Drylands, Deserts & Desertification

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Learning from the Drylands - towards Ecosystem Restoration

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Abstract Book

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Book of Abstracts

Arranged by Lecturer's First Name

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How Will Climate Change Impact Health, And What Can We Do About It

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Adapting to Global Change: A MoEP Perspective

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Chief Scientist of the Israeli Ministry of Environmental Protection (MoEP), Israel

Effects of Climate Change on Drylands: Directional Changes in Precipitation Amount and Variability

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[1] Screening of Nitrogen Fixing Microbial Strains from Moroccan Soils and Assessment of their Effect on Wheat Plant Growth under Different Nitrogen Levels and Phosphorus Fertilization Regime

Mr. Aasfar Abderrahim
Moroccan Foundation for Advanced Science, Innovation and Research (MAScIR), Morocco
Session: Belowground Interactions in a Changing Environment

Due to their ability to convert atmospheric N2 into plant-usable ammonia, nitrogen-fixing rhizobacteria should be explored as a sustainable alternative to chemical nitrogen fertilizers for several economically important crops. In this work, nitrogen-fixing strains were isolated and screened from several rhizospheric soils of Morocco, 23 *nif-H*+ strains belonging to *Bacillus* sp, *pseudomonas* sp, *Arthrobacter* sp, *Burkholderia* sp and yeasts were selected to evaluate their PGPR traits. The results showed that almost all selected strains have significant abilities in atmospheric nitrogen fixation, phosphate solubilization, phytohormone production and their effects on plant growth parameters under controlled conditions. Then, 3 strains were selected to evaluate their ability to reduce chemical nitrogen supply and to evaluate their behavior in combination with TSP fertilizer and rock phosphate as two sources of phosphate. *Rhodotorula mucilaginosa*, *Arthrobacter* sp. and *Pseudomonas* sp used individually or in combination have been shown to reduce nitrogen fertilization by up to 50% without impacting wheat plant yields.

[2] Remote Sensing and Land-Surface Interaction in Dryland

Prof. Abdelghani Chehbouni
Mohammed VI Polytechnic University – Morocco
Session: Water, Energy, and CO_2 Budgets in Desert Environments

Accurate estimation of evapotranspiration (ET) is of crucial importance in water science and hydrological process understanding especially in semi-arid/arid areas since ET represents more than 85% of the total water budget. Multisource remote sensing data is a powerful tool to characterize and constrain the surface. Especially remotely sensed soil moisture (SM) and Land surface temperature (LST) data when used simultaneously can improve substantially ET estimates when using either physically based models or empirical ones. In this presentation we will provide results of the above approach using FAO-56 dual source and Soil Vegetation Atmosphere Transfer (SVAT) Models over semi-arid zones Near Marrakech Morocco. A special attention will be dedicated to how this approach improves the partition of ET into Evaporation and transpiration.

[3] Climate Change Induced Humanitarian Needs and Health Inequities in the Lake Chad Basin Region of Africa

Dr. Adetoun Mustapha
Nigerian Institute of Medical Research, Nigeria
Session: Desertification, Climate Change and Health Inequities

Lake Chad, once one of Africa's largest freshwater bodies and a source of livelihood for about 30 million, has diminished by 90% since the 1960s due to the cumulative negative effects of population growth, urbanisation, unsustainable water and land management, over-exploitation and climate change effects. The Lake Chad "Basin" covers almost 8% of the continent and spreads over seven countries: Algeria, Cameroon, Central African Republic, Chad, Libya, Niger and Nigeria. Climate dependent activities and agriculture provide income and employment for most of the population. People who relied on the lake started migrating to other areas in search of water. Conflict between herders and farmers became common as livelihoods were lost. For over a decade, violence created by non-state armed groups in the region has led to internal displacement of about 3 million people as at November 2021, impacting the social, political, security and humanitarian conditions of communities bordering the lake (International Office of Migration, 2021). Studies have shown that the displaced persons encountered barriers to healthcare access. Poverty was identified as the main personal barrier to the displaced persons' healthcare access while communication was reported to be a barrier to healthcare acceptability (Oginni et al, 2021). This case highlights humanitarian needs and health inequities that are aggravated by climate change in developing countries, which need to become a priority in the public health research agenda. It further underlines the urgency with which the international community needs to increase finance for climate change mitigation in such regions. Ways that international collaboration can make this achievable will be discussed.

[4] Enhancing Nutrient Use Efficiency (NUE) by using Controlled Release Fertilizers (CRFs) in Citrus

Dr. Adriano Altissimo
Landlab, Italy
Session: Importance of Precise Crop Nutrition under Desert Growing Conditions

The use of controlled release fertilizers (CRFs) improves NUE and enables matching crop's nutritional requirements resulting in environmental benefits.

During the years 2012-2022 field trial was carried out, aiming to examine the benefits of CRFs in Citrus crops grown in the southwest part of the Negev.

Data on total yield, number of fruits, and fruit size distribution showed that CRFs result in crop performances equal to the control or better. Calculations confirm that CRFs improve NUE as compared to conventional practices.

[5] Co-Development of Urban Climate Resilience in Arab Localities: The Case of Shefa Amr

Ms. Alaa Obeid
The Galilee Society, Israel
Session: Health Systems Preparedness to Climate Change

Background: Community engagement in urban climate resilience planning is essential for the sustainability of cities. However, there's a low percentage of community engagement and channels for participation in Arab localities.

The overall objective of the project is to increase civil society engagement in promoting climate resilience among the Arab minority through the development and promotion of Shefa-'Amr as a model for collaborative, sustainable climate resilience. Arab communities lack the human, institutional, and collaborative capacities required to build Climate Resilience. Poor social cohesion characterizes Arab localities, where citizens are divided and lack trust in their Local Authorities, and local authorities lack the capacities/participatory processes to promote the welfare of the communities they serve, women and youth are systematically excluded from decision-making processes, and civil society organizations are sparse and lacking in resources and skills. The project addresses these needs/constraints through capacity-building and awareness-raising in order to empower these individuals to harness their agency through participation and collective action to promote CR and ultimately their rights. Community participation is important in building a cohesive community, empowering its citizens, and improving their sense of ownership of their city.

This is not an academic paper on urban social engagement even though it builds from and is inspired by academic writings on resilience.

[6] Biocapture of Phosphorus From Waste streams With Microalgae: Opportunities and Caveats

Prof. Alexei Solovchenko
Lomonosov Moscow State University, Russia
Session: Algae-Based Solutions for Food Crisis Challenges

Nowadays, sustainable usage of mined phosphorus (P) is a major concern for humanity. The rock phosphate used for production of chemical P-fertilizer, the lifeblood of modern agriculture, is a finite non-renewable resource very unevenly distributed between countries of the world. Despite this, current routines of P processing and usage are woefully inefficient meaning that > 80% of mined P ends up as non-recycled waste. A significant part of this waste is comprised of liquid waste- or side-streams. At the same time, the P-rich waste-streams are a valuable source of nutrients for cultivation of microalgae. Conversely, microalgal cultures are a promising vehicle for bioremoval of the excessive P with concurrent treatment of wastewater with co-generation of environment-friendly slow-release biofertilizer. These photosynthetic microorganisms feature the capability of taking P in a large excess of the current metabolic demand (known as 'luxury P uptake') and stockpile it as inorganic polyphosphate in the cell against future shortage. Still, efficient application of microalgae for sustainable usage of P is limited by our insufficient knowledge of the biology of a photosynthetic cell in the P-eutrophicated media. The present talk summarizes the recent progress in the research on luxury P uptake. The mechanisms of P uptake by a microalgal cell as a function of its P-nutrition status are elucidated. An overview is given of the ultrastructural aspects of intracellular storage of P. Implications of the recent findings for biotechnology and environment protections are considered.

[7] A Paternal Carry-Over Effect of Environmental Contamination on Preimplantation embryos – A Lesson from Bovines

Dr. Alisa Komsky-Elbaz
The Hebrew University of Jerusalem, Israel
Session: The Effect of Environmental Contaminants on Animal Health

The decreasing trend in human and domestic animal fertility in recent decades has resulted in the question of whether reduced sperm quality is associated with changes in global climate and the environment. Proposed causes for reduced sperm quality include environmental contaminants, which enter the body of animals through the food chain and are transported to the reproductive tract, where contaminating agents can have effects on fertilization capacities of gametes. Among these, are human-derived contaminants, endocrine-disrupting agents such as pesticides, and naturally occurring toxins such as mycotoxins. Mechanisms by which environmental contaminants reduce male fertility are not clearly defined; however, are apparently multifactorial (i.e., direct and indirect effects) with there being diverse modes of action. Deleterious effects of contaminants on male gametes occur at various stages of spermatogenesis (i.e., in the testis) during passage through the epididymis, and in mature spermatozoa, after ejaculation and during capacitation. The damage includes impairments in acrosome integrity and function, mitochondrial membrane potential and DNA integrity. Here we present new evidence for the long-lasting, multifactorial effects of environmental contaminants on spermatozoa, which carryover to the developing embryos. Exposure of spermatozoa to the contaminants before fertilization altered the transcriptomic profile of the developed embryos. Our findings were directly related to bovine spermatozoa and embryos, but they may also be relevant to humans. Understanding the risk associated with environmental contaminants for animal and human reproduction may lead to new management strategies, thereby improving reproductive processes.

[8] Vulnerability and Adaptation to Climate Change: Perceptions and Experience in an Arab Urban Locality in Israel

Ms. Alix Pahaut
University of Haifa, Israel
Session: Health Systems Preparedness to Climate Change

Background: Situated in a climate hotspot, Middle East cities need to build climate resilience. Understanding population perceptions and existing adaptation can support appropriate preparedness action.

Aim: To analyze climate change experience, vulnerability, adaptation, and perceptions in Shefa-'Amr (Shfaram).

Methods: online questionnaire and semi-structured focus groups with resident population.

Results: Questionnaire respondents (n = 482) represented the three local religions, 58.3% women, overrepresentation of higher education. 96.9% indicated they believe climate change is happening, 50.6% answered they were "very worried" about it. 47.7% responded that they experienced "some" negative health consequences from extreme heat. Respondents indicated high rates of willingness regarding preparedness actions like signing a petition (89.8%), planting trees (86.5%), or designing buildings to require less air-conditioning (83.8%); lower willingness to inquire about whether political candidates include climate preparedness in their agenda (65.6%); and much less willingness to sell or exchange land for local green spaces development (33.0%). Social resilience was not very high, 1.64 ± 0.49 (1 – 3 scale).

Focus groups (n = 9, 4-8 per group, total 52 participants) revealed: a contrast between traditional heat adaptation strategies and current reliance on air conditioning; lack of resilient urban infrastructure and inequality with neighboring Jewish municipalities; mixed attitudes towards preparedness, social resilience, and the municipality.

Conclusion: High levels of climate change awareness and concern were found, and willingness to take a range of actions. Focus groups revealed a more complex picture of social resilience. These findings can be used to engage with and advocate for the community in resilience building.

[9] Static vs Dynamic Management Zones for Remote-Sensing Guided Precision Irrigation

Dr. Alon Ben-Gal
Volcani Institute, Agricultural Research Organization, Israel
Session: Remote Sensing for Dryland Agriculture

There is a standing argument in the world of precision irrigation: are management zones (MZs) inherently static, influenced mainly by soil and elevation dictated properties, or are they dynamic, with possible changes to the nature of spatially variable crop features dictating locally different irrigation strategies or amounts occurring over time, even within growing seasons?

We addressed this question using a corn-cotton rotation in a variable rate center pivot sprinkler system at the Gilat Research Center of Israel's Agricultural Research Organization – Volcani Institute. Drone –acquired multispectral and thermal images were used to generate normalized difference vegetation index (NDVI) and crop water stress index (CWSI) maps weekly over three irrigation seasons. The maps were used to make weekly decisions regarding number and location of MZs in three large replicate areas of the 12.5 hectare field. Each MZ was irrigated according to best practice protocol depending on crop and growth stage.

The dynamic MZs were compared to static MZs determined using multi-parameter statistics via machine learning based on elevation data (topographic wetness index), soil data (apparent electrical conductivity), past year's representative NDVI and past year's yield and using crop water status (as stem water potential and/or CWSI) as a predicted factor. The MZ schemes were also compared to a control treatment irrigated uniformly.

Results showed the advantage of MZ-based precision irrigation over uniform irrigation in reducing field-scale variability and increasing yield and a slight advantage of dynamic over static approaches, which may not be justified economically.

[10] Carbon Metabolites in Interspecific Tree-Tree Carbon Transfer via Mycorrhizal Fungi

Mr. Alon Rapaport
Weizmann Institute of Science, Israel
Session: Belowground Interactions in a Changing Environment

Carbon can be bi-directionally transferred between plants via common mycorrhiza network (CMN) in the soil. However, the chemical forms of this carbon are still unknown. In my MSc project, I investigated and attempted to identify the carbon metabolites transferred via direct hyphal connections between roots of different tree species. For this purpose, I used two experimental platforms. The first is a 13C pulse labeling experiment performed on oak and pine saplings in a controlled environment that allows only mycorrhiza to connect neighboring trees. Furthermore, we shaded some of the saplings to examine the effect of increased carbon demand on the flux and composition of carbon metabolites. The second is a complementing 13CO2 tree labeling experiment in the forest where I collected the mycorrhiza fruiting bodies and identified the carbon metabolites transferred within the CMN. We showed that carbon was transferred to the tree roots exudates, and later from the labeled tree to its neighboring fungi fruiting bodies, within four days. Discovering what materials are transferred can shed light on the role of this phenomenon and its potential benefits for the participating trees and fungi.

[11] Enhancing Automation in Controlled Environment Agriculture (CEA)

Prof. Alon Wolf

Incoming Dean, Faculty of Mechanical and Biomedical Engineering Technion I.I.T ,Israel

Session: The Future of Agriculture - Revolutionize Agricultural Practice: A Technological Revolution in Farming Led by Advances in CEA Technologies

Controlled Environment Agriculture (CEA) is an indoor technology-based production system where crops are grown under a modified and highly conditioned environment. The greenhouse sector and its derivatives such as vertical farming are the most common forms of CEA.

CEA production is labor intensive, requiring workers for a range of critical production tasks including propagation, planting, movement and management of plants, cleaning, harvesting, pest management, pruning, sorting and packaging. The lecture will address launching a challenge to enhance solutions for these challenges by increasing the automation in the production and operations of CEA facilities.

[12] Development of a Static In Vitro Feed Digestion Model in Rainbow Trout, Oncorhynchus Mykiss for the Development of an Artificial Fish Intestine

Dr. Amir Bitan
National Center for Mariculture, Israel
Session: Next Generation Aquaculture

An artificial fish intestine (Fish-AI) composed of a scaffold mimicking the Rainbow trout (RT) intestinal villi lined with epithelial cells is currently being developed as part of the H2020-FETOPEN project initiative Fish-AI. The aim is to develop a screening platform based on RT intestinal cells to test the applicability of novel feeds for aquaculture. Towards this aim, we performed in vitro digestion (IVD) of fish feed in order to expose the feed to the gastric and intestinal digestive conditions, using either RT stomach or intestinal enzyme extracts. This will allow the introduction of partially digested feed to the Fish-AI to better simulate the conditions in the intestine of RT. On-the-bench analysis allows us to assess that proteolysis occurred during the IVD, and metabolomic analysis permits us to assess the nutrients profile in the IVD feed as compared to digested feed that was sampled from the intestine of RT fed the same diet. We demonstrated that the IVD feed produced by this method can be introduced to cultured enterocytes with no significant cytotoxic effect on the metabolic status, cell plasma membrane integrity, lysosomal integrity and cell barrier integrity. The predictive power of the Fish-AI is presently being tested in vivo, in RT.

[13] Assessing Global Dryland System Designations: Land-Uses, Conservation Status and Congruency of Global Arid Landscapes

Dr. Amir Lewin
Ben Gurion University of the Negev, Israel
Session: Remote Sensing Applications for Drylands Ecology

Drylands encompass a large part of Earth's land surface, supporting vital human and natural environments. A major challenge facing land-use planning in such regions is the application of several disparate classifications (e.g., dry, desert, arid, etc.) – comprising broad and non-overlapping regions. We examined several dryland designations to evaluate their degree of global congruence, protected area coverage, and current and future land-use pressures. We focus on four of the foremost landcover designations among major international organizations – (1) Deserts and Xeric Shrublands (WWF), (2) Drylands (UNEP-WCMC), (3) World Terrestrial Ecosystems (USGS-Nature Conservancy-ESRI), and (4) Global Agro-Ecological Zones (FAO) – each utilizing dissimilar methodologies categorizing "drylands". We identify core regions of drylands identified as such across all designations, in addition to regions falling under only one or few designations – thereby highlighting their potential complementarity, while also identifying unique desert regions omitted by other designations. Our findings reveal significant variation among designations, and unique desert regions encompassing approximately 12.1 million km^2. We also find that relative to other biomes, deserts are among the least protected by assigned conservation areas aimed at protecting biodiversity (i.e., IUCN categories I-IV), particularly the most arid subtypes, and the extent of this coverage varies among designations. These attributes were further highlighted in major dryland regions separately, revealing regions of very low protection and high human agricultural and urban pressures (e.g., Asia), representing high conservation priority. Identifying desert classifications and their spatial distributions will be integral to determining potential threats, requisite conservation interventions and land-use planning in desert regions globally.

[14] Monosex Populations of Prawns for Aquaculture and Biocontrol

Prof. Amir Sagi
Ben Gurion University of the Negev, Israel
Session: Next Generation Aquaculture

Novel husbandry approaches to favor investment of energy on growth in the expense of reproduction and aggressive behavior are suggested by monosex culture biotechnologies. In the aquaculture of the giant prawn Macrobrachium rosenbergii two monosex approaches were investigated, all-male culture and all female culture. The first caters for large sized prawns under less dense conditions and the second aims at a uniform aquaculture product under a more intensive husbandry. Both contribute to more sustainable culture due to the fact that it reduces the chances of escapees from the aquaculture operation to become invasive and pose an environmental threat. The possibility of producing a single sex population that could not breed opens also the possibility to sustainably use prawns as biocontrol agents against pest snails in aquaculture, agriculture and even snails that carry human disease vectors. For environmentally safer biocontrol, possible future development of sterile biotechnologies will be discussed.

[15] Watershed Management as a Base for Developing Agro-Silvopastoral Systems: Capacity Building in Northern Turkana, Kenya

Mr. Amit Eliyahu and Mr. Asaf Karavani
Keren Kayemeth LeIsrael-Jewish National Fund (KKL-JNF), Israel
Session: Practical Methods for Dryland Afforestation and Landscape Restoration

Traditionally the Turkana People are semi-nomadic pastoralist. Due to increasing survival stress, a growing number of Turkana families can no longer sustain the traditional way of life and are "in transition". Agriculture is becoming a complimentary or an alternative way of life for many who are in transition from traditional pastoralist life.

Following the success of Furrows in the Desert (FID) agricultural development program, nowadays there is agricultural activity in over 50 communities in northern Turkana, Kenya, through FID graduates and their assistants. FID is a joint operation of MCSPA Kenya, The Arava Institute for Environmental Studies (AIES, Israel), the Turkana Farmers Association and the People on northern Turkana. Our current focus is on the establishment of farming clusters and farming centers within the region of our operation.

The most limiting factor for development in the region is the scarcity of water. While most of the farming activities are based on underground water delivered through boreholes, most of the rainwater is lost along barren, over-grazed, clay-rich slopes into dry river runoff. Over-grazing and land degradation are common problems in Turkana, especially around farming communities.

With the increase of local food production and the growth of agricultural activities within the farming clusters, the resilience of some of the communities also increases, and they are now able to invest their limited resources into managing the environment they live in.
During the last 3 years we developed water harvesting sites around three FID communities in Turkana (Lobur, Kopotea and Kaikor). This initiative is part of a study for the adaptation of appropriate watershed management and runoff water harvesting methods with an aim to: (a) Improve ecosystem services by rehabilitation of the agro-silvopastoral system, (b) Increase the local production of pasture and other animal feed for use of domestic animals, (c) Prevent land degradation through erosion of fertile soils, (d) Improve soil quality by decomposition of organic matter, (e) Increase rainwater residual times to percolate through the soil and re-charge ground water aquifers, (f) Increase food production towards food security and to diversify the types of nutrients available to the local Turkana People, and (g) make a positive contribution to the

environmental education and awareness of the local communities through the high visibility of variable and dense plant production especially of trees.

This initiative is based on knowledge and experience developed over the last decades by Keren Kayemeth LeIsrael – Jewish National Fund (KKL-JNF), the acting Forest Service of Israel. A combination of research-based management, combined with a pioneering attitude, has helped KKL-JNF rehabilitate vast areas of degraded dryland in southern Israel. The methods developed by KKL-JNF are now adapted to the physical and cultural environment of northern Turkana by Israeli experts, FID staff and the local Turkana People.

[16] Sustainable Aquafeeds: Where Have We Been and Where Are We Going?

Dr. Andre Dumas
AD Aquaculture Nutrition Services Inc., Canada
Session: Next Generation Aquaculture

Compound aquaculture feed stands out as the main factor responsible for environmental impacts of fed aquaculture species based on life cycle assessment analyses. Production and transport of raw materials represent between 30 and 95% of all environmental impact categories, whereas feed processing is the main contributor to greenhouse gas emission (GHG). The objectives of this presentation are to (1) demonstrate past achievements, among which some were made inadvertently, to contribute to the sustainability of aquafeeds, (2) identify challenges yet to be addressed globally and in Israel, and (3) propose a strategic roadmap to improve sustainability of aquaculture feeds that support food production systems for the growing human population. Israel, particularly in the Negev, can contribute to tackle challenges by considering the limitless possibilities offered by biotechnologies (e.g. microalgae, bacteria and yeast production) in a context of finite resources. Finally, nutrient recycling and principles of circular economy are pivotal to enhance aquafeed sustainability in such context and will be discussed with consideration for their role in securing food supply in an ever-changing world.

[17] Ecosystem Integrity – Sensor /EO-Service (ESIS) for Monitoring Bio- and Geodiversity, Vegetation Health and Land-Use Intensity by Spectral Traits, Remote Sensing

Dr. Angela Lausch
Martin Luther University Halle-Wittenberg, Germany
Session: Remote Sensing Applications for Drylands Ecology

Ecosystems and sustainable agricultural landscapes fulfil a whole host of ecosystem functions that are essential for life on our planet. A huge number of long-standing and standardized ecosystem health and monitoring approaches of bio-and geodiversity exist and are increasingly integrating RS based monitoring approaches. Unfortunately, these approaches in monitoring, data storage, analysis, prognosis and assessment still do not satisfy the future requirements of information and digital knowledge processing of the 21st century. If we want to understand the complexity of our system, we have to apply a holistic RS monitoring approach.

Traits and trait variations exist at all spatiotemporal scales. Traits are the crucial interface between different ecosystem domains, coupling of in-situ and RS monitoring approaches and are proxy indicators for ecosystem- and human health interactions. RS traits can be used to quantify the genesis-, structural-, functional-, and taxonomic geo- and biodiversity, vegetation health and indikatores of land use intensity.

In this presentation, we present the development of an "EcoSystem Integrity – RS/Modelling Service (ESIS). The basis of the ESIS idea is that close-range, air-and spaceborne sensors/EO sensors can monitor traits as well as trait variations in vegetation, soil, geomorphology, water quality, land-use-intensity and social-ecological systems. In the future, close-range, air- and spaceborne multisensor and multitemporal RS technologies (optical RS Data, RADAR, TIR Data) will be combined in the ESIS to make modular traits and trait variations quantifiable in a fast and standardized way in only a few steps. ESIS will implement the concepts of data science

[18] The Mechanistic Link between Stored Non-Structural Carbohydrates and Plant Water Relations

Prof. Anna Sala
University of Montana, USA
Session: Desert Plant Ecology: Lessons for a Warming Planet

The frequency and severity of droughts is expected to increase with climate change and to cause plant drought stress. Such stress could potentially lead to drought-induced mortality, changes in plant community composition, and vegetation shifts. Drought stress limits plant water transport and carbon assimilation, potentially causing plant hydraulic dysfunction and depletion of stored non-structural carbohydrates (NSC), both of which have been invoked as drivers of plant drought mortality. Empirical and modelling evidence indicates that the interaction between plant hydraulic function and stored non-structural carbohydrates (NSC) is critical to understand plant drought responses and survival to drought. However, the mechanistic nature of this interaction is not well understood, which hinders our understanding and ability to predict species- and ecotype-specific responses to drought. In this talk I will summarize our current knowledge of the mechanistic link between NSC storage and plant water relations and responses to drought, including our own experimental evidence showing negative consequences of stored NSC depletion on osmoregulation. I will also explore the degree to which NSC storage becomes a priority carbon sink with consequences on plant carbon allocation and plant life history strategies.

[19] Reflecting on 40 Years of the Middle East Regional Cooperation Program

Dr. Anne Dare
U.S. Agency for International Development, USA
Session: Cross Border Desert Research- Science and Collaboration

The Middle East Regional Cooperation (MERC) Program – managed by the U.S. Agency for International Development and implemented with the support of the U.S Embassy in Israel – promotes cooperation between Arab and Israeli scientists, technicians, students, and communities by supporting joint research grants that address regional development challenges. MERC was authorized by the U.S. Congress in 1979 after the Camp David Accords to support Israel-U.S.-Egyptian scientific cooperation, and expanded in 1993 to include the broader MENA region. To date, the MERC program has awarded grants between partners in Israel, Egypt, Jordan, Lebanon, Morocco, Tunisia, and the West Bank and Gaza.

In 2021, the MERC Program commissioned an assessment looking back over 40 years of support for joint Arab-Israeli research and asked two main questions: (1) has MERC built results-oriented research capacity in partner Arab research institutions?, and (2) what degree of cooperation has been achieved between Arab and Israeli researchers? This presentation will provide highlights from that assessment, share examples of outcomes from MERC-supported research, and discuss how the program is adapting in light of a changing region and world.

[20] Untangling the Human and Climatic Impacts on Vhanges in Vegetation Using Large Scale Exclosures: National Borders and Military Areas

Mr. Ariel Meroz
The Hebrew University of Jerusalem, Israel
Session: Remote Sensing for Environmental Sustainability and Climate Change

Human activity impacts vegetation, however, attributing the extent of changes to which is the result of human actions or of climate variability is challenging. The Israeli Negev desert is bordered by two countries (Egypt and Jordan), and by the Palestinian Authority (Gaza Strip and the West Bank), crossing three climate zones and a variety of soils and lithologic settings. Desert vegetation was traditionally subject to herds grazing, mostly done by the local Bedouin (semi-nomadic) community. Due to the extensive grazing, trampling, bush gathering, and rainfed agriculture by Bedouins, and other human land uses such as military training areas and protected areas, the anthropogenic impact on desert vegetation is hard to evaluate. We chose to use large-scale exclosures such as national borders and six military bases to estimate the different impacts that grazing and bush gathering have on vegetation cover and thus to isolate the human factor from the climatic factor. We used remotely sensed derived proxies of vegetation (the Normalized Difference Vegetation Index, NDVI) and surface albedo from Landsat and MODIS satellites to estimate the anthropogenic impact on vegetation cover in the past four decades (since 1984 - 2019). Our results showed that the cross-border differences in grazing and bush gathering led to a significant impact on vegetation cover within exclosures. These cross-border differences were more pronounced in the semi-arid and arid climate regions and decreased in the hyper-arid region. We also found that the sandy soil bed was the most active environment for vegetation growth in the arid environment, causing the most profound difference between the two sides. Exclosures thus provide a natural experiment which enables us to test the factors driving changes in natural vegetation.

[21] The Ecological Implications of Interplant Drought Cuing

Prof. Ariel Novoplansky
Ben Gurion University of the Negev, Israel
Session: Belowground Interactions in a Changing Environment

Plants can perceive, integrate, and respond to multiple signals and cues informative of imminent threats and opportunities. Here, we tested the hypothesis that unstressed plants are able to perceive and adaptively respond to stress cues emitted from their drought-stressed neighbors and to induce adaptive responses in additional unstressed plants.

Triplets of split-root Stenotaphrum secundatum plants were grown in rows. One root of the first plant was subjected to drought while its other root shared its pot with one of the roots of an unstressed target neighbor, which in turn shared its other pot with an additional unstressed target neighbor.

Cuing from drought-stressed plants increased survival in both proximate directly cued and in more distant relayed-cued target plants under drought. Drought cuing lowered plant performance under benign conditions. Experiments with Wilty mutants and fluridone treatments showed that drought cuing was greatly reduced in ABA-deficient plants.

Our findings demonstrate for the first time the possible adaptive implications of both direct and relayed stress cuing among neighboring plants, the possible cost of plant responsiveness to drought-cues under benign conditions and the involvement of ABA in interplant drought cuing. The results suggest that interplant root communication of drought cues could have novel implications for plant interactions, survival, and performance under both natural and agricultural settings.

[22] Livestock Production Systems under the Current Climate Change Era

Dr. Ariel Shabtay
Volcani Institute, Agricultural Research Organization, Israel
Session: The Effect of Environmental Contaminants on Animal Health

World population is expected to reach 9 billion people by 2050. Urban population size, demographic, and socio-economic trends result in an increasing demand for animal protein. This drives the need for efficient utilization of animal genetic resources, but with respect to the animals we grow and to the environment they grow in. Global warming is expected to pose stress and vulnerability on farm (homeothermic) animals, with impacts on their welfare, health, productive and reproductive efficiencies. On the other hand, global animal production systems are often criticized for consuming food edible by humans, graze on pastures that could be used for crop production, and are (especially ruminants) seen as poor converters of feed into food products. Thus, sustainable livestock production, if it takes place, may balance part of the deleterious interplay between animals and environment, under climate change.

It is hypothesized that the key to reducing disease incidence and animal discomfort appears to be centered at reducing the response to stress. Monitoring stress and managing livestock to diminish its negative impact is therefore prerequisite. To this end, strategies that involve thermal conditioning at early age, dietary manipulations and selection for adaptive breeds, have been studied in order to alleviate stress in aves and ruminants. It will be presented herein that, these strategies:

1. Reduced mortality and improved body temperature regulation in layer hen.
2. Alleviated intestine disease and discomfort, decreased antibiotics utilization, and inhibited blood parasites invasion in cattle.
3. Improved low quality feed efficiency and tolerance to blood parasites.

[23] Mapping Wildfire Scares – NDVI vs. NBR vs. AFRI

Prof. Arnon Karnieli
Ben Gurion University of the Negev, Israel
Session: Remote Sensing for Environmental Sustainability and Climate Change

Assessing the development of wildfire scars during a period of consecutive active fires and smoke overcast is a challenge. The study was conducted during nine months when Israel experienced massive pyro-terrorism attacks of more than 1100 fires from the Gaza Strip. The current project strives at developing and using an advanced Earth observation approach for accurate post-fire spatial and temporal assessment shortly after the event ends while eliminating the influence of biomass burning smoke on the ground signal. For fulfilling this goal, the Aerosol-Free Vegetation Index (AFRI), which has a meaningful advantage in penetrating an opaque atmosphere influenced by biomass burning smoke, was used. On top of it, under clear sky conditions, the AFRI closely resembles the widely used Normalized Difference Vegetation Index (NDVI), and it retains the same level of index values under smoke. The relative differenced AFRI (RdAFRI) set of algorithms was implemented at the same procedure commonly used with the Relative differenced Normalized Burn Ratio (RdBRN). The algorithm was applied to 24 Sentinel-2 Level-2A images throughout the study period. While validating with ground observations, the RdAFRI-based algorithms produced an overall accuracy of 90%. Furthermore, the RdAFRI maps were smoother than the equivalent RdNBR, with noise levels two orders of magnitude lower than the latter. Consequently, by applying the RdAFRI, it is possible to distinguish among four severity categories. However, due to different cloud cover on the two consecutive dates, automatic determination of a threshold level was not possible. Therefore, two threshold levels were considered through visual inspection and manually assigned to each imaging date. The novel procedure enables calculating the spatio-temporal dynamics of the fire scars along with the statistics of the burned vegetation species within the study area.

[24] A Deep Learning Approach for Automatic Identification of Ancient Agricultural Water Harvesting Systems

Ms. Arti Tiwari
Ben Gurion University of the Negev, Israel
Session: Space Based Technological Applications for Water Management

Despite the harsh climatic conditions in the Central Negev Desert, Israel, thousands of dry stonewalls were built across ephemeral streams between the fourth and seventh centuries CE to sustain productive agricultural activity. Since 640 CE, many of these ancient terraces have remained untouched by humans, instead buried by sediments, covered by natural vegetation, and partially destroyed. The main goal of the current research is to develop a procedure, using a deep learning approach, for the automatic recognition of ancient water harvesting systems by incorporating two remote sensing datasets (a high-resolution color orthophoto and LiDAR-derived topographic variables) and two advanced processing methods (an object-based image analysis (OBIA) and a deep convolutional neural networks (DCNN) model). A confusion matrix of object-based classification revealed an overall accuracy of 86% and a Kappa coefficient of 0.79. The DCNN model achieved a Mean Intersection over Union (MIoU) value for testing datasets of 53. The individual IoU values of terraces and sidewalls were 33.2 and 30.1, respectively. The current study demonstrates how incorporating OBIA, aerial photographs, and LiDAR in the context of DCNN improves the identification and mapping of archaeological structures.

[25] Water Potential for Mortality of Cupressus Sempervirens Corresponds with 50% Embolism

Mr. Assaf Alon
The Hebrew University of Jerusalem, Israel
Session: Plant Hydraulics in Response to Environmental Stress

Field observations of individuals of *Cupressus sempervirens* (CS) in an arid region showed that they died at the end of the dry season with xylem water potential (Ψ_x) of only -6.5 MPa, despite CS's more resistant xylem (Ψ_{50} ~-10 MPa). Thus, we hypothesized that the observed CS mortality was driven by other (than xylem tension) agents, and that CS has the potential to survive severer droughts. Our goal was to characterize the water potential and hydraulic failure that lead to mortality in CS.

We performed a terminal drought experiment in a greenhouse with different CS genotypes: K type- based on propagation from a forestry organization seed source; and R type- based on clones from cuttings from a robust tree in a dry area (Yatir forest). Water content, water potential, photosynthesis, membrane leakage, water loss by weight, leaf conductivity, and leaf non-structural carbohydrates (NSC) were measured throughout the experiment.

K type water loss was lower, which was reflected in lower mortality rates on day 18. Mortality of 14/30 and 19/30 individuals was observed following 40 days in R type and K type, respectively. Mortality corresponded with 40% water content and Ψ_x ~-10 MPa. Following rewatering significant differences were observed in membrane leakage but not in NSC between recovered and dead seedlings.

This work demonstrates that CS's Ψ_x can approach its Ψ_{50} under drought. We also found that a water-saving genotype delayed mortality.

[26] Agricultural Desertification – The Curse of Resources for Arabian Babblers in the Arava Valley

Prof. Aviad Heifetz
Open University of Israel, Israel
Session: Economics & Desertification

In the Arava valley in southern Israel, during the last 50 years water for greenhouse agriculture is getting drilled from increasing depths, causing flora dehydration outside the seasonally flooded wadis, and fauna attraction to the unpredictable organic garbage piles surrounding the greenhouses. In Shezaf nature reserve, this process is detrimental in particular to the population of the Arabian babbler, the only cooperatively breeding songbird in Israel. The number of individuals and groups shrank by about 50%, and groups next to the greenhouses live a much more intensive and brutish life, with larger but less stable groups in smaller territories, increased aggression both inside the groups and towards neighboring groups, shorter life span, with more nesting rounds per year but less offspring surviving to adulthood per nest. We present a game-theoretic model with such consequences due to volatile and unpredictable resources. We conclude with low-cost recommendations to the farmers and the authorities/regulators for alleviating these adverse repercussions to the wildlife.

[27] The Dark Side of the Light: The Effect of Modern Artificial Light at Night (ALAN) on Welfare, Production and Feed Efficiency of Livestock

Dr. Aviv Asher
MIGAL – Galilee Research Institute, Israel
Session: The Effect of Environmental Contaminants on Animal Health

With the wide-spread adoption of electrical lighting, humans and animals became exposed to Artificial Light at Night (ALAN) of high intensities short wavelength illumination, similar to those of day time, resulting in suppression of Melatonin (hormone that mediate the darkness signal between the master clock to the tissues) production and consequently causing real health hazard to humans. In Jun 2012, American Medical Association declared that environmental factors that cause misalignment of internal physiology rhythms should be classified as "Chrono-disruptors" caused by "Light pollution".

In the last several years we have conducted experiments that aimed to investigate the effect of ALAN on livestock welfare, performance and feed efficiency (FE). Suckling calves that were exposed to ALAN showed disruption in their heart rate (HR) rhythmicity and had significantly higher HR and heat production and lower melatonin concentration in the plasma compared to calves that were not exposed to ALAN. The results also showed that ALAN reduces FE and this trend was also maintained during the various stages of growth, hinting that there is a critical period for metabolic programming. Dairy cows and goats that were exposed to ALAN showed lower concentration of melatonin in plasma and milk and lower FE. They also had lower milk quality and their HR rhythmicity was disrupted compared to the animals that were exposed to natural illumination. These new results support the claim that ALAN should be defined as "light pollution" that has a negative effect on the welfare, health and production efficiency of livestock.

