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Modeling the impact of forest roads on flood generation at the catchment scale

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The objective of this paper is to present a methodology to estimate the impact of forest roads as part of forest management practises on flood generation at the catchment scale.

The investigations were carried out in the Austrian mesoscale catchment of the river Traisen, primarily dominated by forest. The area of the catchment at the outlet is about 700 km^2. More than 90% of the forest land are managed. The length of forest access roads has substantially increased up to 4000 km in the catchment nowadays.

The impacts of access roads on runoff formation are seen in the intersection of slopes which reduces the slope length, the collection of surface water in ditches along the access roads, in draining the interflow of slopes and in an increase of less pervious surface.

A continuous, semi-distributed rainfall-runoff model, COSERO, is used to simulate the runoff of the catchment. The catchment is subdivided into homogenous units that were identified by intersections of sub-catchments, land cover information and elevation bands. For each unit the model requires a set of parameters which refers to mean characteristics like interception losses, infiltration capacity, soil storage capacity, road density, drainage density and surface roughness, hillslope length and distance to the outlet of the catchment in streams or ditches. Other parameters take different vegetation and land use types into account.

Surface and subsurface runoff flow to the outlet of the catchment on or in hillslopes and finally in streams or ditches. The mean values of these distances of the catchment are obtained using a digital elevation model (DEM), with and without the road network, respectively. Additionally, the effect of culverts can be taken into account by reducing the fraction of the stream distance by a factor, dependend on the mean distance between culverts.

The mean fraction of hillslope length to the whole distance to the outlet decreased from 7% to 4% with the road network. However, assuming a proper culvert system, this fraction merely decreased from 7% to 6%.

The kinematic wave model is used to estimate the relation between the hillslope length and length to the outlet of the catchment in streams to the parameters of the hydrological model for surface flow, subsurface flow and stream flow, respectively. Thus the parameters of each unit were adjusted to simulate runoff at the outlet of the catchment without a road network, taking the different road density of each unit into account.

This leads to a decrease of the magnitude of flood peaks and the flood volumes of 2% at the outlet of the catchment. Additionally the time of occurrence was slightly delayed.