An eco-efficiency evaluation of community-scale rainwater and stormwater harvesting in Aarhus, Denmark - DTU Orbit (17/08/2019)

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Urban areas in Denmark are currently challenged by the increase in extreme precipitation events, resulting in heightened flood risk, and higher water stress caused by population growth. Therefore, we need to diversify water resources and reshape stormwater management.

Our study evaluated the potential for increasing economic value while reducing the environmental impacts of implementing new concepts for non-potable rainwater use in a new urban development. We analysed five alternatives: a conventional groundwater-based drinking water system (A0-GW), three types of centralised ways of treating runoff collected from impervious areas (CT1-CT3) and a decentralised system for rainwater harvesting (DT-RWH). All five alternatives included stormwater collection with a system of basins and trenches for flood protection.

Potential environmental impacts were quantified by life cycle assessment (LCA), while the economic system value was assessed in terms of total value added (TVA). The LCA and TVA were evaluated over the entire water chain, including effects at the end-user level and an estimation of the single economic added value for each stakeholder. A combined LCA and TVA provided an assessment of eco-efficiency.

The four runoff-based alternatives exhibited up to 95% reduced freshwater depletion impacts compared to the conventional drinking water system. In all alternatives, more than 94% of the ecotoxicity impacts were due to the discharge of metals (zinc and copper) from runoff into freshwater, and the three centralised treatment alternatives (CT1-CT3) reduced ecotoxicity by 80%. Overall, the two centralised ultrafiltration plants (CT1-CT2) showed the lowest effects in all impact categories, except for reserve base resource depletion, which was affected by stainless steel production.

CT1-CT2 also showed slightly higher TVA (app. +3–5%) compared to conventional treatment. The TVA for CT3 and DT-RWH was found to be between −14% and −116% lower than conventional treatment. Except for the reserve base resource depletion category, CT1 and CT2 were considered the more eco-efficient alternatives compared to the conventional drinking water system.

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