MedPine 6 - Mediterranean Forest Ecosystems:

Forestry, Ecology, Conservation, and Human use

Sponsored by the Israeli Forest Service
- Keren Kayemeth LeIsrael (KKL-JNF

Dear participants and colleagues,

It is a great pleasure to welcome you to the 6th MedPine International Conference on Mediterranean Forest Ecosystems in Rehovot. Israel. During the conference days, you will experience a diverse program that includes plenary sessions, a diversity of talks and poster presentations and field trips. The conference aim is to provide an opportunity to meet experts within the field and be updated on the latest research on Mediterranean forests and forest ecosystems. We have organized exciting social opportunities, field trips and a post-conference tour, so you will get the chance to interact as well as experience the professional, cultural and historical sides of Israel.

We hope you will enjoy the conference!

MedPine 6 Organizing committee:

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University of Haifa

DAY 1 - MONDAY OCTOBER 8, 2018 – ZIMAN AUDITORIUM

Time	Ziman Auditorium
08:30-09:30	Registration
09:30-10:00	Opening ceremony Greetings: - Dr. David Brand - Chief Forester and Head of Forest Department, KKL-JNF - Prof. Zohar Kerem, Faculty of Agriculture, Food and Environment - Conference organizing committee - Welcome
10:00-13:00	SESSION 1: MEDITERRANEAN FOREST DYNAMICS Chair: David Brand
10:00-10:55	Keynote: Avi Perevolotsky Pine-oak relations: an emerging novel ecosystem or a reason for organizational conflict
10:55-11:10	Coffee break
11:10-11:30	Bonneh Omri. *Evolution of Israeli forestry from pure even-aged pine plantations to sustainable uneven-aged mixed forests*
11:30-11:50	Grünzweig José M., Gliksman Daniel, Haenel Sabine, Osem Yagil, Zangy Ela, Yakir Dan & Preisler Yakir. *Impact of canopy cover and dry-season conditions on litter decomposition in Mediterranean pine forests*
11:50-12:10	Vargarechea Marta, Fortin Mathieu, Del Río Miren & Calama Rafa. *Modelling regeneration occurrence in mixed Mediterranean forest through survival analysis*
12:10-12:30	Wayman Rebbeca & Safford Hugh. *Recent bark beetle outbreaks and subsequent wildfire severity in mixed-conifer forests of the Sierra Nevada, California, USA*
12:30-12:50	Shkedy Yehoshua & Margareta Walczak. *Pinus halepensis in nature reserves – data, emotions and policy*
13:00-14:00	Lunch
14:00-14:30	POSTER SESSION

14:30-16:40	SESSION 2: ECOPHYSIOLOGY AND FOREST ECOSYSTEMS Chair: Tamir Klein
14:30-15:20	Keynote: Jordi Voltas Extracting the most out of provenance trials: novel phenotyping and multi-environment approaches for understanding intra-specific adaptation
15:20-15:40	Preisler Yakir, Müller Jonathan, Ahiman Ori, Grünzweig José M., Rotenberg Eyal, Birami Benjamin, Ruehr Nadine & Yakir Dan. *Elimination of seasonal drought and its effect on canopy gas exchange in a dry Mediterranean pine forest*
15:40-16:00	Tague Naomi & Klein Tamir. *Interacting ecophysiologic and hydroclimatic controls on post thinning forest water use and carbon sequestration*
16:00-16:20	Rog Ido, Jakoby Gilad & Klein Tamir. *Angiosperm and gymnosperm tree carbon allocation dynamics revealed by pulse labeling and a flux-coupled tree*
16:20-16:40	Tatarinov Fyodor, Preisler Yakir & Yakir Dan. *Azimuthal variation of sap flow in Aleppo pine in semi-arid forest in Israel – preliminary results*
16:40-17:00	Coffee
17:00-18:00	SESSION 3: GENETICS, GENOMICS, AND BREEDING Chair: Rakefet David-Schwartz
17:00-17:20	Hagar Fox, Doron-Faigenboim Adi, Shklar Galina, Burstein Roni, Mushelion Menachem & David-Schhwartz Rakefet. *Comprehensive approach to decipher molecular mechanisms of Pinus halepensis responses during drought stress*
17:20-17:40	Houminer Naomi, Osem Yagil, Riov Joseph & David-Schwartz Rakefet. *Pinus brutia X Pinus halepensis hybrids in Israel*
17:40-18:00	Calev Ailon, Har'el Roi, Herr Nir & Bonneh Omri. *The adaptability and suitability of Pinus nigra, Cedrus libani and Cedrus atlantica for planting in high elevations in the Galilee Mountains and the Golan Heights in Israel*
	ISRAELI DINNER

DAY 2 - TUESDAY OCTOBER 9, 2018 – ZIMAN AUDITORIUM

08:00-09:00	Registration
9:00-13:00	**SESSION 4: CARMEL 2010 FIRE.** Sponsored by the Israeli Ministry of Environmental Protection Chair: Orna Matzner
9:00-10:00	Keynote: **Hugh Safford** **Using fire in California ecosystem management: replacing the missing link**
10:00-10:20	**Raviv Orna**, Zemah Shamir Shiri, Lotan Alon, Izhaki Ido, Mansfeld Yoel & Collins-Kreiner Noga. *The seasonal, land-use and residence-place elements affecting the recreational value of a biosphere reserve*
10:20-10:40	**Tessler Naama,** Dolev Amit, Zemah Shamir Shiri & Rosenberg Ben. *Ecological and Economic aspects of grazing management in buffer zone*
10:40-11:00	**Steel Zachary,** Fog Alissa, Burnett Ryan, Roberts L. Jay & Safford Hugh. *Changing patterns of severe wildfire leads to bird diversity declines and community transitions in conifer forests of California, USA*
11:00-11:20	**Coffee break**
11:20-11:40	**Ashkenazi Mor,** Ungar Eugene David, Zoref Chanoch, Avraham Yechezkel, Moshe Yosef & Osem Yagil. *Fuel-break treatments and their effect on vegetation structure In Mediterranean coniferous forests*
11:40-12:00	**Ne'eman Gidi,** Milavski Renana, Bar-Massada Avi & Ben-Shlomo Rachel. *The genetic composition of Aleppo pine at Mt. Carmel, as a basis for conservation policy*
12:00-12:20	**Zitun Rami,** Wittenberg Lea & Malkinson Dan. *The effects of post-fire forest management on soil erosion rates 3 and 4 years after a wildfire, demonstrated on the 2010 Mt. Carmel fire*
12:20-12:40	**Wittenberg Lea,** Malkinson Dan & Shtober-Zisu Nurit. *Assessment of soil-loss potential following repeated fires – Mt. Caramel as a case study*
12:40-13:00	**Keasar Tamar,** Ornai Alon & Ne'eman Gidi. *The effects of forest fire buffer zones on pollination webs*
13:00-14:30	**LUNCH & POSTER SESSION**

14:30-17:30	SESSION 5: CLIMATE CHANGE AND MEDITERRANEAN FORESTS Chair: Efrat Sheffer
14:30-15:00	Orna Matzner. *Israel's preparations for adaptation to climate change: recommendations for national strategy*
15:00-15:30	Schiller Gabriel. *What must be done to enhance the sustainability of planted and natural forests in Israel in view of climate change? Combined research-results*
15:30-15:50	Klein Tamir, Cahanovitc Rotem, Sprintsin Michael, Herr Nir & Schiller Gabriel. *A nation-wide analysis of tree mortality under climate change: forest loss and its causes in Israel 1948-2017*
15:50-16:10	López Rodríguez Rosana, Javier Cano Francisco, Sangüesa-Barreda Gabriel, Camarero Julio J., Rozenberg Philippe & Gil Luis. *Tree-ring density and C isotope data are early-warning signals of drought-induced mortality in the Canary Island pine*
16:10-16:30	Coffee
16:30-17:30	SESSION 6: FUNCTIONAL AND FOREST ECOSYSTEM ECOLOGY Chair: Yakir Preisler
16:30-16:50	Livne-Luzon Stav, Shemesh Hagai, Osem Yagil, Carmel Yochai, Bruns Thomas D. & Ovadia Ofer. *Effects of fire season on community composition of soil fungi*
16:50-17:10	Manon Helluy, Prévosto Bernard, Balandier Philippe & Donès Nicolas. *Modelling Mediterranean pine stands dynamics: a first functional approach*
17:10-17:30	Perelman Yotam & Yagil Osem. *Effect of abiotic environmental factors on Leaf area organization in water limited Pinus halepensis forests*
	DINNER

POSTERS: all posters will be presented in the poster session on both days

Herr Nir. *Israel's Brutia pine: invasive species or native in the Eastern Mediterranean region?*
Lapidot Omri, Ignat Timea, Rud Ronit, Rog Ido, Alchanatis Victor & Klein Tamir. *Leaf temperature and transpiration relationships in five tree species of the Mediterranean maquis*
Levy Shay, Disegni Dafna, Shechter Moti, & Ne'eman Gidi. *The causes of fires in forests and groves in the eastern Mediterranean (Israel) and the cost of extinguishment*

Megidish Shacham, Rog Ido, Wagner Yael, Lapidot Omri & Klein Tamir. *Conifers and broadleaf growing in the same Mediterranean environment conditions adapt different water strategies*

Stern Rafael, Amer Madi, Rotenberg Eyal & Yakir Dan. *Comparing biogeochemical and biogeophysical effects of a planted pine forest and different land covers under same climatic conditions in a semi-arid region in Israel*

Tavsanoglu Cagatay & Pausas Juli G. *BROT 2.0: A functional trait database for Mediterranean Basin plants*

Walker Rebecca H., Hadar Liat, Navon Yael, & Grünzweig José M. *Impact of pine colonization on the woody vegetation and soil biogeochemistry in a Mediterranean shrubland in Israel*

Wang Huanhuan, Rotenberg Eyal, Sprintsin Michael, Gitelson Anatoly & Yakir Dan. *Linking eco-physiological processes to remote sensing signals in a semi-arid forest*

DAY 3 - WEDNESDAY OCTOBER 10, 2018 - Field Trip

8:00 Depart from Faculty of Agriculture, Rehovot	
Tel Azeka	The Israeli puzzle: Natural and planted forests, agriculture, history and urban development.
Yaar hakdoshim LTER	Forest research & management under semi-arid conditions, the effects of stand densities on: forest trees and their spontaneous regeneration, on the diversity of ground vegetation, animal life and more.
Shluhat Shayarot	Post-fire forest restoration, spontaneous expansion of pines into natural forests, natural forest regeneration in planted pine forests
Hamasrek	Lunch
Hamasrek Nature Reserve	Can we preserve the eastern ecotype of *P. halepensis*? Challenges in management of miniature reserves: conservation, fire and human settlement.
Sataf	Mutual spontaneous dynamics of pines and natural forests; Forest ecosystem services, targeted forest management, fires
Ein Karem	Visit to historic Ein Karem and its churches

DAY 4 - THURSDAY OCTOBER 11, 2018 – ZIMAN AUDITORIUM

08:00-09:00	Registration
9:00-11:00	SESSION 7: FOREST MANAGEMENT AND MEDITERRANEAN ECOSYSTEM SERVICES Chair: Asaf Karavani
9:00-10:00	Keynote: José Antonio Bonet Mycosilviculture as a way to optimize the ecosystem services provided by the fungal communities
10:00-10:20	Cohen Noa, Osem Yagil, Deutch Tova, Muklada Hussein, Ashkenazi Mor & Landau Serge Yan. *Goat grazing or pine-tree removal in after-fire management of rocky slopes in Mediterranean woodlands*
10:20-10:40	Loewe-Munoz Verónica. *Advances in Stone pine (Pinus pinea L.) cropping in Chile, South America*
10:40-11:00	Adar Kalil & Grünzweig José M. *Pine management as a tool for regulating understory secondary succession – as reflected in Yechiam and Elkosh mature pine-oak forests*
11:00-11:20	Coffee break
11:20-13:00	SESSION 8: FOREST POLICY AND SOCIO-ECONOMY Chair: Liat Hadar
11:20-11:40	North Malcolm P., Stevens Jens T. & Greene David F. *Reforestation for resilience in Mediterranean forests*
11:40-12:00	Zoref Chanoch & Ramon Uri. *Changes in vegetation structure following agricultural land abandonment and afforestation: the Jerusalem Mountains as a case study*
12:00-12:20	Orenstein Daniel E., Eizenberg Efrat, Zimroni Hagit & Bezalel Israel. *One picture, multiple perceptions: perceiving the Carmel forest through multiple cultural, political and disciplinary lenses*
12:20-12:40	Noy Ivanir Adi, Lissovsky Nurit & Orenstein Daniel E. *More housing, more urbanization, what's the future of Israeli afforestation?*
12:40-13:30	LUNCH

