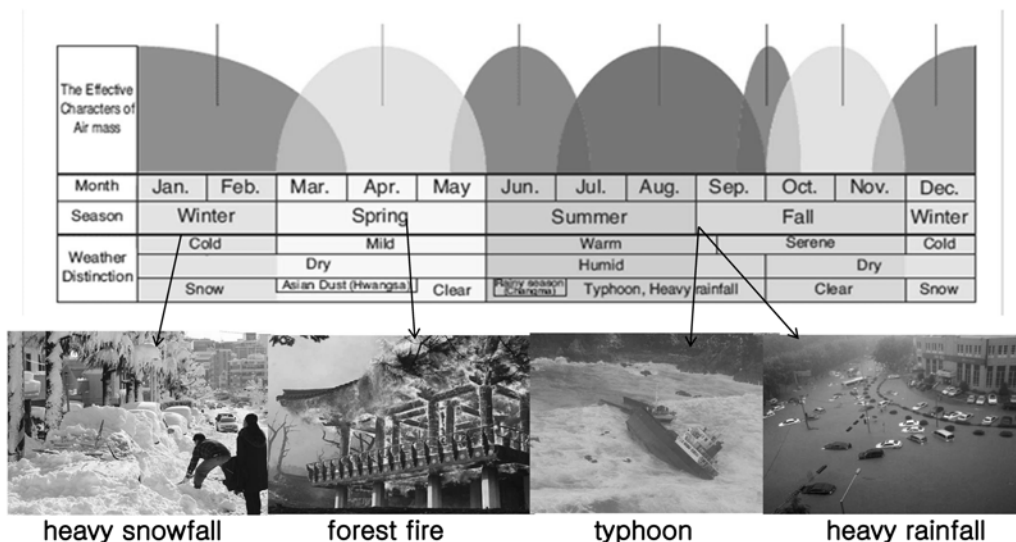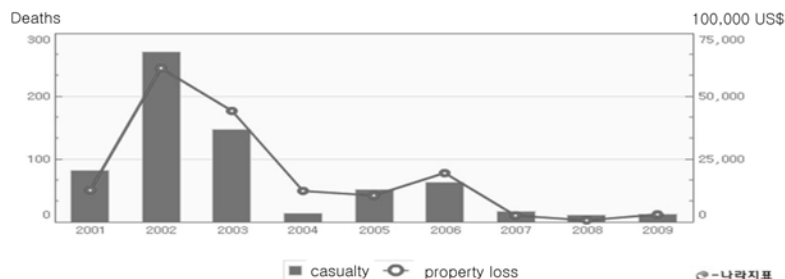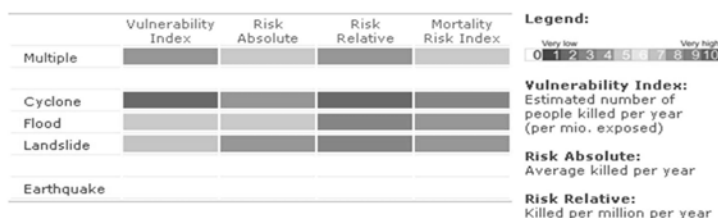
External Cause of Death in Korea

An **external cause of death** is a death due to accidents and violence including environmental events, circumstances and conditions as the cause of injury, poisoning, and other adverse effects.
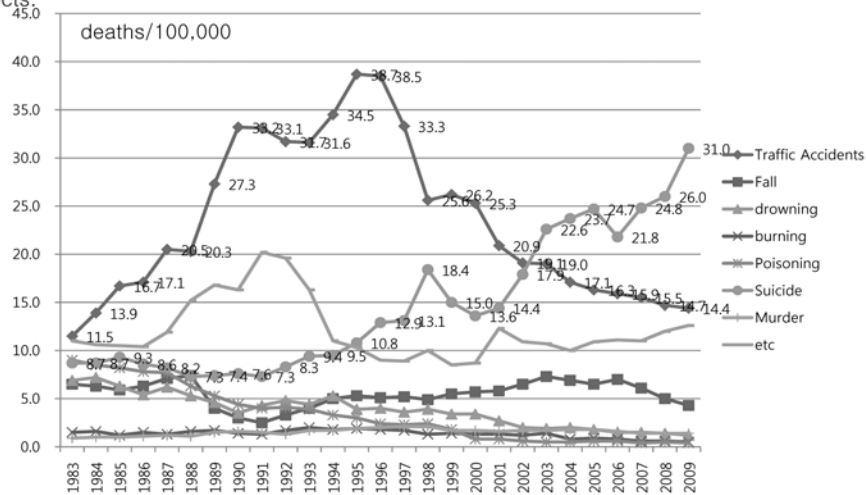
Traffic Accidents in Korea
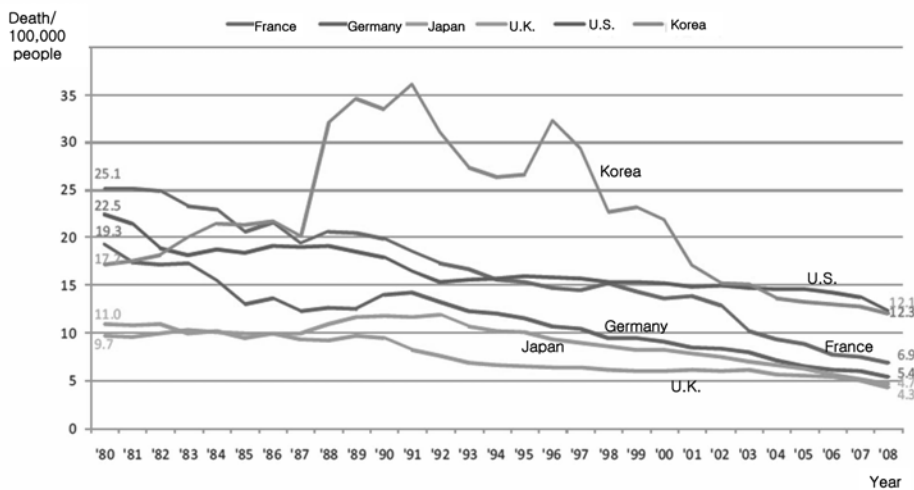
DISASTER MANAGEMENT ORGANIZATIONS IN KOREA
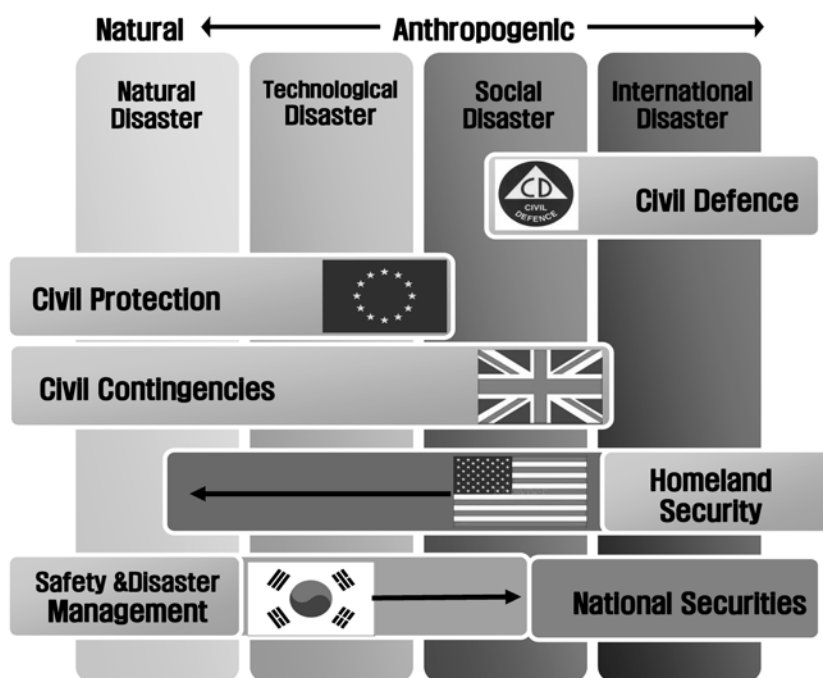
Source: Alexander(2007); Jibum Chung(2009)

NEMA

- National Emergency Management Agency (NEMA)
  - Korea's first independent disaster management government authority, was established on June 1, 2004.

- Major Duty
  - NEMA's main objective is to protect the lives and property of the Korean people from large-scale disasters, which have been recurring in Korea every year since the 1990s

- Background
  - To establish a comprehensive response system against natural disasters and manmade disaster(all hazard approach), after Daegu Subway Accident

History of Disaster Related Acts

- 2004. 03. **Master Act on Disaster and Safety Management**
- 2004. 06. Launched **NEMA**
- 2004. 12. Formulated the 1st 5-year **National Safety Management Plan**
- 2005. 01. Revision of the **Countermeasures against Natural Disasters Act**
- 2006. 03. **Act on Insurance for Storm and Flooding Damages**
- 2007. 07. **Act on Support for Corporations' Efforts for Disaster Reduction**
- 2007. 07. **Act on Prevention of Disasters for Steep Slope Areas**
- 2008.03. **Act on Earthquake Disaster Countermeasures**
- 2008.   Establishment of **the Ministry of Public Administration and Security** (MOPAS)
- 2009. 06. **Forest Protection Act (Korea Forest Sevice)**
- 2009. 12. Formulated the 2nd 5-year **National Safety Management Plan**

Korean Government Structure

President

Office of the President
- Board of Audit and Inspection
- National Intelligence Service

- Broadcasting and Communications Commission

Prime Minister

Prime Minister's Office

Office of Minister for Special Affairs

- Ministry of Government legislation
- Ministry of Patriots & Veterans Affairs

- Fair Trade Commission
- Financial Services Commission
- Civil Rights Commission

| Ministry of Strategy and Finance | Ministry of Education, Science and Technology | Ministry of Foreign Affairs and Trade | Ministry of Unification |

- National Tax Service
- Korea Customs Service
- Public Procurement Service
- Korea National Statistical Offices

| Ministry of Justice | Ministry of National Defense | Ministry of Public Administration and Security | Ministry of Culture, Sports and Tourism |

- Supreme Prosecutor's Office
- Military Manpower Administration
- Defense Acquisition Program Administration
- Korean National Police Agency
- National Emergency Management Agency
- Cultural Heritage Administration

| Ministry for Food Agriculture, Forestry and Fisheries | Ministry of Knowledge Economy | Ministry of Health, Welfare and Family Affairs | Ministry of Environment |

- Rural Development Administration
- Korea Forest Service
- Small and Medium Business Administration
- Korean Intellectual Property Office
- Korea Food & Drug Administration
- Korea Meteorological Administration

| Ministry of Labor | Ministry of Gender Equality | Ministry of Land Transport and Maritime Affairs |

- Korean Coast Guard
- Multifunctional Administrative City Construction Agency

the Ministry of Public Administration and **Security** (MOPAS)

National **Emergency Management** Agency (NEMA)

Wild Fire: Korea Forest Service

National Disaster Management Support System

Overall process of negotiations and coordination among the departments

Top Coordination
중앙안전관리위원회
Central Safety Management Council
Head: Prime Minister
Deputy: NEMA Administrator

Office of the President
National Security Council

Coord. Cmte.
MOPAS

중앙사고수습본부
Central Accident HQ
Compt. Ministers

중앙재난안전대책본부
CDSCH
Head: MOPAS
Deputy: NEMA

Response to large-scale disasters

Central Emergency Rescue Control Team
Central SAR
Head: NEMA

Subcmte.
Ministers

Ctr. Recovery Support T/F
(Experts called by CDSCH)

Ctr. Assessment T/F
(called by CDSCH)

Overseas Disaster Assistance T/F
(called by the Governor)

Central level

Local level

시도안전관리위원회
Provincial Council
Head: Governor, Mayor

시도재난안전대책본부
Provincial HQ
Head: Governor, Mayor

Provincial SAR
Head: Fire Commander-General

Local Assmt. T/F
(called by the Governor)

Local Council
Head: District Head

Local HQ
Head: District Head

Local SAR
Head: Fire Chief

중앙재난안전대책본부
CDSCH (Situation Control Office)

유관부처 – 산림청 등
Related Ctr. Governments & Other Organizations

Support Request

Support · Cooperation

Support · Report Support Request

Central Recovery Support T/F

Report and Support Request for the Financial Admr. Support Request

Report and Support Request

Pan-National Support

시도재난안전대책본부
Provincial HQ (Situation Control Office)

비상지원본부
Emergency Support HQ (Disaster Field Office)

Holistic Support

Disaster Site

Support

Report Support Request

Support · Report Support Request

Report

Support

Report Support Request

Support

Support Request

EMS · S&R

시군구재난안전대책본부
Local HQ (Situation Control Office)

Situation Report

긴급구조현장지휘소
SAR Field Office

Ex) Wild Fire Management

Department	Role
Prime Minister Office (Central Safety Management Council)	Approval of **National Safety Management Plan** including wild fire Coordination among the relevant departments Declaration of national disaster zone
MOPAS (Central Disaster Safety Measures Headquarters)	Coordination of National Safety Management Plan including wild fire Managing the **Central Disaster Safety Measures Headquarters** Providing measures to expand local government's workforce and organization for wild fire
Korea Forest Service (Supervisory Agency)	Establishing and operating **wild fire prevention policy** Establishing and operating wild fire response organizations Wild fire response and recovery
Local Governments (Relating/Working Agency)	Establishing and operating local plan of prevention, response and recovery Operating **Local Headquarter of wild fire prevention**
National Emergency Management Agency (Relating Agency)	Supporting wild fire response workforce/equipments Emergency rescue/Co-work with Korea Forest Service & Local Governments
Ministry of Food, Agriculture, Forestry and Fisheries (Relating Agency)	Operation of **Central Accident Headquarter** of wild fire Supporting relations with other related departments
Korea National Park Service (Relating Agency)	Establishing wild fire prevention policy in the national park area Emergency recovery of wild fire

DISASTER MANAGEMENT PLAN OF KOREA

The 1st Korean National Safety Management Plan (2005-2009)

Vision

Safe Korea: to protect the lives and property of the Korean people

Objectives

① Establish a comprehensive response system against natural disasters, focusing on preventive countermeasures
② Establish a disaster prevention information system and science-based disaster prevention strategies and policies
③ Promote international cooperation and prepare for the unification of Korea

The 2ⁿᵈ Korean National Safety Management Plan (2010-2014)

Vision

To Reach High Safety Level of OECD Advanced Nations

Objectives

① To settle advanced safety culture
② To guarantee safe environment of living space
③ To ensure safety of industries from disasters
④ To maintain stable Critical Infra-Structure
⑤ To administer effective disaster management system

The 2ⁿᵈ Korean National Safety & Disaster Management Master Plan

Main Strategies

① **Promoting public safety awareness**
② Spreading safety design concept to all areas
③ Promoting national safety & disaster management policy focused on **mitigation & prevention**
④ Building safety management system **led by local government**
⑤ Encouraging **participation of private companies** in broader fields of safety management
⑥ Active management of national critical infrastructure system
⑦ Establishing rapid and accurate disaster reporting system
⑧ Establishing rapid response and emergency recovery system
⑨ Responding to the **future disaster environment**

The 2nd Korean National Safety & Disaster Management Master Plan

Policy Tasks

① Establishing basis to increase safety awareness
② Enhancing public safety awareness with education and public relation
③ Utilizing resources effectively with public-private partnership
④ Spreading application of safety design to each domain of society
⑤ Expanding basis of disaster and safety management
⑥ Enhancing life safety on vulnerable groups to disasters
⑦ Promoting comprehensive prevention of accidents
⑧ Promoting safety city projects
⑨ …

Paradigm Shift in Korean Master Plan

1st Master Plan 2005 - 2009

- Focusing on natural & man-made disaster
- Effective Top-Down System
  - Integrated system of disaster preparedness
  - Rapid disaster responding

2nd Master Plan 2010 - 2014

- All Hazard Approach (including safety in living environments)
- Encouraging Participation of all sectors
- Local government centered
- Public safety awareness
- Including private companies

NEW CHALLENGE - CLIMATE CHANGE & DISASTER

Climate Change in Korea

- Global temperature during the last Century: 0.74 ℃ ↑
  - At the end of this Century in the East Asia: 3~4℃ ↑
- Average temp. in Korea during the last Century: 1.8 ℃ ↑
  - (two times to global average in six metropolitan cities)
  - At the end of this Century in Korea: 4℃ ↑ , **rainfall 20%** ↑
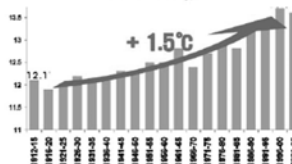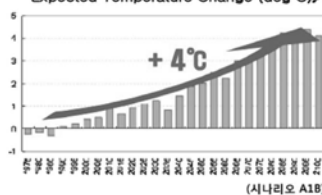
Source: Yeon-Soo PARK(2008). Climate Change and Disaster Risk Reduction in Korea.

Precipitation Pattern Change
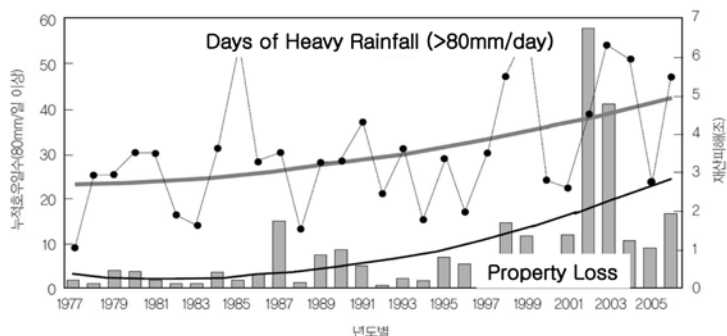
- Extreme levels of rainfall compressed into relatively short periods of time
- high proportion of surface water flooding compared with flooding from river
  - No warning for this types of flooding, difficult to be prepared

flooding from river

surface water flooding
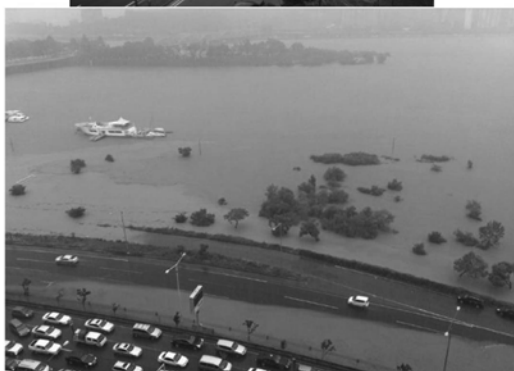
Woomyun Mt. Landslide

Government's Response

- Taking threats by climate change as an opportunity for the new growth initiatives
  - Promoting and fostering "Green Industries" as new growth power through low-carbon green growth
- Operating Climate Change Task Force under the Office of the Prime Minister
  - Establishing comprehensive basic plans and countermeasures basic Act
- Disaster managers are participating in "Adaptation" area of the three major areas
  - NEMA established the "Climate Change Response Division"

Major Response Areas
① Science: cause analysis, monitoring, scenario, forecast, etc
② Impact and Adaptation: set up of measures thru impact assessment, etc
③ Mitigation: alternative energy development, reducing greenhouse effect, etc
* following IPCC and other international climate change study classification

Source: Yeon-Soo PARK(2008). Climate Change and Disaster Risk Reduction in Korea.

T/F for adapting climate change disaster

- Background
  - to establish advanced disaster prevention systems adapting to climate changes disasters

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Command of the President

Instruct to encourage the improvement of fundamental systems including re-establishing standard of the disaster prevention and disaster management on climate change issues.

※ Cabinet meeting(8.2), radio address(8.8), congratulatory speech on National Liberation Day(8.15), and etc

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- Constituting 『T/F for adapting climate change disaster』 within Prime Minister's Office* (2012.8.10)
  - Relative government departments(13), local governments(Seoul, Gyeonggi-do), private experts(5), and etc.

Focus of T/F activities

- Examine the comprehensive policy of whole Government for disasters which went through three times since 1999 and,
- Include issues which were necessary but previously inadequate
  - Small River, Debris Barrier Maintenance
  - Small-scale Facility Maintenance
  - and etc (total of 26 corresponding policies)

Comprehensive Plan to Improve Disaster Management

- Establish 『Comprehensive Plan to Improve Disaster Management』 based on 163 issues from government departments
  - The disaster-related budget for the year of 2012 is five trillion won which is increased by 21% of the year of 2011.

Total	National Emergency Management Agency	Ministry of Land, Transport, and Marine Affairs	Korea Meteorological Administration	Ministry for Food, Agriculture, Forestry and Fisheries	Ministry of Environment
163	53	49	16	11	10
Korea Forest Service	Ministry of Public Administration and Security	National Police Agency	Seoul City Government	Korea Communications Commission	Ministry of Knowledge and Economy
8	5	4	4	2	1

Thank You

감사합니다

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Organization of Forest Fire Protection in the Southeast European / Caucasus Region

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Abstract

In the last twenty years forest fires are one of the most detrimental and destroying factors in region of Southeast Europe and Caucasus. In the same period more than 1.2 million ha of forest and forest land has been burned in the region. Depending on the economic and social conditions in the country, ownership of the forest, history of fires etc., different institutions and organizations are involved in the forest fire protection. The best result gives the organization where the leading role in the forest fire protection plays the forestry sector, supported by other institutions and organizations. The existence of the well trained forest fire management staff in all institutions, especially in the forestry sector, is extremely important.

INTRODUCTION

In the last twenty years forest fires, especially in some years in that period, appeared as most detrimental and destructive (qualitative and quantitative) factors which have influence on forests and other vegetation in Europe, mostly in Southern and Southeast Europe. In the same period more than 1.2 million ha of forest and forest land has been burned in the region of Southeast Europe and Caucasus (Nikolov, 2007). The reasons for that are different: extreme climate conditions (high air temperatures with long dry periods), human behavior (as a main causer of fires), type of forests (vegetation type) etc. In many cases the main reason for the large burned area is inadequate forest fire protection organization in the country. It means, which institution or organization is responsible to organize and carry out the

measures of prevention, pre-suppression and suppression.

ORGANISATION OF THE FOREST FIRE PROTECTION

Organization of the forest fire protection is a very complex issue. In depends on the economic and social circumstances in the country, ownership of the forest, history of fires etc., different institutions and organizations are involved in the forest fire protection in the countries of the Southeast European and Caucasus region.

Forestry Sector

Almost everywhere, without exception, the main sector responsible for forest fires protection, within certain national institutions, is the forestry sector. It is clearly determined in the national Laws, mainly Forest Laws, such is the case in Croatia, Macedonia, Serbia, Bulgaria, Turkey, and Armenia. All of these institutions (Ministries, Public Enterprises, Agencies etc.) have obligation to organize and carry out measures of prevention, pre-suppression and suppression of forest fires. It means that they have to have staff especially educated in forest fire management, trained forest fire fighters, proper tools and equipment, special vehicles etc.

In the countries with long forest fire history the issue of forest fire protection is part of all main forest management documents, e.g. in the 10-years forest management plans. Some documents are especially addressing forest fires, such is annual forest fire protection plans (Macedonia, Serbia, Turkey, etc.).

One of the main reasons why the forestry sector is the first responsible for forest fire protection is that many of the measures of forest fire protection are part of forest management activities. Also, one of the reasons is that foresters (engineers and forest's workers) know very well the terrain, forest, local weather conditions and other local circumstances. The forestry engineers are also knowledgeable and well trained specialists in terms of fundamental knowledge about forest fires, e.g. the natural variables which determine fire behaviour and ⁻ost importantly ⁻he risks for firefighters and civilians to become affected by a fire. It is very important in the process of planning of the measures of prevention and pre-suppression but especially for decision making during the fire suppression.

Other National Institutions

In some cases, very large number of forest fires, large territories with active fires etc., the forestry sector is not able to suppress the fires only with his own capacities. In that case the assistance of other national institutions or agencies is necessary.

Usually, the professional fire fighters (for urban fires) are engaged to help to forestry sector at first. Also, some other institutions (the Directorate for Protection and Rescue of Macedonia, the National Protection and Rescue Directorate of Croatia, the Ministry of Interior, Sector for Emergency Management of Serbia, and the Ministry of Emergency Situations of Armenia) are called to assist in fire suppression.

However, there are some problems in reality. The urban professional fire fighters very often are not trained for forest fire suppression or don't have a proper tools, equipment or vehicles for that purpose. They don't know well the terrain and the forest, as well. Some of the other above-mentioned institutions have proper tools, equipment and vehicles but there is still lack of training and knowledge for the terrain.

Apart these institutions, the army could be engaged in forest fire suppression activities in some countries in the region, as well. It is in case of large number of forest fires and large fires due to lack of firefighters to suppress the fires. The Armed Forces can play an important role to carry out logistical tasks during fire emergencies, e.g. transport of equipment and firefighters, or evacuation of populations.

Volunteers

The voluntary fire protection in many countries in Europe and the world is part of the fire protection system. The need for voluntary fire protection comes from there that not all the time there are sufficient numbers of professional firefighters available to suppress the forest fires without assistance.

The organization of voluntary fire protection today is found in many countries in the region such as Slovenia, Croatia, Macedonia, Serbia, and other countries. But there are countries in which voluntary fire protection is not developed due to

various reasons, such as in Bulgaria, Romania, or Albania. How important could be the volunteers the best example is Croatia with 2,157 professional firemen and 63.060 voluntary firemen (Grum, 2005).

But although this is a voluntary organization that does not mean that their activities are not regulated in a particular law frame and with certain regulations. The volunteers are well trained and equipped as well. It is particularly important because volunteer firefighters participate in many dangerous, life-threatening situations, such as forest fire suppression.

International Organizations

Apart from the national institutions and organizations (governmental, non-governmental) some international organizations could be involved in the forest fire protection system. The different organization has different activities, programs and roles. Basically, their role is to transfer the knowledge and assist the collaboration among countries in terms of all measures of forest fire protection (prevention, pre-suppression and suppression). Among others, such kind of organization is the Global Fire Monitoring Center (GFMC) in Germany, which in this region is represented by Regional Fire Monitoring Center (RFMC) in Skopje (www.fire.uni-freiburg.de and www.rfmc.mk).

Organization of the Forest Fire Protection System

It is clear that in the organization of the forest fire protection are involved a large number of institutions and organizations (governmental, non-governmental). The real problem and challenge in the reality is how to organize them to work together as a coherent system. In order to achieve that, each country has developed scheme of organization of forest fire protection (Schemes 1 and 2). All laws and other legal regulations are in agreement with this scheme. In these laws and regulations the roles and competences of all involved institutions and organizations are clearly defined. It should enable the institutions to work harmonized as a system. Sometimes, not harmonized work of the institutions, especially during the forest fire suppression, is one of the reasons for large burned area. It was case in Macedonia in 2007, Croatia 2007, Bosnia and Herzegovina 2007, or Serbia 2012.

Scheme 1. Organization of forest fire suppression in Serbia
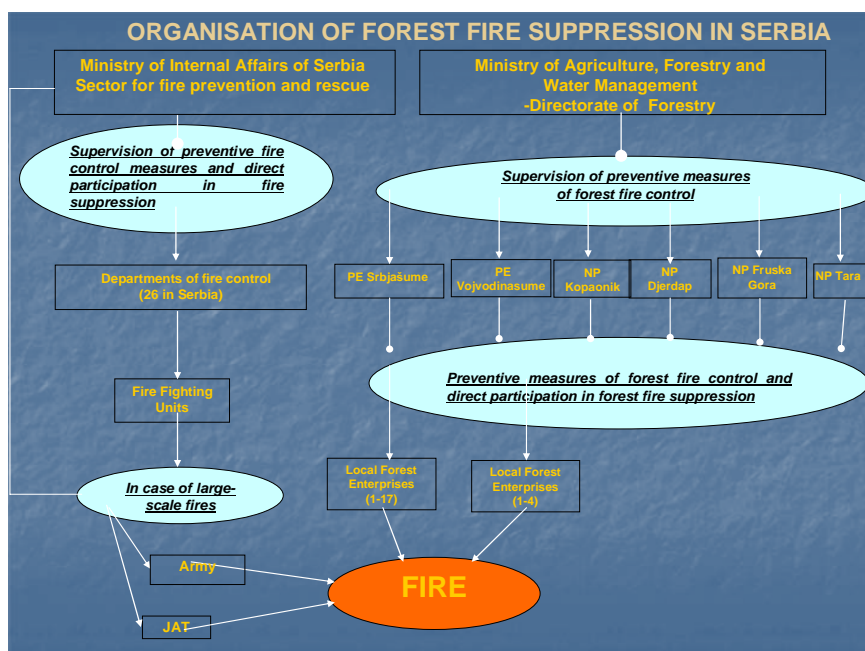
Scheme 2. Organization of forest fire protection in Macedonia
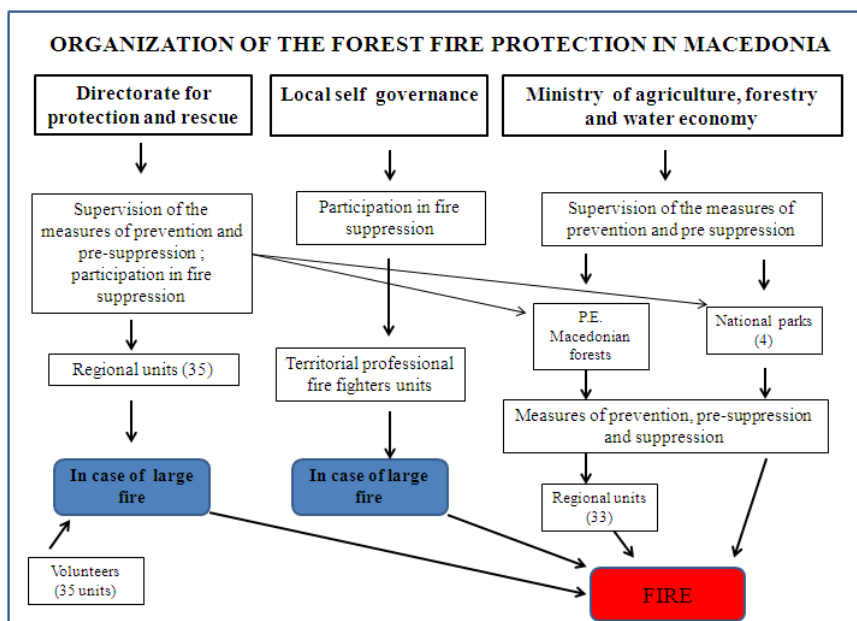
CONCLUSIONS

One of the most important things in the forest fire protection organization in the region of Southeast Europe and Caucasus is the need of clearly defined place and role of the institutions and organizations. The best result gives the organization where the leading role in the forest fire protection plays the forestry sector, supported by other institutions and organizations. The existence of the well trained forest fires management staff in all involved institutions, especially in the forestry sector, is extremely important.

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Session 2

January 15, 2013

1. Forest Fire Prevention Policy of Korea

2. Fire management of Korea National Park Service

3. Canadian Forest Fire Strategy

4. Towards Regional Cooperation in The Fields of Mitigating Forest Fire in Asia through AFoCO

Forest Fire Prevention Policy of Korea

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1. Status of Forest Fires

- 387 fires of annual average during recent 10 years (2003-2012). 734 hectares of burned area
  - Annual trifling occurrences are 2,500 fires
- Forest fires continuously increased until 1990s, but the occurrences have been decreasing thanks to operational optimization of expanded resources since 2010.
  - 1990s: 336 times (1,368 ha) → 2000s: 523 times (3,726 ha) → 2010s: 250 times (486 ha)

2. Development of Fire Response

- Ground Forces
  - 3,000 persons of specialized forest fire prevention and suppression forces were introduced in 2003. → Expanded to 10,000 persons in 2012.
- Aerial Attack System
  - Forest Aviation Headquarters was established in 1971 with 3 helicopters. → 47 helicopters in 9 aircraft stations nationwide as of 2012.
- Ground Suppression Equipment
  - Forest fire trucks were supplied in 1995, small-sized water pumps in 2007, medium-sized water pumps in 2010.
- Supporting IT Systems:
  - Forest Fire Location Monitoring System (2009) and Suppression Technology System (2010)

- Resources expansion until 2010: Helicopters, fire trucks, and personnel are reinforced continuously and achieved 80-90% of the target.
- System upgrade after 2010: Supporting IT system settlement and upgrade to use expanded resources effectively.

	Helicopters	Fire Trucks	Personnel	IT
Target	55	1,200	12,000	300
Present State	47	1,148	9,950	30
Present/Target Ratio	80%	96%	83%	10%

3. Future Plan of Forest Fire Prevention

■ System Upgrade
  − Web-based situation management system including fire risk forecast, trekking courses opening and closure, and patrol management will be integrated into Fire Incident Management System.

■ Fire Prevention
  − Water sprinkler system will be introduced to protect valuable natural and cultural heritages.

■ Aerial Attack
  − Helicopters' arrival at the spot within 30 minutes nationwide
  − Operation of Aerial Navigation System to prevent safety accidents

■ Ground Suppression
  − Suppression Technology System considering Korean mountainous terrain will be settled and Suppression Forces will be organized to operate the system. (193 teams in city/county level, 9 teams in broader level)

■ International Cooperation
  − The 6th International Wildland Fire Conference (IWFC) will be held in 2015 in Korea to share fire management knowledge and experience.