[28] A Decision Support Tool for Optimizing Spatial Sampling in Precision Agriculture

Dr. Aviva Peeters
TerraVision Lab and SCE Shamoon College of Engineering, Israel
Session: Leveraging Agro-Informatics and Big Data Applications to Improve Crop Production and Farmers' Livelihood

An important aspect in precision agriculture is the representation of in-field spatial variability as a basis for dividing a field into homogenous management zones (MZ) in order to promote optimization of resources application. MZs can serve as the basis for applying spatially- and temporarily-variable rate inputs such as irrigation. This has important economic implications on the sustainable management of resources in water-limited regions. Management decisions often utilize sampling and/or sensors placed within MZs with the expectation that they will capture and represent a zone's properties. Yet, to optimize sampling distribution several challenges should be addressed, including how to accurately represent the spatial variability in the field while considering cost-effectiveness and how to integrate multivariate big-data from a variety of sources?

Spatial sampling aims to estimate the attributes of spatially distributed phenomena in un-sampled locations by maximizing the probability of capturing spatial variability. Traditionally, decisions concerning the number of samples/sensors and their locations use non-spatial methods that do not address spatial autocorrelation and/or spatial heterogeneity.
A model and tool based on machine learning and spatial statistics have been developed to provide a decision support tool for distributing samples/sensors in a field while accounting for the spatial structure of multiple variables. The tool is based on stratified-based sampling where MZs act as the confining strata, and on assigning weights to MZs based on their degree of spatial autocorrelation, to reduce sampling redundancy. The tool outputs the optimal number of samples and their location and has been tested on a variety of case studies in Israel, Czech Republic, Spain and the U.S. The tool is available in a user-friendly interface for producing dynamic sampling maps to support sustainable precision management in drylands.

[29] Selecting for Enhanced Growth of N. Oceanica in High Light Environments Through the Improvement of ROS Tolerance

Mr. Avraham Ben-Sheleg
Ben Gurion University of the Negev, Israel
Session: Algae-Based Solutions for Food Crisis Challenges

The shrinking availability of arable land and freshwater resources for conventional agriculture demands the development of alternative feedstock sources for human and animal nutrition. The mass production of photosynthetic marine microalgae on non-arable land using alternative water resources is a vital aspect of building a resilient and secure food system. Marine microalgae provide an alternative sustainable source of high-value proteins and essential omega-3 fatty acids (Moomaw et al. 2017). Nannochloropsis is a genus of marine microalgae, composed of a few predominantly marine species (including N. oceanica) with high industrial potential. These microalgae accumulate large amounts of omega-3 long-chain polyunsaturated fatty acid (LC-PUFA) eicosapentaenoic acid (EPA, 20:5n-3) in their membrane lipids. ROS protective mechanisms are an interesting candidate for study due to the central role that ROS plays as a feedback system on the photosynthetic apparatus. The photosynthetic apparatus proliferates large amounts of ROS in high light, especially when combined with other environmental stress. Here I will show how Rose bengal (a singlet oxygen photosensitizer) was used as part of a strain selection program for enhanced growth of N. oceanica in high-light environments.

[30] A Systems Approach to the Peace-Sustainability-Climate Nexus

Prof. Bernard Amadei
University of Colorado, USA
Session: Cross Border Desert Research- Science and Collaboration

There is enough evidence that humanity will continue to face significant challenges way into the rest of the 21st century. In that context, a question arises as to whether it is possible to envision a world where *all* humans have fulfilling lives, meet their basic needs, and live with dignity and peacefully, without degrading the ecosystems and services upon which they depend. Meeting that overarching goal of human development will not be easy.

Promoting peace and sustainability in human development and security while accounting for the risks associated with climate change has become more imperative than ever. It is hard to envision (i) a sustainable world that is not peaceful and climate secured; (ii) a peaceful world that has not endorsed sustainable practices and does not support climate adaption and mitigation practices; and (iii) a climate secured world that has not endorsed sustainable practices and is geopolitically unstable.

This paper makes a case for using an integrated and coherent approach to addressing human development and security issues and explores, more specifically, the underlying dynamic of *the peace-sustainability-climate security (PSC) nexus* at the community scale. Peace, sustainability, and climate security are considered as three interconnected *states* (or cultures) that *emerge* from the interactions of multiple shared systems in a community landscape (environment) subject to various constraints (political, social, cultural, economic, environmental) and adverse events. These states influence and depend on each other.

The approach used in this paper acknowledges that there are no one-size-fits-all unified and optimized static states of peace, sustainability, and climate security as they are context and scale-specific. What works in one community landscape may not work somewhere else. As a result, it is easier to define all three states by what they are *not* rather than what they are. In doing so, multiple "good enough" states can be explored. Therefore, peace, sustainability, and climate security have "to be read as a plural."

[31] Croptune, a Real-Time Decision-Support Mobile Application for Continuous Monitoring of Nitrogen Deficiencies and Fertilization Recommendations

Dr. Chanan Sluszny
Haifa Group, Israel
Session: Importance of Precise Crop Nutrition under Desert Growing Conditions

Nitrogen fertilization/nutrition of desert-growing crops is challenging due to the soil structure that tends to be light/sandy, characterized by very low cation exchange capacity and organic matter content. Continued monitoring of Nitrogen content in crops with the Croptune app enables accurate timing and adjustment of fertilization amount, thus ensuring optimal crop growth and development while avoiding salinity build-up in water and soil, losses, and environmental contamination caused by nitrogen overdosing.
- Includes hands-on Croptune demonstration

[32] Highlighting Partners in Health's Experience of Addressing Climate Disaster in 2022

Dr. Chiyembekezo Kachimanga
Partners In Health, Malawi
Session: Health Systems Preparedness to Climate Change

Background:
In January 2022, Cyclone Ana ravaged many southern Malawi districts. In Neno, a district with about 150,000 people, and Chikwawa, a district with over 500,000 people, many households were affected with loss to lives, crops, livestock's and property. Since 2007, Partners In Health (PIH) has employed an all-inclusive approach in its mission of "Providing a preferential option for the poor in health care". We document the PIH short and long term support during the recent cyclone Ana in Malawi.

Response:
Firstly, PIH provided technical support to the Ministry of Health (MOH) by participating in emergency operation center activities supporting MOH on areas that need to be included in national disaster response plans. At district level, PIH supported the district councils to ensure they convened district level meetings to plan the response to cyclone Ana.

Secondly, PIH supported provision of medical care for people living in camps. In Neno, we supported the set-up and provision of care in five camps. For Chikwawa district, we reached out to 15,700 people who were living in camps with medical care. Finally, we supported 9,674 people and 9,080 in Chikwawa and Neno respectively with immediate relief items like food (mainly maize), household items and construction materials. Currently, we have identified 43 households who completely lost their houses and have started providing housing support to these households.

Lessons:
Climate related changes are becoming common and raise health concerns in Malawi, hence the need for multi-sectoral stakeholder involvement. Therefore, health and welfare organizations should adapt to these changes and build appropriate collaborative response mechanisms.

[33] Monitoring Forest Health Through Remote Sensing Time Series Analysis to Assess the Effects of Extreme Drought Events in Forest Seasonality

Mr. Christos Theocharidis
ERATOSTHENES Centre of Excellence & Cyprus University of Technology, Cyprus
Session: Remote Sensing for Environmental Sustainability and Climate Change

Climate change in the Mediterranean region is anticipated to result in heat stress and water scarcity, leading to more frequent drought occurrences, increasing forest mortality events, and thus affecting forest biodiversity. Therefore, it is vital to evaluate the forest stands' vulnerability to extreme climatic events such as drought in the Mediterranean forest tree species, even if they are considered drought resistant. Inside all these forecasts, the already affected Cyprus's natural resources are expected to further aggravate climate change pressure due to the island's semi-arid climatic conditions. Satellite image time-series data contributed notably to monitoring the effects of drought events on forest health and forest phenology since they allow us to observe how climate change has affected these ecosystems and how this will change in the following years. This study conducts a time-series analysis using the BFAST time-series decomposition algorithm to detect possible abrupt changes in forest seasonality and the impacts of extreme drought events on forest health, examining four remote sensing indices from 2017-2021. Land Surface Temperature (LST) derived from Landsat-8, Normalised Difference Moisture Index (NDMI), Enhanced Vegetation Index (EVI), and Green Chlorophyll Index (GCI) were created by Sentinel-2 and assessed to find possible correlations between them. The study area focuses on the forest of Paphos due to its unspoiled vegetation and the highly reduced number of forest wildfires in this area in recent years, favouring the reliability of the research's results.

[34] Ecological Climate Health Research Beyond Numbers

Prof. Colin MacDougall
Flinders University and University of Melbourne, Australia
Session: Desertification, Climate Change and Health Inequities

Climate change, drought and desertification combine ecological, economic, political and moral problems. Multiple streams of political theory helps us understand what researchers can do to increase the chances that their work reaches crowded policy agendas. This happens when three streams of problem definition, policy formulation and political will converge. Science and numbers are excellent for defining the problem. Policy development requires co-production with communities and policy makers using qualitative data to craft credible proposals. Despite the use of knowledge transfer and exchange strategies, influencing the political stream remains a methodological problem. Researchers can act as policy entrepreneurs, synthesising action research methods to bring the problem, policy and politics streams together.

This paper draws lessons from two Australian case studies about promising methodologies mixing qualitative and quantitative methods. The first reflects on empirical research into a decade long drought in South Australia showing how co-production of local mixed methods data with policy makers produced credible policy proposals. The second describes published research into the long Queensland drought, calling for a new combination of scientific and community indicators and knowledge.

The paper concludes with a call to action for Australian researchers to redress centuries of colonialism in science and water management. This requires mixed methods research informed by Indigenous epistemology and strengths-based approaches. Examples of this approach show how two way learning between Indigenous and non-Indigenous researchers helps each to walk together towards decolonising research for the sake of the planet.

[35] Growing Vines in Dry Conditions: What Can We Learn from the Mediterranean Experience?

Prof. Cornelis van Leeuwen
University of Bordeaux, France
Session: Viticulture in a Changing Climate: Vineyard-Environment Interactions

Climate change will impose increasingly warm and dry conditions on vineyards. Wine quality and yield are strongly influenced by climatic conditions and depend on complex interactions between temperatures, water availability, plant material and viticultural techniques. In established winegrowing regions, growers have optimized yield and quality by choosing plant material and viticultural techniques according to local climatic conditions, but as the climate changes, these will need to be adjusted. Adaptations to higher temperatures include changing plant material and modifying viticultural techniques such that harvest dates are maintained in the optimal period (end of September or early October). Vineyards can be made more resilient to drought by planting drought resistant plant material, modifying training systems, or selecting soils with greater soil water holding capacity. While most vineyards in Europe are currently dry-farmed, irrigation may also be an option to grow sustainable yields under increasingly dry conditions but consideration must be given to associated impacts on water resources and the environment.

Mediterranean countries have always been exposed to warm and dry conditions. Considerable resources do exist in this area in terms of plant material and expertise to cope with these conditions. Until recently, these resources have been ignored by the scientific community and the mechanisms driving the heat and drought tolerance of Mediterranean varieties and training systems remain largely unknown. A better understanding of this plant material and cultivation practices would be particularly useful to adapt viticulture to the changing climatic conditions across all winegrowing regions in the world.

[36] Does the Presence of Active Pharmaceuticals in Reclaimed Wastewater Affect Embryonic Health?

Prof. Dalit Sela-Donenfeld
The Hebrew University of Jerusalem, Israel
Session: The Effect of Environmental Contaminants on Animal Health

Water shortage is a major concern of climate change that increases the use of reclaimed wastewater for irrigation. Active pharmaceuticals that are excreted from individuals, or from the industry, are frequently detected in reclaimed wastewater in minute concentrations. The anticonvulsant drug carbamazepine is such an environmentally ubiquitous compound. Besides irrigation water, carbamazepine is also detected in the entire agroecosystem, including irrigated soil and edible produce, and humans consuming such produce.

Carbamazepine risks the health of human fetuses when provided at therapeutic doses to pregnant mothers. Yet, it is unclear whether it can pursue similar effects at very low concentrations by environmental exposure. To explore this possibly, chick and mouse embryos have been chosen as two complementary model organisms. Since early chick embryos are similar to mammalians, yet they develop in eggs, toxic effects were directly analysed in a controlled system without maternal influences. On the other hand, as mouse embryos develop in utero, pregnant mice have been exposed to environmental levels of carbamazepine via their drinking water in order to examine whether it can approach the embryos and affect their development.

Using morphological, cellular, molecular and imaging strategies, we revealed that direct application of carbamazepine into chick embryos, or indirect exposure of mice embryos to carbamazepine through their mothers, compromises the embryonic morphology and growth in a dose- and stage- dependent manner. These results call for in-depth risk analysis to ensure that the environmental presence of pharmaceuticals is not causing irreversible ecological and public-health damages.

[37] Ecosystem Temperature Management under Water Scarcity

Prof. Dan Yakir
Weizmann Institute of Science, Israel
Session: Water, Energy, and CO_2 Budgets in Desert Environments

Evapotranspiration (ET) is considered the key means of controlling leaf and ecosystem temperature. Under dry conditions, ET is greatly suppressed, temporally and in the total water availability. Yet, vegetations succeed in keeping leaves and canopies within the physiological limits of about 35C, which becomes increasingly important for survival under climate change. We show that this relies on shifting the dominant underlying temperature management processes from those relying on "water cooling" (evaporation) to those relying on "air cooling (turbulence)." A critical component in this shift is the enhanced production of sensible heat flux, which requires changes in the aerodynamic resistance to heat transfer. We briefly discuss the evolution of this process from the leaf through branches to the canopy scale. We also argue that the contribution of sensible heat fluxes to heat dissipation, and its contribution to vegetation temperature management is often underrated in general and not only in dry conditions.

[38] Vapor Pressure Deficit is not a Limiting Factor for Gas Exchange in a Mature Dryland Forest Under Well-Watered Conditions

Prof. Dan Yakir
Weizmann Institute of Science, Israel
Session: Plant Hydraulics in Response to Environmental Stress

Climate change is often associated with increasing vapor pressure deficit (VPD) and decreasing soil moisture (SM). While atmospheric and soil drying often co-occurs, their differential effects on plant functioning and productivity remain uncertain. In a field study in a mature semiarid Aleppo pine forest, we aimed to elaborate the divergent effects and their underlying mechanisms of soil and atmospheric drought, based on continuous, in situ, measurements of branch gas exchange with automated chambers. To do so, we compared the response of control trees exposed to combined soil-atmosphere drought (low SM, high VPD) with the response of trees released from soil dryness (high SM) but subjected to atmospheric drought (high VPD). During the drying period, the rates of transpiration, net photosynthesis, and stomatal conductance decreased in the low-SM trees, but greatly increased in high-SM trees. In response to increasing VPD (to a maximum of 7 kPa), E and g_{br} decreased in the control trees, but increased in irrigated trees. These observations were consistent with predictions based on a simple plant hydraulic model showing that plant water potential is a good predictor of g_{br} response to increasing VPD. The results demonstrated that trees exhibit the capacity for a fast opportunistic response to increasing soil moisture. In turn, the elimination of the supply-side drought and the plant hydraulic regulation eliminates the effect of atmospheric demand (VPD) as a stressor on canopy gas exchange.

[39] Sweet Sleep; Dormancy of Plant Buds in a Changing Climate

Dr. Dani Eshel
Volcani Institute, Agricultural Research Organization, Israel
Session: Plant Adjustment to Biotic and Abiotic Stresses in Changing Environments

Bud endodormancy (ED) is a crucial stage in the life cycle of many perennial plants and is regulated by genetic and environmental factors. ED release requires the accumulation of a certain amount of cold exposure, measured as chilling units. However, the mechanism governing the effect of cold on ED duration is poorly understood. We use the potato tuber system to investigate storage organ metabolism and signaling in response to chilling as associated with ED release. Cold-induced sweetening (CIS) is a well-known response of potato tuber to chilling. We developed sugars accumulation measure during CIS and defined it as sugar units. We showed that ED release was better correlated with sugar units' accumulation than chilling units. In turn, CIS was associated with shorter ED. Heat exposure also caused sugar unit accumulation, followed by faster ED release. A logistic function was developed to predict ED duration based on sugar unit measurements. Modifying sugar unit level by knockout of the vacuolar invertase gene (StVInv) extended ED, while StVInv overexpression shortened it. We found that the time gap between sugar accumulation and ED release is associated with an abscisic acid (ABA) level that serves as a growth inhibitor. Our results suggest that sugar units are better predictors of ED duration than chilling units. We also found a novel interaction between ABA and sugar metabolism that determines the timing of bud growth. We believe that better understanding of the effect of climate change on bud dormancy will allow the development of cultivars that are more thermotolerant.

[40] Remote Sensing Techniques for Groundwater Measurements in Drylands Subsurface

Mr. Daniel Kamoun
Brandeis University, USA
Session: Space Based Technological Applications for Water Management

In 2003 Daniels, Blumberg et al. proposed to combine ground and aerial experiments to identify buried objects. Here, we inquire about next steps that could be taken to push forward the research for subsurface 3-D mapping in particular by utilizing satellite data. They analyse the dependence of the total returned electrical field, and quoting Campbell et al., they argue that "SAR systems using long wavelength can complement an orbital sounding system and ground penetrating radar in order to obtain an optimal depth penetration, vertical resolution and volumetric local data". In view of this objective, we work on SAR Remote Sensing theoretical models, to show how we could reach a relatively fine (few meters) depth resolution for subsurface mapping, in particular in very dry lands or in ice regions. Those opto-geometrical models aim to measure the change of Doppler shift as a function of the relative antenna-target velocity and the look angles, using multiple antennas, orbit revisits, or several measures at various stages of the flight with only one antenna, and in turn, infer the height or depth of a target (or layer). Two main outcomes of our study are the determination of an optimal look angle for topography and the definition of a horizontal upper limit of a groundwater table. Our ultimate goal is to map the subsurface for various geomorphological layers, with maximum penetration in the ground and the best possible resolution. This study is relevant for climate change, desert agriculture and development and natural resources management.

[41] I'm a Survivor – Acacia trees ability to cope with extremely hot and dry environment

Ms. Daphna Uni
Weizmann Institute of Science, Israel
Session: Desert Plant Ecology: Lessons for a Warming Planet

Among living tree species, Acacia raddiana (Savi) and Acacia tortilis (Forssk), species of the legume family, populate some of the hottest and driest places on earth. Our research investigates the physiological processes underlying the unique survival of trees in extreme environmental conditions. We measured Acacia trees in their natural habitat together with a controlled experiment under scenarios of drought and low N on a lysimeters system to unravel their water use strategies and growth dynamics. In the field, temperature positively influenced the growth rate of the trees, daily and annual gas-exchange curves showed higher gas exchange during noon and in summer, when temperature and radiation are maximal (44°C, 2000 µmol m-2 s-1), and the air is dry (21% RH). Furthermore, in the controlled experiment, Acacia saplings keep transpiring water (180g per day), especially at noontime (0.08 g/gplant/ min), and therefore continue growing in low soil water content of 5%. With climate change predictions, understanding the response of these trees to varying environmental conditions is important both for conservation and to increase carbon sequestration in a warming and drying Earth.

[42] Can Energy Conversion Materials be Sustainable? Solar PV Ones, Maybe

Prof. David Cahen
Weizmann Institute of Science, Israel
Session: Energy and Sustainability: Materials

While sustainable energy's global impact increases (as solar electricity generating possibilities, i.e., photovoltaic, thermal, & wind, add to the nearly completely used hydroelectric ones, which also store energy), the need for the *materials* that enable this, looms as a growing problem. Indeed, sustainability, implying long life-span, runs up against the *mantra of continuing quantitative growth and consumerism,* which adds to the science and technology (S&T) challenge of re-turning to repairable devices, starting with designs that make it practical. The pecking order is from repair to healing to self-repair to self-healing, where the last ones are mostly relevant for materials that form the components device. This challenge is reminiscent of what faced renewable energy, which disappeared with the industrial revolution, but rebounded from science fiction to real-world achievements over the past half century. The additional concern that *if 'things' last too long creativity will suffer,* is outside the realm of (today's) exact S&T.

I will focus on a few cases where materials for light ⟷ electricity interconversion can fix their damage, autonomously, with emphasis on materials for photovoltaics, where we try to learn design rules from these few cases.

[43] Urban Planning Tools for Maximizing the Effect of Shade Trees on Pedestrian Thermal Comfort

Prof. David Pearlmutter
Ben-Gurion University of the Negev, Israel
Session: Energy & Sustainability: The Built Environment

In the face of local as well as global warming trends, cities that are already uncomfortably hot for much of the year must be continually reimagined to make them more walkable and more sustainable. The most effective way to combat urban heat stress is the provision of shade – ideally by covering large portions of the pedestrian realm with healthy, broad tree canopies. This is a complex and expensive endeavor, however, and our research is aimed at developing tools with which urban planners can prioritize their interventions in order to plant trees where they can have the maximum benefit. This presentation will summarize two parts of this work: in the first part, we use an extensive campaign of mobile on-site microclimatic measurements in Tel Aviv to calibrate a model for the mapping of pedestrian thermal comfort, and in the second part we address the "walkability" of different urban street segments based on a large-scale observational study of pedestrian behavior and the tendency to choose shaded paths over those with differing extents of solar exposure.

[44] Changes in Soil Carbon Turnover Following Drought Elimination in a Forest at the Dry Timberline

Dr. David Yalin
Weizmann Institute of Science, Israel
Session: Soil-Plant-Atmosphere Continuum: Effect of Rewetting and Drought on Soil Gases Emissions

The extensive storage of organic C in forest soils relies on the relatively slow turnover of this carbon pool. However, changes in water availability due to changing precipitation patterns may alter the rate of micorbial soil organic matter degradation and thus lead to shorter organic carbon turnover time and a positive feedback, which may even accelerate climate change.

In this work we present the findings from a three year drought elimination experiment in Yatir forest, a pine forest planted in the semi-arid region of Israel. The measured soil C fluxes under trees and between trees are compared with those in a non-irrigated plot, to try and elucidate the effect of soil moisture availability on soil C processes. The effects of drought elimination on soil C emission following re-wetting are highlighted.

In addition measurements of the soil organic C pools six years after irrigation commenced and the partitioning between a stable soil organic C pool (associated with soil minerals) as compared to a labile organic C pool are discussed. The integration of the soil fluxes and pools is used to elucidate major mechanisms expected to take place in a changing climate.

[45] Cool Roofs in Europe

Prof. Denia Kolokotsa
Technical University of Crete Kounoupidiana, Greece
Session: Energy & Sustainability: The Built Environment

The aim of the presentation is to provide information for the recent developments of cool roofs and cool materials and their implementation in buildings and construction infrastructures, as a means to mitigate the urban heat island effects at building, district and city levels, as well as territories.

Moreover the EU policies and standardization procedures for cool materials and cool roofs will be discussed and the recent experience of the development of a CEN/CENELEC Workshop Agreement on cool materials will be analyzed. The role of pilot implementations will be also highlighted.

[46] How Does an Extreme Climate Make Domestic and Wild Animals Evolve Similarly?

Mr. Denis Larkin
Royal Veterinary College, United Kingdom
Session: Thermal Stress Regulation in Animals

Livestock breeds are a reservoir of genetic variation useful for properly responding to agriculture needs during the ongoing climate changes. Evolutionary processes occurring in response to extreme environmental conditions could be better understood using adapted local populations as well. We focused on studying the northernmost cattle from Siberia, the Yakut cattle. We found that Yakut cattle separated from European taurines approximately 5,000-10,000 years ago, escaped major introgression with other Bovinae populations, and contain numerous ancestral and some novel genetic variants allowing their adaptation to harsh conditions of living above the Polar Circle. Our data pointed to a Yakut cattle breed-specific missense mutation in the NRAP gene, involved in heart force transmission. This is a young amino-acid residue convergent change shared with at least 16 species of hibernating/cold-adapted mammals. The follow-up de novo assembly and annotation of the Yakut cattle genome allowed for a systematic search of convergently evolved/selected missense changes in the Yakut cattle proteins and proteins of hibernating, cold-adapted, and deep-diving species. This analysis has confirmed a convergent nature of the NRAP variant and pointed to novel convergently-selected variants in the cattle and hibernating/cold-adapted/deep-diving species' proteins. Among these were changes in PLA2G4F и PAFAH1B2, previously shown to be under selection in Siberian native human populations, SNX19 involved in regulation of blood pressure and insulin secretion, and POPDC2, controlling the heart rate. Our results suggest multiple acclimation-related convergently evolving events along the mammalian phylogenetic tree and their fast fixation in a single cattle population exposed to a harsh climate.

[47] Odds or Evens? Relationships between the Industry and Academy

Ms. Dikla Zadaka
Watergen Ltd., Israel
Session: Water Harvesting: The Interface between Research and Industry

Technology development via academy and industry vision is crucial to think outside the obvious box.

Despite serious limitations due to differences in cost, IP, interest and timelines, the technology transfer is much easier in cases where joint development efforts are taken.
Other benefits of such collaboration include expanded research capacity, project funding, excess to cutting edge technologies, academic publications from the university side and lower research overhead, excess to world class expertise, future employees recruiting and progress in product development from the industry side.

So, where are we at?

Water scarcity now and in the near future has great awareness and concern. Air as a new emerging source of drinking water is getting more and more popular.
Watergen has decided to take the lead of generating water from the air and communicate with the university from the above mentioned points to improve its knowledge as experts in atmospheric water.

Cooperative research has promoted Watergen nowadays to communicate with global regulatory bodies which considered Watergen as a focal point in building and shaping international standards related with the scientific side of AWG.

What other pros and cons? How to elevate the success of such cooperation from the industrial side? How wins the IP? And other questions will be addressed.

[48] Atmospheric Water Capture by Desert Soils

Dr. Dilia Kool
Ben Gurion University of the Negev, Israel
Session: Water, Energy, and CO_2 Budgets in Desert Environments

Atmospheric water, or non-rainfall water inputs (NRWIs) are an important source of water in arid areas. Considering the large surface area of arid and extremely arid regions, NRWIs are a critical, albeit largely overlooked, component of the global hydrological cycle. Water vapor adsorption is not only the least studied form of NRWI but likely the most common one in arid areas. The amount of water vapor adsorption mainly depends on the gradient between water vapor pressure between the air (ea) and the soil (es). Sea breeze, which carries moist air from the sea landward, can result in a significant daily increase in ea in desert areas.

We have examined the diurnal cycle of soil water content derived by water vapor adsorption and evaporation in two very different deserts: the Negev (loess soil, ~100 mm y^{-1}) and the Namib (sand dunes, ~20 mm y^{-1}). Water vapor adsorption into the Negev's loess soil has been established as the dominant NRWI (with 0.3-0.5 mm $night^{-1}$). Even in the Namib, which is known as a fog desert, even on nights with fog, at least half of the water accumulation occurred via water vapor adsorption, before the onset of fog (0.1-0.2 mm $night^{-1}$).

[49] Environmentally Important Bacteria: from Ecology to Isolation

Dr. Dror Minz
Volcani Institute, Agricultural Research Organization, Israel
Session: Belowground Interactions in a Changing Environment

Soil and plant root microbiota are crucial for plant growth, development and health. Comparative study of microbiota composition found that root systems of different plants select for completely different microbiota, when grown in identical conditions. It was shown that cereals (wheat and maize) root communities are similar in structure and composition, different from those of cucumber, and all were different from those of tomato. Moreover, plant species-specific stimulation of bacteria in the bulk soil suggested that the more active community was affected by root exudates. Metagenomics of root microbiota demonstrated high redundancy in functional potential between communities, highly disparate in their composition, pointing to a generalized root colonization toolbox. However, metatranscriptomic analysis revealed many plant specific traits. One of the main observations was that while in microbiota of wheat root, gene expression patterns suggested life under lack of available oxygen, in cucumber community metatranscriptome suggested high oxygen availability.

In wheat, all denitrification pathway genes but nosZ were highly expressed. The latter is the only enzyme known to perform conversion of N2O to N2, thus the end product of denitrification in such system is expected to be N2O. This may explain the extreme role of agriculture in global N2O emission. N2O reducing bacteria were isolated from wheat roots, and some of them, when augmented to soil, were shown to efficiently colonize the wheat root, causing a pronounced decrease in N2O emission. These results demonstrate the power of ecological studies and ‘ecology to engineering’ process for microbiota.

[50] DIP™ Platform Used to Discover Genes that Provide Drought Tolerance Crops

Dr. Dror Shalitin
PlantArcBio, Israel
Session: The Future of Agriculture - Revolutionize Agricultural Practice: A Technological Revolution in Farming Led by Advances in CEA Technologies

Plantarc Bio Ltd. (TASE:PLNT) is an Ag-biotech company engaged in research and development in the field of gene discovery and biological components to improve plant traits, intended primarily for use in the agricultural industry, with a vision to contribute to global food security and address sustainable agriculture.

PlantArcBio developed a unique, patented protected process for discovering genes that enhance various target traits desired for selected plant varieties – DIP™ (Direct In Plant). With the DIP™ technology we collect samples from different environments to create proprietary gene libraries, we transform millions of genes into model plants, and apply stress to screen for the best performing plants to identify desired genes.

Using DIP™ - the company detects new genes that have beneficial effects on plants, such as drought resistance, herbicide tolerance, fertilizer use efficiency and improved yield.

In the talk I will give a few examples of genes we discovered, that made all the way from the desert and the Dead Sea region into model plants and to real important agricultural crops and show drought tolerance and yield increase

[51] Ethnic Identity and Stigmatized barriers to Attaining Mental Health Services Among the Arab-Bedouin Society in the Negev

Mr. Dvir Matzri
Ben Gurion University of the Negev, Israel
Session: Challenges and Opportunities as Stimulus for Transformation for the Bedouin-Arab Society in the Negev, Israel

Background & Aims: Minorities whose ethnic identity is separate and distinct from the majority group in their language, characteristics, and cultural customs tend to face institutional and social barriers. Attainment of formal mental health services among the Arab-Bedouin society in the Negev was found to be underused. Hence, the question arises of what leads to the barriers to the lack of use of these services among the Arab-Bedouin society in the Negev to seek the assistance of formal mental health services. This study examined barriers and catalysts for formal mental health services while examining the unique identity of Bedouin Arab society in the Negev. The Arab Bedouin society living environment varies in three primary residential environments: (a) Residents of the established cities and localities (Rahat, Lakia, Segev Shalom, Tel Sheva, Arara in the Negev, Kuseife, and Hura), (b) residents of the undeveloped recognized villages, united under two regional councils (Neve-Midbar and Al Kasum) and (c) residents of the unrecognized villages. The present study distinguishes between Stigmatized and Non-Stigmatized barriers to attaining mental health services.

Method: The barriers to mental health services were examined using the BACE questionnaire, a tool for assessing participants' attitudes toward mental health services and the barriers to seeking support. Ethnic identity was examined using an EIS questionnaire, which examined the ethnic identity in three dimensions; Affirmation, Resolution, and Exploration of one's ethnic identity.

Sample: The study sample included 654 subjects from the Arab-Bedouin society in the Negev aged 18-91 (M=31.14, SD=14.71), distinguishing between three primary residential environments; the established cities and localities (433, 68.2%), the undeveloped recognized villages (85, 13.4%) and the unrecognized villages (117, 18.4%).

Results: Significant differences were found between residents of different residential environments. Subjects from established cities and localities experienced less stigmatized and non-stigmatized barriers from others. The Affirmation ethnic identity dimension was negatively associated with barriers to mental health services among the study sample.
Discussion: The present study focuses on the typology of ethnic identity (EIS) as a basis for assessing the intensity of one's perception of his own ethnic identity as a Bedouin Arab and how

the ethnic identity interacts with barriers to seeking mental health services. A stable Affirmation of one's Arab-Bedouin identity reduces one's vulnerability to mental health services attainment barriers.

[52] Impact of Treated Wastewater Irrigation on Antibiotic Resistance in Soil and Plants

Dr. Eddie Cytryn
Volcani Institute, Agricultural Research Organization, Israel
Session: Belowground Interactions in a Changing Environment

Treated wastewater contains antibiotic resistant bacteria and genes, and thus may be a point source that disseminates these elements to irrigated crops and soil, potentially contributing to the global scope of antibiotic resistance. Nonetheless, there is conflicting evidence regarding the persistence of antibiotic resistance constituents in natural environments, and therefore their epidemiological potential is unclear. The overall aim of this presentation is to explore the fate of antimicrobial resistance determinants in treated wastewater and irrigated soil and crops, and evaluate the capacity of wastewater-derived determinants to persist or proliferate following prolonged residence in the environment. We applied a holistic approach that combines several cutting edge methodologies including cultivation-based evaluation of multidrug resistant *E. coli*, qPCR/ddPCR quantification of antibiotic resistance genes, amplicon sequencing and shotgun metagenomics.

Collectively our data strongly indicates that antibiotic resistant bacteria and associated resistance genes persist poorly in irrigated crops and soil, and we determined that this is at least partially associated with the resilience of environmental microbiomes. Nonetheless, short-term inoculation of soil and produce in nutrient-rich medium resulted in regrowth of wastewater-derived multidrug resistant *E. coli* two weeks after going below detection levels, underlining the fact that "not detected" is not necessarily "not present". Similar inoculation of treated wastewater- and freshwater-irrigated soils also promoted differences in microbiomes and resistomes that were not apparent in direct analyses of the soils, and these differences became more dramatic as a function of anthropogenic exposure. Collectively, our results demonstrate the power of ecosystem functioning in mitigating antimicrobial resistance; however, provide evidence that hazardous antibiotic resistance determinants may persist "under the radar".

[53] Deciphering the Source(s) of Rapid Nitrous Oxide Emissions in the Negev Desert Using Hydroxylamine and Iron Oxides

Dr. Edwige Demangeat

Ben Gurion University of the Negev, Israel

Session: Soil-Plant-Atmosphere Continuum: Effect of Rewetting and Drought on Soil Gases Emissions

While the majority of current research focuses on biological reactions within N cycle, recent reports point out the importance of abiotic pathways in regulating soil N oxides (nitrous and nitric; N2O and NO) emissions in deserts. This work aims at (i) identifying N2O abiotic production and (ii) assessing the role of NH2OH and iron towards N2O emissions following a rewetting event in the Negev desert. Rewetting was performed with three different solutions (distilled water, 0.034 mM NH2OH and 1 g/L iron (III) oxides). Gas-tight jars and undisturbed soil cores experiments allowed to measure post-wetting soil emissions of NOx, N2O and CO2 (at 35% WHC, pH 7.3) in irradiated and non-irradiated soils. Preliminary measurements of nitrification potential confirmed that irradiation prevented microorganisms from performing nitrification in irradiated soils. The first set of experiments (gas-tight jars) showed that N2O emissions depend on the relative amounts between iron and hydroxylamine, and that change in iron concentration affects N2O emission to a greater extent than NH2OH does. It was also shown that after addition of NH2OH (i.e., irradiated soils, without iron addition), the soil still provides a reactive substrate for NH2OH oxidation and subsequent N2O release. Nitrous oxide production increased after addition of iron oxides together with NH2OH. These results were confirmed in the second set of experiments (undisturbed soil cores). NH2OH triggered high fluxes of N2O in both irradiated and control soil but the addition of iron oxides alone didn't foster N2O production, suggesting that NH2OH wasn't naturally released or not in sufficient amount.

[54] Conserving Our Land: Current and Future Challenges

Dr. Eli Argaman
Ministry of Agriculture and Rural Development, Israel
Session: Sustainable Agriculture & Climate Change

Over the recent centuries, industrial development and the demand for food production accelerated land degradation processes. Further, the challenging expansion of agricultural fields over marginal lands requires the adaptation and development of new soil conservation practices to conserve soil quality and quantity. The current presentation explores recent studies that focused on developing new practices and methods to sustain the soil system. For example – [1] in a long-term study conducted in the Menashe area (Israel), caused by extreme soil erosion from agricultural fields, we implemented a new soil and water conservation practice that enables farmers to utilize local resources and reduce agro machinery costs while sustaining the land; [2] Earthworks waste soils are a significant concern in many countries, where Infrastructure and industrial development rapidly change the landscape. This waste reaches nearby agricultural fields without appropriate treatment and causes severe environmental problems, runoff, and soil erosion that harm neighboring infrastructures. A recent study revealed that part of the waste soils could be used, following appropriate treatment, in agricultural fields while enabling land managers and farmers to use these waste soils as a resource rather than a hazardous material; [3] recently, dual-use of agricultural land has become an emerging topic. However, the current knowledge and soil conservation practices are missing. A recent study aimed to provide new insights into the development of sustainable practices to mitigate the impact of runoff and soil erosion in dual-use lands is under development these days.

[55] Multi-Aged Eco-Hydrological Functioning of Water Harvesting Systems on Soil and Vegetation Dynamics in a Semiarid Region, Israel

Dr. Eli Argaman
Ministry of Agriculture and Rural Development, Israel
Session: Research-based Dryland Afforestation and Landscape Restoration

Desertification processes affect ground surface properties and soil-water availability, thus impacting vegetation dynamics and ecosystem functioning. Semiarid areas – encompassing the major part of grazing lands and providing a wide range of ecosystem services – are subjected to both 'natural' and anthropogenic degradation processes Afforestation projects that have been implemented by the Keren Kayemet Le'Israel (KKL) to restore degraded lands rely on water harvesting systems (WHS).

In this study, we analyzed the temporal development of different planted sites in the Ambassador's afforestation land. This area has been under afforestation since 2005. For this study, we selected four multi-aged sites within the afforestation area, including undisturbed, hillslopes, where no water harvesting systems or tree planting have been conducted.

