The cooling potential of green spaces in and around Vienna during prolonged dry periods

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During heat waves in urban areas, thermal stress is known to have devastating effects on human health. To curb urban heat, major efforts are being made to plant more vegetation and remove sealed surfaces. However, many green roofs and green facades are not irrigated, which in turn causes drought stress for plants during extended summer heat periods without precipitation. As a result, evapotranspiration from vegetated areas is reduced and the desired cooling effect is not achieved. During dry periods, the agricultural environment cannot develop its full cooling effect even during the day.

In the framework of the ACRP project Imp_DroP (Impact of longer Drought Periods on Climate in Greater Vienna: appropriate Mitigation measures), the cooling potential of green areas in and around Vienna is determined via evapotranspiration and future irrigation demand.

In spring 2022, four measurement sites have been set up on green roofs in different local climate zones of Vienna. At each of the selected sites, two lysimeters have been installed for extensive and intensive green roofs. At one site, an additional set of lysimeters is irrigated and the surface temperature is monitored with infrared radiometers. Three soil moisture sensors are installed in the top layer of the lysimeters and the surrounding green roof. Thus, the onset of rain can be clearly detected in the data. Another soil moisture sensor is installed in the deeper layer of the lysimeter of the intensive green roof. The initial results for the summer 2022 show that the driest green roofs were at the site with the large, low buildings, and the site above the roof was drier than the site below the roof. Despite the long dry period in the 2022 summer, almost all plants survived without irrigation. In 2023, the measurement campaign is continued.

These measurement data are used in a further step for the calibration of the crop growth model AquaCrop, the data in 2023 will be used for validation. Thus, soil moisture can be simulated for selected dry periods on green roofs. For the surrounding agricultural areas of Vienna, soil moisture is simulated with the ARIS model.

All collected data are used in the final step to initialize, run and validate the coupled WRF-TEB model. Here, the atmospheric conditions as well as the urban microclimate is simulated for current and future summer drought episodes in order to estimate the expected thermal load on the Viennese population. The selection criteria for drought episodes is defined as a biennial event with a cumulative negative NPET (precipitation - potential evapotranspiration (PET)) of not more than 5 mm of precipitation. The time frame is set to the year 2050, with best- and worst-case scenarios being run and compared. For the climate scenarios, in addition to the drought episodes, a status quo scenario without irrigation demand, a scenario with maximum irrigation, and a scenario with adapted crop irrigation are considered.