13:30-15:00	SESSION 9: REMOTE SENSING AND FOREST LANDSCAPES Chair: Hermann Ittai
13:30-13:50	Paz-Kagan Tarin, Vaughn Nicholas R., Martin Roberta E., Brodrick Philip G., Stephenson Nathan L. & Asner Gregory P. *Leaf to landscape responses of giant sequoia to hotter drought along the Sierra-Nevada*
13:50-14:10	Mandelmilch Moshe, Dadon Alon, Ben-Dor Eyal & Sheffer Efrat. *A new scheme for plant species classification by airborne hyper-spectral remote sensing technology over Mediterranean forest*
14:10-14:30	Michael Yaron, Lensky Itamar M., Brenner Steve, Tessler Naama & Helman David. *Using high-resolution planet satellites constellation images to assess economic damage of a wildland–urban*
14:30-15:00	CONFERENCE SUMMARY AND ANOUNCEMENT OF LOCATION FOR MEDPINE 7

Avi Perevolotsky Is a full professor at the department of Agronomy and Natural Resources at the Agricultural Research Organization - Volcani Center (Israel). He is a leading expert on the ecology of Mediterranean ecosystems, working on various projects related to the structure and function of these ecosystems at local to landscape scales, with specific interests in ecosystem management and Mediterranean grazing systems. Avi has served as chief scientist of the Nature and Parks Authority of Israel, and chair of the team of scientists that developed the National strategic plan for the Restoration of the Carmel after wildfires. Avi's research in the past decade explored natural processes and management of planted pine forests in light of principal ecological processes such as forest succession, pine-oak relations, and the impacts of droughts.AVI

Pine-oak relations: an emerging novel ecosystem or a reason for organizational conflicts

Avi Perevolotsky, Agricultural Research Organization – The Volcani Center

Pines have been part of the eastern Mediterranean flora for millennia. As a sole source of timber, humans heavily exploited these pines. By the end of the 19th century, only a few groves of native pines have survived in the Land of Israel (Palestine). The fate of the native woody formation, dominated by oaks, was not different. It has been burnet, cut and heavily grazed for centuries. After WWI, the British Mandate and the Jewish National Fund (KKL) initiated a massive afforestation campaign in the region and the first forest reserves have been established. Afforestation was intensified during the early days of the newly established State of Israel (1950-1960). Planted trees, mostly conifers, cover, at present, 5-7% of the country area (~10-12% of the Mediterranean region). The KKL (practically the Israeli Forest Service) have been managing these forests according to guidelines adopted from commercial forestry even though there is no wood industry in the country. Since the early 1960's conservation laws and a designated agency (Nature and Parks Authority) were established and became responsible for managing the nature reserves. For many years, the dominant management policy of the NPA was a passive one – let nature take its course. The two agencies – KKL and NPA – are managing, side by side, much of the open landscape of Israel. Each agency has had a rather static view of the ecosystem they manage: planted forest vs. mature oak woodland. Both partly ignore the successional dynamics and the spatial interactions between the ecosystems. Conservationists consider the colonization of pines within oak stands in nature reserves as a biological invasion and harsh managerial activities are applied to control it. Many foresters interpret the recovery of woodland species within the planted forest, creating a dense and diverse understory, as mal-management of the forest or a sign of losing control. The outcome of the ecological processes differs quite significantly from the ideal formation of a "forest" or a "reserve" as defined by the agencies. However, the managerial challenges for both land-use units is quite similar. In conclusion, management interventions would have limited impact on oak woodland recovery, on one hand and on the colonization of pines in open niches within non-forested areas, on the other hand. The self-creation of a mixed forest – a novel ecosystem in the region - due to spontaneous, ecological processes is inevitable and corresponds with the pristine climax of the region.

Jordi Voltas. Is a full professor, head of the department of Crop and Forest Sciences, University of Lleida (Spain), and principal investigator of the research group on Forest Management of the CERCA Institution AGROTECNIO. His research focuses on the ecophysiology and adaptive characterization of Mediterranean trees, particularly using tree traits for high-throughput phenotyping and tree breeding. Currently working on evolutionary tradeoffs among life-history characteristics that contribute to differentiation among-populations in Mediterranean pines. Jordi's work integrates physiological and environmental information in statistical models for describing genotype by environment interaction in forest genetics and growth responses in dendroecology. Jordi is involved in national and international projects on genetics, drought ecophysiology and biodiversity of forest and crop species.

Extracting the most out of provenance trials: novel phenotyping and multi-environment approaches for understanding intra-specific adaptation

Jordi Voltas, Crop and Forest Sciences, University of Lleida, Spain

The issue of plant adaptation to changing environmental conditions is a tough one. It is definitely more a dynamic than a static concept, as individuals often lag behind their environments trying to get adapted to an ever-changing suite of exogenous factors. At present, plants are being confronted with a strong climate instability that is pushing entire populations towards their physiological limits. From an evolutionary perspective, forest trees – and Mediterranean pines in particular –may currently resemble a hamster on a spinning wheel, always stepping forward but getting nowhere. Indeed, there is an urgent need to understand the adaptive capacity of such long-lived organisms in relation to the threats posed by global change.

After more than a century of provenance research, forest genetic trials are ubiquitously distributed around the globe, and the Mediterranean basin and Mediterranean pines are not exceptions. Provenance trials are invaluable instruments for understanding the extent and patterns of intra-specific variation. For example, they allow for separating the roles of standing genetic variation and phenotypic plasticity on population differentiation for meaningful functional traits. They are also suited for extensive phenotyping at the tree level beyond the traditional monitoring of growth and survival. However, they have often been the result of well-intentioned, but isolated national or regional initiatives, consequently lacking supranational coordination, and frequently they are poorly managed or maintained, which limits their applicability to present-day adaptation studies. Despite these flaws, there is a lot waiting to be learnt from provenance trials.

Here, I will review recent results about two complementary aspects of provenance research. First, the use of novel tools potentially suited for high-throughput phenotyping of adult trees with regard their physiological performance; amongst these, the use of stable isotopes in xylem water to infer tree water sources, the ground penetrating radar to study root distribution, and the implementation of UAV imagery (multispectral and thermal) to derive vegetation indices are promising approaches for in-field tree phenotyping. Second, the opportunity to collate results from different trial networks of the same species using advanced mixed-effects models for analysis of genotypic stability and derivation of response functions to climate. I argue that these methodologies may significantly improve our understanding of local adaptation patterns of Mediterranean pines in the forthcoming years.

Hugh Safford. Is Regional Ecologist for the USDA-Forest Service's Pacific Southwest Region (California, Hawaii, Pacific territories), and a member of the research faculty in the Department of Environmental Science and Policy at the University of California-Davis. Safford manages a staff of Forest Service ecologists that provide expertise in vegetation, fire, and restoration ecology, climate change, inventory, and monitoring to the 18 National Forests in the Pacific Southwest Region. The Safford Lab at UC-Davis is focused on applied ecological support to resource and fire management in California, neighboring states, and other Mediterranean climate regions. Safford provides international technical assistance on fire, forest management, and climate change issues in partnership with the US-Agency for International Development (USAID) and the International Program of the Forest Service; recent projects include fire management planning in northern Mexico, climate change adaptation in southeast Brazil, and forest restoration in North Africa and the Levant. Safford is a current Fulbright Global Scholars Program fellow, studying post-fire ecosystem restoration practices in the Mediterranean Basin.

Fire use in California ecosystem management: replacing the missing link

Hugh Safford, USDA Forest Service, Pacific Southwest Region, Vallejo, CA 94592 USA

In recent decades the western United States has seen an enormous increase in burned area, fire size, and in some ecosystems, fire severity. Trends are especially strong in California, which leads the nation in fire risk, burned area, economic losses, and fatalities from fire. California's Mediterranean-type climate includes an annual 3-6 month drought and high interannual variability in precipitation. Much of California is also comprised of public land (National Forests, National Parks), which leads to high continuity of natural fuels across large landscapes. Most public lands in California support one of two major fire regime types: conifer and hardwood forests characterized by high frequency, low severity fires ("Fire Regime I", FR1); and chaparral and serotinous conifers characterized by low frequency, high severity fires ("Fire Regime IV", FR4). Human settlement and interference in the fire regime have greatly changed fire in both types. In FR1, a century of fire suppression has succeeded in nearly erasing low severity fire from the landscape, leading to a fire deficit, changes in dominant species, and major increases in fuel loading and fuel continuity. As a result, modern fires, when they escape initial attack, tend to be uncharacteristically large, severe, and difficult to contain. In FR4, human ignitions have swamped the ecosystem, and fire frequency is much higher today than under reference conditions. Current conditions in FR1 and FR4 ecosystems are very different, and management responses must also differ. In FR4, the focus is on fire suppression under all conditions, strategic fuel reduction (near values at risk), and fire prevention. In FR1, the focus has long been on fire suppression, but that strategy is failing. Science has also shown that the long-term lack of low severity fire is having deleterious effects on biodiversity and multiple ecosystem processes. Focus has shifted to broad-scale modification of fuels, either through direct manipulation (mechanical or hand thinning), prescribed fire, or wildland fire use/managed wildfire. Each of these tactics has advantages and disadvantages, and all three approaches are currently used. However, current economic conditions, social resistance to thinning, and issues of scale – among other things – lead to the conclusion that a major expansion of wildland fire use (WFU) – i.e., fire regime restoration – is necessary. I summarize the current science vis-à-vis WFU effects on ecosystems, biota, and subsequent fire, and describe the WFU/managed wildfire programs on National Park Service and National Forest lands in California.

José-Antonio Bonet. Is an Associate Professor at the University of Lleida (UdL, Spain) with a PhD in Forest Engineering, as well as an associate researcher and former Director of the Forest Science and Technology Centre of Catalonia (CTFC, Spain). He is acknowledged as one of the leading European scientists in the field of mycology having participated in more than 50 national and international research and knowledge transfer projects, including large collaborative EU-funded FP6, FP7 and H2020 projects. Currently involved in international and national interdisciplinary research projects on the relationships between forest management and fungal diversity and productivity. His research combines new-generation DNA sequencing methods, advanced modelling techniques and multi-scale approaches. As a result of his research activity, he has produced more than 100 publications including peer-reviewed international publications, books and book chapters, mainly dealing with above- and belowground fungal dynamics and forest management.

Mycosilviculture as a way to optimize the ecosystem services provided by the fungal communities

Bonet, José Antonio, University of Lleida-AGROTECNIO centre. Lleida, Spain; and Forest Science and Technology Centre of Catalonia (CTFC). Solsona, Spain.

Mediterranean forests provide a wide array of ecosystem services that are increasingly requested by Society as a guarantee of future human welfare. However, the prevalence of other forest functions in the past, have led Mediterranean forests to a condition in which they will not be able to meet the changing demands of forest users and society at large. In this scenario, forest management is a tool that can modify the current forest structure and composition so that it can fulfill future public demands on these ecosystems. The presentation will broadly review the main Mediterranean Pine ecosystem services that society demands prospecting the proper forest management techniques that will provide such demands. The forest management techniques aiming to optimize fungal diversity and productivity of Mediterranean Pine ecosystems will be presented as an example of the open options for the different ecosystem services. Particularly, mycological models based on long-term data records, the engine of mycosilviculture, will be examined.

