COST Action ES1306

Short Term Scientific Mission Report

COMPARING SEDIMENT CONNECTIVITY IN TERRACED AGRICULTURE AND FIRE-DISTURBED FORESTS, AND THEIR CONSEQUENCES FOR LONG-TERM SEDIMENT YIELD, USING A MODELING APPROACH

Beneficiary: João Pedro Nunes, University of Aveiro, Portugal

Host: Saskia Keesstra, Wageningen University and Research centre, Netherlands

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1. Introduction

In the last decades, the mountains of the NW Iberian peninsula have experienced a large-scale replacement of traditional agriculture by commercial forest plantations with eucalypts and maritime pines. Traditional land-management relies on intricate networks of terraces and irrigation channels to enhance water connectivity while breaking sediment connectivity and conserving soil in the fields. Commercial forest management, on the other hand, leads to regular disturbances of vegetation and soil (every 12 years in eucalypt plantations) which greatly enhance water and sediment connectivity during a few years. Recurrent forest fires might enhance these disturbances.

It is therefore possible that afforestation and forestry management has actually enhanced soil erosion when compared with traditional agriculture. However, the irregular nature of forest disturbances and enhanced connectivity periods makes this problem difficult to assess with observations. Different methods such as spatially-distributed models are required to evaluate these processes and estimate actual long-term erosion rates.

2. Purpose of the STSM

This STSM aimed to take advantage of data collected at the University of Aveiro in Portugal on erosion in agricultural and burnt forests, and of the LAPSUS-D spatially-distributed sediment yield model developed at Wageningen University & Research centre in the Netherlands (Keesstra et al., 2014). The Macieira de Alcoba mountain catchment (1 Km^2) was instrumented in 2010 in order to study soil erosion in terraced agricultural fields, but a forest fire in 2011 allowed a comparison of erosion and sediment yield between both areas. Furthermore, the catchment was already instrumented during a previous fire in the early 1990s, allowing for an

assessment of the impact of repeated fires. An application of the LAPSUS-D model to the Macieira catchment for the period between the late 1980s and now will highlight how sediment connectivity differs between terraces and plantation forests, especially under fire and clear-cut disturbances, and how this could influence long-term erosion rates in the region.

The main purpose of the present one week STSM was, therefore, to set up a collaboration between UA and WUR to complete this work.

3. Description of the work carried out during the STSM

Over the course of this week-long STSM I have visited Saskia Keesstra, the developer of LAPSUS-D, and her team at WUR. During our discussions, we have:

- examined the Macieira de Alcoba case-study and available data, with implications for sediment connectivity in the catchment;
- discussed the LAPSUS-D model, its capacities, limitations and data requirements;
- examined the available data for Macieira, and what would be needed to apply LAPSUS-D to the catchment;
- designed a model experiment to assess the impacts of fires and terraces on connectivity in Macieira using LAPSUS-D;
- designed a workplan to achieve these results, and explored ways to fund further collaboration.

The interactions also allowed for meeting the team and to discuss other collaboration possibilities in connectivity studies.

4. Description of the main results obtained

The main result of this STSM is a workplan aiming to estimate erosion in terraced agricultural fields and pine/eucalypt plantation forests in Macieira, central Portugal, from 1980 to present, a period including several wildfires and clearcutting operations. The analysis tool will be the LAPSUS-D landscape evolution model, which has an adequate spatial resolution to simulate the impacts of terraces and forest disturbances on hydrological and sediment connectivity, while taking individual storms into account. The model will be calibrated for the area using a 4-year dataset with hydrological and spatially-distributed erosion measurements.

The workplan will last for 6 months, and will include the following tasks:

1) process existing data to conform with LAPSUS-D requirements;
2) apply, evaluate and if necessary modify LAPSUS-D;
3) compile information on land-use evolution and forest disturbances using satellite imagery since 1980 (Landsat);
4) apply the model to estimate long-term erosion rates between 1980 and 2015 in agricultural and forest terrains, taking forest disturbances into account.

This work will result in two collaborative publications. The first, to be submitted in the middle of the workplan, will evaluate LAPSUS-D in simulating spatial patterns of erosion using the Macieira dataset. The second, to be submitted at the end of the workplan, will focus on the long-term impacts of short periods of enhanced connectivity for soil loss.

5. Description about how the results contribute to the Action aims

This STSM has contributed to COST Action ES1306 by promoting a joint European collaboration on connectivity. While this was only a preparatory mission, it was relatively short and inexpensive. The future collaboration will study two different patterns of hydrological and sediment connectivity coexisting in the same landscape: a terraced agricultural patchwork and a forest experiencing recurrent periods of high connectivity. Both are poorly studied, and this work will highlight how a transition between connectivity patterns can impact a landscape. The work will therefore be within the scope of the COST action, especially related with WG2 (data) and 3 (models), since it will take a spatially-distributed dataset and analyze it with a model-based approach, but also with WG5 (sustainable management) by looking at connectivity as an explanation on the impacts of recent afforestation on hydrology and soil loss.

6. Other comments

A letter from Saskia Keesstra from WUR confirming the successful execution of the STSM is attached. I hereby authorize posting this report at the COST ES1306 Action exercise.

Aveiro, 18/02/2015

João Pedro Carvalho Nunes