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Alterations of C allocation patterns associated with climate-change induced vegetation die-off: effect over soil pools, soil biodiversity and functions and controls of soil respiration

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The number of episodes of forest defoliation and mortality associated with drought events has increased substantially during the last decades, and they are further expected to increase even more given the projected climate change scenarios. These increase in episodes of tree mortality suggest that many tree species worldwide are experiencing their survival limits under the currently warmer and increasingly drier conditions (especially during summer). For instance, in the past years, extended tree mortality has been observed in the temperate-continental climate region of Romania (Eastern Europe), where due to the decreases in summer precipitation many populations of Scots pine (Pinus sylvestris L.), Black pine (Pinus Nigra subs. nigra), and Silver fir (Abies alba Mill.) have suffered substantial damages. This phenomenon is extended also in the Mediterranean basin, where, many tree species have started to show increased rates of crown defoliation, reduced growth, and mortality during the last decades. Here, even drought-tolerant species, such as Quercus ilex L. subsp. ballota [Desf.] (Holm oak) have started to show acute signs of decline, extended areas from the Iberian Peninsula being affected. Less is known, however, about how and at which extent climate-change induced vegetation mortality may alter patterns of carbon (C) allocation to e.g. vegetative growth and plant allocation to soil organs and soil organic matter (SOM). The loss of health and subsequent death of the vegetation is responsible for both modifying abiotic conditions (e.g. radiation incidence and soil moisture) and limiting the capacity of ecosystems to capture carbon (GPP) and hence supply the energy (carbohydrates specially) demanded by soil biological communities. This may result in irreversible losses of the soil biodiversity that sustain soil functions (e.g. nitrogen fixation, mineralization of essential nutrients or C stabilization) and hence on the capacity of soils to store carbon (C) and retain/provide essential nutrients like nitrogen (N) or phosphorous (P) to further sustain ecosystem growth and health. We here want to summarize the results obtained from a large latitudinal study consisting on a total of more than 30 permanent plots distributed thought the Iberian Peninsula (Spain) and the Carpathians mountains (Romania) to investigate the effects of tree defoliation and mortality over historical growth patterns (dendrochronology, NDVI), leaf/root functional traits, soil C and nutrient pools, soil biodiversity and soil functioning. Our results show strong decadal-time scale impacts of climate-change related tree mortality over vegetation growth and C allocation patterns, alterations of the vegetation functioning (leaf and fine roots functional traits) and dynamics (secondary sucesional processes) causing chronic effects over the diversity and capacity of soil biota to provide essential functions for ecosystem survival and resilience. Alterations of the controls and magnitude of key ecosystem processes such as soil respiration, the larger outgoing flux of CO_2 from terrestrial ecosystems, further suggests that models should take into account tree health and mortality in order to predict future terrestrial emissions in scenarios of climate change.