Use of Geographic Information Systems in Crop Protection Warning Service in Germany

3rd Conference on PRECISION CROP PROTECTION
Bonn, September 19 - 21 2010

Zeuner & Kleinhenz
Content

- Introduction
- Spatial input data
  - Temperature and relative humidity
  - Precipitation
- Risk maps
- Summary & Conclusion
Structure of ZEPP

Central Institution for Decision Support Systems in Crop Protection

Modelbuilders
scient. Institutions
(Universities, Federal Research Centers
for Agriculture and Forestry, etc.)
in Germany and Europe

other partners
German Met. Service,
Software Companies, etc.
in Germany and Europe

14 Crop Protection Services of the German Federal States
Aims in Crop Protection Warning Service by ZEPP

Improvement of Decision Support Systems (DSS)

- Forecasting the first appearance of plant diseases
- Identifying areas of maximum and minimum infection risk
- Giving best control for pests and diseases
- Optimising spraying strategy
- Reducing the fungicide intensity
Forecasting models as working tool

Models

- in practical use: 22
- under development: 18
- total models: 40

Use of internet warning service

- met. data
  - temperature
  - relative humidity
  - precipitation

- field data
  - cultivar
  - plant emergence
  - crop rotation
  - geographic data
  - etc.

(www.isip.de)
Technical advance

geographic data

met. data + elevation + aspect + slope + geo data

spatial met. data

temperature + precipitation + relative humidity + forecasting model

forecasting model run

risk map

\[
f(y) = \frac{f(MR) + \sum x_n \cdot f(\text{entf}_n)}{1 + \sum f(\text{entf}_n)}
\]

\[
f(\text{entf}_n) = \left( \frac{1}{p - \bar{w}_n} \right)^2
\]
Content

- Introduction
- **Spatial input data**
  - Temperature and relative humidity
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Storage of spatial met. data

- virtual weather database
- grid of 1 km²
- virtual met. stations
- Germany: 357 050 km²
- 360 000 virtual stations

3 met. stations against 1367 virtual stations on this map
Content

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Interpolation of temperature and relative humidity

Deterministic interpolation methods
- IDW
- next neighbor method
- spline

Geostatistic interpolations methods
- kriging
- multiple regression
Interpolation with multiple regression (MR)

met. data (measured)
- temperature
- relative humidity
- 570 met. stations over Germany

regression formula
\[ F(x) = \text{const} + H \cdot x_1 + N \cdot x_2 + E \cdot x_3 \]

geographic data (at met. station)
- dlm
- dem
- elevation
- slope
- aspect
- etc.

spatial met. data map

spatial geographic data

best correlations with altitude, longitude and elevation
## Validation of model results

### Validation of the method

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<th>year</th>
<th>days/Year</th>
<th>hours/Day</th>
<th>stations</th>
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<th>humidity</th>
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### Number of Boxplots

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Validation of model results

• similar results for other Boxplots

• Statistic check (T-Test): not significant

• useful as input for forecasting models
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One hour with precipitation

- No met. station in the center of the convective rainfall event

Radar grid:
- 0 mm
- 0 - 2.4 mm
- 2.4 - 4.9 mm
- 4.9 - 7.5 mm
- 7.5 - 11.4 mm
- > 11.4 mm

Met. stations:
- Kaiserslautern
- Rhein
- Mainz
- Wiesbaden
- Ludwigshafen
Spatial precipitation with radar data

- Spatial measured precipitation data is collected by the German Met. Service
- 16 radar stations measure the data nationwide over Germany
- The radar data is calibrated by 1600 classic automatic precipitation stations (Ombrometer) which are located over the whole area of Germany
- The radar data is collected in a frequent of one hour and in a spatial resolution of 1km²
Comparison between radar data and independently classically collected precipitation data

- wet month May 2007

- dry month August 2007

Comparision between radar data and independently classically collected precipitation data

n = 744/station
Introduction

Spatial input data
  • Temperature and relative humidity
  • Precipitation

Risk maps

Summary & Conclusion
Risk maps

spatial input data  warning service  risk map presentation

temperature

relative humidity

precipitation

field specific input data
cultivar, plant emergence, crop rotation, etc.

forecasting models

spatial result presented as risk map
Two type of models used by ZEPP

**First Type**
- plant disease outbreak
  - date of first monitoring
  - date of first treatment

![Graph showing plant disease outbreak](image)

**Second Type**
- plant disease infection risk
  - high/low risk situations
  - spraying strategy

![Graph showing plant disease infection risk](image)
First type: Risk maps of late blight with SIMBLIGHT1

Forecast of the outbreak of potato late blight in Germany

05-31
06-05
06-10
06-15
06-20
06-25
06-29

Germany

forecast of the outbreak of potato late blight in a high risk scenario

advice of first treatment

yes
no
Second type: Risk maps of infection pressure with SIMPHYT3

- The output of SIMPHYT3 is a daily met. data based infection pressure for late blight by checking at met. data of the last 14 days
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Summary and Conclusion

- Virtual met. data were produced and tested on validity
  - interpolation method for temperature and relative humidity
  - radar data for precipitation
- Virtual met. data were used as input for forecasting models to produce risk maps
  - risk maps show hot spots of disease outbreak
  - risk maps show daily infection pressure for plant diseases
- Forecasting results as risk maps are easier to understand and to interpret
- GIS helps to obtain more detailed calculations and results with higher accuracy than before
- Risk maps are available under www.isip.de since April 2010

This leads to a reduced pesticide use and an economical and environmental friendly crop protection strategy
Thanks for your attention
SIMPHYT3
2007