Forest Fire Control Policy In Korea

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Director, Forest Fire Control Division, Korea Forest Service

Contents

Ⅰ. Conditions of Forest Fire

Ⅱ. Forest Fire Control Policy and Practices

Ⅲ. Preparations for the 6th IWFC

Ⅰ. Conditions of Forest Fire

The Status of Forest Fire

▶ 478 fires of annual average, 1,161ha of Burned area

※ Trifling occurrences are 2500 fires

▶ Irregular fire occurrences and scales depending on weather conditions

Fire status

Major fires

Goseong Fire
• Date: 23-25 April 1996 (54 hours)
• Burned Area: 3,762 hectares
• Damage: 21 million USD
• Maximum Wind Speed: 27 m/s

Yangyang Fire
• Date: 4-6 April 2005 (32 hours)
• Burned Area: 974 hectares
• Damage: 19.5 million USD
• Damaged Household: 191
• Maximum Wind Speed: 32 m/s

Cheongyang & Yesan Fire
• Date: 14-15 April 2002 (18 hours)
• Burned Area: 3,095 hectares
• Damage: 5.5 million USD
• Maximum Wind Speed: 15.1 m/s

East Coast Fire
• Date: 7-15 April 2000 (191 hours)
• Burned Area: 23,794 hectares
• Damage: 33 million USD
• Maximum Wind Speed: 23.7 m/s

Ⅰ. Conditions of Forest Fire

The Causes of Forest Fire

▶ Most fires are caused through carelessness of people

mountain hikers 42%
Land Clearing 18%
etc. 11%
Waste incineration 10%
Cigarette burn 9%
Cemetery visitors 6%
Building fire 2%
Firework by Children 2%
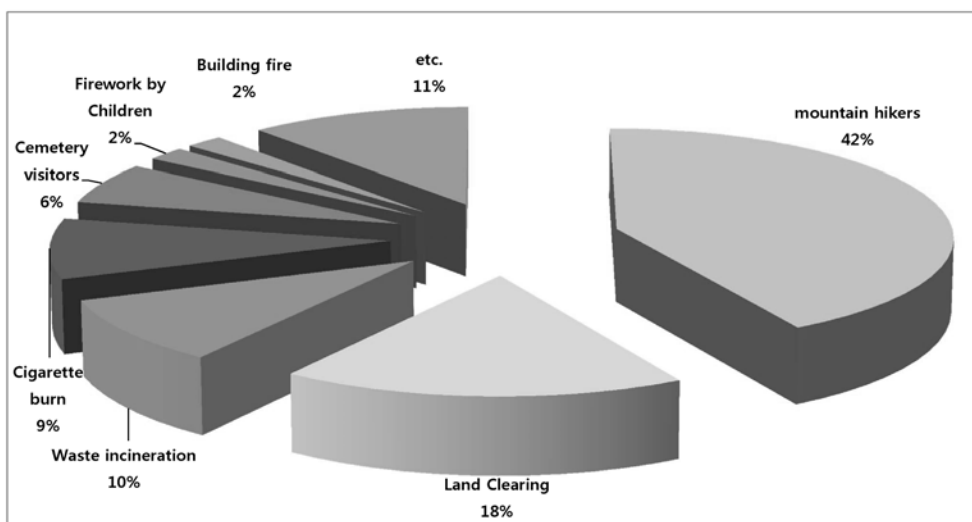
I. Conditions of Forest Fire

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

Monthly Fires
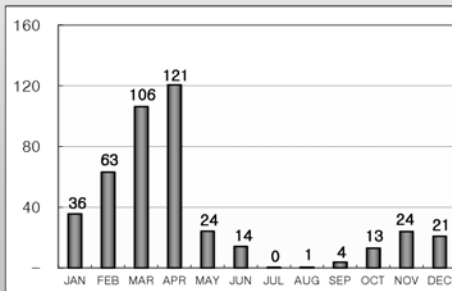
Seasonal fires
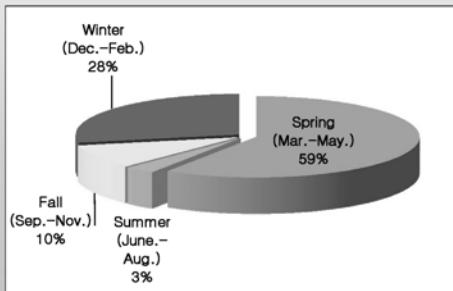
I. Conditions of Forest Fire

Topography

▶ Forest covers 64% of the land(6.37 million ha)

▶Forest land is mountainous, curved, and steep
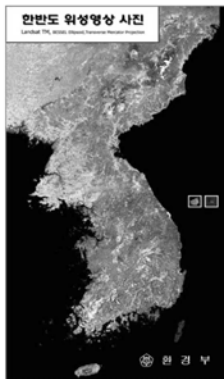
Ⅰ. Conditions of Forest Fire

Forest

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

Ⅱ. Forest Fire Control Policy and Practices

Goal

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

Strategy

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

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

II. Forest Fire Control Policy and Practices

Organization for Forest Fire Control
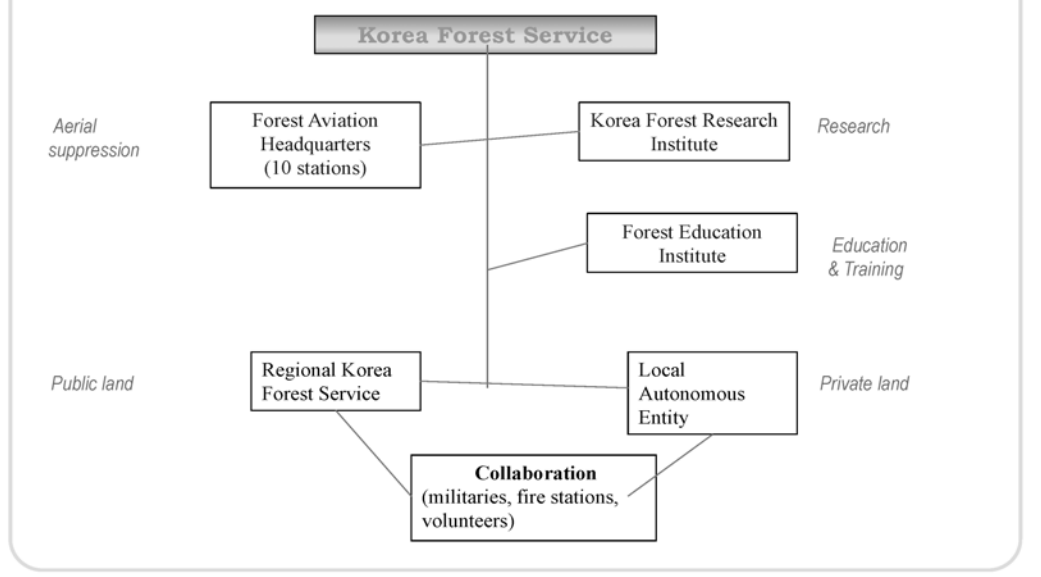
Prevention Practices

(1) Forest Fire Danger Rating System & Forest Fire Danger Information

- To provide hourly "Forest Fire Danger Rate" to web-based service in real time
- To take an action for forest fire prevention by deploying forest fire watchers
- To deliver text message by informing 'forest fire danger information' to the head of local districts, offices of local districts, and forest fire watchers

< Real time forest fire danger rating>   < Forest fire information>   < Forest meteorological information>

Prevention Practices

(2) Prohibition of mountain entrance & closure of trekking courses

- **To prohibit climbing up to 30 % of forest land during the fire intensive season**
- **To distribute fire watchers at the entrance of trekking courses and restricted areas**
- **To report unauthorized entrance of hikers**

Easy-to-read trekking allowed places and trails by Web based service

Solution of inconvenience and complaints issued from the public
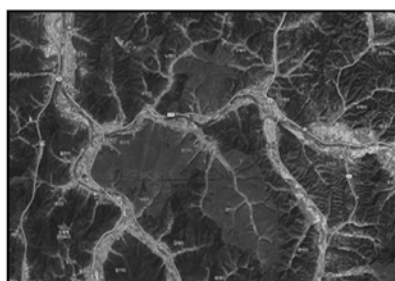
Prevention Practices

(3) Pre-remove Factors of Forest Fire Danger

- **To Pre-remove agricultural wastes within 100m and near forest**
- **To Remove flammable materials and fuels at trekking course**
- **To Keep space open and separated for temples and cultural heritages**

〈 Fingerprint of 'Hein-sa' Temple 〉

< Completed project>

Prevention Practices

(4) Protect forest reserves and buildings from crown fires by sprinklers

Early-Detection Practices

(1) Running 25,000 forest fire watchers during fire season

- To recruit & distribute local people as patrols

- To provide GPS devices for fire watchers' location trace in real time
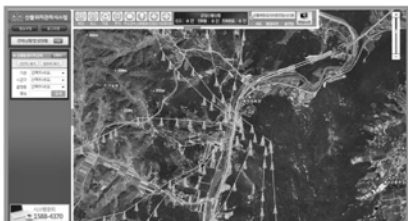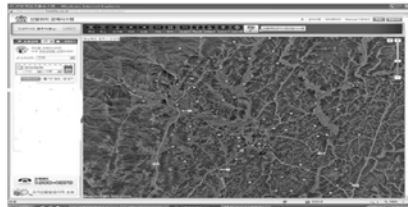
Forest Fire Location Monitoring System
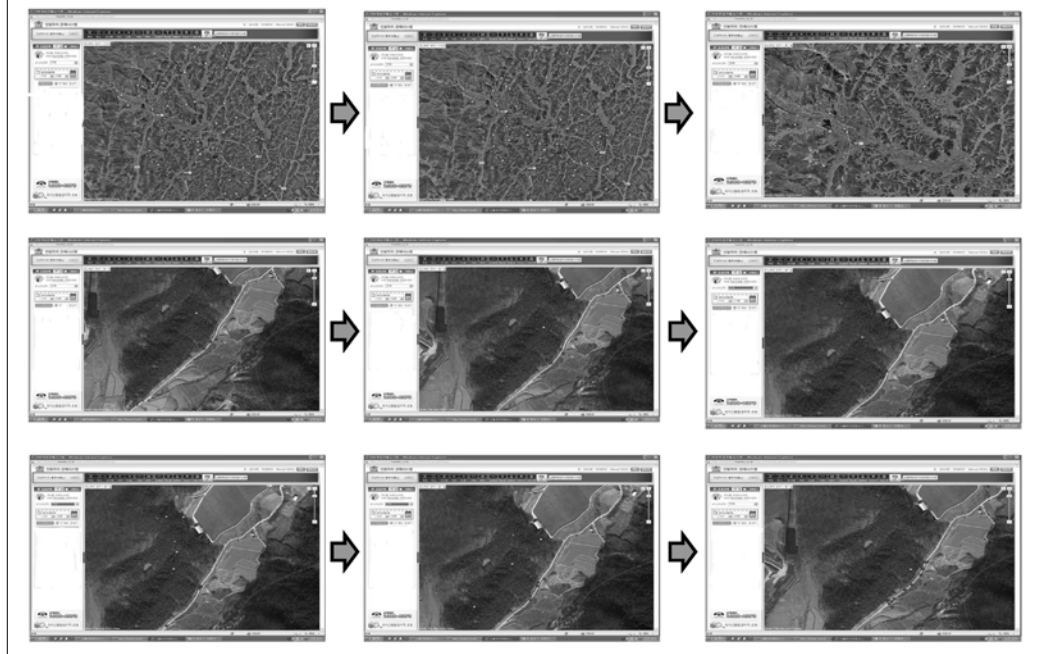
Usage of Forest Fire Report System
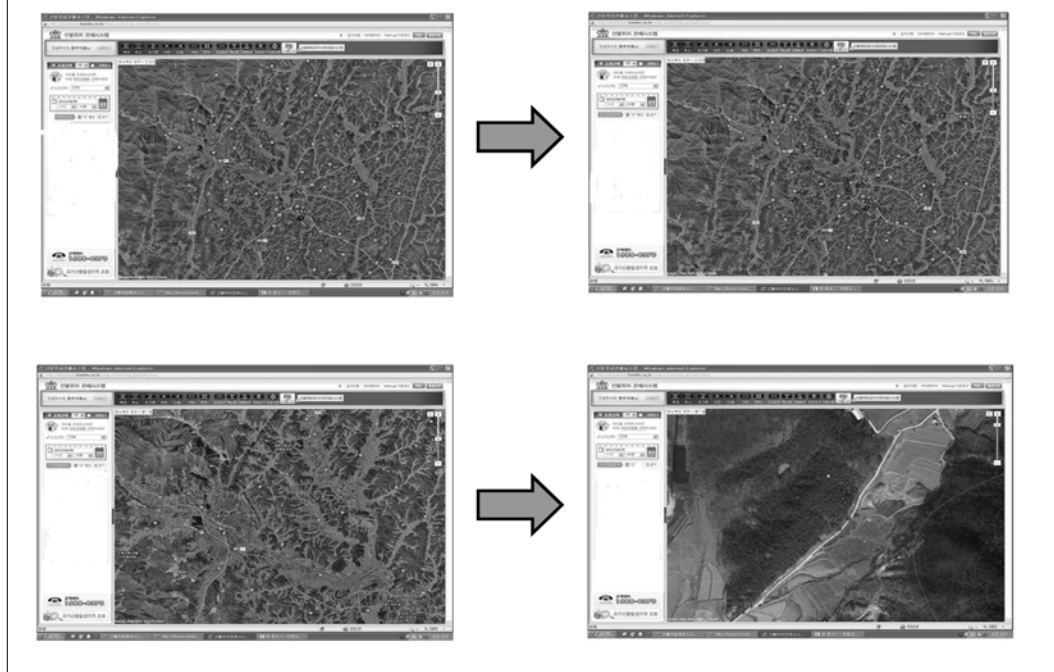
Early-Detection Practices

(2) 795 cameras for surveillance within 10km

(3) 2600 Hikers checkpoint guides, 900 Surveillance towers

Forest Fire Integrated Situation Control System

☞ Forest fire warning information

☞ Forest fire warning short message system (SMS)

☞ Monitoring camera connecting system

☞ NFC(Near Field Communication) system

☞ Watchers and Fighters position Monitoring

☞ Multimedia Messaging System (MMS)

☞ Trails and restricted areas information

☞ Electric lines and towers information

Forest Fire Attack Practices

(1) Korea Incident Integrated Command System
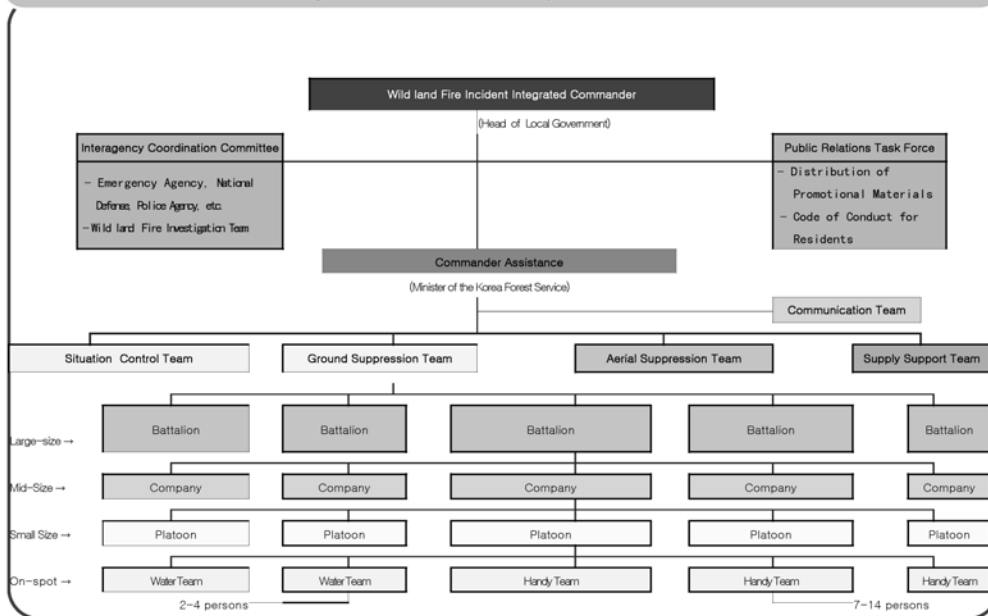
Forest Fire Attack Practices

(2) Efficient air attack system using helicopters

- At first, using 47 helicopters from KFS
  - 50 rented helicopters from local government
  - cooperation with other organizations : military 21, fire station 26

- To be always ready for less than 30 minutes arrival at the spot <30min'AH>
  - To place Helicopters in 10 aircraft stations, dispatch long distance places

KA-32T

S-64

Bell-206

Military

Forest Fire Attack Activities

Forest Fire Attack Activities

Forest Fire Attack Practices

(3) Ground Forces with Korea Mountain Pumping System

◆ Initial attack: specialized forest fire prevention and suppression forces(10,000 persons)
◆ Major or night fire stage : trans boundary suppression team (9)
◆ Auxiliary forces : forest workers, military, volunteers (23,000 persons)

Forest Fire Attack Practices

Korea Forest Fire Ground Suppression System
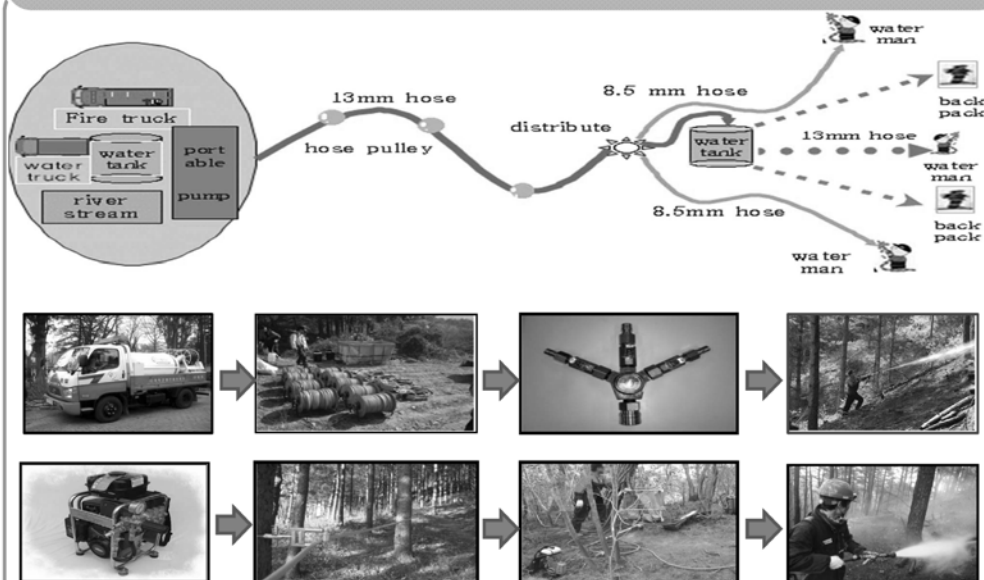
Forest Fire Attack Practices

Forest Fire Ground Suppression Activities

Forest Fire Attack Practices

Forest Fire Ground Suppression Activities

Forest Fire Attack Practices

(4) Supporting System

Helicopter Location Monitoring System

Carrying hoses to higher places by Helicopter

Real time on-spot situation monitoring system
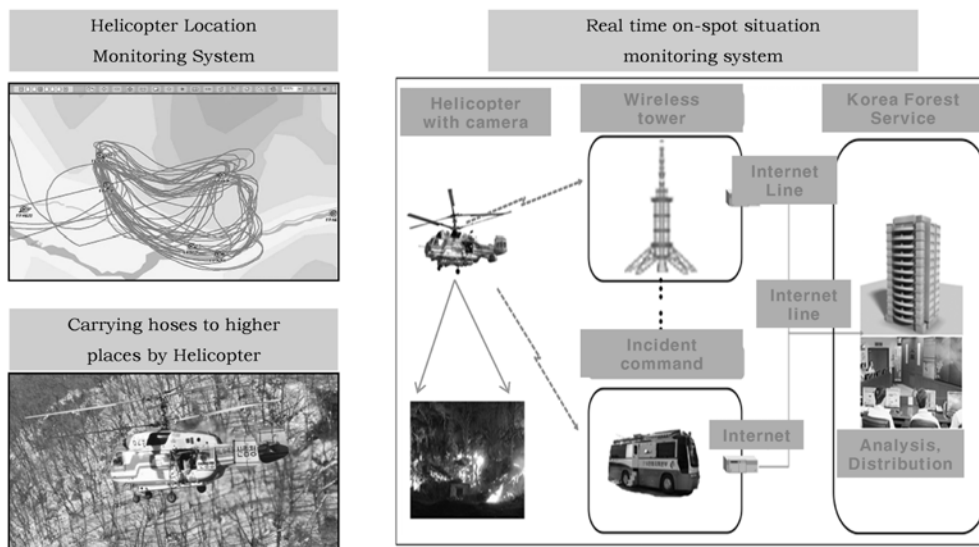
III. Preparations for the 6th IWFC

> **Preparation Meeting for the 6th IWFC** (2 July 2012, GFMC, Germany)

1) Participants: KFS, ILC, UNISDR-WFAG, IFAWG, GWFN, UNECE, FAO, ITTO, UNU, etc.

2) Discussion Agenda

- Operating Plan: Update of the ILC Charter and Confirmation of Provisional ILC Office

- Determination of Slogan: Fire of the past, Fire in future

- Designation of Conference Date: 12-16 October 2015

- Suggestion of Holding 'High-level Segment' in Conjunction with the 6th IWFC:

  Detailed Agenda will be established.

- Future Plan for Conference Promotion

III. Preparations for the 6th IWFC

➤ **Preparation Status as of November 2012**

1) Production of logo is completed

2) Provisional website will be completed in mid-December 2012.

3) The venue is determined after 2012 considering political situation in the host country (presidential election in December 2012).

4) Registration fee and accounting matters will be determined after 2012.

5) Agenda Development Team for Conference Program and IWFC High-level Segment and its Operating Plan are under development.

Thank you

Fire management of Korea National Park Service

Gongju Na

Korea National Park Service

Abstract

The KNPS(Korea National Park Service) is one of the collaborative organizations of which the given commitments given is to prevent, mitigate, and suppress fire in the 20 Korean National Parks for securing the people and properties. This aims to introduce how to control and manage fire in the Korean national parks and to share the lessons learnt from our activities as well as to get advice from experts.

The major contents supposed to be presented are as follows,

Introduction of Korean National Parks
Fire Information in the Korean National Parks
 ― fire statistics: Yearly, Monthly, Weekly
Prevention, mitigation and suppression
 ― Policy and strategic: goals and objectives of FM
 ― Major activities to reduce fire
 ― Cooperation with Fire management organizations
Conclusions and Further Discussion

AFoCO: Asia Forest Cooperation Organization

1997-98 El Nino Southern Oscillation (ENSO) event
- 25 million ha of land has been affected by fire (Worldwide)
- Especially in Indonesia, 11.7 million ha of land was damaged fire

Global attention to mitigation and management of forest fire
- Southeast Asia
  : coping with the Haze caused from Indonesian fire
   "Trans-boundary Haze Agreement was signed by ASEAN members in 2002
- Global cooperation and supports to ASEAN

ASEAN-ROK Agreement on Forest Cooperation : A Dialogue Platform for AFoCO

From ASEAN-ROK Cooperation towards AFoCO

ASEAN-Korea Environmental Cooperation Programme (AKECOP) 2000~	ASEAN-ROK Commemorative Summit (Initiative of AFoCO) 2009-11	ASEAN-ROK Agreement on Forest Cooperation 2012-14	Asian Forest Cooperation Organization (AFoCO) 2014-15
Theme "Restoration of Degraded Forest Ecosystems in Southeast Asian Tropical Regions"	ROK's proposal for the establishment of **AFoCO** Dialogue between ASEAN and ROK on forest cooperation agreement	Cooperation activities on Sustainable Forest Management, ecosystem maintenance, community forestry and climate change. Dialogue for the establishment of AFoCO	Establishment of AFoCO (Multilateral regional organization)

ASEAN-Korea Environmental Cooperation Project (AKECOP) (from 2000 till now)

- Enhancement of human and institutional capacity to address SFM, carbon sequestration, watershed management; enrichment of biodiversity, restoration of forest ecosystem, and poverty alleviation
- Participated by 19 institutions from 9 countries (except Singapore)
- Training & education programs for ASEAN foresters (4 PhDs,9 MSs, 8 long-term and 178 short-term participants completed)
- 338 participants in various technical workshops

Initiative on the Establishment of AFoCO

Asian Forest Cooperation Organization (AFoCO)

AFoCO was proposed by the Korean President Lee, Myung-Bak at ASEAN-ROK
Commemorative Summit (June 1~2, 2009 in Jeju,ROK)

Closer ties with the adoption of the Joint Summit Statement

The Summit statement on AFoCO (excerpts)

"We agreed to endeavour to strengthen our cooperation in the context of the United Nations Framework Convention on Climate Change (UNFCCC), especially on the Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD) initiative, enhancement of sustainable forest management, watershed restoration, and promotion of industrial forestation. In this regard, we appreciated the ROK's proposal to establish an "Asian Forest Cooperation Organisation."

"To deliver action-oriented activities with close and effective collaboration"

Progress in Establishment of AFoCO

- ASEAN-ROK Foreign Affairs Ministers signed the **"ASEAN-ROK Forest Cooperation Agreement"** at the 14th ASEAN-ROK Summit **(18 November 2011 in Bali)** and paved the way for the establishment of AFoCO

- **The Agreement entered into force on 5 August 2012** after ROK and 6 ASEAN Member States completed respective domestic procedure

ASEAN-ROK Forest Cooperation Agreement

- Agreement Between the Governments of the Republic of Korea and the Member States of the Association of Southeast Asian Nations on Forest Cooperation

- Objectives:

  - To facilitate forest cooperation and translate sound forest policies and proven technologies and to prevent deforestation and forest degradation in the context of SFM as well as climate change

  - To provide platform for dialogue between ASEAN and ROK towards the establishment of AFoCO5 August 2012

- Signed 18 November 2011

- Entered into force 5 August 2012

- Effective 2 years (until 4 August 2014 subject to extension)

Roadmap for AFoCO
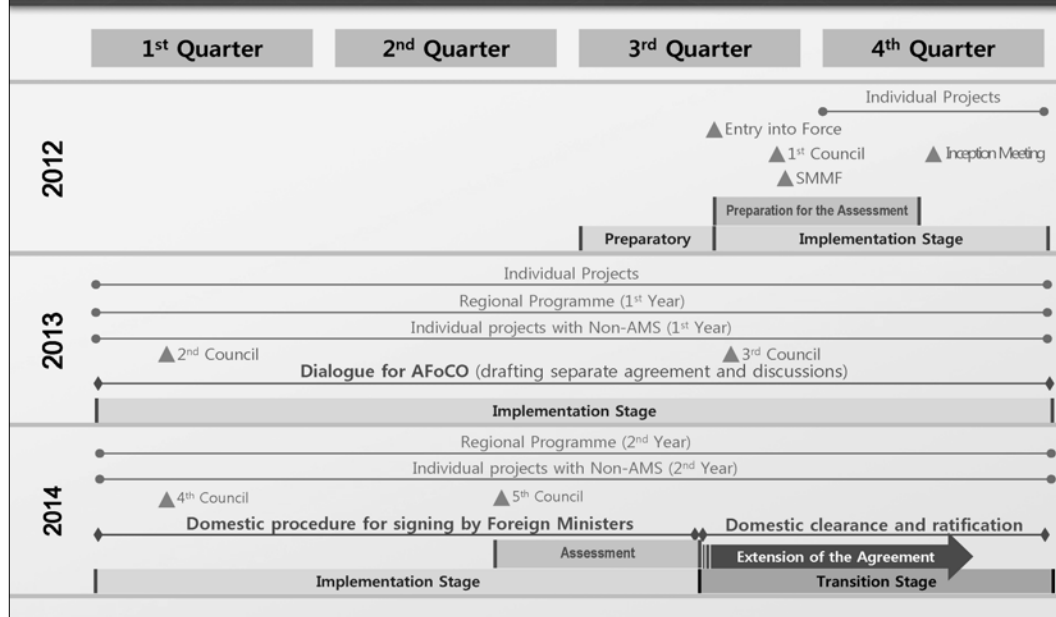
| 1st Quarter | 2nd Quarter | 3rd Quarter | 4th Quarter |

2012
- Individual Projects
- ▲ Entry into Force
- ▲ 1st Council   ▲ Inception Meeting
- ▲ SMMF
- Preparation for the Assessment
- Preparatory | Implementation Stage

2013
- Individual Projects
- Regional Programme (1st Year)
- Individual projects with Non-AMS (1st Year)
- ▲ 2nd Council   ▲ 3rd Council
- Dialogue for AFoCO (drafting separate agreement and discussions)
- Implementation Stage

2014
- Regional Programme (2nd Year)
- Individual projects with Non-AMS (2nd Year)
- ▲ 4th Council   ▲ 5th Council
- Domestic procedure for signing by Foreign Ministers   Domestic clearance and ratification
- Assessment   Extension of the Agreement
- Implementation Stage   Transition Stage

AFoCO: Asia Forest Cooperation Organization

AFoCO, a legally binding regional organization established by an intergovernmental multilateral arrangement involving 10 ASEAN countries, ROK, and more other Asian countries.

Sustainable Development for a Green Asia

Forest rehabiliatation and prevention of forest-related disasters	Climate change mitigation and adaptation	Sustainable forest management	Capacity building and transfer of technology
Rebilitate forest ecosystem to prevent calamities	Enhance forest carbon stocks and support initiatives on mitigation and adaptation of impacts of climate change	Promote sustainable forest management practices	Establish human resource development
Restore degraded tropical forests and combat desertification in Asia	Support REDD activities prevent forest disasters	Encourage sustainable trade of forest products	Promote public awareness
Prevent forest disasters	Reinforce sound industrial plantation within the region	Protect livelihood of forest dependent and indigenous communities	Research and development in forest sector
		Promote community-based forestry activities	Establish database for comprehensive information sharing

Cooperative Activities under AFoCo

1. Individual Project

- ROK initiated pilot projects for 2010-2011 (USD 150,000)
  - To promote ASEAN-Korea Cooperation and establishment of AFoCO
  - 4 projects supported (Cambodia, Indonesia, Myanmar and Philippines)

- ASEAN-ROK Forest Cooperation Projects for 2011-2012 (USD 880,000)
  - 9 projects supported (10 AMSs, except Singapore)
  - 4 key areas of cooperation
    : ① Mitigation of climate change, ② Biodiversity and conservation,
    ③ NTFPs development and **renewable biomass energy**,
    ④ Human capacity development

- Individual Forest Cooperation Projects for 2012-2013 (USD 1 M)

Individual Forest Cooperation Projects

2011 - 2012

0

Brunei Darussalam

Brunei Plant Biodiversity: Endemics and Database in Brunei Darussalam

- Period: Jan ~ Dec 2012

- by Forestry Department,
  Ministry of Industry and Primary Resources

- Major Activities:
  Documentation of endemic plants
  Development of plant database

Cambodia

Improving Capacity on Forest Restoration in Cambodia

- Period: June 2011-May 2012
- By Institute of forest and Wildlife Research and Develpoment

- Major Activity: Restoration of community forests for sustainable use and poverty reduction of participating community

- Restoring degraded *Dalbergia* forest and establishing mass production facilities by tissue culture

Indonesia

Database Management Development for Forestry Research and Development Results and Capacity Building on Biomass Energy in FORDA

A. Training on GIS and spatial analysis

B. Training workshop for junior analysts level in FORDA's GIS Laboratory

C. Bio-Energy training in KFRI

Lao PDR

Building Core Capacity for Village and Village Cluster Forestry

- Period: October 2011-Present
- By Department of Forestry
- Major Activity:
  Development of a field guide on village and village cluster forestry
  Training of core group of master trainers on methodologies and practices of implementing village forestry

Malaysia

Establishing Plant Biodiversity Enrichment Model in Greened Ex-tin Mine and Strengthening Human Capacity Developments in Malaysia

- Period: June 2011 – July 2012
- By: Ministry of Natural Resources and Environment
- Major Activity:
  Establishment of plant biodiversity enrichment model in ex-tin mine in Bidor, Perak (3 ha)
  Strengthening staff capability in key areas of sustainable forest management in Peninsula Malaysia
  Training forest operator

Myanmar

Mitigation of Climate Change Effects through Restoration of Degraded Forests and Ecosystem and REDD-plus Activities in Bogo Yoma Region of Myanmar

- Period: Dec 2011 – Dec 2012
- By: Forest Department
- Major Activity:
  Demonstration on restoration and ecosystem conservation, survey, measuring carbon stocks and reference emission levels, field operating manuals
  Capacity building among staff and relevant stakeholders on REDD+ readiness and ecosystem restoration

Philippines

Addressing Climate Change through Community-based Fuelwood Plantation Development and Management

- Period: January 2011 – December 2012
- By: Forest Management Bureau, DENR
- Major Activity:
  Establishment of 20 ha fuelwood tree plantation as an alternative source of energy for local communities
  Simple monitoring system for carbon sequestration accounting and inventory

Thailand

Strengthening Collaboration of Forest Research and Sustainable Forest Management with Local People's Participation

- Period: October 2011 – Present
- By: Royal Forestry Department
- Major Activity:
  Preparation of community-based forest management plan, participatory implementation of activities
  Participatory Rural Appraisal (PRA), on-job training on forest management, monitoring and reporting

Viet Nam

Developing Non-Timber Forest Products (NTFPs) in the Northwest of Vietnam as the Mechanism for Sustainable Forest Management and Livelihood Improvement for Local Communities

- Period: June 2011 – July 2012
- By: Vietnamese Academy of Forest Science
- Major Activity:
  Field survey, documentation and guidelines for planting, harvesting, processing and marketing of NTFPs in 4 provinces
  Workshops, meetings and training courses for dissemination of practices and information

Individual Forest Cooperation Projects (In Consideration)

2012 - 2013

0

Proposed Projects of AMS (2012)

Country	Project Title
Brunei Darussalam	**Fungal Diversity** in Stems of *Aquilaria* Species in Brunei Darussalam
Cambodia	Improving Capacity on **Forest Restoration** in Cambodia (Phase II)
Indonesia	Development of **Wood Processing** Workshop and **Capacity Building** for Forestry Vocational High School (SMK) Students at Kadipaten, West Java, Indonesia
Lao PDR	Enhancing Capacity for **Village Forestry** in Laos

Proposed Projects of AMS (2012)

Country	Project Title
Malaysia	Enrichment of Rainforest Tree Species Diversity in the greened ex-tin mine [FRIM, Forest Research Institute Malaysia] Biodiversity Conservation and Ecotourism Enhancement of Matang Mangrove Eco-Educational Center, Kuala Sepetang, Perak [FDPM, Forest Department of Peninsular Malaysia] Restoration and Rehabiliation of Degraded Mangroves Ecosystem in Kuching Wetland National Park-Ramsar Site, Srawak [FDPM, Forest Department of Peninsular Malaysia

Proposed Projects of AMS (2012)

Country	Project Title
Myanmar	Mitigation of Climate Change Impacts through Restoration of Degraded Forests and REDD-plus Activities in Bogo Yoma Region of Myanmar
Philippines	Climate-Proofing of the Philippine Revised Master Plan for Forestry Development
Thailand	REDD in Nam Reab Watershed at Nam Province of Thailand: A Community Forestry Initiative for REDD+ Concept Based on Climate Change Adaptation and Sustainable Forest Management
Vietnam	Developing Non-Timber Forest Products (NTFPs) in the Northwest of Vietnam as the Mechanism for Sustainable Forest Management and Livelihood Improvement for Local Communities

Regional Cooperation Projects

2013 - 2014

0

Overview

- **Following the entry into force of the AFoCo Agreement on 5th August 2012**
- **Forest cooperation activities between ASEAN and ROK are expected to implement in full scale**
- **ROK committed to support USD 3 M in voluntary contribution for 2 years projects**

Cooperative Activities under AFoCo

2. Regional Cooperation Project

- ROK have committed to support USD 3 M in voluntary contribution for 2 years

- Reclamation, Rehabilitation and Restoration of Degraded Forest Ecosystems (USD 1 M)
  - Mekong River Basin countries (Myanmar, Thailand, Lao PDR and Cambodia) led by Thailand (USD 0.5 M)
  - Brunei, Indonesia, Malaysia, Philippines and Singapore led by Malaysia (USD 0.5M)

- Capacity Building on Improving Forest Resources Assessment and Enhancing the Involvement of the Local Communities to Address the Adverse Impact of Climate Change (USD 2 M)
  - All AMSs led by Indonesia

Project pilot sites
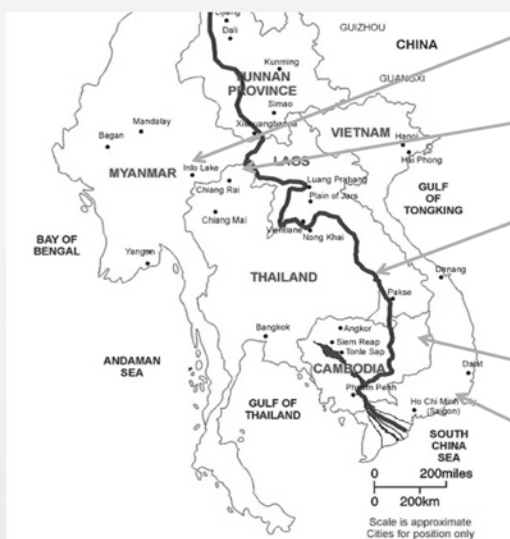
Myanmar: Inlay (protected watershed)
Ecotourism with watershed management

Thailand: Mae Kok (restored forest)
Ecotourism with forest restoration

Lao PDR: Xebangnouane (community forestry)
Participatory forest management with certification

Cambodia: Mondolkiri (protected forest)

Vietnam: Bidoup Nui Ba (national park)
Ecotourism with biodiversity conservation

Proposed Regional Projects

- **Capacity Building on Improving Forest Resources Assessment and enhancing the Involvement of the Local Communities to address the adverse impacts of Climate Change**
  - **All ASEAN Members States Led by Indonesia**
  - **USD 2,000,000**

AFoCO's Opportunity Towards Regional Cooperation in Asian Forest Fire

AFoCO: Asia Forest Cooperation Organization

AFoCO, a legally binding regional organization established by an intergovernmental multilateral arrangement involving 10 ASEAN countries, ROK, and more other Asian countries.

Sustainable Development for a Green Asia

Forest rehabiliatation and prevention of forest-related disasters	Climate change mitigation and adaptation	Sustainable forest management	Capacity building and transfer of technology
Rebilitate forest ecosystem to prevent calamities	Enhance forest carbon stocks and support initiatives on mitigation and adaptation of impacts of climate change	Promote sustainable forest management practices	Establish human resource development
Restore degraded tropical forests and combat desertification in Asia	Support REDD activities prevent forest disasters	Encourage sustainable trade of forest products	Promote public awareness
Prevent forest disasters	Reinforce sound industrial plantation within the region	Protect livelihood of forest dependent and indigenous communities	Research and development in forest sector
		Promote community-based forestry activities	Establish database for comprehensive information sharing

Invitation to join AFoCO dialogue

- **ASEAN-Korea Forest Cooperation will invite Asian countries to establish AFoCO**
- **Start from pilot projects proposal**
  - In line with the areas of AFoCO cooperation
    - Sustainable Forest Management
    - Addressing climate change issues
    - Capacity building and technology transfer
    - Dialog for the establishment of AFoCO

Process in general

```
Set the Area of        Proposal from         Reviewed by
Cooperation      →      country         →    project review
  Project                                        team
                                                  ↓
Progress Report       Implementation        Approval by the
and Monitoring   ←    by the recipient  ←      Governing
                         country                 Council
   ↓
Final report and       Closing of the
Financial Audit   →       project
```
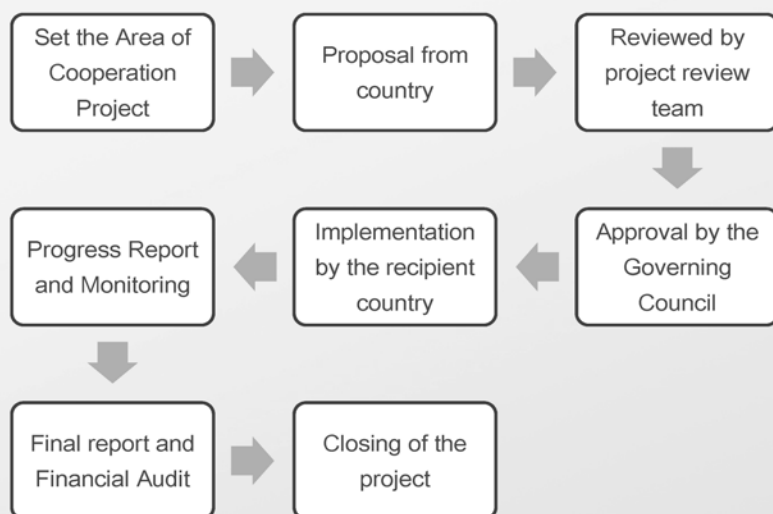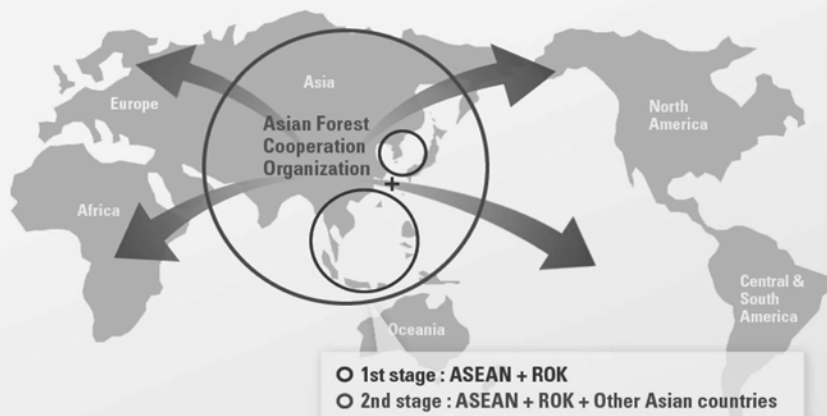
Future Cooperation for the AFoCO

- Expansion of the Regional Forest Cooperation
  - 11 Member countries of AFoCo Agreement (10 ASEAN Member States + ROK)

  → Broader Asia (DRPK, NE Asia, South Asia, Central Asia, etc.)

