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Redox potential dynamics in a grassed swale used for storage and treatment

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Treatment wetlands are used to remove pollutants from water. Most swales are designed to infiltrate stormwater into the subsurface. A combination of both functions can help to enhance water quality and reduce flooding risks in urban areas. The chemical forms and possible removal of pollutants such as nitrate and heavy metals in wetlands are highly dependent on the redox conditions. The redox conditions are expected to be highly dynamic and dependent on water levels and flow. We studied the correlation between these factors in an urban grassed swale system, and show that more factors play a role in these systems than water levels alone.

The study system is located in the World Heritage site "Bryggen" in the city of Bergen, Norway. It consists of a series of SUDS, a socalled treatment train. The system is fed by storm water, which is at first stored in a rain garden then led to grassed swales. Water infiltrates into the subsurface in the swales. The reason for implementation of the system at this site is the protection of the highly organic archaeological layers at the site, which requires reduced conditions. Swales 1 and 2 were equipped with pressure loggers and multi-level redox and temperature probes (-2, -5, -10 and -20cm from surface). Redox and temperature probes were connected to a HYPNOS system. Measurements were taken for more than 1 year at 15 minute interval. A weather station supplemented the dataset with precipitation measurements.

The redox potential in the swales show a strong correlation with water level. The regularly flooded swale 2 shows frequent anoxic events (Eh < 200mV) where as swale 1 shows oxic conditions (Eh = 650mV) throughout the same measurement period. Swale 1 has fewer flooding events than Swale 2 and a more coarse soil with less organic matter than swale 2. These redox results are as expected given the local conditions, and show that redox conditions are localised phenomena that depend on local soil conditions.

Analysis of the redox conditions during single events reveal a time lag in response to flooding events. The lag period depends on the occurrence of previous events, as does the depth of anoxia. Even a short period with moist conditions without flooding could reduce the soil enough to obtain anoxic conditions at the depths -10 and -20cm. These results show that the microbial community, responsible for reduction in the soil, might not be homogeneous through time. The community will exhibit a certain level of conditioning after previous reducing or oxidizing events. Treatment systems that depend on a certain redox condition should therefor not be kept in another state too long, or given enough time to restore its function again.