Scientific Report to COST

Action ES1104

Training School 1 ; March 2 - to March 10, 2013
"Northern Negev desert, Israel: Role of biological sand crusts in a desert ecosystem versus "upgrading" ecosystem productivity."

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Description and participants of TS

A very successful TS was organized by the MC Israel partners and held in the NW Negev desert. The TS encompassed lectures, field visits, and selected experiments within an arid ecosystem containing sandy, rocky and loessial soils. About 35 applications were received. A total of 8 European PD, PhD and MSc students were accepted in the TS along with 3 Israeli graduate students. All Trainees had educational backgrounds relevant to the TS. Three Hebrew University scientists (molecular ecology, earth sciences, plant sciences) and a German professor of soil conservation, a Dutch micrometeorologist, and an Italian agricultural biotechnologist comprised the Trainers and brought together a wealth of experience and interdisciplinary knowledge.

The sand dune belt has biological sand crusts (BSC) that play a major role in stabilizing sand dunes in many desert areas. The destruction of this crust by anthropogenic activities promotes land degradation and desertification and has led to serious ecological and socio-economic problems in sandy areas of the Mediterranean Basin. This is evident along the northern half of the Egyptian-Israeli-Gaza Strip border, easily recognized in satellite images due to the high albedo on the Egyptian side caused by severe land degradation. In contrast, the protected Israeli side appears much darker. By stabilizing the mobile sand surface, the BSC provides conditions conducive to seed germination, plant establishment and plant productivity. Accordingly, there is considerable value in understanding the mechanisms that allow sandy regions to become stable or recover following disturbance of their protective BSC as this can lead to approaches and methods to encourage/accelerate crust formation and the return of vegetation. Topics and experiments (controlled and field) covered included:

-effect of grazing and agriculture along the Egyptian-Israeli border-role of biological sand crusts (BSC) in stabilizing dunes
-disturbance and recovery of BSC
-overnight/early morning experiments on BSC activity
-meteorological experiments; dew, soil moisture, temperature
-soil field exercises on BSC, disturbed plots, and sand
-Israeli agricultural activities and problems with sand mobility

In contrast, rocky geomorphology in arid and semi-arid regions can lead to the development of an ecosystem reliant on runoff water. The concentration of runoff water

creates patches and belts along the hillslope that are more fertile since an annual rainfall of 100 mm can be the equivalent of 200 or 300 mm in such runoff receiving areas. Observations on runoff water led to the ancient Nabatean kingdom (app. 200 BC-100 AD) developing unique techniques and approaches to control runoff water, maximize runoff water yields, store water, and develop several towns in the northern Negev to support their trade route industry from Arabia to Egypt. This was a remarkable feat given that annual rainfall in the northern Negev is 100 mm and falling within 3-4 winter months. Over the past 50 years, research in the Negev on rain/runoff/surface properties led to novel ways to increase ecosystem productivity such as hillslope minicatchments to support tree growth, and disturbance of soil surfaces to encourage infiltration.

Topics covered included:
-Ancient Nabatean and modern runoff and agriculture techniques, related archaeological sites
-Tree planting on rocky arid hillslopes
-Induced disturbance of the landscape to increase production
-Planted forests

Linkages created:
As a result of the Negev TS, this cluster of young researchers specializing in crusts has established an internal network to maintain contact and update each other about their research. We hope that such contacts will be maintained and developed. Knowledge of crust research being carried out in Spain was presented by 1 of the Spanish PhD Trainees. At least 1 of the Israel MCs and 1 or 2 of the Israeli Trainees plan to attend a Workshop in Spain in June 2013 dedicated to crusts.
(https://sites.google.com/site/biocrust2013/home)

Some highlights of the TS
This Negev TS enabled some unique and interdisciplinary short-term experiments to be carried out under controlled and field conditions. As examples:
-photosynthetic activity gain/loss of the Biological Soil Crusts was conducted overnight using a fluorometer and measurement of the fluorescence signal during desiccation at early morning. This was done in parallel with micrometeorological measurements.
- some advanced fine TDR (Time Domain Reflectance) probes were inserted just below the Biological Soil Crust to test for sensitivity to dew input.
- an optical wetness sensor (OWS) was used as an independent means of measuring crust surface moisture. This OWS was also tested with crusts placed within a controlled humidity/light/temperature chamber.
-an electronic penetrometer was tested to assess soil crust strength in the field.
-a thermal camera was used in the field to assess surface temperature differences and variability of crusts, disturbed crusts, mobile sand, vegetation, etc. Even under late winter conditions, differences of up to 20^0C were found between them. This is not surprising from a micro-climate point of view but is of potential value to biologists investigating organism response(s) or adaption(s) to stress.