



Optimal design of nature-based solutions in highway runoff management based on resilience to climate and pollution load changes

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Sedimentation ponds (SPs) are nature-based solutions (NBSs) for sustainable stormwater management. SPs control the quantity and quality of runoff and promote biodiversity. Hence, the optimal design of SPs is crucial for ecosystems resilience in urban and natural environments. This study aims to optimize the design of roadside SPs in terms of location and surface area, considering the resilience to stressors such as climate changes and pollution load variations. Accordingly, the highway runoff in a new 22 km highway (E18 Arendal-Tvedestrand) in southern Norway was simulated by the storm water management model (SWMM). The quantity and quality (BOD and TSS values) of highway runoff in all probable scenarios of existing uncertainties were estimated for potential outfall points using the repeated execution model of SWMM coded in MATLAB[®]. The scenarios were defined based on applying best management practices (BMPs), including grass swale and infiltration trench in different sections of the road that work before SPs, climatic (rainfall quantity estimated by the LARS-WG model), and modeling uncertainties (buildup and washoff coefficients). The generated dataset was then applied to assess the resilience of sedimentation ponds in potential outfalls to climate change and pollution load shocks. The resiliency was quantified for three metrics, including the quantity and quality of receiving runoff to sedimentation ponds and biodiversity in ponds over 25 years (2020-2045). The biodiversity index was defined based on Shannon's Entropy computed from field observation in 12 highway sedimentation ponds across Norway. Using this procedure, it was determined that the proper arrangement of BMPs along the road and the optimal design of ponds enhance the resilience of SPs by 40% over time. This study makes important contributions to stormwater management, the resilient design of NBS, and achieving UN SDG6 (Clean water and sanitation).