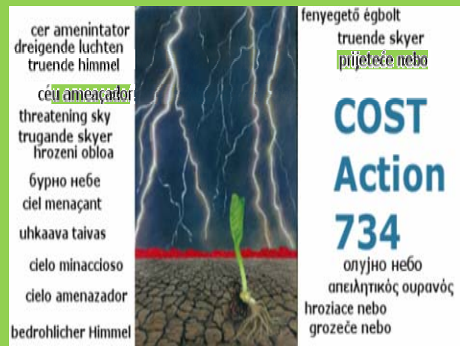
COST 734 – CLIVAGRI

Impacts of Climate Change and Variability on European Agriculture

2006-2011



www.cost734.eu

Pavol Nejedlik
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Organizational – What is COST?

Intergovernmental framework for European Cooperation in Science and Technology

-coordinating nationally funded research

-networking existing projects and activities

-supporting cooperation

-no research money in COST!!!

COST Action

-based on Memorandum of Understanding of cooperating countries with some objectives

COST Action 734 MoU main objective

„The evaluation of possible impacts from climate change and variability on agriculture and the assessment of critical thresholds for various European areas“

Tools being used by the Action to reach the objectives

-Joint WGs meetings with the scientific performance following the MC meetings

-Cooperation with the bodies dealing with the topic on European and global scale /WMO, JRC, FP7/

-Topic oriented symposia organized together with WMO, JRC and FP7 projects /CECILIA, Adagio/

-STSMs to enhance the scientific work

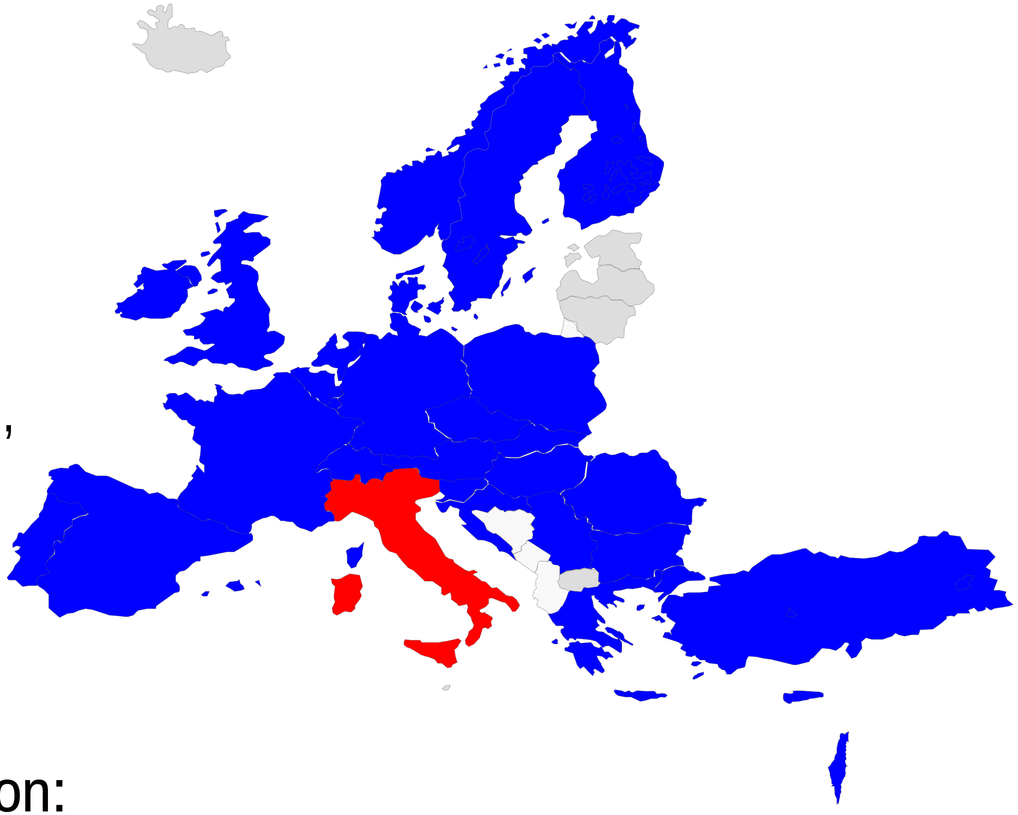
-Training schools to involve young researchers

Geographical impact

COST Countries : 29

Chair : IT

List of COST country
AT, BE, BG, HR, CY, CZ, DK, FI, FR, DE, GR, HU, IE, IL, IT, LU, NL, NO, Pl, PT, RO, SR, SK, SI, ES, SE, CH, TR, UK



