

**CLIMATE CHANGE & FOREST FIRES
IN THE MEDITERRANEAN BASIN
MANAGEMENT & RISK REDUCTION**

**JANUARY 24 - 26, 2012
NIR ETZION ISRAEL**

Photographer: Nir Herr / Forestry Department JNF - KKL

This conference has been organized by the Office of the Chief Scientist at the Ministry of Environmental Protection in collaboration with the KKL-JNF, ERA-NET CIRCLE2 and the Natural Resource Division at the Ministry

Production:

Publications, Information and Internet Division,
Ministry of Environmental Protection
Publications Unit, Keren Kayemeth Lelsrael



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Welcome to Israel to the Climate Change & Forest Fires Conference

The objective of the conference is to share scientific knowledge, policy and practices for effective management of forest fire prevention and ecological rehabilitation under the conditions of climate change.

The academic community, policy makers and practitioners in the field of forest management provide multidisciplinary views on the nature and consequences of fire. We hope that this conference will contribute knowledge for creating cross sectoral and international synergies that address the complexity that environmental and societal agents deal with.

Wishing you all fruitful conference and enjoyable stay in Israel,

The Conference Steering Committee

Program

24 January, 2012 Sharing of Scientific Knowledge

- 8:00-9:00** Registration
- 9:00-9:30** **WELCOME**
Sinaia Netanyahu, Chief Scientist, the Israeli Ministry of Environmental Protection
David Brand, Chief Forester - Head of the Forest Department, JNF - KKL
- OPENING SESSION AND KEYNOTE SPEAKERS**
Orna Matzner, Chair
- 9:30-9:50** **Climate Impact Research & Response Coordination for a Larger Europe**, Tiago Capela Lourenço, CIRCLE2 ERA-NET Project Coordinator, University of Lisbon, Portugal
- 9:50-10:20** **Wildland fires in the Eastern Mediterranean and the Near East from the perspective of the United Nations International Strategy for Disaster Reduction**, Johann G. Goldammer, Global Fire Monitoring Center (GFMC), Max Planck Institute for Chemistry, Freiburg University / United Nations University (UNU), Germany
- 10:20- 10:50** **Interactions between Climate and Human demography in large California Wildfires**, Jon E. Keeley, U.S. Geological Survey, and University of California, Los Angeles
- 10:50-11:15** Coffee break

SESSION I:

11:15-12:35 CLIMATE CHANGE AND FOREST FIRES

Jon E. Keeley, Chair

Likely impact of climate change on vegetation and fire regimes in the Mediterranean Basin, José M. Moreno, Department of Environmental Sciences, University of Castilla-La Mancha, Toledo, Spain

The role of climate extremes (heatwaves) driving large wildfires in southern Europe & Meteorological fire risk in the Mediterranean, Ricardo Trigo, University of Lisbon, Campo Grande, Portugal

Climate changes over Israel in relation to fires, Pinhas Alpert, Tel-Aviv University, Israel

Weather conditions during the Mount Carmel 2010 Forest Fire and other fires in Israel, Dan Malkinson and Haim Kutiel, Haifa University, Israel

12:35-13:40 LUNCH



Photographer: Olshansky Yulia / forest plantation planner, KKL

SESSION II:

13:40- 15:00 FOREST FIRE MANAGEMENT

José M. Moreno, Chair

Wildfire regime in Israel in the 2000s: a national analysis using satellite images, Noam Levin, The Hebrew University of Jerusalem, Israel

Post-fire restoration in the perspective of climate change, Ramon Vallejo, CEAM, Spain

Forest Fire Management in Israel: Ecological and Economical Aspects, Shay Levy, Haifa University, Israel

Livestock grazing in managed pine forests: fire hazard reduction vs. forest regeneration and diversity, Yagil Osem, Agricultural Research Organization, Israel

15:00-15:20 Coffee break



Photographer: Olshansky Yulia / forest plantation planner, KKL

SESSION III:

15:20-17:00 FOREST FIRE MANAGEMENT

Ramon Vallejo, Chair

Soil erosion assessment and mitigation following wildfires in Portugal: the state-of-affairs of the EROSFIRE decision-support tool for post-fire land management and impact assessment of future scenarios, Jan Jacob Keizer, Centre for Environmental and marine Studies (CESAM), University of Aveiro, Portugal

Fire effects on soil properties and erosional dynamics: new perspectives, Lea Wittenberg, Haifa University, Israel

Using synthetic polymers to prevent soil erosion after fire in Mediterranean forests, Meni Ben-Hur, Institute of Soils, Water and Environmental Sciences, Volcani Center, Israel

Resilience and natural post-fire regeneration of Mediterranean trees - implication for post-fire management, Gidi Ne'eman, University of Haifa-Oranim, Israel

The effect of fire on the fauna of the Mediterranean basin: an overview and synthesis, Ido Izhaki, University of Haifa, Israel

SESSION IV:**17:00-18:00 KNOWLEDGE GAPS, RESEARCH AND NETWORKS***Ido Izhaki, Chair*

EU perspective on Forest Fires: Knowledge gaps, research and networks, Jesús San-Miguel-Ayanz, EC - Joint Research Centre, Institute for Environment and Sustainability, Forest Resources and Climate Unit - FOREST, Italy

Knowledge gaps in light of the 2010 Mount Carmel fire, Avi Perevolotsky, Agricultural Research Organization, Israel

Regional perspectives: The role of formal and informal networks in enhancing international cooperation in wildland fire management, Johann G. Goldammer, Global Fire Monitoring Center (GFMC), Max Planck Institute for Chemistry, Freiburg University/ United Nations University (UNU), Germany

25 January, 2012 From Science to Policy and from Policy to Practice
09:00-09:30 WELCOME

Recorded greeting from Jan McAlpine, Director of the United Nations Forum on Forests (UNFF) Secretariat

Alona Sheaffer (Karo), Director General, Ministry of Environmental Protection, Israel

Yael Shaltieli, Director General, KKL-JNF, Israel

OPENING SESSION AND KEYNOTE SPEAKERS

Sinaia Netanyahu, Chair

9:30-10:00 Rehabilitation of Mount Carmel after the fire in December 2010, Yeshayahu Bar-Or, Ministry of Environmental Protection, Israel

10:00-10:30 Wildland fire urban interface in Israel, a methodological approach to prevention and reduction of the social and economic impact, Rodríguez y Silva, University of Cordoba, Spain

10:30-11:00 Making fuels management compatible with restoration objectives in the wildland-urban interface: case studies from the US Mediterranean-climate zone, Hugh D. Safford, USDA Forest Service, California, USA

11:00-11:20 Coffee break

SESSION V:

11:20-12:30 FOREST FIRE MANAGEMENT – PANEL DISCUSSION

David Brand, Chair

11:20-12:00 Forests fire prevention management presentations:

Prevention management of forest fire in Israel, David Brand, Chief Forester - Head of the Forest Department JNF – KKL, Israel

Forests fires prevention programs in natural reserves and forests in the region of the Mediterranean, Yehoshua Shkedy, Nature & Parks Authority, Israel

Grazing as a tool for fire prevention, Shmuel Fridman, Ministry of Agriculture, Israel

Government involvement in determining forest management policy in Israel, Hagai Snir, Ministry of Agriculture & rural development, Israel

12:00-12:30 Discussion (Local Authorities – TBC)

12:30-13:45 LUNCH

SESSION VI:

13:45-15:40 COMMUNITY ENGAGEMENT IN FOREST FIRE MANAGEMENT

Yehoshua Shkedy, Chair

13:45-15:05 The Biosphere Reserve - a paradigm shift in nature conservation?

Uriel Safriel, Hebrew University, Jerusalem, Israel

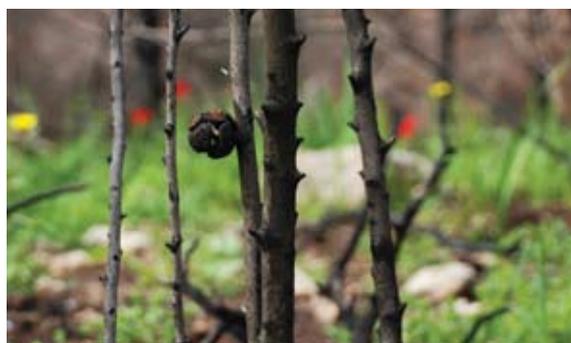
Research for people, but without people: What is missing in research on forest ecosystem services? Daniel Orenstein, Center for Urban and Regional Studies, Faculty of Architecture and Town Planning, Technion Haifa, Israel

FireSmart: Forest and land Management options to prevent unwanted forest fires, Ana Sebastián López, FireSmart Project Coordinator, GMV Aerospace & Defense Spain

Protecting each other - The forest and the community, Salman Abu-Rukun, Nature & Parks Authority, Israel

15:05-15:35 Discussion

15:35-16:00 Coffee break



Photographer: Olshansky Yulia / forest plantation planner, KKL

SESSION VII:

16:00-17:40 TECHNOLOGIES AND INNOVATIVE APPROACHES IN FOREST FIRE MANAGEMENT

Ricardo Trigo, Chair

Forest Fire Modeling aided by Web GIS in a Changing Climate, Kostas D. Kalabokidis and Palaiologos Palaiologou, University of the Aegean, Greece

Assessing fire risk: post-fire analysis of pre-fire mapping - a recent case study from Mount Carmel, Yohay Carmel, Technion - Israel Institute of Technology, Haifa, Israel

Evaluating drought stress changes in planted forests by means of remote sensing, Michael Dorman, Ben-Gurion University of the Negev, Israel

Very Large-Scale, High Spatial Resolution Airborne Thermal Mapping of Wildfires in Northern Canada using the TABI-1800, Stephen Achal, Itres Research Limited, Canada

26 January, 2012 **Professional Field Tour**
(by invitation only)



Photographer: Olshansky Yulia / forest plantation planner, KKL

LIST OF POSTERS:

Fire Forecasting System, Besora Regev, Shai Amram, Ministry of Public Security, Israel

The influence of recurrent forest fires on the abundance of *Pinus halepensis* Mill, Mt. Carmel, Israel, Naama Tessler, Lea Wittenberg, Noam Greenbaum and Ella Provizor, University of Haifa, Israel

Forest wildfires and post-fire management: Changes in soil chemical and microbial components, Orit Ginzburg and Yosef Steinberger, Bar-Ilan University, Israel

Integrating GIS, Remote Sensing and Web technologies for forestry management: monitoring, decision making and public participation, Azaria Ilan, SensinGIS Geospatial Services, Israel



CLIMATE CHANGE & FOREST FIRES IN THE MEDITERRANEAN BASIN: MANAGEMENT & RISK REDUCTION



Photographer: Ilan Malester/Ministry of Environmental Protection

STEERING COMMITTEE

The conference is led by the Office of the Chief Scientist at the Ministry of Environmental Protection under the collaborative framework of the EU FP7, CIRCLE2 – ERA-NET. The conference program is a result of collaboration between the members of the steering committee represented by the Israeli Ministry of Environment; Keren Kayemeth LeIsrael - Jewish National Fund (KKL-JNF); The Global Fire Monitoring Center, Germany; University of Haifa, Israel; Agricultural Research Organization, Israel; Ministry of Agriculture, Israel; Nature and Parks Authority, Israel; Centre for Environmental and Marine Studies (CESAM), University of Aveiro, Portugal; and University of Castilla-La Mancha, Toledo, Spain.

The Ministry of Environmental Protection wishes to take this opportunity to extend its appreciation to the members of the steering committee for the time and attention that each and every member has devoted to putting together this rich program.

Finally, the Ministry thanks CIRCLE2's Project Coordinator, Tiago Capela Lourenco, of the University of Lisbon, Portugal and to the members of CIRCLE2 for their guidance and support in forming the conference and to the EU FP7 for enabling the financial support for the conference via CIRCLE2.

Financial support for the conference was also provided by the Natural Resources Division at the Ministry of Environmental Protection and the KKL-JNF.

