Examples of successful applications of weather and climate products for agriculture in Europe

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Plan

- Introduction
- Context and needs
- Examples for high resolution products and services
- Examples for agrometeorological monitoring
- Examples for tactical decision aids
- Examples for a better understanding of climatic risks
- Examples for communicating information
- Conclusions
Introduction

- **Limits**: short time to prepare and short time for the presentation, so it’s not a comprehensive overview!

- Wide variety of fields in agrometeorology, including forest fires management, and various users (farmers, research community, governmental bodies, private sector), at different scales, so the choice of examples was difficult!

- **Sources**: activities of Météo-France, correspondence with NMHSs in the individual countries and with the member of ETCUAP of RA VI, internet search, publications, COST actions (EU R&D actions)

- Examples come mainly from France but I tried to expand the list of these examples to other countries in Europe (through EU projects or international agencies)

- The presentation should not be a catalog of examples unrelated, but there must be some logic between the different examples presented (overview, products, keys to success)
Choice of examples

Context

- Improving the accuracy of products and services
- Coping with rapid changes in agricultural prices - need to anticipate
- Taking into account the climatic risks
- Reducing inputs such as fertilisers, insecticides and pesticides
- Using modern communication tools

Examples

- High resolution products and services
- Assessment of crop production
- Better understanding of water availability
- Tactical Decision Aid products
- Use tools as Internet

WEB SITES

PREVIEW
FARMSTAR
MARS
ISOP
DMCSEE
VINEYARD
Need for high resolution products and services

2 examples:
- Forest Fire in FP6 PREVIEW project
- FARMSTAR service
PREVIEW was a research and development project co-funded by the European Commission (6th Framework Programme – 2004-2008). PREVIEW proposes to develop, at the European scale, new or enhanced information services for risk management in support of European Civil Protection Units and local or regional authorities.

In practice PREVIEW has developed information services for assets mapping, risk mapping, risk monitoring, risk forecasting and awareness and damage assessment for the following types of hazards: Atmospheric (Floods, windstorms, forest fires), Sismic (Earthquake, volcanoes, landslides) and Man-made.

The Fire Meteo Indices anticipate risk in monitoring and predicting fire danger. The indices are based on high-resolution meteorological data in order to model soil water content, biomass condition and the fire danger.
How does it work?

Fire Weather Index is an index that calculates, by taking into account weather conditions, the global fire danger (index summarizing the probability of outbreak and spread rate). The calculation of the FWI is based on the calculation of different sub indices. The state of the vegetation is estimated with a model by monitoring weather conditions throughout the year.
The starting point of this service is the EFFIS operated at European level by the JRC. This operational system addresses the issue of delivering homogeneous information at the European scale for fire risk rating.

- Operated by Joint Research Centre, Italy: http://effis.jrc.ec.europa.eu/
- Computed over the whole Europe
- Based on the output of numerical weather prediction models
- 50 km spatial resolution
PREVIEW: products at regional scale

Finnish Forest Fire Index (FFI):
- High resolution (1 km) forest fire risk index maps for Boreal forests
- Applied and tested in Finland
- Based on observations (analyses) and model data (forecast)
- National and Regional products

Fire Weather Index (FWI):
- High resolution (8 km) forest fire risk index maps for Mediterranean and Temperate type of forests
- Applied and tested in France
- Based on observations (analyses) and model data (forecast)
- National and Regional Products
**PREVIEW : keys to success**

- Use of all available observations in each country.
- Combination of radar imagery with ground observations.
- Use of the same algorithm to calculate Fire Indices. **Services can easily be adapted in any country**; they can be implemented “as is” or they can be tailored to take into account the local climatology and the requirements of local/national rescue authorities.
- Close cooperation with JRC and NMHS.
- Strong involvement of end users to test products.

Large high resolution fire meteo indices maps are become an operational service of Météo-France at the end of the PREVIEW project. **Output of index models is flexible**: maps, charts, time series including **both analyses and forecasts of the fire risk** over certain area of interest. **Products can also be used for climatological purposes** - study of long-term trends or climate change impact.