Long-term analysis of meteorological trends revealed that the area had been subjected to substantial climatic change. A decadal rate increase of 0.45°C was observed in air temperature, while a 1.3% decrease in (minimal) relative humidity. Although a long-term change in evapotranspiration has not been detected, summer values have been significantly increased.

For each of the afforestation sites, a significant reduction in seasonal NDVI values was recorded compared to the undisturbed slopes. However, following the WHS construction, the seasonal NDVI average was significantly higher than that in the prior seasonal values, as well as higher than that in the undisturbed hillslopes. At the same time, in the newly disturbed sites (planted in 2016), the average seasonal values were substantially lower after the establishment of runoff harvesting systems than those in the prior year.

[56] Drought as a Climate Change Agent Affects Afforestation in Runoff Water Harvesting Systems under Semiarid Conditions

Dr. Eli Zaady
Volcani Institute, Agricultural Research Organization, Israel
Session: Research-based Dryland Afforestation and Landscape Restoration

Water is the principal limiting resource in many dry environments, and its redistribution by landscape heterogeneity tightly controls landscape function, productivity, and diversity. The northern Negev characterizes by a semiarid climate where water availability is limited, which leads to the development of landscape patchiness. The landscape patchiness characterizes shrubs surrounded by a biocrust matrix. The shrub patches are sinks for the runoff water transported from the biocrusts. The source-sink relationship between the two patch types is critical for the system's functioning; in the existing ecosystem, part of the water, not absorbed by the shrubs, leaks out of the system. Afforestation under these conditions utilized the knowledge acquired in studying the ecological system using local resources. Counter-banks were built horizontally to the hill slopes to stop the water leakage from the system. Different tree species, adapted to grow in water-enriched patches, were planted to increase the biological productivity of the areas.

Since the beginning of the 2000s, consecutive years of droughts have characterized northern Negev and led to a 25-30 percent decrease in the annual amount of rainfall. This phenomenon has led to the mortality of many shrubs whose runoff created by biocrusts has not been sufficient to support their survival. The planted trees responded partly to droughts, and Mediterranean species did not survive in part compared to native species that characterize arid areas. The need to consider climate change has led to change and the need to adapt plantings to species more adapted to arid areas.

[57] Restoration of Cyanobacterial Crust as an Interface in the Critical Zone for Stabilizing Sandy Soil Surface

Dr. Eli Zaady
Volcani Institute, Agricultural Research Organization, Israel
Session: Cyanobacterial Soil Amendment and Restoration

The biocrusts are critical factors in landscape structure and function. In dryland environments, where water is the main limiting factor, biocrusts are considered ecosystem engineers and play significant roles in ecosystem processes. Metabolic polysaccharides secreted by cyanobacteria glue the soil particles to aggregates, which form the crust layer, allowing better water retention in the soil over time by reducing evaporation and desiccation and stabilizing the soil surface.

Cyanobacterial crusts play a crucial role in geomorphological processes by preventing wind erosion. There is positive feedback between the biocrusts and the percent of fine particles in the soil surface layer. The lack of clay and silt inhibits cyanobacterial crust colonization growth rate, even in relatively wet desert areas with 100–250mm average annual rainfalls. The incorporation of dust particles into biocrusts increases the growth of cyanobacteria, strengthening the biocrusts' cohesion.

The expansion of agriculture into drylands leads to the use of fragile sandy soils that are potentially inappropriate for farming. Sand transport systems can change significantly in short periods. Therefore, active dunes pose one of the main problems in desertified lands, as in vast areas worldwide, and stabilizing dunes after disturbance is a significant challenge. Restoring disturbed dunes by enriching their surface with silt and clay particles will enhance cyanobacterial colonization and dune stabilization, reducing the sand transport damage in the farmland.

[58] Cracking the code of Root Microbiome Chemical Communication

Dr. Elisa Korenblum
Volcani Institute, Agricultural Research Organization, Israel
Session: Plant Adjustment to Biotic and Abiotic Stresses in Changing Environments

The first step in plant-microbe interactions is usually chemical-based, e.g. plant roots and rhizosphere microbes exchange various chemical signals, nutrients, and metabolites. The metabolites exuded by the roots shape the composition of the root microbiota; that is, plant roots select specific soil microbial populations and can govern microbial activity for their benefit. The focus of my research is to decode these chemical dialogues to understand the complex interactions belowground between plants and microbes. Interestingly, the plant microbiome may also trigger, on the host side, a sequence of events from signal perception to metabolic changes locally (at the colonization site) or at distal parts of the plant. By conducting a series of split-root experiments in tomato plants, where half of the root system of each plant was treated with a soil microbiome, and the other half was grown in sterile conditions, we analyzed the systemic changes in the host metabolome and transcriptome controlled by a local root microbiome colonization. We found that the root microbiome induces systemic metabolic responses and changes tomato root exudation via root-to-root signaling. We termed this process “SIREM” for “Systemic Induced Root Exudation of Metabolites”. SIREM is chemically diverse and microbiome specific. For instance, in tomato plants, systemic exudation of specific acylsugars is associated with local colonization of bacteria affiliated with the Bacillales. We also discovered that glycosylated azelaic acid is microbiome induced and might act as a mobile signal in SIREM. SIREM is a microbiome-reprogrammed systemic root exudation that governs carbon sink in the rhizosphere. SIREM and the entire metabolic circular economy in the rhizosphere present a so far underexplored chemical diversity that may regulate soil conditioning and plant-soil feedbacks in natural and agricultural systems.

[59] Cocoa Farming at a Strategic Inflection Point

Dr. Ellen Graber
Volcani Institute, Agricultural Research Organization, Israel
Session: Sustainable Agriculture & Climate Change

One of the world's most important tree commodity crops, cacao, is grown across the tropics belt in many nations of the Global South. More than 80% of the 5 million tons of cocoa produced annually is grown by small-holder farmers, and 70% of cocoa globally is grown in West Africa. The economies of the top two producing countries in the world, Côte d'Ivoire and Ghana, are dependent on cacao for a large part of their foreign currency. A typical family-run cacao farm encompasses 1 hectare with up to 1000 trees. Problems such as low fertility soils, destructive pathogens and pests, and a disappearance of natural pollinators have been plaguing the world's cocoa growing regions for many decades. A warming and drying climate is adding additional pressures, resulting in a perfect storm of simultaneous and manifold biotic and abiotic stresses that threaten the future of cacao production. Millions of small-scale farmers growing cacao using old-fashioned methods are incapable of meeting these challenges. This presentation will focus on how intensive agriculture practices once unique to food production in semi-arid and arid areas can be adopted in cacao to increase production and reduce deforestation and poverty.

[60] The Effect of Irrigation-Initiation Timing on the Phenolic Composition and Overall Quality of Cabernet Sauvignon Wines Grown in a Semi-Arid Climate

Dr. Elyashiv Drori
Ariel University, Israel
Session: Viticulture in a Changing Climate: Vineyard-Environment Interactions

In semi-arid areas, irrigation is usually mildly supplemented to wine grapes by drip systems, in order to confer moderate drought stress. This practice ensures the development of high-quality grapes- otherwise hampered by overly abundant water conditions, without damaging the vegetative and productive perennial development. This work deals with the question of the proper irrigation initiation time, and its effect on wine quality- should irrigation initiate with bud break or rather once stress conditions appear?

Our results show that initiating irrigation late in the growing season causes the development of lower midday stem water potential (SWP) in these vines after irrigation initiation, as compared to vines irrigated earlier in the season. Consequentially, these vines tend to produce a lower number of bunches per vine and smaller berry size, leading to lower yields. Nevertheless, the wines produced from the late-irrigated treatments had higher phenolic content, primarily due to higher levels of catechin and epicatechin. The late irrigation treatments also led to wines with higher color intensities compared to those irrigated at earlier stages, due to higher levels of most anthocyanins. Finally, we show that the wine sensory score given by professional winemakers for wines made from delayed irrigation treatments was approximately five points higher compared to wines made from the early season irrigation treatment.

[61] A Land Long Term Climate Data Records from Polar Orbiting Earth Observation Satellites and its Application

Dr. Eric Vermote
NASA Goddard Space Flight Center, USA
Session: Remote Sensing for Environmental Sustainability and Climate Change

Surface reflectance is one of the key products used in developing several land Essential Climate Variables, such as Vegetation Indices, Albedo and LAI/FPAR, it is therefore seminal to detecting trends in the biosphere and land surface and has been classed by NOAA as a "Fundamental Climate Data Record (FDCR) for Land". Building a long-term surface reflectance data record of climate quality requires combining data from different instruments, sensors and satellites, accounting for different spatial resolutions and spectral characteristics, assuring consistent calibration, and correcting for atmospheric and directional effects.

In this work, we use robust reflectance data records and inter-comparison methods that we have developed over the past several years (consisting of atmospheric correction, directional effect correction and spectral normalization) to establish and verify the inter-consistency of the reflectance products from the AVHRR sensors on-board NOAA 7, 9, 11, 14, 16, 17,18, 19 and METOPB, the MODIS sensors on-board Aqua and Terra, the VIIRS sensors on-board Suomi-NPP and JPSS1, the TM/ETM+ on Landsat 5/7, the OLI on Landsat 8 and the MSI on Sentinels 2A,B. The resulting dataset being the 40 years surface reflectance product and vegetation indices from 1981 to present of increasing spatial, spectral and accuracy performance, which provides a solid basis for deriving a number of Terrestrial Essential Climate Variables. We will conclude by presenting applications of this dataset to long term monitoring of agriculture and human earth interactions.

[62] Unraveling the Biogeochemical Mechanisms of Drought and Rewetting Induced Nitric and Nitrous Oxide Emissions from Dryland Agriculture

Dr. Eric Wilkman
Ben Gurion University of the Negev, Israel
Session: Soil-Plant-Atmosphere Continuum: Effect of Rewetting and Drought on Soil Gases Emissions

The duration and frequency of seasonal drought is expected to increase across the world. These effects will be especially pronounced in dryland agricultural sites. Drought and rewetting events alter the soil nitrogen cycle, potentially modifying the sustainability of these agroecosystems. Plant-soil-nutrient cycling models, such as the widely used CENTURY model, define the roles of soil texture and precipitation on biogeochemical cycling and yet a mechanistic understanding of processes under different soil types and conditions and in response to the seasonality and intensity of drought and rewetting is still ill-defined. This project determines the temporal N2O and NO emission patterns in response to seasonal changes in soil N and water availability during and after droughts. We hypothesize that rewetting after in-season drought will cause greater N2O and NO emissions and this will be controlled by N availability. Rewetting after non-growing season drought will cause less emissions and will be controlled by C availability. We used 4 replicates of 3 separate soil types (sand, clay, and sandy-loam) transplanted from the North, Central, and Negev Regions of Israel. In half of the randomly allocated replicates, rainfall was manipulated with transparent rainout shelters. We found that there were significant differences in N oxide fluxes across soil types. Loess soils dominated emission patterns and while pulse emission losses were seen after rewetting, emissions decreased in the 2nd rewetting treatment. These findings are significant as mitigation of soil N emissions can only be accomplished by further understanding drought-climate feedbacks from precipitation induced fluxes.

[63] Antimicrobials and their Impacts on Microbes in both Indoor and Outdoor Environments

Prof. Erica Hartmann
Northwestern University, USA
Session: Resource Oriented Sanitation in Drylands

The built indoor environment is enriched for antibiotic-resistant pathogens compared to natural outdoor environments. In our quest to diminish the number of viable antibiotic-resistant pathogens indoors, with the ultimate goal of halting the spread of infectious disease, we have created an arsenal of antimicrobial chemicals, which we now embed in various materials and use in countless cleaning and personal care products. Regardless of where we put these chemicals, they can have unintended consequences on indoor microbes by changing the structure of indoor microbial communities or selecting for certain functions, including antibiotic resistance. Their use further complicates subsequent efforts in resource recovery, e.g., in greywater reuse. Using molecular and traditional microbiology techniques, my lab assesses whether antimicrobial chemicals are indeed associated with decreased microbial viability. Our work focuses on undomesticated, non-model organisms to observe responses of authentic microbial communities. Using synthetic microbial communities and microcosm experiments, we probe causal relationships between exposure to antimicrobial chemicals and the development of different resistance phenotypes and genotypes. We evaluate whether exposure to antimicrobial chemicals is associated with outcomes including enrichment for antibiotic resistance genes, as well as phenotypic responses like sporulation and biofilm formation. We also use analytical chemistry techniques to track the fate and transport of antimicrobial chemicals. Together, this work provides a window into microbe-chemical interactions transpiring within buildings and in engineered systems for resource recovery, giving us knowledge we need to make better design choices.

[64] Organic Photovoltaic Polytunnel Greenhouse Agrivoltaics

Dr. Esther Magadley
Triangle Research and Development Center, Israel
Session: Agrivoltaics – How Can It Be Implemented in a Desert Environment?

This talk presents the results of several projects over the last 6 years looking at different aspects of the integration of organic photovoltaic (OPV) modules into tomato greenhouses, in collaboration with leading researchers in the USA and Europe.

The experimental site is at the TRDC in Kfar Qari, Israel. Extensive studies on different types of OPV modules integrated on top and inside the polytunnel investigated different aspects of the electrical performance and ageing of OPVs in greenhouse applications as well as their effect on the greenhouse microclimate and crop performance.

Main results are:

- Greenhouse microclimate and crop performance values were similar in both the OPV polytunnel and control polytunnel with shading net with same shading percentage
- The installation of the modules across the arch of the tunnel roof from east to west led to a more distributed output throughout the day, an advantage both for onsite use and for grid connection.
- OPV efficiencies on the greenhouse roof peaked around 3% [1,2].
  - The electrical output was highest under direct irradiance, however OPV module efficiencies on the tunnel roof peaked when they were not in direct incident irradiance
- The rate of degradation of the OPV modules was reduced when installed inside the greenhouse as opposed to on top. [4]
- From green, blue, and red modules tested, the red modules had the lowest electrical performance. However, the green and blue modules showed a faster degradation rate.

[65] The Effect of Surface Cover Vegetation on the Microclimate and Power Output of a Solar Photovoltaic Farm in the Desert

Prof. Evyatar Erell
Ben Gurion University of the Negev, Israel
Session: Agrivoltaics – How Can It Be Implemented in a Desert Environment?

Part of a commercial solar photovoltaic farm in the hot dry Negev Desert of Israel was modified by planting low-rise surface cover crops in the spaces between the rows and beneath the solar panels. In two test plots of about 0.22 hectares each, modifications to the microclimate resulted in lower air temperature, higher humidity and reduced radiant loads on the lower face of the panels compared to a control plot that was not modified. PV panel temperature in the planted test plots was up to 4.5oC lower, resulting in an increase of electricity output of 1.2% over the summer. The temperature reduction is attributed primarily to smaller fluxes of solar radiation reflected from the plants, which have a lower albedo than the bare soil, and to less infrared radiation emitted from the plants, which are cooler. Water consumption for irrigation was 24-30% lower in the partly shaded zones during the initial planting and growth phase (depending on the type of crop) but was only 7-11% lower in the height of summer once the crops had matured. The crop yields beneath a partly shaded area beneath the panels were about 60% of the yield in fully exposed areas of the site, but the Land Equivalent Ratio of the test plots was 1.67. An analytical model, adapted from the Faiman equation, can describe PV panel temperatures in the presence of crops accurately, providing a basis for estimating the electricity output based on their rated temperature coefficient.

[66] Crustivoltaics for Arid Soil Restoration at Scale

Prof. Ferran Garcia-Pichel
Arizona State University, USA
Session: Cyanobacterial Soil Amendment and Restoration

Interventions to restore soils to their pristine state through inoculation of impacted areas with biocrusts or biocrust organisms are currently widely pursued. Current technologies can only be implemented effectively in small, high-importance settings, but not at the landscape scale that is needed for impactful ecological restoration. One potential avenue to overcome the scaling problem is to make use of existing, extensive photovoltaic energy generating installations as ad hoc biocrust nurseries, as such installations provide a greenhouse-like setting similar to those proven to work well in the production of biocrust inoculum, an approach we call crustivoltaics. Such dual use would not be without benefits for solar projects, diminishing fugitive dust deposition on PV panels, and its costly cleaning costs. Compared to agrivoltaics, on-site additional disturbance by the secondary use should be minimal. In order to probe the feasibility of crustivoltaics and to provide some initial guidance to develop best practices, we carried out minimally invasive, 2-year long pilot experiment of soil inoculation and monitoring with a variety of approaches to reconstitute the cyanobacterial biocrusts typical of pristine soils in the lower Sonoran Desert, sourced from remnant biocrusts in the immediately surrounding areas of a local solar farm. We provide evidence that the approach is feasible and useful in terms of fugitive dust suppression.

[67] Detecting Wheat Response to Elevated CO_2 and Drought Using Remote Sensing Metrics

Mr. Gabriel Mulero
The Hebrew University of Jerusalem, Israel
Session: Remote Sensing for Environmental Sustainability and Climate Change

The spectral-based photochemical reflectance index (PRI) and thermal imaging-derived leaf surface temperature (Tleaf) derived from thermal imaging are important metrics of plant functioning. The relationship between PRI and radiation use efficiency (RUE) and Tleaf and leaf transpiration could be used to monitor crop photosynthesis and water use. We conducted an [CO2] enrichment experiment in which three wheat genotypes were grown at ambient (400 ppm) and elevated (550 ppm) [CO2] under well-watered and drought conditions in two replicate glasshouses. Leaf transpiration (Tr) and latent heat flux (LE) were derived to assess evaporative cooling, and RUE was calculated from assimilation and radiation measurements on several days during the season. Simultaneous hyperspectral and thermal images were taken at 1.5 meters from the plants to derive PRI and the temperature difference between the leaf and its surrounding air (∆Tleaf-air). A PRI-RUE decoupling was observed under drought at ambient [CO2] but not at elevated [CO2], likely due to changes in photorespiration. For a LE range of 350 W m-2, the ∆Tleaf-air range was 10°C at ambient [CO2] and only 4°C under elevated [CO2]. Thicker leaves in plants grown at elevated [CO2] suggest higher leaf water content and consequently more efficient thermoregulation at high [CO2] conditions. PRI, RUE, ∆Tleaf-air, and Tr decreased linearly with canopy depth, displaying a single PRI-RUE and ∆Tleaf-air – Tr model through the canopy layers. Our study demonstrates the utility of these sensing metrics for detecting wheat responses to future climate and environmental changes.

[68] Development of Sustainable Building Materials Based on Local Industrial Waste and Quarrying Materials

Dr. Gabriela Bar–Nes
Ben-Gurion University of the Negev, Israel
Session: Energy and Sustainability: Materials

The production of Portland cement for the concrete industry is known to leave an enormous environmental footprint due to the immense amount of natural resources needed to produce billion tons of concrete each year and the massive emissions of carbon dioxide involved. Therefore, the development of supplementary sustainable materials partially or fully replacing the Ordinary Portland Cement (OPC) is essential. Using waste-based materials to replace OPC not only reduces the costs and energy required for the production processes but offers an additional environmental benefit by reducing the waste disposal volumes and overall ecological hazard involved. Therefore, this approach would also provide an efficient, green disposal path for quarry or industrial waste, which currently poses an environmental concern. This lecture will present several studies aiming at the development of building materials using waste materials and quarrying waste. One approach involves the use of dolomite-based quarry-dust (QD) waste material as a filler to Portland cement-based pastes and to Fly-ash based geopolymeric mixtures. Experiments showed that unused QD may be integrated at high replacement rates (up to 40% by weight) in both CEM-I and FA-based systems, showing good and, in some cases, even significant improvement in their engineering properties. An additional approach was the use of local oil shale ash (PAMA Ltd, Israel) as a main component in the development of novel, valuable, building materials. Oil shale ash (OSA) is rich in calcium content and therefore possesses self-cementing properties. Local OSA was used combined with Portland cement to yield products with fair compressive strengths, emphasizing the high potential of OSA waste to be utilized as a new sustainable building material.

[69] The Water Enigma – How Come the Water Scarcity Became an Increasing Problem on Every Continent

Mr. Gal Zohar
CEO, Watergen Ltd., Israel
Session: Water Harvesting: The Interface between Research and Industry

There is nothing more essential to life than water. Yet, from the Israeli Negev to Flint, Michigan, and from rural, sub-Saharan Africa to Asia's teeming megacities, there's a global water crisis. Humanity is struggling to access the quantity and quality of water they need for drinking, cooking, and growing their food.

From the Dawn of Civilization, humans have chosen to live close to water sources for domestic and agricultural water supply, and with time, humans have been able to decrease their reliance on direct proximity to rivers by developing advanced measures to transport adequate water from other sources (for example, canals or pipelines, groundwater pumping, and desalination)

Water scarcity is commonly analysed using the vital concepts of shortage (impacts due to low availability per capita) and stress (impacts due to high consumption relative to availability) which indicate difficulties in meeting the needs of a community.

While water consumption increased, the population under water scarcity increased from 0.24 billion (14% of global population) in the 1900s to 3.8 billion (58%) in the 2000s. Today, nearly all sub-national trajectories show an increasing trend in water scarcity.

The concept of scarcity trajectory models and shapes is introduced to characterize the historical development of water scarcity and suggest measures for easing water scarcity and increasing water availability and sustainability.

The presentation discusses the two main water scarcity drivers (quality and availability) and suggests that in the world's extremely dry regions, more far-reaching policies are needed to avoid solve the problem as technological solutions are in hand

[70] A View from Space of Drylands Agriculture Over the World

Dr. Garik Gutman
NASA Headquarters, USA
Session: Remote Sensing for Environmental Sustainability and Climate Change

A compilation of the NASA Land-Cover/Land-Use Change Program's projects on drylands agriculture over the world during the past 25 years will be presented. Results for different continents are compared. The data spanning the last 25 years from Landsat, MODIS and very high-resolution sensors have been used. Prospects for advancement methods are considered.

[71] Observing Arid and Semi-Arid Grasslands at Multiple Spatio-temporal Scales: What Land Surface Phenologies Can Reveal About Ecosystem Dynamics

Prof. Geoffrey Henebry
Michigan State University, USA
Session: Remote Sensing Applications for Drylands Ecology

Land surface phenologies are the spatio-temporal-spectral patterns in upwelling radiation that vegetated landscapes manifest when observed seasonally using remote sensing. LSPs are related to--but distinct from—the phenologies of specific plants or vegetation communities observed at ground level. Here we explore the opportunities in using LSPs to characterize grassland dynamics to reveal interannual variation to weather, disturbance responses, and land use changes in arid and semi-arid montane landscapes in the Central and Inner Tien Shan ranges of Kyrgyzstan. We focus on the LSPs extracted from the dense spatio-temporal time series collected by VENµS during 2018-2020 at the “NARYN” site as well as LSPs from longer time series of Landsat VNIR and MODIS TIR data collected across the first two decades of the 21st century. Comparing the LSPs detected at different spatial resolutions, temporal durations, and ecological zones enable us to understand both the insights available from LSPs and the limitations to interpretation of LSPs.

[72] Data Standards for Model Development and Data Analytics for Decision Support

Prof. Gerrit Hoogenboom
University of Florida, USA
Session: Leveraging Agro-Informatics and Big Data Applications to Improve Crop Production and Farmers' Livelihood

The International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) Project was funded by the US Agency for International Development in the 1980s to address food security in developing countries using a systems approach. The outcome of this project was the Decision Support System for Agrotechnology (DSSAT; www.DSSAT.net), comprised of dynamic computer models for the prediction of growth, development, and yield for the main cereal, legume, and tuber food crops. However, for the efficient development of these crop simulation models, as well as the application of crop models for real-world applications, data standards are required. These encompass standards for data collection, storage, and dissemination. The IBSNAT project developed the Minimum Data Set (MDS) for experimental data collection that defined standards for weather data, soil profile data, crop management, and for measuring growth, development, yield, and yield components. This has led to the development of ICASA Standards for documenting field experiments and production. Unfortunately, adoption has been very slow by experimental scientists who do not see value in disseminating data in a Findable, Accessible, Interoperable, and Reusable (FAIR) format. A recent project entitled Agricultural Research Data Network tried to overcome this challenge by developing special tools for documenting existing experimental data files. With the new emphasis by many funding agencies to make research data available at the end of a project, hopefully these tools and standards will become adopted by more scientists.

[73] Towards Drought Tolerant Ideotypes: Using Integrative Approaches to Identify Drought Tolerance Trait Syndromes in Grapevine

Prof. Greg Gambetta
Bordeaux Sciences Agro & Institut des Sciences de la Vigne et du Vin (ISVV, France
Session: Viticulture in a Changing Climate: Vineyard-Environment Interactions

The idea of breeding drought tolerance has been around for a long time, but we still haven't been very successful. Perhaps one reason is that drought tolerance is not dependent on a single trait, but on many traits that all interact. This presentation will discuss how we can integrate phenotyping and modelling approaches in order to identify the multi-trait combinations, or "trait syndromes", that have the potential to increase drought tolerance. The talk will introduce the hydraulic traits that contribute to drought tolerance, discuss their genetic diversity and environmental plasticity, and finally explore their sometimes emergent and unpredictable interactions that result in drought tolerance. The diversity of drought tolerant trait syndromes we have identified helps explain the hierarchy of drought tolerance observed across traditional varieties while at the same time pointing the way to the development of even more drought tolerant genotypes in the future.

[74] Treatment of Sewage Ponds in Rural India without Energy Investment Using The Coupled Microalgae-Bacteria Biofilm (CMBB) Technology, Punjab

Dr. Hadas Mamane-Steindel
Tel Aviv University, Israel
Session: Resource Oriented Sanitation in Drylands

Water scarcity and insufficient sanitation create a major negative impact on public health. Lack of water is a severe problem in several states in India, as 77.6% of the country is exposed to drought resulting from irregulated monsoons, which has happened in four out of the last ten years (Patil & Eslamian, 2017). Many of the rural wastewater ponds do not have treatment, while others may have primary treatment only, where untreated sewage from the ponds is eventually discharged into the ground or a nearby water stream. Conventional wastewater treatments are energy demanding, thus, improving the efficiency of wastewater ponds, typically through aeration, will constitute a massive energy demand. In rural areas, decentralized systems are more flexible and can suit a wider range of site conditions, including topography where conventional sewage treatment cannot be implemented (Kumar & Tortajada, 2020), however, conventional centralized systems can reach a higher quality of treatment. Environmental indicators refer to the environmental efficiency of the wastewater technology in terms of quality of the effluent, resources used, emissions created process flexibility, and carbon footprint for the energy consumed to carry out the treatment. For a system to be environmentally sustainable, it should ensure the conservation of resources, such as the recycling of nutrients and energy.

Our innovation is a decentralized wastewater treatment method, working as natural remediation carried out through harnessing the synergic relations between microalgae and bacteria, which naturally exist in wastewater. We developed a specially designed biodegradable carrier, which serves as a medium platform through which a natural-based remediation process can occur in wastewater, turning it into water appropriate for reuse, to be utilized mainly for agricultural irrigation. Our joint research is conducted the state of Punjab, India, which suffers significantly from water & sanitation (WASH) challenges, alongside having a largely rural and agriculturally based population. Punjab's agriculture sector is the largest in the state, with 36% of the population directly dependent on it as their main income and source of livelihood. Conclusions: Currently, we are in its pre-pilot stage (demo of 10 m3 of sewage pond at Thapar university), following 3-4 years of lab-based R&D, alongside social and financial evaluations which are being researched, with the aim of implementing this solution for 500 villages in a future pilot stage, to take place in the wastewater ponds of rural Patiala and Ludhiana districts, Punjab. The CMBB technology enhanced the removal of chemical oxygen demand (COD),

biochemical oxygen demand (BOD), ammonium, phosphates, and micropollutants. For example, with our process, the COD reduction, compared with control reached a value of 50 mg/L, below the PPCB Standards (Discharge for treated water for Irrigation) of <150 mg/L COD. When addressing solutions in the field of sanitation, the importance of facilitating and following the social context of the adoption process should be especially emphasized. In comparison to innovations in other fields and sectors such as energy, transportation, or communication systems, the adoption of new sanitation solutions has a higher level of complexity due to intimate end-user interaction with the technology, which makes social acceptance a critical factor for success. We are conducting further research including alternative substrate designs, long-term studies, social aspects, and early adopters and financial aspects.

[75] Aquaculture Improvement Toolkit for Grey Mullet (mugil cephalus): Broodstock Management & Production of all-Female Genetic Line

Dr. Hanna Rosenfeld
Israel Oceanographic & Limnological Research, National Center for Mariculture, Israel
Session: Next Generation Aquaculture

Introduction

The grey mullet, *Mugil cephalus,* are fished and farmed world-wide. To avoid the continuous pressure on the wild populations, we developed at the IOLR-NCM breeding and larval rearing protocols for captive mullets, along with developing formulated grow-out feeds for their rearing to market size. Following a success in closing the species' life cycle in captivity, improved economics of production is expected by culturing all-female mullet populations, largely due to their highly prized roe used for preparing a seafood delicacy called "Karasumi". To achieve this goal, the current study has adopted the indirect feminization strategy, involving the masculinisation of genotypic females, and crosses of the produced neomales with normal females, to produce a female monosex mullet population. Along these lines, our specific objectives were to: (i) optimize broodstock management and improve spawning success, (ii) establish functional neomales (=sex reversed females) (iii) develop sex-specific molecular markers for identification of the neomales, (iv) produce an all-female grey mullet genetic line.

Materials and Methods

Induced gonadal development and spawning – To stimulate gonadal development several hormone-based treatments were tested. In females, the effects of twined combinations of Metoclopramide (an antagonist of dopamine D2 receptors; DA) with either rFSH (yeast produced recombinant FSH) or GnRH-EVAc (implants for sustained release of the GnRH analogue) were tested. Experimentation with males evaluated the effect of r-FSH as a sole therapeutic agent vs. r-FSH use to prime the fish prior to the administration of MT-EVAc (implants for sustained release of methyltestosterone). To induce spawning, fully mature grey mullet females and males were treated with two consecutive injections consisting of GnRHa +DA given 22.5-h apart.

Induced masculinization - A masculinized phenotype was obtained by exposing for 4 months, hatchery produced mullet fry, at 3 age categories (3, 6 and 9- month old), to food supplemented with methyltestosterone (MT; 10 or 15 mg MT/Kg of food). The sex phenotype was monitored by histological secession of the gonads and/or gonadal biopsies.

Sex-specific molecular markers - Analysis of genomic alleles was based on whole- genome sequencing of a male and female. Based on sequence variation along the assembled target gene and read-pair information, sex-specific alleles were manually separated using Gap5 viewer.

Variants that fit the XY system model were tested for association with sex by Sanger sequencing of sample of individuals from two families. Variants that passed this test were further examined on the population level by Sanger sequencing. The sex specific markers were validated and used to identify mullet neomales.

Results and conclusions

The optimal treatment consisting of DA+r-FSH, resulted with 91% post-vitellogenic females within the treatment-group. The r-FSH was a potent steroidogenic hormone during the onset of spermatogenesis. All males that were primed with r-FSH and then subjected to MT-EVAc implantation produced sperm. The spawning induction trials gave rise to high quality eggs and larvae and later on to large numbers of robust juveniles during natural (September-November) and shifted (January-February) reproductive seasons.

The results of the masculinizing studies highlight the period of 6 to 9 month of age, as a labile phase when the differentiating gonads are most susceptible to androgens. Regardless of the dose, administration of MT to the 6-month old fish, produced 100 % males upon the completion of sexual differentiation. After sexual maturity was achieved, spermiating mullet neomales were crossed with normal females giving rise to, the first all-female mullet stock, ever produced. Furthermore, body weight measurements revealed enhanced growth of the all-female mullet juveniles relative to mixed population of the same age class.

Altogether, our results corroborate the notion that the culturing of all-female mullet populations would improve production significantly due to the faster growth of females in comparison to sibling males and could provide mullet roe for Karasumi production if fish are reared to sexual maturity. Both of these advantages would improve the economics of mullet culture and justify rearing them in monoculture.

[76] Characterization of Stress Situations and Coping Strategies among Arab Bedouin Teenagers Living in Unrecognized Villages in Israel

Dr. Hassan Ganayiem
Ben Gurion University of the Negev, Israel
Session: Challenges and Opportunities as Stimulus for Transformation for the Bedouin-Arab Society in the Negev, Israel

The lives of Bedouin teenagers in unrecognized villages are complex and characterized by ambiguity - in addition to the universal challenges of teenagers, they face new challenges due to the gaps between the traditional and urban life values that they are transitioning between.

I wish to apply the interaction theory of Lazarus and Folkman (Lazarus & Folkman, 1984) to the self-defined stressors and coping of this Bedouin youth: Lazarus and Folkman defined coping as an attempt to change the stress situation by problem-solving strategies, regulating the subjective components involved in the stress situation, or both of them. Coping strategies derived from this theory have been examined primarily in Western populations. In studies conducted among non-Western populations the results were inconsistent. Therefore, the aim of the present study is to characterize unique stress situations that Bedouin teenagers face and their coping strategies, and to understand whether coping strategies help them deal with stressors in the same way they help in Western societies.

The findings of the present study indicate that the stress sources the teenagers presented are due to the turbulent and stressful developmental stage in which they are, the low socio-economic status and the modernization process their society is undergoing. Apparently the various characteristics of the Bedouin society that include the support it provides to its members, the high number of demands from them, the scarcity of resources and the low socio-economic status are responsible for the finding that the external resources presented by the teenagers were also found as sources of stress. Also, the internal resources raised indicate an expansion of the resource box among the teenagers following the process of change and modernization that the Bedouin society is going through. In addition, it seems that the characteristics of society and its emphasis on gender roles are responsible for a large part of the gender differences in the use of coping strategies. The current study found that female teenagers expressed emotional responses, sought emotional support, and tended to use avoidance more than their male counterparts did.

[77] AgriPV High Performance Systems

Dr. Helena Vitoshkin
Volcani Institute, Agricultural Research Organization, Israel
Session: Agrivoltaics – How Can It Be Implemented in a Desert Environment?

Israel is the obvious and excellent candidate for development in dual-use technologies because of its many sunny days and its limited area. Moreover, vast desert areas would profit from the shading that solar cells would provide if we further develop agriculture in this region.

While Agrovoltaics has clear advantages for the present and the future of agriculture, standard systems provide a challenge that needs to be met. This is the simple fact that standard solar panels typically block some of the sunlight that crops could benefit from because of the method of installation. Our projects address this challenge.

One of the current projects is aimed at developing a spectrally selective solar collector delivering required radiation (PAR) to the plants and other radiation to the PV panels. The concept is based on the idea that splitting the solar spectrum and optimizing the conversion mechanism of each waveband will increase the system's efficiency. We designed and built a lab-scale prototype to provide experimental measurements for cross-validation with optical models. Based on the obtained results, the optical model was developed for a field-scale system. Simultaneously, experiments with growing plants under modified light are carried out, while the results are used as data for crop model software. Data from both sources enables us to evaluate the dual-use land efficiency.

The other two projects are exploring the potential use of organic photovoltaic films in greenhouse cultivation and developing a dynamic solar tracking method based on canopy to air temperature ratio in a citrus orchard in southern Israel.

[78] Restoring our Commons: Securing our Future – Practical Experience from the Foundation for Ecological Security (FES)

Ms. Himani Sharma and Mr. Anil Sarsavan
Foundation for Ecological Security, India
Session: Practical Methods for Dryland Afforestation and Landscape Restoration

Drylands span across 224 million hectares, constituting 68 percent of the total geographical area of India. Drylands in India contribute to 44 percent of the total food grain production, consist of 66 percent of the total livestock population and support the livelihoods of more than 500 million people. However, the drylands in India, as in many other parts of the world, faces widespread degradation. They are characterized by undulating terrain, low soil depth, regular drought and erratic rainfall conditions, depleting groundwater levels and high concentrations of poverty and backwardness.

Community forests, pastures and water bodies, collectively the Commons, constitute nearly one-fourth of the drylands area. Commons serve critical ecological functions (and services) contributing to carbon sequestration, biodiversity conservation and maintenance of hydrological and nutrient cycles. They meet critical livelihood needs of food, fodder, medicine, firewood, small timber of diverse group of rural households, from the landless and socially marginalized groups to often the dominant groups with access to land and other resources. Commons not only act as a 'safety net' to which vulnerable households turn to when everything else fails, but are also the foundation to multiple production systems in a manner in which it strengthens the resilience of these systems. Despite the ecological, social and economic significance, Commons have been neglected due to unfavourable property rights and weak institutional arrangements for local management and governance resulting in widespread degradation of the drylands.

In this context, Foundation for Ecological Security (FES), a non-governmental organization (NGOs) working across 12 states in India, helps decentralise the top-heavy approach to environmental management and demonstrates the strength of local communities to collaborate and deploy local knowledge to cost effectively manage natural resources, Commons in particular. The presentation by Foundation for Ecological Security (FES) aims to share reflections and insights from our experiences of working on the inter-connected issues of tenure, local governance and restoration of degraded landscapes for improved health of ecosystems and resilient livelihoods. The presentation will highlight the landscape level approach and the fundamental dimensions of our work at village as well as landscape level. We will share about FES's experiences of -

- working with community institutions, government and civil society actors to enable communities secure their rights on Commons, strengthen collective action and enhance investments on restoration;
- the ecological processes, methods and the best practices in restoration of Commons;
- application of tools and technology to enable data and evidence-based decision making at scale;
- impact in terms of improved vegetative cover and carbon sequestration, improved environmental services and resilience of agro-ecosystems, stronger local stewardship, sustainable land and water management addressing land degradation.