Steering Committee:

Bar-Or, Yeshayahu. Ministry of Environmental Protection, Israel

Brand, David. JNF – KKL, Israel

Goldammer, Johann G. The Global Fire Monitoring Center (GFMC), United Nations University, Germany

Izhaki, Ido. University of Haifa, Israel

Keizer, Jan Jacob. Centre for Environmental and Marine Studies (CESAM), University of Aveiro, Portugal

Matzner, Orna. Ministry of Environmental Protection, Israel

Moreno, José M. University of Castilla-La Mancha, Toledo, Spain

Netanyahu, Sinaia. Ministry of Environmental Protection, Israel

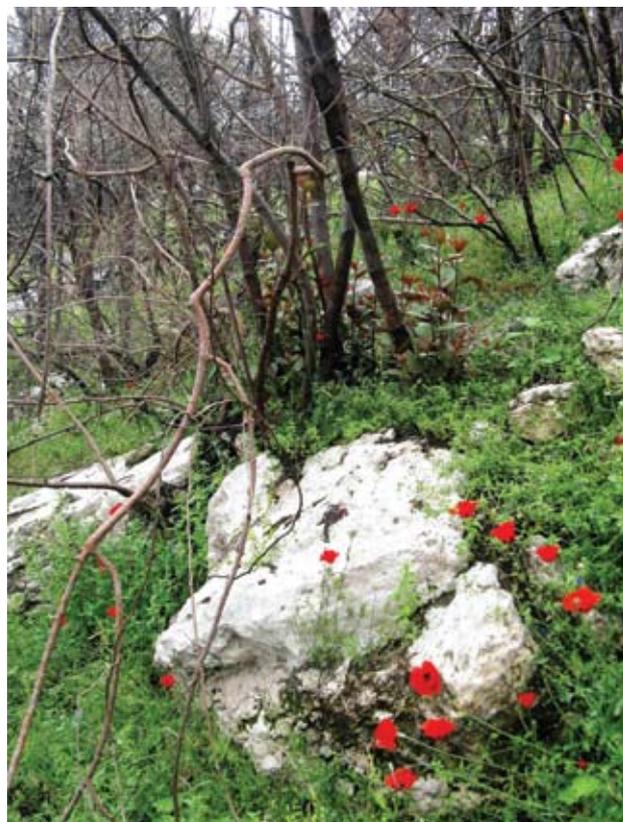
Perevolotsky, Avi. Agricultural Research Organization, Israel

Shkedi, Yehoshua. Nature and Parks Authority, Israel

Snir, Hagai. Ministry of Agriculture, Israel

Walczak, Margareta. Nature and Parks Authority, Israel

Zalutsky, Menachem. Ministry of Environmental Protection, Israel



Photographer: Nir Herr / Forestry Department JNF - KKL



Photographer: Ilan Malester/Ministry of Environmental Protection



ABSTRACTS



Photographer: Ilan Malester/Ministry of Environmental Protection

Climate Impact Research & Response Coordination for a Larger Europe: CIRCLE-2 ERA-Net

Tiago Capela Lourenço, CIRCLE2 ERA-NET Project Coordinator, University of Lisbon, Portugal

Adaptation to a changing climate presents a call to action in Europe and beyond. To coherently address this challenge there is a growing need to incorporate sound scientific knowledge into policy and practice. But uncertainties on the science side are large and policy has to deal with a multitude of problems (e.g. economic, social) often leaving little room to "think" and "act" on climate change adaptation. In this context, where exactly does the European Research Area (ERA) come into play and why is Europe in need of stronger scientific (and policy) transnational networks? Responses to these questions can be directed to the 3 main areas: (1) Ensuring a good knowledge base for all actors; (2) Adaptation and mainstreaming; and (3) Economics and resources. At the national and sub-national levels, knowledge on climate adaptation is growing but is hardly accessible to the European level since joint coordination is lacking and language barriers still remain. Actors in each member state are looking to the European White Paper on Adaptation as a framework that should deliver a common base for compiling, organizing and sharing information and help them structure some of their own initiatives (e.g. National Adaptation Strategies). Mainstreaming adaptation into policies and instruments is proving to be a difficult task at all levels, not only because different countries have different notions of "what does adaptation mean" but partly because scientific uncertainties are hard to cope in decision-making processes that have to be carried out under changing conditions (and sometimes changing public support). Gearing up enough financial resources to set up and move adaptation forward in Europe is a third issue facing difficulties, and in times of economic downturn, priorities have to be clearly set. Considering current policy developments and research gaps, how can European scientific (and policy) networks such as CIRCLE-2 ERA-Network contribute to such processes? And in this Workshop's particular case, how to do this under the topic of CLIMATE CHANGE & FOREST FIRES: MANAGEMENT & RISK REDUCTION IN THE MEDITERRANEAN BASIN.

Wildland fires in the Eastern Mediterranean and the Near East from the perspective of the United Nations International Strategy for Disaster Reduction

Johann Georg Goldammer, *Global Fire Monitoring Center (GFMC), Max Planck Institute for Chemistry, Freiburg University/ United Nations University (UNU), Germany*

Contemporary wildland fire regimes and wildfire problems in the countries of the Eastern Mediterranean Basin, the Near East, and the adjoining regions of the South Caucasus and Middle East are determined by diverse ecosystem properties, and facet-rich socio-economic and political conditions. However, land-use change is the most prevailing and common determinant of fire use and wildfire occurrence and impacts. Rural exodus caused by urbanization of the young generation in many countries has resulted in the depletion of the rural work force and their role in land cultivation and fire protection. Rapidly growing fallow in many countries contributes to an increase of wildfire hazard. Climate extremes, possibly already a precursor of regional climate change, are another common determinant of increasing wildfire risk. The combination of extreme dry spells, high fuel loads on abandoned lands, a diminished rural work force and the lack of appropriate technical measures and means for wildfire prevention and suppression in many countries result in an overall increased wildfire risk. At the same time the vulnerability of communities, critical infrastructures and protected UNESCO World Heritage sites to become directly affected by wildfires is increasing at the wildland-residential / urban interfaces, and indirectly through long-distance transport of vegetation fire smoke pollution. Other indirect or secondary damages include post-fire soil and ecosystem impoverishment, and threats to humans and infrastructures by erosion and landslides. The problem of fires burning in terrain contaminated by unexploded ordnance (UXO) and landmines stemming from previous conflicts, and wildfires started intentionally or as collateral damages during armed conflicts, or as consequences of political tensions, constitute additional threats to human security in the region.

Interactions Between Climate and Human Demography in Large California Wildfires

Jon E. Keeley *U.S. Geological Survey, Western Ecological Research Center, Sequoia-Kings Canyon Field Station, Three Rivers, CA 93271, USA and Department of Ecology and Evolutionary Biology, University of California, Los Angeles, CA 90095, USA*

Kathryn N. Keeley, *Department of Ecology and Evolutionary Biology, University of California, Los Angeles, CA 90095, USA*

Mediterranean climate evergreen shrublands and forests are distinct from other fire-prone woody vegetation by the fact these communities are subjected to hazardous fire conditions on an annual basis. These landscapes present complicated fire management problems because they are often adjacent to large metropolitan areas and represent centers of high plant and animal diversity. Thus, balancing fire hazard reduction and resource conservation is a challenge and made even more challenging by evidence of global warming. In southern California eight megafires (>50,000 ha) are recorded for the region and half have occurred in the last 5 years. These burned through a mosaic of age classes which raises doubts that accumulation of old age classes explains these events. Extreme drought is a plausible explanation for this apparent rash of such events and it is hypothesized that drought leads to increased dead fine fuels that promote the incidence of firebrands and spot fires. However, increased fire activity over the past 40 years has not occurred in all parts of the state and forests have not responded the same as non-forested habitats. In addition, human population growth has increased fire activity in the northern part of the state but had less of an impact in the south. This regional variation in anthropogenic impacts is mirrored by differential impacts of climate in these two regions.

Likely impact of climate change on vegetation and fire regimes in the Mediterranean Basin

José M. Moreno *Department of Environmental Sciences, University of Castilla-La Mancha, Toledo, Spain*
josem.moreno@uclm.es

Every year, over 0.5 M Ha are burned by wildfires in the EU, a significant number of them occurring in the southern countries. Fire is dominant in Mediterranean landscapes nowadays. Fires are the result of socioeconomic, climate and biological factors. I will present some general figures about fire occurrence in the region, focusing in Spain, and on the factors that control them. I will also present landscape-level information to assess how fires alter landscapes and can further affect future fires and change fire regime. The relationships between weather and climate and recent fire trends will be also analyzed. Based on these relationships, I will use various scenarios of climate change to evaluate future fire risk. I will consider the relationship between vegetation responses to fire and climate, including the sensitivity of plants to germinate under various temperatures, or to regenerate under changing rainfall patterns, including drought, to assess the effects of future changes in climate on vegetation in relation to fire.

The role of climate extremes (heatwaves) driving large wildfires in southern Europe & Meteorological fire risk in the Mediterranean

Ricardo Trigo, University of Lisbon, Campo Grande, Portugal

The last decade has been characterised by frequent heatwaves within the Mediterranean-European region. Quite often these heatwaves have triggered a large number of wildfires, such as in Portugal (2003, 2005), Spain (2006), Italy and Greece (2007) and, more recently, Ukraine and Russia (2010). Following the methodology developed in previous works it is shown the temporal evolution of the large-scale atmospheric circulation and fire activity associated with the two largest heatwaves observed over western Europe in 2003 (Trigo et al., 2005) and over Russia in 2010 (Barriopedro et al., 2011).

The 2003 heatwave was characterized by new all time record values of maximum and minimum temperatures over Portugal in early August. These extreme temperatures and the associated low humidity values triggered the most devastating sequence of large fires ever registered in Portugal with an estimated total burnt area was about 450.000 ha (Trigo et al., 2006). Additionally we show that the 2010 heatwave exceeded the amplitude and spatial extent of the previous hottest summer of 2003 (Barriopedro et al., 2010). Using 10 year of MODIS data we put the intense fire season of eastern Europe (Russia, Ukraine, and the Caucasus region) within a wider scope. Finally an analysis is performed on the spatial distribution of fire events during the period of July and August 2007-2009. It is evaluated the possibility of producing daily maps of fire risk over Mediterranean Europe, on an operational basis, by making an integrated use of i) meteorological information from ECMWF forecasts, ii) information about land cover from GLC2000 and iii) occurrences of active fires as detected by SEVIRI.

References:

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- Trigo R.M., García-Herrera R., Díaz J., Trigo I.F., Valente M.A. (2005) How exceptional was the early August 2003 heatwave in France?. *Geophysical Research Letters*, 32, L10701, doi:10.1029/2005GL022410
- Trigo R.M., Pereira J.M.C., Pereira M.G., Mota B., Calado M.T., DaCamara C.C., Santo F.E. (2006) "The exceptional fire season of summer 2003 in Portugal". *International Journal of Climatology*, 26.
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Climate changes over Israel in relation to fires

Pinhas Alpert, Tel-Aviv University

I will review the recent trends in temperature and rainfall and the future projections based on IPCC and our regional climate simulations.

Outstanding features found in the Mediterranean trends will be investigated in relation to fires.

Focus will be given to tendency to more extreme weather over the Mediterranean region and Israel employing both downscaling approaches and observations.

I will present our regional climate modeling results performed in Tel-Aviv University in order to predict the changes in extremes including potential for fires. These are analyzed along with changes in the synoptic systems. For instance, the number of days with the dry "Red-Sea trough" synoptic system has doubled in the last 50 years which can be directly related to some recently observed and projected climate changes.

Weather conditions during the Mount Carmel 2010 forest fire and other fires in Israel

Haim Kutiel and Dan Malkinson, Department of Geography and Environmental Studies, University of Haifa, Haifa, Israel

Past studies have analyzed the synoptic conditions during large fires in Israel. Herein we present a statistical approach to determine the dominant weather factors associated with the large fires in Israel during 1991-2007. Using a maximum likelihood approach we distinguish between forest fires and open-range fires, to partition the relative role of these factors in events larger than 100 ha. Accordingly, we demonstrate that days since the last precipitation event, ambient temperature during the fire day, wind and relative humidity are significant variables in both types of wildfires. However, the role of maximum daily temperature is 50% higher in forest fires, while the role of relative humidity is twice as high in the open range fires compared to the forest fires.

We further present the relationship between predicted climate change and wildfire occurrence in Israel, based on Alpert et al.'s climate change simulations. With respect to the climatic drivers described above we did not find any significant changes in their annual distribution, and hence we conclude that according the predicted climatic changes no significant changes are expected in the wildfire regimes in Israel.

We analyze the weather conditions during the Carmel 2010 as a particular case study. The forest fire (2-5 December 2010) was a traumatic event in the recent history of natural disasters in Israel due to its devastating effects and very high cost in human lives during which, 44 fire fighters, policemen and prison guards were killed. Weather conditions in the days previous to the fire and during it, demonstrated very dry conditions: Temperatures were above normal for the season and the region (20-25°C), very low relative humidity (10-20%) which are very uncharacteristic in this region, strong easterly winds (20-40 Km*hr⁻¹) and a very long dry period (about 8 months) without rain. This combination of weather conditions caused a very rapid fire propagation, which ran out control a short time after it started.

A dramatic change in the wind direction from easterly to westerly on December 5 caused a rapid increase of the RH from about 10% to 80% in very few hours. The combination of these two factors lead to a statement from the event's central command that they succeeded in suppressing the fire, and on the next day it was completely extinguished.

Wildfire regime in Israel in the 2000s – a national analysis using satellite images

Noam Levin and Aliza Heimowitz, The Department of Geography, The Hebrew University of Jerusalem
noamlevin@mscc.huji.ac.il

Wildfires are part of the mediterranean ecosystem. Under Israel's climate conditions, all wildfire are human caused, either intentionally or un-intentionally (Kutiel and Kutiel, 1991). Previous studies found that larger forest fires in Israel tend to occur after rainy winter seasons, and have found relationships between synoptic conditions and the regions where forest fires had higher probabilities of taking place (Levin and Saaroni, 1999). In spite of the dangers of fires, there is at present no national monitoring of the areas burnt on a yearly basis, and documentation of wildfires is partially done by the Jewish National Fund or using aerial photos (Tessler et al., 2010). In this study we aimed to examine the temporal and spatial patterns of wildfires in Israel in the 2000s using MODIS imagery, and to examine the factors controlling wildfire regime. To map the fires we used two MODIS products as our basis – the MCD45A1 at a spatial resolution of 500 m, and the MOD13Q1 at a spatial resolution of 250 m. We evaluated the accuracy of two MODIS based wildfire scars between themselves and with respect to wildfire scars mapped from Landsat satellite images at a spatial resolution of 30 m. To examine the factors controlling wildfire we used GIS layers of land use, and a Landsat-based national vegetation map (Levin et al., 2011). Wildfire occurred in areas where annual rainfall was above 300 mm, mostly in areas with herbaceous vegetation. Wildfire frequency was especially high in the Golan Heights in the Judean Shefela, and a high correspondence was found between military fire zones and the spatial distribution of fire scars. The use of MODIS satellite images enabled us to map wildfires at a national scale due to the high temporal resolution of the sensor. MODIS imagery is not adequate to map small (< 0.5 km²) fires, however large fires account for a large proportion of all fires, and pose the greatest threats. This database can aid managers in determining wildfire risks in space and in time.

References:

Kutiel H. and Kutiel P., (1991). The Distribution of autumnal easterly windspells favoring rapid spread of forest wildfires on Mount Carmel, *Israel. GeoJournal*, 23, 147–152.

Levin N. and Saaroni H. (1999), Fire weather in Israel - Synoptic climatological analysis. *Geo Journal*, 47, 523-538.