Pine management as a tool for regulating understory secondary succession – as reflected in Yechiam and Elkosh mature pine-oak forests

Kalil Adar[1], José M. Grünzweig[2]

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Pine trees in the overstory, both compete to, and facilitate the establishment and development of the understory. Quantitative data collection in this field has progressed in recent years, although processes involved regulating this secondary succession are not yet clear.
The uniqueness of our research is that it examines mature pine forests 15 years after thinning. It actually opens a window to succession stages that has developed since.
Two mature Pine forests in the Western Galilee were chosen; Elkosh and Yechiam. Both planted in 1950 and thinned in 2000. Similarity in geology, flora, and climate were obligatory. In each forest four treatments where chosen: normal thinning, heavy thinning, extreme thinning (clear-cut) and natural woodland as a control.
Our result reaffirm that pine densities has a negative effect on understory development.
Furthermore, we have found that both understory volume and litter biomass have inverse effect on species richness. Non-significant values of LAI between treatments are mainly due to overstory and or understory cover intermixed.
In conclusion, our results, which are part of a wider research, emphasize the role of pine overstory in regulating the composition and development of the understory.

Fuel-break treatments and their effect on vegetation structure In Mediterranean coniferous forests

Mor Ashkenazi[1,2], Eugene David Ungar[1], Yosef Moshe[1], Yagil Osem[1], Chanoch Zoref[3], Yechezkel Avraham[3]
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An increase in the frequency and intensity of wildfires throughout the world, and in the Mediterranean basin in particular, has been reported over recent decades. In response, forest thinning to create fuel-break zones is practiced in fire-prone East-Mediterranean pine forests. This study evaluated the effect of thinning mature *Pinus brutia* forests on the accumulation of vegetative fuels. Fuel-break establishment (in 2007-2008) created three overstory tree densities which were sampled (in 2013-2014) in 10 sites (replicates): open fuel-break (50 trees ha-1), created by heavy thinning alongside the fire road; shaded fuel-break (130 trees ha^{-1}), created by moderate thinning further away from the fire road; and un-thinned control (250 trees ha^{-1}), at the furthest distance from the fire road. The amount and composition of vegetative fuels were measured in the forest overstory (pine trees), understory (woody and herbaceous vegetation), downed woody material and litter. A positive effect of thinning intensity was found on fuel load accumulation in the forest understory. A widely-used set of equations was adopted to compute fire risk from the quantity, composition and spatial arrangement of fuels measured at the three tree densities. The predicted rate of fire spread in the forest understory was lowest in the control treatment and increased gradually with increasing thinning intensity. The risk of crown fire development (torching index) was very low in all three treatments, although it also increased with increasing thinning intensity. The risk of active crown fire development (crowning index) declined significantly with increasing thinning intensity, for a given understory fuel load. Based on the model, we found the critical threshold of understory fuel load above which the risk of crown fire development increased significantly to be 1 kg m^{-2}. Based on the study results, a practical tool for planning and managing FBs in East-Mediterranean conifer forests is proposed.

Evolution of Israeli forestry from pure even-aged pine plantations to sustainable uneven-aged mixed forests.

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The planted forests in Israel are at present multifunctional, and designated for the provision of various ecological services. Afforestation in Israel, which was begun 110 years ago by Keren Kayemeth LeIsrael (KKL) the Israeli Forest Service, was based on the "classical" forestry approach and was characterized in its early days by dense pine plantations dominated by Aleppo pine (*Pinus halepensis*). A massive dieback of 40-year-old planted Aleppo pine stands, attributed mainly to an outbreak of the Israeli pine bast scale (*Matsucoccus josephi*), in the early 1970s led to the use of other pine species, mainly *Pinus brutia*, instead of Aleppo pine. Toward the late 1980s the use of native broadleaf species in forest plantations in addition to coniferous species was dramatically increased.

In 1990 KKL Forest Department revised its forest policy. The new policy aimed to create mixed, multi-layered, well spaced forests with higher tolerance and better resilience to climate-change impacts such as drought, fire, and insect infestations .

In support of the new policy, ecological surveys were conducted in planting sites, to enable preparation of detailed planting plans that would be matched to site characteristics. Mechanical point site preparation was mainly applied, with especial care given to preservation of native broadleaf species that were found in planting sites. In forest areas that had undergone clear-cutting and regeneration planting following fires or other damaging factors, outstanding individuals and clusters of conifer species that were not affected as well as native broadleaf species were left as a basis for uneven-aged, multi-layered mixed second-generation growth. Use of prescribed fires for site preparation was stopped, and weed control was implemented in a selective manner rather than broadcastly. In mixed plantations, native broadleaf species were either randomly scattered among the coniferous species (single-tree mixture) or, alternatively, planted in separate patches of varied sizes (group mixture) to create a complex mosaic pattern .

The main goal of thinning operations implemented in planted forests in Israel is to promote the development of sustainable and resilient forests. Increasing species and age diversity and decreasing stand density through selective thinning ought to achieve this goal. Since KKL formulated its new forestry policy, there has been a sharp decrease in stand density recommended for different site qualities and age.

The adaptability and suitability of *Pinus nigra*, *Cedrus libani* and *Cedrus atlantica* for planting in high elevations in the Galilee mountains and the Golan heights in Israel

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Three coniferous species were examined in experimental plots in Israel for their adaptability and suitability for planting in high elevations in the Galilee Mountains and the Golan Heights. The collapse of *Pinus halepensis* man-made forest stands in occasional heavy snow storms that occurred in these areas in elevations above 600 m triggered the search for alternative species that are less vulnerable to snow damage.
Pinus nigra and *Cedrus* spp. experimental plots were established in 1993 and 1995 respectively in Bar'am Forest in the Higher Galilee (elevation, 675 m a.s.l.; annual precipitation, 750 mm).
Pinus nigra provenances originating from Greece and Italy performed better than the provenances from Turkey and the former Yugoslavia with respect to survival rates and height and diameter growth, but the differences were not significant. Our conclusion is that *Pinus nigra* can be successfully planted instead of Aleppo pine at elevations above 600 m in the Higher Galilee, in chalky-gray rendzina soils and, presumably, also in low-lime-content soils such as brown rendzina and terra rossa.
Comparison of survival rates and height and diameter growth of 18-year-old *C. libani* and *C. atlantica* that originated in various countries, revealed that *C. libani*, originated in Turkey, had significantly higher survival and height growth rates, and better (but not significantly so) diameter growth than *C. atlantica*. Among the various countries of origin of *C. atlantica*, the seed sources from France provided the best performance.
Comparison of the superior cedar provenances of the various species and countries of origin revealed that the Turkish provenances of *C. libani* from Hassa in the Amanos Mountains and Pozanti in the eastern Taurus Mountains had higher survival rates, and higher height and diameter growth. It is recommended to use these seed sources in future cedar plantations in Israel, especially on terra rossa and brown rendzina soils that had developed on dolomite rocks and hard lime stones and that contain low amounts of chalk.

Goat grazing or pine-tree removal in after-fire management of rocky slopes in Mediterranean woodlands

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Crown driven fire in adult pine-trees represent the most dangerous way of fire-expansion. The cycle of fires in pine-dominated woodlands is initiated by large-scale germination of pine-tree seedlings. Therefore, early control of pine-tree seedlings density in fire-prone zones is a pre-requisite to the prevention of fires. Mechanical clearance of the vegetation in rocky and steep wadi slopes is practically impossible. In the first holistic study of the development of pine-trees and their associated species, *Cistus* spp and *Pistacia lentiscus* and the nutrition of goats, six plots of approximately 0.18 ha were allotted to three treatments: control (C), selective pine-tree removal (PR) or goat grazing (GG). Vegetation volume was measured along two transects in each plot for two consecutive years and the individual pine-tree seedling development, demographics and ecophysiology were monitored. Goat grazing was applied in late spring at high stocking rates (600 grazing days/ha). The dietary proportions of lentisk, pine tree and cistus was established by fecal NIRS. Plant cover volume was 40% lower in GG plots than in controls. Pine-tree cover represented 6, 8, and 15% of total in PR, GG, and C; and pine-tree foliage cover, which did not differ before grazing, represented 34, 17, and 46% after grazing, in the same order. The leaf to stem ratio was 0.4 in GG, compared with 1.4 in C. The PR treatment did not result in total eradication of the pine stand: pine-tree density stabilized at 2000 in PR (down from 10000) and ca. 4000 (down from 6000) per hectare in GG and C. Trunk diameter increase did not differ between pine-trees subjected to GG and C, but height increased in C (and PR), but not GG trees. Following defoliation, pine-trees kept stomata open in summer allowing for gas transport and evaporation at a time where stomata were closed in C and PR trees. Finally, the Leaf Area Index was four-fold lower in GG, inferring that combustible biomass was four-fold more elevated under C and PR than under GG management. Pine-trees represented 12 % of ingested DM, i.e., ca. 170 g/day of DM from pine-trees. Crude protein in selected diets decreased from 12 to ca. 10% of dry matter, and supported maintenance of goats but not the growth of kids. To summarize: goat grazing did not decrease pine-seedling density but impaired their development to adulthood and decreased the accumulation of combustible matter. This mechanism implies that grazing cannot be discontinued.

Impact of canopy cover and dry-season conditions to litter decomposition in Mediterranean pine forests

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Decomposition is a key process in the cycling of carbon in ecosystems, but it is unclear how it will be affected by climate changes in climate and land management in drylands. Reduction in canopy cover of pine forests as a consequence of extreme drought events significantly modifies abiotic factors, such as solar irradiance and humidity conditions, thus potentially affecting decomposition. In addition, we also have little knowledge on the dynamics and the magnitude of decomposition in forests during successive dry and wet seasons. This study investigated the impact of canopy cover and seasonality on litter decay in Mediterranean pine forests. We conducted litterbag experiments in plots of different tree densities in a semiarid and a dry-subhumid Mediterranean pine forest for 613 days. Litter mass loss was greater in forest gaps than under tree canopies in both forests. Similarly, a reduction in tree density tended to increase decomposition. While the decay rate slowed down considerably from the first to the second wet season, litter decomposition remained stable during the first and the second dry season, with the combined dry seasons contributing 30% to the overall mass loss. The stability and extent of the dry-season contribution to annual mass loss may exert an even larger control on litter decomposition when also accounting for the fact that decay drivers operating in the dry season are likely to contribute to decay during the common dry spells in the wet season. Combined, ongoing tree mortality and the predicted prolongation of dry periods due to climate change may enhance litter decay, possibly reducing ecosystem carbon stocks in drylands.

Comprehensive approach to decipher molecular mechanisms of *Pinus halepensis* responses during drought stress and recovery

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Improving drought resistance among pine species, which are completely dependent on environmental conditions, requires comprehensive information regarding candidate genes to be used in breeding programs and biotechnological approaches. In this study we used *Pinus halepensis* (Aleppo pine) originated from a semi-arid area with suboptimal growth conditions and thus represents drought-resistance. In order to decipher the molecular mechanisms in which *P. halepensis* uses to withstand drought, we performed large-scale physiological and transcriptomic analyses. We selected a mature tree from a semi-arid area for clonal propagation through cuttings in order to reduce the genetic variation effect and to maintain mature tree properties. We used a high-throughput experimental system to continuously monitor plants in parallel and calculated whole-plant transpiration rate, daily biomass gain, water use efficiency and whole-plant stomatal conductance. Six physiological stages were selected for transcriptome analysis including baseline, stomatal closure, maximum drought, post-irrigation, partial recovery and full recovery. A 'drought-stressed *P. halepensis* transcriptome' was de novo assembled using paired-end RNA-seq and was compared to the published *P. halepensis* transcriptome. Transcriptome analysis revealed ~6,000 differentially expressed transcripts. These included genes related to turgor loss, osmotic and oxidative responses, secondary metabolites and hormones biosynthesis as well as genes related to epigenetic response. A hormonal profile suggests the involvement of ethylene, cytokinins, auxin and ABA-GE as the main ABA source. A multi-disciplinary approach utilizing topophysis to achieve high-throughput physiological measurements, RNA-seq and hormonal profiling offers a better opportunity to identify drought-related genes in forest trees.