O 1st stage : ASEAN + ROK
O 2nd stage : ASEAN + ROK + Other Asian countries

Contact Information

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Thank you

Ar Kun!
Terima kasih!
Khawp Chai lai lai!
Chezu tinbade!
Salamat Po!
Khawp khun khrap!
Cam on!
Kamsahamnida!

Poster Presentation

No.	Title	Presenter	Affiliation
P-1	Effects of postfire silvicultural practices on stand structure and wildlife in Korea	Eunjae Lee	Daejeon Development Institute
P-2	Comparison of soil arthropod communities cording to fire and recovery method	Seung-JaeJung	Korea Forest Research Institute
P-3	Monthly change of ants in the burned forest	Tae-SungKwon	Korea Forest Research Institute
P-4	Niche breadth and habitat type of butterflies in burned grassland and unburned forest	Tae-SungKwon	Korea Forest Research Institute
P-5	Long-term change of arthropods in burned forests	Tae-SungKwon	Korea Forest Research Institute
P-6	Ants foraging vegetation, ground, and soils in the burned forest	Tae-SungKwon	Korea Forest Research Institute
P-7	Dynamics of sprout and seedling through fire resistant forest establishment in the forest fire area	Kwangsoo Lee	Southern Forest Resources Research Center
P-8	Combustion characteristics of lignocellulosic biomass slurry in the narrow reactor tubing system	Seok-Hwan Choi	Korea Forest Research Institute
P-9	Modeling of pulse-combustion process reactor for lignocellulosic biomass slurry saccharification	Seok-Hwan Choi	Korea Forest Research Institute
P-10	Estimation of forest management ratio for private forests in Chungcheongnamdo	Yeonok Seo	Warm-Temperate and Subtropical Forest Research Center
P-11	The Prediction of Successive Change and Selection of Desirable Species in the Forest types of Mt. Gariwang Area	Ji Hong Kim	Kangwon National University
P-12	Combining a fire suitability model and a dynamic forest succession and distu rbance model for fire risk assessment in Samchuk region	Dongwook W. Ko	Kookmin University
P-13	Differences in amphibian and reptile communities under different forest environmental conditions at forest fired area in Samcheok, Gangwonprovince,Korea.	Changdeuk Park	Seoul National Univeristy

No.	Title	Presenter	Affiliation
P-14	Analysis on Weather Factors in Baek dudaegan Mountains of Gangwon Province	Daesung Won	Climate Change Research Institute of Korea
P-15	Differences in breeding ecology of varied tit(Parus varius) by post-fire restoration methods in Samcheok, Gangwon Province, Korea	Jinyong Kim	Seoul National Univeristy
P-16	Effects of seed tree density on seed rain, soil seed bank and seedling emergence of Pinus densiflora in Mt. Joongwang, Korea	You Lim Jang	Seoul National Univeristy
P-17	Comparison of Crown Fuel Characteristics on the Two Eco-types of Pinus densiflora Stands in Korea	Sungyong Kim	Kongju National University
P-18	Biomass and carbon stock assessments of natural mangrove stands in Palawan, Philippines	Azyleah C. Abino	Kongju National University, Laguna Lake Development Authority, Diliman
P-19	Surface Fuel Characteristic sand Fuel Loadon Thinning Intensity of Pinus rigida Stands	Mina Jang	Kongju National University
P-20	Construction and Validation of Stem Volume Functions for Pinus kesiya in the Conife rous Forests of Northern Philippines	Roscinto Ian C. L umbres	Kongju National University, Laguna Lake Development Authority, Diliman
P-21	The study of forest fire risk a round facilities in wildland—urban interface	Si-Young Lee	Kangwon National University
P-22	An analysis of tower yarder operation system	Koohyun Cho	Forest Practice Research Center, Korea Forest Research Institute
P-23	Historical changes in lake sedimentation in Lake Shirarutoro, northern Japan over the last 300years	YoungSang Ahn	Chonnam National University
P-24	Effects of forest fires on forest ecosystems in eastern coastal areas of Korea	YoungSang Ahn	Chonnam National University
P-25	Soil Characteristics by Restoration Patterns on Forest Burned Area in Gyeongju National Park	Sungcheol Jung	Warm-Temperature and Subtropical Forest Research Center

No.	Title	Presenter	Affiliation
P-26	Research of Mountain Climbers Recognition about Forest Fire Prevention	Sungcheol Jung	Warm-Temperature and Subtropical Forest Research Center
P-27	Assessment of Productive Areas Using Environmental Factors for Quercus mongolica by Ecoprovince in Korea	TaeU Kim	Kookmin University
P-28	Predicting the effect of climate change on forest biomass in different ecoprovinces and forest types of Korea	JinYoung Shin	Kookmin University
P-29	Prediction of stand structure change over time by silvicultural treatment in natural deciduous forest	JooHan Sung	Korea Forest Research Institute
P-30	Developing Socio-Economic Damage Level Standards and Evacuation Algorithms of Landslide Disasters	Geunyoung Kim	Kangnam University
P-31	Thermal Stability of Metal Hydroxides and Intumescent Flame Retardant Treated Wood Plastic Composites	Sunyoung Lee	Kangnam University
P-32	Effects of Different Irrigation Period on Growth Performances and Photosynthesis of container seedlings of Fraxinus rhynchophylla	Jaehong Hwang	Kangnam University
P-33	The early effect of fertilization on growth of Quercus serrata and Zelkova serrata seedlings in harvested Pinus rigida plantation	A-Ram Yang	Forest Practice Research Center, Korea Forest Research Institute
P-34	The Photosynthesis and Growth Performances of Tilia amurensis Grownat Different Container Types in the Container Nursery System	Minseok Cho	Forest Practice Research Center, Korea Forest Research Institute
P-35	The effects of fire resistance and fixation on flame retardant treated wood by electron beam treatment	Dongwon Son	Korea Forest Research Institute
P-36	Improvement of Fire retardancy and Toxicity Evaluation of Carbonized board	Sangbum Park	Korea Forest Research Institute
P-37	Estimating the Economic Impact of Forest Road Using Input-Output Analysis	Hosang Lee	Korea Forest Research Institute

No.	Title	Presenter	Affiliation
P-38	A new tree disease caused by My copappus sp. found in forest-fire-affected sites in Gangwon province, Korea	Sanghyun Lee	Korea Forest Research Institute
P-39	Tree diseases occurring in forest-fire-affected stands in Samcheok LTER Site	Sanghyun Lee	Korea Forest Research Institute
P-40	Impact of site aspect on the initial development of natural forest after Uljin fire in 2007	JeongHwan Kim	Korea Forest Research Institute
P-41	Growth characteristics of containerized pine seedlings on site aspect in burned -forest site	JeongHwan Kim	Korea Forest Research Institute
P-42	The Management Plan of Forest-fire control in North Korea	Kyungseok Park	Korea Forest Research Institute
P-43	Vegetation Type and Habitat Characteristics of Hongneung Arboretum at Seoul	KwangIl Cheon	Korea Forest Research Institute
P-44	Community Structure of Quercus mongolica Stand from Chiljeolbong to Dongglebong at the Baekdudaegan	KwangIl Cheon	Korea Forest Research Institute
P-45	The Responses of Chlorophyll Contents and Chlorophyll Fluorescence of Acer triflorum on Calcium Chloride Concentration	MinYoung Kwon	Korea Forest Research Institute
P-46	Suggestion of Suitable Time for Forest Fire Suppression using Seawater	SunHee Kim	Korea Forest Research Institute
P-47	The Effect of Shading and Water Stress on Physiological Characteristics of Pinus densiflora	SunHee Kim	Korea Forest Research Institute
P-48	Physiological Responses of Pinus koraiensis by Shad ingand Water Stress	SunHee Kim	Korea Forest Research Institute
P-49	Physiological characteristics of Siberian elm seedlings under dry condition	GoEun Park	Korea Forest Research Institute
P-50	Changes in stand structure and growth of natural hardwood forests after thinning practice	KiCheol Kwon	National Forestry Cooperative Federation

No.	Title	Presenter	Affiliation
P-51	A multi-agent system approach to optimize forest ecosystem management under different policy options in the Gariwang-San region	SooJin Park	Seoul National University
P-52	The effects of a thinning treatment on stand growth and aboveground carbon stocks of Pinus densiflora stands in Korea	Kyungwon Seo	Korea Forest Research Institute
P-53	The characteristics of seedlings occurrenceby regeneration methods in natural Pinus densiflorastand	Hyunseop Kim	Korea Forest Research Institute
P-54	Growth Characteristics and Carbon storage on tree density of Yellow Poplar	Sangtae Lee	Korea Forest Research Institute
P-55	Estimating the Economic Impact of Forest Road Using Input-Output Analysis	Hosang Lee	Korea Forest Research Institute
P-56	A Study of Development for Dredging Assessment Form Using AHP Analysis	Yugyeong Jung	Yeungnam University
P-57	A Study on Sediment Volume Change in a Dredging Area of Debris Barrier by Using Terrestrial LiDAR	Junpyo Seo	Yeungnam University
P-58	Assessing the Effects of Climate Change on the Geographic Distribution of Pinus densiflora and Quercus mongolica using NFI data and Ecological Niche Model	ChunJung Hwa	Korea Forest Research Institute
P-59	The Study on Quantitative Performance Evaluation of Forest Fire Suppression Equipments	JeongHun Kim	Hoseo University
P-60	Wind Distribution of Mountain Area by AWS and Spot Measurement	EungSik Kim	Hoseo University
P-61	Study on Installation of Landing Points on the Forest Roadside	Byoungyun Ji	Korea Forest Research Institute
P-62	Analysis of fire weather in South Korea using KLAPS reanalysis(2005-2010)	Jonghun Jin	National Institute of Meteorological Research
P-63	Analysis on future forest fire occurrence considering the variation of anthropogenic factors in South Korea	Hanbin Kwak	Korea University

No.	Title	Presenter	Affiliation
P-64	Prediction of the wind field on the wild fire in a forest using computational fluid dynamics	Taewan Park	Kunsan National University
P-65	Analysis of Forest Fire Risk around Facilities in Forest Areas	Si-young Lee	Kangwon National University
P-66	Analysis of soil Physical and Chemical Characterization in Simjeok forest wetland	Myeongjong Lee	Kangwon National University
P-67	Construction of Spatial Fuel Load Distribution Database for estimating on Potential For est Fire Hazard in Korea	Myoungsoo Won	Korea Forest Research Institute
P-68	The Type Classification of Erosion Control Dam considering Ecosystem Connectivity	Changwoo Lee	Korea Forest Research Institute
P-69	The Trend Analysis of Future Landslide Risk Using Rainfall Data by RCP 8.5	Changwoo Lee	Korea Forest Research Institute
P-70	Development of early detection system for landslide using USN techniques	Choongshik Woo	Korea Forest Research Institute
P-71	Forest fire studies on medium-andlong-term science and technology development in China	Ki-Hyung Park	Korea Forest Research Institute
P-72	Situation of stony desertification in China	Ki-Hyung Park	Korea Forest Research Institute
P-73	Stability evaluation of concrete erosion control dam for compressive strength in Injea county, Gangwon province, Korea	Ki-Hyung Park	Korea Forest Research Institute
P-74	Countermeasures of Erosion Damage of Coastal Disaster Prevention Forest in Korea	Ki-Hyung Park	Korea Forest Research Institute
P-75	The analysis of change costal disaster prevention forest by aerial image	YeongTae Bae	Korea Forest Research Institute
P-76	Perspective Changed to Vulnerability of Forest Fire	Gyesun Ryu	Korea Forest Research Institute
P-77	The Classification of Burn severity using Rapid Eye image and Estimation of Greenhouse gases (GHGs) Emissions from Biomass burning in Yecheon, Korea	Youseung Kim	Korea Forest Research Institute

No.	Title	Presenter	Affiliation
P-78	Soil physical-chemical characteristic soncoastal disaster prevention forest of Korea	ChanBeom Kim	Korea Forest Research Institute
P-79	Comparison of growth rates by planting densities of Callicarpa japonica	ChanBeom Kim	Korea Forest Research Institute
P-80	Landslide Risk Predict and Evaluation Based on GIS Using Logistic Regression Analysis	Hanjoong Ryu	Korea Forest Research Institute
P-81	The Verification of Standard Rainfall on Warning and Evacuation for Landslide Using Tank Model	Dooyoung Choi	Korea Forest Research Institute
P-82	The Development of Comprehensive Simulator for Studies of Landslide and Debris Flows	Dooyoung Choi	Korea Forest Research Institute
P-83	Forest Climate Monitoring System −Mountain Weather Observation Network in Gangwon-do and Gyeongsangbuk-do in 2012-	Dayoung Choi	Korea Forest Research Institute

Effects of postfire silvicultural practices on stand structure and wildlife in Korea.

산불 후 복원 방법에 따른 임분 구조 및 야생동물의 영향

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Abstracts

We examined the abundances and diversity of wildlife and stand structure at unburned and burned stand resulting from two different postfire silvicultural management practices within a pine forest in Korea. The habitat structure changed dramatically depending on the postfire silvicultural practices. Most measured variables of the stand structure and downed trees were significantly different among the differently-managed stands. The abundances and diversity of mammals and birds were the lowest in the planted stand which showed simple stand structure due to removal of coarse woody debris. However, the abundances of some species such as water deer, common kestrel and black-striped field mouse were the highest in the planted stand. The effects of postfire silvicultural practices on wildlife populations should be considered in the postfire management of a burned pine forest in Korea. Also, studying changes in wildlife population over longer time periods will provide a better sense of the long-term impacts of postfire silvicultural practices on wildlife within pine forests in Korea.

요 약

본 연구는 2000년도 산불피해지역인 강원도 삼척 검봉산 일대의 산불 미피해지와 산불피해 후 자연복원지 및 조림지에서 산불 후 복원방법에 따른 임분 구조와 야생동물 종 풍부도 및 다양도의 차이를 파악하기 위해 실시되었다. 산불 및 산불 후

복원에 따라 산림환경구조는 크게 변화하였다. 조림지는 타지역에 비해 중상층 피도량이 낮고 하층피도량이 발달한 단순한 산림구조를 보였으며, 특히 산불 후 고사목 및 도목잔존물을 처리하여 자연복원지에 비해 수목잔존물의 양이 적게 나타났다.

　조류, 중대형 포유류, 소형포유류로 구분하여 지역별 야생동물상 차이를 파악한 결과 종풍부도 및 다양도는 산림환경구조가 단순한 조림지에서 비교적 낮게 나타났다. 그러나 황조롱이와 고라니, 등줄쥐 등 개활지 선호종의 경우 조림지를 더 많이 이용하는 것으로 나타났다. 차후 산불지역에서 천이단계별 야생동물상 군집구조의 변화 등을 파악하기 위한 장기생태 모니터링이 이루어져야 할 것으로 생각된다.

Comparison of soil arthropod communities according to fire and recovery method

산불과 복원방법에 따른 토양절지동물 군집 비교

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Abstracts

Change of surface layer of soil caused by forest fires affects distribution of arthropods. After fires, recovery methods will affect community structure of soil micro-arthropod. This study was carried out to evaluate the effect of fire, and recovery methods on soil micro-arthropod communities in four burned areas, Goseong, Gangneung, and Samcheok in Gangwon-do and Uljin in Gyeongsangbuk-do on June 2012. In each study area, the soil samples were collected in one unburned site and two burned sites. Micro-arthropods were extracted from soil samples using Tullgren extraction method. Collembola and Formicidae were identified to the level of species and other taxa including Acari were identified to the level of order. Soil arthropods were more abundant at the burned sites than the unburned sites, and among the burned sites, it differed between the natural recovery sites and reforestation sites.

요 약

산불에 의해 야기된 토양의 표토층의 변화는 절족동물 분포에 영향을 준다. 산불 이후 복구방법은 토양미소절족동물의 군집구조에 영향을 줄 것이다. 본 연구는 2012년 6월에 강원도의 고성, 강릉과 삼척과 경상북도 울진의 4개의 산불지에서 토양미소절족동물에 대한 복구방법의 영향을 평가하기 위해서 수행되었다. 토양 샘플은 각각의 지역마다 1곳의 미피해지와 2곳의 피해지에서 채집되었다. 미소절지동물들은 Tullgren추출방식을 이용해 토양샘플에서 추출되었다. 톡토기목과 개미과는 종

수준으로 분류했고, 응애류를 포함한 기타 분류군들은 목 수준으로 분류했다. 토양 절지동물의 풍부도는 산불지가 비산불지 보다는 높았고, 산불지에서는 자연복원지와 인공복원지 사이에서 차이가 나타났다.

Monthly change of ants in the burned forest

산불지 개미의 월별 변화

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Abstracts

Fires change insects in forests. The present study aimed to find patterns for the monthly change of anty communities after fire. Ant survey was carried out at the burned and unburned pine forests after the Goseung mega-fire in 1996. The survey had been monthly conducted from April 1996 to May 1997. Ants were collected using pitfall traps. The 1308 ants belong to 13 species were collected: 696 ants of 15 species at the burned site, and 612 ants of 13 species at the unburned site. Thus, richness and abundance were higher at the burned site than the unburned site. Pattern of the monthly change of richness was similar between the burned and unburned sites, whereas that of abundance was different between the burned and unburned sites. At the burned site, abundance peaked at May 1996, just after the fire, whereas it peaked in autumn at the unburned site. This pattern occurred at the dominant species such as *Myrmica carinata*, *Paratrechina flavipes*, and *Pachycondyla javana*. The different occurrence of ants would be caused by the environmental change (e.g., temperature, habitat) due to fire.

요 약

산불은 산림에 서식하는 곤충들을 변화시킨다. 본 연구는 산불 후에 나타나는 개미군집의 월별 변화패턴을 파악하기 위해 수행되었다. 조사는 1996년 고성 대형 산불 후 산불지 1개소와 인접한 소나무림에서 조사를 실시하였다. 조사는 1996년 4월부터 1997년 5월까지 월별로 실시하였다. 개미의 채집은 함정트랩법으로 하였다. 총 16종 1,308개체의 개미가 채집되었고, 산불지가 15종 696개체, 비산불지가 13종

612개체으로 산불지는 종수와 개체수 모두 비산불지에 비해 많았다. 종수의 월별 패턴은 산불지와 비산불지 모두 비슷하였으나, 개체수(밀도)는 달랐다. 산불지는 산불 직후인 5월에 밀도가 높았으나, 비산불지는 가을에 밀도가 높아졌다. 이러한 패턴은 우점종인 나도항아리뿔개미, 스미스개미, 일본침개미 등에서 나타났다. 이러한 상이한 밀도 패턴은 산불로 인한 환경변화(온도 및 서식처) 때문일 것이다.

Niche breadth and habitat type of butterflies in burned grassland and unburned forest

산불지와 비산불지의 나비 생태적소 범위와 서식처 타입

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Abstracts

Fires change insects in forest ecosystems. The present study aimed to find patterns for the change of butterfly communities after fire. Four predictions were set up for the present study as follows; increase of butterfly richness, grassland species, and generalist species, and more changed communities. Butterflies had been surveyed for 5 years after the big Uljin fire in 2007. In each year, butterflies were counted monthly using line transect method from April to October at two sites (burned vs. unburned, ~ 1.5 km routes). Specialist grassland species decreased in the year of fire but generalist species did not increase significantly. Butterfly richness did not increase but butterfly diversity decreased due to sudden increase of a species, *Polygonia c-aureum*. Butterfly community in the year of fire was different from those of later years, showing temporary change of community in the year of fire. Butterfly communities were not much different between the burned and unburned areas.

요 약

산불은 산림생태계에 서식하는 곤충들을 변화시킨다. 본 연구는 산불 후에 나타나는 나비군집의 변화패턴을 파악하기 위해 수행되었다. 본 연구를 위해 다음과 같은 4가지를 예측하고 연구결과를 토대로 이를 검정하였다. 산불지에서는 나비 종풍부도와 초지성 종, 일반종이 증가하고, 군집의 급격한 변화가 예상된다. 나비는 울진대형 산불지에서 2007년부터 5년간 월별로 실시하였다. 나비는 산불지와 비산불

지(조사구간 약 1.5km)의 2개 조사지에서 4월부터 10월까지 선조사법으로 월별로 조사하였다. 초지 전문종은 산불 당해 연도에 감소하였으나, 일반종이 유의하게 증가하지는 않았다. 산불지에서 나비의 종풍부도는 증가하지 않았으나, 종다양도는 네발나비의 갑작스런 증가로 감소하였다. 산불 당해 연도의 나비군집은 다른 연도의 군집과는 다소 달랐다. 전반적으로 나비군집은 산불지와 비산불지에서 크게 차이 나지 않았다.

Long-term change of arthropods in burned forests

산불지 절지동물의 장기변화

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Abstracts

This study was carried out to find the long-term change of arthropods inhabiting the burned forest. The study sites were located in four areas such as Goseung, Samcheok, Gangleung, Uljin in the eastern coastal region of South Korea. Fire burned forests twice in 1996 and 2000 in Goseung, and in 2000 and 2007 in Uljin. Fire occurred in 2000 in Samcheok, and in 2005 in Ganleung. In each of the study areas, three study sites were selected; the natural recovery site (naturally recovered after crown fire), the plantation site (reforestation after crown fire), and the unburned pine forests (reference site). Arthropods were collected using pitfall traps from late May to early June from 2005 to 2012. Total arthropods were more abundant in the burned sites than the unburned site from 2005 to 2007. However, they did not differ between the burned and unburned sites since 2008. Abundance was much different among kinds (coarse functional guilds) of arthropods. Predators such as spiders and ants were most abundant in the plantation sites, followed by the natural recovery sites and the unburned sites. However, the pattern of detritivore such as flies was the opposite. Beetles with diverse functional guilds showed complex annual patterns. This finding indicates that arthropod communities are still different between the burned and unburned sites.

요 약

산불지에 서식하는 절지동물의 장기적인 변화를 파악하기 위해 본 연구를 실시하였다.조사지는 동해안에 위치한 고성, 삼척, 강릉, 울진 4개 지역으로 고성은 1996년

과 2000년에 산불이 발생하였고, 삼척은 2000년, 강릉 2005년, 울진은 2000년과 2007년 산불이 난 곳이다. 각 지역 마다 수관화 피해 후 자연복원 되는 곳, 수관화 피해 후 조림한 곳, 그리고 산불피해를 받지 않은 소나무림 한 곳을 조사지로 잡았다. 절지동물의 조사는 함정트랩법으로 2005부터 2012년까지 매년 5월말부터 6월초에 실시하였다. 절족동물의 개체수는 2005년부터 2007년까지는 산불지에서 많았으나, 2008년 이후에는 산불지와 비산불지가 비슷해졌다. 그러나 곤충의 종류별로 변화패턴은 매우 달랐다. 포식성인 거미와 개미는 밀도가 인공복원지가 가장 높고, 자연복원지, 대조구 순이었으나, 부식성인 파리는 반대의 패턴이 나타났다. 기능군이 다양한 딱정벌레는 연도별로 패턴이 상이하게 나타났다. 이러한 사실은 산불지의 절족동물 군집은 비산불지와 아직 차이가 있음을 의미한다.

Ants foraging vegetation, ground, and soils in the burned forest

산불지 식생, 지표, 토양에서 서식하는 개미

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Abstracts

This study was conducted to estimate the effects of fire and recovery methods on ant communities in four burned forests, Goseong, Gangneung, and Samcheok in Gangwon-do and Uljin in Gyeongsangbuk-do. Ants foraging vegetation, soil, and ground were collected by sweeping, soil-cores, and pitfall traps, respectively. Ants of 850 individuals belonging to 27 species were collected. *Paratrechina flavipes* was the most abundant species with 202 individuals (25% of total individuals), and *Pachycondyla javana* was the second most abundant species with 124 individuals (15% of total individuals). There were 211 individuals of 21 species in the 4 unburned sites, 284 individuals of 22 species in the 4 natural recovery sites (natural succession after crown fire), and 355 individuals of 19 species in the 4 reforestation sites (reforestation after crown fire). At the reforestation sites, species richness was lowest but abundance was highest. Grassland ant species such as *Paratrechina flavipes*, *Camponotus japonica*, and *Tetramorium caespitum* were more abundant in the burned sites than the unburned sites, showing different ant community structures between the burned and unburned sites.

요 약

본 연구는 강원도 고성, 강릉, 삼척과 경상북도 울진의 4개의 산불지에서 개미군집에 대한 산불과 복원방법의 영향을 평가하기 위해서 수행되었다. 식생, 지표, 토양에 서식하는 개미는 쓸어잡기법, 툴그렌법, 함정트랩법으로 각각 채집되었다. 총

27종 850개체의 개미가 채집되었다. 스미스개미가 202개체(25%)로 가장 많이 채집되었고, 다음으로 일본침개미가 124개체(15%)로 많이 채집되었다. 비산불지는 21종 211개체, 자연복원지(수관화 피해후 자연천이)는 22종 284개체, 인공복원지(수관화 피해후 조림)는 19종 355개체가 채집되었다. 종수는 인공복원지가 가장 적었으나 개체수는 가장 많았다. 산불지에서는 초지성종인 곰개미, 일본왕개미, 주름개미가 많아 비산불지와 군집구조도 달랐다.

Dynamics of sprout and seedling through fire resistant forest establishment in the forest fire area

산화지에서의 내화림 조성에 따른 맹아 및 치수의 동태

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Abstracts

This study was carried out to investigate the conditions of fire resistant forests and to return the damaged and non-damaged pine forest area to fire-resistant productive forest land, respectively. In the non-damaged healthy pine forest, after appropriate fire resistant practices by two types of striped thinning in the demonstration area, the number of shooting sprouts ranged from 2 to 7 per each stump of oak trees of which composed of four species such as *Quercus variabilis.* Blume, *Q. serrata* Murray, *Q. mongolica* Fisch. ex Ledeb., and *Q. acutissima* Carruther, the number of shooting sprouts ranged 20,200 to 21,800 per ha, and the average height of these sprouts ranged from 60 to 250cm. The seedling production rate showed a similar tendency in all study area, from 2,500 to 4,000 seedlings per hectare in pine stands, 300 to 900 per hectare in oak stands. In the damaged poor pine forest, demonstration area was divided by healthy pine maintenance, healthy deciduous maintenance, damaged tree maintenance, and cutting area of damaged tree. The number of shooting sprouts per each stump ranged from 2 to 15, the number of resprouts per hectare ranged from 8,400 to 64,400, the number of average height these sprouts were 32 to 190cm, the number of seedlings ranged from 1,800 to 12,500 per hectare in pine forest, and showed from 400 to 5,000 trees per hectare in oak forest.

요 약

　본 연구의 목적은 산화지 소나무림의 내화력 실연시험 결과를 분석하여 피해지의 내화력 증진 기술을 파악하고 이로부터 비산화지의 건전 소나무림에 대해서도 내화성이 강한 임분으로 유도하기 위한 기초자료를 획득하는데 있다. 건전임분에서 맹아 발생 상황을 보면, 임내의 참나무류는 굴참나무, 졸참나무, 신갈나무, 상수리나무의 4종으로, 전체적으로 그루터기당 2~7개의 맹아 발생을 보였으며 ha당 맹아발생 수는 20,200~21,800개를, 수종별 평균 맹아고는 60~250cm의 범위를 보였다. 치수발생량은 전체적으로 비슷한 경향을 보여 소나무는 2,500~4,000본/ha, 참나무류는 300~900본/ha의 범위로 나타났다. 산불피해 지역에서 맹아발생 상황을 보면, 임내의 참나무류는 굴참나무, 졸참나무, 신갈나무, 갈참나무의 4종으로, 전체적으로 그루터기 당 평균 2~15개의 맹아 발생을 보였으며 ha당 맹아발생 수는 8,400~64,400개, 수종별 평균 맹아고는 32~190cm의 범위를 보였다. 치수발생량은 소나무 1,800~12,500본/ha, 참나무류는 400~5,000본/ha의 범위로 나타났다.

Combustion characteristics of lignocellulosic biomass slurry in the narrow reactor tubing system

좁은 반응기 튜브 안에서의 목분 슬러리의 연소특성

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Abstracts

Wood combustion in a narrow reactor tubing of high temperature saccharification prior to the slurry used to produce bio-ethanol can be carbonized. In particular, the behavior of the fluid within very narrow tubing is very limited because of difficult to prevent this combustion. According to the experimental results shown, but typically at a temperature higher than the hemicellulose, cellulose saccharification glycosylated in a narrow tube before the carbonization by burning the composition estimated in crystalline form of cellulose, hemicellulose than if many grediants were thus except ligin, high-temperature supercritical conditions of water for trees to be glycosylated in the slurry commitment to improve the flow of liquidity to securitization as one of these pre-processing is necessary to consider and go through the proper pretreatment. Wood slurry was applied in the pilot-plant of KFRI and we increase the liquidity of this study was to explore the relationship of carbonization and combustion and glycosylated.

요 약

바이오에탄올을 생산하기 위해서 사용하는 목분 슬러리는 고온의 좁은 관 안에서 당화되기 이전에 연소하여 탄화될 수 있다. 특히 매우 좁은 관 안에서는 유체의 거동이 매우 제한적이기 때문에 이러한 연소를 미리 방지하기 어렵다. 일반적으로 셀룰로오스는 헤미셀룰로오스보다 높은 온도에서 당화하지만 실험결과 나타난 바에 따르면 좁은 관 안에서 당화되기 이전에 연소하여 탄화된 성분은 리그닌을 제외하면 헤미셀룰로오스보다 셀룰로오스를 이루고 있는 결정체인 경우가 많은 것으로 추

정되었다. 따라서 고온-고압의 초임계 조건의 물에서 당화되기 위한 목분 슬러리는 미리 적절한 전처리를 거쳐야 하며 이러한 전처리의 하나로서 유동성의 흐름을 개선시키는 유동화제의 투입을 고려할 필요가 있다. 본 연구는 국립산림과학원의 실증 장비에 적용한 유동성을 증가시킨 나무 슬러리의 탄화 및 연소와 당화의 관계를 살펴본 것이다.

Modeling of pulse-combustion process reactor for lignocellulosic biomass slurry saccharification

목분 슬러리의 당화를 위한 펄스 연소 공정 반응기의 모델링

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Abstracts

For the saccharification of wood flour slurry reactor in the form of a variety can be offered, but you can try applying a pulse combustion reactor that could be present in the reactor using the existing rotation of the liner in order to solve the problem of occlusion and carbonization. Carbide and obstruction of wood flour slurry ultimately bio-ethanol, as it must be glycosylated in this case it does not solve the problem, the high-temperature fluid flow behavior in the supercritical state of water may not be controlled. Glycosylated and carbonization of wood flour slurry, and flow of control in this study relates pulse is applied to the puppets installed in the pilot plant of KFRI onto the supercritical water saccharification in the simulation of the reactor pulse reactor seems to be effective.

요 약

목분 슬러리의 당화를 위한 반응기의 형태는 여러 가지가 제안될 수 있지만, 기존의 회전 강선을 이용한 반응기에서 나타날 수 있는 탄화와 폐색의 문제를 해결하기 위해 펄스 연소 반응기를 적용해 볼 수 있다. 궁극적으로 목분 슬러리는 당화되어서 바이오 에탄올이 되어야 하므로 탄화와 폐색의 문제가 해결되지 않으면 고온-고압의 초임계 상태의 물 안에서 거동하는 유체의 흐름을 제어할 수 없다. 이 연구는 국립산림과학원에 설치된 초임계수 당화실증장비에 적용한 펄스 반응기의 시뮬레이션에 관한 것으로서 목분 슬러리의 탄화와 당화 및 흐름의 제어에 있어서 펄스 반응기가 효과적일 수 있음을 보인다.

Estimation of forest management ratio for private forests in Chungcheongnamdo

충청남도 사유림에 대한 산림경영율 추정

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Abstracts

This study was conducted to analyze the forest management ratios for private forest in Chungcheongnamdo using the 5th Korean National Forest Inventory data. A total of 971 forest management areas out of the 752 plots located in Chungcheongnamdo encompass the scope of this study. The results showed that the proportion of the forest managed sample area to total sample forest area was 86.37% having an average of 17.27% per year. In terms of regional forest management ratio, Gongjusi and Hongseonggun recorded the highest (14.07%) and lowest (1.14%) ratios, respectively. The diameter class was observed to decline from small class (43.27%), middle class (35.18%) to large class (1.41%). Age class 3 with 33.77% and age class 4 with 37.64% showed the highest forest management ratios. The study also observed a high forest type management ratio on broad leaf forest with 33.25% while coniferous forest as the lowest with 27.88%. The species, on the other hand, was higher in *Pinus densiflora* which resulted to 9.23%.

요 약

본 연구의 목적은 충청남도에 분포하는 사유림에 대하여 지역별, 경급별, 임상별, 주요 수종별 산림경영율에 대하여 분석하고자 하였다. 충청남도 사유림에서 조사된 제 5차 국가산림자원조사 자료 고정표본점은 971개소이며, 사유림에 시업이 이루어 진 고정표본점은 752개소로 나타났다. 본 연구 결과에 의하면, 충청남도 전체 사유

림에 대한 산림경영율은 약 86.37%로 나타났으며 연도별 평균적으로 17.27%의 산림경영율을 보였다.

지역별 사유림에 대한 산림경영율은 공주시에서 14.07%로 가장 높은 경영율을 보였고 반면에 홍성군이 1.14%로 가장 낮은 경영율을 보였다. 경급은 소경목(43.27%), 중경목(35.18%), 대경목(1.41%)으로 갈수록 산림경영율이 감소하는 경향을 보였으며 영급은 3영급(33.77%)과 4영급(37.64%)에서 가장 높은 산림경영율을 보였다.

임상별 산림경영율은 활엽수림에서 33.25%로 가장 높게 나타났으며 반면에 침엽수림에서 27.88%로 가장 낮게 나타났고, 주요 수종은 소나무림에서 9.23%로 가장 높은 산림경영율을 보였다.

The Prediction of Successive Change and Selection of Desirable Species in the Forest types of Mt. Gariwang Area

가리왕산 일대 산림유형의 미래 변화 예측 및 경영대상 수종 선정

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Abstracts

This study was conducted to predict change in the future forest composition and to select desirable species based on forest succession trends in order that forest naturality might be maintained and timber could be sustainably produced. The vegetation data were collected on 45 square sample plots (400㎡ per sample plot) at the natural deciduous forest in 123 ~ 125 compartments of the Mt. Gariwang area which was located on Pyeongchang-gun, Gangwon-do in the east-central portion of Korea. Based on the investigated vegetation data, 1) cluster analysis was conducted to classify among similar forest type, 2) dominant and potential dominant species were estimated in each of the forest types, and 3) aspect of the future change was predicted by analysis of forest succession in this study site. As a result, the study site was divided into four types; *Quercus mongolica-Fraxinus rhynchophylla*, *Betula schmidtii-B. costata*, *B. costata-Ulmus laciniata*, and mixed mesophytic forest. As generation passed, aspect of successive change was estimated that *Q. mongolica, B. schmidtii* and others (7 species) would be slowly declining, but *F. rhynchophylla, Tilia amurensis* and others (3 species) would be gradually increasing. Six desirable species was selected by summarizing the above results and considering growth traits of the woody species; *B. costata, A. pictum* subsp. *mono, F. rhynchophylla, Q.*

mongolica, *Cornus controversa*, and *T. amurensis*.

요 약

본 연구는 산림의 자연성을 유지하면서 지속적인 목재생산을 위해, 산림천이 경향을 바탕으로 미래 산림구성의 변화를 예측하여 그에 따른 갱신 양상과 경영대상 수종을 선정하고자 실시되었다. 연구를 수행하기 위해서 강원도 평창군 가리왕산 123~125임반의 천연활엽수림을 대상으로 표본구(20m × 20m) 45개를 조사하였다. 조사된 식생 자료를 바탕으로 유사한 산림유형끼리 묶어주는 1) Cluster 분석을 실시하였고, 2) 산림유형별 우점 수종과 우점 가능수종을 파악하였으며, 3) 산림천이 분석을 통해서 미래 변화 양상을 추정하였다. 그 결과, 연구대상지는 신갈나무-물푸레나무림, 박달나무-거제수나무림, 거제수나무-난티나무림, 중생혼합림 총 4개의 산림유형으로 분류되었다. 세대가 지남에 따라 신갈나무, 박달나무 외 7개 수종은 그 세력이 점차 감소하는 반면, 물푸레나무, 피나무 외 3개 수종은 점차 그 세력이 증가할 것으로 예측되었다. 위의 연구 결과들을 종합하고 나무의 형질을 고려하여 거제수나무, 고로쇠나무, 물푸레나무, 신갈나무, 층층나무, 피나무를 경영대상 수종을 선정하였다.

