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Object: Scientific Report for the STSM Proposal “The effect of facilitation on water and soil connectivity paths in the Mediterranean semiarid brushlands”

Reference: COST Action ES1306

Reference code: COST-STSM-ECOST-STSM-ES1306-150315-056724

Host institution: Department of Geography and Environmental Studies - University of Haifa

Period: 15/03/2015 to 29/03/2015

Grantee: Chiara Callegaro, University of Padova (Italy).

Host: University of Haifa (Israel)

Purpose of the visit

The mobility was aimed to open a discussion thread between the host and guest research groups about the role of inter-species facilitation on water and soil connectivity paths in the Mediterranean semiarid brushlands.

Description of the work carried out during the visit

An initial briefing took place, aimed to outline the current research activities which are being carried out by the two research groups.

Theoretical framework and experimental evidences about inter-specific facilitation between plants were shared.

Data collected by Dr. Wittenberg and Dr. Malkinson from an experimental field in a post-fire situation were made available to Ms. Callegaro in order to analyze them numerically. The correlation between different shapes of vegetation and soil patches and the run-off coefficient and solid waste concentration were investigated. Particular attention was drawn to the connectivity between soil patches, and its effects on the run-off motion and erosion process.

Digital images of the plots were processed with GIS and an algorithm was developed in order to automatically detect soil patches in the digital images and evaluate their geometric properties. A number of indices for describing the effectiveness of the patches distribution in run-off production and erosion were designed, and a correlation was drawn between these indices and empirical measurements of run-off and sediment transport.

A field survey allowed Ms. Callegaro to observe the monitoring techniques used in post-fire experimental sites. A further trip through the Negev desert allowed Ms. Callegaro to watch closely the state of the desert after the exceptionally 2014/2015 wet season.

Description of the main results obtained

The analysis of the experimental data shows that the shape of the patterns and their orientation with respect to the run-off flow direction is positively correlated with the run-off coefficient. This is especially clear for high precipitation events, and the correlation is even stronger if data are scaled by precipitation levels. On the other hand, the simple ratio of

bare soil cover turns out to be a very bad predictor of run-off. This result is of great interest because, up to now, the run-off coefficient is generally evaluated based on the soil cover distribution, while spatial patterns in soil cover are overlooked. Our study suggests that the pattern shape and orientation, which are tightly related to their connectivity in the sense of preferential flow paths, play a dramatic role in run-off production.

The correlation between the soil pattern configuration and sediment transport seems to be weaker, suggesting that the erosion process is a much less linear phenomenon, where the after-fire transitory probably plays a crucial role in the soil structure (presence and loss of dead vegetation roots, ashes).

Further developments are under work, meant to explore the analogies between the role of surface connectivity in run-off and sediment production and the role of the vadose zone connectivity in groundwater flow.

Description about how the results contribute to the Action aims

The results of the STSM contribute to the main aims of ES1306 Action, Working Groups 1, 3, and 4. In particular, our finds meet the aim of WG1 as the role of patches shape and orientation in water and sediment connectivity is highlighted. The development of an algorithm for digital images analysis explicitly aimed at identifying soil cover patches meets the goals of WG3. In accordance to the objectives of WG4, we identified an index that takes into account the shape and orientation of the patterns and is thus a measure of their tendency to be connected, and this index turned out to be a very good predictor for run-off.

Future collaboration with host institution

The Mission offered the opportunity to the two teams to get to know each other's research topics and resources. Short and long term future collaboration opportunities are under evaluation, such as the planning of a Summer School hosted by the University of Padova, possibly with the presence of a Professor from the University of Haifa, and a one year stay for future PhD students in the mutual Universities.

Projected publications/articles resulting or to result from the STSM

The results of the work carried out during the visit are going to be reported and discussed soon in a paper (manuscript under preparation).

Moreover, a further paper is under review that was benefitted by exchange of ideas during the CONNECTEUR meeting in Valencia (January 2015) and by and in the phase of preparing the STSM in Israel.

Authorization to post the report at the Action website

I hereby authorize the Action Committee to post the report at the Action website.

Chiara Callegaro