[79] Local Adaptation Mediates Floral Responses to Pollinators in Arid Habitat

Mr. Ibrahim Salman
Ben Gurion University of the Negev, Israel
Session: Desert Plant Ecology: Lessons for a Warming Planet

Studies along geographical gradients can improve the understanding of the diverse selective forces that drive floral signals and insect distribution, and particularly of the way in which local habitat conditions affect floral signals within and among populations. Here, we provided an overview of variation in plant-pollinator interactions along a geographical gradient and related it to the strategy adopted by the plants in response to their habitat. We hypothesized that floral morphology and biochemistry were associated with biotic and abiotic environmental contexts. To test our hypothesis, we used six populations of white mustard (*Sinapis alba*, Brassicaceae) distributed from the Mediterranean to arid sites. To investigate if the *S. alba* populations are locally adapted to specific climatic conditions, and to detect possible environmental drivers of the adaptation, we performed a common garden experiment in the most arid site. We found that the more Mediterranean the populations, the larger their flowers, the higher their intracellular CO_2 concentration and the higher their leaf temperature values. In addition, we have found differences in the olfactory signal the population emitted: the more Mediterranean the population origin, the less maltose, and the more undecane the flower produced. The differences detected in the flower signals of the populations has affected the pollination services, causing the plant populations of more Mediterranean origin to be less attractive to the local, arid origin, pollinator community. Our results demonstrate the significance of local adaptation between plants and their pollinators for plant reproductive success.

[80] Geodiversity Enhances Resilience of Dryland Ecosystems to Climatic Change

Dr. Ilan Stavi
Dead Sea and Arava Science Center, Israel
Session: Restoration and Rehabilitation of Desert Ecosystems – Session 2

Over the past decades, the frequency and severity of droughts have been increasing across extensive parts of the world. In southern Israel, long-term droughts have been prevalent since the turn of the 21st century. In the northwestern Negev, droughts have caused the mass mortality of shrubs, particularly impacting Noaea mucronata (Forssk.) Asch. & Schweinf, which is a dominant shrub species across the region. Recent studies revealed that this mass mortality is confined to low-geodiversity hillslopes, characterized by a thick (>1 m) and non-stony soil layer. Meanwhile, high-geodiversity hillslopes, characterized by a thin (~10 cm to the underlying bedrock) and very stony soil layer, were not adversely affected. In this project, we employed a wide range of procedures and methodologies, including soil sampling and analyses, remote sensing, 3-dimensional underground geophysical mapping, and mathematical models, to investigate the mechanisms underlying these marked differences. Overall, the datasets converge to suggest that the high-geodiversity hillslopes present generally better habitat conditions than the low-geodiversity counterparts, in terms of soil-water content, soil quality, and strata properties. Specifically, greater soil-water content in the high-geodiversity hillslopes stimulates biogeochemical cycles, resulting in improved living conditions for the shrubby vegetation as well as for the entire ecosystem. This study aims to gain better knowledge of the factors shaping drylands resilience under climate change. Climatic forecasts – including rising temperatures and increasing aridity in low-to-mid latitudes, resulting in dryland aggravation and expansion – emphasize the relevance of this study.

[81] Plant-Bacteria Interactions Induce Multigenerational Tolerance for Abiotic Stressors and Increased Biocontrol Properties in the Symbiotic Bacterium Bacillus Subtilis

Dr. Ilana Kolodkin-Gal
The Hebrew University of Jerusalem, Israel
Session: Belowground Interactions in a Changing Environment

Bacillus subtilis (B. subtilis) is a plant growth promoter and a biocontrol agent that supports plant growth and protects it from bacterial, fungal, and viral infections. These bacteria and related species are well adapted to extreme environments and offer an unexploited reservoir for bio-fertilizers and bio-control agents against various abiotic and biotic stresses that endanger diverse agricultural ecosystems. Here, we propose that history-dependent behavior is an essential manifestation of plant colonization in extreme abiotic stresses, such as drought and salinity, worth classifying and quantifying. To study history-dependent adaptation to plant hosts, we developed a simple framework for measuring the physiological memory of B. subtilis about past interactions with the plant.

We found that A. thaliana secretions reduce the lag time in pre-exposed bacteria compared with naïve B. subtilis cells, even after their complete removal. Pre-exposed B. subtilis cells colonized plant roots more efficiently than naïve bacteria, were more resistant to salicylic acid, increased salinity, and had an advantage in the competition for root colonization against naïve colonizers. Transcriptome analysis of both ancestors and descendants revealed that a specific core of plant-induced processes, including c-di-AMP signaling, and the general stress response, maintain the signature of association with the plant in descendants of pre-exposed bacteria. Consistently, plant secretions compensated for losing a c-di-AMP diadenylate cyclase but required the general stress response and the master regulator Spo0A to exert their short and long-term effects.

Overall, our work demonstrates that bacterial memory manifested by long-term adaptation to plant hosts confirms an advantage to symbiotic bacteria during competition and survival of extreme abiotic stress.

[82] Reuse of Treated Wastewater for Sustainable Aquaculture: Historical Overview, Current Situation and Future Possibilities

Dr. Inbal Zaibel
Dead Sea and Arava Science Center, Israel
Session: Next Generation Aquaculture

Although aquaculture has been the fastest-growing food production sector during the last decades, its annual growth rate is simultaneously declining. Freshwater availability is a major limiting factor for production due to competition from more powerful sectors. Effective management of alternative water resources, such as treated wastewater, can reduce the competition and help cope with the increasing water demand. Moreover, reuse of treated wastewater as an alternative water source for aquaculture holds economic and environmental advantages. Reuse of wastewater or treated wastewater for agriculture and aquaculture has been practiced around the world for centuries. Yet, the extent of treated wastewater reuse for aquaculture and the scientific attention it gets are negligible compared to treated wastewater reuse for agricultural irrigation. According to most of the published studies, fish culture in treated wastewater is feasible in terms of fish survival and growth. In addition, fish have been found to be safe for human consumption in terms of microbiological contamination and the bioaccumulation of heavy metals and certain organic-micropollutants, as the detected levels have been in accordance with international standards (EU and/or FAO) for human consumption. It appears that the sociocultural perception is a major barrier to the implementation of treated wastewater reuse for aquaculture, which can be overcome by a combination of further research, legislation, and public relations.

[83] Tall buildings and the City – On Energy, Micro-Climate and Sustainability Considerations

Prof. Isaac A. Meir
Ben-Gurion University of the Negev, Israel
Session: Energy & Sustainability: The Built Environment

Tall buildings are becoming the prevailing urban building type, yet little research has been conducted on the way they affect their immediate environment. This includes energy efficiency, shadows cast, wind deflection, even pollutant concentrations. On the other hand, the different levels of a tall building are exposed to a climate changing with height above ground. Whereas in theory this includes dropping air temperature and increasing wind velocity with height, in reality such effects may be significantly different due to the interrelations between adjacent buildings, and between them and their urban context.

This paper will present ongoing research spreading over several years. The research focuses on Tel Aviv where a massive skyward development is taking place as part of the new policy and city plan. Tools and methods include thermal and energy simulations, on-ground and along height monitoring of micro-climatic parameters, pollutant concentrations monitoring, questionnaire based surveys on thermal perception etc.

Research results have numerous implications, among them appropriate building design for energy conservation, as well as appropriate building and cluster design promoting public open spaces usability and pedestrian comfort.

[84] Spectral Assessment of Chickpea Morpho-Physiological Traits from Space and Ground

Dr. Ittai Herrmann
The Hebrew University of Jerusalem, Israel
Session: Remote Sensing for Dryland Agriculture

Chickpea (Cicer arietinum) is an important grain legume in semi-arid regions and water-stress is a major constraint to its productivity. Area under chickpea cultivation is growing but higher precipitation instability risks yields. The ability to assess water potential can support irrigation decisions and promote more efficient irrigation. The current study aims to assess leaf water potential (LWP) and leaf area index (LAI) by spaceborne and ground spectral sensors. Field experiments were conducted in locations representing different climatic conditions in Israel. Six irrigation regimes were applied, from 0%, 50%, 75%, 100%, 120% and 140% of Penman-Monteith evapotranspiration were implemented at the Gilat and Neve Yaar research stations as well as in commercial fields. Plants were characterized weekly for morpho-physiological traits and grain yield data was obtained at the final harvest. Canopy reflectance was acquired with a MicroSatellite VENµS (11 spectral bands, 420-910 nm) and a field spectrometer dual-field of view system at ground level (ASD, 350-2500 nm). The VENµS and ground level hyperspectral data were divided to calibration and validation data sets. Partial least squares regression and artificial neural networks were used to quantitatively estimate the morpho-physiological traits. The coefficient of determination values of independent validation models for the LWP and LAI estimated by VENµS were 0.60 and 0.67 and hyperspectral 0.66 and 0.80 with root mean square error (RMSE) of 0.24 Mpa, 0.95, 0.23 Mpa, and 0.83, respectively. The VENµS and hyperspectral ground level data are useful for evaluation of morpho-physiological chickpea plant traits.

[85] Water Harvesting and Afforestation as a Means for Rehabilitation of Degrades Areas of the Negev

Mr. Itzhak Moshe
Former Deputy Director Southern Region, K.K.L., Israel
Session: Practical Methods for Dryland Afforestation and Landscape Restoration

Large areas of the Negev of Southern Israel are considered as desertified areas. In the past, the Negev had known periods of economic prosperity. Ruins of ancient agriculture farms and towns (1000 B.C – 700 A.D) are spread over large areas of the Negev.

Abandonment of the ancient farms and towns by the permanent residents, mismanagement of soil and water resources, non-maintenance of the ancient agriculture sites, clear cut of vegetation, heavy grazing pressure and improper land cultivation, had led to degradation processes.

Rehabilitation of degraded areas is based on proper management of soil, water and vegetation resources. Afforestation and soil conservation efforts over the dry environment are based on water harvesting. Ancient water harvesting methods with modern technique and knowledge are implemented on slopes and valleys in order to enrich soil humidity, thus enable the success and growth of planted trees and natural herbaceous vegetation

Applied research and long term monitoring, as well as adaptive management, play an important role for achieving sustainable rehabilitation.

The rehabilitated areas improve life quality of the inhabitants and provide ecosystem services, such as: green belts around urban areas, recreation opportunities, improved pasture and shade for wildlife and controlled livestock grazing, soil conservation and flood control, as well as preserving the cultural heritage of the area.

[86] Today's Most Promising Directions for High-Impact Solar Research and Development

Prof. Jeffrey Gordon
Ben Gurion University of the Negev, Israel
Session: Energy and Sustainability: Materials

Recent dramatic breakthroughs in photovoltaic (PV) production technology reorient which solar research and development (R&D) directions are now capable of high impact. We'll show that this will principally be the storage of, and the synthesis of conventional fuels from, PV-generated electricity, complemented by smart controls in interfacing to energy infrastructures, and in-situ diagnostics and predictive capabilities for PV systems (with wind power playing a major but secondary role).

Around 1 terawatt (TW) of peak PV power has been installed worldwide, growing at about 0.2 TW/year. PV is now the most economical mode of electricity generation, bar none, surpassing wind, hydroelectric, natural gas, coal, biomass and nuclear. The levelized cost of PV electricity has dipped below €0.02/kWh, with PV arrays representing as little as 15% of total system cost. We'll illuminate why this is relegating basically all solar thermal and solar photoelectrochemical technologies to the dustbin of technological history.

As ground transportation shifts to all-electric vehicles and space heating to high-efficiency heat pumps, the fraction of primary energy consumed as electricity will increase by hundreds of percent (relative), and with it, the need for the large-scale affordable storage and control of PV electricity will rise steeply. We'll also show that for solar-generated conventional fuels, no major changes in fuel distribution and storage systems worldwide would be needed (a supply-side strategy). Fossil fuels will be largely eliminated from the global energy picture, the question then being not if it will occur, but when.

[87] Agrivoltaics in Arid Environments: Keys to Successful Projects

Mr. Jordan Macknick
National Renewable Energy Laboratory, USA
Session: Agrivoltaics – How Can It Be Implemented in a Desert Environment?

Agrivoltaic installations, which combine solar energy technologies and agricultural activities in the same land space, can provide simultaneous food, energy, and water benefits to arid regions. Crop yields and vegetation growth can be increased, water requirements can be reduced, and lower temperatures from vegetation can lead to higher energy output. However, for agrivoltaic projects to provide sustained benefits to multiple stakeholders, five key conditions, termed "The 5 Cs," must be met. First, the 1) Climate and ambient environmental conditions must be able to support vegetation growth. Second, the 2) Configuration of the solar technologies implemented must allow for appropriate sunlight and shading to create ideal microclimates. Third, the 3) Crop selection and vegetation establishment methods must be aligned with the altered microclimate the technology configuration creates. Fourth, the solar installation must be 4) Compatible with the agricultural planting, maintenance, and harvesting methods. Lastly, 5) Collaboration and partnerships across energy and agricultural sectors must be durable and mutually beneficial to ensure continued operations over the long-term. Building on six years of agrivoltaic research across 25 field research sites in the United States, we examine how various approaches and variations of the 5 Cs have led to successes and failures in commercial and research-based agrivoltaics projects. Lessons learned from these agrivoltaic sites can help inform future research as well as deployment of agrivoltaic systems to across the globe to ensure more successful, mutually beneficial projects.

[88] Prospects of Microalgae to Meet a Growing Food Demand

Dr. José Pedro Cañavate

Andalusian Institute for Research and Training in Fisheries and Agriculture, Spain Session: Algae-Based Solutions for Food Crisis Challenges

Microalgae have long been considered an important food resource, although their quantitative contribution to global food supply is still poorly perceived. The trophic support that phytoplankton provides for fisheries and various aquaculture practices has often been overlooked, with more attention given to controlled production systems using specific microalgae strains. Technological development of mass cultures is progressively generating biomass of some microalgae species that show phylogenetically well-differentiated nutritional profiles. Production costs of phototrophically grown microalgae are slowly declining, although they are still above values compatible with economically feasible use in most feedstuffs. Addition of bulk microalgae in aquafeeds has been the most common practice but optimum inclusion levels are still moderate. Despite showing good levels of essential nutrients such as amino acids and fatty acids, some aspects of biochemical stability, digestibility and bioavailability of specific nutrients need to be better understood in order to achieve higher microalgae ratios in compound diets. Specifically, a more in-depth knowledge is needed about the effects that processing of microalgae biomass exerts on the above aspects. For optimal food use, it must be clear whether it is better to use bulk algae or biomass fractions obtained through purification or biorefinery processes. Microalgae can alternatively be produced from natural populations in managed aquaculture systems where the phytoplankton community structure can be modulated to improve their nutritional value. The aim is to achieve highly efficient food webs for trophic transmission from the base to consumers, represented by aquaculture species that can act both as natural harvesters and as phytoplankton trophic upgraders. Managed phytoplankton production in ponds can be linked to the restoration of degraded coastal ecosystems. It therefore represents an option to contribute to a net increase in the production of marine food resources that are currently exploited to their limit and whose global availability is in a steady state. Both the intensive monospecific production of microalgae other than Dunaliella and the ecosystem approach based on the management of natural phytoplankton communities have been little explored in drylands. Despite the extreme conditions existing in various dryland areas, they offer a good opportunity to increase supply of foods with high nutritional value through production of microalgae. Some key requirements for this will be to have selected strains of microalgae adapted to the environment, to tailor mass production systems to operate in drylands, and to improve knowledge about phytoplankton ecology in such particular conditions.

[89] Soil Fungal Communities in Dryland Afforestation Programs; Are We Recovering these Fundamental Elements of the Ecosystem?

Dr. Josu G. Alday
University of Lleida, Spain
Session: Research-based Dryland Afforestation and Landscape Restoration

Restoring degraded ecosystems and especially those located in drylands is one of the most difficult restoration practices that as restoration practitioners we can currently face. The scarcity of water and the new global change effects limit the natural recovery of forest in these areas. As a consequence, it is quite common to plan revegetation programs and tree plantings with the idea of favouring the forest recovery. During the recent years, scientific and practical research has focused mainly on ways to improve tree establishment, however, the recovery and evolution of the soil biotic component remains understudied. The afforestation needs to be in parallel with recovery of the soil biotic component. The soil microbiomes, especially fungi, are globally related with biogeochemical cycles. Soil fungi provide relevant ecosystem services, such as organic matter recycling or carbon sequestration with clear implications in plant performance and composition. Also, some research indicates that mycorrhizas can help the tree in the collection of soil water from soil. Thus, recovering below-ground microbial communities at the same time that we plant trees could be an option to enhance the tree species recovery/survival in these dryland areas. In this talk, I will explain all these concepts and the importance of soil fungi in afforestation programs using the experiments that I develop aiming to restore degraded drylands in Spain.

[90] Container Size and Fruit Load Intensity Affect Tomato Root Development under Salt Stress

Ms. Kaining Zhou
Ben Gurion University of the Negev, Israel
Session: Plant Adjustment to Biotic and Abiotic Stresses in Changing Environments

Salt stress is the prevailing threat to crop reduction worldwide especially in arid and semiarid regions since saline water is increasingly used for irrigation. Fruit thinning is a common practice in modern agriculture to manipulate sink–source interaction since fruit is the major sink organ. Moreover, containers are widely used in greenhouse crop cultivation but little attention is paid to the possible root restriction effects. Plant root systems are essential for the adaptation against different types of biotic and abiotic stresses. However, there are few studies that have been carried out on root architectural plasticity under combined stresses mentioned above due to the difficulty to access roots.

In this study, integrated root phenotyping methods were applied to study root development of tomato plants grown with various container sizes, fruit load intensities, and salinity levels. Results revealed that these combined stresses induce altered root-to-shoot ratio, root distribution, as well as biomass partitioning in different crop organs. Restricted root volume is the major factor inhibiting both physiological and morphological performance of plants. Smaller containers overexpress effects of salt stress on plants compared with what is expected in large containers. In conclusion, properly increasing container size is suggested in order to alleviate yield reduction under saline irrigation. In addition, the size of containers needs to be taken into consideration when conducting plant salt stress experiments.

[91] Restoring Australian Deserts through Mammal Translocations

Dr. Katherine Moseby
University of New South Wales, Australia
Session: Restoration and Rehabilitation of Desert Ecosystems – Session 1

More than 30 species of native mammals have become extinct in Australia in the last 200 years. Extinction rates have been highest in Australia's deserts due to the accumulative and interacting effects of feral species and overgrazing by domestic stock. Restoring native mammals to desert areas is challenging due to introduced predators such as feral cats and foxes. However, reintroductions to fenced safe havens where cats and foxes are excluded have been very successful, and lessons learnt within these safe havens have helped improve restoration of arid systems at a broader scale.

This talk will discuss some of the successful marsupial reintroductions to desert areas including within fenced reserves at Arid Recovery and Wild Deserts, and at unfenced sites in the Ikara-Flinders Ranges. As well as restoring the species themselves, these translocations have triggered tropic cascades and reinstated ecosystem processes that are important for arid zone ecosystem function. These include foraging pits dug by the greater bilby which create important microsites for seedling germination; warrens dug by the burrowing bettong that provide shelter from weather extremes for a range of other species; and predation by the western quoll that helps control overabundant macropods and leads to vegetation recovery. Broadscale restoration of desert ecosystems without fences is still extremely challenging but recent advances in pest animal control and improved understanding of predator thresholds suggests that broadscale restoration may be more successful in the future.

[92] Mitigating Effects of CO2 In and Outside Trees Facing Drought

Prof. Kathy Steppe
University of Ghent, Belgium
Session: Plant Hydraulics in Response to Environmental Stress

Worldwide, trees are threatened by climate change. They must cope with a multitude of stressors, including drought. One of the critical global challenges of our current generation is predicting how trees respond to climate change and these stressors. How can we determine the transition from a healthy to an unhealthy state, and how can we detect early signs that a critical threshold is about to be crossed?

A combination of plant sensors and mechanistic plant modelling enables to capture plant hydraulic functioning in fine detail and, hence, early signs of stress responses (Steppe et al. 2015). This results in novel technology and applications to, for instance, assess and automatically distinguish between atmospheric and soil drought stress (Van de Put and Steppe 2022).

Critical thresholds that define the transition from a healthy to an unhealthy tree are known to be affected by CO2. Here, not only the potential of elevated atmospheric CO2 concentration in mitigating adverse effects of drought on leaf and whole-tree functioning is important to consider (Lauriks et al. 2022a,b). Also tree internal, locally respired CO2 might play a crucial role in tree survival under climate-change-driven drought, especially when it is refixed by woody tissue photosynthesis (De Baerdemaeker et al. 2017, De Roo et al. 2020a,b). Such studies help us to revisit predictions of tree water transport dynamics and tree water management under climate change scenarios.

[93] Emotional Reactions and Coping Resources Among Bedouin Arab Adolescents in the Negev Following Demolition of Houses in Negev Villages

Prof. Khaled Al-Said
Kaye Academic College of Education, Israel
Session: Challenges and Opportunities as Stimulus for Transformation for the Bedouin-Arab Society in the Negev, Israel

This research investigated how coping resources explain emotional reactions, in the context of the threat of house demolition, among adolescents in three groups: Adolescents living in a recognized village with no demolition, adolescents living in an unrecognized village (by the Israeli government as legal) with no demolition, and adolescents living in an unrecognized village with demolition. The conceptual framework of this research is based on Antonovsky's salutogenic theory, which suggests examining the ability to cope with stressful situations.

The present study is a multi-group cross-sectional study that was carried out during 2010-2011 and included 910 participants, of whom 411 adolescents lived in unrecognized villages, where 193 of them experienced home demolition. Participants filled out a questionnaire including demographics, coping resources and emotional reactions.

The findings showed that stress reactions were the highest among the adolescents from unrecognized villages with demolition. Personal sense of coherence was related to fewer emotional reactions among the adolescents from recognized villages. However, among the adolescents from unrecognized villages, especially adolescents living in an unrecognized village with demolition, a stronger sense of coherence was linked to stronger emotional reactions. These findings have important implications for understanding the role of coping among youth from different cultural groups.

[94] GeneNeer Technology Aims to Unlock Plant Potential and Increase Crop Yields

Dr. Kinneret Shefer
GeneNeer, Ltd., Israel
Session: The Future of Agriculture - Revolutionize Agricultural Practice: A Technological Revolution in Farming Led by Advances in CEA Technologies

GeneNeer's technology aims to address one of the biggest challenges that the world is facing today – the reduction in crop yields caused by global warming. Our technology is based on a library of smart genetic locks that can be unlocked using an external inducer that can be applied by aerial or tractor spray. The ability to lock traits under normal growth conditions and unlock them when needed is essential for managing complex traits such as drought tolerance.

[95] Plant Drought Tolerance from Cells to Ecosystems

Prof. Lawren Sack
University of California, Los Angeles, USA
Session: Plant Hydraulics in Response to Environmental Stress

Droughts are increasing in number and frequency in many regions worldwide, with enormous impacts on plants in natural and crop ecosystems, including semi-deserts. I will review recent advances in the impact of drought on plant cells and the leaf water transport system, and how these scale up to influencing plant productivity and mortality. In particular I will focus on the plant wilting point, a.k.a., turgor loss point, and its implications for plant drought responses across scales from leaf and ecosystem gas exchange and productivity to species' distributions within diverse ecosystems, with a focus on semi-desert systems.

[96] Coherent Interactions of Turbulence and Microclimate in Irrigated Vineyards

Prof. Lawrence Hipps
Utah State University, USA
Session: Viticulture in a Changing Climate: Vineyard-Environment Interactions

Water use by irrigated vineyards is a critical issue at present. The GRAPEX project recently has examined eddy covariance measurements and remote sensing models for ET in irrigated vineyards.

The microclimate in the canopy represents the environment in which the grapes grow. Also, the complex interactions between the microclimate and air above the canopy are key mechanisms of the ET process. Modern technology offers the ability to examine episodic variations in microclimate and its connections with turbulence transport.

Eddy covariance systems installed above and within irrigated vineyards, measured at the same time three components of wind, temperature, and the water vapor density. This allows examination of the coherence between variations in microclimate with transient turbulence exchanges within and above the vines.

Results show large differences in humidity exist between the above, inter-row and within row locations. The mean values of temperature and humidity above and within the canopy do not reflect the episodic nature of air temperature and humidity. We examine the probability distribution of contiguous periods exceeding various humidity thresholds; intermittency of temperature and humidity; and the scales and intensities of turbulence above the vines that couple with changes within the canopy. This will demonstrate the nature of vine microclimate and its interactions with the regional hot and dry air.

[97] Groundwater under Global Changes in Drylands: Lesson from Morocco Cases

Prof. Lhoussaine Bouchaou
University Ibn Zohr, Morocco
Session: Water, Energy, and CO_2 Budgets in Desert Environments

Morocco's drylands cover over 90% of the land area. Several activities and ecosystems suffer greatly and are impacted by the water crisis particularly in the southern part of Morocco with less than 200 mm/y of rain and recurrent droughts. The multiple studies and surveys indicate a high depletion and quality degradation of groundwater considered as a strategic resource to maintain the main activities (e.g., agriculture, tourism, pastoralism), livelihood and security food. Faced with this situation, various development organizations aim for the recovery of local traditional conservation and participatory water management practices. The shifting to economic irrigation techniques in modern agricultural sectors was the main strategy to save water. However, in other sectors, some traditional techniques and heritage cultures remain a topical means for water and ecosystems management. Many lessons are learned from these drylands regarding the water scarcity and environmental shocks resilience. In Pastoralism, many strategies were used to adapt to the predominant water deficit (e.g., forms of lifestyles, herd size, and complementary activities). Rainwater harvesting as well as hydraulic facilities, storage and tank services for isolated populations are being implemented at several points. Alternative solutions like desalination and treated wastewater reuse were developed to balance water deficit mainly for agriculture and drinking. The analysis suggests that to achieve the resilience and adaptations against climate change, agricultural policies should shift from maximizing agricultural output to the consideration of the synergy between ecosystems, the promotion of the nexus food water energy and the concrete involvement of all concerned stakeholders and local communities.

[98] Effects of Climate Conditions on Seed Germination of Amaranthus albus- A study Along a Climatic Gradient

Dr. Lior Blank
Volcani Institute, Agricultural Research Organization, Israel
Session: Plant Adjustment to Biotic and Abiotic Stresses in Changing Environments

Predicting responses of plants to abiotic stress is a key challenge in ecology. Here we examined climate-related mechanisms regulating seeds germination. Our objectives were to assess germination traits and temperature responses in populations collected along a climatic gradient and to test for evidence of clinal variation in germination traits. Nine populations of Amaranthus albus, a noxious weed, were collected along a climatic gradient. The seed weight and germination dynamics of F1 seeds produced under shared conditions in a common garden experiment were compared with seeds collected in the field (F0). A germination experiment with six constant temperature regimes was performed. Germination dynamics varied considerably between the populations for the F0 seeds. Seeds collected in an area characterized by a semi-arid climate in the eastern part of the gradient showed rapid germination patterns, with time to 50% germination being 1-2 days under a constant temperature regime of 30°C. In contrast, some populations collected from areas with a typical Mediterranean climate, provided an extended germination period for the same temperature regime, with time to 50% germination ranging from 10 to 15 days. Yet in most populations, the germination dynamics of F1 seeds were similar to the rapid increase in germination that characterizes F0 seeds from the eastern populations. Furthermore, the average weight of F1 seeds in eastern populations was lower than that of F0 seeds, while for western populations it was higher, resulting in similar weights among F1 seeds across populations. In this study we found a phenotypic plasticity response to different climatic conditions, showing how species cope with climatic variations and indicating eco-evolutionary mechanisms that enable them to survive extreme environmental conditions and potentially also under novel regimes caused by climate change. These results highlight the need for a regional approach to weed management, taking into account the effects of climate on weed phenology and tailoring control measures accordingly.

[99] Mono-Specific Algal Diets Shape Microbial Networking in the Gut of the Sea Urchin Tripneustes Gratilla Elatensis toward Specialization in the Decomposition of Algal-Polysaccharides

Dr. Lior Guttman
National Center for Mariculture, Israel

Session: Next Generation Aquaculture

Algivorous sea urchins like Tripneustes gratilla elatensis can obtain energy from a diet of a single algal species, which may result in consequent changes in their gut microbe assemblies and association networks. To ascertain whether specific microbes lead to such changes, we compared the microbial assembly in the three major gut regions of the sea urchin when fed a mono-specific algal diet of either Ulva fasciata, or Gracilaria conferta, or an algal-free diet. DNA extracts from at least 5 individuals from each diet treatment were used for Illumina MiSeq-based 16S rRNA gene sequencing (V3–V4 region). We calculated the niche breadth of each microbe in the assembly to identify core, generalist, specialist, or unique microbes. Network analyzers were used to measure the connectivity of the entire assembly, each microbe within it, and whether it altered with a given diet or gut region. Lastly, analysis of the metabolic arsenal of key microbes in the gut enabled us to understand their potential contribution to the decomposition of dietary algal polysaccharides. Sea urchins fed with U. fasciata grew faster, and their gut microbiome network was rich in bacterial associations (edges) and networking clusters. Bacteroidetes was the keystone microbe phylum in the gut, with core, generalist, and specialist representatives. A few microbes of this phylum were central hub nodes that maintained community connectivity, while others were driver microbes that led the rewiring of the assembly network based on diet type through changes in their associations and centrality. Niche breadth agreed with microbes' richness in genes for carbohydrate-active enzymes and correlated Bacteroidetes specialists to the decomposition of specific polysaccharides in the algal diets. We propose our findings contribute to expanding the knowledge on the gut microbial assembly in T. gratilla elatensis while strengthening the correlation between microbes' generalism or specialism in differed ecological niches and their metabolic arsenal, which may aid host nutrition.

[100] The Effect of Plant Nutrition on Herbivores Biotic Stress

Dr. Liora Shaltiel-Harpaz
MIGAL - Galilee Research Institute, Israel
Session: MIGAL - Galilee Research Institute

For millions of years plants are trying to avoid consumption while herbivores are trying to optimize food exploitation. Plants nutritional values have a major effect on herbivores' fitness. Herbivores must also cope with plants secondary metabolites, which are used for defense and their production depends largely on the nutrients available to the plants.

In agro ecological systems this understanding is important when trying to control pest populations. In our research we focused on two macronutrients: Nitrogen (N) and Potassium (K). Our general hypothesis was that high levels of N will positively affect pests while high levels of K will negatively affect pests.

We tested our hypothesis in a tomato and bean system looking at fitness of 3 pests feeding on different plant tissues. The results support our hypothesis that both nutrients can affect pests depending on the feeding tissue and plant family.

[101]Monitoring of rangeland health using RS and GIS technologies in Uzbekistan

Mr. Mahmud Muminov
Samarkand Sate University of Uzbekistan, Uzbekistan
Session: Remote Sensing Applications for Drylands Ecology

The main goal of the project is to assess the ability of geographical information systems (GIS) and remote sensing (RS) to monitor the health of rangeland in the foothill artemisia-ephemeral rangeland regions of Uzbekistan. These techniques for monitoring rangeland vegetation enable not only the identification of geographical areas, but also the use of this data to scale a physiologically based assessment of the influence of environmental conditions on vegetation. Rangeland currently covers 22.5 million ha of Uzbekistan's land area, or 50% of the country's total land area (Gintzburger et al. 2003). It was discovered that numerous anthropogenic influences had an impact on 40% of Uzbekistan's natural rangelands (Mukimov et al. 2021).

The dry and semi-arid rangeland regions of Uzbekistan have been a place for human activity since antiquity. Because of this, dry and semiarid rangeland plants underwent natural selection under pressure from anthropogenic factors in addition to abiotic environmental constraints. The rangeland areas are disturbed and destroyed by heavy anthropogenic impact, which frequently causes rapid land degradation and desertification (Rajabov 2009). The main dominant Artemisia diffusa L. grows the entire year and subdominant species Poa bulbosa L. and Carex pachystylis L. grow during the rainy season in the artemisia-ephemeral rangeland area.

The desert rangelands are influenced by various factors: overgrazing of livestock (44%), uprooting (25%), shortage of water resources (15%), sand encroachment (10%), and cropping (5%), and industrial activities (1%) (Yusupov 2003). Rangeland health can be revealed by evaluating this area using the normalized difference vegetation index (NDVI). The summertime NDVI values in the Artemisia-ephemeral rangelands varied from -0.076 to 0.480. Less than 0.100 NDVI values of the rangelands were found to be in an unhealthy condition based on the results of the field sample. As a result, I advise that a strategic plan be developed to manage and safeguard rangeland for future usage.

[102]Study of the Hydraulic Strategy of Prosopis Tamarugo and Acclimatization Mechanisms under Phreatic Level Decrease in the Atacama Desert, Northern Chile

Prof. Marco Isaac Garrido Salinas

University of Chile, Chile

Session: Plant Hydraulics in Response to Environmental Stress

The groundwater extraction in the Pampa del Tamarugal, Atacama Desert, has put at risk the survival of *Prosopis tamarugo*, a strict phreatophyte endemic to the region. In this context, this thesis aims to determine the hydraulic strategy with which *P. tamarugo* faces water stress and survival. The hypothesis considers that *P. tamarugo* deploys an acclimatization strategy based on hydraulic security and plasticity of its hydraulic architecture under water stress due to phreatic level decrease. The results obtained in field studies with native trees in the Llamara Salt Flats, and semi-controlled conditions indicate that in the short-term, *P. tamarugo* deploys an anisohydric strategy (water stress tolerant) based on a low stomatal regulation on tissue embolism as water stress intensifies; and in the long-term, it modifies its hydraulic architecture at the tree, canopy (leaf shedding and foliar tolerance to stress) and branch vascular tissue level. Hydraulic architecture adjustments did not always occur in the continuous efficiency-safety, contributing in net terms to maintaining functional homeostasis of its water status and gas exchange. Based on the results obtained, the trees subjected to a decrease in phreatic level are in a deteriorated state that, to be prolonged or intensified, would result in death due to hydraulic failure, being this their probable death physiological mechanism. This is how conservation initiatives conducive to ensuring the source of water for the species are necessary.

[103]Using Remote Sensing to Monitor Vine Water Status in a Production Environment: Opportunities and Challenges

Dr. Maria Mar Alsina Marti
E&J Gallo Winery, USA
Session: Viticulture in a Changing Climate: Vineyard-Environment Interactions

In California the grape industry is one of the major agriculture drivers, and currently 70% (250000 ha) of the grape acreage are planted to wine grapes. Regulating vine water status along the growing season is crucial to achieve the desired yields and quality. Too much stress at certain phenological stages result in yield losses that may carry over to the next season, while at other stages, the water deficit is purposely caused to regulate vegetative and/or grape growth and improve quality. Long periods of drought and frequent heat waves are becoming more common in California, and these events are likely to increase in length and severity. Therefore, viticulturists need tools to minimize irrigation while avoiding excessive stress and maintain profitable yields. Remote sensing techniques can provide spatial information of vine water status over large vineyard areas compared with the more traditional methods that are time consuming and only provide discrete information. However, the proposed remote sensing methodologies often require very high-resolution images, not routinely available and costly. Publicly available thermal and optical data from satellites may not have the spatial resolution required for complex vineyard canopy architecture In the GRAPEX project; we have collected vine water status data under different spatial resolution thermal and optical images with the aim to develop water status models that can be used in a commercial environment. Here we present a summary of our results, and we review the achievements along with the unresolved issues.

[104]The Seasonal Cycle of Surface Soil Moisture: Global Characterization and Applications to Soil Quality

Dr. Mason Stahl
Union College, USA
Session: Space Based Technological Applications for Water Management

The seasonal cycle contributes substantially to soil moisture temporal variability in many parts of the world, with important implications for seasonal forecasting relevant to agriculture, and the health of humans and ecosystems. There is considerable spatial variability in the seasonal cycle of soil moisture, yet a lack of global observations has hindered the development of parsimonious theories explaining that variability. Here, we use six years of global satellite observations to describe and explain the seasonal cycle of surface soil moisture globally. An unsupervised clustering algorithm is used to identify five distinct seasonal cycle regimes. Each seasonal cycle regime typically arises in both hemispheres, on multiple continents, and across substantially different local climates. To explain this spatial variability, we then show that the observed seasonal cycle regimes are reproduced very well by a simple but physically-based water balance model, which only uses precipitation and downwelling surface shortwave radiation as inputs, and includes no free parameters. Surprisingly, no information on vegetation or land cover is required. To our knowledge, this is the first characterization of the seasonal cycle of surface soil moisture based on global observations. Beyond applications to climate, our characterization and attribution of the drivers of the seasonal cycle of surface soil moisture provides insight into observed patterns in soil chemistry in both dryland and non-dryland environments (e.g., pH, soil salinity, soil redox conditions) and importantly helps to explain why certain regions soil chemistry deviates from conditions that would be expected under the prevailing annual climatic setting.

