Simulating field operations at a European scale for use in complex dynamic models

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The challenge

- **Models; DNDC-EUROPE, Mobile DNDC, DailyDayCent**
- **All of Europe**
- **High resolution**
  - Circa 42 000 locations
- **Models characteristics:**
  - High temporal resolution (daily time steps)
  - Corresponding demand for driving variables
- **Focus here:**
  - Timing of field operations

Timelines for field operations

- **Tillage, sowing, fertilisation, manure applications, harvesting**
- **Must reflect effect of local climate**
  - Geographically specific
  - Respond to trends in climate
- **Must reflect effect of weather**

Approach

- **Estimate spatially specific dates for sowing and harvesting**
  - Provides reference points
- **Use agronomic knowledge:**
  - To place other operations
  - To implement mitigation measures

Sowing and harvesting dates

- **Developed for JRC's Crop Growth Modelling System**
- **Estimated dates for sowing and harvesting/ripening**
- **Spatially interpolated from limited empirical data**
- **MARS grid (50x50km)**
- **Relates to circa 1986-1996**

Calibrate sowing/harvesting dates

- **Calculate temperature sums for CGMS sowing/harvesting dates**
- **Use temperature sums + weather data to generate dates for 1971-2030**
  - 1972-2000 MARS data
  - 2000-2030 REMO data
- **Start of growing season = sowing date for spring barley**
- **End of growing season = sowing date for winter wheat + 21 days**

Agronomic logic – winter crops

- **Solid manures + tillage immediately before sowing**
- **Slurry applied at start of following growing season**
- **Mineral fertiliser applied in two amounts**
  - At start of growing season
  - After 20% of growing season has elapsed

Agronomic logic – spring crops

- **Solid manures, slurry and tillage immediately before sowing**
- **Mineral fertiliser applied in two amounts**
  - 2 days before tillage
  - After 20% of growing season has elapsed