Combining a fire suitability model and a dynamic forest succession and disturbance model for fire risk assessment in Samchuk region

산불 적합도 모델과 동적 산림 천이 및 교란 모델의 통합 적용을 이용한 삼척시 산불 취약성 평가

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Abstract

This study presents a combined method of applying two modeling approaches to evaluate fire risk in Samchuk region of South Korea. The quickly maturing forests of Korea are experiencing a variety of conditions that can both increase or decrease the risk of large fire disturbance events. Maturing forest stands can accumulate massive amount of fuel for fire, but larger trees may have greater resistance to damage and mortality caused by fire events. The lack of active management in pine plantations is creating dense stands that are vulnerable to fire events. Meanwhile, generally successful fire suppression in the last 4 decades in Korea is quickly converting conifer-dominated forests into mixed or deciduous forest, which generally show greater fire resistance. Our method first uses MAXENT, a predictive model with a machine-learning approach, to reconstruct fire ignition probability map based on past fire records. This ignition probability map is then used as an input for LANDIS-II, a dynamic forest landscape succession and disturbance model, to demonstrate the spatially explicit fire ignition conditions across the landscape. Overall, fire risk seems to increase over time, but the difference between coniferous and deciduous stands seems to decrease, probably due to lower risk associated with older stands. Our results suggest that while the approach is valid, improvements should be made in model parameters and background data to develop realistic fire characteristics and forest regeneration after fire events. A carefully designed

scenario-based approach will be necessary for a more useful application of this approach.

요 약

본 연구는 두 가지 모델링 방법을 연계하여 삼척 지방의 산불 위험도를 평가하는 방법을 소개하는 것을 목적으로 한다. 대한민국의 산림은 빠른 속도로 성숙하고 있으며, 이에 따라 산불 위험을 증가시키거나 감소시킬 수 있는 다양한 조건을 만들어내고 있다. 임분이 성숙함에 따라 가연성 연료가 증가할 수도 있으나, 이는 반대로 산불 피해나 고사에 대한 내성 또한 증가시킬 수도 있다. 한편 지난 40여년 간 산불 억제 정책이 어느 정도 성공적으로 수행됨에 따라 임분의 밀도 증가와 침엽수림이 혼효림이나 활엽수림으로 전환되면서 산불 위험도에 영향을 미칠 것으로 예상된다. 본 연구는 machine learning method를 차용한 MAXENT와 동적 산림 경관 식생 천이 및 교란 모델인 LANDIS-II의 연계 적용을 활용하고자 한다. MAXENT와 과거 산불 발생 공간 자료를 활용하여 산불 점화 적합도 지도를 작성하고, 이를 기반으로 LANDIS-II에 산불 배경 공간 명시적 패러미터를 제공함으로써 앞으로 100년간 산림의 성숙과 임분 변화 및 갱신에 따른 산불 위험도의 변화를 추정하였다. 그 결과 전반적인 산불 위험도는 높아지는 것으로 보이나 침엽수림과 활엽수림 간의 차이는 점차 줄어드는 경향을 보였는데, 이는 각각의 임상과 성숙해지는 영급의 산불 피해 특성의 영향이 주로 개입된 것으로 평가된다. 한편 이 연구에 필요한 식생 발달, 갱신, 산불 반응, 그리고 산불 발생에 대한 배경 데이터의 추가적인 확보와 기후변화 영향을 적용한 베이스 모델의 안정화와 개선이 시급한 과제이다. 또한 앞으로는 시나리오에 기반한 접근 방식을 사용하는 것이 본 연구의 활용성을 개선시키는데 큰 도움이 될 것으로 판단된다.

Differences in amphibian and reptile communities under different forest environmental conditions at forest fired area in Samcheok, Gangwon province, Korea.

강원도 삼척 산불 피해지의 산림환경에 따른 양서·파충류 군집 특성 차이

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Abstracts

This study was conducted to clarify the differences in amphibian and reptile (herpetofauna) communities in relation to characteristics of forest environmental conditions in the unburned and two burned (naturally restored, planted) stands on Mt. Gumbong, Samcheok, Gangwon Province, Korea. As a result of line transect sampling at nine survey lines, each of the three lines, in three seasons except winter (because most herpetofauna are less active) between July 2011 and June 2012, the abundance and diversity of reptile species were higher in the unburned stand than those in the burned stand, while there were no significantly differences in abundance and diversity of amphibian species among stands. Of the major reptile and amphibian species, the abundance of short-tailed viper snake and Dybowski's brown frog were higher in the unburned stand than in the burned stands. There were no differences in the abundance and diversity of amphibians and reptiles between naturally restored and planted stands. This result shows that the amphibian and reptile communities could be more affected to forest fire than postfire silvicultural practices. Because most of amphibian species sensitively respond to climatic factors than environmental conditions, and reptiles have relatively wide home range with various habitats.

요 약

본 연구는 2000년 동해안 산불 피해지 중 하나인 강원도 삼척시 검봉산 일대의 산불 미피해지와 피해지 내 자연복원지 및 조림지에서 양서•파충류 군집의 특성을 파악하기 위해 실시되었다. 2011년 7월부터 2012년 6월까지 선형횡단조사를 실시한 결과, 파충류는 산불 미피해지에서의 풍부도 및 종다양도가 피해지보다 더 높게 나타났으나, 양서류는 지역별 차이를 보이지 않았다. 각 지역별 주요 양서파충류 종의 풍부도를 비교한 결과, 까치살모사와 북방산개구리가 지역별 차이를 보였다. 자연복원지와 조림지간 양서•파충류의 종풍부도 및 종다양도는 유의한 차이가 나타나지 않았다. 따라서 양서•파충류는 산불 후 복원방법보다는 산불 자체에 대한 영향을 더 많이 받는 것으로 판단된다. 이는 양서류는 산림환경 요인보다 기후적 요인에 더 민감하게 반응하며, 파충류는 비교적 행동권이 넓어 피해지 내에서 다양한 산림환경을 폭 넓게 이용하기 때문인 것으로 생각된다.

Analysis on Weather Factors in Baekdudaegan Mountains of Gangwon Province

강원도 백두대간 기후모니터링 분석

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Abstract

Korea experiences severe changes in local weather due to complex terrain, 64% of which consists of mountains. Baekdudaegan of korea exists variety of vegetation and wildlife across from temperate forest to freezing forest zone. Gangwon Province contains about 55% of the Baekdudaegan Mountain Protected Area core zone. Since this province is representative of the entire Baekdudaegan Mountain Protected Area. Our research areas were selected in the Gangwon Province area of Korea's Baekdudaegan Mountain analyze weather variables in relation to altitude. Therefore, this study was conducted to provide of basic data for ecological management policy on Baekdudaegan Mountain of Gangwon province.

This study analysed to temperature, relative humidity, light intensity and soil temperature at 14 study sites on 4 districts of Baekdudaegan Mountain of Gangwon province.

요 약

우리나라는 국토의 64%가 산림으로 구성되어 있기 때문에 산림내 국지적인 기상의 변화가 심하며, 특히 백두대간은 난대에서 한대에 걸쳐 다양한 동식물이 생존하고 있다. 특히, 강원도의 백두대간은 백두대간 보호구역의 55%를 차지하고 있다. 본 연구는 강원권역 백두대간 내에서 고도와 사면을 고려하여, 4개 권역 16개 조사지를 선정 하고 매 86일 간격으로 기온, 상대습도, 조도, 토양온도 데이터를 취합, 기

상인자의 변화를 분석 하였다. 본 연구의 목적은 장기 연구 모니터링을 통해 향후 강원지역 백두대간 생태계 관리 정책에 필요한 기초 자료를 제공하기 위함이다.

Differences in breeding ecology of varied tit (*Parus varius*) by post-fire restoration methods in Samcheok, Gangwon Province, Korea

강원도 삼척 산불피해지역의 복원방법에 따른 곤줄박이의 번식생태 차이

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Abstracts

This study was conducted to clarify the breeding ecology of varied tit(*Parus varius*) using nest boxes at unburned, post-fire naturally restored and post-fire planted stands in Mt. Gumbong, Samcheok, Gangwon province, Korea. The habitat structure and the amounts of CWD changed dramatically depending on the postfire silvicultural practices. The mid and suboverstory coverage were the highest in the naturally restored stand while the understory coverage was the highest in the planted stand. Also, there were more snags and downed trees in the naturally restored stand than planted stand. The rate of nest use, breeding success and fledging success of varied tit were the highest in the unburned stand and the lowest in planted stand. As a result of analyzing feeding rate by video camera, feeding rate was the highest in the unburned stand and the lowest in the planted stand. There were significantly different in chick's weight and tarsus length among stands, which is the highest in the naturally restored stand. We suggest that food availability and size of each stand would affect chick's weight and size. More detailed researches on food quantity and quality would be needed to understand characteristics of breeding ecology of varied tit after forest fire.

요 약

  본 연구는 산불 후 복원방법에 따른 곤줄박이(varied tit, *parus varius*)의 번식생태 차이를 파악하기 위해 2000년도 산불피해 지역인 강원도 삼척 검봉산 일대의 산불 미피해지와 산불 후 자연복원지 및 조림지에서 인공새집을 설치하여 실시되었다. 산림환경구조 조사를 실시한 결과 미피해지에서는 상층피도량, 자연복원지에서는 중상층 및 중층피도량, 조림지에서는 하층피도량이 발달하였다. 수목잔존물의 양은 자연복원지가 조림지에 비해 높은 값을 나타내었다. 둥지의 이용률과 번식성공률, 이소율 모두 미피해지가 가장 높게 나타났으며 조림지에서 가장 낮게 나타났다. 비디오 카메라를 이용한 어미의 급이율 조사결과 미피해지에서 가장 높았고 조림지에서 가장 낮게 나타났다. 새끼의 무게 및 부척 길이는 모두 유의한 차이를 나타내었으며 자연복원지에서 가장 높게 나타났고 조림지에서 가장 낮게 나타났다. 이는 각 서식지의 산림 환경에 따른 먹이의 가용성과 크기의 차이에 의한 것으로 판단된다. 차후 각 서식지의 먹이량과 어미의 정성적, 정량적인 급이량 등에 대한 보완 조사가 이루어져야 할 것으로 생각된다.

Effects of seed tree density on seed rain, soil seed bank and seedling emergence of Pinus densiflora in Mt. Joongwang, Korea

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Abstracts

Pinus densiflora is a long-lived pioneer species and famous for its preference for bare soil after stand replacing disturbance such as a large fire in regeneration. Seed supply is critical in the regeneration of *P. densiflora* because it regenerates only from seed. For a successful regeneration, *P. densiflora* seed has to travel from a seed tree as seed rain and soil seed bank, should be able to germinate and grow to a seedling competing against herbaceous plants. This study investigated the relationship between the seed tree density and the seed density of seed rain and soil seed bank, and the seedling density along the path of *P. densiflora* seed in a former *P. densiflora* stand where seed tree regeneration method was applied. In addition, herbaceous plants which compete against emerging seedlings were also examined to understand the relationship between herbaceous plants and the *P. densiflora* seedling establishment. The cuttings in the seed tree method were conducted in three levels and soil scarification practice was followed. Thus, three study sites with different seed tree density (Site 1: 25 stems ha^{-1}, Site 2: 125 stems ha^{-1}, Site 3: 75 stems ha^{-1})were selected. Seed rain composition and density was examined using four 1m × 1m seed traps randomly established in each study site. Soil seed bank composition and density were examined by collecting soil samples at five meters away from the seed trap in the four directions (N, E, S, and W) at the organic layer and the depths of 0–2 cm and 2–5cm. A total of 144 soil samples were collected in 10cm × 10cm surface area. The height and coverage of

herbaceous plants in the herb layer was measured. The site with higher seed tree density showed higher seed rain density and soil seed bank density of *P. densiflora* as the highest seed rain density of 3.8 seeds m^{-2} and soil seed bank density of 165 seeds m^{-2} in Site 2 and the lowest seed rain density of 0.5 seeds m^{-2} and soil seed bank density of 10 m^{-2} in Site 1. However, seedling density of *P. densiflora* was not significantly different in three study sites (Fig. 1), indicating that the seed tree density was not determinant factor for seedling establishment of *P. densiflora* and the density of seed trees in the study sites was enough to provide seeds for the *P. densiflora* seedling emergence. The seedling density of *P. densiflora* showed a negative relationship with the height of herb layer (Fig. 2). The management of seed rain and soil seed bank was important for the seedling establishment, and moreover, the management of herbaceous plants was critical for the successful seedling establishment of *P. densiflora*.

요 약

소나무(*Pinus densiflora*)는 갱신과정의 초기에 나타나는 수종으로서 큰 산불 등의 교란 이후에 나출된 토양에 잘 정착한다. 소나무의 갱신은 오로지 종자를 통해서만 이루어지기 때문에 후대의 소나무숲으로의 천연갱신에서 종자의 공급은 중요한 인자로 작용하게 된다. 소나무의 성공적인 갱신을 위해서는 소나무 종자가 모수에서부터 종자우, 그리고 매토종자의 형태로 이동해야 하며, 소나무 매토종자와 그로부터 발아된 소나무 치수는 주변 초본과의 경쟁에서 살아남아 발아와 생존에 성공해야 한다. 이번 연구는 강원도 평창군 가리왕산 소나무 모수림작업지의 실연연구지에서 소나무 모수의 밀도와 종자우, 매토종자에서의 종자밀도 그리고 소나무 치수의 밀도 간의 관계를 분석하였다. 또한 소나무치수과 경쟁하는 초본식물과 소나무 치수발생과의 관계를 알아보기 위해 초본식물에 대한 조사도 진행하였다. 조사지에서의 소나무 모수림작업은 3가지 방법으로 이루어졌으며, 작업 후 토양표토긁기 작업이 진행되었다. 이에 따라 서로 다른 소나무 모수의 밀도를 보이는 3가지 조사구(Site 1: 25 stems ha^{-1}, Site 2: 125 stems ha^{-1}, Site3: 75 stems ha^{-1})가 선정되었다. 종자우의 구성과 밀도는 1 m × 1 m의 종자망을 각각의 조사구에 4개씩 랜덤으로 설치하여 조사하였다. 매토종자의 구성 및 밀도는 종자망을 기준으로 4방위로 5m씩 떨어진 곳에서 낙엽층, 0-2cm, 2-5cm의 깊이의 토양을 채취하였다. 10cm × 10cm의 방형구에서 총 토양표본 144개가 추출되었다. 초본에 대한 높이 및 피도 또한 측정되었다. 조사

구 2에서 소나무 종자우의 밀도(3.8 seeds m^{-2})와 매토종자의 밀도(165 seeds m^{-}2)가 가장 높고, 조사구 1에서 종자우의 밀도(0.5 seeds m^{-2})와 매토종자의 밀도(10 m^{-2})가 가장 낮게 나타나는 것처럼 소나무 모수의 밀도가 높을수록 소나무 종자우와 소나무 매토종자의 밀도가 더 높게 나타났다. 하지만 소나무 치수의 밀도는 3개의 조사구별로 유의한 차이를 보이지 않았다(Fig. 1). 이것은 소나무 모수의 밀도가 소나무 치수발생에 결정적인 요인으로 작용하지 않음을 보여준다. 소나무 치수의 밀도는 초본의 높이와 음의 상관관계를 보였다(Fig. 2). 종자우와 매토종자에 대한 관리는 소나무 치수발생에 중요한 부분을 차지하지만 초본에 성공적인 소나무 치수의 발생 및 생존을 위해서는 초본에 대한 관리 역시 필수적인 것으로 나타났다.

Comparison of Crown Fuel Characteristics on the Two Eco-types of Pinus densiflora Stands in Korea

소나무림 생태형에 따른 수관연료특성 비교

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Abstracts

The objective of this study was to compare the characteristics of canopy for the different *Pinus densiflora* stand ecotypes such as the Gangwon type and Jungbu type. Sample trees were selected based on diameter at breast height (DBH) class distribution. A total of 55 *Pinus densiflora* trees were harvested for this study, specifically, 33 trees for Gangwon type and 22 trees for Jungbu type. The harvested trees were analyzed by partitioning the canopy layers (needles, branches: <0.5 cm, 0.5 - 1 cm, 1 - 2 cm, 2 - 4 cm and >4 cm). On the average, the crown moisture contents of the two ecotypes were found similar at around 100%. It was observed that the crown volume of the ecotypes increases as the DBH increases. The crown volume of Jungbu type was larger compared to the Gangwon type. This causes the central region of Jungbu type pine trees to grow branches at a 90° angle from the stem. On the other hand, the pine forest in Gangwon province grows branches more than 100° angle. Furthermore, crown bulk density of the *Pinus densiflora* stand was calculated by dividing the crown fuel load to the crown volume. Results showed that the Gangwon type has a higher crown bulk density with $0.231 kg/m^3$ as compared to the Jungbu type with $0.171 kg/m^3$. Overall, crown base height of the Kangwon type appeared to be higher than the Jungbu type *Pinus densiflora*.

요 약

  본 연구의 목적은 생태형이 상이한 강원지방소나무림(금강형)과 중부지방 소나무림을 대상으로 수관특성을 비교하고자 하였다. 이를 위해 표본목은 흉고직경 별로 고르게 분포하도록 선정하였으며, 강원지방소나무 33본, 중부지방소나무 20본을 벌채하였다. 벌채된 표본목은 수관층을 층위별로 구분하여 분석하였다. 본 연구 결과에 의하면 수분함량의 경우 두 지역에서 큰 차이가 없는 것으로 나타났으며, 평균적으로 100% 내외의 수분함량을 보였다. 수관체적 비교에서는 강원지방소나무림에 비해 중부지방 소나무림이 수관체적이 다소 큰 것으로 나타났으며, 흉고직경이 커지면서 차이가 뚜렷한 양상을 보였다. 이러한 원인은 중부지방소나무림의 가지는 수간에서 90° 방향으로 생장하는 반면 강원지방소나무림의 가지는 100° 이상의 각도로 생장하므로 발생하는 현상으로 사료된다. 연소가능한 수관연료밀도를 분석한 결과 강원지방소나무림의 경우 0.231kg/m³, 중부지방소나무림은 0.171kg/m³로 차이를 보였으며, 지하고의 경우에는 강원지방소나무림이 중부지방소나무림에 비해 높은 것으로 나타났다.

Biomass and carbon stock assessments of natural mangrove stands in Palawan, Philippines*

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Abstract

The ability of the mangroves to sequester and store carbon provides global benefits as it mitigates the effects of climate change. The Philippines claims international recognition for its mangrove-rich ecosystem with a huge percentage of the total carbon held and locked in the biomass and sediments are attributed to the stands located in the province of Palawan. The coast of Bahile, aside from receiving global attention as a home to the Puerto Princesa Subterranean River National Park, covers the only mangrove forest in the province with adequate stocking. However, there is a lack of information on the precise carbon sequestration and storage potential of this wetlands ecosystem. The objective of this study is to assess the biomass and carbon stock assessments of the Bahile natural mangrove stands and determine the equivalent carbon dioxide. Sixteen plots with a size of 100 m^2 were established in the mangrove stands using quadrat sampling technique to identify, count and measure the trees. Allometric equations developed by Komiyama et al. (2005) were utilized in the estimation of biomass and tree carbon storage. Sediment carbon stock was likewise determined using the bulk

density and percent organic carbon of the soils collected in undisturbed portion using a 30 cm high and 5 cm diameter corer in eleven plots within the stands. A total of 146 sample trees representing five mangrove species belonging to three families were identified at the site. Among the stands, 73% of the total biomass was attributed to the above-ground (412.72 t ha^{-1}) while 27% was credited to the roots (149.08 t ha^{-1}). The total carbon sequestered and stored in the biomass and sediment of the natural mangrove stands were 264.05 t C ha^{-1} and 173.75 t C ha^{-1}, respectively, which were equivalent to 1606.73 t CO_2ha^{-1}. Overall, these values suggested that Bahile's carbon sinks had the potential to sequester large amounts of atmospheric carbons; hence sustainable management and protection are essential. Otherwise if the biomass is cut and burned and the sediment is excavated and oxidized to make way for fish and shrimp ponds and similar coastal disturbances, that huge amount would be revert back to the atmosphere and further contribute to the alarming concentration of carbon dioxide in the atmosphere.

Surface Fuel Characteristics and Fuel Load on Thinning Intensity of Pinus rigida Stands

리기다소나무 임분의 간벌강도에 따른 지표층 연료특성 및 연료량 추정

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Abstracts

Thinning is one of the important forest management strategies to decrease of wildfire hazard within the forest. The combustibles (leaves and branches) that served as fuels are significantly reduced which is important in the reduction wildfire occurrence. Therefore, this study was conducted to determine the fuel characteristics and fuel loads of surface layer in *Pinus rigida* stands with different thinning intensity in South Korea. Plots with a size of were established in the stands with no thinning or control stand, 10% thinning intensity, 20% thinning intensity and 40% thinning intensity. Furthermore, surface fuel were classified into shrub, herb, dead leaves and dead branches (Scott and Reinhardt, 2001), and the weights of these surface fuels were measured. Samples were collected more than 25% to estimate moisture content and fuel load in overall weight of each fuel. The shrub fuel loads of surface layer were estimated the control stand was 0.499ton/ha, 10% thinning stand was 0.347ton/ha, 20% thinning stand was 0.544ton/ha and 40% thinning stand was 0.333ton/ha. The herb fuel loads was observed to increase as the thinning intensity increase. Fuel loads of the dead leaves and dead branches were estimated the control stand 10.707ton/ha, 10% thinning stand was 9.720ton/ha, 20%

thinning stand was 10.047ton/ha and 40% thinning stand was 8.467ton/ha. It was observed that the control stand was higher than 40% thinning stand.

요 약

간벌은 임내 산불 위험성을 낮추는데 매우 중요한 시업 중 하나이며, 산불 발생 시 연소물질로 작용하는 연료를 줄여준다. 따라서 본 연구에서는 리기다소나무림을 대상으로 하여 간벌강도에 따른 산림 내 지표층 연료특성과 연료량을 파악하고자 하였다. 표준지는 간벌을 실시하지 않은 대조구와 10%, 20%, 그리고 40%로 간벌을 실시한 구역으로 구분하여 각각 3개의 표준지를 로설치하였다. 지표층 연료는 관목, 초본, 낙엽, 낙지로 구분되며(Scott and Reinhardt, 2001), 각 표준지마다 그 임분의 표준이 되는 지점 3곳을 선정하여 방형구 내 모든 관목과 초본, 낙엽, 낙지의 생중량을 측정하였다. 수분함량 및 연료량 추정을 위하여 각 연료별로 전체 무게 25% 이상의 시료를 채취하였다. 간벌강도에 따라 추정된 지표층 관목 연료량은 대조구 0.499ton/ha, 간벌강도 10%일 때 0.347ton/ha, 강벌강도 20%일 때 0.544ton/ha, 간벌강도 40%일 때 0.333ton/ha으로 나타났으며, 초본 연료량은 간벌강도가 높을수록 증가하는 것으로 나타났다. 낙엽과 낙지 연료량은 대조구 10.707ton/ha, 간벌강도 10% 일 때 9.720ton/ha, 간벌강도 20%일 때 10.047ton/ha, 간벌강도 40%일 때 8.467ton/ha으로 대조구와 비교하여 간벌강도 40% 일 때의 연료량이 다소 적은 것으로 나타났다. 향후 수행되는 연구에서는 보다 더 다양한 간벌강도에 대한 자료와 리기다소나무 외에 다양한 침엽수종에 대한 정보를 구축하여, 간벌과 연료량 간의 관계를 규명해 나가야 할 것이다.

Construction and Validation of Stem Volume Functions for Pinus kesiya in the Coniferous Forests of Northern Philippines*

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Abstracts

The objectives of this study were to develop volume equations and validate these models using independent dataset for *Pinus kesiya* in northern Philippines. It is hope that the equations developed can help forest managers in acquiring a more reliable and accurate estimates of volume for *Pinus kesiya* forests in the Philippines. Volume equations for the different tree species in the Philippines are still lacking and insufficient. This could be attributed to the heterogeneity in species composition and structure which is considered as one of the major challenges in the volume model development for natural tropical forests. A total of 481 trees from *Pinus kesiya* stands in Benguet province were measured through non-destructive sampling. Using the CRITERION400 device, diameters outside bark of the stem were measured in the different height or position with an interval of 1-3 m. Furthermore, DBH (cm), total height (m) and volume (m3)ofalltreesweredetermined. The dataset was randomly split into two groups which were used for initial model development and validation. A total of 385 trees or 80% of the dataset were used for initial model development. For the validation of the developed models, a total of 96 trees or the remaining 20% of the dataset were used. The best five models were used for the final model development utilizing the combined data or 100% of the dataset. In order to evaluate the performance of these models, the following evaluation statistics were used: the coefficient of determination (R^2); root mean square error

(RMSE); bias (); absolute mean difference (AMD); and, coefficient of variation (CV). The models with two predictors (DBH and height) performed better as compared to the models with only one predictor (DBH) based on the fit statistics. Overall, model 5 ($V=aD^bH^c$) showed the best performance while model 1 ($V=aD+bD^2$) was the poorest based on the five statistical evaluations.

The study of forest fire risk around facilities in wildland‒urban interface

산림인접지 주변 자연 환경의 산불위험성 연구

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Abstracts

Facilities in wildland-urban interface were a main cause of forest fire ignition or protection object from forest fire and suffered from forest fire extremely. For preventing forest fire damage to these facilities, the estimation of the forest fire danger rating around these facilities is very important for protection of the life and the property. In this study, we surveyed an environment factor(forest floor, slope, distance from forest, etc.). After surveying, we graded this environment factor using records of forest fire damage to facilities in wildland‒urban interface. Finally, we classified according to this grade rule using G.I.S tool. We classified three regions (Kyungjoo-Si, Uljin-gun, Bonghwa-gun). In results, the forest fire danger rate according to the forest floor in Uljin-Gun and Bonghwa-Gun was much higher than Kyungjoo-Si. The forest fire danger rate according to the distance from forest in Uljin-Gun and Bonghwa-Gun was much higher than Kyungjoo-Si. Absolutely safety area (distance was above 300m from forest) was 78.6% in Kyungjoo-Si, 52.5% in Uljin-Gun and 48.6% in Bonghwa-Gun. The danger area according to slope was

15.5% in Kyungjoo-Si, 42.1% in Uljin-Gun and 53.7% in Bonghwa-Gun.

요 약

   산림 인접지 내 시설은 산불의 주요 발생원이자 보호 대상이며, 특히 산불 발생
시 많은 피해가 예상된다. 이러한 산림 인접 시설물의 산불 피해를 방지하기 위해
산림 인접 지 주변 자연환경이 산불 위험성을 평가하는 것은 국민의 생명과 재산
보호를 위해 필수적이라 할 수 있다. 본 연구에서는 이러한 산림인접지 내 시설물
주변의 산불위험성을 평가하기 위해, 실제 산불이 일어난 지역의 주변환경(임상, 경
사도, 이격거리)를 조사하고, 등급화를 하여 산불 위험성을 평가하였으며, 이를 활용
하여, G.I.S 도구를 활용하여, 경주시, 봉화군, 울진군의 산림 인접지의 산불 위험성
을 평가하였다. 평가 결과 임상과 관련하여, 울진군과 봉화군의 위험성이 경주시 보
다 높은 것으로 조사되었으며, 산림으로부터 이격거리 경주시가 가장 안전한 것으로
조사되었다. 특히, 절대안전지역(산림으로부터 이격거리 300m 이상인 지역)은 경주
시가 78.6%, 울진군 52.5% 봉화군 48.6%인것으로 조사되었다. 또한, 경사에 의한
위험 지역의 분포는 경주시가 15.5%, 울진군 42.1%, 봉화군 53.7%인 것으로 조사
되어 봉화군이 가장 높게 나타났다.

An analysis of tower yarder operation system

타워야더 집재작업시스템 분석

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Abstracts

This study was conducted to investigate the efficiency of the logging operation system, the optimum setting-up spacing in order to establish the optimum logging operation system with a tower yarder (Koller K301-4, Koller K300) in Korea. The study area is located Gangneung-Si, Gangwon-Do in the middle of Korea. The forest is artificial forest of pine tree(*Pinus densiflora*). pine tree(*Pinus densiflora*) is one of the popular species in Korea. Thinning operation was tree length system. In thinning logging operation by tower yarder(Koller K301-4), the ratio of choker setting and lateral time was 19% of total logging time. By tower yarder(Koller K300), the ratio of choker setting and lateral time was 18% of total logging time. And the ratio of choker setting and lateral logging time among productivity time element was the highest. An average logging productivity of a tower yarder(Koller K301-4), in the thinning operation was $33.6m^3$ per day and 8.4 m^3 per man-day. An average logging productivity of a tower yarder(Koller K300), in the thinning operation was $18.4m^3$ per day and $4.6m^3$ per man-day. Evaluating the efficiency of logging operations through the research of high performance forestry machines and providing basis data for efficient system selection are purpose of this study.

요 약

타워야더(Koller K301-4, Koller K300)의 적정한 집재작업시스템을 확립하기 위한 적정설치거리, 집재작업시스템의 효율성을 조사하기 위하여 수행되었다. 조사지는 강원도 강릉시에 위치하고 있으며, 소나무 인공림지역이다. 소나무는 우리나라에서 대표적인 수종의 하나이다. 간벌작업은 전간작업시스템으로 작업을 하였다. 타워야

더(Koller K301-4)의 간벌작업은 총집재작업시간의 19%가 초커설치와 측방집재시간이었고, 타워야더(Koller K300)은 총집재작업시간의 18%가 초커설치와 측방집재시간이었다. 요소작업시간 중 초커설치와 측방집재시간이 가장 높았다. 타워야더(Koller K301-4)의 평균생산성은 1일 33.6m^3, 1인당 생산성은 8.4m^{3}이었고 타워야더(Koller K300)의 평균생산성은 1일 18.4m^3, 1인당 생산성은 4.6m^{3}이었다. 본 연구는 고성능 임업기계의 연구를 통한 집재작업의 효율성을 평가와 효율적인 시스템 선정을 위한 기초 자료로 제공하는데 그 목적을 두고 있다.

Historical changes in lake sedimentation in Lake Shirarutoro, northern Japan over the last 300 years

최근 300년 동안 시라루토로호수의 토사퇴적량 변화

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Abstracts

Sedimentation rates estimated for the past ca 300 years in Lake Shirarutoro indicated that catchment development has influenced the shallowing process in the lake by increasing sediment production. The sediment yield under initial land-use development conditions for the first two periods was 514 tons yr^{-1} from 1694 to 1739 and 542 tons yr^{-1} from 1739-1963. The development of the Shirarutoro catchment intensified in the 1960s with deforestation and agriculture activity leading to an increased sediment yield of 1261 tons yr^{-1} after 1963. The sediment yields after intensified land use development, such as forestry and agricultural development, were about 2 times higher than that under initial development conditions, leading to accelerated lake shallowing over the last ca 50 years.

요 약

산림유역에서 벌채와 농지개발은 다량의 세립토사를 유출시키고 있다. 조사대상지인 시라루토로지역의 산림유역은 벌채와 농경지 개발로 인한 세립토사 유출의 영향으로 호수 수질과 저수용량이 감소되고 있다. 따라서 본 연구는 토지이용에 따른 유역 토사생산량 변화를 추정하기 위해 11개의 호수 토사퇴적물을 채취하여 약 300년 동안의 토사동태를 분석하였다. 채취한 호수 퇴적물에는 2개의 화산재층(1694년 Ko-c2층과 1739년 Ta-a층)과 세슘피크(1963년)가 존재하였고, 이들의 연대를 이용하여 장기간의 토사퇴적량을 분석하였다. 인간의 활동이 거의 없었던 초기개발기

(1694-1739과 1739-1963)에는 533 tons/year의 토사가 호수에 퇴적되었고, 1960년대 이후 삼림벌채와 농지개발로 인하여 1261 tons/year(1963-2007)이 호수에 퇴적되고 있었다. 최근 산림유역 개발에 따른 다량의 세립토사 퇴적으로 인해 산지호수의 저수량의 감소가 빠르게 진행되고 있음이 밝혀졌다.

Effects of forest fires on forest ecosystems in eastern coastal areas of Korea

산불이 동해안지역 산림생태계에 미치는 영향

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Abstracts

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. Fire also accelerates the decomposition of organic matter and nutrient release, thereby improving forest productivity. 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.

요 약

최근 대형산불 발생 증가로 인해 산림생태계복원의 중요성이 강조되고 있으며, 복원은 생태적, 사회적, 경제적 요인을 종합적으로 고려하여 실시하는 것으로 정책

을 수립하였다. 동해안지역의 산림은 봄에 건조한 바람이 많이 발생하고 있으며 송이 생산을 위해 불에 잘 연소되는 소나무림이 넓게 분포하고 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. 그러나 산불은 토양의 유기물 분해를 촉진시켜 양분순환을 촉진 시키고 있었으며, 비교적 산불피해가 적은 활엽수림에서는 맹아발생 등으로 인한 식생회복도 빠르게 진행되고 있었다. 산불피해가 컸던 침엽수림에서는 지역 주민의 요구(특히 송이버섯 서식지 복원)에 의해 소나무를 조림하는 인공복원사업이 실시되었다. 이러한 대규모 소나무림 조림지에서는 대형 산불 발생 가능성이 높기 때문에 내화수림대를 조성하여 송이 생산과 더불어 산불 재해를 저감시키기 위한 방법이 시도되고 있다.

Soil Characteristics by Restoration Patterns on Forest Burned Area in Gyeongju National Park

경주국립공원 내 산불피해지 복원유형별 토양특성

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Abstracts

This study analyzed about soil characteristics of restore type on forest fire damaged area in Gyeongju National Park. Soil pH in nature restoration site 1 was the highest, control site was the lowest. Available phosphoric acid and total organics were high value in nature restoration site 1 and 2, total nitrogen in nature restoration site 2 was the highest. Ca ++ in control site was the highest; Mg++ in nature restoration site 2 was the highest; K+ in nature restoration site 1 and 2 were the highest; and Na+ in nature restoration site 2 was the highest. We conclude, because time has passed soil chemical properties in forest fire damaged area similar with natural forest soil properties. Basically, Soil chemical properties tend to increased temporarily after forest fire, and through leaching of nutrients decreased. This study also showed a similar trend. However, soil ecosystems can be damaged due to sediment runoff and soil loss in forest fire damaged area, we will require continuous monitoring.

요 약

본 연구는 경주국립공원 내 산불피해지 복원유형별 토양특성을 분석하였다. 토양 pH는 자연복원지 1이 높게 나타났으며, 대조구가 낮게 나타났다. 유효인산과 총유기물 함량은 자연복원1과 2에서 높게 나타났으며, 전질소 함량은 자연복원지 2가

높게 나타났다. 양이온치환용량은 자연복원지 1이 높게 나타났으며, 대조구와 조림지 1에서 낮게 나타났다. 치환성양이온 중 Ca++함량은 대조구에서 높게 나타났으며, Mg++함량은 자연복원지 2에서 높게 나타났다. K+함량은 자연복원지 1과 2에서 높게 나타났으며, Na+함량은 자연복원 2에서 높게 나타났다. 산불피해지에서 토양의 화학적 특성이 산불 미피해지와 비슷하게 나타난 것은 산불발생 후 일정 기간이 지났기 때문으로 판단된다. 일반적으로 산불이 발생하면 토양의 화학성은 일시적으로 증가하였다가 토양 내 양분의 용탈로 감소하는 경향을 보이는데, 본 조사지에서도 비슷한 경향으로 나타났다. 그러나, 산불피해지는 토사유출 및 토양유실로 인한 토양 생태계가 훼손될 수 있으므로 지속적인 모니터링이 필요할 것이다.

Research of Mountain Climbers Recognition about Forest Fire Prevention

산불예방에 대한 등산객 인식조사

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The result of recognized survey that target for climbers of forest fire prevention policy as follows: 46.6% of climbers thought "Public relations for the climbing culture to improve"; 24.5% of climbers thought "Installation CCTV in fragile land"; 23.5% of climbers thought "Strengthen inspection of climbers' inflammables" is effective policy. 47.4% of climbers did check a restricted area of a mountain and closing trail using Korea Forest Service (KFS) homepage, 52.3% of climbers did not check. Most of climbers has not yet been checked a restricted area of a mountain and closing trail. That reason is most of climbers is senior who cannot use internet. When climbers check a restricted area of a mountain and closing trail on KFS homepage, 62.1% of climbers have no complaints. This result is effective provide information about a restricted area of a mountain and closing trail. However, 37.9% of climbers who have complaints need "More detailed information about a restricted area of a mountain and closing trail. KFS will public relations not only KFS, other public institution with cooperation.

