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Screening soil moisture conditions reveals an increased risk of drought in a Swedish drainage basin

The risk of drought in the Norrström drainage basin, Sweden, increased during the 20th century, a new study has found. As the frequency of the dry periods increased, less water was available in the landscape for agriculture and for the resupply of groundwater — despite an increase in precipitation in the area over the same period. The researchers reached this conclusion after screening soil moisture conditions in the basin over the course of the century.

Soil moisture is a key part of many natural processes and plays an important role in the landscape, influencing vegetation, ecosystems and agriculture. Soil moisture also affects, and is affected by, variable climate conditions. Knowledge of changing soil moisture under climate change is therefore important for understanding and predicting processes that lead to floods or droughts, for example.

In this study, the researchers examined the historical relationship between soil moisture and climate conditions in the Norrström drainage basin, Sweden. The area, containing the capital Stockholm, is one of the most densely populated in the country. Soil in the basin is fertile and agriculture is an important feature in the landscape.

The researchers developed a framework linking existing soil water models to long-term changes in soil moisture conditions in the landscape under a changing climate. They applied the framework to the 20th century and two contrasting soil types, sand and clay-loam.

The soil water models considered surface changes caused by variability in climate and land use, as well as changes in the subsurface soil conditions. They modelled how water flows through the basin, including in the unsaturated zone (from the soil surface to groundwater table) and groundwater table, using historical climate data from the Swedish Meteorological & Hydrological Institute, a publicly available database containing precipitation data, as well as estimated evapotranspiration rates (evaporation from the surface of the land and water vapour released from plants). They focused on times of very dry and very wet soil moisture conditions in 20 year periods over the century.

The results revealed that the frequency of very dry and very wet soil moisture conditions increased during the 20th century for both soil types. This was particularly noticeable for very dry periods, defined as the driest conditions, occurring 1% of the time during 1901 to 1920. The occurrence of days with very dry soil moisture conditions increased in each 20 year period, from 1% of the time at the beginning of the century to 35% of the time by 1982–2002. The researchers say that even allowing for uncertainties associated with the modelling, such a noticeable increase indicates decreased water availability in the basin.

Although the frequency of dry periods increased from the beginning to the end of the century, precipitation (rainfall and snow) in the basin has also increased. The researchers say this indicates that the dry events were not a result of less precipitation or changes in the pattern of precipitation, but rather because land-use changes led to more moisture being lost from the landscape to the atmosphere through evapotranspiration.

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Source: Destouni, G. & Verrot, L. (2014). Screening long-term variability and change of soil moisture in a changing climate. *Journal of Hydrology*. 516: 131–139. DOI:10.1016/j.jhydrol.2014.01.059. This study is free to view at: http://www.sciencedirect.com/science/article/pii/S0022169414000081X

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The occurrence of very wet soil moisture conditions also increased over the century but to a lesser extent than very dry periods (4% compared with their occurrence at the beginning of the century). Very wet conditions were defined as the wettest conditions, occurring 1% of the time during 1901 to 1920.

The study also showed that during the warmer months, May to October, when evapotranspiration would be at the highest levels, soil moisture decreased over the century. And whereas groundwater levels experienced a peak in August at the beginning of the century, they experienced a dip in August by the end of the century.

The methodology used by these researchers can also be used to predict soil moisture changes under future climate change scenarios. This information can be used by policymakers to better monitor and manage drought and flood risks and mitigate their impact on agriculture and the availability of drinking water in a catchment area.

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