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Shifts in Evapotranspiration due to Historical Wet Meadow Land Conversion to Agriculture in Sweden

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MOTIVATION

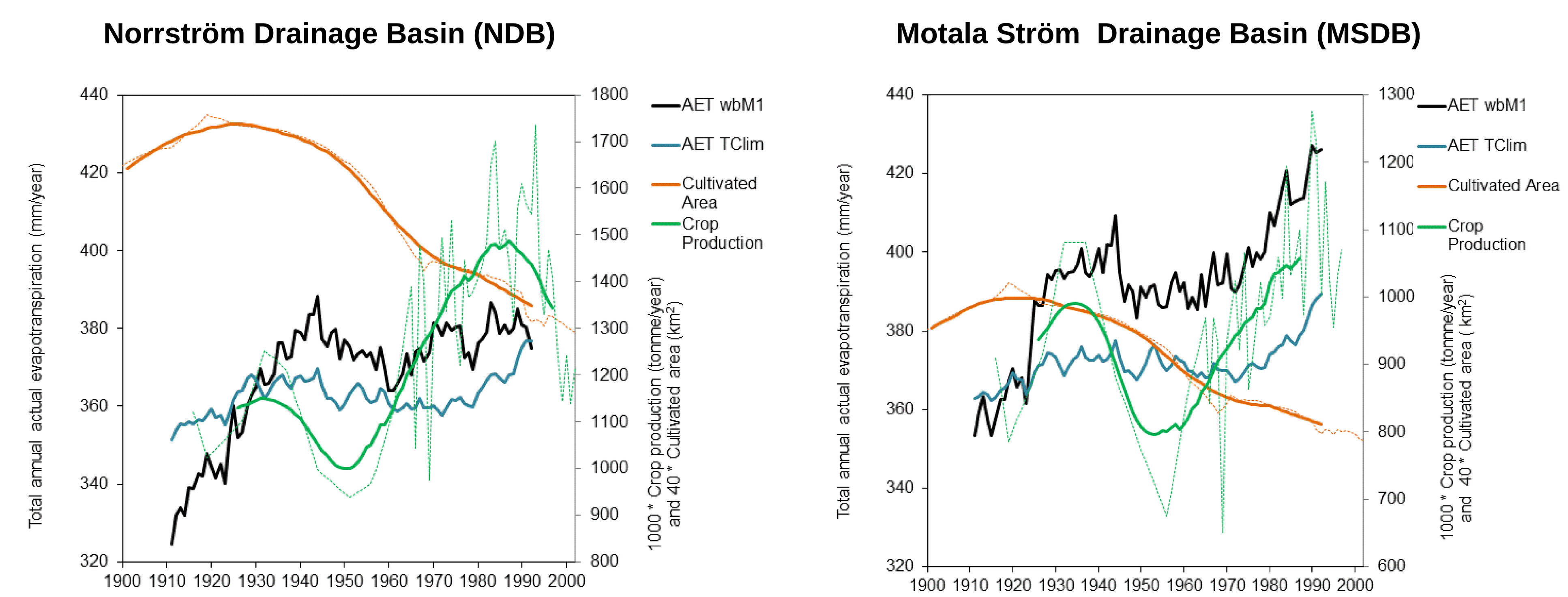
The dynamics of non-irrigated agricultural development and its impacts on the hydrological cycle need to be understood especially now that food demand is increasing at a fast rate.

These dynamics are; however, difficult to understand since one must separate the impact of land use and land cover changes from those of climatic change on hydrological flow partitioning. Developing methods to do this separation is important for the application of management measures linked to adaptation to both climate and land use change.

HYPOTHESIS

Historical agricultural changes such as the gradual conversion of original wet meadows to agricultural land in Sweden during the 20th century may have led to significant impacts on evapotranspiration and thus hydrological flow partitioning.

RESULTS



Figures 4a and 4b.- Development of cultivated area and crop production during the 20th century and its link to AET based on Turc equation (1954) (AETTClim) and for Scenario 1 of the water balance approach AETwb in the NDB and MSDB.

