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Landslide hazard and forest fires - the relevance of geology for landslide type and development

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Current research indicates an increasing number of forest fires incidents and burned areas for Europe in the future (e.g. Moriondo et al., 2006). Besides economical and environmental impacts they can cause future "secondary" hazards like landslides, debris flows and flash floods. There are many past and current studies investigating effects of erosion and landslide phenomena like debris flows in burned areas (s. Shakesby & Doerr, 2006). The influence of the geological framework is often neglected in these studies. Furthermore, deep seated landslides and slumps are only hypothetically described (Swanson, 1981). To study the relevance of geology and to observe the processes, areas in Attica and the western Peloponnese in Greece burned by the catastrophic wildfires of 2007 and 2009 were investigated.

The Tertiary Flysch units and the Neogene deposits in the Pyrgos area of the western Peloponnese are generally a landslide prone area. The slopes in the area show the typical morphological features of a landslide landscape. This is not only true for the in 2007 burned areas but also for unburned areas even in some kilometre distance. Large rotational slides with 20 m and higher main scarps interact and build up complex staircase landslide cascades. Even so vegetation indicates for the unburned areas currently a low activity. In contrary in the burned areas even 2 years after the fires many recent effects from landslides can be observed, like slope failures, cliff break ups, road failures, destroyed retention walls and cracks in houses. While the shallow landslides show a very high dynamic, also older larger landslides are developing or reactivating. As the changes in landslide activity are limited to the burned areas, it is reasonable that the changes in the hydrological conditions like Swanson (1981) predicted due to the destroyed vegetation are the main trigger mechanism for the new and reactivated landslides. An increased availability of water at the sliding plane and the additional weight of the saturated soils change substantially the limit equilibrium. In general the findings show that the changed environmental conditions due to the fires drastically increased the landslide activity in the area at least locally. In Attica, the affected areas are mostly located in Mesozoic metamorphic units build up from schist and marbles. As the fires stopped only two months before our site visit, the landslide effects are not that explicit and were just beginning to develop. Furthermore, due to the different geology and morphology the areas are not known as typical landslide areas. In the schist areas besides the development of rills and gullies, at several localities shallow soil slip with some 10 m extension could be observed. Anyhow the processes were limited to the weathered cover of the rocks which are much more permeable. On the other hand, in the marble areas only local erosion in the thin soil cover and first activation of debris could be observed. Anyhow, heavy precipitation events lead already to flooding.

The results show that the type and extend of landslides which develop after a fire incident are also controlled by geological features like rock types or permeability. Moreover, in an appropriate landslide environment even very large landslides might develop after a forest fires.

Moriondo, M. et al. 2006. Potential impact of climate change on fire risk in the Mediterranean area. Climate Res. 31, 85-95.

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Swanson, F.J., 1981. Fire and geomorphic processes. in: Mooney et al. (Eds.), Fire Regime and Ecosystem Properties, USDA For. Serv. Gen. Tech. Rep. WO-26, 401–421.