요 약

등산객들의 산불예방 정책에 대한 의식을 설문한 결과, 입산자 실화 등을 방지하기 위한 효과적인 정책에 대해 46.6%가 '등산 문화 개선을 위한 홍보'가 효과적이

라고 응답하였으며 다음으로 '취약지 CCTV설치'가 24.5%, '등산객 인화물질 검사 강화'가 23.5%로 나타났다. 등산 시 산림청 홈페이지를 통한 입산통제구역 및 폐쇄 등산로를 확인하는 등산객이 47.7%로 나타났으며, 확인을 하지 않는 응답자도 52.3%로 조사되어 많은 등산객들이 산림청 홈페이지를 통하여 입산통제구역과 폐쇄 등산로를 확인하지 않는 것으로 나타났다. 이와 같은 결과는 응답자들의 높은 연령 으로 인한 인터넷 미사용에 따른 결과로 판단되었다. 또한, 산림청 홈페이지를 통한 입산통제구역 및 폐쇄 등산로 확인 시 불편 사항에 대해서는 62.1% 가 '불편한 사 항이 없다'라고 나타났다. 이는 산림청 홈페이지를 통한 정보 확인에는 불편한 점이 없는 것으로 분석되어 산림청 홈페이지를 통한 입산통제구역 및 폐쇄 등산로 정보 제공은 현재 효과가 있는 것으로 판단된다. 그러나 산림청 홈페이지를 통한 정보 확인 시 불편을 느끼는 등산객들은 "자세한 입산통제구역과 폐쇄 등산로 정보와 산 림청 이외의 홍보도 필요하다"라고 응답하여 관계 기관과 협조하여 많은 정보제공 이 필요한 것으로 판단되었다.

Assessment of Productive Areas Using Environmental Factors for Quercus mongolica by Ecoprovince in Korea

환경요인을 이용한 생태권역별 신갈나무의 적지판정

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Abstracts

This study was conducted to develop site index equations and to estimate productive areas for *Quercus mongolica* by ecoprovince in Korea using environmental factors. Using the large data set from both a digital forest site map and a climatic map, a total of 48 environmental factors including 19 climatic variables were regressed on site index to develop site index equations. Four to six environmental factors for *Quercus mongolica* by ecoprovince were selected as independent variables in the final site index equations. The result showed that the coefficients of determination for site index equations were ranged from 0.30 to 0.50, which seem to be relatively low but good enough for the estimation of forest stand productivity. The site index equations developed in this study were also verified by three evaluation statistics such as the estimation bias of model, precision of model, and mean square error of measurement. According to the evaluation statistics, it was found that the site index equations fitted well to the test data sets with relatively low bias and variation. As a result, it was concluded that the site index equations were well capable of estimating site quality. Based on the site index equations for *Quercus mongolica* by ecoprovince, the productive areas by ecoprovince for all forest areas were estimated by applying GIS technique to the digital forest site map and climate map. In addition, the distribution of productive areas by ecoprovince was illustrated by using GIS technique.

요 약

본 연구는 환경인자를 이용하여 우리나라에 생태권역별로 분포하는 신갈나무의 지위지수 추정식을 개발하고 적지면적을 추정하기 위해 수행하였다. 이를 위해 산림 입지도와 전자기후도로부터 산림생산력에 영향을 미칠 것으로 판단되는 19개의 기후변수를 포함한 총 48개 환경인자를 도출한 후, 최적 조합에 의해 지위지수 추정식을 조제하였다. 최종 생태권역별 신갈나무의 지위지수 추정식에는 각각 4~6개의 환경인자가 독립변수로 사용되었고, 지위지수 추정식의 설명력을 나타내는 결정계수는 0.30~0.50의 범위에 있는 것으로 분석되었으며, 모형의 평균편의, 정도, 표준오차의 3가지 평가통계량에 근거하여 검증을 실시한 결과 비교적 지위 추정능력이 높은 것으로 판명되었다. 또한 본 연구에서는 생태권역별 신갈나무의 지위지수 추정식을 이용하여 적지면적을 산출하고 적지분포를 도해하였다.

Predicting the effect of climate change on forest biomass in different ecoprovinces and forest types of Korea

기후변화에 따른 생태권역별 · 임상별 산림 바이오매스 변화량 예측

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Abstracts

This study was conducted to predict the changes on forest biomass in different ecoprovinces and forest types under changing climates based on cumulative data (i.e., digital forest site and climate maps, National Forest Inventory data) and various prediction models. The results from this study showed that predicted changes over time in biomass varied according to ecoprovince and forest type in South Korea. A reduction in biomass was predicted for all forest types associated with the mountain, southeastern hill, and southwestern hill ecoprovinces. In contrast, the biomass was predicted to increase for the coniferous forest and mixed-forest types in the central hill ecoprovince. Furthermore, increases in biomass are predicted for all forest types, except coniferous forests, in the coastal ecoprovince. The results from this study provide a basis for developing technology to predict forest impacts due to changing climate by predicting changes in forest biomass based on changes in the estimation of site index.

요 약

기후변화에 따른 생태권역별·임상별 산림 바이오매스 변화를 예측하기 위해 수치 산림입지도, 수치기후도, 제5차 국가산림자원조사 등의 누적된 자료와 다양한 통계

모형을 이용하였다. 그 결과 시간 경과에 따른 산림 바이오매스 변화량은 생태권역별·임상별로 서로 다른 패턴을 보였다. 산악권역, 남동산야권역, 남서산야권역에서는 시간이 경과함에 따라 모든 임상에서 바이오매스가 감소하는 것으로 예측되었다. 반면에 중부산야권역에서는 활엽수림을 제외한 침엽수림과 혼효림에서는 기후변화의 영향으로 바이오매스가 증가하는 것으로 분석되었다. 또한 해안도서권역에서는 침엽수림을 제외한 임상에서 산림 바이오매스가 증가하는 것으로 추정되었다. 본 연구는 기후변화 시나리오에 따른 지위지수 추정치 변화에 근거하여 산림 바이오매스 변화량을 산출함으로써 기후변화에 따른 산림재해 변화 패턴을 예측할 수 있는 정보를 마련하였다. 따라서 본 연구의 결과는 산림재해 대응전략 수립에 필요한 정보로 활용될 수 있을 것으로 기대된다.

Prediction of stand structure change over time by silvicultural treatment in natural deciduous forest

시간경과에 따른 천연 활엽수림의 작업방법별 임분 구조 변화 예측

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Abstracts

The purpose of this study is to suggest proper regulation period for three different silvicultural systems (selection forest, two-storied forest, and shelter-wood forest) based on structural diversity characteristics of the stands in a natural deciduous forest in Korea. Based on the current stand conditions, equations were developed to predict for the next 30 years at 5-year interval. These predictions were then used to derive the proper interval for silvicultural applications to reach the target stand conditions. The predicted stands at each of the 5-year-interval were represented by 4 stand structure indices. Our results suggest that additional prescriptions were necessary at 10 and 20years later to ensure proper stand density and to reach target stand conditions for all silvicultural systems. For each additional prescription, it was determined that removal of 13-27% of basal area is required to maintain the stand density for optimal growth. Under such prescription schedule, regulation period could be reached after 30 years for all silvicultural systems considered. In all silvicultural systems, we predicted that structural indices are showed a fluctuating pattern over time. However, the overall change was too small to indicate any meaningful change in stand structual diversity. We conclude that three silvicultural systems can all be considered as environmentally-friendly silvicultural systems, and can successfully improve the economic and ecological values of the future forests.

요 약

본 연구는 천연 활엽수림의 산림 생태계 경영에 적합한 택벌림, 이단림, 산벌림을 목표임분으로 조성되어 있는 임분에 대하여 작업방법별 적정 정리기를 제시하고, 그 과정에서의 구조적 다양성 변화를 예측하고자 하였다. 이를 위해 각 작업방법별 작업지의 임분현황을 파악한 후 매 5년간 30년 동안의 미래 임분을 예측하고, 목표임분을 유도하기 위한 추가 시업을 적용하여 정리기를 제시하였다. 그에 따른 임분구조 변화 분석을 위하여 4개의 임분구조지수를 사용하였다. 각 작업방법별 대상지를 적정 임분밀도 및 목표임분형으로 유도하기 위해 10년과 20년 후 추가 시업이 필요한 것으로 나타났다. 대상지의 임분 밀도를 고려하는 동시에 각 작업방법별 시업지침에 따라 흉고단면적의 13~27%의 제거가 필요하며, 추가시업으로 각 대상지는 30년후 목표 임분형을 구성 할 것으로 추정되었다. 구조지수의 분석결과 모든 작업지에서 시간이 경과함에 따라 약간의 변화가 있었지만 현재의 임분구조 수준을 유지하는 것으로 예측되었다. 연구결과 목표임분으로 유도하기 위한 각각의 산림작업방법은 환경 친화적 시업으로 평가되며, 목표임분을 구성하였을 경우 보다 많은 경제적·생태적 가치를 갖게 될 것으로 기대된다.

Developing Socio-Economic Damage Level Standards and Evacuation Algorithms of Landslide Disasters

산지토사재해 인문사회적 피해강도 기준 및 경계피난 알고리즘 작성

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Abstracts

This report aims to establish appraisal standard for safety of influence area in urban zone of life and develop Evacuation algorithm for developing SOP when landslide disasters occur.

According to passage, results are as follows: (1) After the investigation and analysis of social-major-facilities, it classifies social key facilities of Landslide Disasters: 7 types of high risk group, 4 types of medium risk group, and 2 types of low risk group. (2) In our country, if there is a casualty, they apply damaged district population method. If it is needed to evaluate the value of damaging facilities, they apply restoration or replacement cost. (3) They have suggested the plan of investing grade with overall damage rating of engineering and humanities damage rating applying Matrix method. (4) Investigation from landslide disasters' related law in developed countries gave the implication comparison analysis result investigation with sediment disaster prevention related law in Japan and United States Geological Survey (USGS) related law. (5) For investigating domestic landslide disasters SOP conditions, U-CT referenced information from Korea Forest Service about landslide prevention, actual place manual and considered landslide standard-behavior-manual of city, province and city, county, borough. U-CT also gathered opinion of local government and analysis work-performance-procedure and

legislation, organization and step-by-step work.

요 약

산지토사재해 발생시 도시생활권내 영향지역의 안전을 위한 피해위험도 평가기준을 정립하고 SOP개발을 위한 경계피난 알고리즘을 개발하는 것을 목적으로 하였다. 위의 내용에 대한 결과는 다음과 같다. (1) 사회적 주요시설에 대한 개념을 조사·분석한 결과 고위험군 7개 유형, 중위험군 4개 유형, 저위험군 2개 유형으로 산지토사재해 사회적 주요시설을 구분하였다. (2) 우리나라에서는 인명피해의 경우 피해지역 인구수를, 시설물 피해 가치평가의 경우 복구 또는 대체비용 산정기법을 적용하고 있다. (3) 공학적 피해등급과 인문사회적 피해등급의 종합적 피해등급은 Matrix방식을 적용하여 등급을 부여하는 방안을 제시하였다. (4) 선진국의 산지토사재해 관련 법제도 조사에서는 일본의 토사재해 방지관련법과 미국의 지질조사국(USGS) 관련 법제도를 조사하여 시사점을 비교분석한 결과를 제시하였다. (5) 국내 산지토사재해 SOP현황 분석을 위해 산림청의 산사태 예방·대응 현장 매뉴얼과 시·도 및 시·군·구 산사태 표준행동매뉴얼을 검토하였고, 지자체의 의견을 수렴하였으며 업무수행절차와 법률·조직, 단계별 업무에 대해 분석하였다.

Thermal Stability of Metal Hydroxides and Intumescent Flame Retardant Treated Wood Plastic Composites

금속산화물과 팽창성 난연제 처리된 목재플라스틱 복합재의 열안정성

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Abstracts

Wood flour filled polypropylene (PP) composites with metal oxides and intumescent flame retardant were manufactured by melt compounding and injection molding. The effects of fire retardants such as metal oxides and intumescent flame retardant on the thermal stability of wood flour filled polypropylene (PP) composites in this study. The addition of wood flour (10 to 50%) to PP increased the maximum thermal degradation temperature which means the improvement of fire retardancy. At the addition of 50% wood flour, the maximum thermal degradation temperature of PP increased 30℃. This result is related to the formation of char formation which decrease and delay the heat transfer to polymer matrix. The addition of magnesium hydroxide(MgOH) and aluminum trihydrate(ATH) increases the thermal degradation temperature of PP. The addition of 21% ATH increases the maximum degradation temperature of PP up to 41℃. By the formation of Al_2O_3 during burning, the wood char and char barrier formation contributes to the thermal stability of the composites. The addition of MgOH showed higher thermal stability than that of ATH. The formation of MgO gives rise to the formation of char which is related to the thermal stability of the composites. At the initial thermal degradation of PP, MgO has the effect of heat absorption and char protection layer on the composites. The intumescent flame retardant gives the higher thermal stability than the metal hydtroxides. Melamine cyanurate and pentaerythritol contributed to the thermal stability by the formation char protection layer. Decomposition of APP and decrease of wood degradation temperature decrease and

delay the heat transition to PP. According to cone calorimeter test, the correlation of thermal stability and fire retardancy was investigated in this study.

요 약

금속 산화물과 팽창성 난연제가 처리된 목분/폴리프로필렌 복합재는 용융 혼련 및 사출방법에 의해서 제조되었다. 본 연구에서 금속산화물과 팽창성 난연제가 목분/폴리프로필렌 복합재의 열안정성에 미치는 영향이 조사하였다. 폴리프로필렌 수지에 목분을 10%에서 50%까지 첨가했을 때, 최대열분해온도가 증가했는데, 이는 난연성이 향상된 것을 보여준다. 목분을 50% 첨가시, 폴리프로필렌 수지의 최대 열분해온도는 약 30도 정도 증가했다. 이 결과는 탄화막의 형성으로 고분자 메트릭스로의 열전달이 감소되거나 지연되었기 때문이다. 마그네슘 산화물과 알루미늄 산화물의 첨가는 폴리프로필렌 수지의 최대 열분해온도를 증가시켰다. 21%의 알루미늄 산화물의 첨가는 폴리프로필렌 수지의 최대 열분해온도를 41도 정도 증가시켰다. 연소 동안에 고체 Al_2O_3가 형성되어 목재 탄화물과 탄화막의 형성이 복합재의 열안정성이 향상되었다. 마그네슘 산화물의 첨가는 알루미늄 산화물보다 복합재의 높은 열안정성을 보여준다. 연소과정에서 고체 MgO 역시 탄화물의 형성시켜 복합재의 열안정성을 향상시킨다. 폴리프로필렌 수지의 초기 열분해시, MgO는 열흡수와 탄화보호막의 영향을 보인다. 팽창성 난연제의 첨가는 금속산화물보다 우수한 난연성능을 보여준다. 팽창성 난연제의 조성분인 melamine cyanurate와 pentaeruthritol은 탄화막 형성으로 열안정성에 기여한다. 다른 조성분인 ammonium phosphate의 분해와 목재 열분해온도의 감소는 폴리프로필렌 수지로의 열전달을 감소시키거나 연기시킨다. Cone calorimeter 분석결과, 본 연구에서 난연제 첨가 목재플라스틱 복합재의 열안정성과 난연성능의 상관관계가 구명되었다.

Effects of Different Irrigation Period on Growth Performances and Photosynthesis of container seedlings of Fraxinus rhynchophylla

관수 주기가 물푸레나무 용기묘의 생장 및 광합성 기구에 미치는 영향

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Abstracts

This study was conducted to investigate growth performance, photosynthesis, water use efficiency (WUE), and stomatal conductance (gs) of container seedlings of *Fraxinus rhynchophylla* under three different irrigation periods (1 time/1 day, 1 time/2 days, and 1 time/3 days). The root collar diameter and height of *F. rhynchophylla* seedlings were the highest with 1 time/1 day irrigation. The total biomass of seedlings with 1 time/1 day and 1 time/2 days were not significantly different. The seedling quality index (SQI) of seedlings with all irrigation periods were not significantly different. *F. rhynchophylla* showed the highest photosynthetic rate, 7.62μ molCO$_2 \cdot ^{-2} \cdot ^{-1}$, with 1 time/1 day. As irrigation period was elongated, gs of two species decreased, while their WUE increased significantly. Based on these results, container seedlings of *F. rhynchophylla* should be irrigated 1 time/1~2 days, depending on temperature conditions in greenhouse. In addition, irrigation controlling is very important for physiological characteristics, growth, and quality of container seedling.

요 약

본 연구는 물푸레나무 용기묘를 대상으로 수분 조건에 가장 큰 영향을 미치는 관수 주기 처리별(1회/1일, 1회/2일, 1회/3일) 생장 특성과 광합성 능력, 수분이용효율,

기공전도도 등 광합성 기구의 변화를 조사•분석하여, 우량 묘목 생산을 위한 최적 수분환경을 구명하고자 실시하였다. 근원경과 간장 생장은 1회/1일 관수 처리구에서 가장 높았다. 물질생산량은 1회/1일과 1회/2일 관수 처리간의 유의적 차이는 나타나지 않았다. 묘목품질지수는 세 관수 주기 모두 유의적 차이는 없었다. 광합성률은 1회/1일 관수 처리에서 7.62μ molCO2•m-²•s-¹으로 가장 우수하였다. 관수 주기가 길어질수록 수분 조건이 불량해짐에 따라 기공전도도는 낮아졌으며, 반대로 수분이용 효율은 높아지는 상반된 경향을 보였다. 생장 및 광합성 특성을 종합해 보면, 물푸레나무 용기묘 양묘 시 시기별 온실 내 온도 조건에 따라 탄력적인 1~2일 관수를 실시할 수 있을 것으로 판단된다.

The early effect of fertilization on growth of Quercus serrata and Zelkova serrata seedlings in harvested Pinus rigida plantation

시비 처리가 리기다소나무 벌채지 내 조림된 졸참나무와 느티나무 생장에 미치는 초기 영향

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Abstract

Pinus rigida plantation is occupies about 30% of artificial forest in Korea because this had been widely planted in Korea since 1960s. We have been concerned about selecting planting tree species after harvesting *P. rigida* plantation because it has reached to final cutting age. The objective of this study was to know the early effect of fertilization on growth of *Quercus serrata* and *Zelkova serrata* seedlings in harvested *P. rigida* plantation. Study site is located in Pocheon-si, Gyunggi-do, Korea. *Q. serrata* (1-1, bare root seedling) and *Z. serrata* (1-0, containerized seedling) seedlings were planted with the density of 3,000 seedlings ha^{-1} in April, 2011 after harvesting *P. rigida* plantation. Soil compound fertilizer (N:P:K=3:4:1) were used in the spring of 2011 and 2012; control, F1 (180kg/ha), and F2 (360kg/ha). We measured seedling height (H) and diameter at root collar (DRC), and then calculated relative growth rate (RGR). RGR of H and DRC with fertilization in both *Q. serrata* and *Z. serrata* seedlings did not show significantly differences in 2011. However, in *Q. serrata* seedlings of 2012, both RGR (%) of H and DRC in F1 (62 and 83) were significantly higher than those in control (54 and 64) and F2 (57 and 77). RGR of H and DRC in *Z. serrata* seedlings showed significant differences in the order of F2 (60 and 75) > F1 (40 and 57) > control (28 and 44). Therefore, long-term research would be needed to observe changes in seedling growth because the effect of fertilization must be

observed every year in order to investigate the proper fertilization.

요 약

리기다소나무는 1960년대 우리나라 주요 조림 수종 중 하나로서 인공림 면적의 약 30%를 차지하고 있으며, 최근 벌기령 경과에 따른 생장량 감소로 수종 갱신이 많이 이루어지고 있다. 리기다소나무를 벌채한 임지는 다른 임분에 비해 토양 내 양분이 부족한 것으로 알려져 있어 활엽수 조림시 적절한 임지 내 시비 처리가 요구된다. 따라서, 본 연구에서는 리기다소나무 벌채지 내 시비 처리가 조림 수종의 생장에 미치는 영향을 분석하여 조림 수종별 적정 시비량을 산정하는데 그 목적이 있다. 연구 대상지는 경기도 포천시 광릉시험림 내 리기다소나무 벌채지이며, 2011년 4월 졸참나무(1-1, 노지묘)와 느티나무(1-0, 용기묘)를 3,000본/ha 밀도로 조림하였고, 2011, 2012년 10월에 수고 및 근원경을 측정하여 상대 생장량을 계산하였다. 시비는 산림용 고형복합비료(N:P:K=3:4:1)를 이용하여 2011, 2012년 춘기에 실시하였으며, 대조구(무시비), F1(180kg/ha), F2(360kg/ha) 등 세 가지 처리를 하였다. 2011년에는 시비처리에 따른 생장 차이가 없었으나, 2012년 졸참나무의 수고 및 근원경 상대 생장량(%)은 F1처리구에서 각각 62, 83으로 가장 우수하였으며, 느티나무는 F2(60, 75) > F1(40, 57) > 대조구(28, 44) 순으로 유의한 차이를 보였다. 본 연구는 조림 수종의 초기 생장을 조사한 것으로 장기 모니터링을 통하여 시비 처리에 따른 생장의 변화와 적정 시비량을 파악할 수 있을 것으로 판단된다.

The Photosynthesis and Growth Performances of Tilia amurensis Grown at Different Container Types in the Container Nursery System

피나무의 용기 종류에 따른 광합성 기구 및 생장 특성

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Abstracts

The purpose of this study was to investigate the effects of container types on photosynthesis and growth of *Tilia amurensis* in the container nursery system. We used three container types [20 cavities/tray (150 seedlings/m^2-400ml), 24 cavities/tray (200 seedlings/m^2-320ml), and 35 cavities/tray (260 seedlings/m^2-240ml)] and measured photosynthetic rate, photochemical efficiency, chlorophyll contents, and growth performances. T. amurensis showed the highest photosynthetic rate, 5.98μ molCO$_2 \cdot^{-2} \cdot^{-1}$, at 24 cavities/tray. The photochemical efficiency of seedlings was the lowest at 35 cavities/tray. However, chlorophyll contents of seedlings were not significantly different at all container types. The height of seedlings was the highest at 20 cavities/tray. However, root collar diameter, total biomass, and seedling quality index of seedlings of 20 and 24 cavities/tray were not significantly different. Also, T. amurensis showed the highest total biomass per unit area, 1,478g/m^2, at 24 cavities/tray. Based on these results, 24 cavities/tray is optimal container types for T. amurensis. Usage of optimal container will make us get better quality seedlings as well as reduction of production costs in the container nursery.

요 약

본 연구는 시설양묘과정에서 요구되는 피나무 적정 용기의 용적 및 생육밀도를 구명하고자 수행하였다. 20구(150본/m²-400mL), 24구(200본/m²-320mL), 35구(260본

/m^2-240mL)의 세 용기에 따른 피나무의 광합성 능력, 광화학 효율, 엽록소 함량 및 생장 특성을 조사•분석하였다. 광합성률은 24구에서 5.98μ molCO$_2$·$^{-2}$·$^{-1}$으로 가장 높았으며, 광화학 효율은 35구에서 유의적으로 가장 낮은 값을 보였다. 그러나 엽록소 함량은 세 용기간 유의적 차이는 나타나지 않았다. 피나무 용기묘 간장 생장은 20구에서 가장 우수하였지만, 근원경, 물징생산량 및 묘목품질지수는 20구와 24구에서 유의적 차이를 보이지 않았다. 단위면적 당 물질생산량은 24구에서 가장 높게 나타났다. 생리 및 생장 특성 결과를 종합해 보면, 시설양묘 단계에서 피나무는 24구 용기가 적정한 것으로 판단된다. 수종별 적정 용기의 사용은 우량묘목 생산이 가능하며, 동시에 경제적으로도 비용을 절감시킬 것으로 기대된다.

The effects of fire resistance and fixation on flame retardant treated wood by electron beam treatment

전자빔처리에 의한 난연제의 목재 내 정착 및 난연 성능 향상 효과

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The electron beam treatment was used for increasing of retardant chemical impregnation into the wood. The 300kGy electron beam power was introduced for wood. Fire retardants such as sodium silicate, boric acid, ammonium borate, diammonium phosphate impregnated to wood by vacuum/pressure treatment after electron beam treatment. The effectiveness of flame retardants fixation was investigated using scanning electron microscope (SEM) and energy dispersive spectroscopy (EDS) after leaching tests. Peak heat release rate and total heat release were investigated using cone-calorimeter. After the electron beam treatment, shake of intercellular layer was detected but a pit was unaffected. The electron beam maxim permeation depth was 80mm on larch. Chemical retentions were increased after electron beam treatment. The electron beam could effects chemical fixation in the wood cell after impregnation. Fire retardant treated wood satisfied the KS standard as the 3 grade. And also these specimens passed combustion gases noxious test, which over the 9 minute.

요 약

난연제의 목재 내 주입성능을 개선하기 위하여 전자빔 처리를 도입하였다. 전자빔 처리는 300kGy로 하였으며 처리 후 약제의 주입량 및 목재 내 정착상태를 조사

하였다. 난연제는 액상규산나트륨과 붕산, 붕산암모늄, 인산수소2암모늄을 처리하였
다. 전자빔 처리에 의한 목재 세포 내 변화는 세포간층의 할열이 발생하였음이 관
찰되었고 유연벽공의 변화는 없었다. 전자빔의 목재 내 침투깊이는 낙엽송의 경우,
80mm로 나타났다. 전자빔 처리에 의하여 약제의 주입성능은 향상되었다. 전자빔 처
리 후 약제의 목재 내 정착은 SEM-EDS분석결과 정착에 영향을 미치는 것이 확인
되었으며 용탈량이 감소한 결과를 보였다. 전자빔 처리 후 가압주입 한 난연목재에
대한 콘칼로리미터 분석 결과, 열방출율, 총방출열량에서 난연3급기준을 상회하는
결과를 보였다. 난연처리재의 연소가스 유해성 시험에서 흰쥐의 행동정지 KS기준 9
분을 초과하여 가스안전성이 높은 것으로 나타났다.

Improvement of Fire retardancy and Toxicity Evaluation of Carbonized board

탄화보드의 내화성능 개선과 유해성 평가

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Abstracts

Fire-retardancy and gas harmfulness evaluation of carbonized boards were conducted as a fire retardant door in this study. After carbonizing medium density fiberboards(MDF) at higher than 800℃, the carbonized boards showed good properties such as light-weight, adsorption of formaldehyde, moisture control, barrier of electromagnetic wave, fire-retardancy, and electric conductivity as shown in white charcoal. The carbonized boards also showed excellent processability, providing a suitable characteristic for environmentally-friendly architectural and household materials. In order to use as an interior building material, fire-retardancy property test is required. When fire-rerardancy test for the carbonized boards manufactured at 1,000oC was conducted with a cone calorimeter, total heat release(THR) and peak heat release rate(PHRR) after 10 min heating were 8.5MJ/m^2(KS standard 8MJ/m^2) and 20kw/m^2(KS standard 200kw/m^2), which showed fire-retardancy 3 level but did not show fire-retardancy 2 level. In order to improve the fire-retardancy, the carbonized boards were manufactured at 1,000oC and coated with water glass and hwangto powder. The carbonized boards treated with water glass and hwangto after 10 min heating showed the THR of 2MJ/m^2 and PHRR of 10kW/m^2 which indicated the fire-retardancy 2 level. According to gas harmful evaluation by KS F 2271, the carbonized boards stopped the activity of ICR mouse in 6 min, without passing the KS standard(9 min). However, the carbonized boards treated with water glass and hwangto did not stop the activity of ICR mouse in 14 min, showing no

gas harmfulness. Therefore, the carbonized boards treated with water glass and hwangto represents the potential for environmentally-friendly fire retardancy door manufacture.

요 약

본 연구에서는 탄화보드를 방화문의 방화재료로 사용하기 위해 탄화보드의 난연성능을 개선하고 가스 유해성을 검토하였다. 섬유판을 800도 이상에서 탄화하여 만든 탄화보드는 백탄과 같이 경량성, 포름알데히드 흡착성, 조습성, 전자파차폐성, 난연성, 전기전도성 등이 매우 우수하며 가공성이 탁월하여 친환경 건축·생활자재로서 적합한 성능을 고루 갖추고 있다. 탄화보드를 실내용 건축자재로 사용하기 위해서는 난연성능에 대한 검토가 이루어져야 한다. 1,000℃에서 제조한 탄화보드를 cone calorimeter를 이용하여 난연성능을 검토한 결과, 10분 가열 후 탄화보드의 총열방출열량(THR)은 8.5MJ/㎡(KS기준 8MJ/㎡ 이하)이며, 최대열방출률(PHHR)은 20kW/㎡(KS기준 200kW/㎡)로 난연3급의 성능은 만족하였으나 난연2급의 성능을 만족하지 못하였다. 탄화보드의 난연성능을 개선하기 위하여 1000℃에서 탄화보드를 제조하고, 물유리와 황토혼합액의 코팅처리에 의해 난연성능을 개선하였다. 난연처리 탄화보드(물유리+황토코팅)는 10분 가열 후 총방출열량(THR)은 2MJ/㎡, 최대열방출률(PHHR)은 10kW/㎡로 난연2급(준불연재료)의 성능을 만족하였다. 난연처리 탄화보드의 ICR 마우스에 대한 유해 가스성을 조사한 결과(KS F 2271:2006), 섬유판은 6분 정도에서 마우스의 행동이 정지하여 KS 기준(9분)을 통과하지 못하였으나, 난연처리 탄화보드는 14분 정도까지 마우스의 행동이 정지하지 않아 가스 발생에 따른 유해성은 인정되지 않았다. 난연처리 탄화보드를 이용한 친환경 방화문의 제조 가능성을 확인하였다.

Estimating the Economic Impact of Forest Road Using Input-Output Analysis

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Abstracts

The purpose of the research is to estimate economic impacts on forest road construction by using Input-Output analysis with 2010 inter-industry relation tables (The Bank of Korea, 2011). Inter-industry relation tables are restructured into 29 sections on the industry of forest road construction. The total length of forest road in 2012 is about 17,145km and the 2011 year construction of forest road in length is about 572km, and its density is about 2.69m/ha. In details, national forest road are about 283km and private forest road are about 289km. And the 2011 year total cost of forest road construction and management is about ₩143,552 million. Hence, the result of economic impact with forest road construction is as follow; production inducement effects ₩2,219 billion, labor induced effects 2,099 people, value added inducement effects ₩1,704 billion. As the result of the research, both production inducement coefficients and value added inducement coefficients show relatively lower than the other industry effect, but employment coefficient is relatively higher than the other area. In addition, the result shows that both influence on the other industry area and sensitivity from the other industry field is relatively low.

요 약

2010년 산업연관표(Inter-industry relation tables)를 이용하여 임도건설에 따른 경제적 파급효과를 산업연관분석(Input-Output analysis) 모형으로 분석하였다. 임도건설 산업과 관련된 산업을 중심으로 산업연관표를 제작성하여 총 29개 부문으로 구분하여 분석하였다. 2011년에 건설된 우리나라 임도길이는 총 572㎞이며, 임도밀도

는 2.69m/㏊이다. 국유림 임도는 283㎞이며, 민유림은 289㎞을 건설하였다. 2011년 임도건설 및 유지보수 지원액은 143,552 백만원이 투자되었다. 이에 임도건설을 통해 발생되는 경제적 파급효과는 생산유발(production inducement effects) 2,219억 원, 고용유발(labor induced effects) 2,099명, 부가가치유발(value added inducement effects) 1,704억 원으로 추정되었다. 생산유발계수(production inducement coefficients)와 부가가치유발계수(value added inducement coefficients)는 타산업에 비해 낮게 분석되었지만 고용유발계수(employment coefficient)는 타산업에 비해 높게 나타났다. 또한 임도 건설산업은 다른 산업에 미치는 영향력(influence)뿐만이 아니라 다른 산업으로부터 받는 감응도(sensitivity)도 낮은 것으로 나타났다.

A new tree disease caused by *Mycopappus* sp. found in forest-fire-affected sites in Gangwon province, Korea

강원도 산불피해지역의 *Mycopappus*에 의한 새로운 병해

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Abstracts

A new tree disease was found on oaks and willows in forest-fire-affected sites in Goseung and Samcheok, Korea during a tree disease survey from 2011 to 2012. In early September of the year 2011, sawtooth oak (*Quercus acutissima*) and willow (*Salix pierotii*) trees started exhibiting brown leaf spots and the affected leaves early turned brown and defoliated. White to cream colored, cone shaped fungal propagules formed on the upper surface of the affected leaves. Fungal hyphae on the leaves were hyaline, claviform, and 3-4×0.8-1.2 μ m in size. Sclerotia that are a dormant structure of a fungus were found on infected leaf residues. In 2012, the same symptoms (early discoloration and defoliation) were also observed on rose-gold pussy willow (*Salix gracilistyla*) growing nearby the trees infected in the previous year. The causal agent of the disease was found to be a fungal pathogen in the genus *Mycopappus* through fungal isolations and morphological observations. This is the first report of the disease in Korea. In other countries, diseases caused by *Mycopappus* spp. (e.g. frosty mildew) are known to mostly occur in mountainous areas with low night temperature and high humidity. Based on the association of the disease with cool and moist weather conditions, the new disease incidences in Goseung, Samcheok, and Taebaek are likely attributed to low summer temperatures in Gangwon province in recent years. Diseased trees left untreated may have served as an inoculum reservoir for new infections.

요 약

2011년 9월 초 고성, 삼척지역의 상수리나무에서 잎에 갈색 반점이 나타나고 갈변되며, 조기 낙엽되었다. 잎 윗면에는 흰색~노란색을 띈 균사체 덩어리가 원뿔 모양으로 형성되어 있었으며, 낙엽 진 병든 잎에는 균핵이 형성되어 있었다. 또한 버드나무에도 2011년부터 비슷한 병징이 나타났으며, 2012년도에는 근처에 있는 갯버들에도 *Mycopappus*에 의해 피해 받은 잎이 갈변되고 조기 낙엽지는 현상이 나타나기 시작했다. 이병은 우리나라 미기록 병해이며, 강원도 산불피해지역에서 처음 발견된 병해로 외국에서는 저온성 병해로 알려져 있다. 최근 강원도지역의 여름철 저온 현상으로 고성, 삼척, 태백지역의 상수리나무가 9월말부터 피해가 심한 것으로 조사되었으며, 2011년 피해가 심한 버드나무 옆의 갯버들은 버드나무에서 병원균이 전파된 것으로 추정된다. 병원균은 투명하고 끝이 곤봉모양인 균사로 이루어져 있으며, 크기는 3~4 × 077~1.2um이다.

Tree diseases occurring in forest-fire-affected stands in Samcheok LTER Site

삼척 LTER Site 산불피해지의 수목병원균상

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Abstracts

A long-term survey has been conducted for tree disease occurrences in forest-fire-affected stands in Samcheok Long Term Ecological Research (LTER) site, Korea annually (2001-2004 and 2009-2012) or biannually (2004-2008) since the year 2001. As the forest-fire-affected stands have become stabilized over time, both numbers of tree diseases and tree species with a disease found each year have decreased. In 2001, 28 diseases including Tar spot of maples occurred on 24 tree species. In 2004, 22 diseases were observed on 15 tree species. In 2011, 19 diseases were found to occur on 13 tree species, among which witches' broom of Chinese sumac (*Rhus chinensis*) most frequently occurred. Powdery mildew was prevalent in the surveyed stands throughout the survey period, occurring on a variety of tree and shrub species such as ashes (*Fraxinus* spp.), oaks (*Quercus* spp.), maples (*Acer* spp.), laceshrub (*Stephanandra incise*), and harlequin glorybower (*Clerodendrum trichotomum*). Frequent rainfalls during summer and dense vegetation may have provided a conducive environment for powdery mildew. Rust also commonly occurred on many shrub species such as harlequin glorybower (*Clerodendrum trichotomum*), white mulberry (*Morus alba*), nigaki (*Picrasma quassioides*), and *Zanthoxylum schinifolium*. Oak trees affected or stressed by the fire event were found to suffer from a number of diseases including powdery mildew, Tubakia leaf spot, and Endothia canker, which are not a major concern to healthy trees. Some tree diseases found in the Samcheok LTER site during the

survey have not been reported in Korea. They include Ascochyta leaf spot of Kudzu (*Pueraria lobata*), Anthracnose of weigela (*Weigela subsessilis*), powdery mildew of Chinese flowering ash (*Fraxinus sieboldiana*), and powdery mildew of rugosa rose (*Rosa rugosa*).

요 약

삼척 LTER site의 수목병원균상을 조사한 결과, 2001년도에는 단풍나무 타르점무늬병 등24수종 28병종, 2004년 15수종 22병종, 2011년에는 붉나무 빗자루병 등 13수종 19병종의 병해가 발생되는 것으로 조사되었다. 산불피해지역의 수세가 안정화되면서 병해가 발생되는 수종은 감소한 반면 병종은 증가하는 것으로 나타났다. 물푸레나무, 참나무류, 국수나무, 단풍나무, 누리장나무 등 많은 수종에 흰가루병 피해가 발생되었으며, 여름철 잦은 강우로 습하고 밀식되어 흰가루병 피해가 발생되는 것으로 조사되었다. 또한 누리장나무, 뽕나무, 소태나무, 산초나무 등에 녹병 피해가 발생되었으며, 붉나무에는 점무늬병과 빗자루병이 매년 발생되고 있었다. 특히 참나무류에는 흰가루병, 뒷면흰가루병, 튜바키아 점무늬병, 황색줄기마름병 등 다양하게 병해가 발생되고 있었으며, 참나무류가 산불로 인해 피해가 심한 것으로 조사되었다. 삼척 LTER site에서 칡 겹둥근무늬병, 병꽃나무 탄저병, 쇠물푸레나무, 해당화 흰가루병 등 국내 미기록 병해를 분리하였다.

