Determining the impact of soil regionalization and climate change on wheat grain yield and timothy biomass in southeastern Norway

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Introduction

Southeastern Norway has a heterogeneous soilscape leading to variable agricultural productivity.

This region is dominated by cereal production, but also includes substantial livestock farming with forage crops.

Climate and socio-economic changes could entail changes in the productivity and area of cereal and forage crops.

Scaling methods combined with crop simulation models can be used to determine regional crop yields (Ewert et al 2011).

Materials and methods

- Spring wheat was simulated with the CSM-CERES-wheat and timothy was simulated with the LINGRA model for Akershus and Østfold Counties in Southeastern Norway.
- The simulations included two climate scenarios representing the periods 1961-1990 (baseline) and 2046-2065. Daily weather data for these two periods were generated using the LARS-WG tool (Semenov 2008).
- Four sets of soil profiles, including 76, 16, 5 and 1 profile were used to describe the soil characteristics of the region.
- These sets of soil profiles were constructed by extrapolation of soil texture, organic matter, layering and water holding capacity.
- The simulated yields were weighted according to the relative area of each soil in the four sets of profiles.

Weighted above-ground DM timothy yield for 4 extrapolations of soil profiles to describe the agricultural soils in Akershus and Østfold Counties in southeastern Norway.

Weighted simulated average above-ground timothy yield (kg DM ha^{-1})				
Number of soil profiles	1st harvest	2nd harvest	3rd harvest	Seasonal harvest
1961-1990 climate				
1	6300	3810	3020	13130
5	6330	4130	3150	13600
15	6330	4250	3200	13780
76	6330	4280	3220	13820
2046-2065 climate				
1	6570	3520	3820	13910
5	6570	3870	3950	14390
15	6570	3980	3990	14520
76	6570	4010	3980	14550

Results

- For the 1961-1990 period, the average wheat yields across the whole region varied between 4500 and 5600 kg ha^{-1} among cultivars and soil extrapolations. The wheat yield was 10 to 15 % higher in the 2046-65 period than in the baseline.
- The seasonal above-ground biomass of timothy varied between 13000-14000 kg DM ha^{-1} for the 1961-1990 period , and was approximately 6 % higher in the future period.
- The impact of projected climate change on timothy biomass compared to the baseline varied between harvests, from a 7 % reduction at second harvest to a 25 % increase at third harvest.
- The relative yield differences between the set of 76 soil profiles and the lower resolutions were generally less than 2 % for wheat and less then 5 % for timothy, across the whole region.
- For certain districts within the two counties, there were differences in spring wheat grain yield by up to 30 % and in timothy above-ground biomass by up to 20 % between the soil resolutions.

Weighted simulated average wheat grain yield for 4 soil extrapolations, three cultivars, (Bjarne, Demonstrant, Zebra) and two climate scenarios.

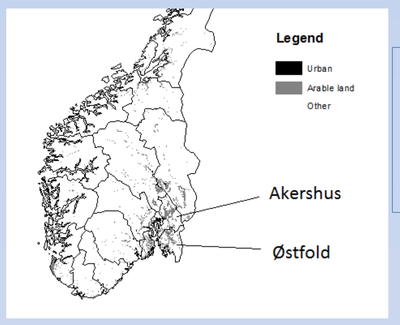
Weighted simulated average spring wheat grain yield (kg DM ha^{-1})			
Number of soil profiles	Bjarne	Demonstrant	Zebra
1961-1990 climate			
1	4524	5253	5432
5	4571	5306	5497
16	4640	5381	5577
76	4592	5323	5504
2046-2065 climate			
1	5034	5797	6334
5	5033	5797	6332
16	5035	5798	6328
76	5014	5776	6303