[105]Deep Learning Strategies for Mapping Complex Vegetation Patterns (CVP) in Mediterranean Environments undergoing Climate Change

Mr. Matan Cohen
Bar-Ilan University, Israel
Session: Remote Sensing Applications for Drylands Ecology

Climatic, topographic, and geological diversity, together with frequent disturbance and recovery cycles, produce highly complex spatial patterns of trees, shrubs, dwarf-shrubs and bare ground patches. Assessment of spatial and temporal variations of these life-forms patterns under climate change is of high ecological priority. This study is one of the very few attempts to classify 3 density levels for the main three Mediterranean life-forms' patterns. The development of an extensive database of orthophoto images representing the different pattern categories was instrumental for training and testing pre-trained and newly-trained DL models utilizing DenseNet architecture. Both models demonstrated the advantages of using Deep Learning approaches over existing spectral and spatial (pattern or texture) algorithmic methods in differentiation of 9 life-forms' spatial mixtures categories.

[106]Establishing Biocrusts to Rehabilitate Drylands: Some Obstacles and Possible Paths Forward

Prof. Matthew Bowker
Northern Arizona University, USA
Session: Restoration and Rehabilitation of Desert Ecosystems – Session 2

Biological soil crusts (biocrusts) are prevalent at the surface of terrestrial ecosystems, both transitioning from disturbance, and as a stable and potentially dominant component of drylands. Microbes and non-vascular plants are the primary biocrust agents aggregating the soil surface into a protective photosynthetic skin. For the past two decades especially, researchers have been seeking ways to actively promote the recovery of these communities to boost dryland function after disturbances. Our research focuses on reintroduction of biocrust organisms grown in artificial settings (greenhouses, farms) to degraded environments. In this effort we have encountered several challenges: harsh environmental conditions, lack of field hardiness, loss to wind and water transport, and even loss to insects. We are actively researching practical solutions to these hurdles. Plant-based soil tackifiers potentially retain added biocrusts on site and aid in stabilizing erodible surfaces. Hormones and osmoprotectants potentially buffer some environmental stresses. Adherence of biocrusts to fabrics and other materials or incorporating biocrust organisms into protective pellets may potentially assist with most or all of these problems. As we find solutions to these establishment barriers, we can better use biocrusts to combat and reverse dryland land degradation.

[107] A Qualitative Study of Resilience among Asylum Seekers from Darfur in Israel

Prof. Maya Lavie-Ajayi
Ben Gurion University of the Negev, Israel
Session: Asylum Seekers from Darfur & Eritrea – Experiences in Israel and in Uganda

We know more about the experiences of trauma, despair, and abuse of asylum seekers and refugees than we do of their resilience, strength, and active struggle to survive and succeed. This presentation explores stories narrated by asylum seekers from Darfur, Sudan, currently residing in Israel, to learn about their forms and sources of strength, resilience, and coping mechanisms. In-depth, semi-structured group interviews were conducted in Hebrew and in English with eight single men, aged between the ages 27–38, who had lived in Israel for between four and seven years. The interviews were recorded and transcribed, and the data analyzed by analytic induction and constant comparison strategies.

Six factors were identified, from the interviewees' perspective, as contributing to their resilience: cognitive coping strategies, behavioral coping strategies, the ability to work, the ability to study and educate oneself, the support of family and friends, and social and political activism. This study corroborates existing literature by identifying personal strategies and social support as important to resilience of refugees; however, and unlike other studies, we did not find religion as an important factor from our interviewees' perspective. We have thus expanded the existing literature by identifying the ability to work and the ability to study as important factors contributing to the resilience of refugees.

[108]Environmental Heat Load Affects Subacute Inflammation, Oxidative Stress and the Endocannabinoid System in Periparturient Dairy Cows

Dr. Maya Zachut
Volcani Institute, Agricultural Research Organization, Israel
Session: Thermal Stress Regulation in Animals

Environmental heat load (HL), a combination of high ambient temperature and humidity, negatively affects livestock production. In the next decades, climate change is predicted to increase the prevalence and intensity of HL. As a consequence, livestock will be increasingly exposed to heat stress, negatively impacting wellbeing and the sustainability of the animal agriculture industry. Due to their increased metabolic rate, high-yielding dairy cows are extremely sensitive to hot environments. In these animals, chronic HL has detrimental effects on feed intake, milk production and reproductive performance. Around parturition, HL contributes to systemic inflammation by increasing the expression of pro-inflammatory cytokines in blood cells, leading to immune dysfunction. Key modulators of the metabolic function such as adipose tissue (AT) are also affected by HL; during seasonal HL, subcutaneous AT of periparturient cows exhibits enrichment of proteins related to the oxidative stress response pathway such as Nrf2-oxidative stress response. The endocannabinoid system (ECS) is a central regulator of whole body metabolism and energy homeostasis, and it is also a potent modulator of inflammatory responses and immune function in mammals. The cannabinoid-2 (CB2) receptor, expressed by various cells of the immune system, can also modulate the release of cytokines and appears to have a critical role in immune regulation and function. Another receptor related to the ECS is the heat-sensitive transient-receptor-potential-cation channel-subfamily-V-member-1 (TRPV1), which is a ligand-gated ion channel that plays a key role in modulation of the sensation of pain and thermal hyperalgesia. We hypothesized that HL during summer may affect the inflammatory state, oxidative stress and the ECS in dairy cows, possibly via TRPV1. We found that seasonal HL during the peripartum period was associated with lower white blood cell counts coupled with increased levels of subacute inflammation and oxidative stress, indicating dysregulation of immune function. In addition, environmental HL, either directly or via reduced feed intake, seems to have a limited effect on ECS components in AT, and the heat-sensitive receptor TRPV1 could be related to the association between HL and the ECS in dairy cows.

[109] Out of the Blue: Phototropins of the Leaf Vascular Bundle Sheath Mediate the Regulation of Leaf Hydraulic Conductance by Blue Light

Prof. Menachem Moshelion
The Hebrew University of Jerusalem, Israel
Session: Plant Hydraulics in Response to Environmental Stress

The Arabidopsis leaf veins bundle sheath cells (BSCs) – a selective barrier to water and solutes entering the mesophyll – increase the leaf radial hydraulic conductance (K_{leaf}) by acidifying the xylem sap by their plasma membrane H^+-ATPase, AHA2. Based on this and on the BSCs' expression of *PHOT1* and *PHOT2,* and the known blue-light (BL)-induced K_{leaf} increase, we hypothesized that, resembling the guard cells, BL perception by the BSCs' phots activates its H^+-ATPase, which, consequently, upregulates K_{leaf}. Indeed, under BL, the K_{leaf} of the knockout mutant lines *phot1-5*, *phot2-1*, *phot1-5phot2-1,* and *aha2-4* was lower than that of the WT. BSC-only-directed complementation of *phot1-5* or *aha2-4* by *PHOT1* or *AHA2*, respectively, restored the BL-induced K_{leaf} increase. BSC-specific silencing of *PHOT1* or *PHOT2* prevented such K_{leaf} increase. A xylem-fed kinase inhibitor (tyrphostin 9) replicated this also in WT plants. White light – ineffective in the *phot1-5* mutant – acidified the xylem sap (relative to darkness) in WT and in the *PHOT1*-complemented *phot1-5*. These results, supported by BL increase of BSC protoplasts' water permeability and cytosolic pH and their hyperpolarization by BL, identify the BSCs as a second phot-controlled water conductance element in leaves, in series with stomatal conductance. Through both, BL regulates the leaf water balance.

[110] Optimizing Crop Growth in an Artificial Environment

Prof. Menachem Moshelion
The Hebrew University of Jerusalem, Israel
Session: The Future of Agriculture - Revolutionize Agricultural Practice: A Technological Revolution in Farming Led by Advances in CEA Technologies

Indoor farming produces fresh crops with minimal food waste, no pesticides, and is close to the consumer. However, indoor farming has a significant energy demand, and it is relatively limited in genetic variation. Understanding the key parameters limiting crop yields under an artificial environment and developing new multidisciplinary tools to cope with the indoor farming challenges are expected to take a major role in the food security challenges of the coming years.

[111]Between a Wild Ass and a Hard Place – The Combined Effect of Large Herbivores and Arid Conditions on the Composition of Desert Vegetation

Prof. Merav Seifan
Ben Gurion University of the Negev, Israel
Session: Restoration and Rehabilitation of Desert Ecosystems – Session 2

Desert vegetation needs to cope with extreme conditions such as water shortage and high temperatures. Therefore, species performance and community composition are shaped by habitat conditions, allowing only highly adapted species to co-occur. Because the vegetation is the food source for primary consumers in this highly stressful system, it is reasonable to assume that vegetation is strongly limited by both resource supply and herbivore activity. Alternatively, there are large similarities between plant adaptations to arid conditions and to the presence of large herbivores. This may imply that desert vegetation is tolerant to the presence of herbivores. The effect of the Asiatic wild ass (Equus hemionus) on vegetation composition in the Negev highlands is an appropriate model system to study these effects. This large herbivore was reintroduced to the region few decades ago, and has successfully recolonized it. Nevertheless, the population depends on artificial water supply, as most of the natural water sources are captured for human use. The dependency on water creates a gradient of herbivore intensity within the region, thus allows for a comparison between sites which are environmentally similar, except for the potential impact of herbivory. To study these effects, we sampled the local seed bank within the region. Seed bank composition is particularly suitable for this comparison because it reflects the local species pool. Therefore, by comparing species composition in relation to wild ass activity and site conditions, we were able to gain an insight into the long-term interplay of these factors on the region vegetation.

[112] Towards Functional Field Maps for Plant and Agro-Ecology

Dr. Meredith Schuman
University of Zurich, Switzerland
Session: Plant Adjustment to Biotic and Abiotic Stresses in Changing Environments

The Spatial Genetics group at the University of Zurich works on scalable, spatially resolved investigations of plant functional genetics in the complex real-world settings of forests and cultivated fields. I will discuss approaches for characterizing the distribution of ecologically active plant metabolites in order to determine the relationship between their distribution, and the success of biological control measures as measured by distributions of herbivorous versus beneficial insects, and outcomes for plants. I will present some results from investigations in a native plant system which shares important features with agricultural systems, and theoretical considerations based on chemical ecology and physical chemistry. Then, I will present measurements and projected chemical-ecological maps for a type of sustainable intensification system for agriculture: push-pull intercropping systems, as part of the Horizon 2020 UPSCALE consortium. I will discuss measurements of plant volatile and non-volatile metabolites as indicators of push-pull function, in the context of recent controversies regarding how this system works to control pests, improve soil quality and increase yields.

[113]Hybrid Grapevine Resistance to Downy and Powdery Mildew

Dr. Mery Dafny-Yelin
MIGAL – Galilee Research Institute, Israel
Session: Viticulture in a Changing Climate: Vineyard-Environment Interactions

Vitis vinifera grapevines are susceptible to downy and powdery mildews (Plasmopara viticola and Erysiphe necator, respectively). During the growing season, 4–10 chemical treatments are given to control these diseases; an alternative solution is the use of resistant varieties. American and Asian grape species have natural resistance to powdery mildew (PM) and downy mildew (DM). Breeding programs for PM and DM resistance have been conducted worldwide for decades. Recently, resistant hybrid cultivars have been brought to Israel from Europe and USA breeding programs . Our research aim was to test these hybrid cultivars' suitability to Israel's local weather conditions. Grapevines from the different programs were planted in four different climate regions in the north of Israel for observation. Results – under natural weather conditions 16 hybrids grapevines varieties found to be less sensitive to PM and DM than the V. vinifera variety. Only one of them, cv. Cabernet Carbon, seemed to be as sensitive to DM and PM as the V. vinifera plants. Laboratory infection with DM was only applied to 4 hybrid varieties. Sporulation of hybrid lines was significantly less than on V. vinifera leaves, including the cv. Cabernet Carbon. In the future, we will monitor fruit sensitivity, and fruit and wine quality.

[114] A New Approach for Early Detection of Red Palm Weevil

Dr. Micha Silver
Ben Gurion University of the Negev, Israel
Session: Remote Sensing for Dryland Agriculture

Red Palm Weevil (RPW), Rhynchophorus ferrugineus (RPW), is recognized globally as a serious pest in many varieties of palm trees. The pest damages ornamental palms, endangering pedestrians and traffic, palm oil plantations in Southeast Asia, coconut palms across the Pacific islands, as well as date orchards throughout the Middle East. Economic damage due to this pest in the Middle East Gulf States is estimated at up to $25 million annually. The pest first appeared in Israel in 1999, in date orchards near the Dead Sea, and has since spread throughout the country.

Early detection of RPW infestation is challenging since no obvious signs appear until the tree crown collapses. When damage becomes serious, the crown suddenly dries up, and eventually leads to collapse of the whole plant. Existing early detection methods are expensive, labor intensive, and not fully accurate. These methods include pheromone trapping, manual inspection of trees to identify infection locations, and trained sniffer dogs to locate RPW infested trees. More recently acoustic sensors that pickup sounds of larvae in the tree trunks have proven moderately successful. However that method is costly, labor intensive, and requires damaging the tree to insert the sensor.

This work proposes a new approach for early detection of RPW based on remote sensing and Machine Learning. Preliminary examination of drone acquired imagery indicates that reflectance in the thermal band, with wavelengths longer than near infra-red, is stronger in infested trees than in clean trees. This effect is most pronounced in the central, sensitive frond ("lulav") region of the tree canopy. After collecting a large data-set of both drone imagery and acoustic sensor data, a Deep Convolutional Neural Network classification model will be trained and validated in an attempt to recognize infested trees.

[115]Herbivore-Induced Root Foraging for Cd in a Metal Hyper-accumulating Plant

Dr. Michal Gruntman
Tel Aviv Univeristy, Israel
Session: Belowground Interactions in a Changing Environment

Plants can respond to heterogeneity in belowground resources by selectively proliferating their roots within nutrient-rich patches. However, an unexplored hypothesis is that such root foraging could be induced by environmental stressors, such as herbivory, which might increase the demand for particular resources, such as those required for herbivore defense. This study examined the way simulated herbivory affects root foraging for cadmium in the metal-hyperaccumulating plant Arabidopsis halleri, which uses this heavy metal as herbivore defense. Simulated herbivory elicited enhanced allocation of roots to cadmium-rich patches, and this response was exhibited particularly by plants from non-metalliferous origin, which have lower metal tolerance. These results provide first support for the idea that root foraging can be induced not only by resource availability but also by environmental changes, such as the presence of herbivores.

[116]Moringa Oleifera; A Novel Livestock Feed, to Face Climate Change Challenges

Dr. Miri Cohen-Zinder
Volcani Institute, Agricultural Research Organization, Israel
Session: Sustainable Agriculture & Climate Change

Ruminant production systems may face major challenges during the current climate change era. With respect to their dietary demand, the supply of high protein- and energy-yielding crops may be at shortage. Thus, the quest for alternative forage resources, to enable sustainable production, characterized by improved feed efficiency (FE), and decreased carbon footprint, is of great significance.

Moringa oleifera (MO), a high protein, antioxidant and vitamin rich plant, is a promising livestock feed. MO is reputed for its adaptability to grow in all types of soils, tolerate hot and dry conditions and low water availability.

By supplementing MO silage to ruminants, we revealed beneficial effects on growth and production performances, which included improved FE, milk yield and composition and product quality. It is assumed that phenolic compounds in the MO, via their capacity to quench ROS and reduce rumen methanogenesis, have enabled energy to be directed for growth and production processes, at the expense of methane and ROS production. In line with the above, our findings from muscle transcriptome analysis of MO-fed lambs indicated differential expression of pathways involved in energy metabolism processes (e.g. mitochondrial biogenesis and ER stress). Currently, our scientific efforts are invested in gaining insight related to the dual effect of dietary MO on methane production and FE.

[117] Transgenerational Transmission of Heat Stress Effects in Dairy Cattle: A Study of Four Consecutive Generations

Dr. Moran Gershoni
Volcani Institute, Agricultural Research Organization, Israel
Session: Thermal Stress Regulation in Animals

Global warming has increased the frequency of heat stress in livestock. Although heat stress directly leads to negative effects on production and reproduction traits in dairy cattle, the transgenerational transition of these changes is poorly understood. We hypothesized that heat stress in pregnant cows might induce epigenetic modifications in the developing embryo germ cells, which, in turn, might lead to phenotypic effects in the offspring. Here, we examined whether transgenerational effects of heat stress contribute to the phenotypic expression of economic traits in Israeli dairy cattle. Since heat stress in Israel occurs specifically between June and October, first, we examined the association of the month of birth of F1 cows (pregnancy of the F0 dam) with the performance of the F2 and F3 female offspring. Then, we calculated an annual heat stress index and examined the association of the heat stress index during the pregnancy of the F0 dam with the performance of her F2 and F3 offspring. Finally, we examined intergenerational interactions of heat stress by comparing the performance of F3 cows according to the pregnancy seasons of the F0 and F1 animals.

We found a significant association between the month of birth, the season of pregnancy, and the heat stress index of F0 females, with the performance of their F2 and F3 progenies, which suggests a true transgenerational effect. The most significant transgenerational effects were on fat yield and concentration, dystocia, still-birth, and maturation.

These findings suggest that heat stress during pregnancy affects the performance of offspring, regardless of life circumstances in at least the last three generations. Therefore, heat stress can reduce selection efficiency in breeding programs and may have economic significance in livestock.

[118] Acoustic- and Light-Based Membrane Fouling Studies

Prof. Moshe Herzberg
Ben Gurion University of the Negev, Israel
Session: Functionalized Antifouling Surfaces in Membrane Based Water Treatment

Fouling and particularly biofouling, presents a major impediment of membrane filtration processes, essential for water recycling and desalination. This lecture will cover part of our lab nano-scale strategies for studying and mitigating membrane biofouling scenarios. We combine Localized Surface Plasmon Resonance (LSPR) sensing and quartz crystal microbalance with dissipation monitoring (QCM-D). While LSPR analysis is sensitive to the interface - molecular and - colloidal interactions with a decay length of ~20–30 nm, QCM-D provides the mass and viscoelastic properties of the hydrated adsorbed fouling layer in a length scale of ~200-300 nm. This way, we characterize in real time, on one surface, both (i) adsorption interactions of biomacromolecules, conformational changes, and structural transformations of the adsorbate in spatial proximity of up to 30 nm from the surface; and (ii) the entire mechanical load on the surface, in a length scale of 300–500 nm, which includes the contribution of the fouling layer hydration. Related applications to be discussed, will include: (1) improved ultrafiltration membranes for purification of municipal secondary wastewater effluents and (2) rapid prediction of fouling rate, reduced membrane performance and membrane cleaning efficiency during desalination of municipal secondary wastewater effluents; (3) studying the function of hydrogels and polymer brushes for separation processes as well as antifouling behavior and mechanisms.

[119] CompoChar: Growing More Food While Fighting Climate Change

Dr. Nadav Ziv
Earth Biochar, Israel
Session: Sustainable Agriculture & Climate Change

Growing plants in a soilless environment allows the grower almost total control over the growing process (water, nutrients, pH, and uptake). Today, most raw materials for soilless substrates are nonrenewable, quarried materials which involve high shipping costs and carbon footprint. The CompoChar™ which is a biochar growing substrate, can be made everywhere from local organic wastes such as wood trimmings and composted sewage sludge (SS), a renewed, nutrient rich raw material. The CompoChar reduces atmospheric CO2 and helps in fighting climate change.

Municipal sewage sludge went through a full composting process. Homogenous ss compost was mixed with shredded wood waste was pyrolyzed at 550°c in a continuous pyrolysis system. The resulting product was characterized for its soilless growing media properties. In addition, pre and post pyrolysis hazardous elements (heavy metals, toxins, pathogens) were measured. Pyrolysis produced a homogenous black material distinct from its original raw material. CompoChar™ has close to ideal water retention curve. The CompoChar™ has a built-in available macro and micro elements found out to be important at times of nutrient stress. CompoChar™ EC is significantly lower compared to SS-compost. Lettuce grown in Compochar weighed 60 gram more than Tuff groups. CompoChar nutrients reservoir lessen blossom-end rot in tomatoes. CompoCharTM blocked fusarium development comparing peat-coco coir growing media. CompoChar™ of H/C ratio measurements were below 0.4 which represent high biological stability appropriate for carbon sequestration. Summary: We find pyrolysis as a promising method to significantly reduce sewage sludge compost hazards and upgrade its value as a soilless growing media.

[120] Towards Capturing Tree Mortality Rates and Mechanisms in Response to Drier and Hotter Conditions

Dr. Nadine Ruehr
Karlsruhe Institute of Technology, Germany
Session: Plant Hydraulics in Response to Environmental Stress

Reports of tree mortality in response to drier and hotter conditions are becoming increasingly widespread. Particularly in already drought-prone environments tree death triggered by prolonged dry periods alongside hotter conditions could be further intensifying in the coming decades due to climate change, which might also put efforts of forest regeneration at risk. But we currently lack the capability to make consistent assessments of tree mortality and linking it to the underlying reasons and long-term consequences. To overcome such challenges, the International Tree Mortality Network (www.tree-mortality.net) was formed, which aims to bring together the global ecological, forestry, remote-sensing and Earth-system science communities to: (1) quantify trends in tree mortality rates globally, (2) attribute the causes of tree mortality and (3) help develop the capability to accurately predict tree mortality trends, in a changing world. Here, we present results from a recently compiled wide-ranging survey of data sources potentially suitable for assessing tree mortality rates globally. We then outline some of the challenges, and potential solutions, to combining these data sources into consistent metrics of tree mortality rates. In addition, we present recent observations of drought and hotter-drought triggered tree mortality in Mediterranean and semi-arid forests and discuss some of the underlying physiological reasons and potential longer-term consequences.

[121]Mapping Wildfire Risk with Orbital Imaging Spectroscopy: A Unified Spectral Unmixing and Atmospheric Correction Approach

Dr. Nimrod Carmon
NASA & California Institute of Technology, USA
Session: Remote Sensing for Environmental Sustainability and Climate Change

The Mediterranean region has experienced increasing amounts of forest fires, in increasingly larger magnitudes, in the last two decades. Whereas traditional wildfire risk products are of kilometer scales, there is a need for high-resolution risk maps to support at-risk communities. With Earth-observing spectral remote sensing, it is possible to characterize vegetation conditions in the forest and estimate a fire risk based on the retrieval of vegetation traits. While vegetation trait models are developed usually for closed-canopy conditions, measured pixels are usually of a mixture of endmember surfaces. This work quantifies the uncertainty due to this discrepancy and provides a new model called the Dimensionality Reduction Emphasizing Analysis of Mixtures for Spectroscopy (DREAMS). The DREAMS model is estimating endmember reflectance signatures directly from at-sensor radiances, leveraging variations in geometry and texture conditions of the unique surfaces. We then estimate vegetation conditions based on the endmember signatures and calculate an improved fire risk index. We show the reduction in uncertainty and improved prediction performance when using the DREAMS model and evaluate it operationally over a selected study site within an Israeli forest.

[122] Could Cyanobacterial Polysaccharides Increase Efficiency and Sustainability of Dryland Agriculture?

Dr. Nina Kamennaya
Ben Gurion University of the Negev, Israel
Session: Cyanobacterial Soil Amendment and Restoration

Agriculture in drylands is intensifying in response to the global deficit of food; however, long-term land cultivation in semi-arid and arid regions requires soil-protection measures. Failure to protect from erosion the thin and loose arable soils leads to their swift and irreversible loss. Additionally, productivity of dryland mineral soils depends on intensive irrigation and heavy fertilization, whereas low content of moisture-retaining organics warrants significant loss of the applied resources to evaporation and infiltration beyond the root zone. We examined how polysaccharide-rich cyanobacterial biomass affects the retention of water and nutrients within the root zone. Large quantities of negatively charged polysaccharides are exuded by some cyanobacteria exposed to excess availability of inorganic carbon. Their negative charge, conferred by sulfate moieties and carboxyl groups of uronic acids, increases the capacity of saccharides to form electrostatic interactions with water dipoles and mineral cations, such as K^+, Ca^{2+} and Mg^{2+}. In turn, the saccharide-associated divalent cations can bind loose clay particles into stable aggregates. Furthermore, the immobilized cations can bridge between the saccharides and NO_3^- and $H_2PO_4^-$ fertilizer anions, averting their loss to infiltration. Here I present the initial results of small-scale studies testing this carbon-neutral approach for increasing sustainability of agricultural practices in the drylands.

[123]Photosynthetic Life in Extreme Environments: How Desert Sand Crust Cyanobacteria Tune Photosynthesis During Hydration/Desiccation Cycles

Prof. Nir Keren
The Hebrew University of Jerusalem, Israel
Session: Cyanobacterial Soil Amendment and Restoration

High light and dehydration are a combination of stress conditions that is relevant to all terrestrial photosynthetic organisms, in both natural and manmade habitats. However, among photosynthetic organisms there is only a small group that can effectively counteract these stresses. These microorganisms make their home in some of the harshest, most fluctuating, terrestrial environments, including deserts, intertidal zones and exposed rock surfaces. In my talk I will focus on the adaptation of the photosynthetic apparatus to these conditions. Our work focuses on the adaptation and acclimation of the cyanobacterial photosynthetic apparatus to hydration/desiccation cycles. We have evidence for a number of mechanisms that allow desert cyanobacteria to shut down photosynthesis when desiccated and immediately restore it when hydrated. These mechanisms function on the level of exciton energy and electron transport. Using spectroscopic techniques, we can follow the initiation of these processes with the progression of desiccation.

[124]Setaria Viridis Plasma Membrane AQPs Contribute to Root Hydraulics and Root to Shoot Signalling of Gas Exchange

Dr. Nir Sade
Tel Aviv University, Israel
Session: Plant Adjustment to Biotic and Abiotic Stresses in Changing Environments

Panicoid crop plants from the C4 type, such as maize, sorghum, and foxtail millet are an important part of staple food worldwide. The high rate of productivity observed in grasses is in part due to their extensive root system. Recently Setaria viridis has emerged as a new genetic model system for panicoid grasses. Natural accessions of S. viridis originating from different parts of the world, with differential leaf physiological behaviour, have been identified.

This work focused on understanding the physiological and molecular mechanisms controlling root hydraulic conductivity and root-to-shoot gas-exchange signaling in S. viridis. We identified two accessions, SHA and ZHA, with contrasting behaviour at the leaf (photosynthesis, transpiration, water potential), root (cell water permeability, hydraulics, transcription pattern), and whole-plant (transpiration) level. Our results indicated a significant role for root aquaporin plasma-membrane intrinsic proteins (AQP PIPs) in the differential behaviour of SHA and ZHA. Moreover, a different response to low levels of abscisic acid (ABA) between SHA and ZHA was observed, which was associated with root AQP and root hydraulics. Using cell imaging, biochemical and reverse-genetic approaches, we identified PIP1;6 as a possible PIP1 candidate that regulates radial root hydraulics and root-to-shoot signalling of gas exchange in S. viridis. In heterologous systems, PIP1;6 was located to the endoplasmic reticulum (ER), and upon interaction with PIP2s, re-localization to the plasma membrane (PM) was observed. PIP1;6 is predominantly expressed at the root endodermis. Generation of two CRISPR/Cas9 knockout PIP1;6 plants (KO-PIP1;6) in S. viridis showed lower root hydraulic conductivity, lower gas exchange, and alteration of root transcriptional pattern associated with cell wall barriers. Our results indicated that PIPs plays an essential role in root water movement and in the regulation of whole-plant water homeostasis in S. viridis. Furthermore, our results suggest that these traits might be regulated by ABA signals.

[125] Impact of Environmental and Cultivation Conditions on Secondary Metabolism and Development of Medical Cannabis (Cannabis Sativa. L.) plants

Prof. Nirit Bernstein
Volcani Institute, Agricultural Research Organization, Israel
Session: Plant Adjustment to Biotic and Abiotic Stresses in Changing Environments

Environmental conditions are known to affect secondary metabolism in plants. Cannabis (*Cannabis sativa* L.) is used by humanity for thousands of years for medical, industrial and recreational use. In recent years, its cultivation for modern agriculture and the demand for medical-grade cannabis products are sharply increasing. The therapeutic effects of cannabis are derived from its chemical constituents, encompassing hundreds of biologically active secondary metabolites, including terpenoids, flavonoids and the cannabis-specific cannabinoids. Understanding regulation of plant response to environmental conditions is key for development of optimal chemical profile for modern medicine. Only little science-based knowledge is available regarding regulation and responses of 'drug-type' medical cannabis plants to environmental/cultivation practices. Such information is essential for the optimization of cultivation for production of high quality standardized material for the medical market, as well as for development of plant products containing specific desirable phytochemical profiles. In the talk we will present and discus various studies in our lab that revealed recently high sensitivity of plant function and biosynthesis of secondary metabolites to a range of environmental and cultivation conditions in cannabis. The secondary metabolite profile is highly sensitive to light intensity, light quality, temperature, micro-environment in the plant shoot as is affected also by plant architectural manipulation and plant density, and to mineral nutrition. These results points at the potential of physical and chemical exogenous effectors imposed during cultivation to regulate plant development and the profile of active secondary metabolites in medical cannabis.

[126]Multidimensional Development amidst Changing Land Uses in the Thar Desert Region of India

Dr. Nisha Varghese
Indira Gandhi National Open University, India
Session: Economics & Desertification

The Great Indian Desert or the Thar desert occupies around 4.5percent of the total geographical area of the country and more than 60 percent of the state of Rajasthan. The forest cover in the state of Rajasthan is only 8 percent. All the districts covering the Thar desert have forest area less than the state average. The area is abysmally low in Jaisalmer and Jodhpur (<1%). The population in this region has been increasing at a rate faster than national average. Some of the districts of this region are also characterized by a livestock density that is even higher than population density. This has led to increased pressure on land for food security of the increasing population and fodder security for the livestock. It is important to take into consideration the direction of change in the land uses while formulating policies for sustainable development of the region. It is also important to study the relation between development and desertification. In this study, I have used Markov Chain analysis to study the direction of change of land use.

Further, the development of the Thar Desert Region was analysed from a multidimensional perspective, looking into development from Demographic, Health, Social, Economic and Environmental perspectives. Development indices were worked out for each of these dimensions and a composite development index including all the dimensions was also worked out. The Districts were ranked on the basis of these indices and relevant policy measures suggested for overall development of the region.

[127] Controlling Fruit Sourness in a Changing Climate: Genetic Loci, Genes, and Metabolic Changes Associated with Grape Malate Levels

Dr. Noam Reshef
Volcani Institute, Agricultural Research Organization, Israel
Session: Viticulture in a Changing Climate: Vineyard-Environment Interactions

Insufficient levels of malate and lack of sourness in commercial grape cultivars (Vitis vinifera) deteriorates the quality of fruit grown in warm climates, and is further exacerbated due to climate change. Conversely, excessive levels of malate in the fruit of wild Vitis species forms a major limiting factor for the introgression of disease resistance alleles to future cultivars by breeding. These contrasting interspecific phenotypes were harnessed, for the first time, to deepen our understanding of malate regulation, with the overarching goal of controlling grape sourness through breeding.

Our aim was to highlight metabolic pathways associated with the interspecific differences in fruit malate levels, and identify associated genetic loci and regulatory genes. We integrated metabolomics, transcriptomics, and physiological analyses of the fruit of wild and domesticated genotypes, and complemented these with QTL mapping, using novel genus-wide genetic markers, on several interspecific mapping families.

Three polymorphic loci were associated with over two-fold differences in malate and 40.6% of the phenotypic variation. Two of these loci were stable in all and in three out of five years, respectively. Elevated malate levels were associated with higher fruit respiration rates, higher levels of amino acids, TCA and fermentation metabolites, and higher expression of their corresponding genes. In addition, transcripts of a cytosolic malate dehydrogenase and malate/dicarboxylate transporters (ALMT/TDT), associated with fruit malate levels, were identified.

These results advance current knowledge regarding the regulation of malate at the mechanistic and metabolic levels, and provide novel genetic markers for improving fruit quality and disease-resistance of future cultivars.

[128]Remote Sensing Index of Electron Transport Rate Relates to Light Use Efficiency and Biomass Production

Dr. Oded Liran
MIGAL Research Institute, Israel
Session: Leveraging Agro-Informatics and Big Data Applications to Improve Crop Production and Farmers' Livelihood

Chlorophyll fluorescence can be remotely sensed via the Fraunhofer atmospheric absorption lines of oxygen and is termed Solar-Induced Fluorescence (SIF). SIF has been extensively related to carbon assimilation at global ecology scale and was interpreted as Electron Transport Rate (ETR). However, SIF was shown to be unrelated directly to carbon assimilation at finer-scale resolution and may be related to other photosynthetic processes, such as non-photochemical quenching. To this end, we defined a novel Remote Sensing Electron Transport Rate index (RS-ETRi) based on a combination of three parameters: SIF, Normalized Differential Vegetation Index (NDVI) and light intensity. It is shown that ETR increased with light intensity in C3 crop, and assumed a linear relationship between the photosynthetic activity and light intensity, with a correlation of R2 = 0.99 to a portable fluorometer. Moreover, RS-ETRi correlated with other traditional vegetation indices of crop structure and stress. In the following step a formulation was devised of how each part of the photochemical mechanism and light energy utilization processes are manifested within this index. Given that the index is constructed from spectral bands that can also be measured from earth observatory system, it will be interesting to see how a scaling down of this index in spatial resolution to a continent level will contribute to our understanding on trends of global warming and climate change.

[129] How Can Advances in Controlled-Environment Agriculture (CEA) Technologies Revolutionize the Modern Farming Sector?

Dr. Oded Shoseyov
The Future of Agriculture, Israel
Session: The Future of Agriculture - Revolutionize Agricultural Practice: A Technological Revolution in Farming Led by Advances in CEA Technologies

A Look Ahead: Agriculture in 2050: What will agriculture look like at the century's midpoint? As global challenges such as population growth, urbanization, and climate change exacerbate food insecurity, the agricultural sector will have to evolve to meet the demands of the upcoming decades. The session will explore agricultural technologies within the controlled-environment agriculture (CEA) framework and discuss emerging trends, advantages, disadvantages, and market adoption. And will seek to answer the question: what role does the indoor farming sector play within the global farming revolution?

[130] Functional Biogeography of Spinescence in the Flora of Israel

Dr. Ofir Katz
Dead Sea and Arava Science Center, Israel
Session: Desert Plant Ecology: Lessons for a Warming Planet

Organismal traits are strongly linked with species distribution. Nevertheless, research tends to focus on explaining distribution variations by traits, but not as much on using distribution to decipher trait functions. This can be of particular importance for multi-functional traits. We demonstrate this potential for spinescence in the flora of Israel, as a trait associated with antiherbivory defence, aridity alleviation and seed dispersal. Our analysis yielded several patterns and trends in the geographic distribution of various spinescence variables (total spinescence in the flora, spinescence by life form and plant part), which can be associated to different degrees with each of the three functions. These patterns can always be most strongly explained by an antiherbivory function, but there are strong indications for spines having an aridity-alleviating function in deserts and indications for spines having a function in seed dispersal, most likely outside deserts. This study is an example of the power and potential of functional biogeography for understanding organismal trait functions and how these traits can vary with climate and shift in response to climate change.

[131]Selectivity of Mineral Acquisition in the Cistanche Tubulosa-Atriplex Halimus Plant Holoparasite-Host System

Dr. Ofir Katz
Dead Sea and Arava Science Center, Israel
Session: Plant Adjustment to Biotic and Abiotic Stresses in Changing Environments

Parasitic plants sequester various resources from their hosts, but the selectivity of this resource sequestration and its impacts on host plant's chemistry are not fully understood. I studied the elemental composition of theholoparasitic plant Cistanche tubulosa and its host, the salt-accumulating Atriplex halimus in the southern Judean Desert as a case study. Essential elements, phosphorus and potassium, are taken up actively by C. tubulosa, probably owing to their particular importance for the parasite (including maintaining a strong transpiration gradient). Results for the essential calcium are less conclusive. Elements that are beneficial but not essential, silicon and zinc, are taken up passively. C. tubulosa excludes chlorine, which binds with sodium in the host A. halimus. It might be that A. halimus plays a role in reducing salinity (sodium) stress for C. tubulosa that infect it, a supposition supported by C. tubulosa preferring salt-accumulating hosts. Sulphur and strontium contents in host A. halimus plants are probably higher than in non-host plants, suggesting a defensive role for these elements. In reference to strontium, this is a first indication for its possible role in plants and a potential mechanism to improve phytoremediation of strontium-polluted soils.

[132]Utilizing Hyperspectral Transmittance Spectroscopy to Quantify and Classify Cultures of Microalgae Strains from Different Genera

Ms. Olubunmi Adejimi
The Hebrew University of Jerusalem, Israel
Session: Algae-Based Solutions for Food Crisis Challenges

In the mass production systems of microalgal species, it is important to ensure the safety and quality of the biomass and product. This requires effective monitoring tools that are sensitive, rapid and simple to use. In this study, hyperspectral transmittance spectroscopy (HTS) was applied for the detection, cell density quantification and classification of algal and cyanobacterial species. A database of HTS data was assembled from samples of seven algal and cyanobacterial species at different cell densities and used for quantifying and classifying the species, using chemometric and machine learning algorithms. The results obtained showed the ability to quantify the species with a detection limit of 104 cells/mL for the Support Vector Machine (SVM) models applied and classify the species at concentrations >105 cells/mL. The current study suggests that HTS is applicable for the quantification of cell density and the classification of species of cyanobacteria and algal cell cultures and may prove an effective tool for the effective monitoring and management of microalgal bioreactors.

