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Assessing the environmental impact of water supplies: a case study in Copenhagen

New research has compared the environmental impact of four alternative methods of water supply in Copenhagen. Results indicated that rain and stormwater harvesting is the most environmentally sound approach, whilst desalination currently has a large environmental impact, mainly due to electricity use. However, if freshwater extraction is included as an impact, the environmental credibility of desalination is improved.

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Source: Godskesen, B., Hauschild, M., Rygaard, *et al*. (2013). Life-cycle and freshwater withdrawal impact assessment of water supply technologies. *Water Research* 47:2363-2374. Doi: 10.1016/j.watres.2013.02.005

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The EU Water Framework Directive (WFD)[1] requires Member States to develop river management plans, which include gathering data on the regulation of water flow. In Copenhagen these have indicated that groundwater is not as abundant as believed and the water management company has been seeking new approaches to sustain water supply to the city. The following four possibilities have been identified, which fulfil WFD obligations:

1. Harvesting rainwater from roofs and stormwater from roads
2. Actions to compensate withdrawal of water, such as transferring water from lakes and re-establishing wetlands
3. Extraction from new well sites using +20km of pipeline
4. Desalination of Baltic seawater at a plant 5km south of the city

The standard life-cycle assessment used in this study considered resource consumption, global warming, nutrient enrichment and toxic effects on humans and ecosystems. Impacts were measured in targeted person equivalents (PET). To calculate PET, the impacts from the four possibilities were divided by the annual impact (including, for example, resource consumption and nutrient enrichment) caused by an average European citizen. This was then weighted by whether these impacts met policy targets; if the target was far from being met, the weighting was high.

The results showed that rain and stormwater harvesting had the lowest impact at 81.9 micro PET per m^3 of water ($\mu PET/m^3$). This low impact was mainly thanks to the avoidance of rain and stormwater discharging into the combined sewer systems of Copenhagen, reducing electricity needed for wastewater transport and treatment. The low calcium content (low water hardness) of rainwater, which reduces the need for laundry detergent and electricity for washing, also lowered the impact.

The approaches that relied on groundwater (2 and 3) had impacts of 123.9 and 137.8 $\mu PET/m^3$ respectively, while desalination had the greatest total impact at 204.8 $\mu PET/m^3$. This was primarily caused by the high electricity demands of the desalination plant.

To account for the use of groundwater as an important environmental impact, especially when groundwater is as scarce as in Copenhagen, the researchers introduced a freshwater withdrawal impact (FWI) into the analysis. With this factor, rain and stormwater harvesting remained the most environmentally sound option at 90 $\mu PET/m^3$, but the environmental impact of desalination changed from being the highest to the second lowest. Desalination does not require extraction of freshwater and, once water scarcity was accounted for, its impact actually decreased to 180 $\mu PET/m^3$.

The results indicate that rain and stormwater harvesting is the best option for the environment in Copenhagen. However, the environmental performance of the other options depends on whether water scarcity is included. Another consideration is the source of electricity. If this becomes 100% renewable in the future, desalination would, in fact, have the lowest environmental impact.

1.http://ec.europa.eu/environment/water/water-framework/