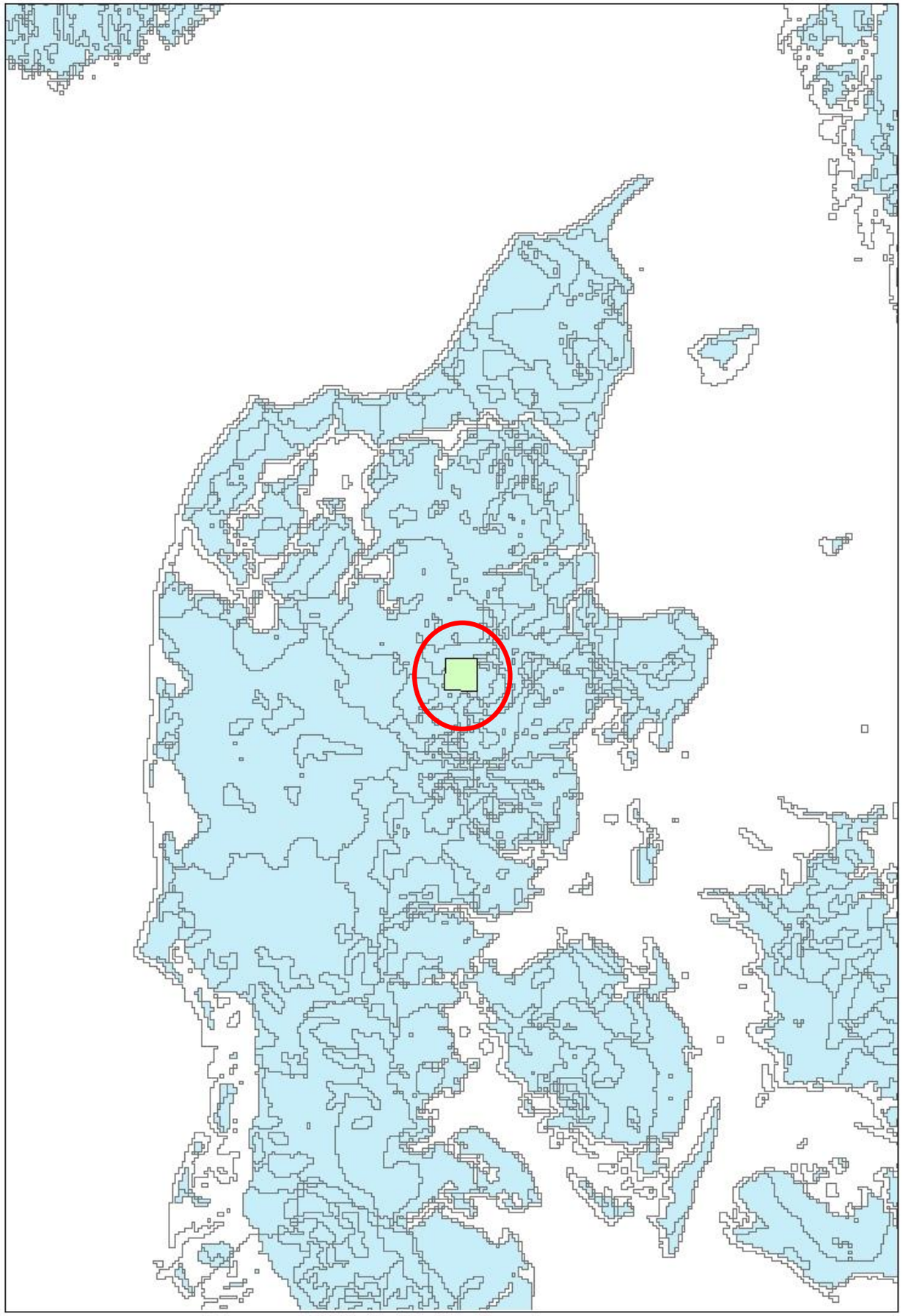
Agronomic logic – grass

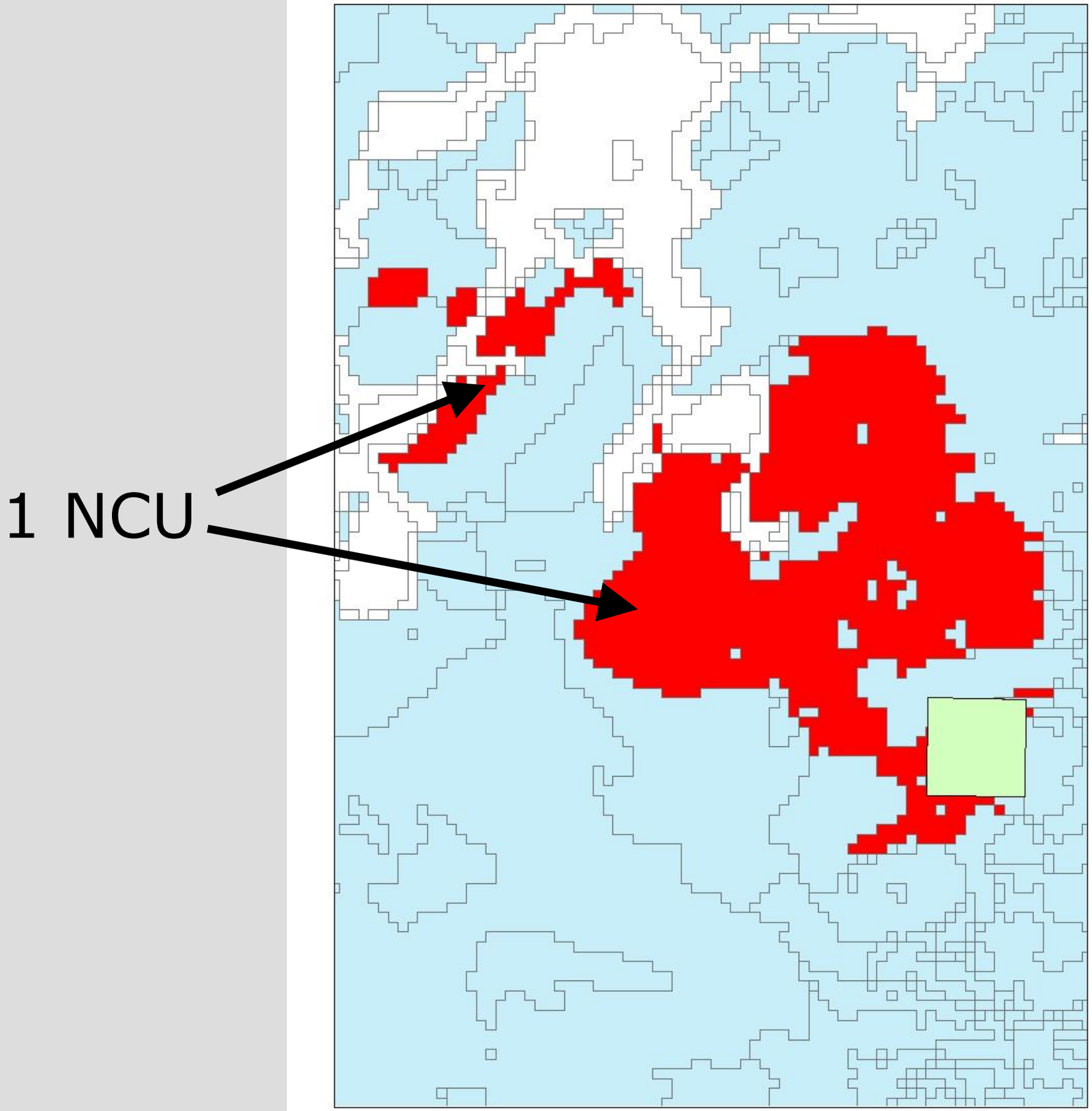
- **Sowing in the autumn**
  - = sowing date for winter wheat
- **Manure/fertiliser as for winter crops**
- **Harvesting**
  - One harvest per 28 days throughout growing season
- **Or**
  - Grazing centred on midsummer
  - (Number of grazing days is an input)

Does it work?

- **NitroEurope Component 4 case study areas**
  - Landcapes in 6 countries
  - Circa 5x5km
    - Field operation data collected for 1-3 years
- **Examples landscapes: DK and F**