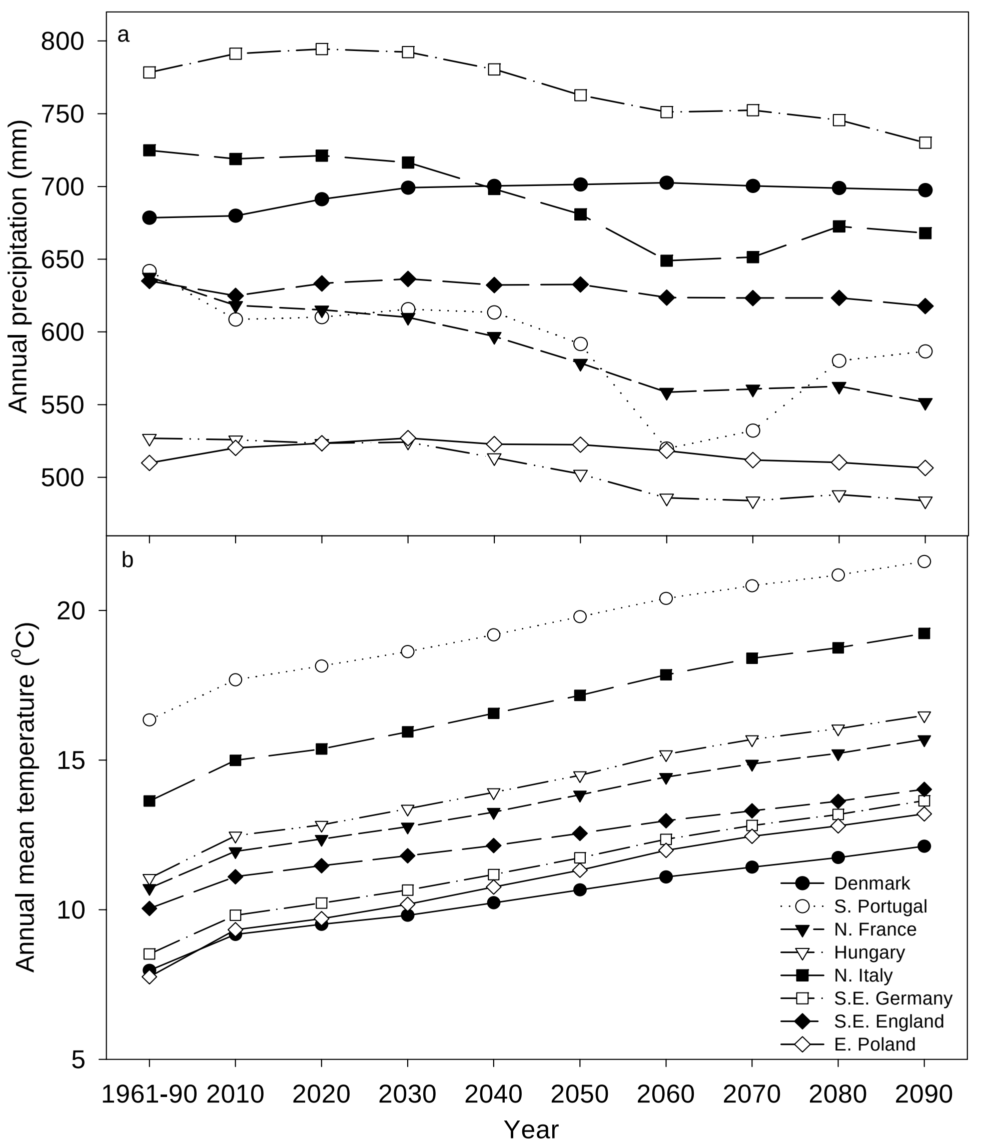
Non-COST Institution:

National Drought Mitigation Centre, University of Nebraska–Lincoln USA
Lincoln University, Canterbury New Zealand
Joint Research Centre Ispra, Agriculture Unit (ex-Agrifish) Italy
WMO – Agricultural Meteorology Division

