Evaluating land management practices for improving sediment retention and water supply ecosystem services in Rilán Peninsula, Chiloé Archipelago, Chile

Investigación CECPAN

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Introduction

Laminar erosion and water scarcity are two critical challenges facing the Chiloé Archipelago in southern Chile, affecting ecosystem services to rural families and others. The area is experiencing rapid deforestation, and ongoing land clearing for timber extraction and ranching is increasing the pressure on local communities, at expenses of native forest (Arenas, Andrade, & Qüense, 2001). People in the Archipelago rely on healthy soils to provide ecosystem services such as productivity (for small-scale farming) and regulating seasonal water supply. Given that water use in this area is primarily from surface and shallow subsurface waters, erosion, soil loss, and the resulting loss in soil water storage capacity directly impact the availability of water to users.

Objectives

This study aims to: (a) evaluate current soil erosion and dry season water availability; (b) link soil erosion and water scarcity to landscape condition and other external parameters; and (c) provide a prioritization guide to decision makers that identifies priority areas to intervene with soil and water conservation activities, in order to promote better management decisions.

Methodology

Soil erosion and water availability were modeled in small coastal watersheds of the Rilán Peninsula, an area highly affected by anthropogenic impacts. Soil erosion was modeled using the InVEST Sediment Retention model (The Natural Capital Project, 2015) and water availability was modeled using the SWAT hydrologic model (Neitsch, Arnold, & Kiniry, 2011). To develop a prioritization scheme for determining which watersheds will most benefit from soil and water conservation activities, we will use the Analytic Hierarchy Process (AHP; Saaty, 2008). This method assumes that factors will contribute unequally to the process analyzed, and uses weights to represent the relative importance of each parameter. In the AHP, we will consider our model results as well as other parameters related to soil erosion and water availability: Land cover; Anthropogenic intervention on landscape (Steinhardt *et al.*, 1999); Water supplied by Municipalities; and Soil infiltration capacity (Hydrogroup). This process analyzes the relative weight of every parameter with respect to the others to generate the individual contribution to the soil erosion and water scarcity. The result of applying the AHP method will be a selection of prioritized watersheds where we will apply the RIOS model (Vogl *et al.*, 2015), a tool which supports the design of cost-effective investments in watershed services.

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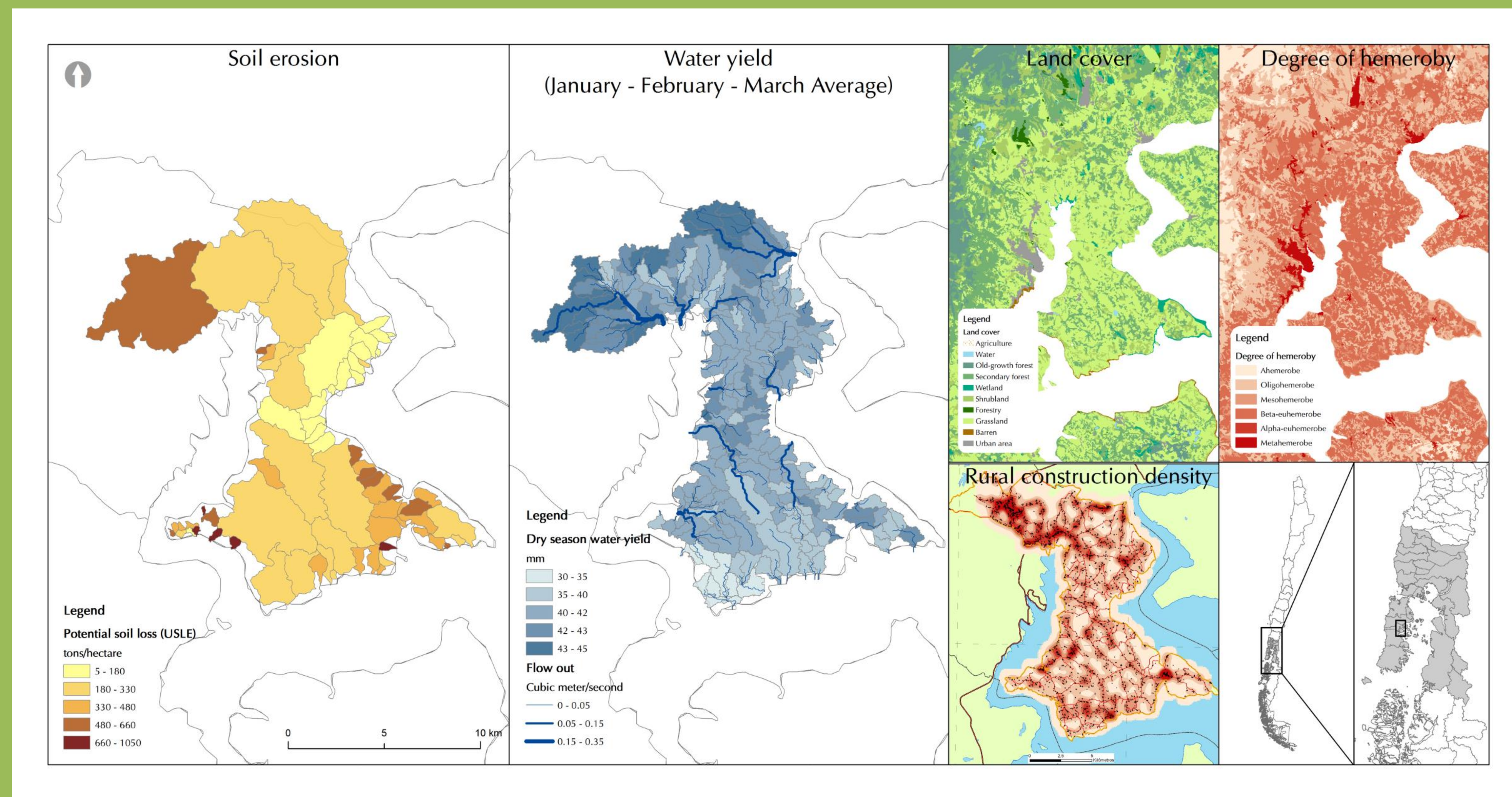