- Index appropriate for the type of forest: **Finnish Forest Fire Index (FFI)**, at 1 km resolution, is designed for boreal forests: Northern Europe, regionally in the Central and Eastern Europe and potentially in Russia. **Fire Weather Index (FWI)**, at 8 km resolution, is dedicated to Mediterranean and Temperate type of forests.
Infoterra has developed Farmstar, a programme for precision farming, in partnership with agronomy institutes: ARVALIS for wheat, barley and maize, CETIOM for rapeseed and ITB for sugar beet, with the collaboration of Météo-France.

Information products for agricultural cooperatives and farmers to help them improve crop management.

Their main customers are French agricultural cooperatives as well as their counterparts in Germany and in England.

2006 : 8 000 farmers on 256 000 ha and 25 000 plots of wheat, canola, barley and maize.
Farmstar: products

- Farmstar is based on processing and analysis of satellite images, and by combining this information with agronomic models, it can generate maps of diagnosis and recommendation telling the farmer how to conduct the crop:
  - recommendations for the addition of nitrogen
  - information about the state of the crops at key dates in their development
  - forecasts on the date of maturity and so on

3rd Nitrogen Application for the wheat
It allows the farmer to adjust its crop practices while taking the variability within plots or between plots into account. It can be used to optimise management of the plot in terms of:
- agronomy (by adjusting crop practices very precisely to meet the real needs of the plant to satisfy needs for nitrogen),
- environment (by reducing expectations related to farming activity, by limiting excess run-off of nitrogen),
- economic (by increasing the price paid for the farm product by improving the quality obtained through better advice on inputs).

It combines remote sensing techniques with agronomic models and meteorological data.
Need to anticipate production
Crop monitoring

2 examples:
MARS System (Europe/JRC Ispra)
ISOP (France)
MARS : overview

The MARS (Monitoring Agriculture with Remote Sensing) project is one of the projects of the Directorate General Joint Research Center (JRC) of the European Commission in Ispra (Italy). This project has the main objective to provide to the European Commission decision makers, mainly in the Agriculture Directorate-General (DG) and Eurostat, early, independent and objective estimates about the production of the main crops in Europe. For the implementation of the Common Agricultural Policy, the European Commission needs timely information on the agricultural production to be expected in the current season.

An extranet site and regular bulletins offer wide variety of information about the current agricultural season in Europe and other important agricultural areas in the world.

Available products include:

- maps of **weather indicators** based on observations and numerical weather models
- maps and time profiles of **crop indicators** based on agro-meteorological models
- maps of **vegetation indices** and **cumulated dry matter** based on remote sensing images
The Crop Growth Monitoring System provides the European Commission with objective, timely and quantitative yield forecasts at regional and national scale.

CGMS monitors crops development in Europe, driven by meteorological conditions modified by soil characteristics and crop parameters. This mechanistic approach describes crop cycle (i.e. biomass, storage organ ...) in combination with phenological development from sowing to maturity on a daily time scale. The main characteristic of CGMS lies in its spatialisation component, integrating interpolated meteorological data, soils and crops parameters, through elementary mapping units used for simulation in the crop model.

In summary, CGMS consists of three main parts:
1) Interpolation of meteorological data to a square grid
2) Simulation of the crop growth
3) Statistical evaluation of the results
The MARS bulletins offer in a near real time and operational context analyses and information at EU level and neighbouring countries like Ukraine, on crop growth monitoring and yield forecasting, including rice and pastures, basing on the MARS Crop Yield Forecasting System.

They include different kind of publications:

- **Full Analysis** are published from 6 to 8 times a year on European Crop Monitoring and Yield Forecasting. These publications are also available on request on paper format. Crops covered are Wheat, Barley, Rice, Maize, Rapeseed, Sunflower, Sugar Beet, Potato and Pastures.

- **Quick Look releases** (i.e. shorter digital versions or e-mail versions) of the same analyses are available to facilitate downloading and are loaded in the site before the final full analysis.