Levin N., Harari-Kremer R., Carmel Y. (2011). Remote sensing of Israel's natural habitats. *Final report, presented to Israel's Nature and Parks Authority, May 2011*. 128 p.

Tessler, N., Malkinson, D., Wittenberg, L., Greenbaum, N. (2010). Forest and maquis fires in the Carmel and the Jerusalem mountains – documentation and analysis of temporal patterns. *Horizons in Geography*, 76, 157-165 (in Hebrew).

Post-fire restoration in the perspective of climate change

V. Ramon Vallejo, *CEAM, Parque Teconológico, Ch. Darwin 14, E-46980 Paterna*
vvallejo@ub.edu

Climate change projections for the Mediterranean region indicate an increase in heat waves and drought, and a more severe fire regime, i.e. longer and more severe fire season and larger exposed areas to wildfires. However, the driest current fire-prone areas might decrease fire hazard because of a reduction of fuel load and continuity. Forest and fire management face large uncertainties in relation to the eventual transition of vegetation and fuels towards drier climate conditions, to the combined response of plant species to climate and fire regime change, and to land use change dynamics. We propose addressing these uncertainties by adopting an adaptive post-fire management approach. Quality control, monitoring and evaluation are critical elements of adaptive management and should be incorporated in post-fire restoration schemes. The suggested strategy focus in the identification of fire-vulnerable ecosystems, and on this basis planning post-fire restoration in three steps: 1) short-term emergency rehabilitation; 2) regeneration reinforcement; and 3) long-term forest restoration considering fire-prevention principles. Steps 2 and 3 have long-term implications, therefore climate change projections should be taken into account.

Restoration techniques should improve ecosystem resilience in front of the expected new fire regime and increased drought. Research on species selection for restoration was concentrated in native woody resprouters, considering their adaptation and acclimation mechanisms to tolerate drought. Nursery cultivation techniques and tree-shelters were especially investigated to improve outplanting success in oak and other sclerophyllous species. Deep containers and the addition of hydrogels into the nursery growing medium improved seedling survival in the field after transplanting shock. Several soil preparation techniques proved to significantly increase rain use efficiency for introduced seedlings. Available forest restoration technology allows for reintroducing native woody plants beyond a minimum site quality threshold. Further research is needed to assess these critical site conditions before planning post-fire restoration projects in degraded lands.

Forest Fire Management in Israel: Ecological and Economical Aspects

Shay Levy¹, Dafna M. Disegni¹, Mordechai Shechter², Gidi Ne'eman¹

¹ *University of Haifa, Israel*

² *The Interdisciplinary Center Herzliya, Israel*

Key words: *Wildfire, management, economy, ecology, fuel, weather, fire ignition cause*

Wildfires are frequent events in the Mediterranean region, they destroy most of the above ground plant-biomass, drastically affect animal life, change the physical structure of the soil, leave almost bare soils, increase water runoff and soil erosion. Despite the severe damage to ecosystems, most of the flora and fauna are able to naturally regenerate after fires. Most of the fires are quickly extinguished, but the few that are not cause large damages to pastures, woodlands, forests, properties and sorely also human victims, as was the case in the recent (December 2010) Mount Carmel fire that caused 44 fatalities. All fires in Israel are of anthropogenic origin, therefore it is probably possible to reduce at least the extent of fires originating from negligence and to lesser extent of arsons.

Our research objectives were: (1) To construct a unified database that includes all available data from the authorities involved in firefighting and prevention. The data were collected from 12 firefighting unions, JNF-KKL (Forestry Department), and airborne firefighting operations. (2) To explore the effects of fire causes, weather, characteristics of the burned area and its extent and fire frequency on fire cost including extinguishing costs and damage to properties and nature.

The results indicate that wildfires occur mostly from May to October, with a peak in May-June. Fires caused by military training and arson, were the most expensive to extinguish. Arson incidents may be reduced by stricter law enforcement and more severe punishment than currently applied. It is essential and possible to reduce the number of fires caused by army training, and to improve their fire extinguishing operations. Fire suppression costs are the highest in grazing lands and open park-forests. These vegetation types have high cover of herbaceous vegetation and low cover of woody plants, which causes rapid fire spread resulting in large burned area and sever damage.

Most wildfires in Israel are small and their suppression-cost is low, however suppression cost and damage increase exponentially with fire size. Fires that occur when easterly winds prevail are the most expensive to suppress. This knowledge is important when designing fuel reduction buffer zones, and for efficient suppression of wild fires.

Israeli ground firefighters are not specifically trained to suppress wildfires that occur in open areas. They use water to extinguish fires, despite the availability of more effective fire retardants that are used by aerial firefighting, which gains momentum in Israel, especially after the extensive use of large planes during the Mount Carmel fire. However, aerial firefighting alone cannot suppress large wildfires unless combined with ground firefighting forces, which is even more effective when applied in combination with fire-prevention treatments. In Israel the responsibility for fire prevention operations and firefighting are scattered among several nation-wide agencies and local municipal, which makes coordination very difficult.

Israeli law prohibits fire ignition in the open, but the investigation of wildfires is scarce and enforcement almost absent. In the few cases where people were found guilty, their sentence was light and non-detering.

Wildfires management policy should use a holistic approach considering plant biomass as potential fuel, plant flammability, topography, weather conditions, consequent fire intensity, fire spread speed and the effect of global climate change. This approach should also take into account human-mediated inputs such as arson, negligence and accidents. Such an approach may reduce firefighting cost and fire damage. Currently, Israel has neither wildfire management nor firefighting policy. Such policies must consider the cost of all fire prevention and firefighting operations, and the economic value of fire-caused environmental damage, as well as education, public relations and law enforcement. Due to limited resources, it is important to follow a path of economic optimization, which takes into account all factors affecting the cost of fire suppression and fire damages.

Livestock grazing in managed pine forests: fire hazard reduction vs. forest regeneration and diversity

Yagil Osem, Agricultural Research Organization, Bet Dagan, Israel

As much as 80%-90% of Israel's managed forest area is subjected to livestock grazing. The portion of grazed area within these forests, the relative contribution of different grazing animals as well as the amount of sedentary vs. transhumant grazing, vary considerably in space and time. In the northern and southern parts of Israel's forests nearly all of the available grazing area is exploited while at the central region considerable area (ca. 30-40%), specifically in the high Judean Mountains, is left ungrazed. The relative contribution among the major grazing animals shifts from domination by sedentary cattle grazing of nearby villagers in the north towards a clear domination of transhumant grazing by mixed sheep-goat flocks owned by Bedouin in the south. To date, the various grazing regimes implemented in each forest area is to large extent the outcome of local constraints. Achieving better compatibility between grazing regime and forest management goals is still a major challenge for the forest managers.

Livestock grazing has long been considered as a desirable tool in managing forests mainly for fire hazard reduction but also for the manipulation of vegetation dynamics and structure. Under certain conditions forest grazing, if adequately implemented, may prove useful for both foresters and herders. In other cases, however, significant conflicts may arise some of which being a direct outcome of knowledge gaps regarding the appropriate grazing regime for different animal species and under variable vegetation formations and forest goals. These questions are becoming increasingly challenging as forest management strategies develop to support multiple forest functions. The talk will focus on grazing in managed pine forests. Pine forests in Israel are multifunctional and are managed to provide a variety of ecosystem services. These forests are also highly prone to fire. The way by which grazing in the forests affects the vegetation in different aspects, including fire hazard reduction, forage production, community structure and natural regeneration, will be presented. The interactions between grazing and forest structure will also be addressed. The relevance and appropriate implementation of grazing as a management tool under different forest designations will be discussed. A differential approach in which certain grazing regime is implemented in fuel breaks while a more variable and flexible strategy is applied in the rest of the forest area will be proposed.

Soil erosion assessment and mitigation following wildfires in Portugal: The state-of-affairs of the EROSFIRE decision-support tool for post-fire land management and impact assessment of future scenarios

Keizer J.J., Nunes J.P., Abrantes N.J., Campos I.M.A.N., Caria M.M.P.F., Cerqueira M.M.A., Esteves V.I., Faria S.R., Ferreira R.S.V., Machado A.I., Maia P.A.A., Malvar M.C., Martins M.A.S., Nunes M.I.S., Pinto R., Prats S. A., Skulska I., Varela M.E.T., Vasques A.R.P.F., Vieira D.C.S. CESAM Research Centre, University of Aveiro, Portugal

Wildfires can produce considerable changes to hydrological and erosion processes. In the case of Portugal, various studies have revealed strong post-fire responses in runoff generation and associated sediment losses, especially during the initial phases of the so-called “window-of-disturbance”. Besides wildfire itself, post-fire forestry practices like e.g. rip-ploughing were found to strongly influence overland flow and erosion in recently burnt areas. The need for a model-based tool for assessing erosion risk following wildfire and, ultimately, for guiding post-fire land management, like the Erosion Risk Management Tool (ERMIT) for the Western U.S.A., is overtly evident in the case of Portugal. Over the past decades, wildfires in Portugal have devastated on average around 100.000 ha each year, with dramatically higher figures for dry years like 2003 and 2005. Also, the envisaged tool could contribute to better predict the land degradational impacts of future scenarios, especially since the frequency of wildfires in Portugal is expected to remain the same or to increase in the coming decades.

Following the dramatic wildfire season of summer 2003 and directly motivated by the corresponding post-fire erosion map produced by the Portuguese Water Institute, the EROSFIRE-I project set out to develop such an erosion prediction tool tailored to the specificities of post-fire conditions in Portugal’s forests. In a nutshell, the project’s approach was to employ field rainfall simulation experiments (RSE’s) as principal method for gathering the data

required for parameterization and calibration of a process-based model for post-fire conditions. In addition, micro- and slope-scale erosion plots were monitored for: i) assessing the representativeness of the RSE results for runoff and erosion processes under natural rainfall conditions; ii) evaluating the up-scaling of the RSE-based modelling results to hillslopes, including in comparison to more simple erosion models, in particular the Morgan–Morgan–Finney model. Subsequent funding opportunities by the Portuguese Foundation for Science and Technology (FCT) have allowed a substantial extension of the scope of the follow-up research in the framework of the EROSFIRE-II and FIRECNUTS projects. This includes: i) catchment-scale sediment yields; ii) carbon and nutrient losses at the plot- to catchment-scale; iii) export of pyrogenic pollutants by overland and stream flow; iv) effectiveness of erosion mitigation techniques at the plot to slope scale.

The presentation will give an overview of the progress achieved so far towards the envisaged decision-support tool and indicate the principal knowledge gaps.

Fire effects on soil properties and erosional dynamics - new perspectives

Lea Wittenberg, *Department of Geography and Environmental studies, University of Haifa, Israel*

In the Mediterranean region fire is largely regarded as a major driving force of geomorphological processes, vegetation dynamics and landscape evolution. Additionally, wildfires impact a variety of soil properties. The magnitude, rate and type of most fire affected processes are determined by the complex interactions between the physical, chemical and biological properties of the soil, as well as the characteristics of the fire itself. For example, following low-moderate fires, properties such as aggregate stability, pore size distribution and water repellency, together with the effects of ash and clogging of macropores, increase runoff and soil loss. However, following severe fires, the presence of wettable ash and the loss of surface water repellency may increase infiltration rates and accordingly decrease runoff and soil loss. Results from previous studies indicate that the most common chemical characteristics of fire affected soils are organic matter, carbon, NPK minerals, cation exchange capacity, pH, and buffering ability.

Soil properties recovery rates and patterns depend on fire history and fire severity, and may last a couple of decades. During this period many nutrients are mineralized and exposed to increased runoff and erosion. Preferential removal of organic matter and nutrients in the thin, degraded soils is just as important as the total soil loss. The loss of nutrients could affect soil fertility and vegetation regeneration, which affect and dictate erosion processes.

The role of a single event in eco-geomorphological dynamics markedly differs from the outcome of repeated fires. Increasing anthropogenic activities in the Mt. Carmel region, coupled with recent climatic trends and the maturing of the planted and natural vegetation, the number of fires and total area of forest consumed by them has dramatically increased since the 1980's. Consequently, some areas have been burnt twice and three times within a twelve year period. Analyses suggest that recurring fires within short time intervals may significantly alter the long-term structure of the vegetation communities, ultimately increasing the dominance of herbaceous vegetation communities. This pattern may have significant implications for the associated runoff and erosion rates, and should be of particular concern given recent changes of fire regimes.

Following this intricate interaction among fire and eco-geomorphic components and processes, the resulting fire-induced soil loss and degradation, specifically at the micro-meso scale frequently exceed the natural rates of renewal. Consequently there are long lasting effects on soil longevity and productivity in fire-affected Mediterranean soils.

Using synthetic polymers to prevent soil erosion after fire in Mediterranean forests

Meni Ben-Hur¹, Assaf Inbar², Marcelo Stenberg², Marcos Lado⁴

¹ *Institute of Soils, Water and Environmental Sciences, Volcani Center, Israel meni@volcani.agri.gov.il*

² *The Porter School of Environmental Studies, Tel-Aviv University, Israel*

³ *Department of Molecular Biology & Ecology of Plants, Tel-Aviv University, Israel.*

⁴ *Faculty of Sciences, University of A Coruna, Spain.*

Forest fires could cause major environmental problems in the Mediterranean region, as they lead to vegetation losses, changes in biodiversity, increases in greenhouse gasses emissions and potential increase of runoff and soil erosion. These problems are expected to become more severe under the predicted regional climate change. Soil erosion by rainfall involves two main processes, (i) detachment of material from the soil surface by raindrop impact and surface runoff shear, and (ii) transport of the resulting sediments by raindrop splash and overland flow. The large increase in runoff and sediment yields following high severity forest fires is attributed mainly to surface cover and vegetation losses, and to an increase in soil sealing and soil water repellency. These soil erosion processes could cause widespread land and water deterioration problems, in terms of soil degradation, transport of pollutants, and environmental hazards. Therefore, one important action after a forest fire is to prevent soil erosion during the first rainfall season after the fire, which is the most sensitive period for soil erosion. One means to increase soil structure stability and to prevent soil loss during rainstorms is using synthetic polymers as soil conditioners. Polymers consist of repeated small identical units (monomers) coupled together to form extended chains. The present study evaluated the application of various amounts of polyacrylamide (PAM) in order to prevent soil erosion after fire in different soils types. The experiments were conducted under laboratory conditions using a rainfall simulator and under natural rainstorms in a Mediterranean pine planted forest. Application of 25 and 50 kg ha⁻¹ granular PAM reduced soil loss in three consecutive simulated rainstorms of 80 mm each. Moreover, the application of granular PAM in field plots at a rate of 50 kg ha⁻¹ in fall after a forest fire reduced soil loss by 50% compared to untreated control. These results indicate that PAM can be used as a potential tool to prevent soil loss after forest fire under Mediterranean conditions.