Modelling Mediterranean pine stands dynamics: a first functional approach

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The frequency and severity of extreme weather events are increasing as a result of climate change. The effects on Mediterranean forests are expected to include events such as longer summer droughts in the near future. Management strategies are thus needed to increase forest resilience. Models are useful tools to test adaptive management strategies and to study their long-term effects in relation to climatic conditions. As there is a lack of functional models of forest dynamics available for Mediterranean forest stands, our study aims to develop a functional-structural model for Mediterranean pine stands. To achieve this, we adapted the RReShar model (Regeneration and Resources Sharing) to the Mediterranean context. This is an individual-based model describing all vegetation strata dynamics in relation to water and light. Here we will present the part of the model related to the pine canopy dynamics. We studied twelve 50 year-old *Pinus halepensis* stands located in the South-East of France distributed in different cover treatments (light, medium or dense). We first developed a water balance model using the stand characteristics (LAI values in particular) and soil properties following the methods used in the BILJOU model. Trees of all stands were measured (height, dbh) and spatialized. Cores from 175 trees were extracted and analysed to produce tree ring increments. We then developed a tree-based circumference model, which predicts radial increment first as a function of the Hegyi competition index then by combining the competition index with a water stress index. We also developed models that predict tree height, as well as crown diameter and crown height. Multiple regressions analysis have been used to produce radial increment models using the competition index and the water stress. Our results show that the competition index and water stress are good predictors of trees growth (model fit improves with these two predictors combined). We expect further improvements to the model by linking understorey growth and the tree regeneration dynamics with water stress and transmitted light.

Pinus brutia X *Pinus halepensis* hybrids in Israel

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The planted forest in Israel is dominated by *Pinus halepensis* (Aleppo pine) which is considered native in this region. Since the 1970s the local forest service gradually turned to the exotic *Pinus brutia* as the leading conifer used for afforestation due to its tolerance to the Israeli pine bast scale *Matsucoccus josephi*.

When *P. brutia* (as female) and *P. halepensis* (as male) overlap geographically, natural hybridization occurs. Recently, mature hybrids of the two species were identified in several forests. These hybrids exhibit morphological traits and a vigorous growth that distinguish them from adjacent *P. brutia* and *P. halepensis* individuals of similar age. However, the frequency of hybridization and the extent to which it depends on environmental biotic and abitic conditions are unknown. Furthermore, the frequency of hybrids exhibiting hybrid vigor and the meaning of this vigor in terms of drought resistance and water use efficiency are unknown .

Hybrids are not easy to identify by morphology alone and can be easily mistaken as variants of *P. brutia* or *P. halepensis*. Therefore, they are identified by molecular markers targeting mitochondrial and chloroplast DNA. These markers however, are only good for F1 hybrid due to the paternal inheritance of chloroplasts and maternal inheritance of mitochondria in pines.

To better identify hybrids and answer the above questions, we generated and analyzed the transcriptomes of *P. brutia* and *P. halepensis* needles and identified 12 nuclear Single Nucleotide Polymorphisms (SNP) based markers. The SNPs can be identified by Cleaved Amplified Polymorphic Sequences (CAPS) and High-Resolution Melt (HRM) analyses.

Next, we began a survey focusing on *P. brutia* stands in which exceptionally vigorous trees where observed (suspected as hybrids). In each stand, 80 random trees were screened for height, diameter at breast high (DBH) and genotype. Preliminary results show that hybrid trees frequencies are between 2.5-6%. Furthermore, the vast majority of hybrids (≈90%) exhibit hybrid vigor that is, their DBH and height are more than 55% and 15% larger, respectively, as compared to stand average. In the following stages, we intend to carry out a comprehensive survey throughout a random sample of *P. brutia* stands bordering with *P. halepensis* stands, to determine the frequencies of cross pollination and hybrid regeneration and the ways by which they are affected by various environmental factors. Furthermore, we plan to look at eco-physiological traits of hybrids as compared to their parent populations.

The effects of forest fire buffer zones on pollination webs

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Pollinating bees are declining worldwide. Their sustainable management, especially in biodiversity hot-spots, requires better understanding of community composition and interactions. We studied how management of forest fire buffer zones in a Mediterranean forest affects its pollination system . The Mount Carmel nature reserve, Israel has experienced many recurring forest fires, exhibiting a mosaic of post-fire regenerating plant communities. It is a typical Mediterranean habitat known for its high plant and bee diversity, mainly in forest clearings generated by human activity. To decrease future fires, buffer zones of reduced tree biomass were established in 2014. Low plant biomass is maintained in the buffer zones by mechanical cutting or sheep grazing. We compared flowering plants and their visitors in cutting, grazing and control (no-maintenance) plots in the buffer zones. The plots varied in fire history and were sampled three times over the 2015-2016 spring seasons
Buffer zone management, sampling session, and plot fire history significantly influenced the composition of flowering species. However, the number of flowering plant species, the number of visiting bee genera, the diversity bee and flower communities and their composition were not affected. Pollination webs tended to be more specialized in managed than in the control plots, due to a significantly higher number of interaction links per species. We conclude that the fire management regimes applied in our study area did not disrupt pollination webs in the short term. Future monitoring is needed to assess the long-term effects of these management practices on fire prevention and on plant-pollinator interactions .

A nation-wide analysis of tree mortality under climate change: forest loss and its causes in Israel 1948-2017

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Is tree mortality increasing? Are recent mortality events related to climate change? Which tree species are the most affected? Many case studies have been published in the last decade, but the necessary large-scale and long-term knowledge is still missing .
Here we combine data from forest surveys and satellite imaging, to create the first spatial tree mortality history at the national scale. Israel is a small country with only 7% forest cover, but its large environmental diversity and mosaic of many, small, forest areas makes it a good 'miniature model' for the task .
Tree mortality events have been increasing significantly since 1991 and correlated well with drought. Among mortality events, 24% of the loss was directly related to drought, and 58% to fire, with 69% of fires occurring over a drought background. Conifers were disproportionally more affected than native broadleaved trees.
Synthesis. This is the first national-scale study of tree mortality dynamics, and it confirms the suspected increase in this phenomenon in recent decades, and the dominant role of drought. Our study opens a way to a better, multi-source monitoring future in service of forest management and ensuring forest sustainability under climate change.

Effects of fire season on community composition of soil fungi

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Fire effects on ecosystems range broadly from direct destruction of aboveground vegetation to direct and indirect effects on belowground microorganisms. Although such effects are expected to be related to fire severity, which can largely vary during the year, little is known about the effects of fire seasonality on soil microorganisms. We carried out a large-scale field experiment examining the effects of spring versus autumn burns on the composition of the soil fungal community in an eastern Mediterranean woodland. We hypothesized that autumn fires should be more severe, inflicting greater damage to the soil fungal community. Fire severity was largely consistent between the two burning seasons, yet there were significant differences in the composition of the soil fungal community between areas subjected to spring and autumn fires. The community composition of ectomycorrhizal fungi, an essential feature for ecosystem functioning, assayed both in pine seedling bioassays and from soil sequencing appeared to be largely resilient to the variation inflicted by seasonal fires.

Advances in stone pine (*Pinus pinea* L.) cropping in Chile, South America

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Stone pine is a Mediterranean species with great economic importance by its edible seeds, the pine nuts, the most expensive and exclusive nuts worldwide. Advances in semi-intensive or intensive management for its cultivation as a fruit tree, however, have been limited, with fruits being harvested mostly from natural forests. This can be attributed to the long fruit development cycle (42 months), with one-, two- and three-year-old cones being present simultaneously on the tree, which makes nutritional and hydric management more challenging than in other fruit or forest trees, among other causes.

How do cultural practices, particularly fertilization and irrigation, influence stone pine growth and fruiting in Chile, an exotic habitat ?

Methods: individual and combined effects of fertilization and irrigation on growth and fruiting, and their correlation were assessed in two young stone pine plantations in central Chile. In a 30 year-old plantation (A), treatments were: control, spring + autumn fertilization, spring + summer irrigation, and combined fertilization and irrigation; in a 16 year-old plantation (B), treatments were: control and spring fertilization. Additionally, the water supply effect on cone production was studied on 3,464 trees along Chile.

In A, fertilization had a positive effect one year after application (>23.5% height growth and >82.3% 1 year-old conelet production than the control). After two consecutive years of application, a significant influence on growth (>17.5% DBH and >20.4% height), and 1 year-old conelet production (>36.4%) was observed, independently of the hydric status of the trees. Irrigation enhanced fruiting but did not affect growth. The maximum 1 year-old conelet number was observed in the fertilized and irrigated plots. In B, tree growth in fertilized plots was higher (>40.8% height and >29.5% crown diameter growth), and bore 93.5 and 141.5% more cones than the control 3 and 4 years after fertilization. Fertilization also affected cone size, significantly increasing the quantity of cones over 350 g. Along Chile, statistically significant differences between irrigated and non-irrigated plantations were found for cone production (60 vs 44 cones/tree), suggesting an increase of over 35% of tree cone production associated with this practice.

Fertilization and irrigation, applied either individually or combined, are useful tools to enhance fruit production in young and adult plantations, with a stronger response if applied at younger ages. An intensive management model for stone pine cropping for fruit production is proposed, including techniques commonly used in horticulture, such as fertilization, irrigation, weed control, grafting and pruning.

Tree-ring density and C isotope data are early-warning signals of drought-induced mortality in the Canary Island pine

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Drought induced forest dieback and mortality have been observed across the globe in the last decades and are likely to increase in the future in Mediterranean areas according to climate models. Here we report drought-induced mortality of Canary Island pine (*Pinus canariensis*) stands at the drier edge of the distribution limit of the species in Gran Canaria, Spain. High mortality occurred after two consecutive extremely dry years, 2011 and 2012, with less than 100 mm of annual rainfall. We investigated the local climatic trend during the preceding 33 years of the mortality event, from 1980 to 2013, and its relationship with radial growth (tree-ring width), wood density, xylem anatomy (lumen area and cell-wall thickness) and changes in water use efficiency (WUE) derived from C isotope discrimination ($\delta^{13}C$) of tree ring wood. We compared these variables in dead and surviving neighbouring trees with similar age and size to *i*) shed light on the mechanisms underpinning tree mortality after an extreme drought event, *ii*) identify how trees balance investments in the competing xylem functions of water transport, storage and mechanical support and iii) facilitate interpretations of climate control over these traits .

Extremely dry conditions in the studied area resulted in low growth rates in both dead and surviving trees with no significant differences even in the years prior to death. However, surviving trees had significantly higher mean ring density, earlywood density and latewood density mainly as a result of forming tracheids with thicker walls. A decrease in latewood density in dead trees several years prior to death was found. Surviving trees showed a decrease in $\delta^{13}C$ possibly associated to an increase in WUE, whereas dead trees showed the same pattern until 2000 when WUE suddenly dropped till the death year. Carbon isotope data and latewood density revealed early-warning signals of tree dieback many years before tree death occurred; these singals may be indicative of either later stomatal closure with could have had a deleterious effect on the water conducting capacity due to generalized hydraulic failure or higher use of reserves to build up or to reinforce tracheids cell walls due to of the scarcity of recently photosynthesized carbohydrates .

We showed in this study that it may be possible to predict the susceptibility to extreme droughts on the basis of tree-ring density and C isotope data. Moreover, our data suggest that even if trees can suffer from C starvation (inferred from thinner tracheid cell walls) during years, the ultimate cause of death after a severe drought is hydraulic failure.

A new scheme for plant species classification by airborne hyper-spectral remote sensing technology over Mediterranean forest

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In recent years, the use of hyperspectral remote sensing (HRS) data for analyses of the physiognomy and composition of forests has become common. However, unsupervised classification methods applied for this purpose often do not realize the technology's full potential. A conceptually novel principal component analysis-based classification (PCABC) intended to provide accurate image-based classification of Mediterranean forest species will be presented. The methodology was tested on a reflectance image from Specim's AisaFENIX airborne HRS sensor taken over Mount Horshan, Israel, and validated on the ground using professional ecologist. PCABC provided highly improved results, compared to commonly used classification methodologies, reaching an overall accuracy of 91%. Moreover, the *Pinus halepensis* trees in the forest were identified with high accuracy rate of 100% (user and producer accuracy). PCABC may contribute to management and monitoring of forest composition, succession, drought and disease hazards in forests.