Some trends in climate of Europe

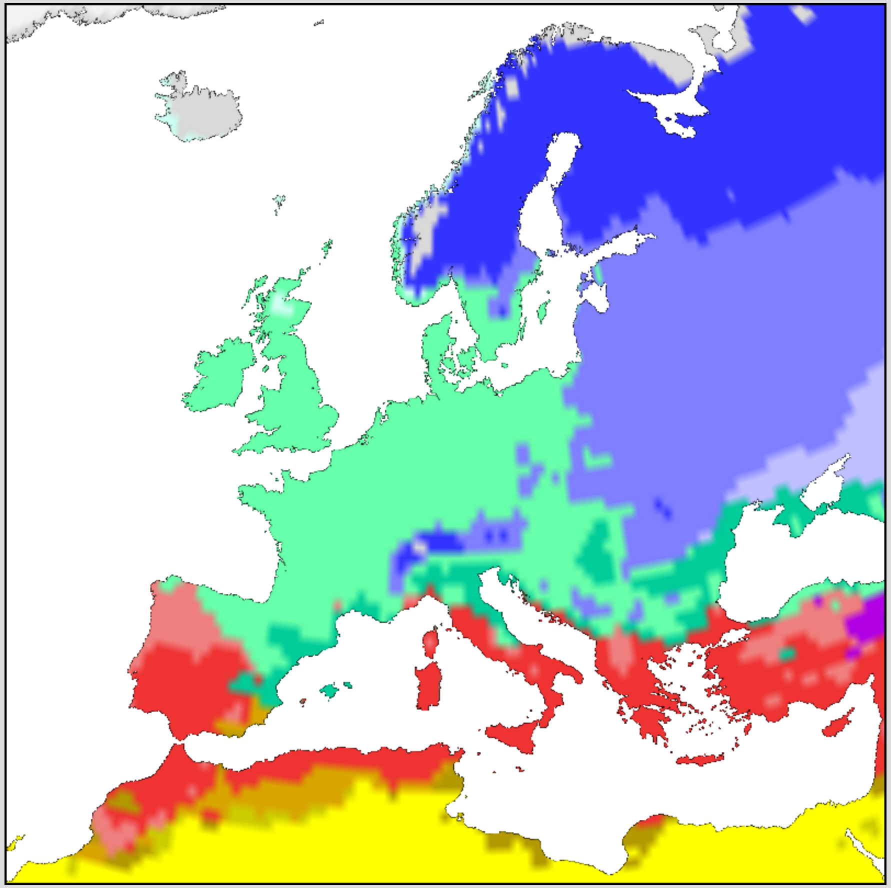
Climate parameters trend

Projected temperature and rainfall



Climate classification

Köppen climate regions, 1961-1990



Warm climate
- Dry
- Very dry

Mild climate
- Dry summer
- Rain all year

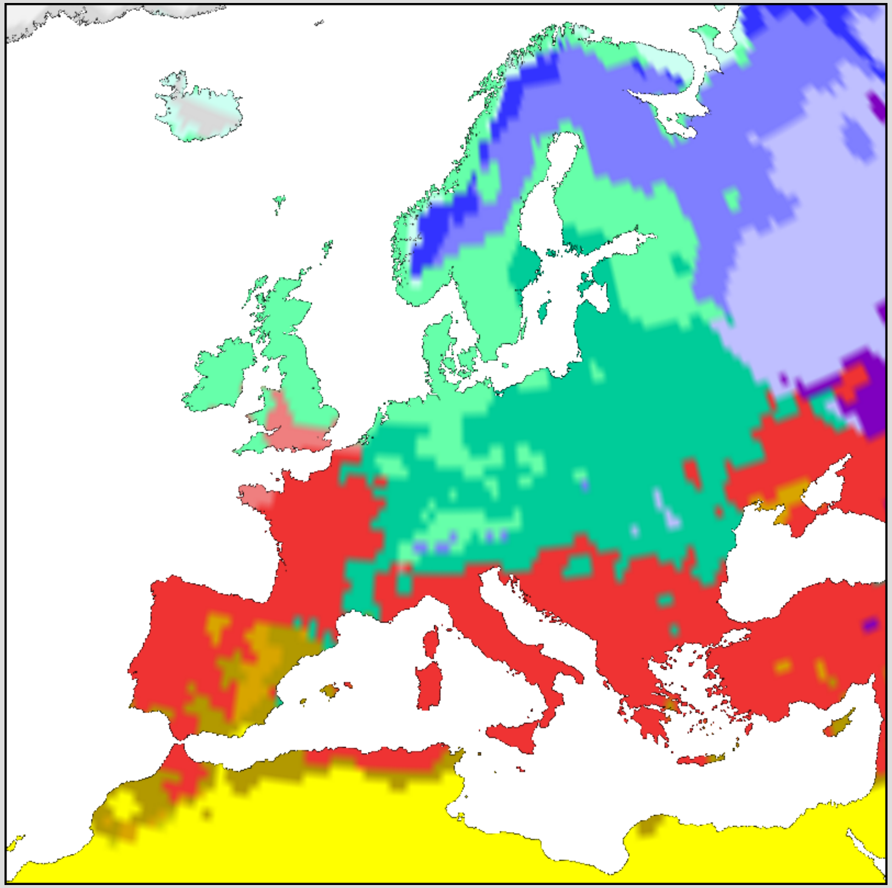
Cool climate
- Dry summer
- Rain all year

Polar climate
- Tundra
- Ice/snow

Jylhä (2007)

Climate classification

Köppen climate regions, 2080 (A2)



Warm climate
- Dry
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Mild climate
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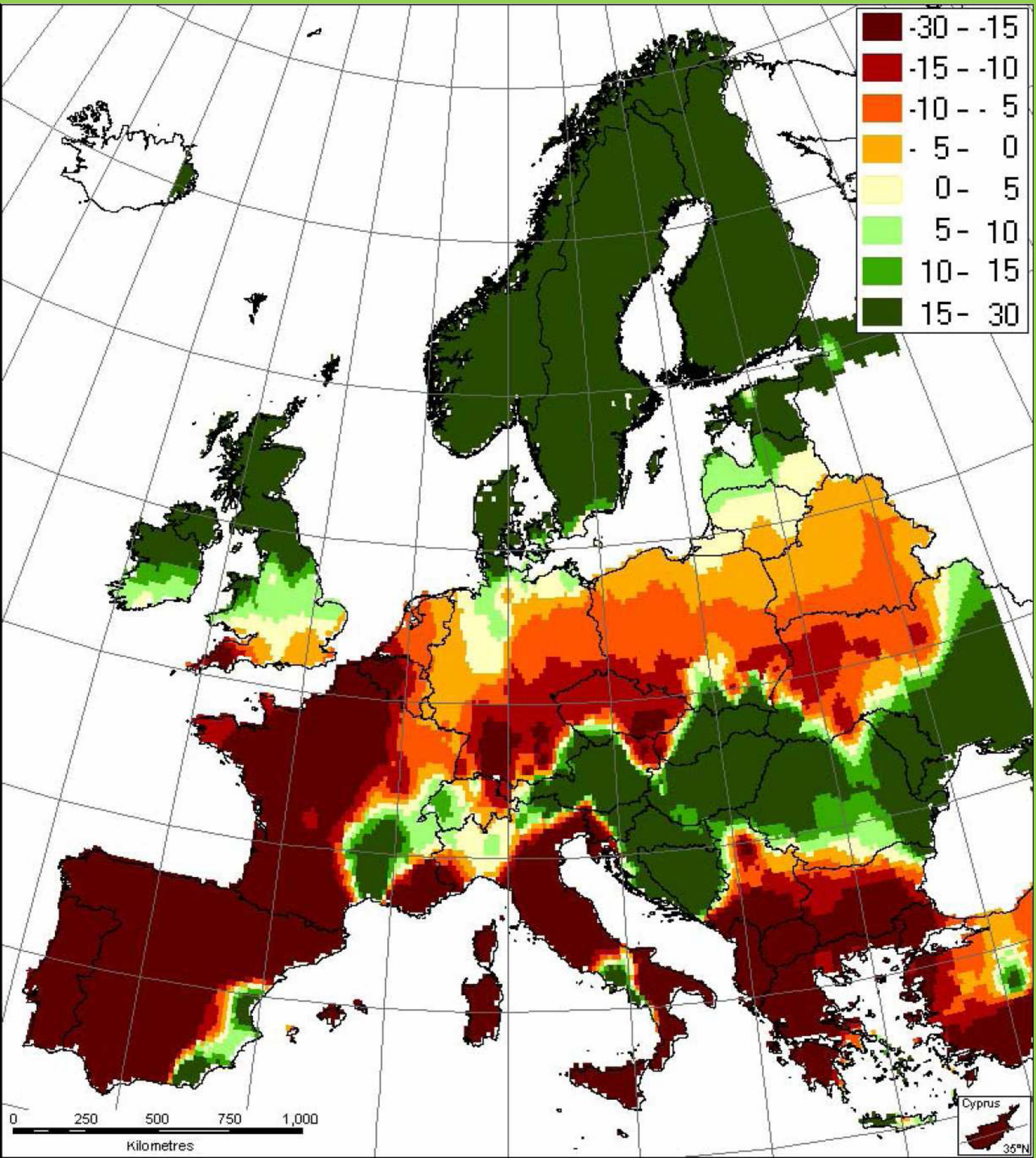
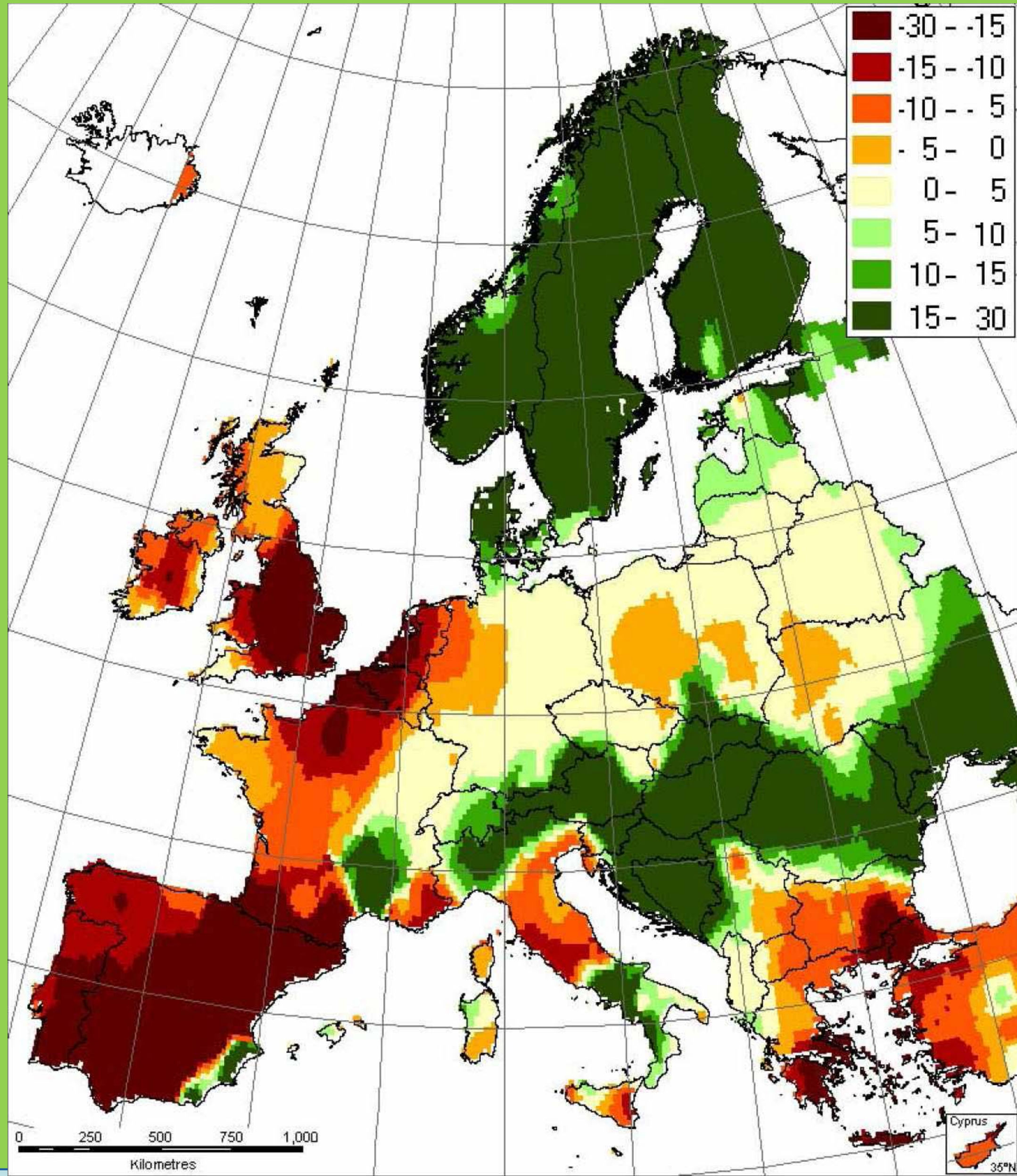
Cool climate
- Dry summer
- Rain all year

