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# Internal hydraulic efficiency of a surface flow constructed wetland receiving agricultural drainage water

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Surface flow constructed wetland (SF-CWs) also named as free water surface (FWS) constructed wetlands are cost-effective technologies designed to intercept and mitigate nutrient losses from agricultural drainage water to the aquatic environment. In ideal conditions the flow distributes uniformly across the system but in reality variations may be identified due to flow resistance and/or local external conditions. Thus, it is crucial to define the internal flow paths as they provide an understanding of the physical settings and define the pollutant distribution, which is available for biota assimilation and sorption by soil.

The investigated SF-CW was established in Fillerup (Denmark) in 2010 and it consists of a sequence of three deep zones alternated with two shallow zones. A total surface area of 0.28 ha (0.6% of the drainage area) is occupied by the system, receiving agricultural drainage water from 45 ha drained fields. A dye and ionic tracer tests using Uranine and Bromide (Br), respectively, were performed under equivalent conditions. The aim was to identify internal flow preferentiality and suggest design adjustments for the already operating SF-CW which also account for local external conditions. Images from the dye tracer test were only used for visual observation while water samples containing Br were collected and analyzed in the lab. The sampling included the outflow and a number of internal points (at 2 different depths) defining a 3D-transect grid system. Therefore, the analysis provides a time dependent, three dimensional characterization.

Outflow and internal Br breakthrough curves (BTCs) are left-skewed, with early and single peak arrival and pronounced tailing. A continuous flow field was created starting from the point-based data and using spline interpolation. Both dye tracer and spline interpolation results show flow preferentiality and lower hydraulic efficiencies along the southern side of the SF-CW. Analysis further shows improved water mixing and recirculation, primarily in the first deep zone. This is due to the presence of the shallow zones and to the action of the wind blowing in opposite direction to the flow.