Using high-resolution planet satellites constellation images to assess economic damage of a wildland–urban interface fire

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The wildland-urban interface (WUI), the area where wildland vegetation and urban buildings meet, is at a greater risk of fire occurrence because of the extensive human activity in this area. Although satellite remote sensing has become a major tool for assessing wildland fire damages, it is unsuitable for WUI fire monitoring due to the trade-off between the spatial and temporal resolution of the images. Here, we take advantage of frequent (c. daily), high-spatial-resolution (3m) imagery acquired from a constellation of nano-satellites operated by Planet to assess fire damage in the WUI of a Mediterranean city in Israel (Haifa). The fire occurred at the end of 2016, consuming c. 17,000 of the trees (152 trees ha^{-1}) within the near-by wildland and urban parts of the city. Three vegetation indices (GNDVI, NDVI and GCC) from Planet satellite images were used to derive a burn severity map for the WUI area after applying a subpixel discrimination method to distinguish between woody and herbaceous vegetation. The produced burn severity map was validated with information acquired from an extensive field survey in the WUI burnt area. Planet's vegetation indices were calibrated using in-field tree measurements to obtain high-resolution maps of burned trees and consumed woody biomass in the WUI. These were used in conjunction with an ecosystem services valuation model (i-Tree) to estimate spatially distributed and total economic loss caused by the fire. We conclude that using the method developed in this study with high-spatial resolution Planet images has a great potential for WUI fire economic assessment.

The genetic composition of Aleppo pine at Mt. Carmel, as a basis for conservation policy

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The largest populations of the unique east Mediterranean ecotype of *Pinus halepensis* in Israel grow on Mt. Carmel. Adjacent are planted *P. halepensis* forests grown from seeds collected in other Mediterranean regions. The future of the eastern ecotype might be under threat from gene introgression from adjacent non-native planted trees. We aimed: 1. To characterize the genetic composition of the eastern ecotype and nearby planted trees. 2. To examine the presence of gene introgression from planted to natural pines. 3. To propose a science-based conservation policy for the locally unique pine ecotype. We sampled 286 trees of three size groups from 13 native and two planted stands. Genetic characterization using AFLP fingerprinting revealed 298 amplified loci; 183 were common to native and planted stands; 69 were unique to native populations, and eight were unique to the planted stand. The native populations were polymorphic (He =0.029-0.137) and genetically different from each other. A Bayesian Cluster analysis divided the populations into nine native groups, with inimitable genetic profiles. The planted stand differed genetically from all of the native populations. Individuals from different size groups within each native population showed comparable genetic profiles. The results indicate that the planted stands had only a minor impact on the genetic composition of the native *P. halepensis* populations on Mt. Carmel. Therefore, it's important to conserve this unique native ecotype by generating buffer zones around these populations that will considerably reduce any threat of introgression. This can be easily integrated into the fire prevention buffer zones.

Reforestation for resilience in Mediterranean forests

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The increasing frequency and severity of fire and drought events have negatively impacted the capacity and success of reforestation efforts in many Mediterranean forests. Challenges to reforestation include the size, cost, and safety concerns of replanting large areas with standing dead trees, and high seedling and sapling mortality rates due to water stress, competing vegetation, and repeat fires that burn young stands. Some standard reforestation practices have emphasized establishing dense tree cover with gridded planting, followed by practices such as shrub control and pre-commercial thinning. Resources for such intensive management are increasingly limited, reducing the capacity for young plantations to develop early resilience to fire and drought stress. This talk uses montane conifer forests in California, USA, to examine conditions under which current reforestation practices need adjustment and makes recommendations on how these practices might be modified to improve their success. In particular we examine where and when plantations with regular tree spacing elevate the risk of future mortality, and how planting density, spatial arrangement, and species composition might be modified to increase seedling and sapling survival through recurring drought and fire events. Within large areas of contiguous mortality, we suggest a "three zone" approach to reforestation following a major disturbance that includes working with natural recruitment within a peripheral zone near live tree seed sources; in a second zone, beyond effective seed dispersal range, planting a combination of clustered and regularly spaced seedlings that varies with microsite water availability in accessible areas; and a final zone defined by remote, steep terrain that limits reforestation efforts to the establishment of founder stands. We also emphasize the early use of prescribed fire to build resilience in developing stands subject to increasingly common wildfires and drought events. Reforestation strategies that foster greater heterogeneity in fuels, vegetation, and planting patterns can increase resilience in regenerating forests.

More housing, more urbanization: what's the future of Israeli afforestation?

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The forests of Israel, like most open areas in the country, are threatened by construction and development intended to meet the needs of a rapidly growing population. In this research, we consider the role of forests in the Israeli landscape and cultural heritage, the interaction between forests and built areas in general and the challenges associated to maintenance of forests increasing pressure to develop land for housing and other infrastructures.

KKL-JNF, the Israeli Forest Authority, manages over 350,000 acres of both natural and planted forests across the country. Most of the country's forests were first planted at the end of the 19th century to meet various needs such as drainage of swamps, development of potential economic resources and perceived improvement of the landscape. Since that time, forestry has continued, though forestry objectives have evolved. In various contexts, forestry has been justified and motivated in order to preserve land, combat desertification, provide employment for immigrants and create "Green Belts" around towns, amongst other goals. The first Master Plan for afforestation, introduced in the 1970s identified explicit objectives, such as the potential to provide leisure and recreational activities. In the past decade, Forest Management Policy has begun to focus on providing ecosystem services.

While the country boasts its history of forestry, and in particular its various contributions to quality of life, the growing population at its demand for an estimated 40 to 60,000 new housing units a year, poses a threat to forests. Many recently established towns, such as Harish, Elad and Modi'in, were established alongside of forested areas, and thus expansion of these towns necessarily occurs at the expense of the forest. This phenomenon significantly harms the landscape, recreational areas and the functionality of national ecological corridors.

With a total population increasing at 2% annually, both population density and the demand for new land for development will increase dramatically. KKL-JNF, whose tasks as the managers of the forests for multiple social and ecological benefits, is in a constant conflict between supporting development and protecting open spaces. This research presents how the JNF-KKL is managing this tradeoff and how the organization works with stakeholders to increase awareness of the importance of forests for public wellbeing.

One picture, multiple perceptions: perceiving the Carmel forest through multiple cultural, political and disciplinary lenses

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Ecosystem service (ES) assessment has become a prominent conceptual tool for characterizing and evaluating the diverse benefits humans derive from ecosystems. While methodological tools for assessing ES have been developing rapidly, cultural services, defined as the spiritual, educational and recreational benefits that humans derive from ecosystems, have proven more challenging to evaluate. In this research, we experiment with the use of visualization in an immersive theater to explore how humans use and value cultural services provided by forested landscapes in Israel's Mount Carmel region, including those that had burned in the 2010 Carmel fire.

We conducted twelve focus group discussions with 70 stakeholder participants altogether, each focusing on ten different landscape scenes from Israel's Carmel Forest. The objective of the discussions was to extract participants' perceptions and narratives around the different forest scenes. We provided guiding questions (e.g. "In which scene would you like to spend time and why?") and then recorded and analyzed ensuing discussion and arguments among participants. We applied a mix-methods approach to the analysis, deriving prominent themes from the discussion protocol and conducting statistical tests to identify significant differences in responses between various demographic groups.

Results revealed several strong differences in perceptions of different scenes based on culture, religion, political disposition and disciplinary expertise of the individuals, and age. Prominent, often conflictual, themes that arose regarding the value of the forested landscapes included refuge, wildlife, isolation, continuity of "home", social activity, politicization and discrimination, and religious and secular traditions. For example, distinct differences regarding land use preferences were revealed between those who identified as ecologists or environmentalists and those who didn't. Likewise, Druze and Jewish respondents displayed differences with regard to what human activities did or didn't constitute disturbances to nature. As such, while the broad categorization of cultural services (e.g. relaxation, spirituality, nature-based tourism) apply here, there is also little consensus regarding preferred services, nor around the way land should be managed in order to optimize the provision of cultural services. Research results support the importance of public discussion around the issue of public land management and of diverse approaches to visitor infrastructure development in forests

Leaf to landscape responses of giant sequoia to hotter drought along the Sierra-Nevada

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Hotter droughts are becoming more common as climate change progresses, and they may already have caused instances of forest dieback on all forested continents. In the Leaf to Landscape Project, we measured the response of giant sequoia, the world's largest tree species, to the extreme 2012–2016 hotter drought in California. The project integrated leaf-level physiology measurements, crown-level foliage dieback surveys, and remotely sensed canopy water content (CWC) to shed light on mechanisms and spatial patterns in drought response. As part of an effort to understand and map sequoia response to droughts we will present here the spatial patterns of foliage dieback. We studied the patterns of remotely sensed canopy water content (CWC), both within and among sequoia groves in two successive years during the drought period (2015 and 2016). Our aims were: (1) to quantify giant sequoia responses to severe drought stress at a landscape scale using CWC as an indicator of crown foliage status, and (2) to estimate the effect of environmental correlates that mediate CWC change within and among giant sequoia groves. We utilized airborne high fidelity imaging spectroscopy (HiFIS) and light detection and ranging (LiDAR) data from the Carnegie Airborne Observatory to assess giant sequoia foliage status during 2015 and 2016 of the 2012–2016 droughts. A series of statistical models were generated to classify giant sequoias and to map their location in Sequoia and Kings Canyon National Parks and vicinity. We explored the environmental correlates and the spatial patterns of CWC change at the landscape scale. The mapped CWC was highly variable throughout the landscape during the two observation years, and proved to be most closely related to geological substrates, topography, and site-specific water balance. While there was an overall net gain in sequoia CWC between 2015 and 2016, certain locations (lower elevations, steeper slopes, areas more distant from surface water sources, and areas with greater climate water deficit) showed CWC losses. In addition, we found greater CWC loss in shorter sequoias and those growing in areas with lower sequoia stem densities. Our results suggest that CWC change indicates sequoia response to droughts across landscapes. Long-term monitoring of giant sequoia CWC will likely be useful for modeling and predicting their population-level response to future climate change.

Effect of abiotic environmental factors on Leaf area organization in water limited *Pinus Halepensis* forests

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About 100,000 hectares of forest area is spread over a wide range of climatic, topographic and adaphic conditions in the Mediterranean region of Israel. Most of these forests were planted as monospecific, even-aged pine forests, with the dominant species being Aleppo pine (*Pinus halepensis* Mill.). Understanding the relationship between abiotic environmental conditions that dictate soil water availability and the structure and function of forests, is necessary in order to assign forest management objectives and develop optimal site-specific practices. In this study, we aimed to examine the use of Leaf Area Metrics (LAM) for the monitoring, assessment and management of conifer forests in Israel .

The aim of the research was to study the relationships between abiotic environmental conditions and the leaf area organization (LAO) in mature Aleppo pine forests. We addressed the following specific questions: How abiotic environmental factors are related to (1) Spatiotemporal variation of forest Leaf area index (LAI), (2) Distribution of LAI between the overstory and understory forest strata and, (3) Pattern of stand density vs. overstory LAI .

A Long-Term Monitoring (LTM) plot system (48 plots), spread over the Mediterranean region of Israel was used for the study. This setup represents various combinations of four principal abiotic environmental factors known to have an effect on habitat's water availability - climatic aridity (wetness index – WI), bedrock type, elevation and topographic aspect. LAM were measured using a combination of remote sensing, ground optical sensing and forest inventory surveys.