Polar climate
- Tundra
- Ice/snow

Jylhä (2007)

Simulated crop yield changes (%) by 2080s according to two different models , (left) HadCM3, (right) ECHAM4 (European Commission, 2007)





Scientific content and objectives (1/1)

-bring together the national research on climate change impacts

-evaluation of possible impacts from climate change and variability on agriculture

-assessment of critical thresholds for different areas in Europe

-evaluation of existing methods of detection to assess climate related impacts /indices and models/

-estimating the trends - climate scenarios for the next decades

-complex tools in evaluation of the fundamental agroclimatic conditions used for the impact studies

Scientific content and objectives (1/2)

WG 1 Agroclimatic Indices and Simulation Models

Deliverables A review and assessment of agroclimatic indices and simulation models relevant for agricultural activities and and their relationships with specific crop responses

WG 2/ WG2.1 Evaluation of the Current Trends of Agroclimatic Indices and Simulation Model Outputs describing Agric. Impacts and Hazard Levels

Deliverables Verification of data and troubleshooting with missing, non-homogeneous and erroneous data, assessment of required resolution for practical agroclimatological applications as a function of variables, areas and agricultural aspects.

Scientific content and objectives (1/3)

WG 3 Development and Assessment of Future Regional and Local Scenarios of Agroclimatic Conditions

Deliverables Collection of future climate scenarios for various European regions according to agroclimatic index and simulation model characteristics.