Impact of site aspect on the initial development of natural forest after Uljin fire in 2007

2007년 울진산불 이후 사면방향이 천연임분의 초기발달에 미치는 영향

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Abstracts

Vegetation and tree measurements were conducted on the north and south facing crown fire-damaged forests in Uljin to determine impact of site aspect on the pattern of natural regeneration. DBH (diameter at breast height) of trees was not significantly different, while dominant species, mean tree height, and understory vegetation was different in each aspect. Pure forest of *Quercus mongolica* was formed at north facing slope, but mixed forest of *Q. mongolica, Q. acutissima, Q. variabilis,* and *Q. serrata* was formed at south facing slope. The mean tree height was 2.56m and 2.25m at north facing and south facing slope, respectively. Herbaceous species diversity was higher at north facing slope than south facing slope (53 and 41 species). Herbaceous species preferring different site condition were emerged together on north facing slope, since it was considered that vegetation on north facing slope was not stabilized. These results indicate that the pattern of natural regeneration after wildfire might be different from site aspect.

요 약

산불발생 이후 자연복원시 북사면과 남사면에서 발생하는 초기 식생의 차이를 확인하기 위하여 울진 산불피해지를 북사면과 남사면으로 구분하여 식생, 매목조사를 실시하였다. 각 사면별로 교목성 수종의 흉고직경은 유사하였으나, 우점종, 피도, 수고생장, 그리고 하층식생에 있어서는 다르게 나타났다. 북사면은 신갈나무 단순림으로 이루어졌으나 남사면은 상수리나무, 신갈나무가 우점하고 있었으며, 관목층은 떡

갈나무, 굴참나무, 졸참나무 등이 출현하였다. 북사면에서 자라는 수목의 평균 수고는 2.56m로 남사면 2.25m 보다 높게 나타났다. 초본층은 북사면에서 53종, 남사면에서 41종이 출현하여 북사면이 종다양성은 높으나 서로 다른 입지를 선호하는 식물이 함께 출현하여, 식생이 아직 안정화되지 않았다. 이는 산불피해지에서 각 사면별로 복원형태나 복원속도가 다름을 의미한다.

Growth characteristics of containerized pine seedlings on site aspect in burned-forest site

산불피해지에서 소나무 용기묘의 사면별 생장특성

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Abstracts

Tree measurements were conducted on the 10 years pine forest which planted by containerized pine seedlings at north and south slope after Samcheok forest fire. Tree height and DRC (diameter at root collar) of trees were significantly different, but annual growth pattern of tree height and DRH were not different in each aspect. The mean tree heights were 2.32m and 3.15m at north facing and south facing. The DRC were 5.64cm, 7.21cm at north facing and south facing, respectively. While annually growth pattern is similar. Annual growth patterns of height and DRC natural increased before 5 years, while rapidly decreased after 8 years at post fire. These results indicate that the vegetation restoration methods diversely apply by site aspect. And containerized generation method might need to topdressing in post fire area.

요 약

산불피해지에 조림된 소나무 용기묘의 사면별 생장특성을 확인하기 위해 삼척 산불피해지에서 10년생 소나무용기묘의 수간석해를 실시하였다. 각 사면별로 수고와 근원경을 조사한 결과 남사면에서 자라는 소나무 용기묘의 수고와 근원경은 3.15m와 7.21cm로 나타나, 북사면에서 자라는 소나무 용기묘의 수고와 근원경 2.32m, 5.64cm에 비해 높게 나타났다. 그러나 수고와 근원경의 산불 이후 연년 생장패턴은 초기 5년간은 산술급수적으로 증가한데 반해, 8년 이후부터는 감소하는 결과가 나

타났다. 이러한 결과는 사면에 따라 복원방법을 다르게 적용하여야 함을 의미하며 산불피해지에서 소나무 용기묘를 이용하여 조림하는 경우에는 시비가 필요할 것으로 판단된다.

The Management Plan of Forest-fire control in North Korea

북한 산불막이(산불방지) 관리 계획

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Abstracts

The plan of forest-fire control in North Korea is based on the degree of forest fire risk with forest fire break line, forest fire watchtower, forest fire watchtower with considering the other building scale and methods. The evaluation of the degree of forest fire risk is carried out with condition of forest fire risk, timing of forest fire, size of forest fire, etc. Forest fire risk is to be analyzed with degree of forest fire risk in sub-compartment and assessed with forest fire risk in the area of forest fire risk line to its compartment and management area. The scales of forest fire break line are as follows; 10~15m from house and around the other building, 40~50m from train rail road, 20~30m from electric train rail road, 10~15m from mountain road, 10~20m from chestnut trees, the grass, and field of reeds, 5m from farmland, 20m from charcoal kiln, which is a source of mountain fire, 10~15m to both electric line with high voltage line, 1.5 times of height in average of mountain area to the other forest-fire break line. Position of forest fire break line is placed into considering geographic features with forest condition, roads, river and stream, high-voltage line, or compartment line could be a base when cutting down trees to manage forest fire. The position of forest fire watchtower is placed into the top area of mountain to cover 12,243~24,486 acre and to spread out mountain fire information quickly.

요 약

북한의 산불막이(산불방지) 계획은 산불위험성에 따라 산불막이선, 산불감시대, 산불감시조직, 기타 시설물의 설치규모와 방법 등을 제시하여 작성된다. 산불위험성 판정은 산불이 일어날 수 있는 위험성 조건과 산불위험 시기, 산불위험성 등급을 기초로 하여 실시된다. 산불위험성은 소반을 단위로 산불위험성 등급을 조사분석하고, 임반과 경영구역 별로 산불위험성 등급선을 그어 해당되는 설계대상 구역에 대해 위험성을 평가한다. 산불막이선의 크기는 살림집과 기타 건물, 시설물 주변은 10～15m, 증기기관차가 다니는 철길로부터 산이 있는 쪽으로 40～50m, 전기 및 내연기관차가 다니는 철길은 20～30m, 임산철길 10～15m, 밤나무림, 풀밭, 갈밭 등에 불놓기를 하는 경우 산불막이선의 너비는 10～20m, 논밭 뚝에 불놓기를 하는 경우 5m 정도로 하고, 숯가마, 송탄유가마, 흙구이 등 불근원으로부터의 산불막이선은 그것을 중심으로 반경 20m, 고압 전기줄 밑의 산불막이선은 전기줄 양쪽으로 10～15m, 기타 산불막이선은 해당 산림의 평균높이의 1.5배 정도로 한다. 산불막이선 배치는 해당 설계대상 구역의 산림상태와 도로, 강하천, 고압선 등 지형지물 및 자연경계를 될수록 이용하며, 그렇지 못한 경우 나무를 벨 경우에는 임반 선과 일치하도록 배치한다. 산불감시대는 주요 산림지대를 중심으로 하여 전반적 산림을 다 감시할 수 있도록 높은 곳에 배치하는데 한 개 감시대에서 5,000～10,000정보 이상 감시하면서도 빨리 연락할 수 있는 지점에 배치하고 있다.

Vegetation Type and Habitat Characteristics of Hongneung Arboretum at Seoul

서울 홍릉수목원 식생유형과 서식처 특성

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Abstracts

The study of the urban forest vegetation type of Hongnueng was divided into four groups and species composition and species diversity with quantitative analysis was conducted to understand the characteristics. Also, clarify the characteristics of vegetation types in the future urban forest vegetation habitat analysis and management is to provide basic data. Based on the existing vegetation consists of four types of vegetation type, vegetation type, each divided into four locations, a total of 16(10m×10m) was to install a fixed irradiation. As a result, Tracheophytes were 162 taxa consisting 64 families, 125 genera, 162 species, 2 sub-species, 11 varieties and 2 forma. Environmental factors, type of vegetation in Grass land-high tree the lowest tree layer coverage, herb layer coverage was the highest. *Pinus densiflora* forest shrub coverage than other vegetation types was the highest with a 61.3%, *Chamaecyparis pisifera* forest tree layer coverage the highest. *Quercus* sp. forest is the most high but the tree layer coverage, herb layer coverage was the lowest. Soil physicochemical characteristics, total nitrogen, sodium, except for the difference between vegetation types showed woody layer species diversity(H') 0.785±0.547～1.043±0.524, herb layer speceis diversity(H') 1.713±0.277～3.141±0.141 respectively. NMS on the woody layer vegetation analysis of the distinct vegetation types and environmental factors, and herb layer vegetation on the slope of DCA

ordination results of applying the method, available phosphorus, soil pH, organic matter and many environmental factors that determine the formatting attributes of herb layer vegetation was found.

요 약

홍릉수목원의 식생유형별 서식지의 특성을 구명하여 향후 도심 내 위치하고 있는 수목원의 관리에 있어 기초자료를 제공하고자 한다. 홍릉수목원의 식생구분은 초지-교목형, 소나무림, 화백림, 참나무 우점림으로 구분하여 식생유형과 환경특성을 분석한 결과, 전체 조사구에 출현한 관속식물은 64과 125속 2아종 11변종 2품종 162종 177분류군으로 확인되었다. 식생유형별 식피율은 초지-교목형의 교목층 식피율이 가장 낮았으며, 초본층 식피율이 가장 높게 나타났다. 소나무림은 다른 식생유형보다 관목층 식피율이 61.3%로 가장 높게 나타났으며, 화백림은 아교목층 식피율이 가장 높게 나타났다. 참나무 우점림은 교목층 식피율이 높게 나타났지만, 초본층 식피율은 낮게 나타났다. 종다양도는 목본층에서는 0.785±0.547∼1.043±0.524, 초본층에서는 1.713±0.277∼3.141±0.141로 나타났다. 토양의 이화학적 특성 중 토양pH, 유효인산(Avail. P2O5),유기물(O.M), 양이온치환용량(CEC) 등에서는 식생유형별 유의차가 있었으나, 토성, 전질소(TN), 나트륨(Na^+)에서는 유의차가 나타나지 않았다. 상층식생에 대한 NMS 분석결과 식생유형과 환경요인은 구분되었으며, 하층식생에 대한 DCA 서열법을 분석한 결과 경사, 유효인산, 토양pH, 유기물함량은 하층식생의 서식특성을 결정하는 요인으로 나타났다.

Community Structure of Quercus mongolica Stand from Chiljeolbong to Dongglebong at the Baekdudaegan

백두대간 칠절봉~동글봉 일대 신갈나무림의 군집구조

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Abstracts

The In order to provide efficiency management ways, this study were investigated the community structure of *Quercus Mongolica* forest and inhabited characteristic of major plants in Dongglebong-Chiljeolbong that covers with gene resource protection zone and military zone. As a result of survey, tracheophytes were 241 taxa consisting 66 families, 158 genera, 208 species, 2 sub-species, 28 varieties and 4 forma and the rare and special plants were classified 23 taxa consisting 12 families, 22 genera, 22 species, 1 variety in research subject area. As a result of attracting analysis, community complex is separated from *Cornus controversa-Quercus Mongolica* community and *Carpinus cordata-Quercus Mongolica Carpinus cordata* community. According to DCA inhabited characteristics of plant showed significant difference due to altitude, slope and coverage of shrub tree layer. Besides, *Quercus Mongolica* is evidenced the best dominance value among the trees, following *Quercus Mongolica* on the list were *Carpinus cordata*, *Pinus densiflora*, *Fraxinus rhynchophylla*. Between *Ulmus laciniata* and *Juglans mandshurica*, *Juglans mandshurica* and *Prunus maackii*, *Acer komarovii* and *Betula costata* showed the postive correlation. Species diversity of research plots showed that herb layer and tree layer are 2.849, 1.105, respectively. Species diversity along with latitude, herb layer and tree layer show similar trend by 1100m, however, tree layer show that increasing pattern from 1100m

요 약

본 연구는 칠절봉-동글봉 일대의 우점종인 신갈나무림의 군집구조와 주요식물의 서식특성을 구명하여 현재 유전자원보호구역 및 군사접경지대인 이곳의 효율적인 관리방안을 마련하고자 한다. 군집구조 분석 결과, 관속식물은 66과 158속 208종 2아종 28변종 4품종 241분류군으로 나타났다. 희귀·특산식물은 12과 22속 1변종 22종 23분류군으로 나타났다. 신갈나무군집은 2개 군집(신갈-층층나무군락, 신갈-까치박달군락)으로 구분되었으며, DCA분석결과 목본층은 고도, 경사, 아교목층 식피율에 따라 수종의 서식특성이 나타났으며 초본층은 고도, 아교목층 식피율, 초본층 식피율에 따라 주요 종들의 서식특성이 나타났다. 우점도는 신갈나무, 까치박달, 소나무, 물푸레나무 순으로 나타났다. 수종간의 상관관계는 난티나무와 가래나무, 사스래나무와 개벚지나무, 시닥나무와 거제수나무, 박달나무에서 정의상관관계가 나타났다. 조사지의 종다양도(H')는 초본층 2.849, 목본층 1.105이며, 고도별 종다양도는 해발 1,100m까지 초본층과 목본층의 경향은 비슷하나 목본층은 1100m지점에서 증가하는 경향이 나타났다.

The Responses of Chlorophyll Contents and Chlorophyll Fluorescence of Acer triflorum on Calcium Chloride Concentration

염화칼슘 농도에 따른 복자기의 엽록소 함량 및 형광반응

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Abstracts

To prevent frequent and heavy snow, the deicer is used very often but, it can be harmful effect such as salt stress to tree around roadside. Therefore, this study was conducted to investigate the physiological traits by the salt stress using the chlorophyll contents, chlorophyll fluorescence and fluorescence image that are nondestructive methods. *Acer triflourm* Kom., which was divided to four treatments(control, 0.5%, 1.0%, 3.0% $CaCl_2$), was experienced during 60days in the greenhouse of Korea Forest Research Institute. Through the two measurements of 30days and 50days, chlorophyll and carotenoid contents decreased with increasing $CaCl_2$ concentration in both periods. The photochemical efficiency (Fv/Fm) and quantum yield of PSII (ΦpsII) were significantly different among treatments but, the photochemical quenching coefficient (qP) and non-photochemical quenching (NPQ) were not different. Through results of above, it is thought that damage of reaction center and insufficient thermal dissipation by salt stress inhibited photoprotection capacity and thus photosystemII was damaged.

요 약

최근 겨울철 도로와 거리에 빈번히 발생하는 폭설의 대안방안으로서 많이 사용되는 제설제는 도로 주변에 심겨진 수목에 염스트레스 및 생리적 피해를 줄 것으로 사료된다. 따라서, 본 연구는 비파괴적 방법으로 알려진 엽록소 함량과 엽록소 형광반응, 형광이미지를 이용하여 염스트레스에 따른 복자기의 생리적 반응 특성을 측정

하였다. 염화칼슘 처리는 4개 농도(대조구, 0.5%, 1.0%, 3.0%)로 하였고 처리 후 60일간 엽록소함량과 형광반응을 모니터링 하였다. 처리 후 30일째와 50일째 두 차례 측정한 결과, 두 시기 모두, 엽록소함량과 카로테노이드 함량은 염화칼슘 농도가 증가함에 따라 감소하였다. 광화학반응은 광계Ⅱ의 활성(Fv/Fm)과 광계Ⅱ의 광화학효율(ΦpsⅡ)은 염화칼슘 농도가 증가함에 따라 두드러지게 감소하였다. 비광화학적 형광소멸(NPQ), 광화학적 형광소멸(qQ)는 처리구간 큰 차이 나타내지 않았다. 이는 염스트레스로 인한 반응중심의 손상과 열 소산을 충분히 수행하지 못하여 광보호 역할의 기능이 떨어지고 이로 인해 광계Ⅱ의 손상이 일어난 것으로 판단된다.

Suggestion of Suitable Time for Forest Fire Suppression using Seawater

바닷물을 이용한 산불진화 적정시기 제안

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Abstracts

The object of this study is to provide a method to minimize harmful influence on *Pinus densiflora* putting out forest fire using seawater, and then physiological response of Pinus *densiflora* is investigated after watering seawater. Five-year-old trees treated with seawater according the leafing stages (1 stage: bud, 2 stage: buds swell and new shoot growing, 3 stage: new needle sprouting; 4 stage: needle growing, 5 stage: mature needle). Seedlings were measured for shoot growth, photosynthetic responses and analyzed for chlorophyll contents. The shoot growth of all of the treated individuals shows almost no differences compared with those of controls, but some individuals in treatment of leafing stage 3 were withered and appeared browning in top of shoot. The photosynthetic rate in treatments of leafing stage 1, 2 and leafing stage 3 decreased after 14 and 7 days of treatment and has recovered after 28 and 42 days of treatment respectively. The rate in treatment of leafing stage 4 and 5 drastically decreased and has not recovered. In treatment of leafing stage 3, the net apparent quantum yield and carboxylation efficiency decreased but the chlorophyll contents did not change very much comparing with those of control. It is mean that photosystem of photosynthesis has temporarily declined by seawater. This result suggested that suitable time for forest fire suppression using seawater is after the leafing stage 3 of *P. densiflora*.

요 약

바닷물을 이용한 산불진화 시에 소나무에 미치는 악영향을 최소화할 수 있는 방

법을 마련하기 위하여, 바닷물 살포에 의한 소나무의 생리적 반응을 조사하였다. 바닷물 살포는 개엽 단계별(1 단계: 눈(芽), 2 단계: 눈이 부풀고 신초가 자라는 단계, 3 단계: 신초에서 잎이 트는 단계, 4단계: 잎이 자라는 단계, 5단계: 잎이 성숙된 단계)로 처리하고 신초생장, 광합성율 변화, 광화학계와 탄소고정계 반응 특성, 엽록소 함량을 측정하였다. 신초생장은 모든 처리구에서 양호하였으나 개엽 3단계부터 신초 상단에 가시적인 피해가 나타났다. 광합성율 변화는 개엽 1, 2단계와 3단계 처리에서 일시적으로 감소하나 각각 처리 28일과 42일 후 회복하였고 개엽 4, 5단계 처리는 완전히 회복하지 못하였다. 순양자수율과 탄소고정효율은 개엽 3단계 처리에서 감소하였으나 엽록소 함량은 대조구 대비 유의적 차이는 나타나지 않았다. 본 연구 결과, 수목에 피해를 최소화할 수 있는 바닷물을 이용한 산불진화 적정시기는 소나무를 기준으로 개엽 3단계 이후로 제안한다.

The Effect of Shading and Water Stress on Physiological Characteristics of Pinus densiflora

소나무의 생리 특성에 미치는 차광과 수분스트레스 영향

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Abstracts

It is required to manage healthy trees for restoration of forest fire damaged area. The purpose of this study is to investigate the physiological responses of *Pinus densiflora* under shading and water-stressed conditions. Five-year-old trees planted in pots were set three kinds of shading treatments (0% (full sunlight) and shaded 35%, 75%) from March 26 and then not irrigated during 35 days from July 2 (two soil water conditions; well-irrigated and not irrigated). We investigated photosynthetic characteristics, chlorophyll content, fluorescence response and leaf water potential during shading water-stressed period. As results, photosynthetic rate under shading water stress is lower than the one under the well-irrigation at 30th day after water stress treatment. Under shading condition, Total chlorophyll content of water stress tree was increased about 2 times of well-irrigated tree and, chlorophyll a/b was not different between the different water treatments. Fluorescence response (Fv/Fm) in all treatments has stayed above 0.73 ± 0.03 until 35th day after water stress treatment. The leaf water potential under water stress is higher 1.7 times than the one under the well-irrigation and, it was grater under shading treatment than under full sunlight treatment. This result means that the decline of physiologic function on *P. densiflora* was more influenced by water stress under shading condition than full sunlight condition.

요 약

산불피해지의 산림복원지에 있어 소나무 식재 및 관리를 위한 기초자료 제공을

위하여 차광 및 수분스트레스 복합처리에 따른 소나무의 생리반응 특성을 측정하였다. 5년생 소나무 포트묘를 대상으로 3월 26일부터 차광처리(전광, 35%, 75% 차광)를 하고 7월 2일부터는 적정관수 및 수분스트레스 처리구를 구분하였다. 각 처리에 따른 광합성, 엽록소함량, 형광반응, 수분포텐셜 등을 측정한 결과, 소나무의 광합성 능력은 적정관수 차광처리구는 차광도가 높을수록 증가하는 반면 수분스트레스 차광처리구는 적정관수 처리 대비 약 89% 감소하였다. 엽록소함량은 적정관수와 수분스트레스 처리 모두 차광도가 높을수록 엽록소함량이 증가하였고 형광반응은 모든 처리구에서 0.73±0.03로 건전범위를 유지하여 수분스트레스에 의한 광합성 광계 Ⅱ가 손상되지 않았다. 수분포텐셜은 차광도가 높을수록 관수 처리 대비 수분스트레스 처리의 수분포텐셜 증가가 컸다. 결론적으로, 소나무는 전광조건 보다는 차광조건에서 수분스트레스 영향을 더 크게 받는 특성을 나타냈다.

Physiological Responses of Pinus koraiensis by Shading and Water Stress

차광과 수분스트레스 처리에 따른 잣나무 생리반응 특성

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Abstracts

It is required to manage healthy trees for restoration of forest fire damaged area. The purpose of this study is to investigate the physiological responses of *Pinus koraiensis* under shading and water-stressed conditions. three-year-old trees planted in pots were set three kinds of shading treatments (0% (full sunlight) and shaded 35%, 75%) from March 26 and then not irrigated during 35 days from July 2 (two soil water conditions; well-irrigated and not irrigated). We investigated photosynthetic characteristics, chlorophyll content, fluorescence response and leaf water potential during shading water-stressed period. As results, photosynthetic rate, total chlorophyll content and chlorophyll a/b in all water conditions was increased with increasing shading level and was lowest in water stress tree under full sunlight condition. Fluorescence response (Fv/Fm) under full sunlight decreased below 0.60 in well-irrigated tree and 0.50 in water stressed tree until 35thdayafterwaterstresstreatment.It is mean that photosystem Ⅱ of photosynthesis was damaged by full sunlight and water stress In full sunlight and 35% shading treatments, the leaf water potential under water stress is higher 2.2 times than the one under the well-irrigation. This result means that the decline of physiologic function on *P. koraiensis* was more influenced by full sunlight and water stress than shading condition.

요 약

산불피해지의 산림복원지에 있어 잣나무 식재 및 관리를 위한 기초자료 제공을

위하여 차광 및 수분스트레스 복합처리에 따른 잣나무의 생리반응 특성을 측정하였다. 3년생 잣나무 포트묘를 대상으로 3월 26일부터 자광처리(전광 및 35%, 55%, 75% 차광)를 하고 7월 2일부터는 적정관수 및 수분스트레스 처리구를 구분하였다. 각 처리에 따른 광합성, 엽록소함량, 형광반응, 수분포텐셜 등을 측정한 결과, 잣나무의 광합성 능력, 엽록소함량 및 엽록소 a/b율은 적정관수와 수분스트레스 처리구 모두 차광도가 높을수록 증가하였고 전광조건의 수분스트레스 처리구에서 가장 낮았다. 전광조건하에서 형광반응은 적정관수처리에서 0.60, 수분스트레스 처리구에서 0.50 이하로 감소하여 광합성 광계 Ⅱ가 손상된 것으로 나타났다. 수분포텐셜은 전광 및 35% 차광처리구의 수분포텐셜은 수분스트레스 처리구가 적정관수처리구보다 2.2배 높았다. 결론적으로, 잣나무는 전광 및 약차광 조건에서 강광저해를 나타내 수분스트레스 영향을 더 크게 받는 특성을 나타냈다.

Physiological characteristics of Siberian elm seedlings under dry condition

건조한 환경에서 보이는 비술나무 유모의 생리적 특성

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Abstracts

Siberian elm is one of the main broad leaved species, which is utilized as a rehabilitation species in dry regions where degraded by fire and overgrazing such as Inner Mongolia in China and Mongolia, and North Korea. To compare the adaptation strategies of Siberian elm at seedling level, the growth, LMA, shoot water potential, and photosynthetic characteristics were investigated for two- and four-year-old seedlings in the open field nursery and greenhouse. Similar to mature trees, two- and four-year-old seedlings grown in the open field showed higher LMA, and lower shoot water potential (more negative values) than seedlings grown in the greenhouse. Also, four-year-old seedlings in the open field showed higher WUE than those in the greenhouse. However, two- and four-year-old seedlings recorded higher growth rate in the greenhouse than in the open field ($p<0.05$). From this study Siberian elm seedling had effective adaptation strategies to water deficient environments and can therefore be a valuable candidate species for rehabilitation of degraded ecosystems in arid and semi-arid areas.

요 약

　중국의 내몽골, 몽골 등의 건조지를 비롯하여 북한 등에서도 산불, 방목 등으로 훼손된 산림 복원의 주요 수종으로 활용되고 있는 비술나무가 유묘 단계에서 건조한 조건에 어떻게 적응하는가를 비교하기 위해, 야외포장과 온실에서 양묘한 2년생, 4년생을 대상으로, 생장과 LMA, 줄기수분포텐셜, 광합성 특성을 조사하고, 토양, 양료, 관수주기 조건을 달리한 2년생 유묘 간의 생장과 광합성 특성을 조사했다. 비술나무 유묘는 수분조건에 따라 형태적, 생리적인 변화를 보였다. 야외묘포에서 양묘한 2년생 4년생 유묘의 LMA값이 각각 4.9~8.3mg cm^{-2}, 5.8~6.4mg cm^{-2}로 온실에서 양묘한 동년배의 LMA값 1.6~22mg cm^{-2}와 4.3~4.5mg cm^{-2}보다 높았고, 근원경과 묘고의 생장은 온실에서 자란 2년생과 4년생 유묘가 상대적으로 컸다($p<0.05$). 줄기수분포텐셜값은 상대적으로 낮았다($p<0.05$). 또한 야외묘포에서 양묘한 4년생 유묘의 WUE가 온실의 유묘 보다 높았다 ($p<0.05$). 이로써 비술나무 유묘가 물이 부족한 환경에서 효과적인 적응 전략을 지니고 있어 건조지 복원 수종으로서의 가치가 있음을 확인할 수 있었다.

Changes in stand structure and growth of natural hardwood forests after thinning practice

간벌작업 후 천연활엽수림 임분 구조 및 생장 변화

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Abstracts

This study was conducted to understand the changes of stand structure and growth along elapsed time after thinning practice in natural hardwood forests located at the 126 compartment of Mt. Gariwang, Pyongchang, Gangwon, Korea. The twenty six sampling plots of 0.04 ha were established in the forests and inventoried trees larger than 6 cm DBH in 1998 and in 2012. Species composition, DBH, height, basal area, stand volume, importance value, Shannon's diversity index, soil characteristics, and diameter growth of 2102 were analyzed and compared to of 1998. In the A layer of soil, acidification was shown ($p<0.01$) and total-nitrogen content was increased significantly ($p<0.05$). After thinning practice in natural forests, the species diversity was simplified from 0.82 to 0.64 and the importance value of *Quercus mongolica* was increased from 33.91% to 44.58%. The importance value of *Cornus controversa* and *Acer pseudo-sieboldianum* were increased while *Fraxinus rhynchophylla*, *Ulmus davidiana*, and *Maackia amurensis* were decreased. The stand density and the stand volume were increased about 18% (from 609 trees/ha to 717 trees/ha) and about 25% (from 118.6 m^3/ha to 147.7m^3/ha), respectively. *U. davidiana*, *U. laciniata*, *C. controversa*, and *M. amurensis* in middle layer were improved in growth pattern after thinning practice whereas *Q. mongolica*, *F. rhynchophylla*, and *F. mandshurica* in upper layer were stable relatively.

요 약

천연활엽수림에서 간벌작업 후 임분 구조 및 생장의 변화를 알아보기 위해 강원도 평창군 가리왕산 126임반 지역을 대상으로 26개의 조사구를 설정하여 1998년과 2012년에 각각 조사했다. 조사지의 수종 구성, 흉고직경, 수고, 흉고단면적, 임분재적, 중요도, Shannon의 종다양성 지수 등의 변화를 비교 분석했으며, 토양환경과 생장량을 분석했다. 전반적으로 A층 토양의 pH가 감소하였고(P<0.01), 유기물함량은 다소 줄어든 반면, 전질소함량은 늘어났다(P<0.05). 천연림 간벌 작업 이후 시간 경과에 따라 종 다양성은 1998년 0.82에서 2012년 0.64로 더 단순해졌으며, 신갈나무의 중요도가 1998년 33.9%에서 2012년 44.6%로 더 높아졌다. 그 외 층층나무, 당단풍나무의 중요도도 높아진 반면, 물푸레나무, 느릅나무, 다릅나무 등의 중요도는 낮아졌다. 임분밀도는 1998년 609 본/ha에서 717 본/ha로 18% 증가했고, 임분재적은 1998년 118.6 m³/ha에서 2012년 147.7 m³/ha으로 25% 증가했다. 이 임분에서 상층에 분포하고 있던 신갈나무, 물푸레나무, 들메나무 등은 천연림 간벌작업에 따른 생장량 변화가 거의 없는 반면, 중층에 주로 분포하는 느릅나무, 난티나무, 층층나무, 피나무 등은 강도 간벌로 생장량 증대를 기대할 수 있다.

A multi-agent system approach to optimize forest ecosystem management under different policy options in the Gariwang-San region

다행위자 시스템을 이용한 가리왕산 일원의 산림이용정책 변화에 따른 산림생태계 이용 효율화 방안

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Abstracts

With rapid changes of people's perception on the value of mountains in Korea, there have been growing social and policy concerns on efficient land uses of mountains and forest resources. Given the uncertainty and dynamic characteristics of human and environmental interactions, we consider that a multi-agent system is a robust tool to simulate ecological and socio-economic impacts on forest ecosystems and consequent landuse changes in mountainous landscapes. This study aims to develop a multi-agent system, called Land Use DynAmic Simulator (LUDAS), to optimize forest ecosystem management by simulating spatial landuse patterns in the Gariwang-San region under different policy options. The model consists of three components, which are the landscape environmental system, the human system, and the policy factor: (i) The landscape environment system has three sub-modules (a module of soil erosion assessment(USPED), landslide risk assessment(SHALSTAB) and carbon stock assessment) that represent physical characteristics and ecosystem services in the study region, (ii) The human system includes human agents and the interactions among the human system, policy factors, and theirlandscapetheyinhibit. In this system, household agents make decisions based on an economic

decision-making procedure (representing the interactions among household agents) and a non-economic decision-making procedure (representing the interactions between the human system and the landscape environment system), (iii) A set of policy factors that affect ecological and socio-economic conditions of forest ecosystems. We set two policy scenarios: the first scenario is the change of the specified forest conservation area, and the second scenario is the change of the agricultural subsidy. The simulation result of this model indicates different landuse patterns depending on different policy scenarios. First, reducing the current proportion of the forest conservation area causes an expansion of agricultural area and a reduction of forest area. However, the other scenario which manipulates the agricultural subsidy does not show notable change in landuse patterns. The result of the model suggests that the policy that encourages human agents to use mountainous regions (e.g. reduction of forest conservation area) causes impacts on forest ecosystems and landuse in mountainous landscapes. With this simulation, we are able to estimate the ripple effect of different scenarios. Nevertheless, future studies will be conducted to validate and refine the decision-making procedure and model interactions.

요 약

최근 사람들의 인식의 급격한 변화로 산지의 이용과 산림자원 활용에 대한 사회적, 정책적 관심이 증대되고 있다. 다행위자시스템은 인간과 자연환경이 상호작용할 때 발생하는 불확실성과 동적 특성을 반영할 수 있어, 산림생태계와 산림의 토지이용 변화에 대한 사회경제적/생태적 영향을 모의하는 데 유용하다. 이 연구에서는 가리왕산 지역을 중심으로 다행위자시스템의 일종인 LUDAS(Land Use DynAmic Simulator)를 구축하여 산림이용 정책의 변화에 따른 산림 토지이용의 변화를 확인하고, 이를 통해 산림생태계 관리의 효율화 방안에 대해서 알아보고자 한다. 이 모델은 자연환경 시스템과 인문환경 시스템 및 이들에 영향을 줄 수 있는 정책요소로 구성된다. 자연환경 시스템은 연구지역의 물리적 특성과 생태계서비스를 반영할 수 있는 토양침식에 관한 지표, 산사태위험에 대한 지표, 산림 탄소저장량에 관한 지표로 구성하였다. 인문환경 시스템의 행위자는 가구로 설정하였으며, 이들은 경제적(인간행위자간의 상호작용)·비경제적 의사결정(인간행위자와 자연환경시스템 간의 상호작용) 프로세스에 따라 행동하도록 설계하였다. 정책시나리오는 산림보호지역과 농업보조금의 변화 두 가지를 설정하였다. 설정한 시나리오에 따라 연구의 결과는

현재와는 다른 토지이용의 패턴으로 도출되었다. 첫째, 현재보다 낮은 산림보호구역을 가정하였을 때 산림면적이 감소하고 농업 토지이용이 이를 대체하였다. 하지만, 다른 시나리오의 경우 토지이용 변화와 관련된 의미 있는 변화를 보여주지 않았다. 이 모형의 결과를 통해 우리는 산림보호구역의 감소와 같은 인간행위자의 산림지의 이용을 활성화하는 정책을 시행하였을 때 산림생태계와 산지 토지이용에 큰 영향을 끼친다는 것을 알 수 있다. 이러한 결과를 통해서 여러 다른 정책 시나리오가 산림생태계에 미치는 파급효과를 추정할 수 있었다. 그러나 의사 결정 프로세스 및 하부모형의 상호작용의 부분에서 추후 보정과 정교화의 과정이 추가로 요구된다.

The effects of a thinning treatment on stand growth and aboveground carbon stocks of Pinus densiflora stands in Korea

강원도 정선지역 소나무 임분의 산림시업에 따른 생장특성 및 지상부 탄소저장량

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Abstracts

This study examined the effects of thinning intensities on stand growth characteristics and aboveground carbon storage in *Pinus densiflora* stands, Korea. The study stands were located in Jeongseon, Gangwon-do that divided into three plots by different thinning intensities: no thinning (control, 613 tree ha-1), light thinning (L, 473treeha-1), and moderate thinning (M, 348treeha-1).We measured canopy openness, stand density, DBH, tree height, basal area, volume, carbon storage, and annual carbon stock from a subsample of trees in each stand at two measurement periods (2009 and 2012). Canopy openness (%) was 11.8 for control, 22.8 for L, and 24.1 for M, respectively. Stand density, volume, and carbon storage was higher in the control than in two thinning treatments. Annual carbon stock was highest in L plot. The pre-treatment aboveground carbon storage (ton C ha-1) was 121.5 for control, 107.9 for L, and 90.1 for M, respectively. The post-treatment aboveground carbon storage (ton C ha-1)was 130 for control, 119.4 for L, and 98.5 for M, respectively. However, annual carbon stock including that of the harvested trees was highest as 11.6 ton C ha^{-1} for M thinning plot.

요 약

본 연구에서는 중부지역 소나무 임분의 생장특성 및 탄소저장량에 대한 간벌처리 효과에 대해 조사하였다. 2009년 강원도 정선지역의 6영급 소나무림을 대상으로 간 벌강도에 따라 대조구(613본 ha^{-1})를 포함하여 약도구(473본 ha^{-1}),적정구(348본 ha^{-1})

등 3개 처리구를 조성하였다. 간벌처리 3년 경과 후, 각 처리구별 수관열림도, 임분밀도, 흉고직경, 수고, 흉고단면적, 재적, 그리고 탄소저장량 및 연평균 탄소흡수량을 분석하였다. 간벌처리별 수관열림도는 대조구 11.8%, 약도구 22.8%, 강도구 24.1%였다. 임분밀도, 재적, 탄소저장량 등은 대조구 > 약도구 > 적정구 순으로 나타났으며, 연평균 탄소흡수량은 약도구 > 대조구 > 적정구 순으로 나타났다. 산림시업 전 지상부 탄소저장량(ton C ha^{-1})은 간벌처리별로 각각 대조구 121.5, 약도구 107.9, 적정구 90.1이었으나, 산림시업 후에는 대조구 130.6, 약도구 119.4, 적정구 98.5였다. 간벌에 따른 지상부 탄소저장량의 증가는 3년 경과 후 뚜렷한 차이가 나타나지 않았으나, 기존 간벌목의 탄소저장량을 고려한 지상부의 연평균 탄소흡수량(ton C ha^{-1}yr^{-1})은 대조구 3.0, 약도구 10.3, 적정구 11.6으로 적정구에서 가장 높게 나타났다.