Three factors were found to be significantly related the spatial variability of total forest LAI (LAIall) - wetness index (WI), bedrock type, and topographic aspect, whereas WI and bedrock type, were significantly related to the temporal trend of LAIall during the last two decades. Both LAIOversory and LAIUnderstory were positively, linearly related to WI. Moreover, the relative contribution of LAIUnderstory to LAIAll increased substantially along the WI gradient (from 0 to 30%). No relationship was found between any of the abiotic factors and forest stand density but the average leaf area of an individual tree (TLA) was positively, linearly related to WI. The relationship between stand density and LAI was non-linear and depended on abiotic conditions. The findings of this study improve our understanding on how abiotic environmental factors influence the structure and function of pine forests in water-limited environments. They provide a basis for using leaf area metrics to monitor, assess and manage these forests.

Elimination of seasonal drought and its effect on canopy gas exchange in a dry Mediterranean pine forest

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Projected intensification of drying and warming trends imply severe risks for widespread forest mortality. Drought-adapted trees in semiarid ecosystems cope with both soil water shortage and high vapor pressure deficit by regulating their leaf conductance, avoiding irreversible hydraulic failure, and maintaining CO2 uptake. To better understand the relative effects of soil vs. atmospheric drought on trees, we carried out a manipulation experiment in a semiarid Aleppo pine forest (*Pinus halepensis*) naturally exposed to long seasonal drought (Yatir forest; 280 mm mean annual precipitation). We provided supplementary irrigation to 1 ha plot to eliminate summer soil moisture deficit and compared it with a similar adjacent control plot. We investigated tree responses to the supplementary irrigation using automatic branch chambers (16 chambers in total), sap flow sensors (SF; 40 trees) and electronic dendrometers (20 trees). Results from the first treatment year showed a typical decline in midday branch net assimilation (A_net) from 15 to 4 g C m 2 h^{-1} and transpiration (T) from 2 to 0.5 mm h-1 in early summer prior to the onset of irrigation. However, upon the onset of irrigation in May, T increased dramatically to 5 mm h-1, 2.5 times higher than the peak wet season values. This increase correlated with the seasonal increase in vapor pressure deficit (VPD) to >5 kPa in June. This was accompanied by a large parallel increase in stem diameter, by 4.5 mm on average from May to June in the treated plot, with no increase in the control plot. Net assimilation in the treated plot also increased, from 15 to 20 g C m^{-2} h^{-1} 1.3 times higher than the wet season values. We will discuss the interplay between soil moisture control and VPD as rate regulation of T across the large VPD range observed in this study (up to 7 kPa); and the unexpectedly high flexibility in adjusting internal water storage to support large increase in T and in the synchronization between the timing of T and sap flow. The enhancement in A_net could be a consequence of the increased stomatal conductance in the treatment plot, in addition to the seasonal rise in temperature and solar irradiance. The results indicate that growth of Aleppo pine at the dry timberline is clearly limited by soil water availability and that atmospheric water demand plays a subordinated role.

The seasonal, land-use and residence-place elements affecting the recreational value of a biosphere reserve

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Measuring the recreational value of a Biosphere reserve (BR) may be a challenge as it contains a mix of different zones and land uses which have a potential to affect its value. Furthermore, the BR's value may be affected by temporal factors, including the periodic ecosystems services (ESS) flux, the recreational facilities available on site, the publicity level of the site's attractions, and more. However, using ESS valuation as a relative index can minimize the effect of the temporal factors and provide new insights regarding the BR zones and land-uses. This study analyses the potential of the ESS valuation to be used as a support tool for BR managers, while using travel cost (TC) and willingness to pay (WTP) modeling to analyze the different elements affecting the BR's value. This study aims to identify the relative consumer's surplus (CS) estimate of the BR zones, land-uses and annum seasons; the elements affecting the CS values in each case; the use and non-use reasons for the respondents' WTP preferences to preserve the BR's recreational value; and the ESS which are important for the BR's residents and visitors, driving them to pay to preserve them. The results show that the BR's recreational value is higher at the spring time compared to the autumn, mainly because visitors travel longer distances at the autumn to visit the BR (reducing their CS). Thus, while different predictors affect the annual number of visits to the different BR zones and land-uses. For example, respondents who claim that they most visit Maquis have a higher likelihood to visit both Maquis and Forest land uses, while the WTP was found significant predicting the number of visits only to the Maquis land-use and Core zone. Furthermore, different use and non-use reasons affect a respondent's WTP to preserve the different BR zones. For example, the most important reason for WTP at the Maquis and Forest is to preserve biodiversity (Existence), while at the Beach it's the Preserve for heritage (Bequest) reason. The WTP predictors also vary among the respondents, such that the BR's residents mainly value Pollination services while the BR's visitors mainly value Trees' shed services. This study's findings can be used as a support tool for BR's decision makers, to refine the spatial and functional design of the BR based on the ESS value and the expectations of the BR's benefit consumers.

Angiosperm and gymnosperm tree carbon allocation dynamics revealed by pulse labeling and a flux-coupled three phase detection method

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Tree growth is affected by influx and efflux of above- and belowground carbon (C). Fixed C allocates to plant tissue biomass and is released to the atmosphere or the rhizosphere in respiration, litter and exudation, respectively. C allocation can be estimated by a mass balance approach, combining biomass measurement with respiratory CO_2 efflux measurement. However, fast turnover C fluxes are difficult to measure directly since they are easily masked by major fluxes. To follow C quantitatively, and study its distribution between the different sinks, we developed a $^{13}CO_2$ labeling method, with a novel flux-coupled three phase detection. C allocation patterns were examined in 2-years-old saplings of two conifer and three evergreen broadleaf Mediterranean forest tree species. ^{13}C allocated first to aboveground compartments, with significant amounts (30-70%) reaching belowground sinks within 2-3 days. Tissue-specific respiration measurements revealed a high correlation between the amount of labeled C in the tissue biomass and respiration of labeled C. Allocation of C to root exudation was at levels comparable with allocation to respiration values. Overall, belowground investments were 50% higher in conifers vs. broadleaf species. Our results suggest fundamental differences in fast turnover C allocation patterns between angiosperm and gymnosperm tree species. Our approach opens the way to a more detailed investigation of C management in forest trees, and its belowground fraction in particular.

What must be done to enhance the sustainability of planted and natural forests in Israel in view of climate change? Combined research-results.\

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Hans Carl von Carlowitz (1645-1714) was the inventor of the term sustainability (Nachhaltigkeit) and the principles of modern forest management. Principles that should be followed everywhere in the forests, especially in the holy land because the conifers are planted and not natural.
Today we know that the sustainability of plantations is influenced by the genetic diversity of the planted stock. The main sylvicultural problem was created by the Mandatory and by the KKL forestry departments, by use of seed material bought from European seed companies, with no indication about their origins, together with seeds collected in the relict stands. Seedlings of different seed lots were randomly mixed in afforested areas.
The continuous research efforts in Israel and other Mediterranean countries to elucidate differences among Aleppo pine provenances in their genetics, phenology, tree architecture and anatomical structure, physiological reaction to site conditions such as drought and insects, resulted in a large amount of knowledge that has lately become common. This knowledge must become one of the milestones on which the forest management and sylviculture in Israel must be based.
As said before, the first generation of conifer plantations in Israel is a mixture of many unknown seed sources (provenances) of Aleppo pine, brutia pine, Canary Island pine, *Pinus pinea* and *Cupressus sempervirens*. The second generation of these genotypes expresses their potential to adapt to the Israeli ecosystems characteristics (site conditions).
Due to climate change in our region - less rain and higher temperatures - there is need for a new approach in forest management, e.g., thinning procedures must be related to the site water availability and consumption by the forest (the water cycle).
It is imperative to use sylvicultural procedures to enhance natural regeneration, so that the seedlings will undergo selection by site conditions and only the best adapted ones will be the foundation of the next generation.

Pinus halepensis in nature reserves – data, emotions and policy

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Baruch (1986) found pollen of pines and oaks dated 3500-5500 years ago, hence we consider Aleppo pine, *Pinus halepensis*, as a native species in Israel. Based on archeological and historical data, Lipschitz and Biger (2001) concluded that Aleppo pine has always been a relatively rare species in this area, so it is generally accepted that extensive monocultures of pines are not a typical element in the Israeli landscape. Only a few small natural *P. halepensis* populations remain today. Comparative analysis has shown that there are genetic and biochemical differences between natural populations of Aleppo pine in Israel and its populations in the western Mediterranean. Eastern Mediterranean populations are recognized as belonging to the "eastern type".

The JNF (which serves as Israel's forestry service) has changed the landscape dramatically, planting pines from the Lebanese border to the Negev highlands over the past 100 years. The result is that most of Israel is rich in pines producing large quantities of seeds and seedlings. More than that, JNF used for the afforestation seeds of *P. halepensis* imported from various regions in the western Mediterranean, rather than the local eastern type. Since the planted forests cover extensive areas, occurring usually in proximity to remnant stands of natural populations, there is no real possibility of conserving the local type with its unique genes.

Pinus halepensis, mostly from foreign types, settle in natural habitats, changing local communities dominated by broad-leaved oaks and *Pistacia* to a mixed forest. As a result the risk of wild fires and their severity increase, promoting further pine expansion. In parallel, the opposite process takes place. The local species, including oaks and *Pistacia*, grow in the planted pine stands causing landscape unification. Of more concern is the invasion of pines into batha, converting relatively rare habitats of grasslands and bush-lands, with their typical flora and fauna, to forests.

The role of pines in the Israeli landscape has created plenty of positive and negative emotions with regard to the species. The policy of the INPA, based on the facts described above, is as follows:

1. Only small scale efforts are done in order to protect the local type of *P. halepensis* mainly by fire protection. At the most, our efforts slow down the domination of the foreign genotypes.
2. Pines are heavily thinned after fires to promote open landscape and to reduce the risk of future fires.
3. Mature pines are harvested every few years in nature reserves where their density is still low, and the goal is to minimize the invasion process.
4. Where pines are a threat to local habitats of rare species (in nature reserves), the pines are heavily thinned.
5. Planted forests in nature reserves and national parks are managed according to forestry rules (thinning, sanitation).

Changing patterns of severe wildfire leads to bird diversity declines and community transitions in conifer forests of California, USA.

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Wildfire drives landscape pattern and community composition of flora and fauna in many of the world's ecosystems. The Mediterranean-type climate region of California's Sierra Nevada Mountains supports yellow pine (*Pinus ponderosa* and *P. jeffreyi*) and mixed-conifer forest communities that are adapted to frequent (10-20 year return interval) low- to moderate-severity wildfires. However, in recent decades it has become clear that through a combination of climate change and forest management practices, wildfires in these forests are becoming larger, and are composed of uncharacteristically high proportions of stand-replacing (high-severity) fire, clustered in increasingly large patches. These patterns result in reduced landscape heterogeneity which is important for biodiversity in this system. Further, because serotiny is rare among Sierran conifer species, areas far from living seed trees within large patches of high-severity fire are increasingly likely to be converted to non-forested states; resulting in permanent shifts in community composition.

We assessed how Sierra Nevada bird diversity is influenced by spatial context within high-severity patches in order to infer the impact of these shifts in fire pattern on the forest community. Specifically, we collected bird occurrence data from 2009-2017 within 27 wildfire areas that encompass a successional gradient of 1-30 years since fire. Using a Bayesian multi-species occupancy modeling framework, we ask how community diversity and composition change across three decades of post-fire succession, and whether such transitions are dependent on distance to lower-severity areas. Individual species responses to time and distance varied widely, but overall, species richness increased initially, reaching an apparent plateau at 15 years post-fire. Across the temporal gradient, communities along patch edges are projected to have greater species richness than communities found in patch interiors. Additionally, there is marked turnover between edge and interior communities with the latter composed of more shrub- and fewer forest-associated species in later years. These findings suggest that increasingly large patches of high-severity wildfire are leading to declines in local biodiversity, and shifts from forest- to shrubland-associated communities. Such shifts are likely to occur across greater areas of the region as changes in climate and fire regimes continue into the future.