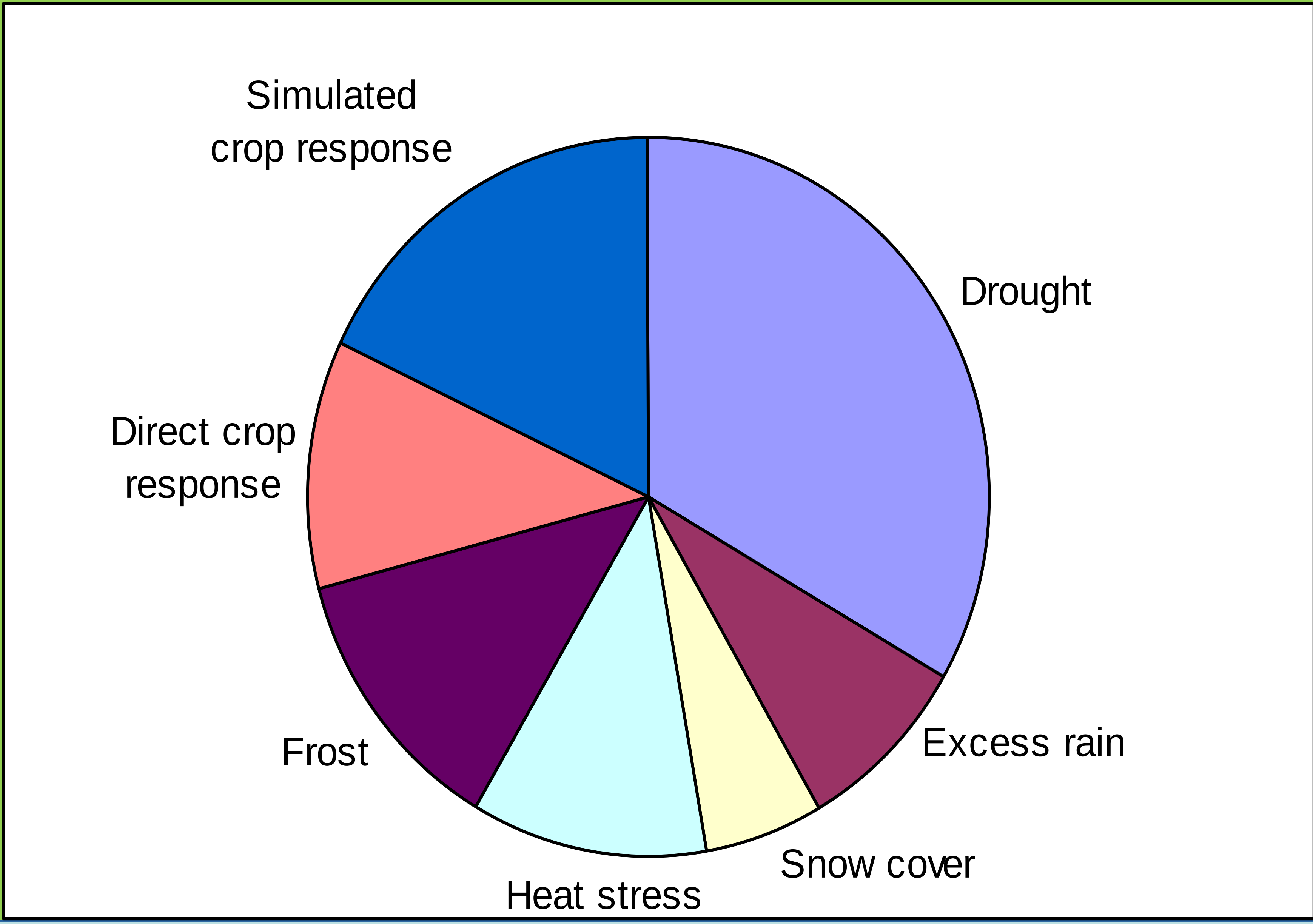
Assessment of future trends of climatic conditions and hazards.

WG 4 Developing and Assessing Future Regional and Local Scenarios of Agroclimatic Conditions

Deliverables Standardization and harmonisation of criteria to evaluate the impact of climate change and variability on agricultural activity. Formulation of specific recommendations and assessments for policy makers, extension services, farmers and other end-users.

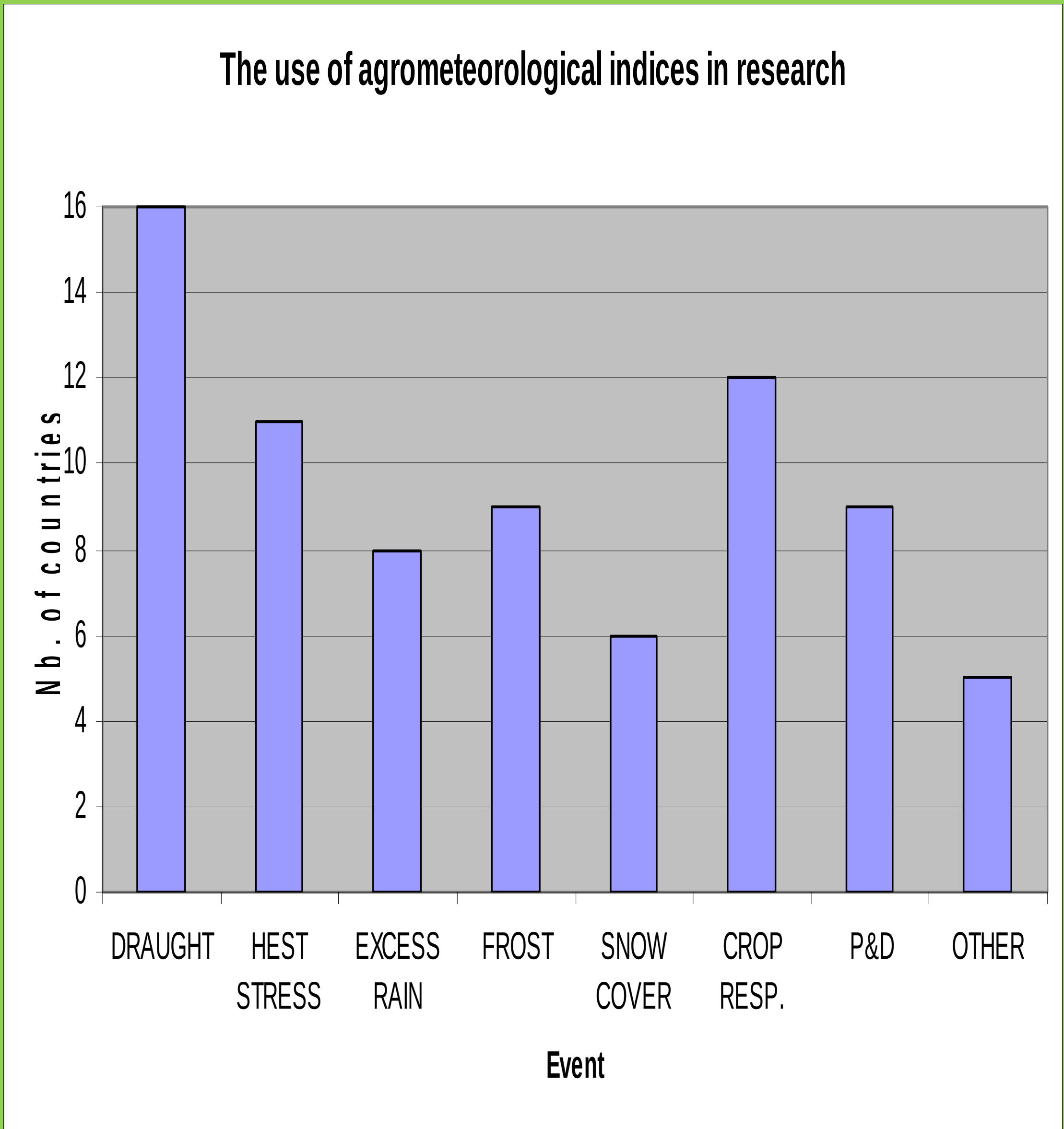
REVIEW AND ASSESSMENT OF AGROCLIMATIC INDICES AND SIMULATION MODELS IN EUROPE OPERATIONAL USE AND RESEARCH