Danish landscape

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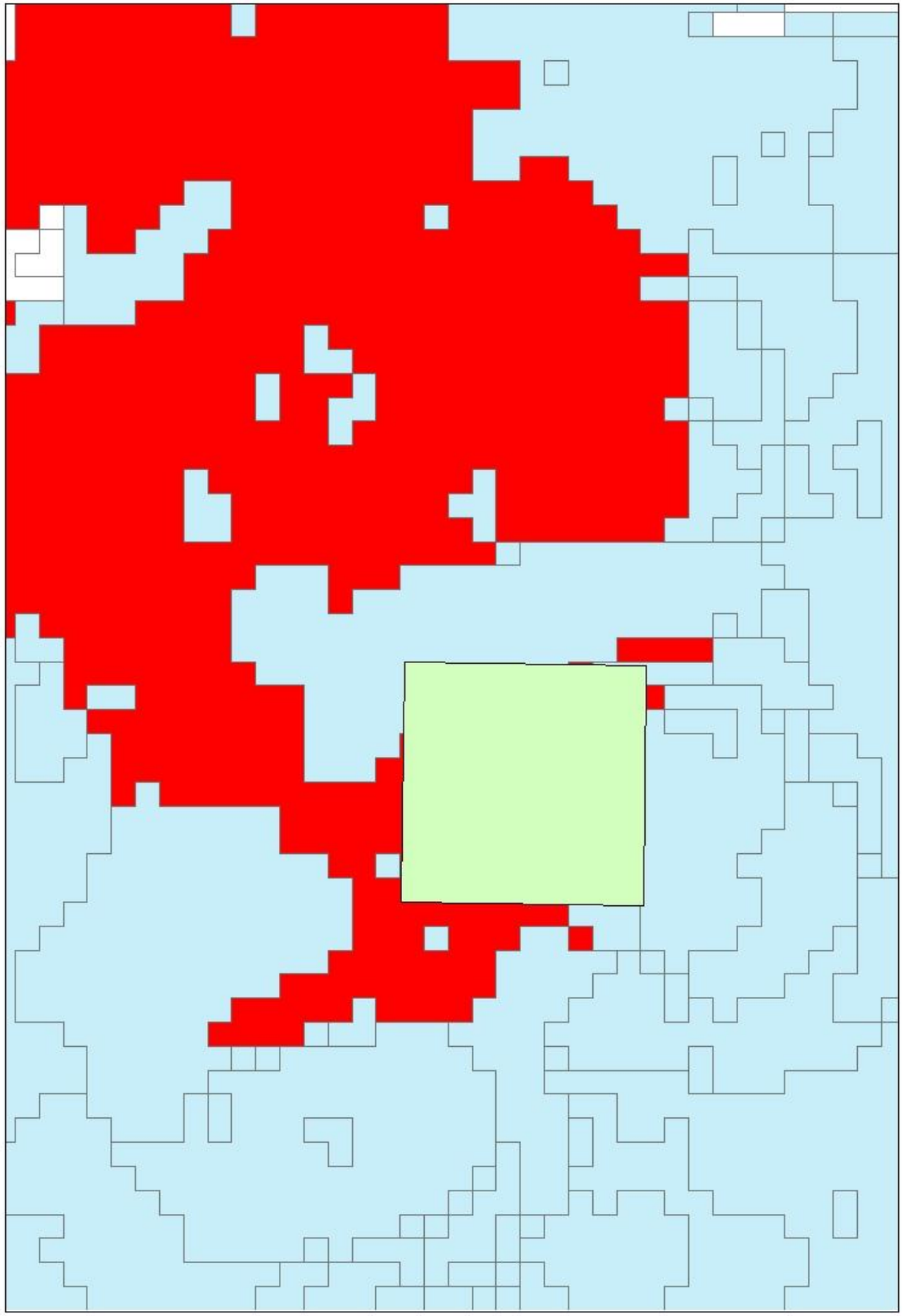
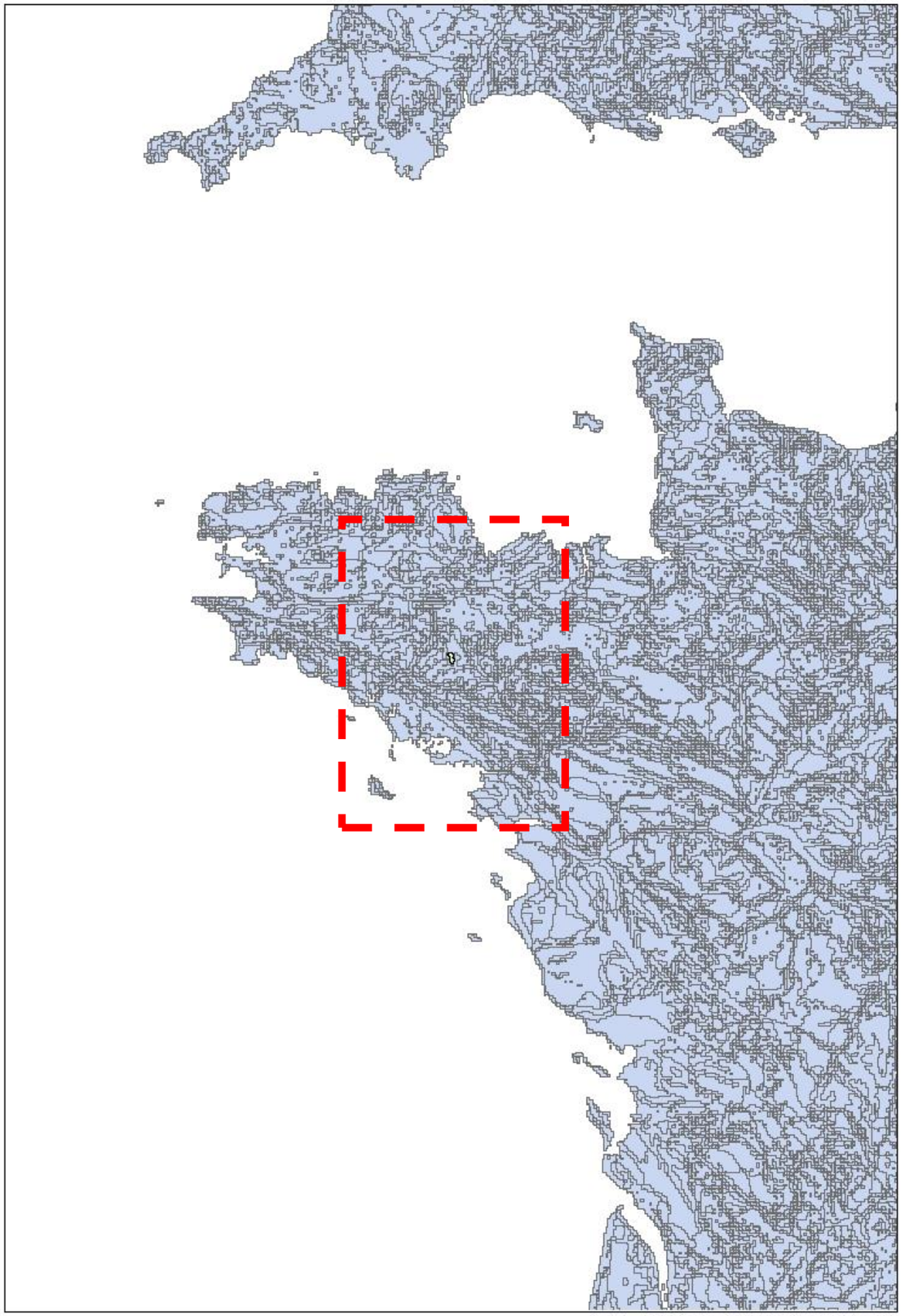