Resilience and natural post-fire regeneration of Mediterranean trees - implication for post-fire management

Gidi Ne'eman, University of Haifa-Oranim, Israel

Fire poses various risks mainly for plants and animals, invasive species, soil erosion and biomass-fuel accumulation for the next fire. Post-fire regeneration modes of plants include resprouting and germination from soil or canopy stored seed bank. All four combinations are found in Australia and South Africa and less in California. In contrast, the vast majority of the species in the Mediterranean basin are basal resprouters with no seed bank, a minority of perennial species consisting of post-fire obligate seeders, and a few species are facultative resprouters with post-fire germination from soil seed bank. Post-fire secondary succession is relatively fast and full recovery of mature native pine forest is achieved within about 30-40 years, depending on site quality, and recovery of oak dominated maquis is even faster. Both communities produce very dense post-fire vegetation with pine forests being much more flammable. Recurrent fires within less than 20 years may pose a juvenility risk for native forests of *Pinus halepensis* that is a post-fire obligate seeder; but long range seed dispersal may decrease this danger. Most of Mediterranean plant diversity is within annuals that flourish after fire; the attractive geophytes are resilient and flower massively after fire. Mediterranean vegetation is very resistance to invasive species, including post-fire regeneration. Thus single fires pose no risk to Mediterranean plants and no management is needed. Increasing drought, due to climate change may cause early post-fire vegetation to burn, increase fire frequency and possibly lead to drastic long term changes in the vegetation from broadleaved maquis and native pine forests to fire-resilient dwarf-shrub batha and grasslands consisted of annual and perennial grasses. Therefore, to minimize that risk we need to reduce post-fire plant density and biomass and prevent recurrent fires. Post-fire management should be aimed in (1) intensive creation of fuel breaks and their maintenance, and (2) large scale extensive reduction of fuel loads mainly by goat grazing in early post-fire stages combined with preventive prescribed burning in adult pine forests.

The effect of fire on the fauna of the Mediterranean basin: an overview and synthesis

Ido Izhaki, *University of Haifa, Israel, izehaki@research.haifa.ac.il*

Wildfires are among the most important natural disturbance in the Mediterranean basin. They impose drastic habitat and landscape modifications that govern not only the vegetation but also invertebrate and vertebrate dynamics and structure from the population up to the community levels. There are a wide range of post-fire succession trajectories for vertebrate and invertebrate populations, whereas the specific-species responses are dependent upon post-fire biotic and abiotic conditions in the burned habitat. The main generalization at the population level is that the burned areas support dense populations of open and edge-habitat species, whereas the species most abundant in unburned areas are forest-dweller species which typically avoid open areas.

Wildfires reduce habitat availability for forest animals, but the overall impact of fire is not necessarily negative as it simultaneously creates heterogeneous landscape with forest patches that support forest dwellers and with open habitats that are critical to maintain open habitat species. But the effect of fires in the Mediterranean basin on biodiversity is highly variable and dependent upon several factors: the extent, severity, frequency of the fire, the initial state of the ecosystem, spatial arrangement and isolation of the post fire burned and unburned patches and various abiotic conditions. From the management point of view, the maintenance of landscape mosaic habitats with different fire history is vital for the preservation of high vertebrate biodiversity in the Mediterranean region.

EU Perspective on forest fires: Knowledge gaps, research, and networks

Jesús San-Miguel-Ayanz, EC - Joint Research Centre, Institute for Environment and Sustainability, Forest Resources and Climate Unit - FOREST Italy

Forest fires are an important element of the forest ecosystems in Europe. Although fires affect mainly southern European forests, they are present in the whole European territory. The European Union has worked intensively in the last decades with the aim of improving the knowledge and understanding of factors that affect fire regimes in Europe. This work has been conducted by the financing of fire research projects mainly through the so-called Framework Programs of the European Commission and through the direct collaboration with the national administrations of the EU and neighbor countries in the context of the European Forest Fire Information System and the Monitoring and Information Centre of Civil Protection.

Although much work has been covered in the past research projects, new research aspects of forest fires and climate change and forest fire prevention are still on going. In the last years, severe fires have critically affected human lives and infrastructures, leading to new approaches in analyzing their effects by integrating all the phases of forest fires. A better knowledge on forest fires in Europe has been reached through the collaboration of the EC with the national forest fire administrations; in this context, EFFIS has played a decisive role in supporting the countries and enhancing international collaboration on forest fire prevention and fighting.

Knowledge gaps in light of the 2010 Mt. Carmel fire

Avi Perevolotsky, Agricultural Research Organization, Israel

Defining knowledge gaps and research priorities after an environmental crisis such as a devastating fire should take into consideration two dimensions: existing knowledge and the specific conditions of the burnt region. In the case of Mt. Carmel we added a third dimension – required and missing information relevant for the proposed restoration program for the area. Consequently the principal topics emerging as most relevant for Mt. Carmel are the treatments of woody vegetation (burnt and re-sprouting); water run-off and soil erosion; establishment and maintenance of fuel-breaks and the control of invasive and outbreak species. Research themes and expected outcome related to these topics will be discussed. One should keep in mind that some topics, e.g. soil erosion, have received relatively much scientific attention in Israel in the last 20 years while others, e.g. fuel breaks, have not been dealt professionally at all.

By definition scientific research is a short-term venture. However, ecosystem recovery and restoration programs operate on a much longer dimension. Therefore we propose to accompany the restoration and recovery processes with a professional monitoring scheme. We will present the consensus reached by a large group of scientists concerning the Mt. Carmel monitoring priorities.

Regional perspectives: The role of formal and informal networks in enhancing international cooperation in wildland fire management

Johann Georg Goldammer, Global Fire Monitoring Center (GFMC), Max Planck Institute for Chemistry, Freiburg University/ United Nations University (UNU), Germany

Globally the need has been recognized by nations and international organizations to share knowledge, human and technical resources in fire management. Transboundary cooperation in fire management aims at taking advantage of and sharing the specific technical and scientific expertise developed in the various countries and regions globally, including concepts and methodologies of best practices and capacity building in fire management. In addition, international assistance is often needed in wildfire emergency situations during which a country may run out of resources and require international assistance. Experienced gained during the past decade is determining the objectives and work programmes of a number of dedicated networks that are covering the territories of Southeast Europe, the Eastern Mediterranean, the Near and Middle East, the South Caucasus and adjoining regions. Many of the multinational efforts and networking activities were developed based on the recommendations and spirit of the International Wildland Fire Summit (2003). Informal networking within the UNISDR Regional Southeast Europe / Caucasus Wildland Fire Network (a regional network of the Global Wildland Fire Network), the Working Group on Forest Fires of *Silva Mediterranea*, partnering closely with the European Forest Fire Information System of the EU, is receiving increasing support. Examples will be given about the cooperation efforts in capacity building and national and regional fire management policy development, notably through the activities of the Global Fire Monitoring Center (GFMC) and financed by the Environment and Security Initiative (ENVSEC), a partnership of six international organizations – the Organization for Security and Co-operation in Europe (OSCE), Regional Environment Centre for Central and Eastern Europe (REC), United Nations Development Programme (UNDP), United Nations Economic Commission for Europe (UNECE), United Nations Environment Programme (UNEP), and the North Atlantic Treaty Organization (NATO). Mechanisms of the United Nations (through the UNOCHA / UNEP Joint Environment Unit) and the EU Civil Protection Mechanism in providing liaison and coordination capabilities for international support during fire emergencies are available to serve nations. Recent experience, including

multinational response to fire emergencies in Israel and Russia in 2010, have revealed the lack of agreed international standards for ground and aerial firefighting missions. The beginning for a new standard will be addressed by the “International Fire Aviation Working Group” (IFAWG), which is operating under the auspices of the UNISDR Wildland Fire Advisory Group. The UN Advisory Group on Environmental Emergencies (AGEE) is addressing the improvement of governing the response to environmental emergencies by national and international responders.

Wildland fire urban interface in Israel, a methodological approach to prevention and reduction of the social and economic impact

Dr. Fco. Rodríguez y Silva, University of Cordoba. Forest Engineering Department. Forest Fire Laboratory. Edif. Leonardo da Vinci. Campus de Rabanales. Cordoba 14071. Spain. e-mail: ir1rosif@uco.es

The wildland fires situation around of the world, and the particular emphasis on Mediterranean ecosystems generates a new way of thinking about the current and future state of the Forest landscape; motivated by and large, the abandonment of forest lands, the high energy component of the large fuel loads, the climatic change, and wildland-urban interface problems. The review, of the forest landscape of Israel, confirms the great importance of the forests has for the nature preservation. The socioeconomic development and the forest recreation activities of citizens is a very important point to an immediate future of high historical, cultural and natural value.

The preservation and defense against the forest fires, more than an option, is an unavoidable necessity that should be structured in a solid plan of integral defense against of forest fires impacts. In this sense the recognition and evaluation of a certain forest scenario, in which a fire can spreading, are basic to develop plan of attack. The design of the combat options requires of the previous knowledge of the structure and space distribution of the forest vegetation, topographical conditions and infrastructures (road, storage of water). The fragility of the ecosystems before situations of high frequency in the presence of the forest fire, requires to dedicate high-priority attention for the importance in the environmental balance. The development of all activity to get an effective line of defense, it cannot separate of an optimized planning, to locate in the forest areas an integral defense in the forest landscape, this work require the permanent analysis on potential forest fire behaviour (Rodríguez y Silva, 2009).

On the other hand, the extensive development of forest areas in Israel since the 1950's and the accumulation of fuel in forests, has led to increased likelihood of high intensity fires, resulting in severe damage to forests and towns adjacent to them. This new situation with higher fire risk around the residential areas during the fire season requires new challenges for the development and management strategies for fire control. In the past 15

years, the landscape of Israel has undergone a major demographic transformation. The massive construction projects and residential areas bordering forests, grasslands and chaparral, has generated a complex wildland / urban interface scenarios across the country. The consequence has been the frequent occurrence of forest fires affecting, houses and citizens.

Between 1980 and 2010, several fires were started in the Carmel Forest and others. On Sunday 2 July 1995, a fire started in the foothills some 15 km west of Jerusalem near the Tel Aviv - Jerusalem highway. Within a short time the fire was out of control and threatening buildings. In the next few hours some kibbutzim and moshavim, had to be evacuated. Some 30 houses were partly or completely destroyed and 29 people were injured by smoke inhalation. This fire was the most destructive fire (2000ha) in the fire history of Israel. The inherent difficulty of managing fire emergencies has been forced to study from a scientific and technical point of view the factors that characterize the wildland fire urban interface, and then propose appropriate measures for to improve the prevention and strategic management of these scenarios.

To achieve these goals it is important to capitalize the experience obtained, because from the experience on the expenditures, dispatched resources, and the fire suppression operations we could model the process. The possibility to complement the economic analysis based on the potential risks to the wildland fire urban interface, given certain fire behavior represents a breakthrough in the design of fire management tools. Also the vulnerability of the forest scenarios is a very important variable that is necessary to determine the level of protection. In this paper is showing the methods and to develop a map to prioritize the necessary prevention and suppression actions as well as the efficient fuel load reduction (Rodriguez y Silva, et al. 2011) in the wildland fire urban interface. The wildland fires becomes a problem of social protection magnitude when large fires escape the realm of the forest environment and enters those heavily urbanized areas, which lack the capabilities to protect themselves from wildland fires (Cohen, 2000). The budget allocation and economy efficient of fire prevention and suppression activities need an objective approach for reducing the socio-economic impacts of wildfires (Molina et al., 2011).

A new approach for operational priorities assessment was developed, which included two aspects: potential risk and fire suppression difficult, being the final index an addition of the two. The paper will present the conceptual scheme for strategic fire prevention and extinction assessment. Also the fire vulnerability data of the urban concentration is considered, including a recent work in Hakdoshin National Forest, (International cooperation Project between KKL of Israel and the Forest Fire Laboratory of the University of Cordoba). With this tool, is possible developing a technical recommendation about de most efficient solution to reduce the potential damage and increasing the safety buffer in the suppression activities.