[133]Understanding How Plant-Microbiome Cooperation Evolved(s)

Dr. Omri Finkel
The Hebrew University of Jerusalem, Israel
Session: Belowground Interactions in a Changing Environment

How plants evolved to shape their microbiota is a long-standing question in ecology and evolution. The microbiome forms a crucial part of how plants adapt to changing environments and that this microbiota optimization should be manifested in a strong genomic and phenotypic signature of adaptation. To study plant adaptation to cooperation with their microbiota, we must develop methods to carefully manipulate the soil microbiota which serves as the primary source of microbes for the plant. To understand how interactions within the microbiome affect plant health, we have been designing and constructing plant-microbe microcosms encompassing synthetic communities composed of hundreds of microbial isolates. By editing these communities, we are able to identify keystone elements in the community with strong effects on plant health. One such example is the genus Variovorax, which we showed is necessary and sufficient to maintain root growth. Using Arabidopsis, and then Sorghum as model plants, we show that the presence of Variovorax is crucial for plant growth, particularly under drought.

[134]Droughts' Instantaneous and Lasting Effects on Grapevines' Water Use

Dr. Or Sperling
Volcani Institute, Agricultural Research Organization, Israel
Session: Viticulture in a Changing Climate: Vineyard-Environment Interactions

Water deficit causes stomatal closure and reduces grapevines' water uptake. Yet, the actual transpiration limitations during vines dehydration and rehydration are unclear. Thus, we set to explore droughts' effects on whole-plant water uptake during water deficits and recovery. We hypothesized that discrete droughts hinder plants' transpiration through long-term limitations to canopy development and stomatal conductance (g_s).

We constructed large (2 m^3) lysimeters to measure how three short (six days) droughts affected vines' seasonal transpiration. Then, we calculated the vines' stress coefficient (K_S) and compared it with the vines' stem water potential and g_s.

Repeated droughts reduced vines' cumulative evapotranspiration by 848 L $vine^{-1}$ (11% of the seasonal uptake). Approximately half of the transpiration losses were directly attributed to water deficits, while the other half were driven by stomatal limitations during the first days of rehydration, and to permanent restrictions to the vines' leaf area. K_S was reliably predicted from SWP, but the relation largely depended on phenology.

The findings highlight the drought's limitation on water uptake could be much larger than its instantaneous effect.

[135] Agri-Voltaic, Policy and Regulation Conflicts

Ms. Orly Aharoni, Adv. LLM
Legal policy advisor, Climate regulation professional, Israel
Session: Agrivoltaics – How Can It Be Implemented in a Desert Environment?

Meeting the challenges of food and energy security in a world facing climate change, will require the use of a significant share of land. In many parts of the world including Israel, which is densely populated, land is a scarce resource. The rising temperatures, more frequent droughts, and lose of arable land for agriculture puts in doubt the future of local agriculture and food security. APV dual use, if implemented in the right balance, could be an efficient solution.

However, the present regulation of agricultural land in Israel, is based on the paradigm that the land could only be used for agriculture, with very minor exceptions of commercial, and semi-commercial use. The historic background leads to the establishment of the state of Israel, the ideal of working and connecting with the land. Years passed, and agriculture has changed in many aspects, yet the regulation is still based on the same principles.

In order to have affective Dual use, meet the targets of reducing emissions and deal with our food security challenge, we must re- imagine the regulation needed. There is an urgent need to draw inclusive policies that regulate the use of land taking in account social and distributional justice, while addressing both food and energy security.

[136]Bedouin Women: How Do Their Coping Resources Relate to Their Coping Strategies?

Prof. Orna Braun-Lewensohn
Ben-Gurion University of the Negev, Israel
Session: Challenges and Opportunities as Stimulus for Transformation for the Bedouin-Arab Society in the Negev, Israel

Bedouin society has undergone rapid changes over the past decade. The younger generation of Bedouin women is better educated, which has enabled them to enter different professions, increased their incomes and elevated their social status. We examined the sense of coherence (SOC) and its components of meaningfulness, manageability and comprehensibility as well as the use of coping strategies among Bedouin women from three age groups. We also investigated the coping resources and strategies before determining the relationships between these variables in the three groups. One hundred ninety-six women participated in the study. Differences were found mostly between the oldest age group (61 years and older) and the two younger groups (21–40 and 41–60 years old). The oldest women reported less meaningfulness and used less positive reframing, planning, humor and acceptance. In terms of coping strategies, venting was used more by the youngest group whereas behavioral disengagement was used more by the oldest group. In the younger groups, SOC and its components were positively correlated with the use of coping strategies that are considered to be adaptive and with emotional support. However, the correlations between these factors were negative among the oldest group, which points to non-adaptive coping strategies used by these women. These results are discussed in light of the salutogenic, stress-appraisal and coping theories.

[137]Raman Spectroscopy, in Combination with Machine Learning Algorithms, for Monitoring the Quality and Safety of Algal Biomass

Dr. Orr Shapiro
Volcani Institute, Agricultural Research Organization, Israel
Session: Algae-Based Solutions for Food Crisis Challenges

Micro-algae are well-established food sources, used as food-supplements, protein-rich supplements of food and drink products, or as an environmentally-friendly animal feed. Beyond their use as food or feed, micro-algae are likely to become a key factor in increasing the sustainability of developing cultivated meat industries. However, there is an inherent conflict between economic and quality/safety considerations in algal cultivation systems. While quality and safety issues can best be regulated by cultivation in closed, strictly regulated systems, cost-effective production typically relies on cultivation in open or semi-open ponds or raceways. These systems are prone to contamination by competing species such as the toxigenic cyanobacterial species Mycrocystis aeruginosa. Detection of contamination events relies primarily on microscopic examination, with an effective detection limit of ~106 contaminating cells/ml. As a result, many commercial micro-algal products contain contaminating photosynthetic micro-organisms, some of which may be hazardous to consumers. Here we test the ability of a Low Resolution Raman Spectroscopy system (LRRS), combined with machine-learning algorithms, to quantify microalgal cultures and differentiate between several algal and cyanobacterial species. We further test the ability of this system to detect and quantify contaminating species on the background of a dense culture of spirulina (Arthrospira platensis). Our findings indicate a potential for similar systems for real-time monitoring of micro-algal bioreactors, allowing early detection of contamination events to improve product quality and safety and minimize losses due to process downtime and loss of product.

[138]Hydrothermal Carbonization of Waste Activated Sludge: A New Technology to Recover Nutrients and Address Food Insecurity

Mr. Osama Khoury
Volcani Institute, Agricultural Research Organization, Israel
Session: Resource Oriented Sanitation in Drylands

The growth in world population is a driving force for nutrient recovery from wastewater. In the developed countries, most of the humans' waste is treated in wastewater treatment plants (WWTP) and most of the nutrients are settled down in the waste activated sludge (WAS). That provides a renewable source of macronutrients (N, P, K) and micronutrients (Fe ,Mn ,Zn ,Mg), an essential input in intensive agriculture. Here, we examined the efficiency of the HTC technology, a thermochemical process that takes place in subcritical water at moderate temperatures (180–375°C) and high pressures (2–22 Mpa), to convert organic feedstock into a carbonaceous product called hydrochar . WAS from a municipal WWTP was treated under several hydrothermal conditions of time (30–120 min) and temperatures (200–300 °C). Mass balances for phosphorus, magnesium, calcium, copper and zinc showed high recovery values of above 80%, while those for iron and manganese were higher or equal to 94%. The recovery values of nitrogen, potassium and sodium were less than 50%, which can be related to their high solubility in the liquid phase of the HTC reaction. To conclude, this study demonstrates the potential of HTC to treat WAS and recover vital plant nutrients. Implementation of this technology in WWTPs may provide a solution to the increasing volumes of WAS and a new renewable source of vital nutrients that is required to address future challenges of food insecurity.

[139]Protists Modulate Enteric Bacterial Communities in Treated Wastewater Irrigated Soils

Prof. Osnat Gillor
Ben Gurion University of the Negev, Israel
Session: Belowground Interactions in a Changing Environment

Water scarcity is an ever-growing, global problem especially in arid and semi-arid regions. Treated wastewater (TWW) irrigation is an effective alternative source that could alleviate the demand for potable water especially for agriculture. But TWW irrigation could contaminate irrigated soils and crops with emerging contaminants and enteric pathogens that may carry antibiotic resistance. Most studies on the effects of TWW irrigation have focused on possible contamination and the edaphic changes that shape the bacterial response. Yet, we know little about the role micropredators play in modulating the irrigated soil microbiome or the dissemination of pathogens and contaminants. In this framework, we investigated temporal and spatial succession of bacterial assemblages and pathogen survival in response to potential predator-prey interactions with native protists across soil types and agricultural practices. We hypothesised that the role of micropredators changed with irrigation water quality, soil and crop types, cultivation time and agricultural practices. To test our hypothesis we evaluated the fate of enteric pathogens in irrigation water, soils and crops samples collected in controlled and field environments. Concomitantly, we monitored the abundance, diversity, function and interactions of the soil microbiome in the water and irrigated soils. In controlled environments, enteric pathogens introduced by irrigation quickly disappeared from the soil. This decrease has ceased once protists were inhibited by antibiotics, suggesting that the introduced bacteria were predated by phagocytic protists. This assumption was verified by analysing the protists communities in the soil samples showing an increase in the relative abundance of members of the *Aveolata*. In the field samples, the bacterial communities significantly differed between TWW irrigated soil types independent of the quality of the irrigation water. Yet, the protist community was shaped by the water quality with members of the *Aveolata* and *Cercocozoa* taxa activated in the presence of the enteric bacteria contained in the TWW. These findings were further supported by network analyses, which indicated the intensity of bacteria-protist interactions upon irrigation with TWW. Our results reveal, for the first time, the non-negligible effects of TWW irrigation on the assembly soil protists communities across soil types and agricultural practices. The biological mechanisms underlying these effects can be well understood within a predator-prey relationship framework in which protists exert strong top-down control on introduced pathogens.

[140]New Chiral Membranes for Separation of Enantiomers from Water

Prof. Pavel Izak
Czech Academy of Sciences, Czech Republic
Session: Functionalized Antifouling Surfaces in Membrane Based Water Treatment

Preparation of enantiomerically pure compounds remains a challenging task, despite the great progress in asymmetric syntheses and separation techniques. Each enantiomer exhibits identical chemical and physical behaviour in achiral surroundings as its counterpart, but their biochemical and pharmacological properties in the chiral environment of living organisms can differ significantly. Thus, the pressing need for innovative and highly efficient separation technologies allowing for large scale production of enantiomerically pure pharmaceuticals. Technologies based on membrane separations have the potential to play a key role to fulfil these needs.

We present a new chiral home-made membranes based on the modified cyclodextrin in Nafion117® [1], a series of unique composite membranes formed from a nano & micro fibrous material with different amounts of achiral selector [2], and optically active linear polyimides and hyperbranched poly(amic acid – imide) [3], which were used for separation of chiral drugs from water.

We were testing these membranes during preferential sorption and pertraction experiments in a diffusion cell. We report that L – Tryptophan is preferentially bound to the membrane, while D-Tryptophan is transported through the membrane with enantiomeric excess exceeding 80 %, depending on the analyte concentration. To increase the permeation rate and amount of chiral selector attached to the membrane, thinner membrane substrate with higher degree of swelling is proposed. All membranes are compared and new perspectives in this challenging research are shown.

[141]Climate-Smart Agriculture, Carbon and Soil Health

Dr. Rafiq Islam
Ohio State University, USA
Session: Sustainable Agriculture & Climate Change

Current high-input conventional farming produces greater amounts of food, feed, and fiber, but effects of these farming practices, together with climate change, are adversely affecting soil health with increased agroecosystem disservices. Agricultural productivity needs to double to support global food security by 2050, which will make existing farmlands increasingly dependent on reactive agrochemicals, freshwater, and energy inputs. Such intensification of farming will have consequences on agroecosystems that are expected to be detrimental. The importance of soil health and increased agroecosystem services, highlighting challenges and opportunities being faced with sustainable practices and technologies that are associated with soil carbon farming for climate change solutions. Such an adoption of agriculture with environmentally compatible soil and water management practices (no-till, crop rotation, multifunctional cover crops, precision chemigation, soil amendments, and chemical inducing) is expected to maintain, rejuvenate, and/or improve soil health, increase drought and salt tolerance of crops, support higher nutrient and water-use efficiency, economic crop productivity, and enhance agroecosystem services. We envision that climate-smart agriculture will address the challenges and opportunities to emphasize the connection among carbon farming approaches, soil health, and climate change solutions.

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[142]Pinus Brutia, Pinus Halepensis and their Hybrids: Physiological and Morphological Traits to Survive Semi-Arid Forests

Dr. Rakefet David-Schwartz
Volcani Institute, Agricultural Research Organization, Israel
Session: Research-based Dryland Afforestation and Landscape Restoration

The planted forest in Israel is dominated by the native Pinus halepensis. Since the 1970's, KKL-JNF has introduced the exotic Pinus brutia for afforestation because of its tolerance to the Israeli pine bast scale Matsucoccus josephi. When *P. brutia* and *P. halepensis* overlap geographically, natural hybridization occurs. These hybrids exhibit vigorous growth especially in semi-arid forests. We analyzed growth performance and physiological response to drought stress in *P. brutia*, *P. halepensis*, and their vigorous hybrids. We used rooted cuttings propagated from mature trees and utilized a high-throughput gravimetric system to measure their response to drought. A higher root-to-shoot ratio, needle length and leaf mass per area (LMA) appeared in the hybrids compared to the two parental species. *P. halepensis* demonstrated higher transpiration rates (E) and stomatal conductance (gsc) than *P. brutia* and showed an earlier reduction in E and gsc in response to drought stress. Similar to the water-saver *P. brutia*, the hybrids showed low E and gsc, and similarly to *P. halepensis* they demonstrated an early stomatal closure in response to drought. Our study suggests that the hybrids; exhibit a unique combination of traits that may contribute to forest resilience in semi-arid regions undergoing climate change.

[143]Hydrothermal Decomposition of Plastic – A New Technology to Fight the Long-Term Effects of Agricultural Plastic Usage

Mr. Ran Darzi
Technion - Israel Institute of Technology, Israel
Session: Sustainable Agriculture & Climate Change

Plastic usage in agriculture was recently estimated as 3.5% of global plastic production. Plastics in modern agriculture serve numerous purposes, making it essential for food security. Agricultural plastic waste poses difficulties to recycling processes with the current technologies. It often contains mixed-polymers products, UV-degraded, and with high content of contaminations (soil, organics, chemicals). Thus, agricultural plastic waste is mostly landfilled, and often leaks untreated into the environment. Our research suggests a new platform for plastic waste valorization using a hydrothermal process. The technology is based on decomposition of polymers in a water medium at high temperature (300–400°C), under sufficient pressure (higher than the vapor pressure). This research aims to 1) understand the decomposition mechanisms of various polymers and their mixtures; 2) characterize the resulted end-products; and 3) evaluate the advantages of this technology over commonly used recycling practices for agricultural plastic waste. Selected polymers of different types (LDPE, PET, PA6) were hydrothermally treated. Comprehensive chemical analyses were made for all phases (solid, liquid, and gas). PET and PA6 polymers were converted mainly into valuable monomeric compounds, from which a new pristine plastic can be produced. LDPE decomposition was limited, but its presence did not inhibit the decomposition of other feedstock during co-processing. Our results indicate the potential of the hydrothermal technology to achieve closed-loop recycling of plastic waste and promote complex waste co-processing. Consequential study of decomposition mechanisms and process efficiency is required to improve waste treatment alternatives and move towards a circular economy for more sustainable agriculture.

[144] Intrinsic Limitations of Nanofiltration Membranes to Achieve Precise Separations

Dr. Razi Epsztein
Technion - Israel Institute of Technology, Israel
Session: Functionalized Antifouling Surfaces in Membrane Based Water Treatment

Since their first introduction in the late 1980s, nanofiltration (NF) membranes, a “looser” version of reverse osmosis membranes, have been proposed for applications involving the selective removal of specific solutes from water, such as water softening, sulfate removal, and concentration of organics in certain industries. More recently, increasing demands for fit-for-purpose water treatment and recovery of valuable elements from water have accelerated the race for the design of highly selective NF membranes for more challenging separations such as lithium and nutrient recovery and selective removal of contaminants from different waters. In this presentation, we aim to challenge (but not disprove) the prevalent notion that NF membranes are suitable for precise separations. We first provide and analyze selectivity data from the literature, highlighting the limited capability of state-of-the-art NF membranes to achieve high selectivity between species. Next, we introduce the principles for ultrahigh selectivity in biological systems and demonstrate how these principles also govern the (limited) selectivity observed in current NF membranes. We then discuss two major intrinsic limitations to achieve precise separation in NF systems; namely, the need for a solute-specific membrane that can transport simultaneously additional species (i.e., water and the complementary salt ion) and the detrimental effect of concentration polarization. We conclude with guidelines and principles to overcome these limitations.

[145]Metabolic and Transcriptomic Response to Water Deficit in Two Grapevine Interspecific Hybrids

Ms. Rebeka Strah
National Institute of Biology, Slovenia
Session: Viticulture in a Changing Climate: Vineyard-Environment Interactions

Climate change is threatening the sustainability of viticulture around the world due to the recurrent drought events during the summer. Grape production is highly dependent on agroclimatic factors, water availability being one of the most important. The changing environment can also influence the incidence of plant diseases by promoting fungal infection. In this context, two new fungus-resistant grapevine genotypes, Cabernet Volos and Fleurtai were investigated, with emphasis on their response to water stress. The grapevine response to water stress was studied on the transcriptomic and metabolomic level by combining the analysis of high-throughput RNA-Seq and metabolite accumulation data with the data of plants' stem water potential. The expression of approximately 800 genes and nine metabolites was found to be changed due to the decreased water potential in at least one of the studied cultivars by the newly developed FadSeqSes script. Besides a large group of the genes showed an important role in the response to water stress in both cultivars, smaller groups of genes with different expressions in Cabernet Volos and Fleurtai were identified. Moreover, correlation was found between the stress-responsive metabolites and their biosynthetic genes.

[146]Cross Border Environmental Cooperation in Desert Communities: The Case of Jordan and Israel

Dr. Rina Kedem and Dr. Suleiman Halasah
The Hebrew University of Jerusalem, Israel, and University of Oxford, England
Session: Cross Border Desert Research- Science and Collaboration

Environmental cooperation became essential and dominant in global environmental governance strategies since the second half of the 20th century. The effectiveness and implementation of international environmental regimes has been vastly researched. Yet there is very little or no specific reference to the environmental regime between countries in post-conflict relations. The southern border communities in Israel and Jordan are under constant threats of desertification and climate change. Environmental and scientific cooperation efforts have been practiced since the signing of the Peace Treaty in 1994. International agencies, universities, and local NGO's have been involved in such cooperation which produced rich experiences and conceptual frameworks. Suleiman and Rina have been developing such environmental cooperation projects in the southern Jordanian and Israeli Arava. This session will present the local and political contexts of their work, the type of projects they lead, the unique methodology they use, and the impacts of this work.

[147]Cereals Productivity in Drylands; What Dose Genetic Studies from Crop and Agro-systems Level Can Tell

Dr. Roi Ben-David
Volcani Institute, Agricultural Research Organization, Israel
Session: Sustainable Agriculture & Climate Change

Water deficit and heat stress are the major abiotic factors limiting cereal production worldwide. This productivity is finally defined by yield per area of land either as biomass for animal feed or grains for both humans and animal consumption. In dryland agro-systems, terminal drought and heat dictating shortening of crop growth season. Hence, under climate change predicted scenarios this productivity challenge becomes radical. An integrated breeding and agronomy research might provide a solution that will stabilize cereal productivity under dryland both at crop and agro-systems levels. Here we present two case studies from our recent field work which might illustrate some benefits of such an integrated research approach: (1) at crop level we investigate structural biomass investment in bread wheat and its association with grain size and yield under terminal drought and heat stress. We show that selecting for highly adapted wheat genotypes with stem water-soluble carbohydrates demonstrates a useful strategy to offset the grain weight and grain yield reduction under water deficit and high temperatures. (2) at agro-system level we perform comparative study of biomass productivity under arid environments. The comparison includes two small grain crops, wheat and barley each represented by modern verities and traditional tall landraces. Here we show barley superiority in biomass production under water deficit compared to wheat. We also show that tall landraces are more productive then their commercial semi-dwarf counterparts under severe drought. We will provide evidence to how varietal and crop selection might improve agro-system productivity and sustainability in dryland.

[148] Global Warming, Climate Change, and Environmental Pollution: Recipe for a Multifactorial Stress Combination Disaster

Prof. Ron Mittler
University of Missouri, USA
Session: Plant Adjustment to Biotic and Abiotic Stresses in Changing Environments

Global warming, climate change, and environmental pollution present plants with unique combinations of different abiotic and biotic stresses. Although much is known about how plants acclimate to each of these individual stressors, little is known about how they respond to a combination of many of these stress factors occurring together, namely a multifactorial stress combination. Recent studies revealed that increasing the number and complexity of different co-occurring stress factors causes a severe decline in plant growth and survival, as well as in the microbiome biodiversity that plants depend upon. This 'multifactorial stress combination effect' should serve as a dire warning to our society and prompt us to decisively act to reduce pollutants, fight global warming, and augment the tolerance of crops to multiple stress combinations. Newly discovered acclimation strategies for stress combination and different approaches to augment the resilience of crop plants to multifactorial stress combination will be discussed.

[149]Controlled-Environment Agriculture (CEA) as a solution to Food Security

Mr. Ronen Redel
Vertical Fields, Israel
Session: The Future of Agriculture - Revolutionize Agricultural Practice: A Technological Revolution in Farming Led by Advances in CEA Technologies

As the climate crisis, covid pandemic, urbanization, and rapid population growth threaten food security, the agricultural sector must seek out innovative and reliable methods to feed a precarious future.

Ronen Redel's lecture will explore the vertical farming industry as a solution to food insecurity. His talk will discuss current vertical farming technologies, the advantages and disadvantages of the industry, the market landscape, and future trends. Furthermore, he will discuss Vertical Field's unique technology and business model as a case study.

[150] Creating Drinking Water from Air: Watergen's Patented Technology Creates High Quality Drinking Water out of Air for People Everywhere

Mr. Roni Litinevsky
Watergen Ltd., Israel
Session: Water Harvesting: The Interface between Research and Industry

Watergen is the pioneering Israeli company that has become the global leader in the atmospheric drinking water devices (AWG) market, machines that create drinking water from the air. The company's solutions are the most effective and economical way to solve the pressing issue of drinking water scarcity in any location and at any time, and also enable the elimination of carbon-intensive supply chains and environmentally-harmful plastic waste.

In the presentation we will review:

- The global problem
- A new source of drinking water
- What makes Watergen stand out
- Cutting edge technology
- Global recognition and awards
- Watergen's portfolio and solutions
- Case studies from around the globe

[151]Low Energy Insulating Building Materials Based on Hemp Bio-Aggregate

Mr. Rotem Haik
Ben Gurion University of the Negev, Israel
Session: Energy and Sustainability: Materials

Buildings are responsible for approximately 40% of the global energy consumption and CO_2 emissions. These values include the operational energy (OE) and operational carbon (OC) required for heating, cooling, etc., but they are even greater if the embodied energy (EE) and embodied carbon (EC) are also included, i.e., the energy and CO_2 emissions involved in the production process. One innovative development of sustainable building materials that was proven to be energy efficient and environment friendly is Lime-Hemp Concrete (LHC) which is based on hemp bio-aggregate and lime. However, lime, like other fired materials, has relatively high EE and EC values. Few works show the high potential of clay (unfired) as an alternative binder for LHC.

The current research studied the influence of replacing the lime in LHC with alternative unfired binders in several contents. Five alternative binders with low EE and EC values were examined (based on clay, limestone, dolomite, and basalt), including waste by-products of aggregate quarries, these last ones presenting additional environmental benefits. The thermal conductivity and heat capacity (thermal mass) were investigated, aiming to obtain a good balance between thermal insulation and heat capacity, in order to improve the thermal behavior of the building and reduce its OE and OC. The thermal, physical, chemical and mechanical properties were also examined. The four mixtures that presented the most attractive results were selected for the next stage which examined the thermal behavior of test cells composed from those mixtures and compared it to conventional building materials. Based on the results of the test cells, the OE and OC were calculated by EnergyPlus simulation. Eventually, Life Cycle Analysis (LCA) was conducted in order to assess the energy and CO_2 savings ensuant to replacing the lime in LHC with alternative binders at several contents, compared to conventional building materials.

[152]Brush Coated RO Membranes for High Recovery Brackish Water Desalination

Dr. Roy Bernstein
Ben Gurion University of the Negev, Israel
Session: Functionalized Antifouling Surfaces in Membrane Based Water Treatment

Desalination is the most common technology for producing potable water from brackish water and seawater. However, mineral scaling – precipitation of sparingly soluble salt on the membrane surface - limits the recovery ratio during desalination. This is extremely important in inland desalination, where the concentrate cannot be discharged back to the sea. Specifically, as there is no antiscalant against Si scaling, Si scaling presents an additional challenge in brackish water containing high Si concentrations. We present a modification process to achieve polyzwitterion pseudo bottle brushes on reverse osmosis (RO) membranes to mitigate mineral scaling propensity.

First, the membrane surface was finalized with poly2-hydroxyethyl methacrylate (polyHEMA) as an active site for grafting the brush. Then, atom transfer radical polymerization (ATRP) initiators were incorporated into the poly(HEMA). Finally, the low-fouling polyzwitterion poly(sulfobetaine methacrylate) was grafted by ATRP as polymer brushes at three different thicknesses. The successful grafting and the differences in brush yield at different reaction times were verified by surface characterization methods. Atomic force microscopy and contact angle measurements revealed that the surface roughness, surface stiffness, and hydrophilicity greatly decreased with prolonged reaction time. A higher grafting yield resulted in lower permeability but a higher salt selectivity. Desalination experiments with synthetic gypsum and silica scaling solutions mimicking 80% recovery of brackish water demonstrated that the scaling of the modified membranes was significantly reduced compared to the pristine RO membrane and that the anti-scaling tendency correlated with brush thickness. The highest-yield modified membrane was further studied for filtration of semisynthetic brackish water, mimicking 90% recovery. While severe scaling appeared on the pristine RO membrane, the modified membrane showed an excellent anti-scaling performance.

Overall, this work provides a convenient approach for preparing bottle brush-like grafts on RO membrane surfaces and expands on the implications of brush-decorated TFC surfaces for mineral scaling.

[153]Subcritical Water – A Green Solvent for Resource Recovery and Circular Economy

Dr. Roy Posmanik
Volcani Institute, Agricultural Research Organization, Israel
Session: Resource Oriented Sanitation in Drylands

Global population growth creates a severe pressure on wastewater treatment plants, and specifically on sludge management. Meanwhile, the global challenge of achieving food-security requires smart recycling of energy, water and agro-chemicals. The hydrothermal technology, using subcritical water as the conversion media has been intensively studied for a wide range of waste feedstocks including sewage sludge. Most of the research in this area was motivated by energy recovery and therefore focused on the solid and oil phases. However, less attention has been given to the aqueous phase – the process water remained after the hydrothermal reaction. This talk will review several implementation opportunities of the aqueous phase by-product. Those include: (1) fast anaerobic digestion for heat and electricity use; (2) membrane distillation – using the internal heat storage; and (3) recovery of valuable agrochemicals with high potential of pre-emergent herbicidal activity. Those pathways suggest that subcritical water can be applied as a green solvent for the recovery of energy and valuable resources from sewage sludge and improve the circular economy in wastewater treatment plants.

[154]Impact of Drought on Microbial Decomposition and Nutrient Cycling in Aridland Soils

Prof. Sean M. Schaeffer
University of Tennessee, USA
Session: Soil-Plant-Atmosphere Continuum: Effect of Rewetting and Drought on Soil Gases Emissions

Dryland ecosystems cover much of the Earth's land surface and may have highly variable weather and climate, making them sensitive to climate changes that alter soil water. In ecosystems with Mediterranean climates, cycles of carbon (C) and nitrogen (N) may be particularly sensitive to shifts in rainfall; the rainy winters support plant growth and C-inputs into soils, but summers are dry and plant C inputs decrease as many plants senesce. Coincident shifts in microbial processes remain relatively under studied but maybe just as critical to biogeochemical cycling. Drought imposes both physiological and physical stress on microbes, and the mechanisms by which they respond to stress can affect C release and storage, and N availability and loss. Here, we will discuss microbial stress response and the implications for large scale changes in biogeochemistry in arid lands, particularly Mediterranean, and other agroecosystems. We find that the length of drought is proportional to the accumulation of organic C and inorganic N with relatively higher bioavailability that can be rapidly mobilized by microbes upon rewetting. Rewetting may also induce a commensurate release of carbon dioxide and nitrous oxide.

[155]Tree Hydraulic Limitations and the Relative Importance of Latent Energy Dissipation in Urban Environments

Dr. Shabtai Cohen
Dead Sea and Arava Science Center, Israel
Session: Plant Hydraulics in Response to Environmental Stress

Urban trees are important for improving human thermal comfort on hot days. It is convenient for analysis of tree cooling to differentiate between that resulting from shading and that from dissipation of energy as latent heat, i.e. evaporative cooling due to transpiration.

Trees' hydraulic systems are limited and in hot climates evaporative demand regularly exceeds the hydraulic capacity and/or the ability of the tree to draw water from the soil. Thus, we often find that mid-day transpiration, as measured with sap flow sensors, reaches a plateau because leaf conductance is reduced as leaf water potential exceeds a certain threshold. The height of the plateau may change with soil water availability or the relative distribution of leaves, stems and roots. But for a given tree the height of the plateau, or the average mid-day transpiration may be more-or-less constant for many days.

This constant value or plateau implies that the relationship between canopy resistance (R_s) and vapor pressure deficit (VPD) will be linear and we have shown that the slope of that relationship is proportional to hydraulic conductance of the tree and the mid-day stem water potential. These relationships will be reviewed.

In a current study on the potential of trees to cool urban climates we analyzed the shading vs. evaporative cooling potential of urban trees in semi-arid Beer Sheva, Israel and in temperate Munich, Germany. Tree transpiration measured with sap flow sensors was normalized to crown projection area in order to compare to other energy fluxes. Slopes of the relationship between R_s and VPD were much higher in summer in Beer Sheva than in Munich. However, for horticultural species in Israel, e.g. citrus, avocado, persimmon and nectarine, slopes were closer to those in Munich. Irrigation recommendations for trees in urban gardens are significantly lower than for horticultural orchards. This suggests that the urban trees that we measured were not well watered and that their water status was poorer than for horticultural trees. Another possibility is that their leaf area index was lower. Therefore water use was less than might be expected for horticultural trees or those measured in temperate Germany, where rainfall is plentiful.

Conversion of water use to latent energy equivalents shows that the urban trees in Israel dissipate less energy as latent heat than in Munich. Considering that the overall energy load is

greater in Beer Sheva, this means that the latent heat contribution to tree cooling is very low and of less significance than in Munich. Thus in Israel urban tree cooling is mainly from shading and not from latent heat dissipation.

[156]How to Correctly Use Static Chambers in Drip Irrigation

Dr. Shahar Baram
Volcani Institute, Agricultural Research Organization, Israel
Session: Soil-Plant-Atmosphere Continuum: Effect of Rewetting and Drought on Soil Gases Emissions

Static chambers are commonly used to provide in-situ quantification of nitrous oxide (N2O) fluxes. This research aimed to study the effects of static chamber bases on water and N distribution and the subsequent impact on N2O fluxes in drip irrigation. N2O emissions were measured in a drip-irrigated avocado orchard for two years, using bases with a dripper at their center (In) and bases installed adjacent to the dripper (Adjacent). During the irrigation/fertigation season, the measured N2OIn fluxes were 3.8±0.56 times greater than the fluxes from the chambers adjacent to the dripper (N2OAdjecent) (0.015 ± 0.003 vs. 0.006 ± 0.001 g m-2 d-1), and the cumulative N2O emission were 40% – 70% higher.

Three-dimensional simulations of water flow, nitrogen (N) transport and N transformations showed two opposing phenomena (a) increased water contents, N concentrations, and downward flushing when the dripper is placed inside the base, and (b) hampering of the lateral distribution of water and solutes into the most bio-active part of the soil inside the base when the base is placed adjacent to the dripper. It also showed that both "In" and "adjacent" practices underestimate the "true" cumulative flux from a dripper with no base by ~25% and ~50%, respectively.

A nomogram in a non-dimensional form corresponding to all soil textures, emitter spacings and discharge rates, was developed to determine the optimal diameter of an equivalent cylindrical base to be used along a single dripline.

[157]The Untapped Free N – What Can Be Done About It?

Dr. Shahar Baram
Volcani Institute, Agricultural Research Organization, Israel
Session: Sustainable Agriculture & Climate Change

Irrigated agriculture is at least twice as productive per unit of land as rainfed agriculture and provides about 40% of the total global food produced. Nitrogen (N) fertilizers are an essential part of any commercial agricultural production. Yet, over-application of N-fertilizers has led to surface and groundwater contamination (mainly as nitrate (NO3-)), increased nitrous oxide emissions, crop loss, and harm to natural habitat following reactive N deposition. Despite its detrimental impact, nitrate in irrigation water of any source (i.e., surface water, groundwater, treated wastewater (TWW)) may serve as a "free N source" for crop production and accounting for that N-source, may reduce the farmer's operational costs, reduce its carbon footprint and serve as a sustainable remediation solution for polluted water sources. To date, continuous, reliable data on the N concentrations in the irrigation water is scarce; hence farmers hardly account for that free N source. Recently, the N-Pool initiative was founded with the aim of providing free real-time data on the N concentrations in irrigation waters, starting with TWW. This will be achieved through collaboration between all relevant government bureaus in Israel and the integration of off-the-shelf N monitoring technologies solutions. Currently, we are working on establishing a pilot trial with TWW reservoirs in Israel.

[158]The Role of Qualitative Research Methods in Assessing Vulnerability and Preparedness Capacities to Extreme Weather Events: Lessons Learned from Cyclone Idai in Southern Malawi

Ms. Shahar Livne
Ben Gurion University of the Negev, Israel
Session: Health Systems Preparedness to Climate Change

Cyclone Idai severely hit Malawi in March 2019. The cyclone has joined other extreme weather events affecting the country, including floods and droughts. Despite this and the grim forecasts of the IPCC for the region, not much has been done to understand the impact of natural disasters on local populations and prepare for future challenges.

In collaboration with Partners in Health/Abwenzi Pa Za Umoyo, this study seeks to help fill this gap in knowledge regarding the barriers to reducing vulnerability and improving preparedness in a setting of extreme poverty and climatic changes. The goals of the study are to understand varying vulnerabilities between populations, emergency needs, and the actions required for better preparedness. Quantitative methods are widely used in climate change research, but these methods alone cannot explain the underlying causes and mechanisms of climate vulnerability and how to address it. In the study, conducted in October-November 2021, participant observations and in-depth interviews with 29 community members and 11 stakeholders were conducted in the Neno District.

The results of the study helped us better understand how the most vulnerable populations interact with their communities and formal authorities, and are assisted by them, in terms of disaster preparedness and disaster recovery.

With the use of qualitative methods, we were able to identify the shortcomings in the support networks and systems and provide recommendations. In order to improve preparedness capacity, investments must be made in official and unofficial community and governmental structures, emphasizing the strengthening of specific populations and their houses.

[159] Leveraging Data Standardization Tools for Better Collaboration and Agronomic Big Data Analysis

Dr. Shai Sela
Agmatix, Israel
Session: Leveraging Agro-Informatics and Big Data Applications to Improve Crop Production and Farmers' Livelihood

The quantity and scope of agronomic data available for researchers in both industry and academia is increasing rapidly. Data sources include a myriad of different streams, such as field experiments, sensors, climatic data, socioeconomic data or remote sensing. The lack of standards and workflows frequently leads agronomic data to be fragmented and siloed, hampering collaboration efforts within research labs, university departments, or research institutes. Researchers and businesses therefore allocate significant time resources into unifying these fragmented data layers into a coherent structure. Implementing data standardization schemes can enable efficient collaboration, and leveraging the collective power of the research community to address critical agronomic knowledge gaps. This presentation will provide an overview of available research data standardization tools and explain the underlying FAIR and other data management principles. Using Agmatix's Axiom platform as an example, we will demonstrate how data from multiple sources can be standardized and used for insightful modeling. We have used 3774 experimental data points from multiple sources in the United States – universities, commercial associations and farm-management systems - to construct a corn prediction model (R2 = 0.9. RMSE = 1.0 Mg/Ha). The standardization platform unifies all datasets to common headers and units, allowing to explore data distributions to ensure an adequate crop yield parameter space is covered. While demonstrated here on corn yield, many different agronomic research domains can benefit from standardization of data. We call on the agronomic research community to adopt standardization, boost collaboration efforts, and increase the potential for tackling the current global agronomic challenges.

[160]Long-Term Ecological Forest Management and Master Plan for Yatir Forest

Ms. Shani Gleitman
Keren Kayemeth LeIsrael-Jewish National Fund (KKL-JNF), Israel
Session: Practical Methods for Dryland Afforestation and Landscape Restoration

Yatir forest, located at the semi-arid transition zone, is the largest planted forest in Israel, having a significant part in Israel's afforestation tradition. This, in addition to its significant contribution to local and global research related to dryland afforestation, desertification & climate change.

Within the forest are located plenty of archeological sites attracting visitors around the year. Moreover, significant natural values existing in the forest include population of Mauntain Gazelles, various raptor species nesting in the forest or using it as a stopover site during migration, Large Sternbergia blooming patches, and rare plant species growing in heavy soil patches, mainly in narrow valleys in the forest and at the edges of agricultural plots.