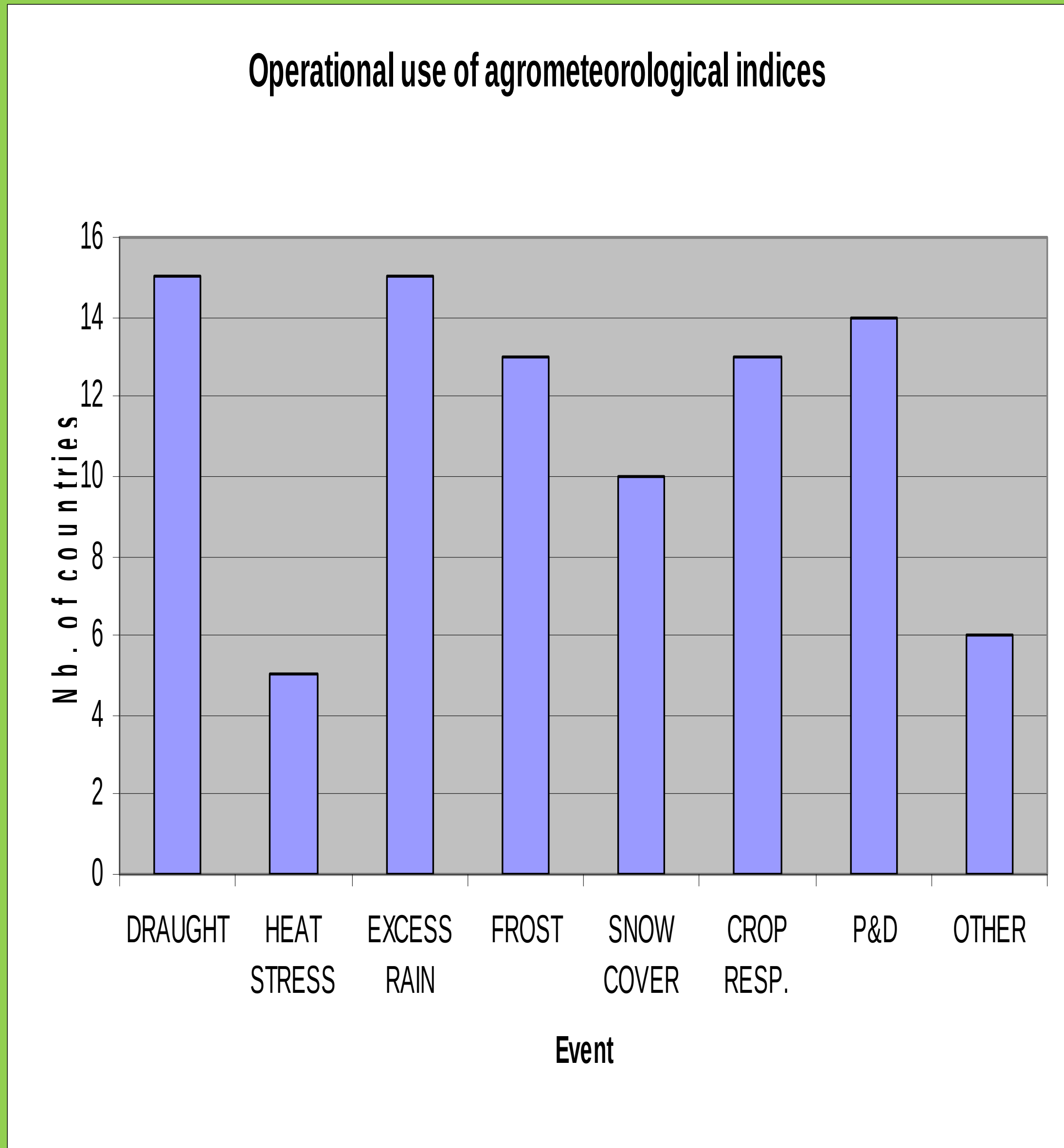
The distribution of the numbers of agrometeorological indices used in research according to their purpose



Does the research match with operational use?

