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Interactions of Generated Weather Raster and Soil Profiles in Simulating Adaptive Crop Management and Consequent Yields for Five Major Crops throughout a Region in Southern Germany

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Generated Weather Raster and Soil Profiles in Simulating Adaptive Crop Management and Consequent Yields for Five Major Crops throughout a Region in Southern Germany

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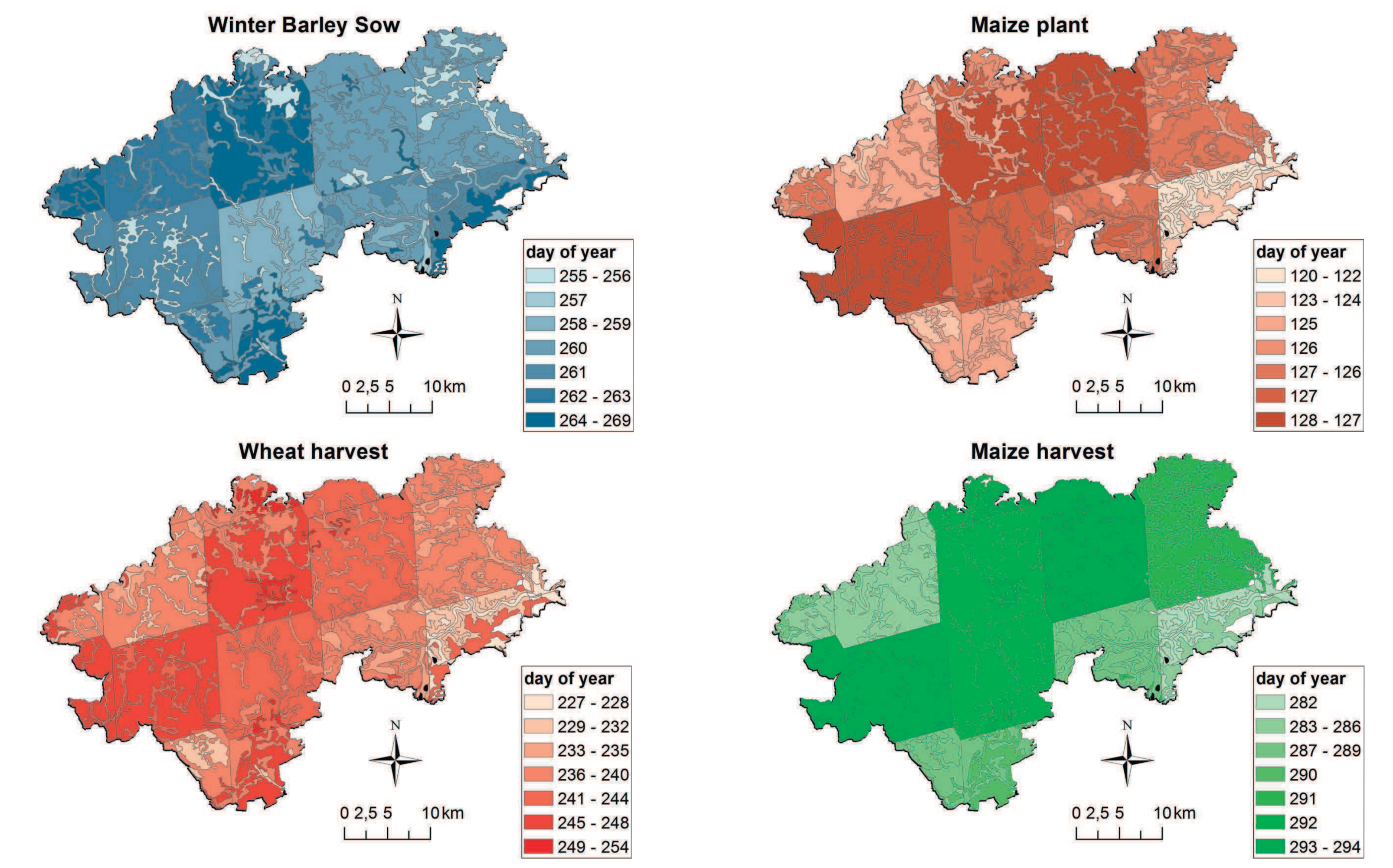
Bioeconomic simulation of the Schwäbische Alb