Interacting ecophysiologic and hydroclimatic controls on post thinning forest water use and carbon sequestration

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A simple conceptual model of the impacts of forest thinning suggests that carbon assimilation and evapotranspiration should be reduced proportional to the amount of photosynthetic biomass removed. However field observations, particularly from semi-arid forests often show less than expected reductions in water loss or carbon assimilation Field observations following thinning in the Yatir Forest in Israel, for example, show relatively small losses in assimilation. Field observations from thinning forest in other Mediterranean systems, show that losses in transpiration may be compensated for by increases in transpiration in adjacent trees and understory/ soil evapotranspiration. Eco-hydrologic models should be able to capture these more nuanced, non-proportional changes in carbon and water cycling, provided key mechanisms are included. Here we compare estimates from RHESSys (regional hydro-ecological simulation system) with observations of thinning impacts at Yatir and use this to identify key mechanisms that lead to observed responses. We then use the model to assess how variation in key ecophysiologic and hydro-climatic variables can alter the impact of thinning on forest carbon and water cycling .

Azimuthal variation of sap flow in Aleppo pine in semi-arid forest in Israel – preliminary results

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The characteristic of the azimuthal variation of sap flow (SF) of a tree is important both from the point of view of tree physiology, as well as for practical purposes of sap flow measurements and up-scaling. There is some evidence that SF can be considerably non-uniform in azimuthal direction, in several fruit and forest trees (Lousteau et al., 1998, Cohen et al. 2008), but there is lack of information regarding this effect in Aleppo pine trees, one of the most dominant Mediterranean forest trees. Within the framework of a complex flux measurements in the Yatir forest Fluxnet site (Israel), detail sap flow measurements of Aleppo pine trees were carried out since 2010 using Granier-type (HDP) sensors.

Four of sample trees with DBH ranging between 12 to 25 cm were measured from two sides of the tree: north (N) and south (S), and one tree from three sides (NW, NE and S); the present study describes the SF dynamics in these trees.

Our results showed that in the semiarid Yatir forest SF rate at the southern side of the tree was usually 1.5-2 times higher than at the northern side. This result was observed in all 5 sample trees. No expressed time lag between north and south sides and no expressed seasonal pattern of the ratio between sides were observed.

However, the diurnal trend of SF(N) usually starts earlier and ends later than SF(S), i.e., North to South ratio in the morning and evening tends to be high, usually above 1, whereas during most of daytime it is stable and below 1. During the dry season, this effect is more pronounced in the morning than in the evening, i.e., the peak of SF just after sunrise with further midday depression and possible additional small peak at the end of the day is more expressed at the northern side.

The domination of the southern over the northern side, can be explained by higher development and higher illumination of crown on that side. It might also be related to the dry conditions in the Yatir forest, while under more mesic conditions this regularity can be less expressed.

Our results indicate that under dry conditions sap flow rate is azimuthally non-homogeneous and that should be taken into account when up-scaling for the tree level either by installing sensors from different sides of the tree or by applying a correction factor.

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Ecological and Economic aspects of grazing management in buffer zone

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During the last century, wide scale regeneration of natural woodlands and changes in the grazing patterns of domestic goats and cattle in Mediterranean woodland led to increase in the cover of dense shrubby Mediterranean maquis. The increase in combustible biomass, along with global climate change, increase in the number of droughts, caused large fires in Mount Carmel. The last huge forest fire (December 2010) in Mount Carmel caused human and nature losses. Recommendations of the Carmel fire committee included creation of buffer zones around settlements and along roads. Our main research question is: what is the best and most cost effective method for long term maintenance of such buffer zones?
Our research examines the ecological and economic aspects of grazing in buffer zone around kibbutz Beit Oren on Mount Carmel as a case study in order to assess the ecological and economically feasibility of forest management.
We examined the following four optional management tools to maintain the buffer zones: (1) cattle grazing, (2) goat grazing, (3) sheep grazing and (4) mechanical mowing of woody plants. Economic cost benefit analysis of the different management options was used to reveal the efficiency and feasibility of each management.
After two years of research, we found that grazing and mowing treatments did not decrease the proportion of woody plant cover. However, re-mowing resulted in 2-3 fold decrease in the height of the main woody plants: *Pinus halepensis, Pistacia lentiscus,* and *Quercus calliprinos*. In addition, mowing decreased the density of *P. halepensis* saplings. We didn't find a distinct change in the height of these woody species under all types of grazing managements. It seems that grazing affected the height and density of these species, but two years period was too short to get any significant effect.
The economic analysis revealed that mowing is the most costly management. Comparison among the different grazing types, showed that sheep grazing saved more money for the shepherd, but without subsidizing the farmers, it is not profitable for them to manage herds for maintaining the buffer zones. Conversely, more grazing in the open spaces raises the value of agricultural tourism.
The insights from this research emphasize the importance of long term of maintenance and management of buffer zones, which must include some subsidizing to increase farmers' incentives and to encourage grazing in these zones. It means that establishment of buffer zones in woody habitats require planning and pooling budget for supporting long term maintenance.

Modelling regeneration occurrence in mixed Mediterranean forest through survival analysis

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Natural regeneration is commonly unsuccessful in Mediterranean pine forests, being the occurrence and establishment of seedlings key steps of the process. In this context, the species specific requirements and limitations could explain the distinct success of the regeneration of coexisting species. However, it is important not only to identify the factors that affect regeneration occurrence but also to determine how their effects can be modified through different management options. In this study, we used data from a network of 1703 permanent plots installed in mixed and pure forests of *Pinus pinea* and *P. pinaster* located on the Northern Plateau of Spain where natural regeneration is annually monitored. The objective was to model the probability of regeneration occurrence in each plot after a time "t" (years since regeneration fellings were carried out), as a function of plot and climate attributes, by means of survival analysis. The results showed that the relationship between regeneration and presence of adult trees varies as a function of the species. Besides, larger regeneration occurrence was associated with larger coverture of grass in the soil as well as the mixed composition in adult trees on the plot. Furthermore, we found that both *P. pinea* as *P. pinaster* regeneration occurrence was controlled through climate variables (mean spring and autumn temperatures and maximum summer temperatures) at the region level. This model improves our understanding of the main limitations on the processes of the natural regeneration in Mediterranean pine forests. Besides, our results complements the findings reported in previous studies, introducing considerations at landscape scale and allowing us to generalize the observed regeneration patterns at the forest management scale.

Recent bark beetle outbreaks and subsequent wildfire severity in mixed-conifer forests of the Sierra Nevada, California, USA

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Insect and drought induced tree mortality dramatically increased in the Sierra Nevada during California's recent prolonged drought, causing widespread concern that severe tree mortality would lead to increased severity of subsequent wildfires. Effects of tree mortality on wildfire severity have been studied in U.S. Pacific Northwest and Rocky Mountain forests with historically low frequency and high severity fire regimes. To our knowledge, no field studies have examined the relationship between tree mortality and subsequent wildfire severity in Sierra Nevada mixed-conifer forests, where historic wildfire occurred at high frequency and low severity. To best allocate resources to the highest priority fuels reduction treatments, managers in California need information on whether severe tree mortality constitutes an increased risk of severe wildfire. In this ongoing study, we examine this relationship using field data collected within areas of patchy red phase (dead needles still retained on branches) mortality caused by bark beetles (principally western pine beetle, *Dendroctonus brevicomis*) that subsequently burned in wildfire. We aim to determine whether and under what conditions wildfire severity relates to severity of pre-fire tree mortality in Sierra mixed-conifer forests during the red phase; we did not study the effects of gray phase mortality (i.e., after needle drop). We collected data on 50 plots in 2016 within the 2015 Rough fire and ~100 plots on the 2016 Cedar fire in 2017. In both fire areas, beetle outbreaks had caused high levels of pine mortality one to two years previous to fire. Pre-fire tree mortality was identified as influential to our two metrics that measured fire severity in terms of the change from live to dead fuels (Relative differenced Normalized Burn Ratio [RdNBR], a remotely sensed metric, and the percent of pre-fire live tree basal area killed by fire, a field metric), but not to our physical measure of fire severity (torch percent, a field measure of the proportion of tree needles consumed by fire). The percentage of basal area killed by fire increased as pre-fire mortality increased, but only up to pre-fire mortality levels of approximately 30% of plot-level trees or basal area. Further increases in pre-fire mortality did not result in greater fire severity. Our results demonstrate that high pre-fire mortality of conifers in Sierra Nevada mixed-conifer forest has a positive influence on fire severity when dead needles are retained on the beetle-killed trees.

Assessment of soil-loss potential following repeated fires – Mt. Caramel as a case study

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Wildfires are of the dominant disturbance factors shaping the Mediterranean landscapes. Burning of the vegetation cover and the rapid increase in soil temperatures during fires are often result in the formation of rock exposures and changes to the hydrological and sedimentological properties of the burned areas, associated with increased runoff and sediment yield. Soil and nutrient losses further result in delayed revegetation. At larger spatial and temporal scales studies point to outcrop exposure, formation of sealed surfaces, extension of the "disturbance window", and generation of soil sources readily available to be eroded during effective rainstorms, even years after the fire event. Most studies conducted in Israel, as well as in other sites along the Mediterranean region, suggest that soil loss rates, during the first year after the fire, surpass the "tolerable soil loss" value by several orders of magnitude. In Mediterranean soils this value under natural conditions is in the range of 10 gr/m2/year. Higher erosion rates may result in irreversible soil losses, in regions which are characterized by shallow soil mantle to begin with. This study focuses on producing high resolution soil-loss risk maps, which may serve as basis for guidelines for optimizing management activities in areas prone to intense soil loss and minimization of cross-system damage. The study aimed at developing a static GIS- based soil loss risk map, and a model based on fire history and the properties of vegetation recovery. The static model is conceptually based on the Revised Universal Soil Loss Equation (RUSLE), and evaluates the combined effects of topography, soil erodibility, rain erosivity, the structure of the vegetation communities and management practices. Additionally, soil erosion risk was mapped and analyzed as a function of the fire history of each location, and the properties of the vegetation regeneration rates. The map shows the areas that have a low, moderate and high potential for erosion. Within the 2010-fire burnt area, 62% of the area is characterized by a low soil loss potential. Only 2% of the area was categorized as susceptible to extreme levels of soil loss risk. These erosion-prone sites are largely associated with steep slopes on the chalky Arkan formation. Verification indicated that locations of high soil loss potential were well-identified.

The effects of post-fire forest management on soil erosion rates 3 and 4 years after a wildfire, demonstrated on the 2010 Mt. Carmel fire.

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In December 2nd-5th 2010 an area of 2,500 ha in the Carmel forests has been consumed by a high intensity wildfire. Consequently, the first few winters following the fire were characterized by major soil erosion from the exposed slopes. While most studies show that post-fire erosion rates largely decline after the second year, in this case we aim to address the continuous effects that different management practices hold on soil erosion rates, three and four years after a fire. Implementing different management schemes on burnt soil, as has been applied in this research, leads to diverse results regarding soil runoff characteristics. Moreover, the plots were located on both north and south facing slopes, showing distinctive differences between the aspects .

The secondary aims were (a) to examine the effect of soil and tree management on soil runoff amounts in slope plots in northern and southern faces and (b) to characterize the chemical and physical features of soil runoff three and four years after a fire.

Eight plots were constructed, four in a north facing slope aspect and another four in a south facing aspect, including: Clear and Removal (CR), Skid Trail (ST), Preservation Management (PM), and Control management types.

CR and ST practices resulted in significantly elevated soil erosion yields in comparison to PM. The sediments following PM had a high percentage of fine material. Furthermore, PM had a major positive effect on the soil regarding the amounts of soil erosion in the plot whereas the other schemes inhibited vegetation renewal and system rehabilitation along with larger amounts of eroded sediments. The different results emphasize the importance of applying the appropriate management practice for the disturbed area and the role it has specifically on erosion rates three and four years after a fire. Differences were noted beyond the treated areas, and therefore more research on the ecosystem level is yet needed .

POSTER: Herr Nir. *Israel's Brutia pine: invasive species or native in the Eastern Mediterranean region?*

Israel's Brutia pine: invasive species or native in the Eastern Mediterranean region?

