EGU21-8848
https://doi.org/10.5194/egusphere-egu21-8848
EGU General Assembly 2021

Identification of the preferred areas for animal burrowing activity with regard to the land cover, topography and soil properties using very high resolution WorldView-2 and LiDAR data

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Bioturbation is assumed to be coupled with vegetation, soil properties and topography. The soil properties influence the amount of nutrients needed for plant growth and determine the resistance of the soil to the burrowing itself and to the burrow stability. Vegetation provides food and shelter for the animals. At the same time, the burrowing destroys the plant roots while the animal presence and changed vegetation distribution affect soil properties. Additionally, the soil properties and vegetation also depend on topographic features as height, aspect or curvature.

This relation between the bioturbation, soil properties and topography are to date understudied, in particular how and if the co-dependencies differ between various climate zones. High resolution remote sensing data provide here a sufficient method to study these dependencies as the soil characteristics change rapidly on microscale. However, the application of fused high resolution WorldView-2 data and LiDAR data for the prediction of bioturbation and soil properties are completely missing.

In our study we used WorldView-2 and LiDAR data with a resolution of 0.5m for a machine learning based prediction of visible indicators of bioturbation activity (number of holes and mounds) and related soil properties. We obtained a land cover classification from the WorldView-2 data and topographic features from the LiDAR data. We then analyzed the relationship between bioturbation, soil properties, land cover and topography in arid, semi-arid and Mediterranean climate zone in Chile.

For this, we measured the number of holes and mounds created by burrowing animals within 60 plots of 10mx10m randomly dispersed on six hillsides in the three climate zones. On each hillside, 20 soil samples were taken in regular distances from the crest to the bottom of each hillside. The soil samples were analyzed for soil skeleton fraction, above ground skeletal fraction, nine soil texture classes, bulk density, water content, organic carbon, porosity, erodibility and skin factor.

We carried out an orographic and topographic correction of the WorldView-2 images and classified the land cover into soil, rocks, cacti, shrub, trees and palms. We calculated several topographic features from the LiDAR data as height, slope, aspect, curvature, surface roughness and flow direction. We then used the WorldView-2 bands, vegetation indices and topographic features to upscale the bioturbation activity and soil properties into the area of 5x5 km at each site using the random forest machine learning algorithm.

Our results show that the bioturbation activity is best predicted by WorldView-2 data and vegetation indices while the soil properties can be best predicted by topography. The bioturbation activity strongly depends on land cover and vegetation distribution in the Mediterranean climate zone while there is a stronger link of bioturbation activity to topography and soil properties in the arid and semi-arid climate zone.