The agent-based model FARMACTOR (Aurbacher et al., 2013) projects agricultural adaptation including the timing of field management actions by interacting with the crop growth model EXPERT-N (Priesack, 2006). Crop growth and management were respectively calibrated to experimental data and local phenological events (Parker et al., 2015), for winter wheat, barley and rapeseed, spring barley and silage maize. To test the integrated models for robustness in regional application, they were run with generated historic weather from ERA-interim Reanalyses data downscaled with the Weather and Research Forecast (WRF) model to a 12 X 12 sq. km grid (Warrach-Sagi, 2013) and ten soil profiles mapped at 1/25,000 scale (LGRB, 1997).

Figure 1. Weather raster cells and soil distribution effects on selected crop planting and harvest dates



Yield and management responses to soil and weather

Soil profiles cause more yield variance than simulated weather cells in all crops (Figures 1 and 2, Table 2). Regionalized calibration may be necessary before models are used for regional bioeconomic study.

Table 2. Weather and soil as sources of variability in simulated yields

	soil and weather-dependent yield mean and variance				
	winter wheat	winter barley	spring barley	winter rapeseed	silage maize
Mean across soils	89.25	96.43	86.46	55.10	417.31
-variance	39.87	13.58	120.54	334.20	6572.29
Mean across weather	87.55	95.36	82.68	46.58	395.99
-variance	2.91	3.93	27.89	46.83	1879.20

Predicted management

Mean predicted planting dates are close to observed, but variance is less. Harvest date means and variance are both reproduced well (Table 1).

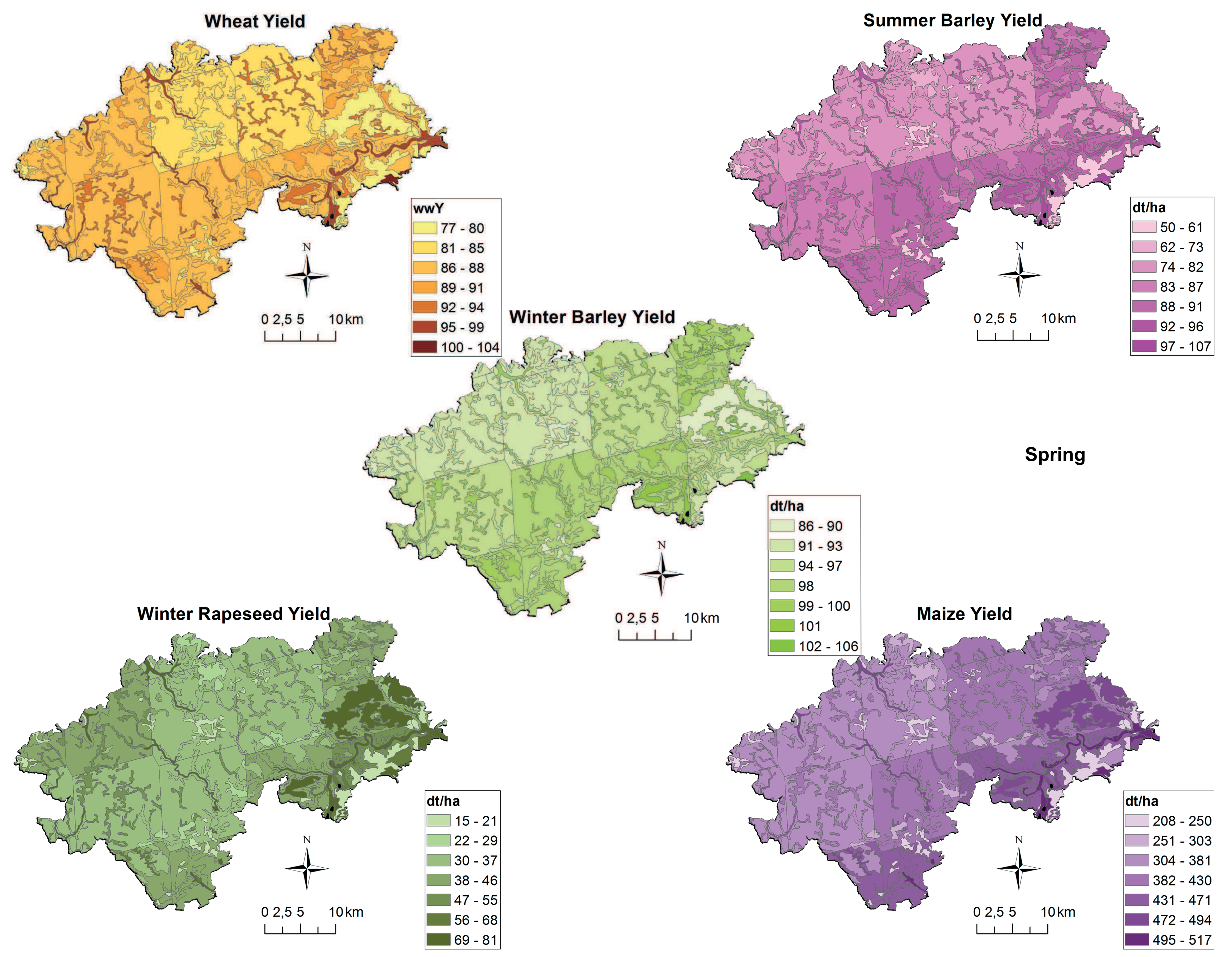
Table 1. Statistics on simulated and observed regional crop performance indicators