Keywords: suppression costs, fireline production ratios, cost-benefit, natural resource values, fuel load reduction, safety buffer, potential damage, vulnerability, economic efficiency

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Making fuels management compatible with restoration objectives: case studies from the US Mediterranean-climate zone

Hugh D. Safford, *USDA Forest Service, Pacific Southwest Region, Vallejo, California, 94592 USA*
Department of Environmental Science and Policy, University of California, Davis, California, 95616, USA
+707-562-8934; hughsaafford@fs.fed.us

Current and projected future trends in fire activity and climate suggest that fire frequency and area burned will increase in most of the world's Mediterranean-climate regions. Human populations and housing density are also increasing in all of the Mediterranean-climate regions. Extraordinary amounts of money and resources are already expended in these regions to protect human societies from fire, and expenditures will likely increase substantially over the next half-century. A major focus of fire protection must be ante facto reduction of combustible fuels, but a major concern is the environmental and ecological impacts of such work. A general fire regime framework can be a useful lens through which to view the relationship between fuel reduction and ecological impact. Fuel reduction work in ecosystems typified by fire regimes characterized by frequent, low or moderate severity fires can be readily accomplished in a restorative framework. In such "fuel-limited" ecosystems in the US Mediterranean-climate zone (principally California), man's primary impact on the fire regime has been to reduce fire frequency through fire control efforts, which – often in combination with other management practices – has increased fuel loadings. In these ecosystem types, fuel reduction efforts that decrease surface and ladder fuel density/connectivity and re-establish fire as an ecosystem process are restorative at many levels. On the other hand, fuel reduction in ecosystems supporting "climate- or weather-limited" fire regimes characterized by less frequent, high severity fires is more likely to produce outcomes that are ecologically undesirable. In chaparral shrublands of southern California, current human-driven fire frequencies are very high and fuel reduction work simply adds more disturbance to an already highly-perturbed landscape. The link between restoration and fuel reduction in such ecosystems is tenuous and requires significantly more thought and creativity. In both fire regime types, successful integration of fuel reduction and ecological restoration requires a marriage between science and application, and strong collaborative frameworks that integrate public and private concerns, and ecological, social, and economic perspectives.

I provide examples from California, USA, of pre- and postfire restoration projects in ecosystems characterized by both fuel- and climate/weather-limited fire regimes. The world's Mediterranean-climate regions are facing many of the same future challenges in the management of ecosystems, fire, and fuels. International collaborative efforts should expand to include information- and technology-sharing in how we link fire and fuel management practices with ecological restoration.

Prevention Management of Forest Fires in Israel

David Brand ,Chanoch Zoref, KKL-JNF, Israel

KKL-JNF is responsible for approximately 400,000 acres (1.6 million dunams) of forest and shrub land through the Land Development Administration. KKL-JNF works from the statutory planning stage at both a national and local level and assumes responsibility for preparing the land, planting, and maintenance of the forest. Maintenance activities include thinning trees, pruning, protecting against forest fires, supervision, and enforcement of forest protection rules. The increased frequency of forest fires and the expanse of areas destroyed in forest fires require special increased surveillance, with an emphasis placed on increased investment in fire-prevention activities, together with augmenting and promoting fire-fighting means and methods.

KKL-JNF is working in four different ways to prevent forest fires:

1. Establishing firebreaks around residential communities to protect these areas from forest fires, and to protect the forest from fires that break out within communities, campgrounds, and roadsides. These firebreaks will consist of two strips (total width of 75 meters). The first strip will be 25 meters wide and will contain a small number of trees and shrubs (no more than 30 trees per hectare) with a distance of at least 10 meters between the tree canopies. The trees will be situated far from adjacent houses. The second strip will be 50 meters wide. The trees in this area will be thinned to a distance of 5 meters between the canopies and the trunks of trees and shrubs will undergo extensive thinning to prevent the branches of the trees from coming in contact with each other.
 2. Prevention of forest fires
 - **Establishment of firebreaks in forests** – These firebreaks, in large forested areas, will create a protective strip that will prevent fires from spreading. The firebreaks will be situated in order to prevent fires from spreading between main forested areas. These firebreaks will be located at the mountain ridges along existing roads. Firebreaks will be positioned according to the topography, prevailing winds, and the history of fires in the area. These firebreaks will be approximately 30 meters wide, based on a large and broad road.
 - **General silviculture** –silviculture methods, tree species selection, tree density and the introduction of herds for grazing in the forest will be aimed at lessening the potential for fires to spread, and making firefighting easier. One of the main problems of maintaining these firebreaks is dealing with the use of grazing. The drastic decrease in the number of sheep and goat herds, together with the low economic feasibility of introducing herds into the forests for grazing, has required us to find means to actively encourage grazing.
 - **An efficient fire warning and firefighting system** – KKL-JNF maintains groups on alert for firefighting, a fleet of firefighting trucks and equipment, observation towers, and a national hotline for receiving and distributing relevant information and warnings.
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Forests fires prevention programs in natural reserves and forests in the region of the Mediterranean

Yehoshua Shkedy, Nature & Parks Authority, Israel

Mediterranean maquis is under an intensive use by humans for the last 7,000 years at least. During the last 50-60 years, human activity in open landscapes and particularly in protected areas in Israel decreased dramatically, the maquis is closing up, and the woody vegetation is too dense for two reasons: species that their habitat is of relatively sparse vegetation cannot find the appropriate conditions, and the risk of fire is high. Therefore, maquis management should deal with both problems.

Fire prevention will be concentrated around fire hazards, mainly near settlements and other human activity centers. Woody vegetation will be intensively removed in a ~70 m wide belt around every settlement. Also, fire breaks will be done along existing roads, paved or unpaved, to let fire fighters getting into the protected areas while a fire is going on. These firebreaks will separate major areas one from the other, thus reducing the rate of fire expansion.

The long-term maintenance of the fire breaks will be done using goats grazing. Other animals, like cows or sheep, were found less effective. Not enough goat herds are available for this mission, so the state should find ways to subsidize this activity.

On top of firebreaks around settlements, intensive efforts should be directed to thinning of woody highly dense areas, for nature conservation purposes. The Israeli tradition and education is in favor of planting trees. The idea that there are too many trees in Israel, and we should dilute trees density to prevent fire and for nature conservation purposes is rather unpopular in the Israeli public.

All of the fires in Israel are caused by human activity. The last and perhaps as important steps are education and enforcement. People should be educated to be very careful while handling fire, and those that fail to behave accordingly, should be severely punished.

Grazing as a tool for fire prevention

Shmuel Fridman, Ministry of Agriculture, Israel

Grazing lands have a significant role in maintaining the soil as a financial agricultural source for farmers, as well as maintaining the biological diversity; however they are mostly essential as a frontline gatekeeper for preventing bushfire outbreaks. The grazing flocks are serving as a sentinel for this purpose (fire managing) by reducing the horticultural (vegetative) biomass. It has been shown, during the last year's bushfire outbreak in the Carmel mountain ridge that areas with a good grazing management regime, helped in expediting gaining control over the flames. Therefore proper grazing management is to be promoted, particularly with the utilization of caprine (goat) flock herds, which are well adapted to the Mediterranean horticulture.

The grazing land management directorate of the Israeli ministry of agriculture is promoting a proper and advanced grazing management régime by providing direct and indirect financial and professional support for the breeders. The methods include an optimal grazing land mapping, with proper subdivision of the properties, and conducting an optimal herd and breeder to soil (area) matching program. Unfortunately there are very few field experts for this matter that are well acquainted with the unique demands and trends of managing and upgrading this field, and though their function can be aided and supported by, it cannot be replaced by the many experts that are lacking field experience.

Government involvement in determining forest management policy in Israel

Hagay Snir, Ministry of Agriculture, Israel

Past

1. In 1926 the British Mandate administration passed the Forest Act. The goals of this act were guarding the capacity of open lands to support the growth of woodland and forest, protecting trees and establishing principles and mechanisms for the act's implementation after long years of destruction of the area's woody vegetation cover. This act gave very broad powers to the "Forest commissioner" who was part of the British administration until 1948 and later (up to 1960) worked in the Israeli Agricultural Ministry Forest Dept. The central forestry policy issues which arose during the Mandate were: tree nursery establishment, erosion prevention, acclimatization of new tree species, dune stabilization, grazing land development, protection of native species, developing forest products for the rural economy and an attempting to create a financial basis for forestry. The British acted through legal declaration of forest areas, physical protection and reclamation planting to extend the area of forests and woodlands. They also created forest reserves through mapping their boundaries, declaring them in the official record and empowering the Forest commissioner to enforce the act and manage the reserves.
 2. 1948-1961 – The activities of governmental forestry that were carried out during the British Mandate period in Israel, continued after establishment of the state within the framework of the Agriculture Ministry. These included managing and planting forests in the forest reserve areas and enforcing the Forest Act. Afforestation activities provided employment for new immigrants, aided in new settlement establishment, utilized lands too poor for agriculture and provided scarce raw materials for industry. The government Forest Department in the Agriculture Ministry was active until 1961 and had approximately 150 employees.
 3. As a result of the covenant signed in 1961 between the JNF (Keren Kayemet Leisrael) and the State of Israel, the JNF became, through its Forest Dept., the party responsible for managing forests and carrying out Israel's forestry policy. Around fifty thousand hectares of forest reserves declared under the Forest Act (including ten thousand hectares of planted forest) passed from the hands of government forest department to the JNF, and this was in addition to lands the JNF had planted with forests before the covenant. The government department was closed and most of its workers were hired by the JNF. Forestry research was the only area that
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was stipulated by the covenant to remain under the aegis of the Agricultural Ministry as part of the Agricultural Research Organization. Under the covenant the Minister of Agriculture decreed the director of the JNF, Forest Department to be the Forest commissioner for all forests and protected trees.

Present

4. In 2001, Israel's High Court ruled that the Agricultural Ministry must be involved in managing of our forests through fulfilling the function of the Forest commissioner. To this end the Justice Ministry set up a procedure whereby all management activities carried out in forests by the JNF must be first checked and approved by the commissioner.
5. In the last two years, with the growth in awareness of the importance of forests for the environment and in their popularity among the public, there has been an expansion in the involvement of the Agriculture Ministry in forestry in general and in protecting trees in particular. This involvement can be seen in the professional approval of the Forest Department's work plans (and those of the National Parks and Reserves Authority in the last year); improved tree protection on open, rural and urban lands; development with the JNF of long-term management plans for sustainable forests; creation of standards for wildfire buffer zones and fuel brakes; and the writing of an updated forest law which provides answers to the challenges of today's forest management in Israel.

Future

6. One of its central functions of the Ministry of Agriculture is to be the arm of the Israeli government that organizes and oversees all activities which conserve and develop forests for the benefit of the public. Within this framework, the ministry's major goals are:
 - Advancing the preparation by the JNF of long-term management plans for each forest. These plans will be based on the principle of goal-oriented management, where each forest or woodland is categorized according the goals it is expected to fulfill: multi-purpose landscape forest, recreation forest, fire protection buffer zone and fuel brakes or forest for research and monitoring.
 - Creating a mechanism for evaluating plans and for overseeing management activities through dialog with the organization carrying out field management as well as research bodies.
 - Creating common tools for reporting on the state of the forests (e.g. size, threats, damage and uses) to the public and to decision makers.
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- Completion of an updated Forest Law that will increase protection of forests and clarify principles of management, authority and responsibility with regard to forests.
 - Advance the declaration by the Minister of Agriculture of all forest areas as forest reserves.
 - Aiding advances in areas such as: commercial use of wood and wood chips (e.g. energy, mulch), implementing technological and scientific advances in forest treatment and protection, fire protection on the forest-urban interface and encouraging grazing on forest land.

In this way, the government of Israel will discharge its responsibility to the public by creating policy, overseeing land management activities having an impact on the public interest and caring for national open lands as natural resources.

The Biosphere Reserve - a paradigm shift in nature conservation?

Uriel Safriel, Hebrew University, Jerusalem, Israel

Man and Biosphere (MAB) is a UNESCO program was originally (40 years ago) created to improve nature conservation through community participation, motivated by tangible benefit derived from conservation. The habitual benefit was revenue from ecotourism, attracted by the natural assets protected by an officially designated nature reserves. The prevailing paradigm was that legislation and enforcement antagonize local people, what makes conservation ineffective. MAB recognized that tourism and conservation not always go together, and hence devised a system of allocating different functions to different sections of a protected area – one in which nature enjoys maximal protection, with no human intrusion (core), encircled by a belt in which nature is disturbed yet remains attractive to tourists (buffer), enveloped by the areas in which the local population resides, and enjoys improved well-being as revenue from the protected nature (i.e. from tourism) is used (transition). To be recognized as such protected area, called “biosphere reserve, it has to include a legally protected core, and a resident, local population using the buffer for basic subsistence and residing in the transition. This paradigm prevailed, being supported by a few cases of apparent success, yet it has an internal inconsistency – the biosphere reserve concept calls for local participation motivated by conviction, yet at the same time it requires legal enforcement, meaning that the population’s conviction would not suffice. A recently increased recognition is that biodiversity should be protected not just due to its aesthetic attributes but mainly owing to its involvement in the provision of ecosystem services, all of which are of tangible benefits critical to human life and the sustainability of human development. This recognition drives a paradigm shift in nature conservation, leading to a different design and management of biosphere reserves, one that may make community awareness of the value of nature more effective in its conservation than legislation and low-enforcement. Among other advantages, this emerging paradigm would support climate change adaptation, including adapting to the increased risks of forest fires.

Research for people, but without people: What is missing in research on forest ecosystem services?

Daniel Orenstein (Ph.D.), Faculty of Architecture and Town Planning, Technion – Israel Institute of Technology, Haifa, Israel

Ecosystem services (ES), defined as “the benefits provided by ecosystems to humans, which contribute to making human life both possible and worth living” (Millennium Ecosystem Assessment, 2005), have emerged as a dominant theme for guiding sustainable natural resource management and land use policy in general, and forestry policy in particular. The assessment of ES (identification, quantification, valuation) has evolved into a major activity bridging the scientific and policy making communities, demanding an integrative approach that considers ecological, economic and social evaluation criteria. While this triumvirate of approaches is advocated in most major writings on the topic, in practice social assessments lag far behind the others in research and application. In this work, I aim to strengthen the role and presence of social research in ES assessment in the Carmel Forest.