The characteristics of seedlings occurrence by regeneration methods in natural Pinus densiflora stand

소나무천연림의 갱신유형별 치수발생 특성

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Abstracts

This study was carried out to understand the characteristics of seedling occurrence by regeneration methods of natural *Pinus densiflora* stand. For this study, we divided regeneration methods into mother tree and clearcutting. After that, we surveyed the seedling's density and age at every 10m of 4 directions(upper, lower, left, right) from mother tree and lower direction of slope from seed stand in clearcutting site. The seedling amount by crown directions of mother tree site was 35% at lower direction as the highest rate. Also, it was 25% and 22% at left and right direction, respectively and 17% at upper part as the least amount. The seedling amount by distance of mother tree was 46% at 0m(below crown) and 7% at 30m from mother tree's crown. It showed that the longer from mother tree, seedling amount is reduced. The distribution of seedling age was from 2years until 5years. However, over 98% of them accurred in 3years after regeneration, with nearly half of them appeared in 2years. The characteristic of seedling occurence by distance from seed stand in clearcutting site was similar to mother tree site. It was 41% at 10m, 32% at 20m and 12% at 40m. Also, distribution of seedling age was from 2years until 9years and nearly 80% of them regenerated in 3years after clearcutting. These results will contribute to decide optimal placement of mother tree and size of regeneration area for secondary growth forest by natural seedling after harvest cutting of *Pinus densiflora*.

요 약

소나무천연림의 갱신유형별 치수림의 생장 특성을 구명하기 위해 강원도 강릉지역과 경북 울진지역의 하종갱신작업지를 대상으로 수관방향 및 모수림의 거리에 따른 치수발생 특성을 분석하였다. 갱신유형은 모수작업과 개벌작업으로 구분하였고, 모수작업지의 치수조사는 모수를 중심으로 사면의 상, 하, 좌, 우 4방향을 10m간격으로 조사하였다. 개벌작업지는 모수림 임연부로부터 사면 아래 방향을 10m간격으로 조사하였다. 분석결과, 모수작업지는 사면의 하부에 전체 발생치수의 35%가 나타났고, 좌우방향에서 각각 25%와 22%의 발생량을 보였으며, 사면상부에서 17%로 나타났다. 거리에 따른 발생량은 수관 0m 지점에서 전체의 46%가 발생했으며, 거리가 멀어질수록 감소하여 30m 지점에서는 7%의 발생량을 나타냈다. 치수나이 분포는 2년~5년까지이나 갱신 3년 이내의 발생량이 98% 이상으로 나타났으며 그 중 갱신 2년 차에 50%가 발생하였다. 개벌작업지 역시 모수림으로부터 거리가 멀어질수록 치수발생량이 감소하였는데 10m지점에서 41%, 20m 지점에서 32%, 40m 지점에서 12%의 발생량을 보였다. 치수나이 분포는 2년~9년까지 나타났지만 갱신 3년 이내에 80% 이상 분포하고 있었다. 이러한 결과는 소나무 수확벌채 이후 천연갱신으로 후계림을 조성할 경우 잔존 모수의 적정 배치 기술 및 갱신상 크기를 결정하는데 있어 기초자료가 될 것으로 판단된다.

Growth Characteristics and Carbon storage on tree density of Yellow Poplar

임목밀도에 따른 백합나무 생장특성 및 탄소저장량

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Abstract

In recently, it has been well known that forest plays an important role in the global carbon(C) budget. Yellow poplar was planted throughout the country in Korea because of its availability, rapid growth, and bio-cycling forests. This study examines tree growth and the carbon budget of Yellow poplar by tree density. The study was conducted in experimental forests (35°11′ N, 128°12′ S), which is located in Jinsung-myeon, Jinju city, Gyeongnam province. Three different planting densities (800 trees ha^{-1}, 1,100 trees ha^{-1}, 1,600 trees ha^{-1}) were planted in 2002. In order to analysis stand growth characteristics and carbon storage of Yellow poplar, diameter breast height(DBH), height and crown width were measured and growth divergence was scrutinized by SAS statistics program in Duncan analysis of ANOVA. The growth characteristics of study sites were surveyed in DBH, basal area, tree height and standing volume which were significantly affected by tree density. Especially, The range of aboveground carbon storage (ton C ha^{-1}) were differed from 31.5 (1,600 trees ha^{-1}),30.9(1,100treesha^{-1})and5.3(800 trees ha^{-1}), respectively, which seem to be influenced by tree density.

요 약

최근 산림이 가지고 있는 대기중의 탄소저장에 대한 중요성이 널리 알려져 있으며, 백합나무는 생장이 빠르고 임목의 형질이 우수해 바이오순환림으로서 우리나라에 널리 식재 되어졌다. 본 연구에서는 백합나무의 식재밀도에 따른 임목 생장 및 탄소저장량을 분석하기 위하여 수행되었으며, 조사지역은 경남 진주시 진성면에 위

치하고 있다. 조사지역은 ha당 800본, 1,100본 그리고 1,600본을 2002년 식재하였으며, 백합나무의 생장특성 및 탄소저장량을 분석하기 위하여 흉고직경, 수고, 수관폭 등을 조사하였으며, 던칸검정을 통하여 생장간의 차이를 분석하였다. 분석결과 흉고직경, 흉고단면적, 수고 그리고 재적은 임목밀도에 따라 차이가 있는 것으로 조사되었다. 임목밀도에 따른 지상부탄소저장량은 31.5 ton C ha^{-1}(1,600본/ha), 30.9 ton C ha^{-1}(1,100본/ha) 그리고 5.3 ton C ha^{-1}(800본/ha)으로 조사되었다.

Estimating the Economic Impact of Forest Road Using Input-Output Analysis

산업연관분석을 통한 임도 건설의 경제효과 분석

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Abstracts

The purpose of the research is to estimate economic impacts on forest road construction by using Input-Output analysis with 2010 inter-industry relation tables (The Bank of Korea, 2011). Inter-industry relation tables are restructured into 29 sections on the industry of forest road construction. The total length of forest road in 2012 is about 17,145km and the 2011 year construction of forest road in length is about 572km, and its density is about 2.69m/ha. In details, national forest road are about 283km and private forest road are about 289km. And the 2011 year total cost of forest road construction and management is about ₩143,552 million. Hence, the result of economic impact with forest road construction is as follow; production inducement effects ₩2,219 billion, labor induced effects 2,099 people, value added inducement effects ₩1,704 billion. As the result of the research, both production inducement coefficients and value added inducement coefficients show relatively lower than the other industry effect, but employment coefficient is relatively higher than the other area. In addition, the result shows that both influence on the other industry area and sensitivity from the other industry field is relatively low.

요 약

2010년 산업연관표(Inter-industry relation tables)를 이용하여 임도건설에 따른 경제적 파급효과를 산업연관분석(Input-Output analysis) 모형으로 분석하였다. 임도건설 산업과 관련된 산업을 중심으로 산업연관표를 제작성하여 총 29개 부문으로 구

분하여 분석하였다. 2011년에 건설된 우리나라 임도길이는 총 572㎞이며, 임도밀도는 2.69m/㏊이다. 국유림 임도는 283㎞이며, 민유림은 289㎞을 건설하였다. 2011년 임도건설 및 유지보수 지원액은 143,552 백만원이 투자되었다. 이에 임도건설을 통해 발생되는 경제적 파급효과는 생산유발(production inducement effects) 2,219억 원, 고용유발(labor induced effects) 2,099명, 부가가치유발(value added inducement effects) 1,704억 원으로 추정되었다. 생산유발계수(production inducement coefficients)와 부가가치유발계수(value added inducement coefficients)는 타산업에 비해 낮게 분석되었지만 고용유발계수(employment coefficient)는 타산업에 비해 높게 나타났다. 또한 임도 건설산업은 다른 산업에 미치는 영향력(influence)뿐만이 아니라 다른 산업으로부터 받는 감응도(sensitivity)도 낮은 것으로 나타났다.

A Study of Development for Dredging Assessment Form Using AHP Analysis

AHP 기법을 이용한 사방댐 준설기준표 개발에 관한 연구

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Abstracts

This study aims to examine the basic function of a debris barrier, present an assessment form for scientific debris barrier dredging consideration of the physical environment, ecosystem, and landscape of the dam. The study was constructed 6 index item and accomplished questionnaire using AHP analysis for weight value. A survey was conducted among 27 individuals including experts in the academic circles and industries and related public officials in consideration of their representation, appropriateness, and expertise with regard to debris barrier dredging. A survey conducted from August 15 2012 to September 15 2012. A value of the consistency index shows that value(0.853) of high reliability in AHP analysis. In weigh of index item by 'the current send deposit rate of debris barriers', 'whether there is any cultivated land private house', 'mountain stream slope', 'amount of movable soil and gravel of the mountain stream', 'history of disasters' and 'basin area' were in order. In dredging assessment form, grade classification is divided into three stage(large, medium and small) by convenience of application. The detailed criteria for the study result are 'necessary to dredge', 'consideration to dredge', and 'unnecessary to dredge' for over 210 point, 166-209 point and below 165 point respectively. The result of study on the development of the dredging assessment form may be considered very significant information to prevent the unnecessary dredging and to present the standard for debris barrier dredging.

요 약

본 연구는 사방댐의 기본적 기능에 적합하고 물리적 환경 및 생태, 경관을 고려한 사방댐의 준설기준표 개발을 목적으로 한다. AHP 기법에 의한 가중치를 부여하기 위하여 6개의 지표항목을 선정하고 설문조사를 실시하였다. 조사대상은 학계 및 업계종사자와 공무원 등 총 27명의 전문가를 선정하였으며, 2012년 8월 15일에서 2012년 9월 15일에 걸쳐 수행되었다. 조사결과, AHP 분석에서 논리적 일관성 검사 (C. I.)의 값이 0.853으로 높은 신뢰도를 보였으며, 지표항목간의 가중치는 현재 저사량, 민가유무, 계상물매, 토석량, 재해이력, 유역면적의 순으로 나타났다. 현장 적용의 편리성을 고려하여 관측범위는 대,중,소로 분류하였으며, 평가점수에 따라 준설필요지역(210점 이상), 준설고려지역(166-209점), 준설 불필요지역(165점 이하)으로 구분함으로써 사방댐의 준설여부를 판정하도록 하였다. 본 연구에서 수행된 준설기준표의 개발은 타당한 준설기준의 제시는 물론이고, 불필요한 준설작업을 방지할 수 있는 중요한 정보를 제공할 것으로 사료된다.

A Study on Sediment Volume Change in a Dredging Area of Debris Barrier by Using Terrestrial LiDAR

지상 LiDAR를 이용한 사방댐 준설지역의 체적변화 연구

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Abstracts

Domestic dredging industry within the debris barrier area is been carried out without definite standards. Mixture of soil and sand accumulations have many positive effects such as relaxing slope of stream bed and preventing erosion of both banks on a mountain torrent. In the debris barrier area, however, If a dredging is conducted without definite standards, physical disturbance causes. Also, the foot of a mountain fixed with angle of repose crumbles. For these reasons, it is necessary to establish definite standards and collect a scientific baseline data for decision of dredging on the debris barrier. Therefore, this research was carried out to determine the sediment volume variations by dredging on the stream bed of debris barrier. The qualitative volume changes were studied before and after dredging and after the rainy season(May ~ Nov. 2012) in both dredged and non-dredged sites by using terrestrial LiDAR. Experiment and control sites are the same in Gunwi and Seongju and LiDAR survey were conducted for each two place. Each per(m2, ha) amount of volume changes were compared because the range of survey site differ from basin area.

As a result, Following the rainy season in the dredged sites, we determined the amount of deposit per m^2 to be 0.34 m^2 and per ha to be 1.74 m^2 in Gunwi and per m^2 to be 0.61 m^2 and per ha to be 2.50 m^2 in Seongju. However, in the non-dredged sites, we determined the amount of erosion per m^2 to be -0.02 m^2 and per ha to be −0.16 m^2 in Gunwi and the amount of deposit per m^2 to be 0.02 m^2

and per ha to be 3.60 m^2 in Seongju.

The average amount of deposit per m^2 to be 0.48 m^2 in the dredged site and 0.09 m2in the non-dredged site. That is, the dredged site saw an accumulation of 5.3 times more soil per square meter. And the average amount of deposit per ha to be 2.12 m^2 in the dredged site and 1.72 m^2 in the non-dredged site. In other words, the dredged site saw an accumulation of 1.2 times more soil per hectare. It can also offer explanations that the dredged site saw more soil and sand accumulation than the non-dredged site because upstream physical disturbance is caused by forming puddle due to the dredging.

요 약

국내의 사방댐 준설사업은 명확한 기준 없이 시행되고 있는 실정이다. 사방댐이 만사되었다는 것은 계상의 물매를 완화시키고, 양안의 침식을 방지하는 등 긍정적인 효과가 매우 크다. 그러나 이러한 사방댐에 명확한 기준 없이 사방댐 준설을 시행 한다면, 안식각으로 고정되어 있는 산각을 붕괴 시키고, 물리적 교란을 야기하기 때문에 사방댐 준설여부를 판단할 수 있는 명확한 기준마련과 과학적인 기초자료를 수립할 필요가 있다. 따라서 본 연구에서는 사방댐 준설사업으로 인해 변화되는 계상의 체적 변화량을 사방댐 준설지역과 비(非)준설지역의 준설전, 후 및 우기후 (2012년 5월~11월)의 지상 LiDAR측량을 통하여 정량적인 체적 변화량을 파악하였다. 실험지역과 대조지역을 동일지역으로 선정하여 군위와 성주지역에 각각 2개소씩 LiDAR측량을 실시하였다. 조사대상지의 범위와 유역면적이 다르기 때문에 각 단위 면적당(m^2, ha) 체적 변화량으로 비교하였다. 그 결과 군위 준설지에서는 우기를 지 나면서 m^2 당 0.34m^3, ha당 1.74m^3 퇴적되었고, 성주 준설지에서는 m^{2}당 0.61m^3, ha 당 2.50m^3 퇴적되었다. 그러나 군위 비준설지에서는 m^{2}당 -0.02m^3, ha당 -0.16m^{3}침 식돠었고, 성주 비준설지에서는 m^{2}당 0.02m3, ha당 3.60m^{3}퇴적되었다. 두 지역의 평 균 퇴적량은 m^{2}당 준설지에서 0.48m^{3}퇴적되었고, 비준설지에서는 0.09m^3 퇴적되어 우기를 지나면서 준설지에서 5.3배 많은 토사가 유입되었다. 그리고 ha당 준설지에 서는 2.12m^{3}퇴적되었고, 비준설지에서는 1.72m^{3}퇴적되어 우기를 지나면서 준설지에 서 1.2배 많은 토사가 유입된 것으로 나타났다. 이는 준설지에서의 준설작업으로 인 한 웅덩이가 형성되어 상류의 물리적 교란을 야기 시켰기 때문에 비준설지보다 더 많은 토사가 유입된 것으로 판단된다.

Assessing the Effects of Climate Change on the Geographic Distribution of Pinus densiflora and Quercus mongolica using NFI data and Ecological Niche Model

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Abstracts

Forest will have a very slow response to climate change because of long life span of trees but the speed of climate change seems to be fast and its effects on forest ecosystem are uncertain. Understanding tree species distribution patterns is essential for effective conservation and management of biodiversity under changing environment. This study employed the ecological niche modeling framework using GARP (Genetic Algorithm for Rule-set Production) to model the current and future geographic distribution of major *Quercus mongolica* and *Pinus densiflora* in Korea based on environmental predictor variable datasets such as climate data including the RCP 8.5 emission climate change scenario, geographic and topographic characteristics, soil and geological properties, and MODIS EVI at 4 km^2 resolution. NFI (National Forest Inventory) derived occurrence and abundance records from about 4,000 survey sites across the whole country were used for response variables. The current and future potential geographic distribution of the two species dominating the current Korean forest were modeled and mapped. Future model for *Quercus mongolica* suggests large areas predicted under current climate conditions may be contracted by 2090 showing dramatic habitat loss. Habitat suitability of *Pinus densiflora* was predicted to have reduced showing range shifts northward and to higher altitudes. For the current species ranges of the *Quercus mongolica* and *Pinus densiflora*, AUC values of modeled results were 0.67 and 0.74 respectively. There are still many possible limitations and uncertainties arising from selecting presence-absence data, the environmental predictor variables for model input and the GARP itself. Nevertheless, ecological niche modeling can be a useful tool for exploring and mapping the potential response of the tree species to climate change.

The final models in this study may be used to identify potential distribution of the tree species based on the future climate scenarios, which can help forest managers decide where to allocate effort in the management of forest ecosystem under climate change in Korea.

The Study on Quantitative Performance Evaluation of Forest Fire Suppression Equipments

산불 진화장비의 정량화 평가에 관한 연구

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Abstracts

Among main ground fire-extinguishing equipments, the performance of motor pumps and a fire-extinguishing vehicle were measured for its distance from the source of water to the ignition point. 4 performance criteria are as follows, amount of water per minute, the maximum pressure of the discharge, the horizontal spraying distance and the vertical spraying distance.

The effects of nozzles were also taken into consideration when measuring the performance. It was found that the maximum distance was 600m with small-sized pump and 800~1,000m with a medium-sized pump. In the case of connecting multiple hose lines, the discharged amounts per minute were reduced by 52~62% and the maximum pressures of the discharge were increased by 26~30% with concern of the damaging hose due to overloading. As a result small-sized pumps are not appropriate for extinguishing forest fire and the medium-sized pumps can be used up for the distance over 1,000m, depending on the performance of high-pressure hoses.

요 약

산불 발생 시 진화를 위해 사용되는 주력 지상 진화장비 중 동력펌프 2종과 진화차량을 대상으로 수원지로부터 발화 지점까지 진화거리에 따른 주요 성능을 측정하

였다. 성능 측정은 분당 토출량, 토출 최대압력, 수평 분사거리, 수직 분사거리의 4개 항목이었으며, 노즐의 종류에 따른 영향을 동시에 고려하였다. 산불 진화 시 적정 거리를 측정한 결과 소형펌프의 경우 600m, 중형펌프의 경우 800~1000m 정도인 것으로 나타났다. 또한 분당 토출량은 3가지 펌프 모두 50m에서 1000m로 연결할 경우 52~62% 감소가 일어나며, 최대 토출압력은 26~30% 상승되어 부하 발생 시 고압호스의 파손 우려도 있는 것을 알 수 있었다. 실험을 통해 소형펌프의 경우는 주 산불진화에 적합하지 않으며, 중형펌프의 경우 고압호스의 성능 에 따라서 1000m 이상의 거리에서도 사용이 가능할 것으로 사료된다.

Wind Distribution of Mountain Area by AWS and Spot Measurement

실측 및 해석을 통한 산악 바람장 분포 연구

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Abstracts

Forest fire has a number of variables and since the effects of wind fields are bigger than any other variables, it is essential to know wind direction and velocity for the forest fire extinguishing techniques and the prediction of fire spread. With regards to the local area that has a high chance of forest fire, the data from meteorological observatory in the area is used for the calculation of basic wind velocity. It is relatively easy to obtain such data as the Automatic Weather Station(AWS) data are available for the whole nation. In the case of forest fire, it is possible to predict the wind velocity and direction of the fire spot by checking the AWS data of the adjacent area. However, the installation of measurement is fixed at 10m high above ground level and the weather station is mostly in the plain area, there is a chance that the data from the weather station may be different with the actual data at the forest. This research will attempt to find difference that may exist between the AWS data and the actual measurement. Simply shaped hills (Sae-byeol hill of Jeju Island and port Ma-geum in An-myeon Island in the sea side) were selected as the experimental locations to minimize the distortion of the wind field by the adjacent geographic features. In addition, analysis of computational fluid dynamics(CFD) for the given geographic features was conducted to examine and compare their consistency.

요 약

산림 화재는 여러 가지 변수를 포함하고 있지만 바람장에 의한 영향이 다른 어떠한 변수보다 상대적으로 크므로 봄철 산림지형에서의 풍향풍속을 알고 있다는 것은 산불진화기술 및 산불확산예측을 결정하는데 핵심 요소이다. 따라서 산불발생 확률이 높은 국지지형에서의 기본풍속 산정을 위하여 기상관측소의 데이터에 의존하게 된다. 우리나라에서의 기상청 자료(AWS)는 넓은 지역에 골고루 분포하고 있어 비교적 간편하게 데이터를 취득할 수 있다. 또한 산불발생 시 임지의 풍속은 인근의 AWS자료에 의존하여 그 강도 및 방향을 예측한다. 이때 기상관측기의 설치높이가 10m로 고정되어 있고 주변의 설치 장소가 대부분 평야지대에 설치되어 있어 실제 산림지형과 차이를 보일 가능성이 높다. 따라서 본 연구에서는 AWS와 제주오름 지형(새별오름)에서의 실측 자료를 비교하여 어떤 차이가 존재하는지 규명한다. 실제 본 연구에서 사용된 지형은 단순 구릉지역으로 주변의 지형지물에 의한 바람장의 왜곡을 최소화 하기에 적합한 지형을 선택하였다. 결과적으로 제주도 지형과 안면도 마검포 지형을 선택 실측하였다. 마검포의 경우 해안을 접하고 있는 지형으로 제주도와 마찬가지로 주변지형지물에 영향을 거의 받지 않는 지형이다. 또한 주어진 지형지물에 유동장 해석(CFD)을 실시하여 어느 정도의 일치성을 보이고 있는지를 비교 하였다.

Study on Installation of Landing Points on the Forest Roadside

임도변 집재장 설치에 관한 연구

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Abstracts

Forest in Korea is gradually nearing harvest time. Logging system is expected to be changed from cut-to-length to whole-tree logging system for expanding use of unused forest-biomass. This study was performed in order to estimate the size and distance of landing site on forest roadside which efficiently processes the collected harvested wood products. We were to investigate the current status of landing site on the forest road in cut-to-length thinning district within Mt. Maehwa in management district of Hongcheon National Forest Office. As a result, most of the landing site was constructed in ridge and valley area, and constructed by surplus soil occurred in the road construction. Average area of landing site was 276.7㎡. Also, tree accumulation types and occupancy area of wood products was mainly loaded on forest road surface because landing site was not enough at whole-tree final cutting district in Samchuk-City, Gangwon-do. The result of calculation facility size and distance of landing site considering final cutting and operation system, facility distance is about 200m, facility size is about 300㎡. These landing site should be the use of fire protection facilities in unused time.

요 약

우리나라 산림은 점차 수확시기에 접어들고 있으며, 미이용 산림바이오매스의 이용 확대를 위해 전목생산시스템으로 점차 변화할 것으로 예상된다. 이에 본 연구에서는 수집한 산물을 임도변에서 효율적으로 처리할 수 있는 임도변 집재장의 규모 및 시설거리를 산정하고자 하였다. 홍천국유림의 매화산 특별경영계획구내 임도를

대상으로 집재장의 구축현황을 조사한 결과, 대부분의 집재장은 능선부나 계곡부에 타원형으로 시설되어 있었으며, 면적은 평균 276.7㎡ 인 것으로 나타났다. 또한 강원도 삼척의 전목 주벌사업지에서 산물 적재형태와 점유면적에 대하여 조사한 결과, 집재장이 충분히 시설되어 있지 않아 노면을 이용하여 주로 산물을 적재하고 있는 것으로 나타났다. 주벌수확과 작업시스템을 고려하여 집재장의 적정 규모와 시설거리를 산출한 결과, 시설거리 약 200m 내외, 시설면적은 약 300㎡ 내외로 하는 것이 바람직할 것으로 판단된다. 이러한 집재장은 미이용 시기에는 방화수조, 저수지, 방화수대, 헬기장 등을 설치하여 방화시설로의 이용도 가능할 것으로 판단된다.

Analysis of fire weather in South Korea using KLAPS reanalysis(2005-2010)

KLAPS 재분석자료를 이용한 남한의 산불 기상 분석(2005−2010)

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Abstracts

Human activities induce forest fire most frequently than natural events in South Korea. Nevertheless natural factors allow that human action triggers ignition, and affect the spread of fire. This study analyzes the factors of atmospheric condition affecting distributions of the forest fire in South Korea. We focused on two variables of forest fire, frequency of the fire occurrence and size of the damaged area. We use KLAPS(Korea Local Analysis and Prediction System) reanalysis data as atmospheric condition. KLAPS is data assimilation system providing very detailed analyses of local atmospheric conditions from variety datasets. This data can describe better than statistical interpolated data about properties of the dynamics or the physics of atmosphere related to forest fire. The distribution of frequency and damaged area are concentrated in the season of spring, in the region of Yeongnam(southeastern region of Korean peninsula). Strong wind in spring accelerates the rate of fire spread, so which can be a reason of large forest fire. Relative humidity and effective humidity can be indicators of the possibility of fire occurrence.

요 약

남한에서 발생하는 산불은 인위적인 활동에 의해서 발생하는 경우가 많다. 하지만 인위적 활동이 발화로 이어지는 데에는 자연 환경 요인이 중요한 역할을 한다. 본 연구에서는 남한에서 발생하는 산불의 분포에 영향을 미치는 대기 상태에 관한 요인들을 분석하였다. 산불의 분포 특성에 대한 지표로는 발생빈도와 피해면적을 이

용하였다. 대기 특성을 나타내는 자료로는 KLAPS(Korea Local Analysis and Prediction System) 재분석자료를 이용하였다. KLAPS는 다양한 자료를 동화하여 상세한 분석자료를 제공하는 시스템이다. 기존의 연구와 대별되는 점은 산불에 영향을 미치는 대기 특성을 파악하는데 있어 점 사상으로 나타나는 지점별 종관 관측 자료를 이용하거나 이를 통계적으로 내삽하는 것이 아니라 대기의 물리/역학 특성을 반영한 재분석자료를 이용하였다는 점이다. 2005~2010년 남한 지역의 산불 발생빈도와 피해면적은 시간적으로 봄철에 집중되었고 공간적으로는 영남지역에 집중되었다. 봄철의 강풍 출현빈도와 지속시간은 산불 대형화의 원인으로 작용하고, 상대습도와 실효습도는 산불의 발생 가능성을 나타내는 지표가 될 수 있다.

Analysis on future forest fire occurrence considering the variation of anthropogenic factors in South Korea

인문사회적 요인변화를 고려한 우리나라의 미래 산불 발생 분석

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Abstracts

As the impact of climate change, predicting future forest fire became more important. To predict future forest fire, specific future scenarios of variables which can affect the occurrence of forest fire are needed. In South Korea, most forest fires have been occurred by human activities. Thus, anthropogenic factors are also should be taken into account. This study was performed to consider human factors as well as natural environment in predicting forest fire occurrence. RCP 8.5 scenario modeled by CMIP5 selected as future climate data. Natural environment such as, elevation, aspect and slope were supposed not to be changed in short-term. Among anthropogenic factors, predictable variables in near future, such as population density, rate of utilization of Recreation Forest were estimated according to the trend of variance. Increase of forest which accelerate fire occurrence was also estimated by forest growth model. Furthermore, to consider spatial autocorrelation, Generalized Linear Mixed Model was used as a regression model. As the result of this prediction, statistical model and predicted map was created. The coefficient of variables related to human activities showed high significance in regression model. In the future occurrence map, forest fires are predicted to be focused in area with high population density. Overall occurrences of forest fires are estimated to be increased.

요 약

기후변화의 영향으로 인해, 미래 산불 발생을 예측하는 것은 더욱 중요해졌다. 미래 예측을 위해서는 구체적인 변수별 시나리오가 필요하다. 특히, 우리나라의 산불은 인간에 의한 산불이 대부분이기 때문에, 인위적인 영향은 반드시 고려되어야 한다. 본 연구는 인간의 영향을 고려하여 미래 산불 발생을 예측하는 것을 목표로 한다. 미래 예측을 위해서, 기후 시나리오는 RCP 8.5를 사용하였다. 자연환경 인자는 경사, 고도, 방위 등을 사용하였고, 이들 인자들은 가까운 미래에는 변화가 없다고 가정하였다. 인위적인 요인인자도 사용하였으며, 이들 중에서, 인구 밀도나 미래 산림휴양림 이용분포 등과 같이 과거 자료로 미래 추세예측이 가능한 자료는 추세를 이용하여 예측하였다. 산불 발생 분석에 사용되는 회귀모형은 공간상관성에 대한 고려가 가능한 일반선형화혼합모형을 사용하였다. 본 연구를 통한 예측결과 최종적으로 통계모형과 미래 산불 발생 지도를 도출하였다. 통계 모형으로 예측된 계수와 유의성을 살펴보면, 인위적 인자에서 높은 유의성을 보였고, 예측 지도를 통하여, 미래 산불 발생 분포는 인구밀도가 높은 지역으로 더욱 집중되는 경향을 살펴볼 수 있었다.

Prediction of the wind field on the wild fire in a forest using computational fluid dynamics

전산유체공학 기법을 활용한 산불 바람장의 예측

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Abstracts

The wind field plays a very important role as the media of transport phenomena in natural disasters such as wild forest fires. In the first stage of fire, if we can predict the change of wind field according to the terrain, the damage is expected to be minimized. However, there has been no precise research on this problem, so the physical mechanism inside the transition from surface fire to crown fire has not yet been obviously understood. In this study, the wake flow behind a parallel array of trees is studied numerically to show the flow separation in the turbulent boundary layer. Finally, the change of wind field is discussed due to the gap of trees and the slope of ground. Through this research, the CFD techniques are shown to be applied to the research of forest composition plan. The physics in the regime from laminar to turbulent flow is qualitatively explained, and the obtained data are compared one another quantitatively.

요 약

산불과 같은 자연재해에서 바람장은 전달 현상의 매질로서 중요한 역할을 한다. 초기 화재 발생 단계에서 지형에 따른 바람장 변화를 예측할 수 있다면, 그 피해를 최소화할 수 있을 것으로 기대된다. 그러나 아직까지 이에 대한 정밀한 연구가 없었기 때문에, 복잡지형의 바람장에 의하여 화재가 진행하는 과정에 대한 물리적 메

커니즘을 아직까지는 명확하게 이해할 수는 없었다. 본 연구에서는 평지에서 일렬 횡대로 늘어선 나무들 후류에서의 수직풍 속도 변화에 대한 수치 해석을 실시하여 지표화(surface fire)에서 수관화(crown fire)로 전이하는데 지대한 영향을 미친다고 추정되는 후류 수직풍의 발생 규모에 대하여 논하였다. 마지막으로, 나무들의 배치 간격과 지면 경사에 따른 바람장의 변화를 비교하여 최적의 나무 배치간격과 지면 경사에 대하여 논하였다. 본 연구를 통하여 현재 통용되고 있는 CFD 기법들이 산림에서의 화재전파와 바람장에 대한 연구에 응용될 수 있음을 밝히고, 층류에서 난류에 이르는 유동 영역에 대하여 유동 물리를 정성적으로 설명하였으며, 나아가 취득된 데이터를 서로 정량적으로 비교하였다.

Analysis of Forest Fire Risk around Facilities in Forest Areas

산림 내 주요시설물 주변 산불위험성 분석

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Abstracts

This study conducted an field investigation from August to November, 2012 on the forest fire risks of each of the 22 facilities within forest areas including temples, Sanitarium, recreational forests, and pensions. As a result of conducting field investigations by classifying 7 categories including location conditions of natural environments, separation distances between forests floors and forests, forest fire prevention facilities, thinning, etc into 30 specific investigation categories, the forests floors were coniferous forests, the hardness levels were of medium hard wood, the density of the near forest floors was high, and the separation distance between the forests and facilities were close for all of the temples, Sanitarium, recreational forests, and pensions and therefore it was investigated that there is a high possibility of damage in case a forest fire occurs.

요 약

연구는 2012년 8월부터 11월까지 산림 내 주요시설물인 사찰문화재, 요양소, 자연휴양림, 펜션 총 22개소에 대하여 각 시설물별 산불위험성을 현지조사 하였다. 조사항목은 크게 시설물 주변의 입지 여건, 임상 및 산림과 시설물의 이격거리, 산불방지 시설, 숲 가꾸기 여부 등 총 7개 항목을 30개 세부조사 항목으로 구분하여 현장조사를 실시한 결과, 사찰문화재, 요양소, 자연휴양림, 펜션 시설물 모두 주변 임

상이 침엽수림, 경급은 중경목, 주변 임목 밀도는 높았고, 산림과 시설물의 이격거리가 짧은 것으로 조사되어 산불 발생 시 피해를 입을 가능성이 높을 것으로 조사되었다.

Analysis of soil Physical and Chemical Characterization in Simjeok forest wetland

심적산림습원 토양의 이화학성특성 분석

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Abstracts

Forest wetland conservation and sustainable management plan sought and at the same time take advantage of the ecosystem as a basic data is a survey conducted. where the administrative sector of the Military Region Gangwon-do Inje-gun, seohwa-myeon simjeok-ri San 1 of korea Altitude is located in 700~720m. Reeds colony, sedges colony wetlands, incarnating the investigation is in progress, pine colony, Quercus mongolica colony forest shared.Wetlands, an average of four seconds of the soil community, pH5.7 showed, Incarnation progress in *Pinus densiflora* forests to pH 5.5 did not differ, Quercus mongolica forest that grows in the downstream pH6.2, with somewhat higher. Study of organic acids generated by the decomposition of plant fluids, which showed similar results with an average of four seconds communities representative herbaceous marsh of pH 5.1.Organic matter and total nitrogen, available phosphoric acid in reed, woody vegetation compared to four seconds communities of organic matter and nitrogen, phosphorus content higher were, This marsh surface water or groundwater, rather than the peat moss to retain for a long time in the nature of water is maintained primarily by rainfall like a sponge containing water and, Showed high levels of development of the peat layer is considered. Exchangeable cations, K^+ Na^+ relatively $Ca2^+$ there was no variance is greater than $Mg2^+$ role in wetland conservation policies and help understanding of these wetlands will be considered, Protect, preserve and restore one of the wetlands to the continuous monitoring of vegetation and presence of the

environment is essential.

요 약

　산림습원의 지속가능한 보전 및 관리 방안을 모색하는 동시에 생태계 기초자료로 활용하고 자 실시한 조사이다. 조사지는 행정구역상 군사지역으로 편제된 강원도 인제군 서화면 심적리 산 1번지의 해발고 700~720m에 위치하고 있다. 조사는 습지가 진행되는 갈대, 사초군락 육화가 진행되는 소나무, 신갈나무림으로 나눴다. 습지가 진행되는 사초군락의 토양은 평균 pH5.7을 보였으며, 육화가 진행되는 소나무림에서는 pH 5.5로 차이를 보이지 않았으며, 하류에 자생하는 신갈나무림은 pH6.2,로 다소 높게 나타났다. 이는 선행연구에서 식물 유체의 분해에 의한 유기산의 생성으로 습원의 대표적 초본인 사초군락의 평균 pH 5.1와 유사한 결과를 보였다.(2003.신영호외2) 유기물 및 전질소, 유효인산에 있어서는 갈대, 목본군락에 비해 사초군락의 유기물 및 질소, 인산의 함량이 높게 나타났으며, 이는 습원의 지표수나 지하수 보다는 주로 강우에 의해 유지되는 특성상 물을 오랫동안 머금을 수 있는 물이끼가 스폰지처럼 물을 함유하고 있으며, 이탄층의 발달로 높은 수치를 보인 것으로 판단된다.(2009.구본학) 치환성 양이온은 K^+ Na^+ 상대적으로 $Ca2^+$ $Mg2^+$보다 큰 변화폭이 없었다. 이러한 습지의 이해는 습지 보전 정책 및 역할에 도움을 줄 것으로 판단되며, 하나의 습지를 보호, 유지 및 복원하기 위해서는 식생 및 입지환경의 지속적인 모니터링은 필수불가결하다.(2010.이명종외)

Construction of Spatial Fuel Load Distribution Database for estimating on Potential Forest Fire Hazard in Korea

산불잠재위험성 평가를 위한 전국 연료량 분포 공간DB 구축

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Abstracts

This study performed to estimate distribution of fuel loads by forest strata and evaluate potential forest fire hazard on forest stands in our country. For estimating distribution of fuel loads on forest stand, we accomplished field survey of pine forest (*Pinus Densiflora* Sieb. et Zucc.) and oak species forest at the 324 forest sites during four years. Using collected field survey data we built up spatial database for fuel loads by forest strata after classifying into coniferous, deciduous and mixed forest using 4th digital forest type map. In Gyeonggi-do region, total fuel loads of upper class, middle class and surface area e.g. grasses, shrub, fallen leaves and twigs ranged from 10.5 to 274 ton/ha and mean fuel load showed 165.7 ton/ha. This study was also based on the Crown Fire theory of Van Wagner(1977) to estimate potential forest fire hazard on forest stand in Korea. Three parameters (fuel moisture content (FMC), height to the live crown base (CBH) and surface fire intensity (SFI)) were calculated for estimating potential forest fire hazard on forest stands on the condition of that fire spreads successfully from surface to crown. These parameters were introduced for assessment of potential fire hazard by estimating critical surface fire intensity (CSI), which determines crown fire transition.

요 약

본 연구는 우리나라의 산림지역에 분포하고 있는 층위별 연료량 분포를 추정하여

현존 임분의 산불잠재위험을 평가하기 위한 것이다. 산림 내 연료량 분포를 추정하기 위해 4년간 전국의 소나무림과 활엽수림(참나무류 위주)을 대상으로 324 개소에서 현장조사를 실시하였다. 수집된 결과를 이용하여 4차 수치임상도를 영급별로 침엽수림, 활엽수림, 혼효림으로 대분류한 후 임분별 층위구조에 따른 연료량을 ArcGIS 9.3을 이용하여 공간자료화하였다. 경기권역의 경우, 상층, 중층, 지표층(관목, 낙엽, 낙지, 초본 포함)의 총 연료량은 평균 165.7 ton/ha, 최대 274.6 ton/ha, 최소 10.5 ton/ha가 분포하는 것으로 나타났다. 또한 본 연구에서는 임내의 잠재위험성 평가를 위해 Van Wagner(1977)가 제시한 Crown Fire 이론을 기반으로 하였다. 지표화에서 수관화로 전이되는 조건으로 연료습도(FMC), 지하고(CBH), 지표화 강도(SFI) 등 3가지 파라미터를 산출하여, 수관화 전이를 결정하는 지표화강도(CSI)를 추정하여 연료량 변화에 따른 임내 산불잠재위험성을 평가하였다.