	planting day of year				
	winter wheat	winter barley	spring barley	winter rapeseed	silage maize
simulated mean 1990-2009	270.8	260.2	92.0	233.8	125.0
standard deviation	0.53	3.86	3.69	1.18	1.82
DWD (2012) observed*	266.8	258.7	91.5	236.5	122.7
standard deviation	7.35	5.53	13.06	7.10	5.24
*Station Stötten, 1990-2009 for winter wheat, barley and rapeseed, and maize, 1981-1990 for spring barley					
	harvest day of year				
	winter wheat	winter barley	spring barley	winter rapeseed	silage maize
simulated mean 1990-2009	238.4	220.6	238.0	220.2	289.5
standard deviation	6.29	6.75	3.36	3.04	3.81
DWD (2012) observed*	230.4	208.1	230.3	216.85	272.75
standard deviation	7.60	6.32	7.59	8.03	9.81
*Station Nellingen, 1990-2009 for winter wheat, rapeseed and barley; 1981-1990 for spring barley; 1981-1984 for maize					
	yield per hectare in dt (100kg)				
	winter wheat	winter barley	spring barley	winter rapeseed	silage maize
simulated mean 1990-2009	88.0	96.0	84.0	46.2	398.4
standard deviation	6.1	3.9	12.5	18.5	87.7
district mean 1990-2009	72.4	61.5	51.8	34.9	470.5
standard deviation	6.0	4.1	4.5	4.7	23.3
trials mean 1990-2001	87.6	77.5	61.1	39.6	562.7
standard deviation	9.81	6.44	9.70	5.91	93.96

Predicted yields

Considering mean and variance of simulated vs. district (DESTATIS, 2014), and state field trials yields (LTZ, 2013), winter wheat is accurate, maize is underestimated and winter and spring barley and winter rapeseed yields are all overestimated (Table 1, Figure 2), raising doubt concerning model application outside of calibration conditions, such as into the future.

Figure 2. 1990-2009 simulated yields for winter wheat, barley and rapeseed, spring barley and silage maize



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