

Effects of climate change on fruit production in the state of Hesse

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To understand the effects of climate change on plants, two aspects need to be considered. First, the reaction of the plant in question to the environment, in particular the reaction to climate variables, needs to be understood and preferably one should be able to simulate it through the use of a model; secondly, a projection of the climate variables in question at the regional level. In the meantime, a number of regionalized scenarios such as WETTREG, REMO and CLM including all required information are available. However, the development of sufficiently accurate models predicting plant development is still at the beginning, particularly when it comes to fruit tree development. Although some models are available for single sites or stations, more generalized models suitable for use in larger regions are still missing.

In fruit trees, one can consider a number of possible threats to production associated with climate change. These could be the increased risk of spring frost, increased risks due to new or more aggressive diseases and pests, hail and water shortage due to drier summers or more variable rainfall with longer droughts. This project concentrated on the spring period with initial flowering and full flowering as the critical phenological stages using apple trees as reference.

In a first step we used a geostatistical modelling approach to develop maps for every year since 1951 for the flowering date of apple trees in the whole state of Hesse. The observations came from the phenological network of the German Weather Service (DWD). The density of the network allowed maps with a spatial resolution of 5 x 10 km. Those maps basically allowed the quantification of the natural variability in the date of flowering observed since 1951 and provided a basis for distinguishing between natural variability and the expected climate change effects.

The next step involved the data produced in the first step and coupling those with the respective historic temperature data to develop a model for flowering of apple trees valid for the whole area of Hesse. We used interpolated temperature data from the ERA 40 project (ECMWF-Reanalysis, ECMWF stands for European Center for Medium Range Forecast) for the period from 1958 to 2001 which is a sufficiently long period for model development. We tested a range of model approaches with the result that the most simple one was the best. That one only calculated heat unit accumulation after the end of dormancy with a linear response to temperatures above a base temperature.

This model was then used to combine it with the temperature data of the projections. Also here an interpolation from either the gridded data of for example REMO or the station data of WETTREG was required to arrive at the same grid as the phenological data. Analysing the projections we realized a clear “flattening” of the distribution. When analysing the reasons for this we discovered that due to the interpolation process extreme values were filtered out and a smaller and less extreme distribution of temperature data was the result of the interpolation process. This is inherent in the current interpolation techniques and is a major point that needs to be addressed in future climate impact research.

However, it also limits the interpretation of the results. In general, we calculated a 6 – 8 days earlier start of flowering for the period 2031-2060. This advance is smaller than anticipated. Nevertheless, we also could not find a significant increase in the risk of spring frost during the flowering period. Both main conclusions are limited by the interpolation techniques available and therefore need to be seen with great caution. For future work one certainly needs to come to interpolation techniques that maintain the full variance including extreme values.