The Type Classification of Erosion Control Dam considering Ecosystem Connectivity

생태계를 고려한 사방댐 유형 구분

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Abstracts

Soil erosion control dam is the most important soil control works in mountainous area for preventing soil runoff by erosion and debris flow by landslide. However the gravity concrete soil erosion control dam which had been installed in the past is required to improve structure because it has a problem on ecosystem connection recently. This study was conducted to find method for improvement of dam structure with having main purpose of soil erosion control dam. We decided two factors that are permeability and the height of ecosystem control as a ecosystem connectivity factor. And the permeability and the height of ecosystem control were investigated by each type of soil erosion control dam. The result shows that permeability was the highest on Tetra-block dam (55.8%), followed in increasing order by Detachable slit dam (44.7%), Eco-piller dam (39.3%), Slit dam (16.5%), Buttress dam (15.8%), Wire rope dam (13.4 %), and gravity concrete dam (0.7%). The height of ecosystem control was the highest on gravity concrete dam (3.0m), followed in increasing order by Wire rope dam (1.5m), Slit dam (1.0m) and Buttress dam (1.0m). But the height of ecosystem control was changed by effective and foundation height for dam, so we judge that the dimensionless index for height should be developed. As a another results, we divided erosion control dam into three types(eco-connection, semi-eco connection and eco-disconnection) by considering physical and structural characteristics such as the permeability and the

height of ecosystem control. In addition, permeability type will be considered as a ecosystem connectivity factor in the near future.

요 약

산지계곡에 설치되는 사방댐은 토사유출저지는 물론 산사태로 발생한 토석류를 저지함으로써 재해방지를 위한 가장 대표적인 사방구조물이다. 하지만 최근 콘크리트 사방댐으로 인한 생태계 단절문제가 제기됨에 따라 과거에 설치된 사방댐의 구조개선이 요구되고 있다. 본 연구에서는 기존 콘크리트 사방댐의 구조개선을 통해 사방댐 본연의 목적을 달성시키면서 생태계 단절문제를 해결하기 위한 구조개선방안을 모색하기 위해 수행되었다. 생태계 고려인자로 사방댐 투과율, 차단높이를 선정하였으며, 사방댐 종류별로 조사하였고, 사방댐의 유형을 구분하였다. 그 결과 생태투과율은 테트라블록댐(55.8%), 분리형슬릿댐(44.7%), 에코필라댐(39.3%), 슬릿트사방댐(16.5%), 버트리스사방댐(15.8%), 와이어로프사방댐(13.4%), 중력식사방댐(0.7%) 순으로 나타났다. 사방댐의 차단높이는 중력식사방댐(3.0m), 와이어로프(1.5m), 버트리스 및 슬리트사방댐(1.0m)등으로 나타났으나, 유효고 및 기초부의 높이를 기준으로 무차원 지수의 개발이 필요한 것으로 판단되었다. 본 결과를 토대로 사방댐을 생태연결형, 생태부분연결형, 생태단절형으로 구분하였으며, 향후 개방형태에 따라 생태연결성 유형을 구분할 필요가 있는 것으로 판단되었다.

The Trend Analysis of Future Landslide Risk Using Rainfall Data by RCP 8.5

전 지구 기후변화 시나리오 강우자료(RCP 8.5)를 이용한 미래 산사태 위험도 경향 분석

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Abstracts

Recently, the landslide areas are increasing by locally heavy rainfall in Korea. Because landslide damaged area is spreading to the mountains in the downtown area, casualties and damage to property are increasing too. This study was carried out to analyze the change trend of future landslide risk using rainfall data by RCP 8.5 for the purpose of producing basic data of countermeasure plan for landslide. The change trend of landslide risk is expressed by standard rainfall which is induced by tank model and the critical rainfall for landslide. And we investigate distribution of spatial and frequency to exceeding standard rainfall locally. The result shows that landslide risk area is shifting and concentrating from southern region to central region of Korea. Therefore we have to concentrate soil erosion control works and early warning system in the central region than southern region of Korea relatively.

요 약

우리나라는 최근 기후변화의 영향으로 판단되는 국지성 집중호우의 증가로 산사태 발생면적이 증가하고 있는 추세에 있다. 특히 지역적으로도 산지뿐만 아니라 도심지역 산지에서의 산사태 발생이 확대됨으로써 인명 및 재산피해 또한 증가하고 있다. 본 연구에서는 향후 산지토사재해 대책마련을 위한 기초자료 제공을 목적으로 기후변화에 따른 산지토사재해 발생위험도의 변화패턴을 분석하였다. 특히 산지토사

재해의 위험도 변화경향은 탱크모델을 이용한 산사태 기준우량의 초과지역의 공간 분포와 빈도분포로 나타내었으며, 기상자료는 전지구 기후변화 시나리오를 이용하여 연대별로 그 변화추이를 분석하였다. 그 결과 시간이 경과함에 따라 산사태 위험도 가 높아지는 지역이 남부지역에서 중부지역으로까지 이동되며 위험지역이 집중되는 경향을 보이는 것으로 나타났다. 따라서 향후 상대적으로 남부지역보다는 중부지역 으로 대상으로 사방사업을 적극적으로 추진해야 할 것이며, 구조물 대책과 더불어 경계피난대책을 동시에 추진해야 할 것으로 판단되었다.

Development of early detection system for landslide using USN techniques

USN기술을 이용한 산사태 조기감지시스템 개발

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Abstracts

Landslides have increased number and scale yearly because regional torrential rains are frequent with the impacts of climate change. Specially, landslides in Urban Zone of life are increased heavy damages as landslides occurred in Mt. Woomyen and Mt. Majuck of Chuncheon city. An effective method to reduce these landslides is constructing a soil erosion dam. But it is difficult to construct of soil erosion dams or is limited in size by characteristics of Urban Zone of life. So, recently studies for predicting triggered times of landslides using various sensors have increased. In this study, early detection system for landslide was developed to detect landslides early in Urban Zone of life using USN(Ubiquitous Sensor Networking) techniques. The early detection system for landslide measures the amount of rainfall and situations of a ground water using soil moisture sensors and tensiometers, rainfall meters. Also, sensor nodes and gateway sends the information to monitoring server. Final process is predicting landslides before 30 to 60 minutes using the gathered information. But to analyze a landslide mechanism, we are monitoring characteristics appeared to each sensors currently using natural rain and artificial rain.

요 약

기후변화의 영향으로 국지성 호우가 빈번한 상황에서 산사태는 해마다 증가하고

있는 추세에 있다. 특히 우면산 및 춘천 마적산 산사태와 같이 도시생활권에서 발생하는 산사태는 큰 피해를 가중시킨다. 이러한 산사태 저감에 가장 효과적인 방법은 사방댐을 설치하는 것이다. 그러나 도시생활권의 특성으로 인해 사방댐의 설치가 어렵거나 규모가 제한적인 경우가 많아 최근 각종 센서를 이용해 산사태 발생시점을 예측하기 위한 연구가 증가하고 있다. 본 연구에서는 USN(Ubiquitous Sensor Networking)기술을 이용하여 도시생활권에서 산사태 발생을 조기에 감지할 수 있는 산사태 조기감지시스템을 개발하였다.

산사태 조기감지시스템은 토양수분센서와 텐시오미터, 강우계 등을 이용하여 강우량 및 토양내 지하수 정보를 측정한다. 또한 USN기법을 이용한 센서노드 및 게이트웨이를 통해 모니터링서버에 정보를 전달한다. 최종단계는 축적된 정보를 종합하여 30분에서 1시간 전 산사태 발생을 예측하는 것이지만 현재는 정확한 산사태 발생기작을 분석하기 위해 자연강우와 인공강우를 이용하여 각 센서에 나타나는 특성을 모니터링하고 있다.

Forest fire studies on medium-and long-term science and technology development in China

중국 산불과학기술연구의 중장기 발전계획

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Abstracts

According to <Decision of the head of the State Council on accelerating the development of forestry>, <Notice of State Council on further strengthening the work on forest fire prevention>, <Development of forestry science and technology medium-and long-term planning(2006-2020)>, <Forestry Science and technology "Eleven-Five" development planning> and <Forest fire prevention in the national medium-and long-term development planning>, State Forestry Administration of P.R.China are trying to prevention and management of forest fire. Short-term goal (before 2010) of prevention forest fire in China constructed a national forest fire prevention research center and one or two forest fire experiment stations, Forest fire prevention technology innovation ability has will be improved greatly.

Mid- and long-term goal (before 2020) of prevention forest fire in China constructed a number of regional forest fire prevention research centers and the overall level of forest fire experiment stations and China's forest fire research will be close to the developed countries in the world. Furthermore, strengthen forest fire science and technology take full advantage of the introduction of advanced international forestry science technology and plan.

요 약

　중국은 <중공중앙국무원의빠른임업발전에관한결정>, <국무원판공청의산불방화작업에 관한통지>, <임업과학과기술중장기발전계획 (2006-2020년)>, <임업과학과기술 "11.5" 발전계획> 및 <전국산불방화중장기발전계획 (2006-2015년)>의 내용에 따라 산불방화작업에 힘쓰고 있다. 중국은 단기계획으로 2010년까지 국가산불연구센터와 1~2개의 중점연구실을 만들어 산불방화과학기술 제고에 힘쓸 예정이다. 중장기계획으로 2020년까지 각 지역별 산불방화연구센터와 산불연구실을 만들어 산불연구를 선진국 수준으로 끌어올릴 예정이다. 뿐만 아니라 산림방화의 과학적인 관리체계 구축, 과학기술 투입, 인재배양, 산불방화연구 개발에 힘쓰고, 외국의 선진 산불방화기술 도입과 국제협력과 교류 등을 통해서 중국의 산불방화체계와 기술 수준을 선진국 수준으로 높일 예정이다.

Situation of stony desertification in China

중국의 석막화 현황

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Abstracts

Stony desertification occurs mainly in the Yungui plateau in China. Range of stone desertification is 463 districts in 8 Provinces, land area is 1,071 thousand km2,thekarstareais452thousandkm2.

In order to control over status and dynamics of stone desertification in karst area, the State Forestry Administration of P.R.China mobilized 4 thousand technicians in "the second stone desertification monitoring" in karst areas from early 2011. Until the end of 2011, karst stony desertification was about 12 million hectares in the total land area of China. Its land occupied 26.5% of the karst, and occupied 11.2% of the region's land area include 5,575 counties in Hubei, Hunan, Guangdong, Guangxi, Chongqing, Sichuan, Guizhou and Yunnan provinces (autonomous regions and cities). Guizhou Province is the largest stony desertification land area in China has 3.024 million ha, accounting for 25.2% of total stony desertification land area. Stony desertification land area of Yunnan, Guangxi, Hunan, Hubei, Chongqing, Sichuan and Guangdong provinces have 2.84 million ha, 192.6million ha, 1.431 million ha, 1.091 million ha, 895 thousand ha, 732 thousand ha and 64 thousand ha respectively. Stony desertification land area in 2011 compared with in 2005 decreased about 960 thousand ha (decrease 7.4%). Average annual reduction area was 160 thousand ha; average annual reduction rate was 1.27%.

요 약

　　중국의 석막화(石漠化)는 주로 중국 남서쪽에 위치한 운귀고원(云贵高原)을 중심으로 발생하고 있다. 석막화 발생 범위는 총 8개 성, 436개 현에 분포하고 있으며, 중국 국토면적의 107.1만km2를 차지하고 있으며, 카르스트 면적이 45.2만km2를 차지하고 있다. 중국 국가임업국은 2011년부터 4,000여명의 인력을 동원하여 "제2차 석막화 모니터링 사업"을 실시했다. 2011년 말까지 카르스트 지역의 석막화 토지 총면적은 1,200.2만ha로, 카르스트 토지 면적의 26.5%를 차지하고 있으며, 이는 국토면적의 11.2%에 해당한다. 석막화 토지 면적이 가장 큰 곳은 귀주성으로 302.4만ha의 석막화 토지가 있으며 석막화토지 총면적의 25.2%를 차지하고 있다. 그 다음으로 운남성(284.0만ha), 광서성(192.6만ha), 호남성(143.1만ha), 호북성(109.1만ha), 중경(89.5만ha), 사천성(73.2만ha), 광동성(6.4만ha) 순으로 많은 석막화 토지가 분포하고 있다. 2011년 석막화 토지는 2005년 제1차 조사 때와 비교하여 96.0만ha가 감소하였으며, 연평균 16.0만ha씩 감소하고 있다.

Stability evaluation of concrete erosion control dam for compressive strength in Injea county, Gangwon province, Korea

강원도 인제 지역의 콘크리트 사방댐 안정도 평가 연구

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Abstracts

Concrete nondestructive test has been commonly used to estimate the concrete strength or for safety diagnosis. Estimate of concrete strength using nondestructive test is aimed at determining whether the structure satisfies the strength requirements in specification. The purpose of this study is based on analysis of the compressive strength of erosion control dams use the formula of Architectural Institute of Japan, stability of the dams built on 2007 in Injea, Gangwon Province was evaluated and the appropriate scope of judgment by nondestructive test was determined. Results of the compression strength investigation express that there is a consistency with visual inspection of stability that has been processed by The Korean Association of Soil and Water Conservation. "Poor" condition Dam was 304.8 kgf/cm^2 respectively. Dam compression strength with "Poor" condition Dam better than "Good" condition Dams. Systematical approach for stability inspection that carries out remodeling or repair when problem on erosion control structures are detected through visual inspection and simple stability test, is necessary for the future disaster prevention.

요 약

비파괴시험을 통한 콘크리트 강도 추정은 시방서 상의 강도를 충족 여부를 파악하는 것을 목적으로 한다. 본 연구에서는 '콘크리트 테스트 해머'를 이용하여 강원도 인제 지역에서 2007년에 만들어진 사방댐 5개소의 대수면, 방수로, 반수면의 반발경도를 측정하고, 보정값 처리 후 콘크리트 압축강도를 산출하였으며, 각 사방댐 압축강도를 일본건축학회 추정식에 대입하여 사방댐의 안정성 경향을 파악을 목적으로 하였다. 육안 검사 결과 불량으로 판정된 인제읍 가리산리 사방댐의 평균 압축강도는 304.8 kgf/cm^{2}이었으며, 양호로 판정된 인제읍 원대리, 북면 원통리, 인제읍 고사리, 북면 한계리 등 4개소의 사방댐 평균 압축강도는 각각 279.7 kgf/cm^2, 296.1kgf/cm^2, 297.9kgf/cm^2, 301.4kgf/cm^{2}였다. 단순 압축강도 결과만을 비교하였을 경우 불량 판정 사방댐의 압축강도가 양호 판정 사방댐보다 높은 것으로 분석되었다. 앞으로 육안 점검과 간이 안정성 검사를 통해 사방 구조물에 이상이 발견될 경우 정밀진단 검사를 통해 리모델링 또는 보수를 실시하는 일련의 체계적인 안정점검 시스템이 구축되어야 할 것이다.

Countermeasures of Erosion Damage of Coastal Disaster Prevention Forest in Korea

한국의 해안방재림 침식 피해 대책

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Abstracts

Coastal erosion not only causes the loss of tourism function like bathing resort and but while it is destructing coastal disaster prevention forests, it is reducing the major function of coastal disaster prevention forest such as resistance against wind, function to prevent tsunami and function to prevent damage from sea water. According to "the 2nd coast maintenance rectification plan (2010~2019) of the Ministry of Land, Transport and Maritime Affairs, after the year 2003, it is conducting monitoring of erosion of 160 places in major coast and out of them in 104 places (65%) it appeared that the coastal erosion is concerned or serious. In order to prevent such coastal erosion, the Ministry of Land, Transport and Maritime Affairs is investigating the actual condition of erosion of major coasts and major bathing resorts and collecting the data from 2003. Korea Forest Research Institute is analyzing the erosion of beach and sedimentation change through the comparison of aerial photograph of coastal area. In addition, it selects the coastal disaster prevention forest damaged by erosion of the West Sea and through the ground radar shooting in each quarter from 2012 it is precisely monitoring the amount of erosion and sedimentation in coastal areas. In the future, coastal disaster prevention forest damaged by erosion will be additionally selected at the West Sea and the East Sea for monitoring.

요 약

해안 침식은 해수욕장 등 관광기능을 상실시킬 뿐만 아니라, 해안방재림을 파괴하면서 해안방재림의 방풍기능, 해일방지기능, 염해 방지기능 등 주요 기능을 감소시키고 있다. 본문에서는 한국의 해안침식 현황과 원인에 대해 간략히 설명하고, 주요 기관의 침식방지 대응과 추후 대책에 대해 설명하고자 한다. 국토해양부의 "제2차 해안정비수정계획(2010~2019)"에 따르면, 2003년 이후 주요해안 160개소에 대한 침식 모니터링을 실시하고 있으며, 이 중 104개소(65%)에서 해안침식 우려 또는 심각한 것으로 나타났다. 이러한 해안침식을 방지하기 위해 국토해양부에서는 2003년부터 주요해안 및 주요 해수욕장에 대한 침식실태 조사 및 자료를 수집하고 있다. 국립산림과학원에서는 해안지역 항공사진 비교를 통해 해안가 침식과 퇴적 변화를 분석하고 있다. 또한 서해안 해안방재림 침식 피해지를 선정하여 2012년부터 분기별로 지상 Lidar 촬영을 통해 해안지역의 침식량과 퇴적량을 정밀하게 모니터링하고 있다. 앞으로 서해안과 동해안에 해안방재림 침식 피해지를 추가로 선정하여 모니터링할 예정이다.

The analysis of change costal disaster prevention forest by aerial image

항공영상을 이용한 해안방재림의 변화 분석

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Abstracts

Coastal disaster prevention forest has a lot of feature that protect living space in coast, rice field and farm against the risk of tsunami and hurricane. Coastal disaster prevention forest decreases due to human activity and sea level rising due to global warming or increases the new composition. In order to analyze change of the size the aerial images those have already been established costal disaster prevention forest were used. The area of Seocheon, Taean, Buan, Wando, Uljin, Pohang were analyzed using the aerial images of 2000s and 2010s. As a result, the area of forest was decreased in case that there were trail road, breakwater and recreational facilities. And it was increased in case of establishing the forest. The cause of reduction in coastal disaster prevention forest area is sea level rising and improper development of human. Monitoring of change coastal disaster prevention forest using aerial images of is expected to be useful basic data when make a decision of the new composition and additional plantation area.

요 약

해안방재림은 태풍과 해일의 위험으로부터 연안의 주거 공간과 논밭을 보호해주는 기능을 한다. 해안방재림은 지구온난화로 인한 해수면의 증가와 인간의 활동으로 감소되거나 신규 조성으로 인해 증가되고 있다. 면적의 변화를 분석하기 위해 항공영상을 이용하여 기 조성된 해안방재림의 생성, 소멸, 증감에 대한 실태조사를 실시

하였다. 이를 위해 충남 서천, 충남 태안, 전북 부안, 전남 완도, 경북 울진, 경북 포항지역의 2000년대의 항공사진과 2010년대의 항공사진을 분석하였다. 분석 결과 산책로, 방파제, 위락시설이 조성된 곳은 해안방재림이 감소하였으며 몇몇 지역은 해안방재림이 증가된 것으로 조사되었다. 해안방재림 면적 감소의 원인으로는 해수면 상승과 인간의 부적절한 개발이며, 증가의 원인은 신규조림으로 나타났다. 항공영상을 이용한 해안방재림의 변화 모니터링은 추가적인 식재와 신규조성 지역을 결정할 때 기초자료로 유용하게 사용될 수 있을 것으로 기대된다.

Perspective Changed to Vulnerability of Forest Fire

산불 취약성 평가의 대두 배경

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Abstracts

Human has experienced large forest fires human cannot controlled since 1990s. Newly, vulnerability assessment is used to allocate their fire resources and do proper policy with fire risk assessment. This paper shows the background why vulnerability concept is rising in fire research recently. First of all, fire weather is changed due to global warming. Second, mega-fire is more frequently presented and it's impact, forest reduction, people losses, infrastructure destruction, is more powerful than before because of our society is more developed than before. Third, mega-fire is defined by the impact with the damaged area, it can be evaluated environmentally, socially and economically. Fourth, wildland urban interface(WUI), which is more vulnerable to fire, is preferred area for people these days. Therefore the population is getting increased, and also the safety needs are increasing in WUI. Fifth, undeveloped area is more vulnerable than developed area in WUI, because the people less have an information about early warning, and the lack of equipments for escaping and suppression. Those things say that vulnerability assessment is more effective for reducing the damage and suppression expenditure.

요 약

1990년대를 전후해 인간이 가진 기술로 제어할 수 없는 대형 산불이 전세계적으로 일어나면서, 산불에 대한 발생위험도 뿐만 아니라 취약성을 평가하여 산불예방 및 진화 자원 배분에 활용하고 있다. 산불 연구분야에서 위험도(hazard)에 이어서 취약성(vulnerability)이 대두된 배경으로는 첫째, 전 세계적으로 최근 지구온난화에

기인하는 산불 기후가 변화하기 때문이다. 둘째, 산림과 인명 손실 및 사회 기반시설의 파괴 등 피해가 큰 대형산불의 빈도수가 증가하였다. 셋째, 대형산불은 피해면적 뿐만 아니라 손실가치에 의해 정의 되어지며, 이는 환경적으로 뿐만 아니라 사회, 경제적으로도 가치를 평가할 수 있다. 넷째, 산불에 취약한 산림인접 지역이 여가를 즐기려는 사람들의 선호 지역으로 떠오르며 인구가 집중되고 이로 인해 안전에 대한 욕구가 커졌다. 다섯째, 발전이 더딘 산림인접지의 경우에는 산불 조기 경고를 듣지 못할 가능성이 크며, 피난 및 진화 수단도 상대적으로 미흡하고, 산불 이후에 삶을 재건하는 데에도 취약함을 보인다. 언급한 이러한 이유들에 의해서 취약한 지역을 사전에 파악하여 산불예방 및 진화를 위한 정책을 마련하는 것이 대형산불 진화에 들어가는 막대한 비용을 줄이고, 산불 피해를 최소화 하는 데에 기여할 수 있어 취약성 평가가 주요한 문제로 대두되고 있다.

The Classification of Burn severity using RapidEye image and Estimation of Greenhouse gases (GHGs) Emissions from Biomass burning in Yecheon, Korea

RapidEye 영상을 이용한 예천 산불피해등급 구분과 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 Yechon on April, 2011. 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'. The emission factors for estimating were separately applied to CO_2 1,580, CO 130, CH_4 9, NOx 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 Yecheon area were estimated to be CO_2 132,594, CO 10,910, CH_4 754, NOx 101, N_2O 58 $g/kg^{-1} \cdot ha^{-1}$.

요 약

본 연구는 RapidEye 위성영상을 이용하여 산불피해지역을 5등급으로 분류하여 각각의 면적과 산불로 인하여 배출되는 온실가스의 량을 추정하기 위함이다. 2011년 4월 1일에 발생한 예천지역의 RapidEye 영상을 활용하여 산불피해등급을 추출하였

다. 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. 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(Lfire = $A \times B \times C \times D \times 10^{-3}$)을 채택하였다. 예천지역의 온실가스 배출량은 각각 CO_2 132,594, CO 10,910, CH_4 754, NOx 101, N_2O 58 $g/kg^{-1} \cdot ha^{-1}$으로 도출되었다.

Soil physical-chemical characteristics on coastal disaster prevention forest of Korea

한국 해안방재림의 토양 물리화학적 특성

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Korea Forest Service announced the 5th forest basic planning(2008~2017). This plan is to restore the ecological axis of revolve around Baekdu mountains and coastline. This study analyzed of soil physical-chemical characteristics on coastal disaster prevention forest of Korea. The study was performed on the coastal disaster prevention forest distributed of west coast, east coast and south coast of Korea, and the study period from April to October in 2012. Research area was investigated total 101site of respective 40site in west coast, 41site in east coast, 20site in south coast. In order to examine the soil physical-chemical characteristics the soil samples were taken to 20cm depth under the surface. We measured the soil characteristics including soil pH, organic matter, total nitrogen, available P_2O_5, soil cation exchange capacity, exchangeable cation, electrical conductivity of soil and NaCl. As a result, soil characteristics are similar in west coast and east coast. However, the south coast available P_2O_5 and organic matter content was higher compared to other regions.

요 약

산림청에서 발표한 제5차 산림기본계획(2008-2017)에 따르면 백두대간과 해안선

을 중심으로 생태축을 복원하여 산림생물다양성 보전 및 생태계 건강성 증진을 목표로 추진되고 있다. 이 연구는 국내 서해, 동해, 남해에 위치한 해안방재림에서 토양의 물리화학적 특성을 분석하여 국내 해안방재림의 지역별 토양특성을 파악하여 해안방재림 조성 및 관리에 기초자료를 제공하기 위하여 수행되었다. 2012년 4월부터 10월까지 조사를 실시하였다.

연구조사지는 서해안 40개소, 동해안 41개소, 남해안 20개소로써 총 101개소 지역에서 토심 20cm에서 토양 시료를 채취하였다. 토양시료는 밀봉 후 토양분석실에 운반하여 토양분석법(농업과학기술원, 2000)에 따라 12항목을 분석하였다.

국내 해안방재림 토양의 물리화학적 특성을 분석한 결과 서해안, 동해안은 비슷한 특성을 보였으나 남해 지역은 토양pH를 제외한 11항목에서 동해, 서해보다 높은 수치를 나타냈다. 이것은 남해지역에 토성이 서해, 동해지역의 사토와 달리 미사성분이 많은 사양토로 구성되어있기 때문으로 사료된다.

Comparison of growth rates by planting densities of Callicarpa japonica

식재간격에 의한 작살나무 생장량 비교

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Abstracts

Korea Forest Service(2007) suggest to afforest coastal disaster prevention forest. It improved ecological stabilization of the coastal areas. Also amenity effect can be obtained. Domestic coastal disaster prevention forest be made up a pure forest(*Pinus thunbergii)*. Variety of vegetation should be phase in coastal disaster prevention forest for ecological diversity. Introduction of a variety of vegetation to increase the ecological diversity of coastal disaster prevention forest. This study was performed to select the shrubs to be forest in the coastal disaster prevention forest. By greenwood cuttings object proliferation perpetually retain to good condition of a genetic factor. *Callicarpa japonica* were selected through a survey of the literature. Then *Callicarpa japonica* was planted in the Korea Forest Research Institute within the test site. Planting densities 10cm, 20cm, respectively 30 objects, 28 objects planting. The study investigated growth rate and life rate to period from 2010 to 2012. As the result, 20cm planting densities high life rate more than 10cm and half many again as growth rate appear.

요 약

산림청(2007)에서 해안방재림 조성은 해안지역의 생태적 안정화 및 어메니티의 향상효과를 얻을 수 있다고 하였다. 현재 국내 해안방재림은 대부분 해송 단순림으로 구성되어 있으므로 생태적 다양성을 높이기 위해서는 다양한 식생의 도입이 필

요하다. 이 연구는 해안방재림 내에 식재 가능한 관목류를 선발하기 위한 기초연구로 수행되었다. 삽목에 의한 개체의 증식은 우량한 상태의 유전질을 쉽게 영속적으로 유지시킬 수 있다(강병화 등, 2009). 문헌조사를 통해 해안지역에 조성 가능하다고 판단되는 작살나무를 국립산림과학원 내 시험지에 삽목하였다. 식재 간격은 10cm, 20cm 각각 30개체, 28개체를 식재하였다. 이 연구는 2010 ~ 2012년까지 생존율과 생장량을 조사하였다. 조사결과 20cm 간격으로 삽목한 개체들 더 높은 생존율을 보였으며 1.5배 생장량 차이를 나타냈다. 식재간격 조절을 통해서 작살나무에서는 생존률뿐 아니라 생장량을 효과적으로 조절할 수 있을 것으로 사료된다.

Landslide Risk Predict and Evaluation Based on GIS Using Logistic Regression Anlaysis

로지스틱 회귀분석을 이용한 GIS기반의 산사태 위험지 판정 및 평가

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Abstracts

Landslide risk areas are managed to the risk district that is selected by the score table for landslide hazard prediction of Korea Forest Service. However, the score table for prediction of landslide hazard is very difficult to apply field that is required to professionalism for field survey, and do not applied by investigation factor and GIS properties data. In this sturdy, GIS-based DB was constructed for landslide damaged areas of approximately 2000 sites. Including Seoul, Pyeongchang, Inje, Bonghwa and so on, selected the landslide DB occurred from 2005 to 2011. Also, curvature, slope length, topography index, soil depth, class of DBH, aspect, forest stand lithology factors were selected by logistic regression analysis. It is developed to landslide predict model (LPM). Reliability analysis results of LPM showed an accuracy of 78%. Verification result using landslide hazard map at 23 sites (ex., Seoul, etc.) for the occurred landslide showed an accuracy of 86%.

요 약

산사태 위험지역은 산림청에서 개발한 산사태 위험지 판정표에 의해 위험지구를 선정하여 관리하고 있다. 그러나 기존의 산사태 위험지 판정표는 현장조사에 대한 전문성이 요구되며 조사인자와 GIS 속성정보의 연동이 쉽지 않아 실무에 이용되기 어려운 실정이다. 따라서 본 연구에서는 2005년부터 2011년까지 서울, 평창, 인제, 봉화 등 전국에서 발생한 산사태 피해지역 약 2000개소에 대한 GIS 기반의 DB를 구축하였다. 또한 로지스틱 회귀분석을 실시하여 최종적으로 선정된 9개의 영향인자

(사면경사, 사면곡률, 사면길이, 지형인자, 토심, 경급, 사면방위, 임상, 모암)를 선정하였으며, 산사태 판정모델을 개발하였다. 개발된 모델에 대한 신뢰성 검증을 수행한 결과 78%의 예측율을 확보하였으며, 산사태 위험지도 제작을 통하여 서울, 포항, 거창 등 산사태 발생지 23개소에 대한 검증결과 86% 예측정확도를 나타냈다.

The Verification of Standard Rainfall on Warning and Evacuation for Landslide Using Tank Model

탱크모델을 이용한 산사태 경보기준 우량의 검증

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Abstracts

To apply early warning and evacuation system for landslide, the standard rainfall of landslide is needed to considering local and antecedent rainfall characteristics. In order to improve these problems, this study was carried out to verify standard rainfall on warning and evacuation for landslide for rainfall that brings to landslide in 2012. The landslide was often occurred in Chungnam, Gyeongbuk and Gyeongnam province. Totally there were 7 landslides in nature slope and 13 landslides in artificial slope in Korea at 2012. At first, we analyzed the false warning and the accuracy of the predictions of standard rainfall for nature slope. The result shows that the accuracy of predictions was 46% and false warning was 91%. These results are due to the quantity and quality of rainfall data. Therefore we judged that the precise rainfall data have to be obtained to improve accuracy of prediction and false warning. In addition, the accuracy of the predictions of standard rainfall for artificial slope was analyzed that was 20%. Because standard rainfall on warning and evacuation for landslide by tank model was induced by nature landslide, the accuracy of prediction for artificial slope was lower than that of nature slope. Thus, it is needed to develop new standard rainfall for artificial rainfall by Tank model.

요 약

산지토사재해 예·경보 시스템의 적용을 위해서는 선행강우 및 지역특성을 고려한

기준우량을 선정할 필요가 있다. 본 연구에서는 이러한 문제점을 개선하여 개발된 기준우량을 적용하여 2012년 발생한 산사태를 유발시킨 강우를 대상으로 검증을 수행했다. 산사태는 주로 충남, 경북, 경남지역에 집중되어 발생했고 자연사면 산사태가 7건, 인공사면 붕괴가 13건이었다. 본 연구에서 사용된 탱크모델은 자연사면을 대상으로 한 모델이므로 타당한 검증을 위해 자연사면을 대상으로 우선적으로 검증을 실시했다. 그 결과 탱크모델을 이용한 기준에 대하여 46%의 정확도를 보였고, 오보율은 각각 91% 이 결과는 데이터의 양과 질이 떨어지는 것이 원인인 것으로 파악된다. 따라서 탱크모델을 이용한 기준의 정확도를 높이기 위해서 강우데이터의 신뢰도를 확보하여야 하는 것으로 판단된다. 추가적으로 인공사면을 대상으로 실시한 강우량 분석 결과 예측정확도는 22%에 불과하였다. 이는 본 기준우량이 자연사면을 대상으로 산정되었기 때문이며, 탱크모델을 적용한 인공사면에 대한 기준이 새로이 마련될 필요가 있는 것 판단되었다.

The Development of Comprehensive Simulator for Studies of Landslide and Debris Flows

산지토사재해 연구를 위한 종합시뮬레이터 개발

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Abstracts

Recent, study for soil sediment disaster has attracted the attention of the people by increasing damage from soil sediment disaster. It is necessary to understand the physical mechanisms of landslide and debris flow in order to reduce the damage. However, the use of the data was limited in Korea. Because the structure of flume is simple and size is small. Therefore, this study has developed flume that has complex structure including confluence that can reproduce debris flow in Korea and can be observed development process of landslide and debris flow for provide data that can be utilized in the field. In addition, this is developed flume to large scale in order to minimize the influence of scale effect such as experimental flume for debris flow on USGS that successfully was applied data on field. This flume is expected that the analysis of yield stress τ_y and viscosity η that are parameter that are required to ascertain physical mechanism of debris flows through diversification of concentration, slope, material can be applied.

요 약

최근 산지토사재해에 의한 피해가 증가함에 따라 산지토사재해에 대한 연구들이 국민들의 관심을 받고 있다. 피해를 감소시키기 위해서 산사태 및 토석류의 물리적 메커니즘을 이해하는 것이 반드시 필요하다. 그러나 국내의 실험수로들은 구조가 단순하고, 규모가 작아서 데이터의 활용이 제한적이었다. 따라서 본 연구에서는 현장

에서 활용이 가능한 데이터를 제공하기 위하여 산지토사의 발생부터 퇴적까지의 발달하는 과정을 관찰할 수 있고, 한국의 전형적인 토석류를 재현할 수 있는 합류점이 존재하는 복합적 구조를 가지고 있는 수로를 개발하였다. 또한, 미국에서 실험데이터를 성공적으로 현장에 적용하고 있는 **USGS**의 토석류 실험수로와 같이 규모적 차이로 인한 영향을 최소화할 수 있도록 대규모의 수로를 제작하였다. 본 수로를 통한 재료의 농도조정, 경사도조정, 재료조정의 다양화를 통해 토석류 메커니즘 구명에 필요한 매개변수인 항복응력(τ_y), 점성(η) 값의 분석도 가용할 것으로 기대된다.

Forest Climate Monitoring System
- Mountain Weather Observation Network in
Gangwon-do and Gyeongsangbuk-do in 2012-

산림기후모니터링시스템
−2012년도 강원권과 경북권의 산악기상관측망 구축−

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Abstracts

The frequent occurrence of forest disaster (forest fire, landslide etc.) increases damages of human and property every year on the influence of mountainous terrain and climate change. It is necessary to predict the disaster and the damage extent of landslide as well as the occurrence and the spread of large fire. However, mountain observation data for these predictions have been lacking as things stand in our country. Therefore, we built mountain weather observation network for gathering of observation data of mountainous regions. In 2012, we selected 30 sites in Gangwon-do and Gyeongsangbuk-do area on the basis of multifractal detrended fluctuation analysis(MDFA) and on-site survey. There was constructed mountainous AWS network in the appropriately selected 30 sites. Meteorological elements of each site consists temperature, relative humidity, wind direction, wind speed in 2m and 10m and surface temperature, pressure, precipitation. Currently, it is monitoring mountain meteorology at the constructed 30 sites.

요 약

산불과 산사태 등 산림재해의 빈번한 발생은 산악지형과 기후변화의 영향으로 인적·물적 피해가 매년 증가하고 있다. 대형산불 발생 및 확산 예측과 산사태 등 산지 토사재해 발생위험 및 피해범위 예측이 필요하다. 우리나라의 현 실정은 이러한 예

측을 하기에 산악지역의 관측자료가 턱없이 부족한 실정이다. 따라서 국립산림과학원에서는 산악지역의 관측자료의 확보를 위해 산악기상관측망을 구축하고자 하였다. 사업을 시작한 2012년도에는 강원도와 경상북도 지역을 중심으로 멀티프랙탈 변동분석(MDFA: Multifractal Detrended Fluctuation Analysis)과 현장답사를 근거로 30개 지점을 선정하였다. 선정된 30개 지점에 대해 산악기상관측용인 자동기상관측장비(AWS: Automatic Weather System) 체계를 구축하였다. 각 지점들의 기상관측요소는 2m와 10m 높이의 기온, 습도, 풍향, 풍속과 기압, 강수량, 지면온도로 구성되어 있다. 현재, 구축된 30개 지점에서 산악지역의 기상을 상시관측 중이다.