A strengthened role is needed for at least two reasons. First, according to their very definition, ecosystem services are as much of a social concept as a biological one, and therefore should be assessed as such. Ecosystem services often have non-material value (e.g. “cultural” services) that cannot be measured using ecological research tools and are difficult, if not impossible, to measure in economic terms. For assessing the importance of such services, the methodological and theoretical tools of the social sciences (e.g. stakeholder surveys and interviews) are required. Second, the strengthening of social assessments is needed to make research more policy relevant. Although researchers often perceive policy making to be a rational, data-driven endeavor crafted by professional, it is actually a social process where rationale and facts do not necessarily determine outcomes. Policy makers require a firm understanding of social preferences regarding ES to order to assure their policy recommendations will be socially acceptable, as well as ecologically wise.

Drawing on my current social ES assessment work in Israel’s southern regions and on international work from the literature, I consider how the inclusion of social ES assessment in the Carmel Forest might strengthen post-fire policy making and fill gaps in our knowledge regarding how stakeholders perceive the forest and its management.

FIRESMART – Management Options to Prevent Unwanted Forest Fires – Towards the final results

A. Sebastián, M.J. Yagüe, L. Villar, J. San Miguel, C. Hernando, J. Madrigal, M. Guijarro, S. Garrido, R. Planelles, A. Buffoni, J. Cunha, R. Alvés, C. Bostrom, A. Gantaumme, B. Prevosto and M. Jappiot.

Fires are already among the most important threats to forests, and still their incidence is expected to worsen as a result of climate change. This fact has raised the need for reinforcing what it is considered a basic pillar of fire fighting: fire prevention. Forest fire prevention is approached according to different methodological considerations, priorities, organizational and legal frameworks. Yet, the base knowledge for fire prevention practices has not been tackled systematically; it is atomized in local procedures and often lacks accessibility. Nowadays it is more and more recognized that money spent in prevention will allow larger savings in the future. However prevention has to be effective in its results and its financing sustainable. This means that prevention activities have to be effectively planned and carried out. Moreover the effects of prevention activities have to be monitored, evaluated and shared to identify the modifications or update needed. The integration of fire prevention measures in the regular forest management is the appropriate way to ensure this sustainability. The comprehensive analysis of the current prevention approaches (theories and practices) and the identification of obstacles and constraints to an effective prevention is in fact a key challenge for a sustainable forest management. FireSmart project is a Support Action financed by the European Commission under the 7th Framework Programme tackling the issues above mentioned. The ultimate objective of this project is to contribute to the prevention of unwanted forest fires by identifying possible obstacles that reduce the effectiveness of prevention measures and by deriving recommendations to integrate fire prevention in regular forest management. FireSmart aims to assess possible options to overcome the above-mentioned obstacles and draw links between stakeholders (particularly among those that compose the silvicultural chain).

To this aim an exhaustive retrieval of information has been carried out by i) gathering all types of fire prevention documentation, and ii) thorough direct interaction with stake holders: from meetings with local agents of the silvicultural chain to international workshops. This interaction includes a 96-item questionnaire designed to ascertain the opinion of European experts about the efficiency and consequences of current management

practices, restrictions, legal issues and social and communication-related activities. The questionnaire was addressed to (circa 2000) forest managers and scientists. All this material was organized in a Web-accessible document management system, analyzed and input into SWOT analysis from which recommendations for improving the efficiency of prevention measures were derived. Results are being uploaded in the project Web page (<http://www.firesmart-project.eu/>) which is expected to be a technical (virtual) meeting point and discussion forum for experts, decisions makers, the academic community, students and citizens. The project results have emphasized the agreement of forest fire experts on the need for a fire prevention common policy. As for of the South European countries it is confirmed that although these countries have comparable problems, each country or region has addressed the fire prevention topic in its own way. A common policy on prevention can represent therefore an opportunity to address the different aspects of the prevention issue in a more effective manner. EU-FireSmart is expected to positively impact several social groups. The availability of a comprehensive collection of up-to-date projects reports, publications, along with the detailed analysis of this information and the derived conclusions will improve the possibilities for the scientific community to address knowledge gaps, develop new proposals, and improve strategies. Forest managers will get condensed results from different projects and the possibility to compare their management approach with the one adopted in other regions. Forestry community is expected to obtain helpful information on the development of prevention strategies that they can use in order to improve local forest management. Finally a strategic roadmap, currently under development, aims to contribute to the definition of a European policy on fire prevention where synergies with other land planning policies related with forest fires (i.e.: civil protection but not only, also agriculture, urban, risk management, land use...) are identified and developed.

Protecting Each Other The Forest and the Community

Salman Abu-Rukun

Israel Nature and Parks Authority, Israel

Living near a forest is a great and rare privilege. But people who live near forests must understand that their lives are intertwined with the forest. We must realize that we protect the forest and the forest protects us.

Many of us do not rightly appreciate the forest as an ecosystem that gives us a variety of services and imparts values – aesthetic, health, social, cultural, economic and ecological. We must also consider the ethical aspect of the environment – we humans have not properly recognized that trees and animals also have a right to live.

I will focus on the ecological aspect of trees, which are the main component of the forest. Trees purify and cool the air and filter, settle and absorb dust, solids and gasses. They also remove odors, reduce noise and prevent erosion, rockslides and floods. Trees are biological sponges and powerful filters; no manmade facility can take their place with the same efficiency – and trees do it all for free.

1. “Clean lung”:

For 80 years of the life of a 90-year-old oak tree (that is young for an oak), it absorbs the carbon dioxide in 40 million cubic meters of air each year – a total of 2,352 kilograms. Such a tree uses about six calories of sunlight and contributes 1,712 kilograms of oxygen to the air.

2. Improving climate

Trees are extremely important under harsh climate conditions like those in our country. Green swathes can bring down the temperature by 3.5 degrees in the summer and raise humidity by 5%. Trees increase air flow around their crowns even on days when meteorological conditions do not allow air pollutants to disperse.

3. Dust and pollution traps

A well-developed, 30-year-old tree in a public park in the center of a community absorbs 1,200 kilograms of dust and 80 kilograms of aerosols (tiny, toxic-gas-bearing, airborne particles that penetrate the lungs). Such a tree purifies 100,000 cubic meters of polluted air.

4. Noise reduction

The thicker, the more dense and layered surrounding trees are, and the larger the area they cover, the more efficiently they reduce noise.

We receive all these essential services and more, especially those of us who live near the forest. Perhaps because forests give their service for free, people tend to discount it, and are willing to give it up without much thought. Sometimes they even do so on the advice of planners, engineers and architects, although these experts lack basic education in biology and ecology – which is no less essential than education in engineering, planning and architecture.

Forests constitute one third of the world's land mass. Once we understand how forests protect us by the services they give us, and that their variegation and biodiversity ensures the perpetuation of these services, it should be natural for us to protect ourselves by protecting the forest. But people do not always know how to do this.

What we need is for communities to become reacquainted with forests on a new and different level. We should get to know the forest with all of our senses and understanding the variety of services we enjoy thanks to it. This should be done by inculcating two principles: Trees and forests have a right to live, just like we do, and for the forest to protect us, we have to protect the forest. This is our moral obligation. It is our task; there is no one else to do it. Let us not cut off the branch on which we sit and on which our lives depend.

Forest Fire Modeling aided by Web GIS in a Changing Climate

Prof. Kostas Kalabokidis and Palaiologos Palaiologou, Geography of Natural Disasters Laboratory, Department of Geography, University of the Aegean, 81100 Mytilene, Greece

Over the last decades, wildfire modeling was evolved and applied in several parts of the world facing the catastrophic effects of forest fires. Fire behavior and fire ecology research was mainly initiated in USA, but important modeling aspects have been studied, implemented and improved elsewhere as well, such as in Canada, Australia and the Mediterranean countries. Computational advances allowed calculations to be done in shorter time, with increased repeatability and storage capacity, added the spatial context, and introduced parallel processing on high performance computing (HPC) and/or cloud computing environments. As a result, fire behavior modeling gained a momentum and interest among researchers, firefighting personnel and managers, while several applications can be now found on literature and the Web. In addition, there is a shift of study attention to the impact and effects of climate change on wildfire phenomena and regimes. Climate change causes alterations both on regional and local weather patterns and vegetation cover. Vegetation is affected by the fire regime change, which is caused by changes in species composition, fuel quantity and distribution. There is an increased need not only for updated current vegetation and fuel maps that can be used for fire risk and fire behavior modeling, but also for a projection of future conditions within the climate change context. Several future climate scenarios are widely available, but there is a need for validation, followed by their usage in conjunction with the projected vegetation types and resulted forest fire response. Desktop fire risk and behavior modeling software tends to be difficult and complex for end-users unfamiliar with Geographic Information Systems (GIS) and fire modeling parameters, demanding a shift to more flexible and user-friendly environments such as Web GIS approaches (e.g. see Google Earth and Bing Maps). In a series of our research attempts, we have calculated average-worst and future local weather conditions and climate change scenarios to integrate them with fire behavior prediction software and produce fire behavior estimations for past and/or simulated fires in Greece (e.g. in Athens and Lesvos Island of the Aegean Sea). In the case of Athens wildfires, the climatic model MAGICC (Model for the Assessment of Greenhouse-Gas Induced Climate Change) and the data base SCENGEN (SCENARIO GENERator) were utilized to create future weather case studies (scenarios) that were utilized within the FARSITE (Fire Area Simulator); simulations did show that the climatic trends of fire weather parameters is

expected to influence increasingly the behavior of forest fires in Greece during the next decades to come. For the case study of Lesvos, we have conducted fire predictions of two on-going shrubland fire events of the summer 2011 based on the HFIRE fire simulator, with promising initial results. Fire weather relied on Remote Automatic Weather Stations (RAWS) and a weather forecasting system based on the SKIRON (<http://forecast.uoa.gr/>) weather forecasting model (horizontal resolution of about 5 by 5 km for an area that covers the entire northern Aegean region). The innovative approach of our methodology is also that all calculations were conducted through a Web GIS platform that is based on a cloud computing environment, as one of many other case study scenarios of the European Union-funded FP7 project VENUS-C (www.venus-c.eu); this may allow firefighting officers to forecast fire spread through a very simple but comprehensive environment by simply providing the ignition point and the projected duration of the wildfire. Complementary, a decision-support Web GIS was developed within the scheme of another Microsoft Research-funded project that provides on-line forest fire prevention and management (<http://virtualfire.aegean.gr>); among the features supported are the creation and visualization of 3-day weather prediction maps for several weather parameters (temperature, relative humidity, cloud cover, precipitation and wind), real-time data monitoring from a network of RAWS (<http://meteo.aegean.gr>) and daily geographical representation of the fire risk forecast at different local areas based on HPC. The daily fire risk prediction map is a combination of meteorological (wind speed, fuel moisture, precipitation, etc.), socio-economic (distances from urban areas, roads, power lines, waste disposal areas, etc.) and biophysical (cover types, fuel models, terrain, etc.) quantitative and spatial parameters calculated with artificial neural networks. The above in conjunction with a rich toolbox of mapping and monitoring utilities (shortest routes, closest water tanks, service areas, measurement and digitizing tools, e-mails, RSS, fleet tracking, web-cameras, etc.) support free-of-charge firefighting forces for two years now in Greece.

Post-fire Analysis of Pre-fire mapping of fire-risk: A recent case study from Mt. Carmel (Israel)

Yohay Carmel¹, Shlomit Paz², Faris Jahshan¹, Maxim Shoshany¹

¹*Faculty of Civil and Environmental Engineering, Technion – Israel Institute of Technology, Haifa, Israel.*

²*Department of Geography and Environmental Studies, University of Haifa, Haifa, Israel*

The recent devastating wildfire on Mt. Carmel provided a unique opportunity to evaluate a fire-risk map constructed for the region, published two years ago in this journal. This largest forest fire in the history of Israel, occurred during December 2010, covering 2,180 Hectares, burning more than half-million trees and causing the loss of life of 45 people.

A study of fire risk in this area was conducted between 2007 and 2009 utilizing a combination of Monte Carlo Simulation of spatial spread of fire ignition with fire behavior model (FARSITE). The fire risk map produced in 2009 is assessed here with reference to the area burnt during December 2010. The results showed that most of burnt areas corresponded to high risk levels in the risk map. According to a null model, the five lower risk levels taken together would have corresponded to 50% of the burnt area, while in fact they were presented in only 5.6% of the area. In contrast, the three highest risk levels, for which the null model expectation would be a representation of 30%, were represented in 87% of the area. Comparing the fire risk map against the map of the real recent fire provided support to the general approach, and strengthened the confidence in our fire risk model.

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Evaluating drought stress changes in planted forests by means of remote sensing

Michael Dorman¹, Avi Perevolotsky² and Tal Svoray¹

¹ *Department of Geography and Environmental Development, Ben-Gurion University of the Negev, Beer-Sheva 84105, Israel*

² *Department of Agronomy and Natural Resources, Agricultural Research Organization, Volcani Ctr, Bet Dagan 50250, Israel*

Global climate change impacts, such as mass tree mortality in forest ecosystems, are being observed with increased frequency worldwide. Remote sensing is a useful method to study this phenomenon, since it is the only method which allows obtaining meaningful data on vegetation physiology, while continuously monitoring large areas with high resolution in time and space. Normalized Difference Water Index (NDWI) is a remote sensing index sensitive to vegetation water content. In previous studies, NDWI was found to be correlated with drought and insects damage in forests. The purpose of this study is to examine NDWI changes during a recent drought period in Israel, and more specifically – the effect of precipitation changes on NDWI along a range of environmental conditions, both at a large scale (forests located in different climatic zones) and small scale (different site characteristics within a forest).