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Brutia pine (*Pinus brutia*) distribution region is in the north east of the Mediterranean basin and its south most distribution is south Lebanon. It is one of the main species in the planted forests of Israel. Its invasiveness and its use in plantation is disputed.
Our questions were: (1) whether Brutia pine is an alien species, (2) has it a colonization potential? If the two questions will be positive, than the species can be invasive.
The first question examined by comparing vegetation maps to geological maps, meteorological data, review of habitat researches, and the outcome of the distance between native and planted population. The second question examined by article review, foresters and forest engineers interviews, and field surveys .
The results show that Brutia pine is native in the region of Lebanon and Israel in the eastern Mediterranean basin. The Galilee region is partly in Israel and partly in Lebanon, and natural population of the species grow adjacent to this region.
Lebanese natural Brutia pine population exist only 45 km from the Israeli border, and 55 km from natural population of Pinus *halepensis* in Israel. Both pines grow on similar habitats.
I argue that South Lebanon and the Mediterranean zone in Israel are actually one region with the same climate, similar geological formations, similar distance to the shore, and mountain ridges with North-South direction proximity.
In the Mediterranean basin scale, this region (200 km in its length) is more likely determined as local. International boundaries do not play a role in this case .
In addition, Brutia pine is not a colonizer tree in Israel. Germination and recruitment happens in the forests, but hardly outside of its borders. The seeds are relatively heavy and usually fall near the mother tree .
In conclusion, Brutia pine is a native tree, not a colonizing one, and therefore is not an invasive tree.

POSTER: Lapidot Omri, Ignat Timea, Rud Ronit, Rog Ido, Alchanatis Victor & Klein Tamir. *Leaf temperature and transpiration relationships in five tree species of the Mediterranean maquis*

Leaf temperature and transpiration relationships in five tree species of the Mediterranean maquis

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Among forest types, the Mediterranean maquis is specifically exposed to fluctuations in water availability. Therefore, water-use patterns of its major tree species are key to ensure its survival and productivity in current and future conditions. However, the traditional measurement methods of tree water-use at high spatial scales are difficult and labor-intensive, so indirect methods become useful. Transpiration from the leaf surface involves evaporative cooling, and hence leaf temperature might serve as proxy for tree water-use .

Here, we conducted a greenhouse experiment in parallel to measurements in the forest, on five key Mediterranean tree species of contrasting leaf shapes (Conifers: *Pinus halepensis*; *Cupressus sempervirens*; Broadleaved: simple: *Quercus calliprinos*; *Ceratonia siliqua*; compound: P*istacia lentiscus*). We used infra-red (IR) thermography for canopy leaf temperature (TL) estimation, simultaneously to infra-red gas analyzer for transpiration rate (Tr) measurements. The TL distribution of the tree species was analyzed and species-specific histograms were created .

We report evaporative cooling across the five species, with TL decreasing by 0.2-0.5 °C for respective increase of 1 mmol m^{-2} s^{-1} in Tr. The conifers were significantly cooler than broadleaves by ~2 °C and produced narrower TL ranges. These differences demonstrated that the dependence of TL on Tr is species-specific, and should relate to leaf morphology and physiology differences between the groups. Species diverged in levels of Tr and water-use efficiency in both field and greenhouse conditions .

Our observations show that IR thermal imaging can detect transpiration-related differences in leaf temperature among species. Yet, the dependence of TL on Tr is species-specific and thus, empiric associations must be developed separately for each of the species. Our approach leads the way to rapid, large-scale tree water-use sensing. In turn, IR thermography will enable testing hypotheses about the level of species competition over water sources, as well as tree species impact on forest eco-hydrology.

POSTER: Levy Shay, Disegni Dafna, Shechter Moti, & Ne'eman Gidi. *The causes of fires in forests and groves in the eastern Mediterranean (Israel) and the cost of extinguishment*

The causes of fires in forests and groves in the eastern Mediterranean (Israel) and the cost of extinguishment.

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About 40,000 wildfires occur each year in Israel. All fires are caused by human negligence or malice. Most fires caused only minor damage, and their causes were not investigated. The aim of this paper is to analyze the relations between the causes of wildfires in Israel and their extinguishing costs, and to suggest ways for reducing damages. In the absence of national database concerning fires, we have collected all possible information on fire causes, the burned areas and extinguishing costs from all agencies involved for 1998-2008. About 18,000 fires were caused by suspicion of arson with extinguishing costs of $\$28\cdot10^6$, extinguishing costs of about 11,000 fires of unknown and other causes were $\$16\cdot10^6$, and those of 4,000 fires caused by vacationers and hikers was $\$2.5\cdot10^6$ and those of 226 fires caused by army training was $\$2.5\cdot10^6$. We conclude that it is needed to allocate more national funds for prevention of wildfires in Israel. The funds and prevention actions should be tailored according the causes of fires. A national fire data base should be established with reliable data on fire causes, damage and extinguishing costs that should be used by decision makers for fire prevention and forest management plans.

POSTER: Stern Rafael, Amer Madi, Rotenberg Eyal & Yakir Dan. *Comparing biogeochemical and biogeophysical effects of a planted pine forest and different land covers under same climatic conditions in a semi-arid region in Israel*

Comparing biogeochemical and biogeophysical effects of a planted pine forest and different land covers under same climatic conditions in a semi-arid region in Israel

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The carbon sink in the land biosphere is considered as a major process with the potential to ameliorate climate change. However, assessment of the climatic effects of the land biosphere requires a combined perspective of both the biogechemical effects (such as the carbon sequestration via photosynthesis), and also the biogeophysical effects (such as the vegetation albedo and radiation balance), which can often have contrasting climatic effects. This work investigates the variations in the balance between these effects among a planted pine forest and three other vegetation types (natural oaks forest, wheat field and shrubland) under similar climatic conditions in southern Israel. This study relies on a state of the art field laboratory to carry out field measurements of eddy covariance fluxes, radiative (incoming and outgoing short and long-wave radiations) and non-radiative (sensible and latent heat) fluxes. Results among different seasons of the years of 2016, 2017 and 2018 are presented. Some of the preliminary conclusions of this study are:

- The pine forest presents the lowest albedo among all the other ecosystems.
- Non-forest ecosystems present higher albedo than forests.
- Albedo is typically higher in the winter.
- LE is kept similar among different ecosystems and seasons.
- Pines present very large sensible heat fluxes, the highest among all the ecosystems, although Rn is predominantly dissipated through large H fluxes in all ecosystems.
- Net CO2 uptake occurs only during the wet seasons - winter and spring in this region.
- NEE rates are similar in both pines and oaks forests, and higher in the non-forest ecosystems (during their respective growing seasons).

POSTER: Tavsanoglu Cagatay & Pausas Juli G. *BROT 2.0: A functional trait database for Mediterranean Basin plants*

BROT 2.0: A functional trait database for Mediterranean basin plants

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Plant trait databases are becoming a key research tool for testing hypothesis regarding the ecology and evolution of species, communities, and ecosystems. Here, we present a database of functional traits for vascular plant species of the Mediterranean Basin (BROT 2.0). In total, we compiled functional trait data from 624 sources, of which 448 are articles published in peer-reviewed journals between 1893 and early 2018, plus some field and experimental observations. The database includes 25,764 individual records of 44 traits from 2,457 plant taxa distributed in 119 taxonomic families. The plant functional traits considered include 22 general vegetative traits (e.g. growth form, specific leaf area, and root depth), 15 regeneration traits (e.g. resprouting capacity after disturbance, heat-stimulated germination, and age at maturity of sapling), and 7 sexual reproductive traits (e.g. dispersal mode, fruit type, and seed dry mass). Data records are geographically distributed throughout the Mediterranean Basin, but some parts of the basin (e.g. the southern rim) are poorly represented, reflecting the lower number of available studies in this area. All records are fully referenced and, in many cases, include geographic coordinates. The database is structured to include different levels of accuracy of trait information for each entry. BROT 2.0 should facilitate testing hypotheses on plant functional ecology within the Mediterranean Basin, and comparing this region with other ecosystems worldwide. The BROT 2.0 database and its trait definitions can be used as a template for creating similar trait databases in other regions of the world.

POSTER: Walker Rebecca H., Hadar Liat, Navon Yael, & Grünzweig José M. *Impact of pine colonization on the woody vegetation and soil biogeochemistry in a Mediterranean shrubland in Israel*

Impact of pine colonization on the woody vegetation and soil biogeochemistry in a Mediterranean shrubland in Israel

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The expansion of *Pinus halepensis* from plantations into natural shrublands of high conservation value is a widespread phenomenon across the Mediterranean region of Israel, with implications for landscape aesthetics and potentially also species composition and ecosystem functioning. As a part of a long-term program for adaptive management in Ramat Hanadiv, a multifunctional nature park in Israel, our study focused on the effect of individual colonizing pine trees on their surroundings. Specifically, we asked how colonization of a single pine tree affects the size and composition of the native woody vegetation, the mass and composition of the litter layer, and the soil carbon and nutrient content in its immediate surroundings.
We selected six spontaneously colonizing *P. halepensis* trees at each of two sites in a grazed Mediterranean shrubland in Ramat Hanadiv. For each tree, we sampled woody vegetation composition, cover and height, plant litter and mineral soil along a transect that extended from the center between the stem and the edge of the canopy to four times the canopy radius. These transects were up to 30 m long and reached far into the native shrubland. The volume of the native shrubs was highest at the edge of the tree canopy and lowest far from the pines. The volume of the co-dominant shrub *Pistacia lentiscus* was largest under the pine canopy. The litter layer mass was five times larger under the pine trees and two times larger close to tree canopies compared to the plot farthest from the pines. Soil organic carbon (C) and total soil nitrogen (N) concentrations were highest under the pine canopy and decreased gradually to about 2.5 and 2 times lower values far from the pine trees. The soil C/N ratio was significantly raised by the presence of pines, increasing from 10.5 far from the trees to 14.4 deep under the canopy. Available soil phosphate was relatively high under the pine canopy and about half that value at the other plots along the transect.
The colonization of Aleppo pines significantly altered the woody vegetation, and increased the mass of the litter layer, the organic matter and the nutrient content of the soil. These changes might significantly impact germination, development and reproduction of the highly diverse herbaceous community in this Mediterranean shrubland.

POSTER: **Wang Huanhuan,** Rotenberg Eyal, Sprintsin Michael, Gitelson Anatoly & Yakir Dan. *Linking eco-physiological processes to remote sensing signals in a semi-arid forest*

Linking eco-physiological processes to remote sensing signals in a semi-arid forest

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Semi-arid regions play important role in the climate system, due to their large area (18% of total land surface) and its sensitivity to a warming and drying climate. Forests can grow in semi-arid regions and modify the land-surface interactions with the climate system, but quantitative information on such effects is scarce. Yatir forest research site has the only 'flux tower' in semi-arid Mediterranean forest, which provides carbon, water, and radiation flux data and meteorology for over 15 years. Remote sensing (RS) data from a spectrometer equipped on the flux tower also provide canopy reflectance database in visible and near infrared range since 5 years. This work is to combine field eco-physiological measurements and RS spectral analyses, in order to find out the link between ecosystem processes of the semi-arid forest and RS signals. Questions for this project are, for example, which is the main driving force of GPP in a semi-arid forest? Is it solar radiation, water content, or any other factors? Is the widely used vegetation index NDVI capable of capturing the seasonal change of eco-physiological process in semi-arid forest? Does NDVI in Yatir forest behave as a proxy of fraction of absorbed photosynthetic active radiation (fAPAR) as in many other temperate forests?
Field measurements and RS data from Yatir tower for the years 2013-2016 are analyzed and showed interesting results. For example, fAPAR does not change significantly through the year. GPP increases with APAR in growing season (December-March), but decreases rapidly with further increase in APAR afterwards. Comparing to light, soil water content is the main driving power of GPP. There is no clear correlation between NDVI and fAPAR. NDVI and GPP both reach maximum in winter but have distinguished peak time. GPP vs light use efficiency (LUE) shows hysteresis over the seasonal cycle with the same GPP reflecting low LUE in summer and high in spring .
These results confirm unique remote sensing traits that are clearly different from those in temperate forests, which may require adjustments in its interpretations in semi-arid regions.

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