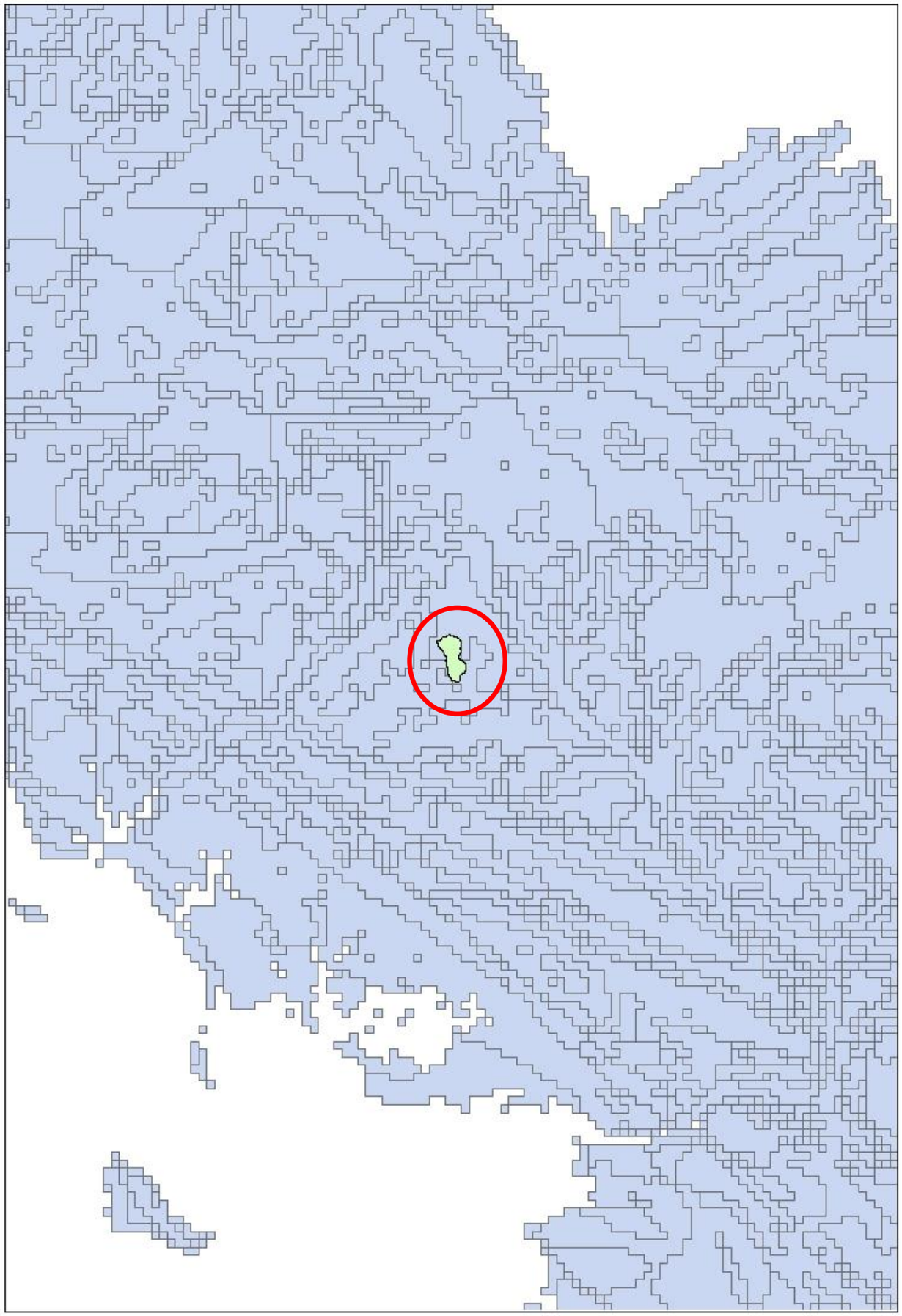
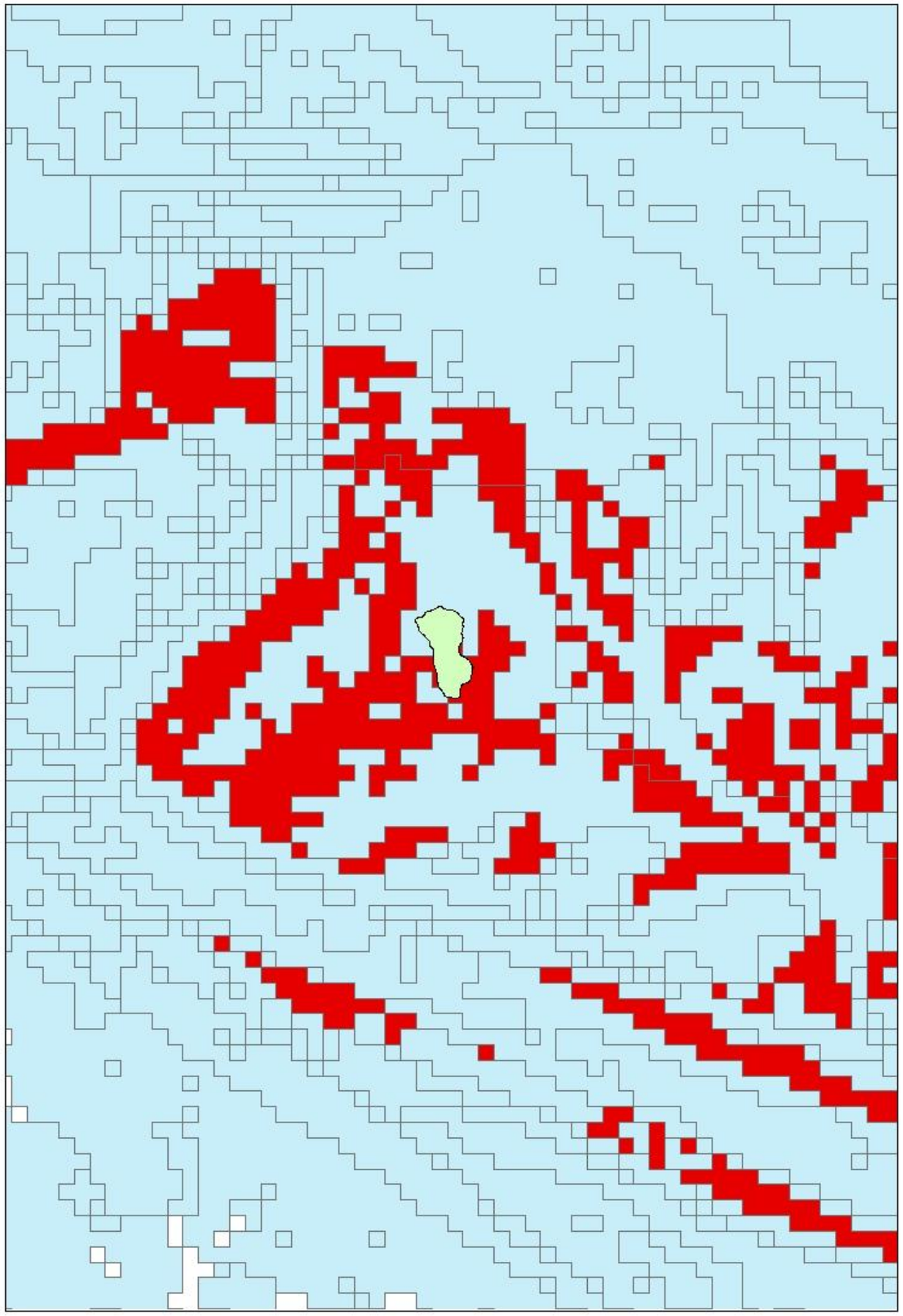