In contrast to most of the coniferous forests located at the Mediterranean zone in Israel, natural regeneration processes of Pine trees, which could be used to maintain forest cover continuity, are absent in Yatir.

During the last two years we developed a long-term ecological forest management & master plan for Yatir forest. This was done as part of a large, ongoing strategic planning process for all the forests managed by KKL on a national scale, and in the context of climate change and its challenges for forest management

In addition to updating the forest management goals, the plan dealt with various management dilemmas such as the physiological status & viability of the forest, and the absent of natural tree regeneration.

The planning process and its products, which will be presents during the lecture, emphasize that sustainable forest planning principles, as defined in KKL's forest management policy, are relevant to forests planted at the semi-arid transition zone in Israel and allow KKL to continue managing the forest in a long-term perspective for the provision of a wide range of ecosystem services.

[161]Extracting Water from Air: The physics Behind

Ms. Sharon Dulberg
Watergen Ltd., Israel
Session: Water Harvesting: The Interface between Research and Industry

Global warming, together with the rapid human population growth, has led the world into increasing water scarcity where there is not enough water to meet all demands, including that needed for ecosystems to function effectively.

On one hand, the existence of fresh water decreases each year: Arid areas are slowly expanding in a process called desertification; existing water sources are being polluted due to industrial waste and fertilization material penetrating the drinking water.

On the other hand, the demand for fresh water increases due to the population growth.

The technology for fresh water extraction is developing rapidly these days, allowing humans to use the water sources available in the planet:

- Filtration- to use brackish water;
- Reverse osmosis (RO)- to use sea water;
- Atmospheric water generators (AWG) that use air moisture as a non-depleting water source

In this lecture, we'll overview the physics behind the AWG machines.

[162]Heat Stress Effects on Transcriptome of Bovine Mesenchymal Stem Cells

Dr. Sharon Schlesinger
The Hebrew University of Jerusalem, Israel
Session: Thermal Stress Regulation in Animals

Heat stress (HS) can have a serious impact on the health of both humans and animals. At the cellular level, HS elevates oxidative stress, decreases proliferation rate, and induces an earlier onset of cellular aging. However, little is known about the effects of HS on cells' transcriptome landscape. Here we use an in vitro experimental system to address how heat shock treatment influences the transcriptome of bovine mesenchymal stem cells (MSCs), the multipotent progenitor cells that are found in most tissues and can differentiate into many cell types, regulate immune responses and maintain physiological homeostasis. Because cattle are sensitive to harsh external temperatures, studying the effects of HS on MSCs provides a unique platform to address cellular stress in a physiologically relevant model organism. To this end, MSCs were extracted from the umbilical cord of a bovine fetus and cultured in the lab. After validation of the cells as MSCs, the cells were exposed to mild HS for different durations. At the end of the experiment, RNA sequencing and bioinformatic analysis were performed. Bioinformatics analysis indicates that heat stress influences many cell processes, namely immune response, differentiation, cell cycle, and cellular stress response, as well as altered the expression of chromatin modifiers, especially KMTases. Interestingly, once normothermia resumes, the transcriptional pattern tends to revert to the typical MSC transcriptome, with only a minimal number of genes differentially expressed. However, the phenotype of the cells is altered, with a longer population doubling time and higher sensitivity to heat shock. We hypothesize that the epigenetic changes induced by heat shock convey a long-lasting phenotypical change in the cells.

[163]Can We Estimate Pasture Quality Using Remote Sensing? An Assessment of Mediterranean and Semiarid Grasslands

Mr. Shay Adar
Tel Aviv University, Israel
Session: Remote Sensing for Dryland Agriculture

Man-managed pasturelands cover more than 30% of Earth's surface and are an essential ecological and economic resource. The dynamics of forage quality (protein and fiber content) as feed for livestock is complex since different plant functional types can determine forage quality via their different phenology, which depends on environmental and biotic conditions. Forage quality monitoring requires frequent and accurate measurement over extensive areas, which is not feasible by traditional field sampling. We studied the effects of the grazing regime on forage quality in semiarid and Mediterranean grasslands by developing a comprehensive pasture quality index (PQI) and monitoring quality via remote sensing tools. We hypothesized that nutritional quality would decrease throughout the growing season as plants mature, and that the plant functional composition would be affected by prolonged heavy grazing, consequently affecting quality. We utilized a multi-scale approach of frequent multispectral satellite imagery and fine-resolution drone imagery, combined with machine learning regression versus field sampling measurements, in two long-term ecological research sites in Israel. Overall, our results show that the plant functional community composition was affected by the grazing regime, with a high occurrence of unpalatable thistles, mainly under intensive grazing. The overall PQI showed higher values at the mid-growth (winter) compared to peak growth (spring). The highest values were observed under intermediate grazing in the semiarid site. The results allowed accurate, comprehensive, large-scale, and continuous monitoring of forage quality changes in the heterogeneous Mediterranean and homogeneous semiarid grasslands, gaining insight into sustainable livestock management under the changing climate conditions.

[164]Early Detection of Environmental Stresses and Leaf Diseases in Potato Plants with Whole-Plant Redox Imaging

Dr. Shilo Rosenwasser
The Hebrew University of Jerusalem, Israel
Session: Plant Adjustment to Biotic and Abiotic Stresses in Changing Environments

Environmental stresses are among the major factors that limit crop productivity and plant growth. Various non-destructive approaches for monitoring plant stress states have been developed. However, early sensing of the initial biochemical events during stress responses remains a significant challenge. In this work, we established whole-plant redox imaging using potato (*Solanum tuberosum*) plants expressing a chloroplast-targeted redox-sensitive green fluorescence protein 2 (roGFP2), which reports the glutathione redox potential (E_{GSH}). We mapped alterations in the chloroplast E_{GSH} under several stress conditions including high-light (HL), cold, and drought. An extremely high increase in chloroplast E_{GSH} was observed under the combination of HL and low temperatures, which specifically induce PSI photoinhibition. In addition, redox imaging was applied to detect the early signs of oomycete *Phytophthora Infestans* infection, causing late blight, a devastating potato disease that led to the Irish potato famine. Using spatially resolved patterns of roGFP2 oxidation state from infected plants, we demonstrated the capability to detect the early presymptomatic biotrophic stage of the diseases, prior to the appearance of irregular-shaped spots, the typical visual symptoms. The presented observations suggest that whole-plant redox imaging can serve as a powerful tool for the basic understanding of plant stress responses and applied agricultural research, such as improving phenotyping capabilities in breeding programs and early detection of stress responses in the field.

[165]Family Ties: Root Social Physiology within Solanaceae

Prof. Shimon Rachmilevitch
Ben Gurion University of the Negev, Israel
Session: Belowground Interactions in a Changing Environment

Root-root communication effects on social physiology among Solanaceae relatives were studied. We examined cherry (C) and field (F) tomato, and bell pepper (B), comprising three degrees of relatedness (DOR), i.e., high (H-DOR; CC, FF and BB), medium (M-DOR; CF) and low (L-DOR; CB and FB). Root respiration, growth, accompanied by the proliferation of fine roots and root length density increased with L-DOR plants, alongside, significant lower investment in total organic carbon and protein within root exudates was observed. Our findings indicate, for the first time, that Solanaceae relatives can recognize the degree of relatedness of their neighbors.

[166] The Reintroduction of the Asiatic Wild Ass in the Negev Desert: Forty Years Later

Dr. Shirli Bar-David
Ben-Gurion University of the Negev, Israel
Session: Restoration and Rehabilitation of Desert Ecosystems – Session 1

Conservation reintroductions are a frequently used management tool for the recovery of endangered species. However, many reintroductions fail to establish viable, self-sustaining populations. There are a multitude of factors that can impact the success of a reintroduction program. However, due to a general lack of detailed long-term data sets, little is known about how different reintroduction strategies affect the viability of a population and the long-term reintroduction success. We study the reintroduction of the Asiatic wild ass Equus hemionus in the Negev desert, Israel. This case study provides a long-term data set that enables us to examine the interactions between social, spatial and demographic processes that have a profound effect on species' genetic structure and its persistence. In this talk we will provide an overview of the research on the reintroduction of the Asiatic wild ass forty year after its onset.

[167]Evaporation and the Water Regime in Deep Vadose Zone Profiles with Underlying Aquifers under Hyper Arid Environments

Dr. Shmuel Assouline
Volcani Institute, Agricultural Research Organization, Israel
Session: Water, Energy, and CO_2 Budgets in Desert Environments

Arid and hyper-arid deserts are characterized by having deep groundwater and negligible recharge by precipitation. Populations in these areas heavily rely on groundwater, so any loss of groundwater by evaporation could be critically important for sustaining their water supply. Evaporation in these environments is also important at the global scale, as hyper-arid deserts represent 10% or more of the terrestrial landscape; therefore, the water balance in these areas, and especially the evaporation component, may play an important role in the global hydrologic cycle. Hence, it is important to improve our ability to quantify evaporation under dry conditions for understanding the local and global impacts of evaporation on the hydrologic cycle. The subsurface of these deserts is characterized with deep groundwater and negligible recharge, whereby water flows from the water table to the surface and evaporates to the atmosphere.

For modeling evaporation under such conditions, we consider steady-state water flow, with liquid-phase flow from the water table and vapor-phase flow towards the surface, separated into two distinct regions of liquid- and vapor-phase flow by an evaporative front that is located within the subsurface. The driving forces for evaporation are pressure head gradients for Darcian liquid flow, and thermal and relative humidity gradients for Fickian diffusive vapor flow. The model accounts for water table depth, atmospheric conditions, and the hydraulic properties of the media. We demonstrate how evaporation predictions are affected by soil type, groundwater depth and atmospheric conditions. The partitioning between liquid and vapor phase flows is presented for the different evaporation rates and conditions. The effect of the geothermal gradient is evaluated and the extent and intensity of water vapor condensation in the soil profile is estimated. Results show that evaporation rates are enhanced as groundwater levels are closer to the surface, and as atmospheric temperatures increase and/or relative humidity values decrease. Evaporation rates drop significantly when the water table deepens from 50 to 200 m, but are almost constant for groundwater levels below ~500 m. The impact of soil type and other related uncertainties are mostly important for water tables with depths shallower than ~300 m. The contribution of condensation to the water regime in the profile, to the recharge of the deep aquifers, and to the hydrologic cycle of such systems, appeared to be very small, practically negligible.

[168]Remote Sensing of Cover Crops: Using Cover Crops as Reflectors of the Spatial Variation in Soil Nutrient Availability

Mr. Simon Futerman
The Hebrew University of Jerusalem, Israel
Session: Sustainable Agriculture & Climate Change

Quantifying spatial variability of soil nutrients is of great importance as it has a direct effect on crop production and environmental pollution. Remote sensing (RS) is a promising tool to gather high spatial resolution information regarding nutrient availability. Cover crops (CC) are incorporated into the crop rotation in order to provide ecosystem services and are often sown in the winter, prior to sowing the cash crop, rather than leaving a bare soil. The benefits of sowing CC include, among others, reducing soil erosion; weed suppression; uptake of nutrients prone to leach, such as nitrate; and N2 fixation when using legumes. We propose a novel approach suggesting that the practice of mixtures of cover crops, together with RS, may reflect the spatial variation in soil nutrient availability. This concept was examined in a study in the Model Farm for Sustainable Agriculture in Neve Ya'ar, Northern Israel. The study had two main goals: (i) inspecting and measuring CC nutrient uptake and biomass based on visual symptoms of nutrient deficiencies, and (ii) using RS, with a UAV equipped with an RGB camera, to classify CC into groups of interest and use the information to generate high-resolution spatial nutrient uptake information aimed at guiding basal fertilizer applications for the following cash crop. In addition to the case study, we suggest, and will briefly present, approaches of using RS of CC to detect two major essential macronutrients: nitrogen (N) and phosphorus (P).

[169]Building Sufficiency and Resilient Comfort in a Desert Context

Prof. Sue Roaf
Heriot-Watt University, United Kingdom
Session: Energy & Sustainability: The Built Environment

The 2022 IPCC 6th Assessment Report: Impacts, Adaptation and Vulnerability presents a very stark picture of future climates, positing that we are already past 1.5^0C in terms of our global temperature increases over the long term averages. The IPCC 2022 3rd Report: *Climate Change 2022: Mitigation of Climate Change* presents an encyclopaedia of action options, with an assessment of their relative impacts. In Chapter 9 of this report a range of policy packages based on the SER (Sufficiency, Efficiency, Renewables) framework aim to give humanity a good chance of limiting GHG emission to levels that will not too seriously impact on the existing functions of the planet and its populations.

There is a concern in the text that 'Low Ambition' policies will lock buildings in carbon for decades as buildings last for decades if not centuries. They claim that building energy codes are the main regulatory instrument to reduce emissions from both new and existing buildings. However, to many, these regulations have done nothing to halt the onslaught of extremely poor climatic design of buildings, reflected in the fact that global emissions are rising annually despite these regulations, much of them from high end buildings in highly developed and heavily 'regulated' countries.

This paper looks at what needs to be done in buildings in desert regions with their already extreme temperatures through a lens of 'sufficiency'. How will people survive in evermore extreme heat that is also now almost universally associated with power outages? Where can we find, and mine, the coolth needed to survive with dignity in this changing world? We argue that the answer lies in better architecture, and possibly different machine, not more efficient Business as Usual models. The presentation will throw out a range of challenging ideas to be discussed over the course of the conference.

Not once in the IPCC 2022/3 Report is thermal comfort raised as a key issue in emission mitigation. We will share what we have found to date on what people already consider as acceptable indoor temperatures in hot regions, and suggest that the way forward, based on understandings raised in our recent book on Resilient Design, is through holistic, flexible and far-sighted design that takes into account people, their customary and cultural lifestyles, buildings, local renewable energy supplies and the climate.

[170]Life is Hard: Rekindling the Arabian Oryx (Oryx leucoryx) Reintroductions in Israel

Dr. Tal Polak
Israeli Nature and Park Authority, Israel
Session: Restoration and Rehabilitation of Desert Ecosystems – Session 1

The Israeli reintroduction program started in 1978 with the arrival of eight individuals of White oryx to Hai Bar Yotvata in the south Arava, Israel. The Hai Bar is a dedicated site created to rear breeding cores for reintroduction. The majority of the reintroduced population was released from 1997-2007 in seven soft-releases of 10-21 individuals. In these releases the animals were transferred from the breeding core to the habituation enclosure at the release area for a period of a few weeks or months and were provided food, water and protection from predators and hunting. After 2007, the soft-release program was discontinued mainly due to the high cost of providing 24/7 security on site.

In 2017, the Israeli Nature and Parks Authority (INPA) decided to conduct a pilot and test hard-release in the Arabian Oryx reintroduction program. In hard-release the animals are transferred from the breeding core directly to the release site and are set free immediately. The pilot had two main purposes, first was to test the survival rate of hard-released individuals and second was to connect the released individuals to wild herds. We selected young but sexually mature females and males for hard-release to allow them to connect with the herd but not to threaten the dominant female and male, increasing their acceptance to the herd. Each release consisted of three oryx released together at the same site, all were marked and two were fitted with Vectronic Aerospace Vertex Lite GPS collars.

To date 42 oryx were released in 15 hard release events in three locations known for high oryx presence in the hyper arid ecosystem in south of Israel: Zihor Wady, Paran Wady and Ashush stream, dry rivers replenished by annual floods. Due to large areas of unreachable habitat we were unable to track released individual hence survival rate was calculated only for collard individuals. Out of 31collard individuals 16 survived the first month of release making survival rate 52% (survival rate was not calculated for five collard oryx due to collar malfunctions). Eleven out of the 16 oryx with known survival connected with wild herds, one female created a herd with a lone male and produced a young.

Even with only 52% survival rate the hard-release method had proven to be fast, flexible and cost-efficient in reintroducing a large number of oryx individuals in multiple sites. This compared to soft-release which is more time and funds consuming and with a limited number of potential release sites. The collared individuals integrated into the local herds provide vital

information on the home range and roaming behavior of the Arabian oryx reintroduced population in Israel. This information is crucial for the establishment of the monitoring program for the Arabian Oryx in Israel.

[171]In Situ Soil Bioremediation to Counter Oil Spill in a Hyper-arid Nature Reserve

Dr. Tal Polak
Israeli Nature and Park Authority, Israel
Session: Restoration and Rehabilitation of Desert Ecosystems – Session 2

Evrona nature reserve is located in the Arava valley, at the southernmost part of Israel. Very low precipitation and high summer temperatures characterize this hyper-arid region. Local water regime depends solely on annual floods, which flow from surrounding mountains and accumulate within desert salt flats edged by Vachellia groves (Vachellia tortilis and V.raddiana).

On December 2014, five million liters of crude oil erupted from the Trans Israel pipeline. The oil flowed via the dry waterway into the braided river within Evrona nature reserve. The foremost impact was germination inhibition for Vachellia trees. Researchers found that without mitigation this would remain permanent. As Vachellia are keystone species in the hyper-arid ecosystem, damaging their recruitment will cause the degradation of the entire ecosystem.

Israeli Nature and Parks Authority decided to initiate in situ soil remediation towards reducing oil concentrations, to facilitate Vachellia recruitment. Bioremediation in a hyper-arid environment represent a challenge, as most methods require high soil moister. The selected method aimed to optimize bioremediation success while minimizing disturbance. Initial pilot results showed 77.6% reduction in oil concentration. Unfortunately, the full-scale treatment reduced oil concentration by only 46.4%, which is not sufficient to support Vachellia germination.

The failure of the bioremediation treatment demands additional actions in order to restore germination, which is crucial for retaining ecosystem integrity. As Evrona is the only known incident of crude oil pollution in a hyper-arid nature reserve, finding a successful restoration procedure is crucial for current and future incidences.

[172] Quantifying Spatial Soil Health Trends at the Catchment Scale

Prof. Tal Svoray
Ben Gurion University of the Negev, Israel
Session: Leveraging Agro-Informatics and Big Data Applications to Improve Crop Production and Farmers' Livelihood

This presentation discusses the formalization of spatial information on soil health, and its implications, for estimating the quality of the remaining soil in the wake of erosion processes or intensive cultivation period. Such an approach extends the notion of water erosion damage from computation of soil budgets, to comprehensive soil health assessment and the provision of ecosystem services. The research framework described here suggests computing spatial autocorrelation of soil properties, by various methods: Moran's I, Nugget: Sill ratio, and variogram envelope analysis and the comparison between the three methods. The spatial computations are demonstrated using geoinformatics procedures to show how GIS layers of the Harod catchment in Israel can be used as an input source for the stratified random approach to further allow to apply spatial interpolation techniques—such as Ordinary Kriging, Universal Kriging and Cokriging—as efficient tools for predicting spatial variation in soil health at the catchment scale. The limited ability to scale up soil health mapping from point measurements to large agricultural areas is a major gap in soil research and is also discussed in this presentation. In this regard, the prime contribution of the presentation, scientifically speaking, is the methodology offered for studying the effect of natural and anthropogenic disturbances on remaining soils in a spatially explicit fashion. From an applied standpoint, it provides farmers and professionals with a tool for estimating the state and dynamics of their field.

[173]Agrivoltaics: Harvesting the Sun Twice - Dual Use of Land for Solar Energy Production and Local Agriculture

Dr. Tali Zohar
Dead Sea and Arava Science Center, Israel
Session: Desert Plant Ecology: Lessons for a Warming Planet

Climate change in general, and in the Middle East in particular, is leading to a significant rise in temperatures, desertification, and an increase in extreme climatic events. The Arava region is particularly vulnerable considering the lengthening of the summer season by two months, followed by the shortening of the winter season. Water is a scarce resource, a result of a decrease in precipitation, evaporation, and increased consumption. These phenomena harm agricultural lands and crops, intensify competition for resources and increase energy demand (for desalination, cooling, and air conditioning).

Especially in an arid climate, the synergistic effects of Agrivoltaics systems are the most promising. It can be expressed in increased yield production because of the reduction of the negative effects of radiation, and in slow evaporation under the shade which may reduce water consumption and minimize financial losses due to increased irrigation during droughts.

In May 2021, an experimental Agrivoltaics facility was established in the southern Arava R&D, which examines the impact on the growth of field crops. During the past year, tomatoes, scallions, lettuce, corn, and wheat were planted in two plots - in the shade and full sun. Preliminary data found interesting differences in growth characteristics and yield between the plots. In the next phase of the research, we will examine whether the impact of the microclimate created under the shade reduces panels' temperature and increases the efficiency and electricity output.

The major goal of the study is to develop an off-grid system that provides a holistic solution to the water-energy-food nexus, which can be installed in areas without access to water and electricity, and to increase food security. The electricity generated from the solar panels aims to enable access to water (through desalination, purification, or water pumps) for drinking and agriculture, operate the irrigation system and a cooling room for post-harvest storage needs, and for any other local uses which require electricity. Such systems are relevant to communities without access to infrastructures in Africa, the Bedouin tribes in the Negev, Gaza, the West Bank, and Jordan.

[174]Physiological Characterization of the Wild Almond P. Arabica Stem Photosynthetic Capability

Dr. Tamar Azoulay-Shemer
Volcani Institute, Agricultural Research Organization, Israel
Session: Agrivoltaics – How Can It Be Implemented in a Desert Environment?

Leaves are the major plant tissue for transpiration and carbon fixation in deciduous trees. In harsh habitats, stem photosynthesis is more common, providing extra carbon gain to cope with the detrimental conditions. We studied two almond species, the commercial cultivar "Um-el-Fahem" (P.dulcis) and the rare wild P.arabica. Physiological, anatomical, and chlorophyll-fluorescence-based analyses revealed two distinctive strategies for carbon gain in these almond species. We found significant differences between leaf, barked-stem and green-stem relative surface-area in P.dulcis (94%, 6%, 0.1%) vs. P.arabica (32%, 7%, 60%). P.dulcis and P.arabica leaves showed comparable chlorophyll levels. However, transpiration and CO2 assimilation rates were significantly higher in P.dulcis leaves. Leaf stomata in P.arabica responded to a lower threshold of elevated-temperatures than those of P.dulcis, suggesting differences in adaptation to harsh habitats. Interestingly, P.arabica stems were distinctively different than those of P.dulcis. Stomata imprint and scanning-electron-microscopy revealed that 1st-year green stems of P.arabica possessed 4x more sunken stomata than P.dulcis. Gas-exchange analyses revealed that in the green stems of P.arabica and P.dulcis, the stomata were functional; yet, transpiration and assimilation were significantly higher in P.arabica 1st year stems. While P.arabica 2nd year stems remained green with functional stomata for CO2 assimilation rates, P.dulcis stems developed a cork-layer and lost their negligible CO2 assimilation rate ability. The significantly higher chlorophyll levels in P.arabica, distinctively concentrated in stems parenchyma-layer and it's fundamental histological unique infrastructures, further support the high-photosynthetic functionality of P.arabica stems, as compared to P.dulcis. Furthermore, PAM analysis showed differences between P.arabic and P.dulcis chlorophyll based fluorescence parameters in both leaves and stems, suggesting differences in the light reactions between the two species. The data suggest a distinctive strategy for coping with high-temperature and detrimental conditions in P.arabica and are of high importance for developing new almond cultivars with agriculturally-important traits.

[175]Study of the Dynamics of Soil Erosion in Response to Climate Prediction Model Rusle2 and WRF Modelling in a Semi-Arid Watershed

Dr. Tamir Caras
Ben Gurion University of the Negev, Israel
Session: Remote Sensing for Environmental Sustainability and Climate Change

Soil erosion is one of the key identifying characteristics of desertification, causing deleterious impacts at all levels - from soil loss to food security. Monitoring these effects and predicting them is central to any long-term plan for soil preservation and desertification counter measure. One of the leading models for erosion risk assessment is the Revised Universal Soil Loss Equation 2 (RUSLE2), which estimates the risk for soil loss and ultimately leads to guidelines for erosion control. The model combines the effects of several physical inputs parameters, including soil erodability (K), slope length (L), steepness (S), land cover (C), and support management soil practices (S) that were based on high-resolution DEM, satellite data and GIS data. However, the dominant factor affecting erosion risk is the climatic parameter (R) derived from precipitation data and calculated into the energetic impacts of major rain events. Rain events are threshold and summed to give the overall/total periodic force precipitation had on the soil in a specified period (from years to single events). In this paper, RUSLE2 model based on current and future predictions of R was tested in the semi-arid HaBsor watershed, Israel. R parameter predictions were provided by the Weather Research and Forecasting (WRF) model output for future precipitation from 2020 (present) to 2036 at a 6-kilometer grid. The resulting RUSLE map for the predicted soil erosion for the HaBsor river catchment area is presented, showing an area with a higher erosion risk, mainly in the lowlands. Integrating both models, the RUSLE2 and WRF enable testing of the effect of future climate conditions on the risk for erosion in desertified areas.

[176] An Analytical Model for Transient Evaporation from Bare Soils under Dry Conditions

Dr. Tamir Kamai
Volcani Institute, Agricultural Research Organization, Israel
Session: Water, Energy, and CO_2 Budgets in Desert Environments

Evaporation is a significant part of the water cycle and the main process for water vapor exchange between Earth's surface and atmosphere. Evaporation from bare soil consists of two main stages: stage 1, with relatively high and often steady evaporation rates that are controlled mainly by atmospheric conditions, and stage 2, with relatively low and exponentially decreasing evaporation rates that are limited by the diffusive nature of the vapor flow and the hydraulic properties of the drying medium. In semi-arid and arid regions that are characterized with long dry spells, stage 1 is short and during stage 2 water is depleted from the top near-surface soil, forming a dry soil layer (DSL), where water flows in vapor phase only. Measuring bare soil evaporation over larger areas is challenging due to the natural heterogeneity. These measurements become even more challenging under dry conditions, due to the equipment needed for capturing low fluxes under extremely high liquid water potentials and equivalent vapor pressures. Therefore, predictive tools are essential for estimation of soil evaporation. To date, modeling of this transient evaporation process is limited, mainly because it either requires sophisticated numerical models that account for its complexities or relies on analytical solutions that are too simplistic to capture its dynamics.

We present an analytical model that accounts for the main mechanisms of the evaporation process, but is relatively simple in its construction. The governing mechanisms during this dynamic process are captured by accounting for the hydraulic properties of the drying medium, the characteristic features of the medium that control water flow, the atmospheric forcing, and the partitioning between the liquid and vapor phases of the water within the drying profile. We validate this simplified approach using data from a numerical model and from evaporation experiments in different soil types, under various ambient conditions. In addition to depicting evaporation rates and the cumulative loss of water over time, we demonstrate the effect of soil hydraulic properties on the evaporation process. Additionally, we run the model with different initial conditions that represent different drying states, and show how it predicts the spatiotemporal partitioning between water (liquid and vapor) phases during drying, with specific attention to the DSL that develops during longer periods of evaporation, with the corresponding downward migration of the evaporative front.

[177]A Hidden Mechanism of Forest Loss under Climate Change: The role of Drought in Eliminating Forest Regeneration at the Edge of its Distribution

Dr. Tamir Klein
Weizmann Institute of Science, Israel
Session: Research-based Dryland Afforestation and Landscape Restoration

The ongoing global warming and associated drying are shaping the fate of forests worldwide. While processes of tree mortality are visible and studied, a decrease in forest regeneration is mostly overlooked, although equally deleterious. Populations at the edge of tree species distribution areas are at higher risk and are hence hotspots for species extinctions.

Here we use a semi-arid pine forest growing at the timberline edge of forest existence as a model for forest survival under warming and drying conditions. Seedling recruitment, including seed germination, seedling survivorship, and multiyear seedling growth, were measured along six consecutive years. To pinpoint the role of drought, we designed a field experiment, manipulating stand density at three levels and grazing regimes.

Seed germination was high across all studied plots, but seedling survivorship and multiyear seedling growth were near-zero. Stand density and grazing exclusion positively affected germination. Seedling survivorship was higher in wetter years. Multiyear seedling growth was stunted by grazing, and seedling height was distributed differently across different stand densities.

Our data indicate that seedling survivorship during the first dry season acts as a bottleneck for forest existence at the dry and hot edge of current forest distribution. We also quantified the roles of other stressors such as shading, and highlighted the eliminating role of grazing on multiyear seedling growth. Forest regeneration should be more closely monitored in sensitive populations, as climate change-driven forest loss can happen even without mature tree mortality.

[178]Conifer Desiccation in the 2021 NW Heatwave Confirms the Role of Hydraulic Damage

Dr. Tamir Klein
Weizmann Institute of Science, Israel
Session: Plant Hydraulics in Response to Environmental Stress

The unprecedented heatwave that hit the Pacific northwest of North America in late June-early July 2021 impacted ecosystems and communities, yet evidence and analysis of this impact are still missing. Here we bring a unique dataset quantifying the impact on conifer trees, which are keystone species of many northwest ecosystems. Moreover, we take advantage of this exceptional event as a broad, extreme, “field experiment” to test a fundamental theory in plant physiology, and prepare our forests for a harsher future. Overall, the data collected confirm the role of hydraulic vulnerability in drought-induced injury to trees. Among the recorded species, we obtained P50 data for 27 species, represented by 64 cultivars. Plotting needle browning extent by P50 revealed important thresholds of drought sensitivity: (1) species with P50 <-6 MPa were unaffected by drought. (2) species with -6 MPa< P50 <-5 MPa had mild extent of needle browning, up to 25% of the canopy. (3) species with P50 > -5 MPa had browning of up to 95%. The sharp divergence among resistant and vulnerable conifer species according to their xylem vulnerability, all of which simultaneously exposed trees to the same extreme event at the same site, is evidence to the key role of P50, in agreement with previous assessments of drought effects on angiosperms. Among local, NW conifer species, some cultivars proved hardier than others. The aftermath of the 2021 NW heatwave should take advantage of this broad, extreme, “field experiment” to prepare our forests for a harsher future.

[179]Tree-Based Multilevel Spatial Decision Support Systems to Close the Yield Bap in Almond Orchards

Dr. Tarin Paz-Kagan
Ben Gurion University of the Negev, Israel
Session: Leveraging Agro-Informatics and Big Data Applications to Improve Crop Production and Farmers' Livelihood

Agricultural productivity is subject to various stressors, including abiotic and biotic threats, many of which are exacerbated by climate change. Identifying key yield determinants will, therefore, provide the ability to predict yield and enhance the ability to manage within-field variability. Hence, the collection and integration of multi-layer heterogeneous large datasets and advanced analytics are needed to generate insights about the key constraints to yield potential for optimizing (e.g., water and nitrogen) at the field level or in each management zones (MZ). Thus, we aim to investigate the environmental, biological, and management factors that determine tree-level yield variability of almond orchards. We aim to achieve this by integrating multiple factors that are known to affect yield, including manageable primary resources (i.e., irrigation and fertilizer application), using machine learning algorithms and spatial statistics. The study was conducted in two almond orchards in Israel and the USA. We spatially evaluate the effects of abiotic and biotic stress-causing factors on the yield gap and monitor the crops using standard sampling (i.e., soil and leaves), UAVs (i.e., thermal, LiDAR, multispectral) with high spatial resolution and high revisit time. These by considering dynamic in-season MZs based on detecting abiotic and biotic stress-causing factors (i.e., water status, N-pool, N-use-efficacy, light interception, and vegetative growth), management of sensors or sampling, and remote sensing data. These were transformed into a tree-based data-driven spatial decision support system for irrigation and fertilization, including determining MZs and building prescription irrigation and fertilization maps to optimize differentiated yield.

[180]Predicting of Canopy Nitrogen Content based on UAVs and Satellites Data Fusion in Citrus Orchards

Dr. Tarin Paz-Kagan
Ben Gurion University of the Negev, Israel
Session: Remote Sensing for Dryland Agriculture

Nitrogen (N) is often regarded as the most critical nutrient and the growth-limiting factor in soil for plant growth and often needs to be supplemented by N-fertilization to minimize yield loss. However, over-application of N fertilizers may cause nutrient imbalance, contribute to groundwater contamination by nitrate (NO3-) leaching. Today the evaluation of plant nutritional status (including N content) is mainly based on chemical analysis of leaf samples in the lab'. These are expansive time consuming, and not representing the spatial variability in the agricultural system. Remote sensing applications extracted from satellites and unmanned aerial vehicle (UAV) images and machine learning algorithms have been proved effective in assisting nutritional analysis in plants. However, each platform has its pros and cons, and therefore, the fusion of UAV data with satellite may overcome part of these limitations. This study suggests investigating the ability to combine Sentinel-2 and VENμS data with UAV-derived canopy data to assess canopy nitrogen content (CNC) in citrus orchards. A new framework to infer the nitrogen content in citrus-tree at canopy-level using spectral data and vegetation indices with the ML algorithm is suggested. The framework includes six steps (1) leaf sampling for N content data, (2) image preprocessing of UAV (3) and satellite data preprocessing, (4) feature extraction, (5) model calibration and validation based on ML, and (6) the development of site-specific N management model. The suggested model was proven flexible and could include different or additional variables, enabling the delineation of fine site-specific nitrogen management (SSNM) zones in orchards. The model can be used to reduce the need for chemical analysis of the leaf tissue and optimizes the CNC monitoring , by taking into account the spatial and temporal variability in the citrus orchard.

[181]Incorporation of Winter Tree Physiology into Satellite-Based Rorecast Models of Orchards Bloom and Yield

Dr. Tarin Paz-Kagan
Ben Gurion University of the Negev, Israel
Session: Remote Sensing for Environmental Sustainability and Climate Change

Climate shifts, especially warmer winters, reduce deciduous tree-crops sustainability because commercially productive plantations require chill. The newly developed Carbohydrate-Temperature (C-T) model establishes a metabolic association between carbohydrate metabolism in dormant trees, hourly wither temperature and predicting blooming time based on the model. The C-T model was applied in Google Earth Engine (GEE) to predict the blooming time based on PRISM temperature data for almond orchards in the Central Valley of California from 2017-to 2022. Then, a time-sires analysis was applied to two spectral indexes of an enhanced blooming index (EBI), quantifying flowering status and Normalized difference vegetation index (NDVI) quantifying Chlorophyte status over almond orchards to validate the C-T model. The EBI model based on satellite data was validated based on drones and time-lapse cameras to assess the blooming phenology of flowering and leafing. The temporal and spatial extents were used to label satellite image pixels with the proportion of a pixel footprint that is flowering. The model accurately predicted pixel-level flowering proportion throughout the flowering season, across sites with dense to the sparse canopy and different background soil covers, and is robust to not detecting false positive flowering when no flowering events occur. The model can be deployed to generate regional maps of flowering dynamics and can be used to monitor deciduous tree-crops conditions and phenology. In addition, the C-T model was validated and parametrized, enabling predicting blooming time based on the hourly temperature data at the regional scale. The research breaches the gap between fundamental science and farming applications and could guide post-harvest farming applications.

[182]Harnessing the Rhizosphere for Improved Plant Productivity

Prof. Taryn Bauerle
Cornell University, USA
Session: Belowground Interactions in a Changing Environment

Hydrological properties of the rhizosphere influence the connection between the root and soil, affect soil aggregation and modify soil organic carbon (SOC) pools, making the rhizosphere the first critical component in the soil-plant-atmosphere water continuum. Low soil water content can exacerbate the variability in the spatial distribution of the soil water, resulting in a disconnect between the rhizosphere and the bulk soil limiting plant growth and productivity. These processes are critical to maintaining sustainable agricultural practices because the ratio of the rhizosphere to the bulk soil can determine the relative contribution of root inputs into soil carbon (C) storage. Few have attempted to examine the complexity of the near root zone as a system, i.e. probing the interactions between water, chemistry and biology along the gradient from the root to the soil. In particular, the lack of suitable technology to measure the interplay of roots, water, and carbon directly at the root-soil interface has severely limited our ability to elucidate the temporal and spatial variation in rhizosphere processes and include it in current plant breeding and crop management programs.

[183] A Low Cost Field-Test Kit for Illiterate Farmers in Developing Countries

Mr. Terry Hofecker
Soil1 LLC, USA
Session: Sustainable Agriculture & Climate Change

Agronomic agriculture is transitioning from an industrial/chemical paradigm to a sustainable/ecological paradigm affording the opportunity to transition pre-industrial, smallholder farmers directly from pre-industrial to sustainable climate smart farming practices. Yet many of the 450 million smallholder farmers worldwide have no educational basis for grasping complex scientific paradigms and may even be illiterate. Using carbon-based testing, The Ohio State University has developed a low-cost, 15-minute soil health field-test that outputs results by color chart. This one-step test utilizes flocculation to decolorize soils such as *terra rosa* or muck soils, pH buffering to stabilize reaction processes, and permanganate oxidation to assess available carbon levels. Since active carbon has strong correlation to soil organic matter, biological nitrogen, and microbial biomass, the test results give a useful indication of regenerative soil health. These results can be input into a cloud-based app to give minimally-trained personnel an onsite carbon-conservative regenerative agriculture prescription. This technology is based on nearly 60 years of research by The Ohio State University on a large set of agronomic soils from around the world. Our next research phase is developing partnerships to adapt the core chemistry to the carbon cycle of dryland biomes.

