Geophysical Research Abstracts
Vol. 19, EGU2017-2240, 2017
EGU General Assembly 2017

Quantifying long-term human impact in contrasting environments: Statistical analysis of modern and fossil pollen records

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Reconstructing and quantifying human impact is an important step to understand human-environment interactions in the past. Quantitative measures of human impact on the landscape are needed to fully understand long-term influence of anthropogenic land cover changes on the global climate, ecosystems and geomorphic processes. Nevertheless, quantifying past human impact is not straightforward. Recently, multivariate statistical analysis of fossil pollen records have been proposed to characterize vegetation changes and to get insights in past human impact. Although statistical analysis of fossil pollen data can provide useful insights in anthropogenic driven vegetation changes, still it cannot be used as an absolute quantification of past human impact. To overcome this shortcoming, in this study fossil pollen records were included in a multivariate statistical analysis (cluster analysis and non-metric multidimensional scaling (NMDS)) together with modern pollen data and modern vegetation data. The information on the modern pollen and vegetation dataset can be used to get a better interpretation of the representativeness of the fossil pollen records, and can result in a full quantification of human impact in the past. This methodology was applied in two contrasting environments: SW Turkey and Central Spain. For each region, fossil pollen data from different study sites were integrated, together with modern pollen data and information on modern vegetation. In this way, arboreal cover, grazing pressure and agricultural activities in the past were reconstructed and quantified. The data from SW Turkey provides new integrated information on changing human impact through time in the Sagalassos territory, and shows that human impact was most intense during the Hellenistic and Roman Period (ca. 2200-1750 cal a BP) and decreased and changed in nature afterwards. The data from central Spain shows for several sites that arboreal cover decreases bellow 5% from the Feudal period onwards (ca. 850 cal a BP) related to increasing human impact in the landscape. At other study sites arboreal cover remained above 25% beside significant human impact. Overall, the presented examples from two contrasting environments shows how cluster analysis and NMDS of modern and fossil pollen data can help to provide quantitative insights in anthropogenic land cover changes. Our study extensively discuss and illustrate the possibilities and limitations of statistical analysis of pollen data to quantify human induced land use changes.