Pinus halepensis is the most common tree species in the planted forests of Israel. Increased mortality rates of this species have been observed lately in many forests, following a series of dry years which started in 1998-99. NDWI index was calculated for three forests along the precipitation gradient in Israel: Biryá (~650 mm), Gilboa (~420 mm) and Yatir (~260 mm). For this purpose Landsat-7 ETM+ images obtained during September-October were used, one image per year during 2002-2011. Significant decrease of average NDWI during 2002-2011 was found in Yatir ($p < 0.001$) and Gilboa ($p < 0.01$), but not in Biryá ($p > 0.05$). Correlation of NDWI with total amount of precipitation during previous rain season was significant in Yatir ($p < 0.01$), but not in Gilboa and Biryá ($p > 0.05$). Correlation of NDWI with precipitation was not random in space, i.e. distinct areas with high correlation of NDWI with precipitation could be observed. We propose to further study the environmental factors effect on NDWI both at a large and small spatial scale.

Very Large-Scale, High Spatial Resolution Airborne Thermal Mapping of Wildfires in Northern Canada using the TABI-1800

Stephen Achal, *Itres Research Limited, Canada*

The TABI-1800, a new high-performance, thermal imaging/mapping system, was used between May and July 2011 to operationally map active wildfire-affected regions in Northern Canada. This commercial-off-the-shelf imager, with proven high detection rate of hot spots, ability to see through most smoke, and patented 1800 across-track pixel diffraction-limited optical system, was flown under contract to the Alberta Government in a Cessna 310 aircraft in support of wildfire suppression efforts. Over 400 square kilometres of actively burning boreal forest were thermally mapped each night by a small crew at an average spatial pixel resolution of 1.5 meters/pixel. After each night's mission, fast turnaround of more than 100 gigabytes of raw TABI-1800 data to radiometrically calibrated, orthorectified, mosaicked and analyzed fire map products was typically completed in less than five hours after landing. Large scale, precision georeferenced, and GIS-compatible map products showing detailed fire front perimeters and delineated hot spots were provided to wildfire managers before the commencement of the next day's suppression efforts. These maps were used to efficiently and effectively coordinate both water-bombing air operations and mobilization of ground personnel and assets.

Fire Forecasting System

Besora Regev, Mr Shai Amram, Ministry of Public Security, Israel

Background

- Yearly, an average of 1,000 fires are forest fires which burn 37,000 m²
- About 75% of these fires occur between May and September.
- The majority of forest fires occur near roads, at a distance of up to 50 meters from the road.
- Today, the Ministry of Public Security together with the Fire Brigade are able to forecast real time fire occurrences, including the direction of the fire, fire lines and fire intensity.
- Currently, the Ministry together with other units are working to prepare a data base to determine fire prone areas based on scientific data: sediments, soil type, direction and force of winds, dampness of soil and vegetation, kindling and land topography.

MODELS:

- All models use the same permanent variables such as direction and force of winds, precipitation, dampness, land conditions and combustion materials.
- European countries: FARSITE and BEHAVE – models estimating the direction of fire spread.
- US and Canada: National Center for Atmospheric Research (NCAR). The US model has been developed in combination with the following agents: National Center for Atmospheric Research (NCAR), National Center for Environmental Prediction (NCEP), FSL Weather, Air Force Weather Agency (AFWA), University of Oklahoma and the Federal Aviation Administration (FAA).
- Weather Research Forecasting Model (WRF Fire) is based on tools and models which include all vital variables.

Fire Forecasting System - MATAS:

- The forecasting system receives fire locations reported directly from the field, inputs the information and generates a result of fire progression according to topography, land use and atmospheric variables.
 - An operational system which includes high geographical distinct resolution, up to 50 meters.
 - Updates itself every six hours.
 - An integrated tool for fire brigade, Keren Kayemet LelIsrael (KKL) and Israel's Nature and Parks Authority (INPA), to manage fire fighting in open areas and forests.
 - Decision making tool for decision makers for everyday purposes and in an emergency:
 - Future development – incorporation of contaminating fuels model as a result of spread of hazardous materials
-

Insights:

- Proposed system will serve all organizations dealing with fire fighting: fire brigade, KKL and INPA, and will be incorporated into “Shalhevet” system – The Fire brigade operational system
- System allows for current routine mapping of dangerous areas in Israel
- In real life events the system is able to determine the direction and force of the fire in advance and 6 hours ahead of time.
- The system can determine the access route, altitude, sensors, human resources, danger zones, location of hazards materials and more

Initial system which will act as a platform for future models needed, such as: contaminating sediments model and urban fires.

The influence of recurrent forest fires on the abundance of *Pinus halepensis* Mill. Mt. Carmel, Israel.

Naama Tessler^{*1}, Lea Wittenberg¹, Noam Greenbaum^{1,2} and Ella Provizor¹

¹ *Department of Geography and Environmental Studies, University of Haifa, Haifa, 31905 Israel. 972-4-8249609*

² *Department of Natural Resources and Environmental Management, University of Haifa. Haifa, 31905 Israel.*

* *ntessler@geo.haifa.ac.il*

Forest fires represent one of the most important ecological factors in Mediterranean ecosystems. Considered as a natural disturbance, fires play a key role in the evolution, distribution and organization of this environment. Particularly, in *Pinus halepensis* forests, the importance of fire towards the maintenance of their structure and biodiversity has long been documented. Recent alternations in fire regime due to coupled effect of possible climate change and intensification of human activities, can lead to changes in vegetation structure and species composition.

The Mediterranean ecosystem of Mt. Carmel, in the NW of Israel, is subjected to increasing number of forest fires, some of which occur in areas that have been previously burnt.

Accordingly, the study aimed at assessing the effect of recurrent burnings on the regeneration and the spatial distribution of *Pinus halepensis*, as reflected by the number of trees in 18 sites, differing by the number of previous fires and time lapses since last burning. Four treatments were addressed: 'single-fire' sites burnt in 1989, 1999, 2003, 2005, 2006; 'two-fire' sites, burnt in 1982/2006, 1983/2006, 1983/1989, 1989/2003, 1989/2005, 1998/1999, and 1999/2005 and 'three-fires' sites burnt in 1989/1998/1999 and 1989/1999/2005, in addition to four control (non-burnt) areas.

Methods included field survey; at each site, 100 1m² quadrates were randomly placed to record the number of the trees, statistical differences between the sites were calculated using nonparametric ANOVA (Kroskal-Wallis) test.

The results reveal differences in the number of pine trees presented at each treatment. Generally, the amount of pines is inversely related to the number of fires. For example, trees density in the sites that were last burnt during the spring of 2005 varied between 1.2 tree/ 1m² (single-fire) and 0.25 and 0.39 tree/1m² in the two and three-fires sites, respectively, whilst in the control site 0.46 tree/1m² was recorded. Similarly, trees density in the areas that were last burnt during summer 2006 were 3.26 and 2.51 tree/1m² for the single and two-fire site, and 0.39 tree/1m² in the control plot. Equivalent trend was apparent at all treatments. The effect of recurrent fires, however, was particularly evident when time interval between two successive fires was less than 20 years – the time needed for *Pinus halepensis* to mature and produce an adequate seed bank. Apparently, not only the number of fires, but also the fire season has a major effect on regeneration dynamics. Seemingly, spring fires may lead to strong decrease in *Pinus halepensis* germination and regeneration. Under Mediterranean climate, germination of pine seeds occur only after the first winter rain, therefore, in case of long dry period between the fire and the precipitation the seeds might be exposed to predation.

Key words: Mediterranean, Mt. Carmel, *Pinus halepensis* Mill., Recurrent forest fires

Forest wildfires and post-fire management: Changes in soil chemical and microbial components

Orit Ginzburg and Yosef Steinberger, The Mina & Everard Goodman Faculty of Life Sciences, Bar-Ilan University, Ramat-Gan, Israel. oginzburg@gmail.com

Wildfires constitute major disturbances in forests worldwide and extensively affect soil ecosystems. On top of the wildfire damage to the ecosystem, there is further implication of the post-fire practice chosen to be implemented at the burned areas. A common practice used to manage burned areas is logging of the burned or damaged trees. Although this practice is widely used, there are some who oppose it and call for the use of more sustainable methods relying on the natural ability of the forest system to recover. One of the important biological components in soil undergoing recovery processes is the microbial community. It reacts rapidly, changes according to the new conditions, and is, thus, considered a good indicator of soil function. Over a period of 3 years, this research examined the effects of wildfire and post-fire management (natural regeneration versus salvage logging) on the activity and diversity of soil microbial communities in the coniferous Byria Forest in Israel. Methods used included the measurements of combined abiotic (soil moisture, organic matter, total soluble nitrogen) and biotic (microbial respiration, biomass, and catabolic diversity) parameters of soil function. Results indicated substantial changes in moisture and in soluble C and N in soils at burned, compared to unburned, areas. Higher soil microbial activity was found in burned, compared to unburned, areas, followed by lower microbial N which indicated microbial inefficiency to retain soluble N. Areas managed by logging showed lower soil-moisture content during winter and summer due to the exposure of soil to runoff and radiation in these areas. Moreover, lower soil microbial activity was found in logged areas until 1.5 years after logging, indicating the length of time of the logging disturbance. These findings support the recommendations in the literature to postpone logging practice for a period of 1-1.5 years after wildfire in order to prevent additional disturbance or, in turn, create a mosaic of logged and naturally recovered areas that support each other.

Integrating GIS, Remote Sensing and Web technologies for forestry management: monitoring, decision making and public participation

Azaria Ilan, SensinGIS Geospatial Services, Israel

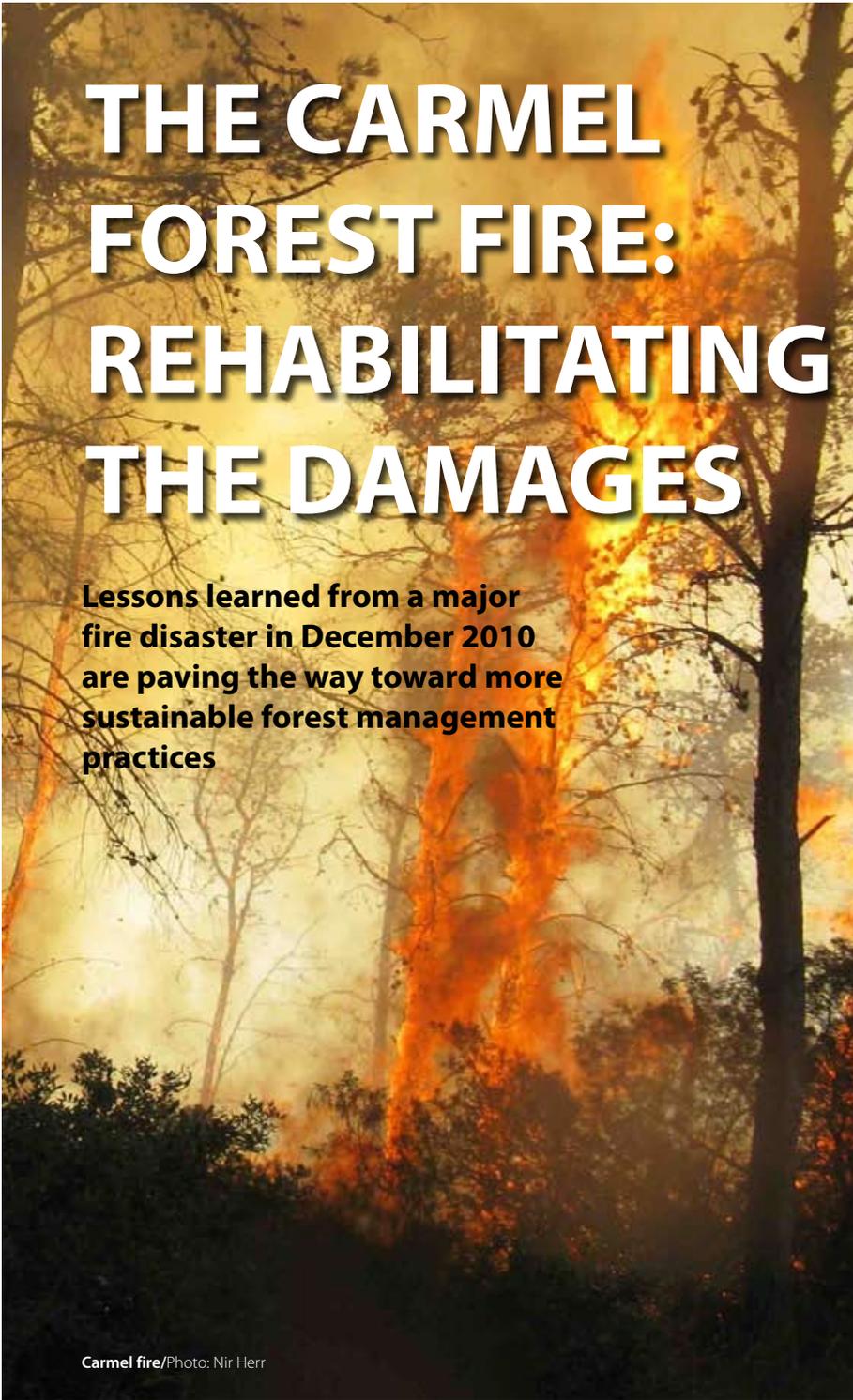
Email address: ilan@sensingis.com

The deterioration of the Mediterranean forest and the climate characteristics of Mediterranean regions make the Mediterranean forest exposed to fire hazards. Due to multiple factors related to climate changes (long-term and short-term), the Mediterranean forest becomes more and more vulnerable during the last decade to this type of natural hazard. However, natural factors and climate changes are not the only reasons for this acceleration of deterioration. Catastrophes related to forest fire in the Mediterranean region have become mega catastrophes due to urban sprawl phenomenon, lack of education and public participation to forest fire hazards, insufficient monitoring and lack of maintenance.

Efficient use of Remote Sensing, Geographical Information System (GIS) and Web technologies can be helpful for this kind of problem. In large scale, local authorities can use these tools as the main platform for the rehabilitation of deteriorated forest or for the protection before forest fire catastrophes.

