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Prognosis of flow conditions for de-centralized seepage of rainwater from roads

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Urbanization programs that include the construction of new settlements or roads lead to an increase in surface sealing. Conventional road drainage is being carried out by a rainwater sewage system coupled with collection and detention basins. This leads to local decreases in evaporation and groundwater recharge, disturbing the natural local water balance. The increased number of climate changed induced extreme precipitation events leads to a higher risk of road floodings as a result of a failure of these systems. Furthermore, the treatment of the discharge loaded with contaminants (such as heavy metals and MTBE) is resolved neither ecologically nor technologically.
By using a natural, effective and sustainable evaporation and drainage strategy it is possible to reduce the probability of road floodings, to restore the natural local water balance and to establish ecologically and economically more beneficial rainwater drainage. By using PCSiWaPro®, a simulation tool for unsaturated soil zone processes developed at the Institute of Waste Management and the Technical University of Dresden, the effects of different atmospheric, hydrological and hydrogeological parameters and system conditions on the subsurface drainage flow conditions in the vicinity of a typical German highway road were studied. Special attention was given to the influence of extreme precipitation events on the drainage time at differently tilted parts of the surface, on surface drainages from lateral noise-protection barriers and on the probability of road surface underwashing. Differently constructed upper soil stratifications were tested for their ability to quickly drain water into the ground, which, besides the reduced risk of road flooding, also influence the duration time for the drainage water in each soil layer. Individual rainwater infiltration rates were applied for different regions of the model. The behaviours of three different types of soil (coarse sand, slightly silty sand and medium silty sand) were tested for their applicability as road base materials. The simulation results showed that for extreme precipitation events, the optimized decentralized road drainage system was able to discharge the accumulated rainwater.
In future applications, the unsaturated flow model will be extended to a reactive transport model in order to develop strategies for optimal local drainage system design with special regard to natural purification features of different soil layer types. Additionally, PCSiWaPro® can be coupled to a groundwater model to simulate the influence of potential local groundwater contamination by road discharge on the whole underlying aquifer.