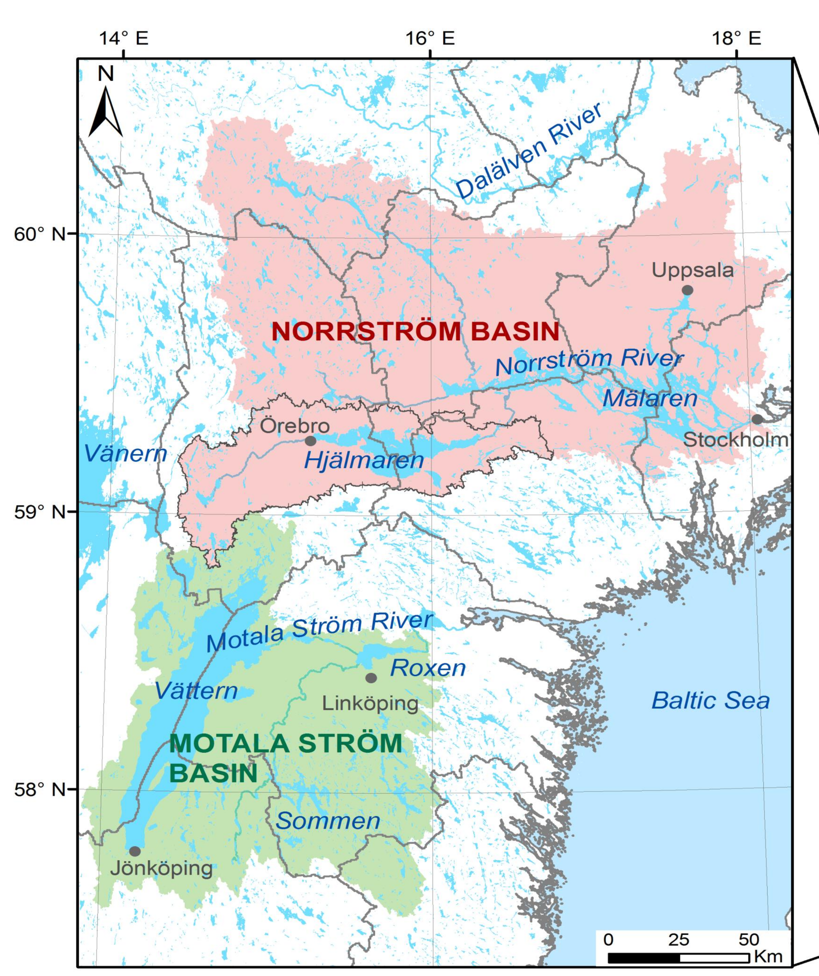
CONCLUSIONS

The hydrological effect of the advance of cultivated agriculture during the 20th century in Sweden is a steep increase of evapotranspiration when cultivated area and production increased, or the latter increased while the former remained essentially stable, during the period 1901-1940.

Comparison between water balance and different climate based evapotranspiration calculations shows that this steep evapotranspiration increase was not driven by concurrent climate change. After this period (1940 onwards), evapotranspiration stabilized at a new higher level once the cultivated area started to decrease more rapidly.

Productivity boost of herbaceous crops may alone alter regional evapotranspiration.

STUDY SITE



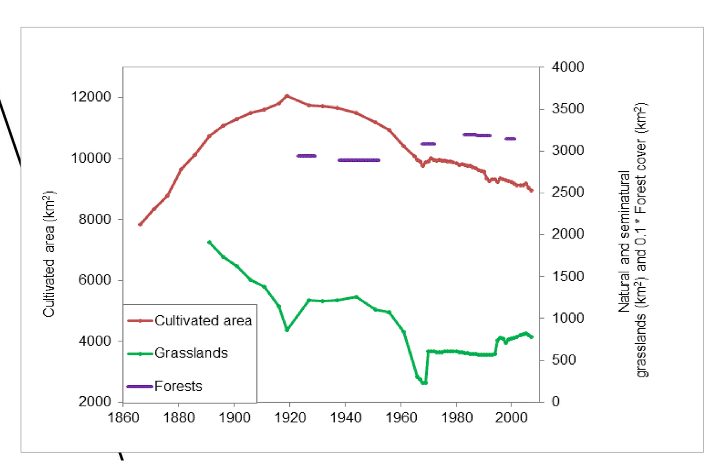
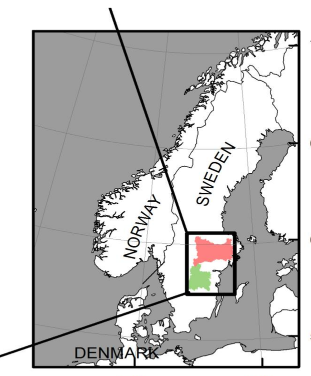


Figure 1 – a) Study site b) Change in major land covers in the area of the two basins.