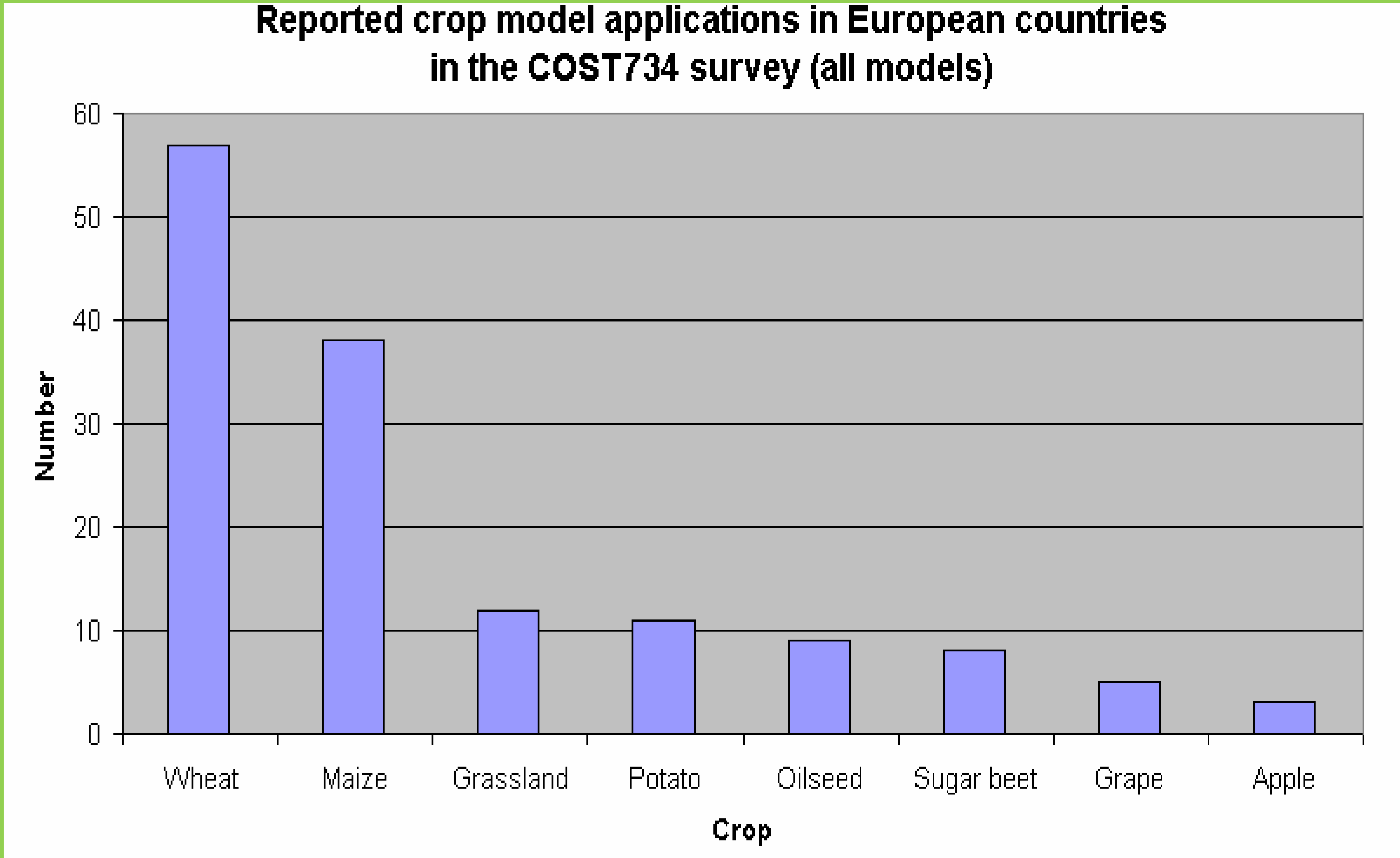
Operational and research use of agrometeorological indices in European countries





Reported crop model applications

(operational and research, one count per model and country)



Use of agroclimatic Indices

Findings

- -Due to their simplicity, agroclimatological indices are considered as valuable tools for research and operational applications
- -The possibility of using wide temporal time steps (daily, weekly, monthly) makes these indices suitable for application with historical climatic series
- -In some cases (e.g. drought indices, grapevine quality index, etc.), where indices also include thresholds describing the consequences of obtained values, they recommend interventions needed to manage and to protect crops from climate related impacts.
- -Agroclimatic indices are used at European level for many purposes at spatial (regional, national) and temporal (nowcasting, past-casting, forecasting) scales.

Recommendation

- There is a need of standardization and harmonization of Agromet. Indices applications in Europe in order to allow inter-comparison and to improve the interpretation of results.

Simulation models

Findings

- Effects of climate change on crop productivity are the dominating studies.
- More complex approaches, namely process oriented models, are still very limited in operational applications (especially crop yield models), except for the more simple models (e.g. crop water balance models focusing on irrigation scheduling rather than on yield estimates), or models for pest and disease management.
- Majority of the model applications neglect the finer spatial resolution due to the lack of input data

Recommendations

- The modelling should also have a closer look on other aspects such as soil fertility, and environmental issues like groundwater recharge and water quality, soil carbon stocks, erosion, trace gas emissions, etc.
- Integrated modelling approaches are required and should reflect the most relevant interactions in the soil-crop-atmosphere system.
- The combination of modelling of climate change impacts with ideas and experiences of sustainable production is needed.

POTENTIAL OF REMOTE SENSING TO SUPPORT THE ASESSMENT OF CLIMATE CHANGE AND VARIABILITY ON EUROPEAN AGRICULTURE

- Two levels of RS data are recognized – direct simple products /indices/ and RS data as the inputs to further systems for processing
- Big advantage of RS data/products is their space distribution
- The main variables that are collected in operational or experimental way are land surface temperature and NDVI.
- There are differences between countries regarding the use of climate and biophysical variables asthe high level products (evaporation, soil moisture, storm detection, etc) require quite complex algorithms or schemes
- The use of RS data in crop models enormously increases
- Strategies for using remote sensing data in crop models include:

-Forcing – which requires frequent data

-Sequential correction – using updating to replace model data with observed data

-Model calibration – where competition between model parameter may lead to an 'ill posed' inversion problem.

