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Kinetic energy of throughfall in a highly diverse forest ecosystem in the humid subtropics

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After decades of research it is generally accepted that vegetation is a key factor in controlling soil erosion. Therefore, in ecosystems where erosion is a serious problem, afforestation is a common measure against erosion. Most of the studies in the last decades focused on agricultural systems and less attention was paid to natural systems. To understand the mechanisms preventing soil erosion in natural systems the processes have to be studied in detail and gradually. The first step and central research question is on how the canopies of the tree layer alter the properties of rainfall and generate throughfall.
Kinetic energy is a widely used parameter to estimate the erosion potential of open field rainfall and throughfall. In the past, numerous studies have shown that vegetation of a certain height enhances the kinetic energy under the canopy (Chapman 1948, Mosley 1982, Vis 1986, Hall & Calder 1993, Nanko et al. 2006, Nanko et al. 2008) in relation to open field rainfall. This is mainly due to a shift in the drop size distribution to less but larger drops possessing a higher amount of kinetic energy. In vital forest ecosystems lower vegetation (shrubs, herbs) as well as a continuous litter layer protects the forest soil from the impact of large drops. The influence of biodiversity, specific forest stands or single species in this process system is still in discussion.
In the present study calibrated splash cups (after Ellison 1947, Geißler et al. under review) have been used to detect differences in kinetic energy on the scale of specific species and on the scale of forest stands of contrasting age and biodiversity in a natural forest ecosystem. The splash cups have been calibrated experimentally using a laser disdrometer.
The results show that the kinetic energy of throughfall produced by the tree layer increases with the age of the specific forest stand. The average throughfall kinetic energy (J m-2) is about 2.6 times higher in forests than under open field conditions. Most of the energy is supposed to be absorbed by shrubs, herbs and the litter layer. For some species in the shrub and herb layer throughfall drops are crucial for seed dispersal (Nakanishi 2002). A higher kinetic energy of throughfall should be advantageous for seed dispersal and probably support biodiversity.
Further, it is shown that the variability of kinetic energy in forests varies among the age of the forest stand which can be related to the forest structure. In our case there is a high variability in young forests (< 30 years) due to selective logging (some older trees were left out) and gaps in the tree layer. Old forests (> 80 years) also have a high variability in kinetic energy. There, external influences like snow and wind break result in a fragmentary tree layer which allows less erosive rainfall to reach the forest floor. Medium aged forests are more homogenous regarding canopy closure or tree heights. Generally, the variability of kinetic energy in forests is increasing with the amount of rainfall.
Moreover, it is shown that the kinetic energy of throughfall is species specific. For the investigated tree species the values range between 24.41 J m-2 mm-1 (Daphniphyllum oldhamii) and 33.24 J m-2 mm-1 (Schima superba) while the concurrent rainfall in the open field has an average kinetic energy of 6.75 J m-2 mm-1. Leaf size and canopy architecture are supposed to be two of the controlling variables for specific species.
These results give implications for afforestation measures and are important input variables for modeling of erosion processes.

Chapman, G., 1948. Size of raindrops and their striking force at the soil surface in a Red Pine plantation. Transactions – American Geophysical Union, 29: 664–670.
Ellison, W.D., 1947. Soil Erosion Studies – Part II. Agricultural Engineering, 28: 197–201.
Geißler, C., Kühn, P., Böhnke, M., Bruelheide, H., Shi, X., Scholten, T., under review: Measuring splash erosion

potential under vegetation using sand-filled splash cups.
Hall, R.L., Calder, I.R., 1993. Drop size modification by forest canopies: measurements using a disdrometer. Journal of Geophysical Research (D10), 98: 18465–18470.
Mosley, M.P., 1982. The effect of a New Zealand beech forest canopy on the kinetic energy of water drops and on surface erosion. Earth Surface Processes and Landforms, 7: 103–107.
Nakanishi, H., 2002. Splash dispersal by raindrops. Ecological research, 17: 663-671.
Nanko, K., Hotta, N., Suzuki, M., 2006. Evaluating the influence of canopy species and meteorological factors on throughfall drop size distribution. Journal of Hydrology, 329: 422–431.
Nanko, K., Mizugaki, S., Onda, Y., 2008. Estimation of soil splash detachment rates on the forest floor of an unmanaged Japanese cypress plantation based on field measurements of throughfall drop sizes and velocities. Catena, 72: 348–361.
Vis, M., 1986. Interception, drop size distribution and rainfall kinetic energy in four Columbian forest ecosystems. Earth Surface Processes and Landforms, 11: 591–603.