- **Climatic Updates** are brief intermediate analyses between two main bulletins and are available only in digital version.
MARS: keys to success

- Operational system at JRC
- Close collaboration between JRC and various organisms
- Combination of meteorological data, crop parameters and soil parameters with the use of a crop growth model
- Products defined by the end user
ISOP : overview

Purpose of ISOP (Grassland Information System Monitoring) :
- Reliable estimations of the forage production over France
- Objective information to estimate real farmers losses
  - Ministry of Agriculture
  - monitoring in case of local or global drought
  - operational system for year 2000

Main ISOP input data meteorological parameters :
- Daily datasets : rainfall & extreme air temperatures, global radiation, Penman-Monteith PET

Main ISOP input data management practices :
- Estimation through a national survey : 8800 fields
- Frequency of mowing or grazing : thermal time between mowings
- Status and amount of nitrogen supplies : winter & spring, initial nitrogen index

Main ISOP input data soil types :
- Soil geographical database of France : dominant soil types (percentage of RFP area)
- Integration and simplification through ARCVIEW GIS : water capacity, nitrogen mineralization properties per layer
ISOP: how does it work

Operating overview

- 200 regions of forage production (RFP)
- 3 grassland types
  - permanent, temporary & pure legume
- 6400 combinations: soil, mowing frequency, nitrogen amount, ...
- Assessment of the current yield
  - aggregation per RFP and grassland type
  - comparison to statistical values (1982/1996)

ISOP crop model STICS

- multi-crop simulator
- evolution of grass above ground dry matter
  - water balance
  - nitrogen balance
- calibration over France with INRA experimental data
ISOP: products

Alert map: overview for day D
- once per month
- one national overview per grassland type
- RFP with deficit (<mean-25%)

Time profiles for relevant drought-striken RFP, on request
Operational system on Météo-France computers

Close collaboration between Météo-France, INRA (National Institute for Agronomical Research) and French Ministry of Agriculture

Combination of meteorological data, management practices and soil data with the use of INRA crop model

Products defined by the end user, to detect crisis situations and to provide yearly assessments of forage production or anomalies
For a sustainable agriculture, reduce inputs such as fertilizers, insecticides and pesticides.
The aim of the Environment Round Table was to define the key points of government policy on ecological and sustainable development issues for the coming five years.

**Topic: Ecological and productive agriculture**

- In time, a 50% reduction in the use of pesticides and ban of around forty chemicals between 2008 and 2012.
- Organic farming on 20 % of farmland by 2020, preferably near drinking water collection points.
- 20 % of produce used in public canteens and catering services will be organic by 2012.
- Integrating environmental requirements into AOC products.
- 50 % of farms committed to earning certification for “high environmental value” by 2012.
- **Irrigation, reduced use of nitrates and phosphates, developing solutions that use less water and artificial fertilizers.**
- Promote and sustainably develop forest resources while protecting biodiversity.
- Systematic use of certified wood for public works.
- Building standards specifically for wood.
- By 2009, launch a plan to protect bees.
One example for optimising the practices Meteo France Extranet for vineyard

- Include all the weather information on a website dedicated to a vineyard.
- Provide specific information for the management of vineyard (treatment, harvesting, etc.), by taking into account the rules and constraints.
- Facilitate access to weather data, including automatic observation stations, and provide climatological tools to allow adapted diagnoses.

Available services:

- Forecasting tools: nowcasting, short, medium and long range weather forecasts (very useful for pest management and other plant production practices).
- Management and visualization of observations data: automatic stations, radar imagery and satellite imagery.
- Climatological tools for monitoring the current year compared to the past, prospects for long-term, or also in relation to disease risk (yearly, monthly and daily climatology).
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Extranet for vineyards: Tactical Decision Aid Product

Bulletins specifically designed for decision making

Example

From May to August:
Risk = rain and/or wind during treatment of vineyards

Example 15 May 2009
No treatment
Extranet for vineyards: keys to success

- All products available on a unique web site
- Design of service with the customer who is familiar with the needs of the wine world
- Collaboration with ITV (Vineyard Technical Institute) and INRA
- The tactical decisions incorporate a wide range of day to day operational decisions concerning fertilisers or pesticides: user needs not only agrometeorological data but also an information which is useful for decision making.
For a better understanding of water availability,
Take into account the drought risk.
Drought is a normal part of climate in virtually all regions of the world, including South Eastern Europe. Drought can cause significant economic losses depending on the stage of crop growth during which it occurs.

Climate change scenarios predict significant decrease in summer precipitation.

Need to establish an operational centre for drought preparedness, monitoring and management = DMCSEE (WMO and UNESCO) (2004).