Photo: Erling Fløistad, Bioforsk

Further studies

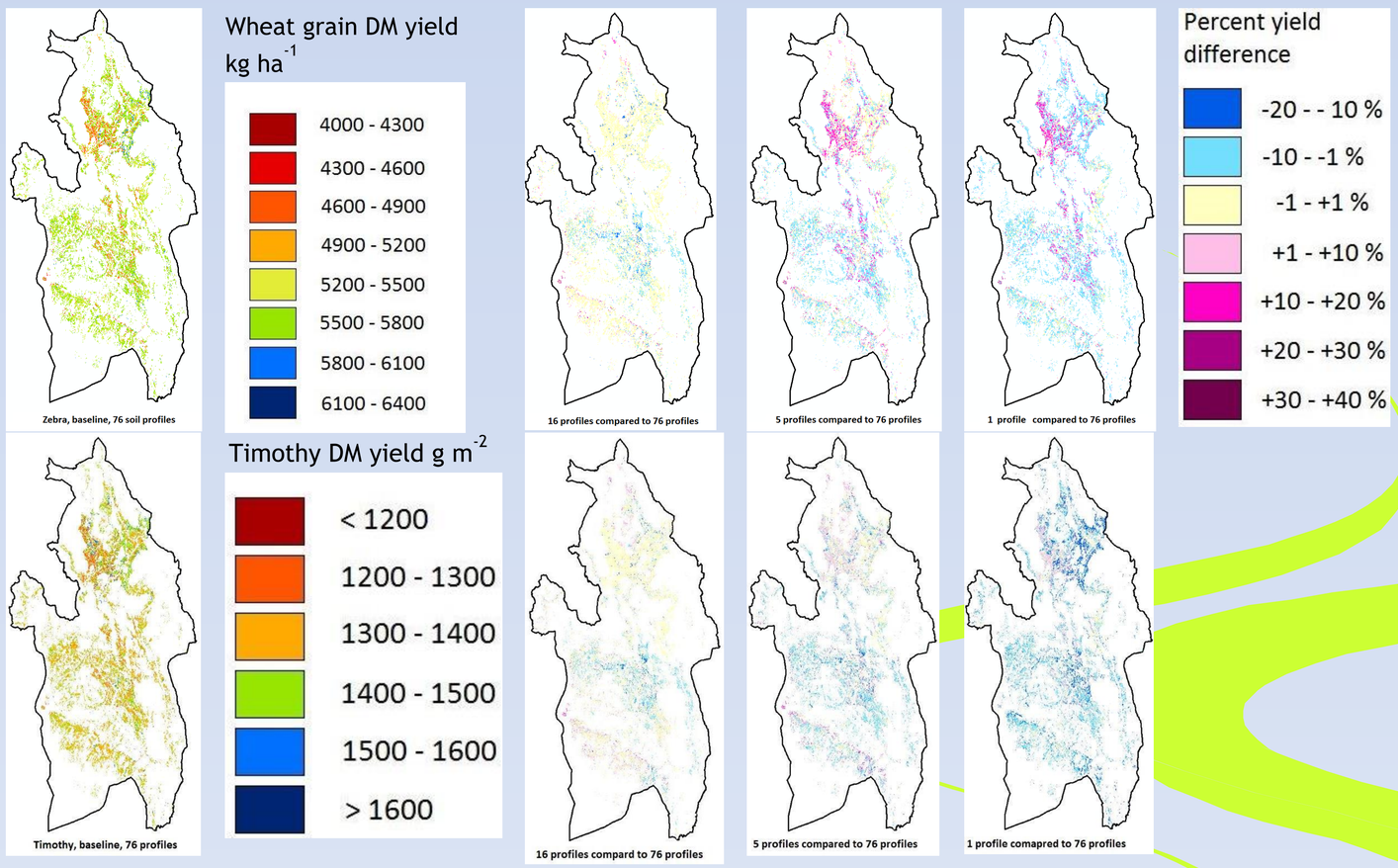
Linking the yield simulations to determinations of the impact of soil water content on the timing of planting and harvest.

Combining criteria for trafficability and workability of farm machinery with different soil extrapolations and climate scenarios with increased spring and autumn precipitation in Northern Europe.



Southern Norway with the study region: Akershus and Østfold Counties.

Spatial distribution of average grain yield (cv Zebra) and timothy above-ground biomass within the study region in the period 1961-1990 for the 76 profile dataset, and % difference for the 16, 5 and 1 profile extrapolations compared to the 76 profile dataset.



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References

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