[184]Economic Implications of Climate-Smart Agriculture

Dr. Thomas Worley
Ohio State University, USA
Session: Sustainable Agriculture & Climate Change

Agricultural management practices are changing in remarkable ways to address an increasing world need for food security and global climate change. By 2050, agricultural production may have to double according to predictions by The United States Department of Agriculture. To achieve such increased output, more expensive and reactive chemicals, water, and energy will be necessary under conventional methods. Intensification of conventional farming under climate change is expected to be detrimental for agricultural productivity, farm economics, and agroecosystem services. However, there are new challenges and opportunities emerging with the advent of expanding science-based knowledge, technology and information systems that are leading to envisioning an agricultural renaissance in the 21st century to improve farm productivity and economics. Climate-smart agriculture based on novel and holistic approaches of conservation tillage, cropping diversity including cover crops (legumes), residue mulching, fertigation, and chemical growth enhancement have potentially higher and more consistent economic returns over time. The objective of this presentation is to evaluate on-farm economic factors and mitigation benefits of climate-smart agricultural production and their cost-effectiveness to be used as a priority for policy incentives. Switching from conventional to climate-smart agriculture may have potential to improve economic returns and mitigation benefits to a greater degree in dry and semi-dry regions of the world than in more temperate regions.

[185]Drought Stress and Recovery at the Arid Timberline: The Role of Functional Damage in Limiting Aleppo Pine Survival

Mr. Timo Knuever
Karlsruhe Institute of Technology, Germany
Session: Plant Hydraulics in Response to Environmental Stress

Extreme drought events are expected to increase around the world due to global warming. Such events have severe effects on forests, including reduced productivity and increased tree mortality. They are especially worrisome in semi-arid environments, where trees are already limited by low water availability and high evaporative demand during most of the year. *Pinus halepensis* trees growing at the dry timberline in Yatir forest in Israel offer a superb case study to understand the processes involved in the impacts of extreme drought on tree physiological and hydraulic functioning. One key aspect is the functional damage in the form of tissue loss or enzyme inactivation induced by dehydration, and its impact on the rate at which trees can recover functionality during the following wet season.

Here, we combine extensive field measurements of +10 years with a process-based model (LandscapeDNDC) that captures tree hydraulic responses and functional impairment due to drought stress. The model translates losses in tree hydraulic conductance into stress legacy via a reduction of active sapwood and leaf area. Also, hydraulic stress can result in sudden or delayed tree death, depending on the stress intensity. Flux measurements from Yatir forest and process-driven understanding from controlled studies conducted in Aleppo pine seedlings are providing the necessary data for model calibration and evaluation. In this talk, we will present the results of initial model simulations, to assess to what degree semi-arid pine forests like Yatir can resist and recover from extreme stress under current and future climate conditions.

[186]Biochemical Analysis and Candidate Gene Discovery for Chilling injury Tolerance in Bell Pepper

Mr.Tobias Strijker
Wageningen University, The Netherlands
Session: Plant Adjustment to Biotic and Abiotic Stresses in Changing Environments

Sweet bell pepper is the major vegetable crop cultivated in the Arava Valley in southern Israel, covering 1,000 hectares, 60 % of which is exported. Chilling injury (CI) is a physical disorder that occurs in the early winter when temperatures drop below 4°C. Usually, the damaged bell pepper is not marketable. Due to their genetic diversity, the level of CI tolerance varies between accessions and cultivars. The most common varieties in the Arava Valley are susceptible to CI. Therefore, new high-quality cultivars CI-tolerant need to be bred. Our study objective was to unravel the genetics underlying CI and identify genetic markers, which can support breeders in selecting CI-tolerant genotypes.

Pepper fruits from 144 accessions of an F2 segregating population were chilled (2°C for 20 hours) and scored for CI tolerance, along with their two parental lines and the F1-hybrid offspring. Biochemical and physiological mechanisms have been explored on susceptible and tolerant accessions by measuring anti-oxidant activity, reactive oxygen species accumulation and the performance of metabolic profiling analysis.

With that knowledge, metabolic pathways can be mapped along with finding candidate genes that express CI tolerance. Additionally, a bulked segregant RNA-seq was performed and revealed differential expression of SNPs of candidate genes associated with CI tolerance in bell pepper. This combined approach of metabolomics and genomics has provided a better understanding of the CI tolerance mechanisms and provided several potential bio- and genetic markers which breeders can use by means of marker assisted selection.

[187]Strategies and Modeling Tools for Urban Decarbonization

Prof. Ursula Eicker
Concordia University, Canada
Session: Energy & Sustainability: The Built Environment

The 2021 Intergovernmental Panel on Climate Change report underscores that it is still possible to achieve the 1.5-degree-target, but only if unprecedented action is taken now. To have a chance of limiting warming to 1.5 degrees, global emissions must halve by 2030 and reach 'net-zero' by 2050. Multilevel action is the new normal: At a historic first, the Glasgow Climate pact of the UN COP26 recognized the importance of local communities, including indigenous people and civil society in its preamble. To support local decision making for ambitious urban decarbonization, digital tools need to capture the complexity of the urban system and have to be structured in a cohesive framework which provides the interfaces between data, urban scale modeling and powerful visualisation and gamified interfaces to engage multiple stakeholders.

Decarbonization strategies for the different sectors within urban areas will be discussed together with barriers and opportunities to accelerate the transformation process.

[188]Making (Non)sense of Grapevine Cultivars Classification into Iso/anisohydric

Dr. Uri Hochberg
Volcani Institute, Agricultural Research Organization, Israel
Session: Viticulture in a Changing Climate: Vineyard-Environment Interactions

Grapevines are frequently classified as isohydric or anisohydric in an attempt to portray their water relations strategy. However, despite the popularity of the iso/anisohydric classification, the underlying biology remains unclear. In this presentation, I will present a simple hydraulic model, field measurements, and the extensive literature on grapevine hydraulics to illustrate that the iso/anisohydric classification depends on the definition used and the environment in which it is grown, rather than describing an intrinsic property of the plant itself. I argue that abandoning the iso/anisohydric terminology and returning to a more fundamental hydraulic framework would provide a stronger foundation for cultivars comparisons.

[189]Resource Recovery and Increasing Productivity in a Sustainable Multi-loop Aquaponic System

Dr. Uri Yogev
National Center for Mariculture (NCM), Israel Oceanographic and Limnological Research Institute, Israel
Session: Next Generation Aquaculture

Food security, specifically in water-scarce regions, is a local and global aim that requires innovative solutions. Aquaponics, the integration of a conventional recirculating aquaculture system (RAS) with hydroponics in a symbiotic arrangement, can be such a solution. In aquaponics, fish excretions are assimilated as a nutrient source for vegetable production. As a result, the assimilation of the fish waste by the plants, 'treat ' the water, and enables its recirculation back to the fish tank. This practice allows for extremely high efficiency in the use of water and nutrients and greatly limits the discharge of pollutants.

Basic aquaponics systems consist of four major components: fish tank, solid filter, nitrification biofilter, and plant beds. The water is continuously recycled through one loop. In these systems, the suspended solids accumulate in the solid filter (sludge), which can reach up to 50% of fish feed, and are washed out from the system, leading to loss of water and the need for further treatment or potential pollution.

Recently, we developed a novel multi-loop near-zero waste aquaponic system. The system includes separate loops for fish production (RAS) and for plant growth (hydroponic) which facilitate optimal conditions per each crop. In addition, two separate loops are used to treat the solid waste (fish and inedible plant bits) by anaerobic digestion, producing nutrient-rich liquid good for plant growth and energy.

Following a stabilization stage, the system was operated for more than 3 years. Fish stocking density reached approximately 50 kg/m^3. Feed (45% protein content) was applied daily at 2% of body weight. Typical fish performance was observed with a survival rate >97% and a feed conversion ratio of 1.33. Lettuce production was up to 5.65 kg/m^2, significantly higher than previous reports, largely because of high nutrients reuse efficiency from the anaerobic supernatant. Of the feed carbon, 24.5% was taken up by fish biomass. Fish solid wastes contained 38.2% carbon, of which 91.9% were recovered as biogas (74.5% CH_4). Biogas production was 0.84 m^3/kg for fish sludge and 0.67 m^3/kg for dry plant material. CO_2 sequestration was 1.4 higher than the feed carbon, which reduced the system's carbon footprint by 64%. This study is the first to demonstrate highly efficient fish and plant production with near-zero water and waste discharge and with energy recovery that can potentially supply the system's energy demand.

[190]Elucidation of Water Deficit Effects on 'Xynisteri' Grapes through Systems Biology Approaches

Dr. Vasileios Fotopoulos
Cyprus University of Technology, Cyprus
Session: Viticulture in a Changing Climate: Vineyard-Environment Interactions

Cyprus is one of the very few phyloxera-free areas worldwide where the vast majority of vines are own-rooted and non-irrigated. 'Xynisteri' is a predominant indigenous cultivar, particularly amenable to extreme conditions such as drought and hot climate, thus rendering it appropriate for marginal soils and adverse climatic conditions. In the current work, a comparative study between irrigated (irrigation initiated at BBCH 71) and non-irrigated 6-year Cordon-trained vines was conducted. An array of physiological (water potential, leaf water content, stomatal conductance, chlorophyll content), biochemical and qualitative indices were monitored during successive developmental stages (BBCH-75, 85, 87, 89). Harvested grapes were additionally monitored for their aroma profile with the employment of GC-MS, while must was analyzed using micro-FT-NIR and E-nose techniques. Physiological parameters of leaves were severely affected from drought stress; stomatal conductance registered exceptionally low values at non-irrigated vines. Non-irrigated berries were characterized by higher total soluble content and Ripening Index (TSS/TA), while titratable acidity (TA) and pH registered lower values. In addition, molecular signatures were mapped in grapes using RNA-sequencing which lead to the identification of a number of key transcripts involved in the response. The effect of irrigation on secondary metabolism with special reference to volatile organic compounds is discussed.

[191]The Role of the Application of Bio-Stimulants during Salinity Stress & an Integrated Bio Stimulant Approach for Alleviating Plant Stress under Desert Conditions

Dr. Vasilis Tsambardoukas
Haifa Group, Israel
Session: Importance of Precise Crop Nutrition under Desert Growing Conditions

Salinity is among the abiotic stresses most negatively affecting agricultural crops due to interference with crop growth and development. Evidence indicates osmotic stress induces oxidative stress that leads to an increase and accumulation of reactive oxygen species (ROS) within the plant cells. The usage of plant extract-based bio-stimulants containing bioactive compounds (antioxidants) helps crops to cope with osmotic stress caused to the plants because of the use of saline-brackish water for irrigation that results in yield reduction. An integrated bio-stimulant approach, aiming at the enhancement of the plant-soil-water system in desert conditions and the introduction of different active molecules per phenological stage of the plant, revealing their mode of action under high temperatures, salinity & drought stress.

[192] Teachers' Perspectives: Challenges in the Integration of Refugee Children Deported from Israel to Uganda

Prof. Vered Slonim-Nevo
Ben Gurion University of the Negev, Israel
Session: Asylum Seekers from Darfur & Eritrea – Experiences in Israel and in Uganda

In 2012, Israel deported 500 South-Sudanese refugee children and their families. A year later, a civil war broke out in South Sudan and the deportees, along with over one million South-Sudanese citizens, fled to the neighboring Uganda. Since then, many of these children have studied in boarding schools in Uganda. After offering some background about the community and the circumstances and outcomes of their deportation, we explore, using qualitative methods, the perceptions, and experiences of six Ugandan teachers all working with these children for at least 5 years. The research is unique in studying children who have previously lived and studied in a developed Western environment, and experienced, subsequently, a transition to the global south, with far more conservative social norms and an authoritarian, teacher-centered conception of education. The results show a clear progression in the teachers' conception of the children, beginning with an impression of the children as rebellious, tending to initiate conflicts, and disrespectful. Gradually, they came to view them as being open and assertive, often very articulate, and communicative. They observed changes in the children's behavior: acquiring language skills, being cooperative with staff, integrating with the other children and caring. Working with the refugee children had a great impact on the teachers' perceptions and on their personal and professional conduct: they substituted punishments—including physical caning—with other methods of discipline. They endorsed open academic methods based on dialogue in class and between teachers and students, and encouraged experiment-based learning methods.

[193]Cyanobacteria-Rich Biocrusts Are Essential Components of Sustainable Rangelands in the Australian Savanna Biome - and Farmers Need to Know About Them

Dr. Wendy Williams
The University of Queensland, Australia
Session: Cyanobacterial Soil Amendment and Restoration

Savannas cover ~20% of continental northern Australia with ~500–2000 mm annual rainfall, a long dry season and regular fire. They are used as rangelands for extensive beef cattle production. Farmers recognise that unsustainable grazing and burning practices, combined with droughts and floods, manifest in compromised productivity. Vast farm sizes (>200,000 hectares) prevent the application of fertilisers or soil ameliorants to compensate for the nutrient losses caused by soil degradation and cattle export. Our project raises awareness of the role of biocrusts in rangelands for protecting soil and generating organic carbon and bioavailable nitrogen, amongst other ecosystem services. Our multidisciplinary research aims to quantify the presence and function of biocrusts so that land managers can make informed decisions. Our study sites encompass two long-term research stations imposing contrasting fire (cool and hot fires) and grazing management (low and high intensity, grazing or seasonal resting). The project examines the functionality of biocrusts and their natural capacity to recover after fire and in relation to grazing regimes. Biocrust cover and micro-organism diversity were studied across micro sites of different soil types using field measurements, laboratory analysis (high throughput phylogenetic marker gene sequencing, carbon and nitrogen relations), as well as machine learning (mobile phone photos), and remote sensing. We highlight features of Australian cyanobacteria-rich biocrusts that have evolved with fire and weather extremes for millennia. We discuss how this knowledge can inform passive and active rangeland restoration efforts to ensure resilient savanna grazing lands.

[194]Recent Extreme Dust Storms in Central Asia Associated with Accelerated Warming in the Tropical Pacific and Arctic

Prof. Xin Xi
Michigan Technological University, USA
Session: Desertification, Climate Change and Health Inequities

Dust storms are a recurring weather hazard in Central Asia and threaten human well-being by deteriorating the air, soil, and water in downwind populated regions. Several extreme dust storms struck Central Asia during recent years, including a haboob-like salt storm from Aralkum in May 2018 and a record-breaking dust storm in Uzbekistan in November 2021. Both events caused persistently high concentrations of particulate pollutants. Such extreme events are typically triggered by two factors: increased availability of erodible sediments and strong near-surface winds capable of dust uplifting. This presentation explores the climate setting and meteorological forcing of the recent dust outbreak from the perspective of sediment availability and wind power. The sediment availability is closely related to the growing-season drought condition, which depends on the preceding cold-season precipitation and Northern Hemisphere circulation anomalies associated with tropical and extratropical forcings. The dust-uplifting winds are primarily triggered by cold air penetration from high latitudes induced by upper-level circulation anomalies. By linking the dust storms with anomalous hydroclimate and circulation patterns, this presentation discusses the impact of the amplified warming in the tropical Pacific and Arctic on the midlatitude climate and dust activity.

[195]All-in-One? One-Fits-All? Lessons Learned from Four Years of the Model Farm for Sustainable Agriculture, Newe Ya'ar, Volcani Institute, Israel

Dr. Yael Laor
Volcani Institute, Agricultural Research Organization, Israel
Session: Sustainable Agriculture & Climate Change

The Model Farm for Sustainable Agriculture was established four years ago in Newe Ya'ar, the northern campus of Volcani Institute (https://www.modelfarm-aro.org/?lang=en). This is a pioneer mega project, aimed at studying, demonstrating and implementing sustainable agricultural practices. We built a full scale real connection between research and practice of sustainable agriculture. Our five key principles are (1) Reducing external inputs; pesticides, fertilizers, water, and energy. (2) Recycling all organic wastes; "zero waste". (3) Conserving the soil. (4) Designing an ecosystem that sustains and supports agriculture, biodiversity, and local habitats, and (5) Increasing animal welfare. With those key principles, we still should demonstrate sustainable economic revenue to farmers over the long-term (what economy?). We recruited parts of the Newe Ya'ar farmland (150 ha) and cattle (200 heads) and translated our 'big ideas' into 5 main platforms (i) Almond orchard (ii) Field crops (iii) A buffer strip along the upper section of Nahalal River (iv) Ruminant Care & Feeding housing, and (v) Waste recycling. The almond orchard is divided into subunits: One is designed to study weed management and service (cover) crops, to minimize soil erosion and reduce herbicides use, a second includes wasp resistant cultivars, to reduce pesticides use, and a third includes drought tolerant cultivars, to cope with climatic changes. The platform of the field crops is also divided into subunits. One is for alternative forage crops, a second is to practice service crops and organic additives, and the third is for precision agriculture practices. The buffer strip embeds research into a full river restoration program. The new ruminant housing (under work) is thoughtfully designed to improve animal welfare, production and profitability, and the waste recycling 'park' is equipped with a full-scale composting drum, demo-scale anaerobic digestion and wetland, and lab-scale hydrothermal processing and composting simulations. The Model Farm has been equipped with state-of-the-art agricultural machinery as well as drones equipped with RGB, multispectral, thermal and LIDAR sensing. We are not an organic farm, neither 'pure' regenerative. We operate in light of the perception that the chances of achieving sustainability depend on the development and assimilation of technological innovation alongside a holistic view and re-adoption of traditional approaches.

[196]Flash Flood Forecasting in Arid Regions - Challenges and Opportunities

Dr. Yael Storz-Peretz
Israel Water Authority, Israel
Session: Space Based Technological Applications for Water Management

Desert regions are characterized by a flashy hydrological regime. Flash-floods often disrupt the daily-routine by blocking transportation routes, causing damage to infrastructure and unfortunately also result in casualties. Flood forecasts and early warnings save lives and increase preparedness. Hence, Israel Water Authority and Israel Meteorological Service joined forces to establish the National Flood Forecasting Center to provide impact based forecasts and early warnings to the civil protection forces and relevant institutions.

The Flood Forecasting Center develops and operates various hydrological models and tools to compute the probability and magnitude of flash-floods in the arid regions of Israel. Modeling of arid streams is challenging and must be improved to achieve better forecasts. Models are being calibrated, validated, and tested against hydrometric ground measurements. However, most ground measurements are located at the basin's outlets though in arid regions only part of the basin is active during rainstorms. The lack of intra-basin observations impairs our ability to improve model performance. In addition, soil moisture measurements, a key factor controlling stream flow generation, are sparse or lacking in arid regions and data is only available at a specific location.

Remote sensing may provide resolutions to overcome these challenges. The use of satellite post-flood stream flow mapping offers an exciting opportunity to validate and improve the performance of hydrological models, and assess their uncertainty. Satellite capabilities can also be tested for extracting soil moisture to improve hydrological models performance. The National forecast center intends to take such actions to improve its tools and services.

[197]Embolism in Aleppo Pine: Occurrences and Consequences

Ms. Yael Wagner
Weizmann Institute of Science, Israel
Session: Plant Hydraulics in Response to Environmental Stress

Xylem embolism impairs hydraulic conductivity in trees and drives drought-induced mortality, yet evidence of its occurrence in mature field-grown trees is not robust. Seasonal patterns of embolism were monitored in Aleppo pine (*Pinus halepensis*) trees growing in a dry Mediterranean forest using Optical visualization sensors (OV) and µCT. In addition, potted Aleppo pine trees were dehydrated in the greenhouse in order to examine the effect of embolism on their survival and recovery from drought.

In forest-grown trees, embolism increased from zero to ~12% along the dry season, with 77% of cavitation events occurring between 10:00 and 16:00. The probability for cavitation increased as vapor pressure deficit (VPD) increased, up to 42% chances for cavitation when VPD > 5 kPa. In potted pines, no trees with embolism levels lower than 60% had died, but stomatal conductance (g_s) following one month of rehydration was lower in dehydrated trees, proportionally to the level of hydraulic damage.

The large difference between native embolism in forest-grown pines and mortality threshold in potted ones, suggests the mature trees are not approaching hydraulic failure. However, the impaired recovery of g_s implies towards potential long-term effect of embolism on productivity, and the increased probability for cavitation with increase in VPD may encompass fatal consequences for these trees under future climate change.

Key message: Xylem embolism was frequent in forest-grown Aleppo pine under seasonal drought, but still low (12%) compared to the mortality threshold of >60%, measured in potted trees.

[198]Stomatal Optimization under Uncertain Climate: The Role of Discounting

Prof. Yair Mau
The Hebrew University of Jerusalem, Israel
Session: Plant Hydraulics in Response to Environmental Stress

Optimality principles have been used to explain stomatal behavior, assuming that plants maximize carbon assimilation, while minimizing water expenditures. This optimization is often realized in models under arbitrary time horizons, from instantaneous optimization to unknown time periods of days and weeks. Here we introduce the concept of "discounting" to the optimization framework. Simply put, discounting makes the assumption that a plant cares more about its fluxes of carbon and water at the present moment than those in the future, where a "discount rate" is used to quantify the amount by which the present is more valued than the future. We explore how the plant continually updates its prior density functions (in the Bayesian sense) regarding future climatic conditions, and how this mechanism relates to memory. We also show that instantaneous optimization and the usual optimization over a fixed period of time are but the extremes in a rich spectrum of behavior in the discount rate axis. Finally, we discuss how to link the idea of discounting to risk attitudes and isohydricity.

[199] Thermoelectric Conversion of Waste Heat into Useful Electricity

Prof. Yaniv Gelbstein
Ben Gurion University of the Negev, Israel
Session: Energy and Sustainability: Materials

Thermoelectrics is an emerging technology for effective recovery of waste heat from power plants, factories, motor vehicles, computers or even human bodies and its conversion into useful electricity without moving parts, noise or the release of harmful chemicals. Therefore, such converters exhibit a high potential to contribute to the global efforts to reduce CO_2 emissions from fossil fuels and towards a cleaner and sustainable environment. Currently available converters contain scarce, expensive and environmentally unfriendly elements. They can only work in a limited temperature range, resulting in limited efficiencies of only up to several percent. In this talk the potential of both *n*- and *p*- type novel and highly efficient materials including the TiNiSn- based half-Heusler, HH, compounds, will be described via understanding the role and controlling of meso-scale defects, such as grain-boundaries, separated phases, dislocations/twinning and chemical impurities on the thermoelectric properties. Such materials, containing available, cost-effective and environmentally friendly constituents, are capable of operation up to 700^{o}C, and therefore expected to enhance the Carnot efficiency with all of the other associated advantages. The efforts of maximizing the potential of such materials by both electronic and phonon phonon effects will be described in detail in the talk and the routes approaching practical energy conversion devices will be addressed.

[200]We Who Drives Will Never Thirst Again". Regulatory Disciplines Integration in Automotive World

Dr. Yaron Aviv
Watergen Ltd., Israel
Session: Water Harvesting: The Interface between Research and Industry

Water quality standards describe the desired conditions of potable water and how it can be achieved. Advances in water production technologies raise regulatory issues that differ from anything that regulators have had to deal with in the past. It even gets harder when multi-disciplines are merged into one product in the automotive world.

21st century as a link of automotive evolution?

Water is life – and life on earth is linked with water. Water has tremendously promoted cars development, from the early 17th century with the invention of the first steam-powered vehicle. Nowadays, humans progressively spend time in their well equipped cars, therefore, it is essential to start new era in which automotives will also generate fresh potable water.

What technology can afford it?

Atmospheric Water Generators (AWG's) have recently become significant yet to be exploited as a source of drinking water. YES, ***water can be harvested from the air!*** Atmospheric water represents a virtually endless supply that is universally available and continually replenished. Technologically, the proprietary patented GENius heat-exchange technology turns air into water that in turn channeled through a multi-stage filtering system and microbiological treatment that ultimately, keep the water fresh and tasty.

Believe, it can happen!- our goal is to upgrade the near future automotives with integral AWG that is not only eco friendly but also provide safe and tasty water.

What challenges lie ahead?

With these objectives, we thoroughly investigate the relations between water-related contaminants combined with automotive-environmental challenges and its consequences in water regulatory and safety aspects.

[201]Studying Reclamation-Oriented Mining of Phosphate in the Negev Desert

Prof. Yaron Ziv
Ben-Gurion University of the Negev, Israel
Session: Restoration and Rehabilitation of Desert Ecosystems – Session 2

Phosphate strip mining in Oron-Ziv region, Negev Desert, has been practiced for over 60 years, destroying the hyper-arid ecosystem, with its unique biodiversity, and fragmenting the landscape. In the last 15 years, a new method of reclamation-oriented mining is applied, where topsoil and overburden are piled separately and returned back in reverse order to maintain the main features of the original landscape. We study the ecological consequences of the new method using an ecosystem approach, to: (1) Analyze the differences in physical and biological groups (soil, microorganisms, plants, arthropods) between the natural (reference) and restored sites; (2) Propose additional practices to improve the reclamation success. We used a conceptual model to identify research directions and established research plots in four different sites to collect soil and monitor the focal biological groups. Soil analysis revealed that biological components differ significantly between natural and restored sits. Genetic analysis of the microbial community showed that the most crucial photosynthetic groups, e.g., cyanobacteria, are significantly less abundant in the restored compared with the natural sites, lessening the development of functional and stabilizing soil biocrusts. Using plant experiments, we showed that germination depression in the restored sites results from missing seed bank, probably because seeds do not accumulate in loose soil without biocrust. Additionally, the restored sites are characterized by generalist arthropods while the natural sites are inhabited by diverse specialist species. Our current studies focus on active practices that increase habitat heterogeneity and facilitate native biodiversity.

[202]Does Social Capital Improve the Quality of Life of Asylum Seekers? Evidence from Israel

Dr. Yifat Faran
Ashkelon Academic College, Israel
Session: Asylum Seekers from Darfur & Eritrea – Experiences in Israel and in Uganda

Asylum seekers (AS) are forced to deal with challenging circumstances and living difficulties in the receiving countries, a situation that tends to increase their psychological distress and impair their quality of life. Based on the Social Capital Theory, the current study sought to identify social factors that might reduce the psychological distress and improve the quality of life of AS. The sample consisted of 227 Darfuri asylum seekers in Israel aged 19 to 58. The participants completed a questionnaire assessing: the dependent measures of psychological distress and physical, psychological, and environmental wellbeing, and the predictors of post-migration living difficulties, number of AS and Israeli friends, social support, and receiving assistance from and volunteering in nongovernmental organizations (NGOs). The findings show that whereas social support, mainly from friends, improved quality of life, the number of AS friends tended to reduce it. The results suggest that merely having friends is not enough to improve one's quality of life and may even have the opposite effect when the two sides share similar adversities. However, when the friends are available to offer support, they can contribute to improved quality of life. Thus, while some social capital indicators are beneficial, others might have a detrimental effect. The results therefore indicate the need to strengthen the social contacts of AS while paying careful attention to the cost of exposure to peers' adversities.

[203]Pruning after Budbreak Affects Phenology, Physiology, Yield Components and Improved Wine Quality of Malbec

Dr. Yishai Netzer
Ariel University, Israel
Session: Viticulture in a Changing Climate: Vineyard-Environment Interactions

Malbec vineyards grown in hot regions (Ayalon valley, Israel) tend to bear high yields, thus in some cases negatively affecting wine quality. In the current work we describe, the use of late shoot pruning (LSP) agro technique practice implied for wine quality improvement. We examined the effect of timing of LSP on Malbec vines for four consecutive years (2016-2019). LSP (applied one, two or three weeks after bud break, E-L stage 4) were compared with standard winter pruning practice (WP) and cluster-thinned winter-pruned vines (WP+T). LSP vines postponed the onset of shoot growth, but the onset of veraison in the LSP vines occurred at the same time as in the control vines. Midday stem water potential indicated less stressed vines and stomatal conductance and CO2 assimilation rate were improved in the LSP vines than in the controls. The LSP practice led to a substantial reduction of the number of clusters and of crop yield. The accumulation rate of soluble sugars in the grapes was higher in the LSP and WP+T treatments than in the WP control. The improved quality of the must components in the LSP treatments (higher titratable acid content, greater red color, lower pH in most years) was also evident in the wines produced. The LSP vines reached a higher total score of the organoleptic test. Our results show that performing the simple and cheap agro technique of LSP at the precise timing after bud burst saved labor, decreased crop yield and improved wine quality in 'Malbec' vineyards. LSP application should be considered a significant tool in enhanced effectiveness of vine growing in warm regions.

[204]Macroalgae as an Alternative Source of Protein and Starch for Food

Prof. Yoav D. Livney
Technion - Israel Institute of Technology, Israel
Session: Algae-Based Solutions for Food Crisis Challenges

Global population increase and the depletion of agricultural land and shortage of freshwater, make ocean aquaculture an attractive alternative source for food. Macroalgae contain a wide variety of nutrients such as protein and starch. Algae can contain up to ~50% protein and up to ~30% starch, by dry weight. These biopolymers are a source of energy and building blocks for the human body and have various functional properties useful in food processing.

Herein, we used the green macroalgae Ulva as a model, and developed a food grade protein extraction protocol, which yielded an algae protein concentrate (APC) containing >70% protein. We found that the concentrate contains all the amino acids, including the essential ones, and that 90% of the protein undergoes proteolysis under simulated digestion. The concentrate exhibited high antioxidant activity due to the presence of polyphenols co-extracted with the proteins. We currently use the protein extract to develop fish alternatives.

Starch extracted from ulva contained a high amount of amylose relative to starches from terrestrial sources such as rice and potatoes. The algal starch had a higher retrogradation tendency, due to the high amylose content, which led to better gelling properties and high resistance to enzymatic digestion, which is desirable, as it causes a moderate glycemic response.

These results indicate there are functional, health and environmental benefits to using macroalgae as a new and sustainable source of protein and starch for human diet and the food industry.

[205]Hydraulic Response of Savanna Plants to Extreme Drought

Dr. Yongjiang Zhang
University of Maine, USA
Session: Plant Hydraulics in Response to Environmental Stress

Extreme drought events are becoming increasingly frequent globally, resulting in widespread plant mortality and forest dieback. Although covering approximately 20% of the land area, responses of savanna plants to extreme drought have been less studied compared to forests. The savannas in Southwest China experienced extreme drought events in 2015, 2019 and 2020. Both evergreen and deciduous species showed high drought resistance and limited mortality, while semi-deciduous species had the highest branch dieback and mortality. Branch dieback and mortality were well-explained by hydraulic traits like embolism resistance and hydraulic safety margins, but the prediction power is affected by leaf habit and growth form. For evergreen shrubs, although they showed high branch dieback, individual mortality was low. They showed high resistance to xylem embolism. The low water potentials (-7.6 MPa to -10.0 MPa) during the drought caused embolism levels from 23% to 65% in terminal branches, and the remaining stems maintained 15% to 35% xylem embolism at the end of the drought. Large within-individual variations in stem vulnerability to embolism were detected, and the shedding of vulnerable branches could be a mechanism for shrubs to reduce water and carbon consumption. Our results suggest that both evergreen species with strong drought tolerance and deciduous plants with drought avoidance can resist extreme drought, while those with an intermediate strategy showed high sensitivity. Additionally, high embolism resistance, shedding of vulnerable branches, and resprouting after drought allow high resilience of evergreen shrubs under extreme drought.

[206]Restoration of Declining Species in Arid Lands: Learnings from the North African Houbara Bustard Translocation Program in Morocco

Dr. Yves Hingrat
Reneco International Wildlife Consultants, LLC, United Arab Emirates
Session: Restoration and Rehabilitation of Desert Ecosystems – Session 1

Conservation translocations are increasingly used to restore declining species, including species from desert and arid ecosystems. However, such ecosystems are more than ever at risk of irremediable degradation and desertification, potentially impeding translocation success. The North African houbara bustard (Chlamydotis undulata undulata) has been declining primarily due to unregulated hunting and poaching. Since 1998, more than 157,000 houbara have been successfully bred in captivity and released across the species range to reinforce wild populations and supplement regulated hunting grounds. Long term individual and population monitoring in a managed area in Morocco revealed the ability of released houbara to survive and breed successfully leading to positive and significant impact of translocations on the population size. However, Integrated Population Models predict that without reinforcement and even under full protection (no hunting) the population is not viable in the long term, mainly due to individual and temporal variation in survival playing a key role in driving the dynamics of the population. Indeed, despite protection measures, mean annual survival remains too low, pointing at potential limitations in the availability of high quality habitats and intrinsic population regulation mechanisms (density dependence). Recent studies on the relationship between abundances and habitat suitability (SDM) confirmed these assumptions and suggest that best habitats are at carrying capacity. However, in a region already under significant changes, land use and climate change scenarios forecast a significant niche restriction for the species. All together these results advocate the need to re-evaluate management decisions in line with the evolution of habitat quality.

[207]Is There a Reason for Concern for Antimicrobial Resistance (AMR) in Greywater?

Prof. Zeev Ronen
Ben Gurion University of the Negev, Israel
Session: Resource Oriented Sanitation in Drylands

The increased reuse of the treated water resources comes with unexpected environmental and public health consequences. While onsite treatment provides reliable solutions, treating emerging pollutants like antibiotic resistance genes (ARGs) and resistant bacteria (ARBs) is not well-considered. In the last few years, we aimed to characterize AMR in greywater sources and evaluate if recycling vertical flow constructed wetland (RVFCW) can be a sustainable solution for removing AMR. Treated greywater from RVFCW was surveyed in a household in the central Negev Desert, Israel. The presence of antibiotic-resistant bacteria in raw and treated greywater was investigated with culture and molecular methods, as well as their presence in the corresponding treated-greywater-irrigated soils. While the RVFCW effectively reduced amoxicillin, kanamycin, and ciprofloxacin ARBs, tetracycline-resistant bacteria increased in the treated greywater, likely due to their concentration on the filter matrix of the treatment systems. No significant differences were observed when comparing ARBs in soil irrigated with TGW or freshwater. Our research quantified ARGs (sul1, qnrS, blaTEM, blaCTXM32, tetG, tetQ, tetW tet39, fabI, and fabV), class one integron (intI1), and bacterial marker (16S) using quantitative polymerase chain reaction (qPCR). The greywater microbial community was characterized using a 16S rRNA amplicon sequencing. The resistome of the GW was characterized by metagenomic analysis. The RVFCW can reduce ARG in greywater by 1–3 log, depending on the gene and the quality of the raw greywater. The metagenome confirmed these observations and also indicated the presence of different families of ARGs. Resistance genes with efflux mechanism (export of antibiotics out of the microorganism, comprised the majority of the ARG abundance for all (raw and treated) samples. It was followed by the group that is resistant to antibiotic inactivation, which consists of enzymes that physically modify antibiotics, related to biodegradation mechanisms Quantitative PCR of ARGs in soils irrigated with either freshwater or treated GW suggests that the contribution of treated GW to the presence of ARGs is not significant compared to other possible routes of introduction, such as natural occurrence, application of composts, or the presence of animals. Our results highlight the prevalence of ARGs and ARBs in raw, and treated GW. However, it is still unclear whether in-site use of these effluents for irrigation introduced AMR into the soil. Mitigation of the risk of ARBs in reusing TGW can be achieved via effluents disinfection. Nevertheless, there is a need to quantitatively examine the potential health risk from arising from ARGs in the treated effluents.

[208]Knowledge Exchange in Environmental Management Needs Integrating with Local Socioeconomic Concerns to Support Sustainable Outcomes in Drylands

Dr. Zheng-Hong Kong
University of York, United Kingdom
Session: Cross Border Desert Research- Science and Collaboration

Knowledge is an intrinsic element of environmental management and closely related to management capacities. Understanding what kinds of knowledge are needed and how to communicate them in effective ways is crucial for enabling well-informed management. However, knowledge and its exchange have often been observed from the angles of its creators and disseminators, rather than from the perspectives of the receivers. This can lead to mismatches between supply of and demand for knowledge, resulting in futile knowledge exchange and wastage of resources. In this research, 3 cases in north-western China where National Environmental Programs (NEPs) have been implemented to combat desertification are investigated to address this gap, using interviews and questionnaires with scientists, grassroots implementers, and farmers/ herders. We aimed to identify what and how knowledge has been exchanged during NEPs implementation, the outcomes from dominant knowledge exchange, and to explain why discrepancies occur and how they can be remedied, considering local stakeholders' perspectives.

We identified constant flows and exchanges of knowledge from and between scientists and policy makers at high levels during the formulation of NEPs, while well-functioned communication channels and mechanisms of existing environmental institutions made implementation very effective and efficient. However, knowledge exchange at high levels encourages large-scale research and simplified concepts, and often overlooks specific contexts. This caused knowledge exchange during the implementation process to be incompatible with some local conditions and saw suspicion and distrust developing among local stakeholders about the relevance and applicability of the knowledge they received. Despite local farmers/ herders, who have resided on their land for generations, have more knowledge about their environment than is presumed by many scientists, their struggles to balance conserving land and making a living require more support from beyond environmental policies.

We suggest knowledge and its exchange in environmental management should "change with the changing" in the biophysical arena and extend beyond the environmental domain to integrate with those that look into local socioeconomic concerns. Such efforts could not only improve environmental management outcomes but also advance sustainable development.

[209]Bioinspired Antifouling Membranes for Water Treatment

Prof. Zhongyi Jiang
Tianjin University, China

Membrane technology has become an indispensable platform technology for water purification, including seawater and brackish water desalination as well as municipal or industrial wastewater treatment. However, membrane fouling, which arises from the nonspecific interaction between membrane surface and foulants, significantly impedes the efficient application of membrane technology. Preparing antifouling membranes is a fundamental strategy to deal with pervasive fouling problems from a variety of foulants. This presentation will first introduce the recent development in antifouling membranes. In particular, the strategies and mechanisms for antifouling membranes, including passive fouling resistance and fouling release, active off-surface and on-surface strategies, will be discussed. The research work on bioinspired antifouling membranes for water treatment will be highlighted.