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Active tectonics in the Mygdonia basin (northern Greece): a combined seismological and remote-sensed geomorphology approach

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In Greek mainland, active extensional deformation resulted in the development of numerous seismogenic E- to SE-trending basins. The Mygdonia graben located in central Macedonia produced major historical earthquakes and poses a serious threat to the neighbouring city of Thessaloniki. Our aim is to determine which active seismic sources have the potential to generate strong events. Active tectonics shape the landscape, control the evolution of the fluvial network and cause the occurrence of strong and frequent earthquakes generated by fault populations. Thus, our approach combined both seismology and remote-sensed geomorphology.
Seismological investigation and more especially relocation analysis was performed for recent seismicity in the area (2000-2012). Low magnitude earthquakes not exceeding 4.8 constitute the seismicity pattern for this period. Accurately determined focal parameters indicate that seismicity is not only localized along major fault zones. Smaller faults seem also to be activated. Temporal and spatial investigation show that seismicity is clustered and seismic bursts often migrate to adjacent faults. The hypocentral distribution of precisely determined microearthquake foci reveals the existence of high-angle (> 60º) normal faults dipping both south and north. This is consistent with fault plane solutions of stronger earthquakes. The largest amount of earthquakes is generated along the NW-SE sub-basin bounded from "Assiros-Analipsi" and "Lagina" fault zone, as well as in "Sochos" fault in the north which dips with approximately 70º-80º to the south. All these structures played an important role in the seismotectonic evolution of the area.
We used geomorphic indices in order to analyse the landscapes of the Mygdonia region. Geomorphic indices were derived from DEM and computed using MATLAB scripts. We classified the landscapes according to their erosional stages using hypsometric integral and surface roughness. Both indices suggest stronger erosion along the southern flank of the Mygdonia graben. Observed differences may be related to a diachronic evolution. River profiles crossing the Thessaloniki-Gerakarou fault system (TGFS) south of the Mygdonia basin display anomalies such as knickpoints or convex segments. These anomalies reflect significant changes in river base-levels possibly triggered by uplift/subsidence processes. We also computed the normalized steepness index (ksn) for concave segments in rivers. We observe an increase of ksn values towards the south while the lithology remains almost constant. These changes in ksn values may be thus related to an increase in deformation rates along the southern TGFS. Our geomorphic analysis also highlighted several flat paleo-surfaces located on top of main ranges at elevations comprised between 300 and 450m above the basin infill. Finally, we produced thematic maps combining present-day seismicity, historical earthquakes and geomorphic features derived from DEM. The combined use of both seismology and remote-sensed geomorphology allowed us to better understand the at-depth and surface expressions of active structures within the Mygdonia basin. It also provided further insights into the tectonic evolution of the study area.

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