METHODS

1. Use the water budget equation P-ET-R-DS=0 across 2 major Swedish drainage basins to calculate Actual Evapotranspiration (AETwb).

2. Analyze AET =P-R-DS for different DS≠0 scenarios .

3. Calculate potential ET as $PET=325+21T+0.9T^2$, where T is temperature. With annual PET and data-based P, calculate two different climate-based estimates of actual annual ET, as $AETclim=P[1-e(-PET/P)]$ based on Budyko, and $AET=P/(0.9+P^2/PET2)^{1/2}$ based on Turc.

4. Calculate total crop production as the product of both data-based cultivated area and crop yield between and 1913-2002 for the most important 18 types of crops.

METHODS (2)

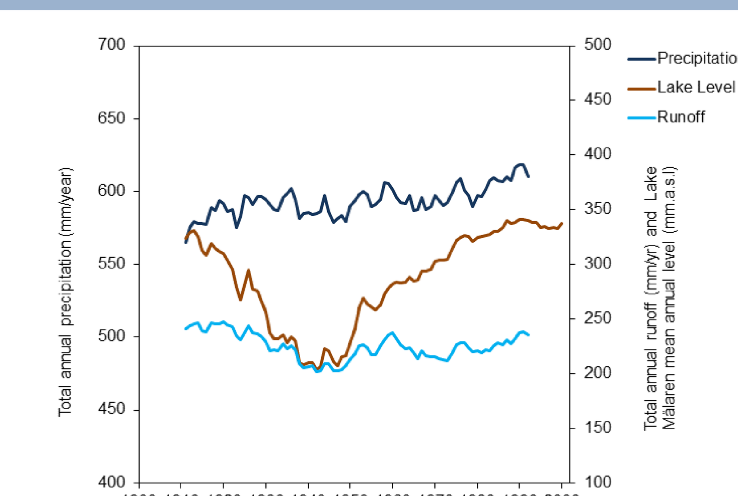


Figure 2 - 20-year moving averages of total annual precipitation P, total annual runoff, R and mean annual level of Lake Mälaren in the NDB over the 20th century.

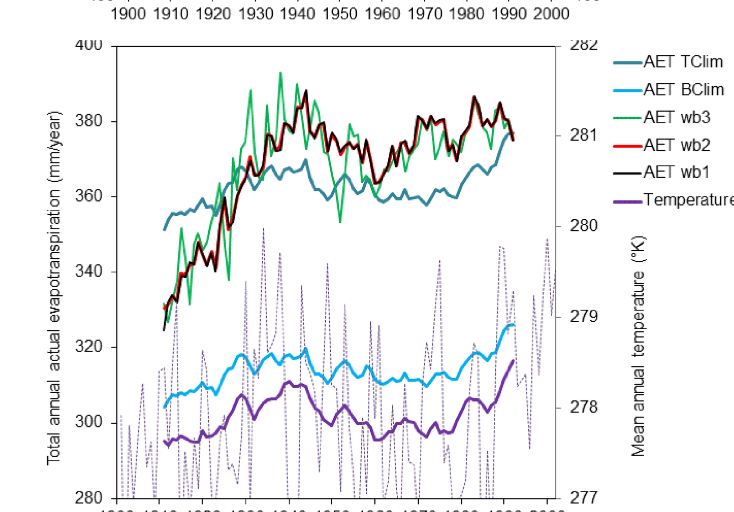


Figure 3 - Comparison in the NDB between temperature and actual evapotranspiration based on Turc (1954) AET Tclim, Budyko (1974) AETBClim and three scenarios for the AET by the water balance approach AETwb:

- AETwb1 for no water storage difference in the basin.
- AETwb2 which accounts for the water storage in Lake Mälaren only.
- AETwb3 which assumes that the interannual water storage in the whole basin is the same as the one of Lake Mälaren.