Slovenia was selected as a host country in 2006. Kick-off meeting held in Ljubljana (Slovenia) in April 2007.

The **mission** of the Center is to coordinate and facilitate the development, assessment, and application of drought risk management tools and policies in SEE.

The **goal** is to improve drought preparedness and reduce drought impacts.
Founding countries (13)

- Albania
- Bosnia and Herzegovina
- Bulgaria
- Croatia
- Macedonia
- Greece
- Hungary
- Moldova
- Romania
- Slovenia
- Turkey
- Montenegro
- Serbia
The agreed core tasks were grouped into eight DMCSEE project objectives:

**Objective 1:** to assess the data available for effective drought monitoring and early warning system;

**Objective 2:** to evaluate and select the most effective and reliable indices and indicators for drought assessment;

**Objective 3:** to conduct a drought risk assessment;

**Objective 4:** to identify the specific training needs;

**Objective 5:** to develop and implement a data and information delivery system on drought management;

**Objective 6:** to develop a comprehensive network of experts and institutions to assist the DMCSEE;

**Objective 7:** to ensure communication and user feedback;

**Objective 8:** to establish the permanent DMCSEE and ensure its sustainable functioning and operations.

With assessments of vulnerability and risk, DMCSEE will be able to advice on improved drought management and policy.
Drought monitoring and forecast products

Drought monitor

Using Global Precipitation Climatology Centre (GPCC) data, maps of the SPI, Percentiles and Precipitation for the region are prepared.

One of the most robust drought indices is Standardized Precipitation Index (SPI). The SPI can be calculated at various time scales which reflect the impact of the drought on the availability of water resources. The SPI calculation is based on the distribution of precipitation over long time periods (30 years (1961-1990) was used). The long term precipitation record is fit to a probability distribution, which is then normalised so that the mean (average) SPI for any place and time period is zero.

Another way to define drought are percentiles. A percentile is the value of a variable below which a certain percent of observations fall. Long term precipitation record is sort by rank by month; 50 years period (1951-2000) was used. The 5th (10th, 15th etc.) percentile is the value below which 5 (10, 15 etc.) percent of the observations may be found.
DMCSEE : key to success

- Close collaboration between several countries
- Set up of an operational system for the supply of maps on drought management
Communication of agrometeorological information

Internet

see presentation Dr Trampf session 6
Examples of NMHS web sites
Examples of NMHS web sites
Internet: keys to success

- Ability to communicate agrometeorological information in a timely and efficient manner
- Ability to provide services with imagery, animations, graphics, tables, customized services
- Ability to integrate the own information from the user
Conclusions
Future successful applications in Europe?

Probabilistic forecast

- Some NMHS provide probabilistic forecasts, but in general not specifically for farmers.
- Deterministic forecast is still predominant, but probabilistic forecast (probability of exceeding thresholds for example) increasingly used by farmers for decision making purposes.
- The gain in computing power (necessary for ensemble prediction system) and the gain in spatial and time resolution, allow to have more and more high quality probabilistic forecast.

Seasonal forecast

- Benefits more evident for the tropics than in Europe.
- Not really used by farmers in RA VI.
- But the DEMETER project had obtained interesting results: when compared to the operational system, for the same level of accuracy, earlier crop forecasts are obtained with the DEMETER system. Furthermore, probability distribution function of wheat yield provide information on both the yield anomaly and the uncertainty of the forecast.
- It is shown that the use of ensembles of seasonal weather forecast brings additional information for the crop yield forecasts and therefore has valuable benefit for decision-making in the management of European Union agricultural production (Cantelaube and Terres, 2005).
Keys to success

- Integrated agrometeorological systems, using crop simulating models with different data sources (forecasts and climate data, soil data, management practices)
- Active collaboration between NMHSs, Universities, technical institutes, agricultural research and private sector in developing value added services
- Use advances in forecasting techniques and observations systems to offer high resolution and increasing long term products and services
- Combining resources and providing products at international or European level
- Agrometeorological Information is not only weather forecast or climatological data, but also services which are useful for decision making, by integrating the constraints of the user
- Feedback from the users for designing the product or service
- Use of efficient communications means: Internet to provide relevant information in a timely and efficient manner
Thank you for your attention!