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Overland flow connectivity in a forest plantation before and after tree thinning (Tochigi Prefecture, central Japan)

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Overland flow connectivity is a key factor to understand the redistribution dynamics of sediments, nutrients, radiotracers, etc., in the different compartments at channel, hillslope and catchment scales. Human organization of landscape elements has a significant control on runoff and soil redistribution processes. Construction of trails, forest roads and firewalls influence runoff connectivity (RC) in forested catchments. In this study we simulated RC in two forested catchments, called K2 (19.3 ha) and K3 (13.6 ha), located on the Mount Karasawa, in the Tochigi Prefecture in central Japan. Forest plantation includes Japanese cypress and cedar and covers 59% of the total area. Native broad-leaved trees (28%) and mixed forest occupy the rest of the study area. We selected the Index of runoff and sediment Connectivity (IC) of Borselli et al. (2008) to simulate three temporal scenarios: i) Sc-2011, before tree thinning (TT); ii) Sc-2012 after TT in most part of the forest plantation in K2 (32% of the total area); and iii) Sc-2013 after TT in some areas of the K3 catchment, affecting 38% of the total area. The study areas were defined from the coalescence point (139^0 36' 04" E, 36^0 22' 03" N) of both catchments upslope. Elevation ranges from 75 to 287 m a.s.l. and the mean slope steepness is of 67 and 65% in K2 and K3. Three different high resolution DEM-LiDAR maps at 0.5 x 0.5 m of cell size were used to run the IC model in each scenario. The permanent streams in the study area have a total length of 2123 m. The mean C-RUSLE factor was of 0.0225 in Sc-2011 and 21% and 25% higher in Sc-2012 and Sc-2013. The total length of the landscape linear elements incremented from 2482 m in Sc-2011 to 3151 m in Sc-2012 and Sc-2013 due to the construction of new skid trails in K2. The mean RC in the study area was of -4.536 in Sc-2011 and increased 7.4% and 8.9% in the Sc-2012 and Sc-2013, respectively, due to the tree thinning operations and the construction of new skid trails for timber activities (cut down and extraction). In Sc-2012 the management practices were only done in the forest plantation of K2 and the increment of RC within the affected area was of 20%. In Sc-2013 tree thinning was done in the coniferous plantation of K3 and the increment in RC within all affected areas was of 19%. In the three scenarios the highest values of connectivity appeared in the forest roads and skid trails. These two linear elements played a key role in the values and spatial patterns of RC throughout the catchments. The combined effect of tree thinning and new skid trails in one part of K2 triggered a significant increase of the RC in this area. Areas surrounding the divides were subjected to a small increment in RC (ca. 4.8%) whereas the increment of connectivity within the streams was of 9.3% and 10.6% in Sc-2012 and Sc-2013 related to the values in Sc-2011.