French landscape

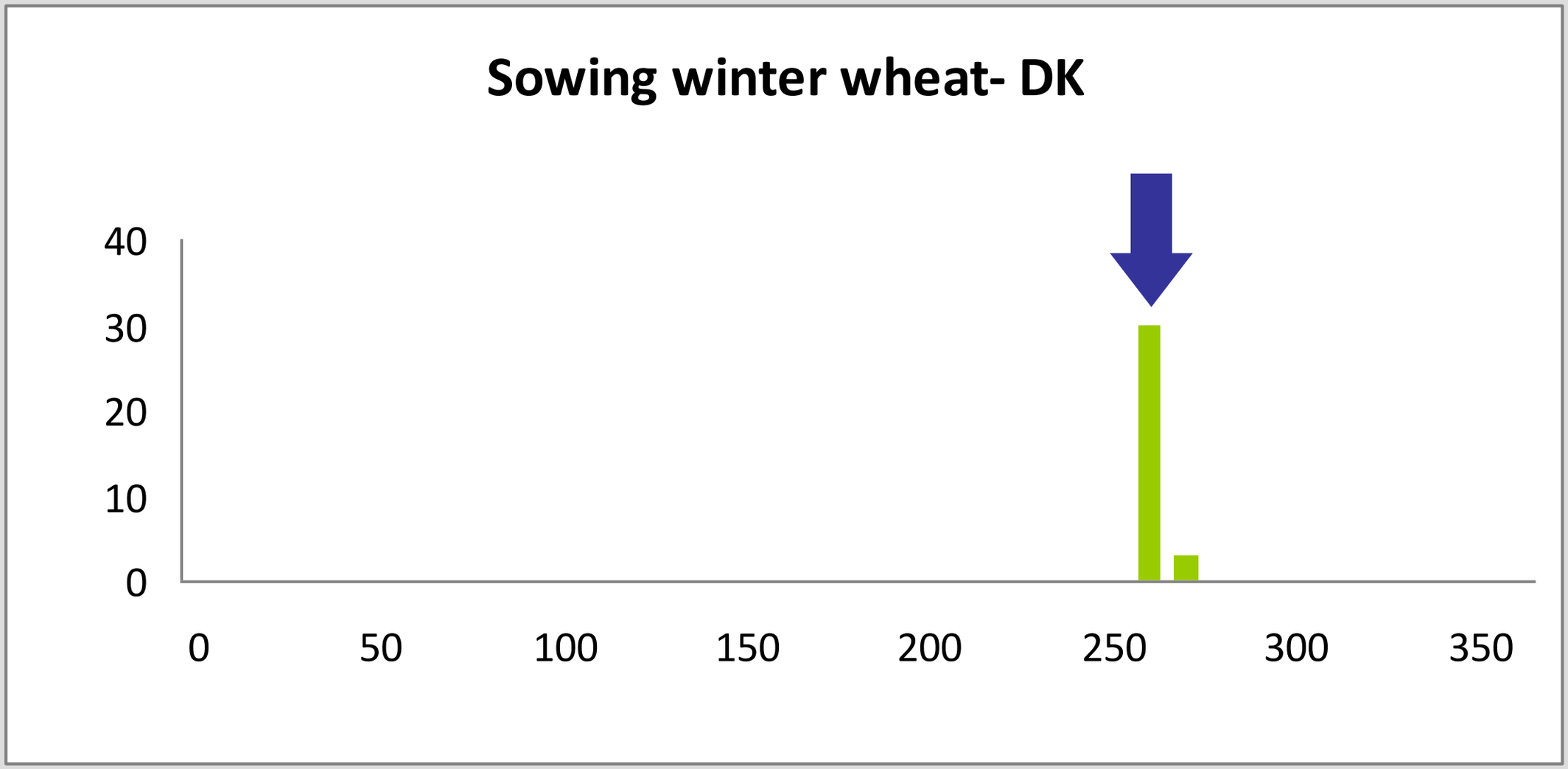






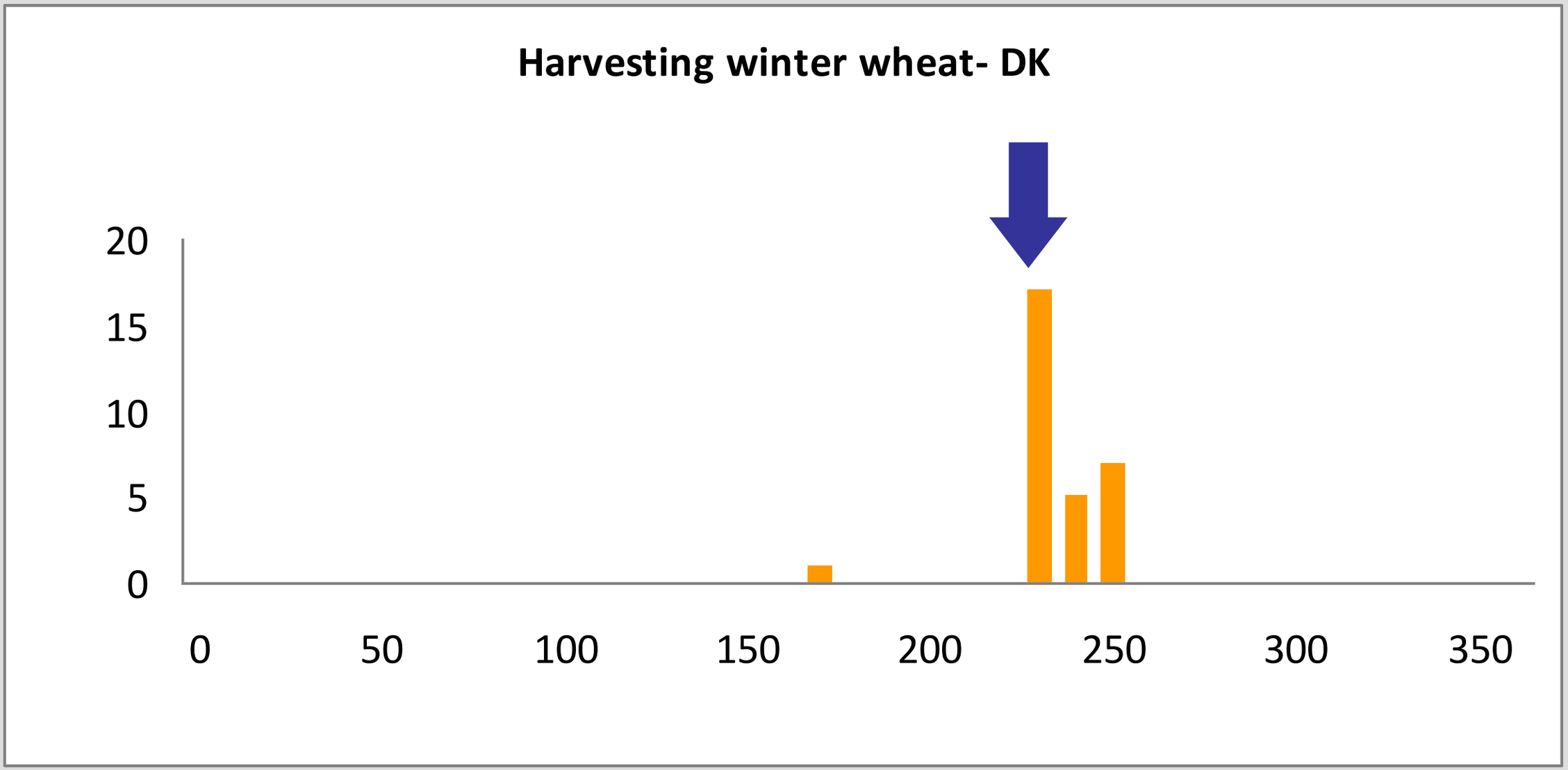
Sowing winter wheat - DK

Predicted date

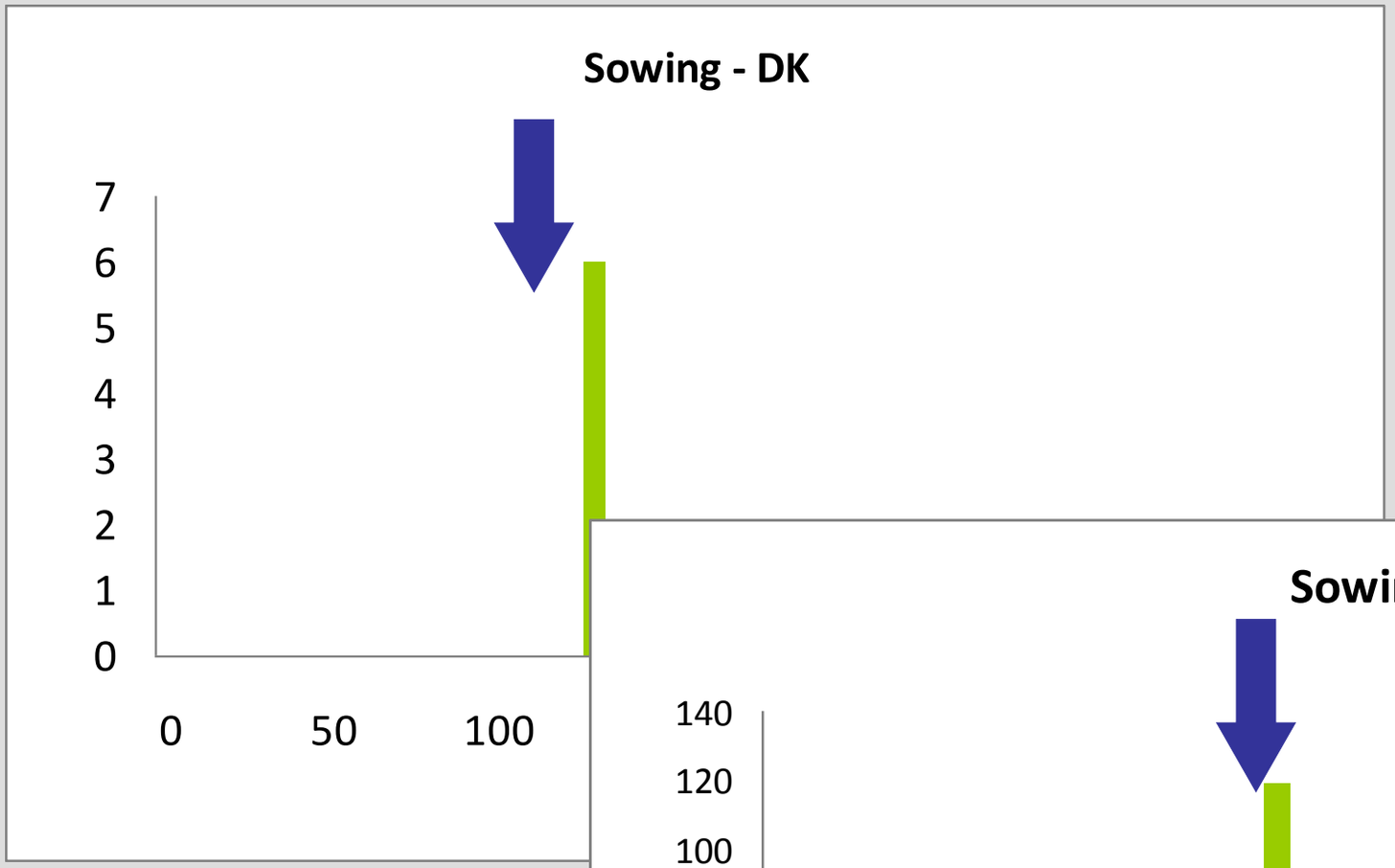


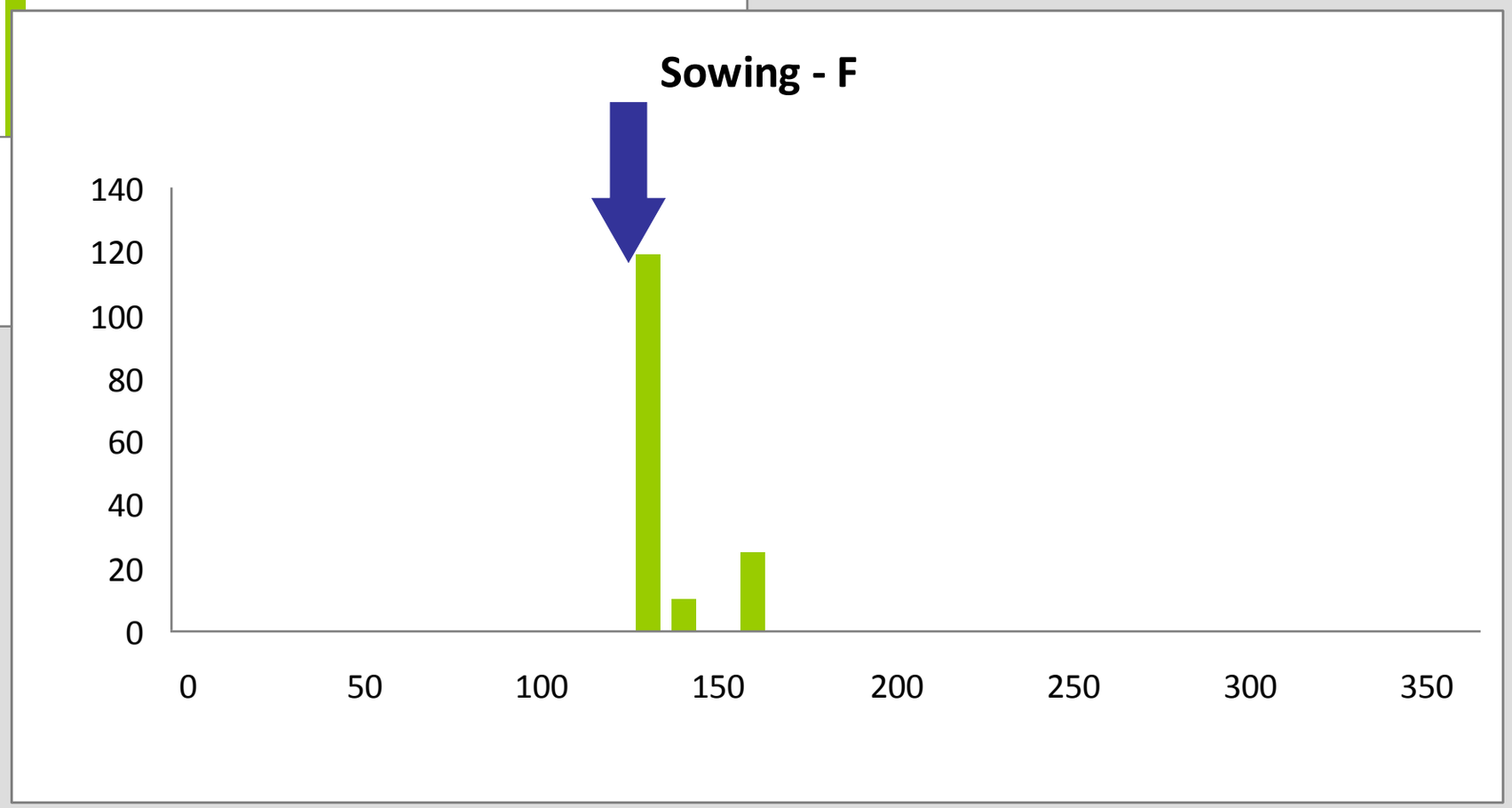
Harvesting winter wheat - DK

Predicted date

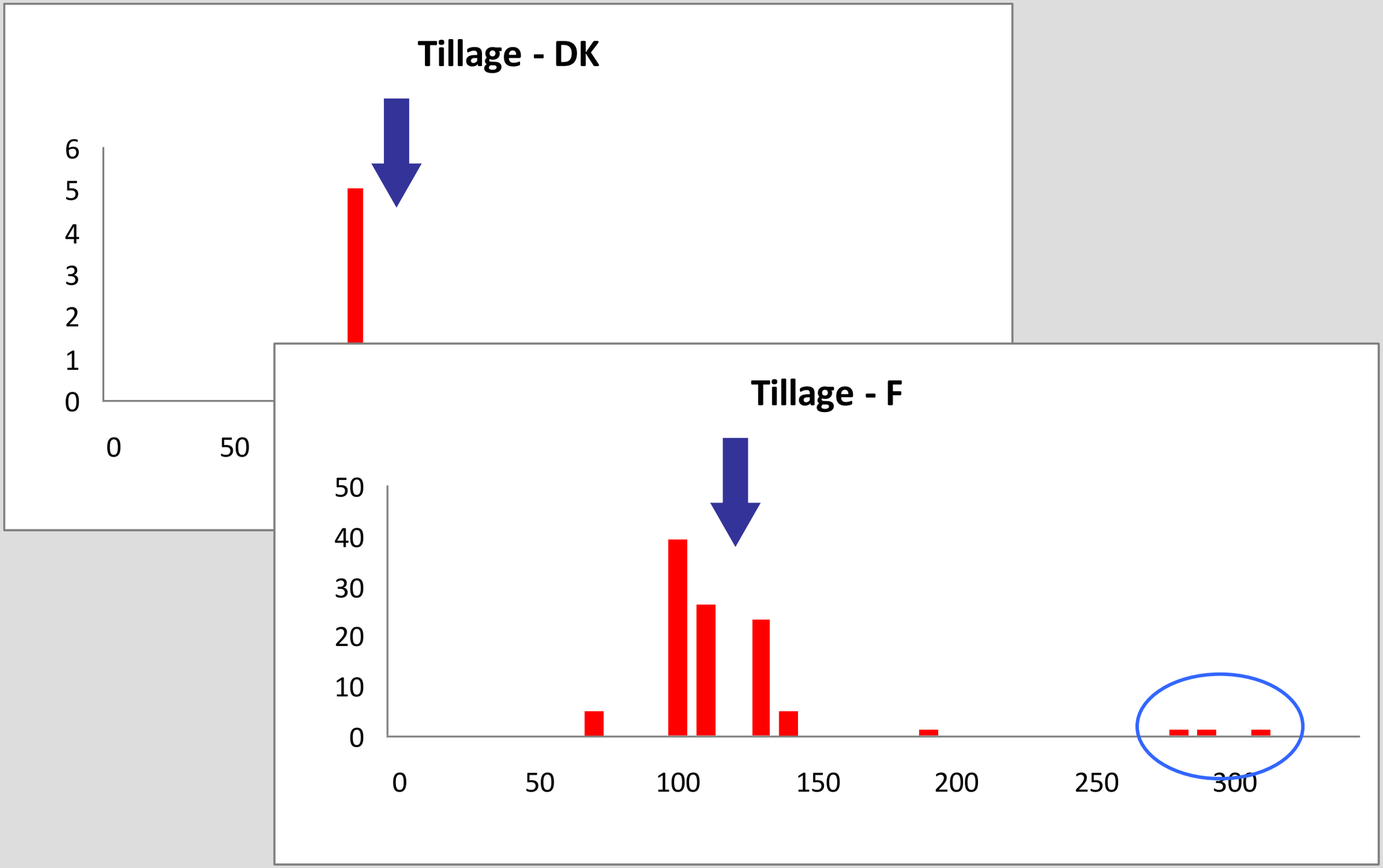


Sowing spring barley





Maize - tillage



Issues

- **CGMS data are 20 years old**
  - Crop breeding
  - Farmers choose varieties that suit the (changing) climate
- **Good agronomic practice is assumed**
  - All Europe is treated as a Nitrate Sensitive Area
- **Cannot simulate irrigation**
- **Timing of field operations may be constrained by soil conditions**
  - Too wet (manure application, tillage)
  - Too dry (tillage)

Conclusions

- **First steps towards spatially and temporally specific timelines for field operations**
- **Incorporate a soil water model**
  - Simulate soil trafficability/workability constraints
  - Enable simulation of irrigation
- **Needs thorough testing**