A spatial database was designed based on scientific theories of Mediterranean forest and field forest survey experience. This database was mainly designed for the rehabilitation of the Carmel forest, where authorities and the population is systematically confronted with forest fires. The data of this web-GIS platform is based on ground survey data collection (high scale geometry resolution) and data from multispectral imaging that allow us to detect temporal changes, anomalies, water stress, classify tree species, soil erosion, DTM. The combination between high resolution ground data collection (DGPS Trimble nomad) and data obtained from multispectral imaging satellites allows us to reduce inaccuracies and to provide reliable information.

The following article was previously published in *Israel Environment Bulletin*, Volume 37, September 2011 following the December 2010 Fire on the Mount Carmel Forest

A photograph of a forest fire with large white text overlaid. The text reads: "THE CARMEL FOREST FIRE: REHABILITATING THE DAMAGES". The background shows a dense forest with a large fire burning through the trees, creating a hazy, orange glow.

THE CARMEL FOREST FIRE: REHABILITATING THE DAMAGES

Lessons learned from a major fire disaster in December 2010 are paving the way toward more sustainable forest management practices

Carmel fire/Photo: Nir Herr

Israel's largest forest fire began on December 2, 2010 on Mount Carmel, just south of Haifa in Israel's northern region. The area boasts a nature reserve, a national park and forested expanses replete with natural, landscape and heritage values. It serves as a green lung and one of the most active recreation and tourism areas for residents of the Haifa metropolitan area and Israel as a whole.

The raging fire was not easily extinguished. Exceptionally warm and dry conditions coupled by strong winds led to its quick spread, with devastating results: 44 lives lost, mostly of Israel Prison Service cadets on the way to evacuate a nearby prison, 17,000 people evacuated, 2,500 hectares of natural forest and shrubland destroyed, nearly 5 million trees burned.

Prior to December 2010, the area was covered by a dense pine forest. A week later, a new landscape was created, made up of patches that were completely burned (mostly pine), partially damaged (mostly Mediterranean shrubland and oak and some pine) and not damaged (mostly shrubland). The havoc created by the fire called for large-scale rehabilitation – of lives, homes, sewage systems, roads, asbestos structures, and the natural habitat.

The response was not long in coming. During the fire, the Ministry of Environmental Protection and the Ministry of Health instructed residents in the area not immediately threatened by the flames to stay inside, shut windows and operate air conditioners to avoid inhalation of the hazardous fumes. The Environmental Protection Ministry also worked with the Ministry of Agriculture, the Nature and Parks Authority and the Keren Kayemeth Lelsrael-Jewish National Fund (Israeli Forest Service) to close down parts of the Carmel which



became dangerous due to the risk of falling trees, and in order to let the competent bodies clear the ground of danger in main roads, hiking paths and parking areas and prevent soil erosion. The ministry took immediate steps to reduce risks from hazardous substances, remove asbestos from buildings that were damaged, rehabilitate sewage infrastructures at a cost of 15 million shekels, and close down illegal garbage dumps in the area.

Preparing for Sustainable Forest Management: From Committees to Recommendations

Recognition of the devastation wreaked by the Carmel forest fire led to a government decision on December 5, 2010 on rehabilitation and rebuilding in the wake of the fire. The resolution called for the establishment of an interministerial steering committee to formulate a plan to remove impediments in the process of repairing the damages of the Carmel wildfire and restoring normal life. The second paragraph of the resolution

called on the Minister of Environmental Protection, in cooperation with the Ministries of Finance and Agriculture, Nature and Parks Authority and Keren Kayemeth Lelsrael-Jewish National Fund (JNF) to formulate and present a plan "to rehabilitate the animal and plant life that was damaged by the fire, including campgrounds, animal parks and the Carmel wildlife preserve (Hai-Bar)."

By the following day, the director general of the Ministry of Environmental Protection convened the representatives of these bodies to discuss the steps necessary to carry out the mandate. During the deliberations it became clear that a vast quantity of information already existed on the subject as a result of previous research studies conducted in the aftermath of major fires, including the devastating fires which took place in the Carmel in 1989 and in Sha'ar Hagai along the Jerusalem-Tel Aviv Highway in 1995. The main problem was not a lack of scientific material and knowhow but rather implementation of the conclusions on the management of forest and woodland areas, especially

when it came to fire prevention. A major goal was to reach a joint action plan based on principles agreed upon by all the stakeholders. Four work teams were born that day to formulate an immediate action plan on the following issues: information and education; safety and immediate action; long term ecological rehabilitation; and mapping. On December 20, 2010, the committee on long-term ecological rehabilitation, headed by Dr. Yeshayahu Bar-Or, Deputy Director General for Natural Resources at the ministry, appointed another three professional subcommittees: on forest management and ecological rehabilitation, on legislation and on landscape rehabilitation in residential areas.

Preventing the Dispersion of Asbestos Fibers from Structures Burned in the Carmel Region

Risk of the release of asbestos fibers from the structures burned during the Carmel fire, especially asbestos cement roofs, led to immediate action by the Ministry of Environmental Protection. Within a few days of the outbreak of the fire, ministry representatives surveyed Carmel communities to identify asbestos structures damaged during the fire. In parallel, funds were allocated to asbestos contractors for actions to prevent public exposure to asbestos fibers from these structures and to dispose the asbestos waste.



The forest management and rehabilitation committee carried out most of its work in expert subcommittees on a wide variety of subjects: planting, fire breaks, grazing, soil erosion, pests, invasive species, rare species, zoological rehabilitation, research, the Hai Bar (the 600 hectare breeding and reaclimatization center), biosphere reserves, and more. The preliminary recommendations of the committee, which were open to public comment and review, were presented to the public in a conference held in Haifa University on May 19, 2011.

During the review process, forest management and ecology experts resisted the popular call for the greening of the burnt area as soon as possible by means of accelerated afforestation. The experts insisted that a return to previous conditions was by no means the ideal. In fact, recommendations called for basing the forest's rehabilitation on natural regeneration processes, which would be accompanied by monitoring and research. The rehabilitation plan itself is based on three foundations: preservation of the newly created patchy landscape formed by the fire, management of vegetation

growth (tree density) which will shape the future landscape and establishment of buffer zones (fire or fuel breaks) around settlements and roads to prevent the quick spread of fire through the area.

The main recommendations for Carmel rehabilitation include:

- › **Natural regeneration:** One of the central recommendations of the committee is that the Carmel would not return to its previous state prior to the fire. Pines will not be planted densely and natural regeneration will be partly based on broad-leaved trees such as oak, carob and other tree species. Pine forests will be allowed to develop in some areas. Pines will be sparsely planted in specific areas and their dense regeneration will be thinned out at an early stage.
- › **Increased grazing:** Grazing will be renewed at a wide scale, as a central tool in thinning surplus vegetation and reducing the dry, flammable material in the forest in order to reduce the frequency and intensity of fires.
- › **Fire breaks:** A system of fire breaks will be established between settlements and main roads and the dense forest in order to reduce the probability of a major fire and the intensity of damages that it may cause residents and passersby. Fire breaks will not be sterile areas which are clean of vegetation, but will include a tree population at a lower density and height than the forest, while still preserving a pleasant landscape and rich biodiversity.
- › **Cooperation:** Full and continued cooperation between organizations which manage the area, local authorities and firefighting units is needed to implement the recommendations.
- › **Additional rehabilitation activities:** Additional recommendations relate to visitor services, treatment of the large quantity of burned trees in the area, management of regenerating vegetation (pines and broad leaved vegetation), new planting, rehabilitation of ancient terraces, prevention of erosion, conservation of rare species, destruction of invasive species, preservation of the natural pine, treatment of pests, functioning of the Carmel as a biosphere reserve, and long term monitoring of the rehabilitation process.
- › **Future planning:** Detailed plans should be made to implement the committee's recommendations in other similarly forested regions in Israel, instead of waiting for the next disaster to strike.

Carmel Biosphere Reserve

UNESCO declared part of Mount Carmel a "Biosphere Reserve" in 1996 within the framework of its Man and Biosphere (MAB) Programme, granting it international ecological significance. Biosphere reserves seek to reconcile conservation of biological and cultural diversity and economic and social development through partnerships between people and nature.

The following description of the Mount Carmel Biosphere Reserve is provided on the UNESCO MAP Biosphere Reserves Directory: "The Mount Carmel massif is situated in the northwestern part of the country, rising from the Mediterranean Sea to about 500 meters above sea level. The mountain is rich in its biological, geological and geomorphologic diversity with contrasting landscapes, a mixture of agricultural areas and prehistoric and archaeological sites. Mount Carmel is mainly covered with Mediterranean oak shrubland (*Quercus calliprinos*) and locally some mixed pine (*Pinus halepensis*) forests. Its batha and garrigue vegetation as well as coastal zones are of special interest from a conservation point of view."

And, of course, an essential element in the recommended action plan is the human factor. Means must be taken to increase public awareness of the risks of forest fires and of the measures which should be taken to prevent them. To address this,



Aerial firefighting/Photo: Menachem Zalutzki

Forest Fires under Climate Change: Israel Presentation to CIRCLE 2 Annual Meeting

In June 2011, CIRCLE 2 (Climate Impact Research & Response Coordination for a Larger Europe) held its first annual progress meeting in Bologna, Italy. Within the framework of a session on potential areas of collaboration for 2011/12, Israel presented the subject of Climate Change and Forest Fires and proposed a Mediterranean workshop in Israel on the subject with the goal of exchanging knowledge, adaptive measures and practical experience on options to prevent forest fires and to manage ecological rehabilitation after fires.

educational and legislative steps must be promoted to prohibit the igniting of fires in forests and their vicinity during extreme weather conditions which pose increased risks for the spread of fires.

Changing the Carmel Landscape: More Biodiversity, Less Fires

Not long ago, the Carmel forest was a low-lying forest, characterized by oak and Jerusalem/Aleppo pine, some carob trees and mostly shrubs. The open patches in the historic forest, along with the grazing in the area, helped prevent the quick spread of fires. However, as planting and seed dispersal from mature trees increased and grazing decreased, patches were no longer left in the lush forest, increasing the risk of wildfires.

A major contributing factor to the 2010 forest fire was the prevalence of pine trees. The indigenous Aleppo pine (locally known as the Jerusalem pine) as well as other pine species planted in the past are highly flammable. However, their quick growth and ability to survive in arid or rocky soil led to their wide use even before the establishment of the State of Israel. Efforts to diversify Israel's forests with such native species as carob, pistachia and oak have been ongoing for more than two decades. This is especially the case when it comes to fire prevention, since oak and other

broad-leaved trees are more fire retardant and their chances of survival after fire are higher than the easily flammable pines.

Toward Implementation

At the May 21 conference on the Carmel fire, Att. Alona Sheaffer (Karo), Director General of the Ministry of Environmental Protection, reminded the participants that the United Nations declared 2011 as the International Year of Forests. In Israel, as elsewhere in the world, emphasis will be placed on measures to assure the sustainable protection and management of forests for the benefit of present and

future generations. The committee's report and its recommendations, said the Director General, "will serve as an important contribution and guideline to forest management in Israel."

In his address to the participants, Environmental Protection Minister Erdan highlighted the government's concern with the devastating results of the fire and its recognition of the need to invest financial resources in implementing the recommendations to assure that such fires do not recur. Therefore, the Ministry of Finance has committed to allocate 55 million shekels (about \$15 million) for implementation



The burning forest/Photo: Menachem Zalutzki

Green Mountain Project Remembering the Carmel through Pictures

"The Green Mountain Project" was launched in the wake of the Carmel fire and invites surfers to create a digital memory album. The project invites surfers to post their memories of the blossoming Carmel by uploading their photographs to an open platform: www.greencarmel.co.il. The platform is slated to become a collective memory album which will allow surfers to view, share and react to photographs of the Carmel.

The project is an initiative of Google Israel, in cooperation with the JNF, the Society for the Protection of Nature in Israel, the Nature and Parks Authority, Channel 2 News, the State Archives, the Sammy Offer School of Communications, the Israel Scouts and others. The photographs will appear as a layer of pictures which will cover the Carmel, using Google Earth technology.

of the committee's recommendations on long-terms ecological rehabilitation.

The implementation of the recommendations will be dependent on their integration into the work plans of the Nature and Parks Authority and the JNF, on the readiness of the public to undertake additional safety precautions designed to prevent forest fires, and on the allocation of sufficient funds by the government.

If the necessary budget is allocated and the recommendations of the ecological committee are implemented, the Carmel will not return to its previous condition.

A new landscape will be created, characterized by increased biodiversity and decreased probability of fire. The natural regeneration of trees such as the oak and carob will be encouraged, while pines will be thinned at an early stage in their regeneration. Wide scale grazing will be renewed and fire breaks will be established.

The recommendations made by the ecological work teams go beyond the specific case of the Carmel to forests throughout Israel. They will become doubly important as the impacts of climate change continue to take their toll in the form of hotter and drier summers



Burning trees in the Carmel. Photo: Nir Herr

in Mediterranean countries, which further increase the risk of forest fires. Therefore, the fire in the Carmel served as an important wakeup call, underlining the importance of moving toward more sustainable forest management in Israel. ■

Contact Information:

The Office of the Chief Scientist, The Ministry of Environmental Protection, Israel

Dr. Sinaia Netanyahu

The Chief Scientist

Tel: +972-2-6553755 Fax: +972-2-6553752

Email: Netanyahu-s@sviva.gov.il

Dr. Orna Matzner

Head of Science Unit

Tel: +972-2-6495845 Fax: +972-2-6495854

Email: Orna@sviva.gov.il

The Office of the Chief Forester, JNF-KKL

Dr. David Brand

Chief Forester - Head of the Forest Department

Tel: +972-2-9905566 Fax: +972- 2- 9915517

Email: davidb@kkl.org.il



www.sviva.gov.il www.kkl.org.il www.circle-era.eu

