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Species-specific tree architectures, leaf traits and soil cover affect splash erosion and interrill sediment transport under forest

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Vegetation cover represents a major factor of soil erosion control and afforestation is a common restoration measure in regions prone to soil losses. Nevertheless, mechanisms of soil erosion under forest are complex due to manifold alteration of rain drop patterns by forest canopies as well as changes of splash and interrill erosion by root systems and different types of soil surface cover. So far, only few studies were conducted on the processes involved and basic principles of soil erosion under forest canopies still remain unclear. This is especially true regarding effects of tree diversity.

To investigate the influence of forest vegetation on splash and interrill erosion, studies were conducted within a forest biodiversity and ecosystem functioning experiment in Southeast China (BEF China). The investigations concentrated on throughfall kinetic energy (TKE) of rain drops measured with splash cups (Tübingen Splash Cup) and initial sediment delivery measured with micro-scale runoff plots (ROPs). Tree and leaf traits of different species in monocultures as well as different species mixtures were surveyed and soil surface cover including biological soil crusts and leaf litter were characterised in detail.

Tree species richness affected TKE at the local neighbourhood scale, which was due to larger crown areas and higher tree heights in more diverse neighbourhoods. Although a negative trend was detectable from diversity level 1 to 8, no further tree and leaf diversity effects on TKE or initial sediment delivery could be found. This was most likely caused by the early successional stage of the forest. Nevertheless, TKE and initial sediment delivery were highly species-specific. TKE was higher than mean TKE of all other species below Choerospondias axillaris and Sapindus saponaria and lower below Schima superba. At the same time, increasing soil erosion rates were related to Choerospondias axillaris, Cyclobalanopsis glauca, Rhus chinensis and Koelreuteria bipinnata; whereas Magnolia yuyuanensis, Lithocarpus glaber, Elaeocarpus chinensis and Liquidambar formosana showed decreasing rates. Initial sediment delivery was further influenced by biological soil crusts, varying leaf species and soil macro fauna within the leaf litter layer.

Species-specific differences were caused by tree architecture and leaf traits. Low LAI, low tree height, simple pinnate leaves, dentate leaf margins, a high number of branches and a low crown base height effectively minimised TKE by changing rain drop velocity and size. Furthermore, evergreen species showed lower TKE than deciduous species. Moreover, TKE was spatially variable at this early stage of the forest plantation and it was lowest below the first branch of a tree individual and highest in the middle of four tree individuals due to low interception.

The erosive potential of natural rainfalls in this particular experimental area could be mitigated by trees with leaf area < 70 cm2, heights < 290 cm, crown base heights < 60 cm, leaf area index < 1, more than 47 branches per tree and in single tree neighbourhoods. It can be concluded that the appropriate choice of tree species is of major interest for erosion control in early successional tree plantations.