Results

Spatial analysis of both erosion and SWAT models show extreme values in the northern area of study: the highest values of soil erosion, as well as retention; and the highest values of water yield and water flows during the dry season in Rilán peninsula. The northern part is one of the most populated areas of the peninsula. However, there are also some high-density areas in the south and south-east zones, where water is much scarcer and we also see very high erosion values.

From the modeling results, it cannot be concluded that land use is a determining factor for the water availability in the area. This might be related to the fact that the SWAT model is not only considering land use, but is also very sensitive to soil characteristics. Precipitation is neither a determining parameter, as it appears to be similarly distributed through the whole area. Thus, results might need a deeper analysis on soil parameters.

Local context	Science	Politics	Population
Planning & Funding			
Deforestation Erosion Water scarcity	Surface water use Erosion/Retention map Water availability	Technical Political	Application Participation
Problem definition	Analysis	Decision-making	Benefits

Next steps

Once the results are further analyzed, individual parameter weights related to soil erosion and water scarcity are going to be determined through the AHP method. This will lead to a watershed prioritization, identifying priority watersheds for application of the RIOS model. Finally, the results provided by RIOS will be a guide to improve the decision-making process, identifying the best locations for protection and restoration activities in order to maximize the ecological return on investment, within the bounds of what is socially and politically feasible.

Erosion model results have already been delivered to the Ministry of Agriculture (MINAGRI), so the Institute of Agricultural Development (INDAP) is aware of the problem relevance and is able to consider changes in their planning. The Chilean government has financial resources assigned for the restoration of degraded soils. Since Chiloé is one of the FAO's Globally Important Agricultural Heritage Systems (GIAHS) of the world, this study is relevant to the discussion of whether to assign some of these resources to Chiloé and to start executing soil restoration plans in the archipelago. At the moment, the plan has gotten approval from the regional technical team, and the islands are waiting for the national level authorization.

Water yield results can be the basis for future water policies since they show critical areas where to prioritize interventions. Applying RIOS modeling, management practices will be suggested in order to improve soil quality, water flows and groundwater recharge in those areas. Since the management activities considered in RIOS will be the ones considered in the Forestry National Corporation (CONAF) and the Institute of Agricultural Development programs, an application of RIOS results in their planning seems feasible.

Coastal areas in Chiloé are defined as highly intervened and dynamic spaces (Arenas, Andrade, & Qüense, 2001), which is another reason for prioritizing the implementation of conservation and restoration actions on watersheds providing ecosystem services, such as of old-growth forest areas (Gutiérrez *et al.*, 2009).

Data limitations

An important point to consider in the local context is the data limitation. This is a direct consequence of the lack of monitoring and controlling soils effects on ecosystem levels. The national institutions (in different scales) act reactively, so there isn't an effective management or a proactive vision for the territory. The involvement of participative planning and related projects funding could improve the current situation.

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