Geophysical Research Abstracts
Vol. 20, EGU2018-2790-1, 2018
EGU General Assembly 2018

Impacts of extreme rainfall events on riverine aquatic pollution and its mitigation strategies under the influence of climate change

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This study aims to evaluate the water quality of a river and the effectiveness of pollution mitigation strategies under the influence of extreme rainfalls resulting from climate change. The Erren River was chosen as the investigated watershed because it is a major water body in the southern Taiwan. The pollution discharges resulting from domestic, industrial and agricultural activities were estimated using the water quality monitoring results conducted by Taiwan Environmental Protection Administration (EPA) and local governing agencies. The endpoint attainable ratios with respective pollution sources were calculated as well. The HEC-RAS was employed to calculate the hydraulic parameters and the tidal impact on the downstream sections using the cross-section measurements provided by the Water Resources Agency (WRA). The water quality was simulated using Qual2K.

Adopting the proposition of the IPCC Fifth Assessment Report (AR5), the scenarios of RCP4.5 and RCP 8.5 were adopted to simulate the water quantity and quality of the near and far future (i.e. 2020∼2040 and 2080∼2100) because they were regarded as the typical future and extreme climatic conditions, respectively. The water quality indices of DO, BOD, SS and NH3-N were simulated accordingly. Furthermore, the Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) model was applied to estimating the river flow changes in the given scenarios. Pollution discharge data, endpoint attainable ratio correction and water quality parameters were introduced into QUAL2k to calibrate and verify water quality simulation under the low flow condition (i.e. Q75).

For assessing the effectiveness of pollution strategy, the contributions from both the sewer systems and on-site treatment facilities were evaluated. Using current situation as the baseline, the simulation results showed that the increase in NH3-N concentration in far future of RCP8.5 scenario was most significant, implying that the NH3-N is the water quality parameter with the highest sensitivity among the four investigated ones. In the case that all the on-site treatment facilities are put into service, the RCP8.5 scenario in the far future resulted in the highest concentration of SS, under which the SS concentration is estimated to increase at a percentage of 56%.

The integrated water quality modeling is shown capable of estimating the variation of water quality under the selected climate change scenarios. Using the integrated modeling framework as the forecasting tool, the potential contribution for pollution mitigation of the sewer systems and on-site treatment facilities can be evaluated, and the resulting outcome can be regarded as the basis for facility maintenance and strategic planning of river water quality protection in the future. Because the water quality of San-ye River, a major tributary of Erren River, is in the moderately-polluted to severely-polluted range currently, it is very much likely that its river water quality might be exacerbated to an even worse situation in the future under the extreme climatic scenario. Therefore, timely and effective pollution control measures should be implemented to assure the river water quality.