RS data use in agrometeorological operational use and research

Findings

-increasing tendency for the use of remotely sensed information among the real users of agrometeorological information
-not enough adequately trained persons among agricultural meteorologists that can effectively provide the dissemination of processed remotely sensed information
-increasing number of unexpected meteorological events (drought, frost, floods, etc.) is consequence of global warming/climate change detected by RS.
-extremely big volume of data needs very strongcomputing power

Recommendations

-to concentrate on hhigh level remote sensing products which are easier to assimilate

-to work with more ‘core’ satellite observations such as low level products which can provide better results, since assumptions made in the satellite product calculation are avoided

-to avoid the assimilation of ‘raw’ remote sensing data as it is often an unrealistic approach due to the computing power required

REGIONAL CLIMATE SCENARIOS FOR EUROPE -use in agrometeorological practices

Information based on the European activities

- "Prediction of Regional scenarios and Uncertainties for Defining European Climate change risks and Effects" (PRUDENCE; http://prudence.dmi.dk) (Christensen et al., 2007b);
- "Modelling the Impact of Climate Extremes" (MICE) (Hanson et al., 2007);
- "Statistical and regional dynamical downscaling of extremes for European regions" (STARDEX; http://www.cru.uea.ac.uk/projects/stardex/);
- "Development of a European Multimodel Ensemble system for seasonal to inTERannual prediction" (DEMETER; http://www.ecmwf.int/research/demeter/) (Palmer et al., 2004).
- CECILIA

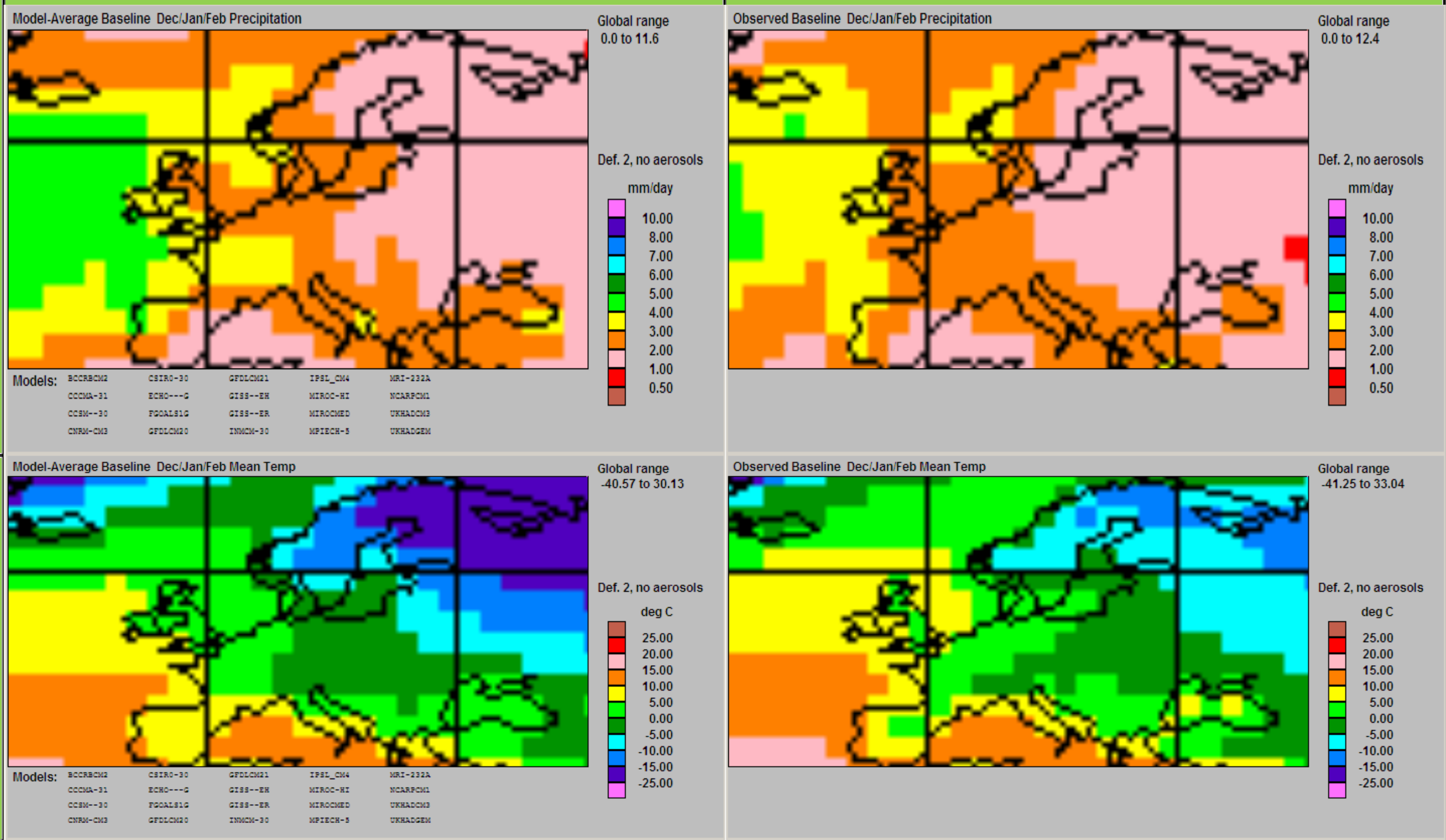
- **Even in the case of very high-resolution simulations some sort of post-processing is needed to deal with biases in the modeled meteorological fields**

- **RCMs give an appropriate analysis in quasi-homogeneous region and enable to apply the postprocessing at very high resolution of about 10 km**

Simulated and observed values of temperature and precipitation – Winter (1980-1999)

Temperature (°C)

Precipitation (mm/day)



20 GCM mean	Observed values (ERA-40)

Comparison of simulated(left column) multi-model ensemble mean seasonal temperature (upper row) and precipitation (lower row) with ERA-40 diagnostics (right column).

Impacts of climate change on crops in Europe

- Only a limited number of studies have examined the regional variation in Europe in terms of impacts and addapatation to climate change

Assumptions:

-There is a large variation across the European continent in climatic conditions, soils, land use, infrastructure, political and economic conditions.

-Intensive farming systems in western and central Europe generally have a low sensitivity to climate change

-There may be considerable difference in adaptive capacity between cropping systems and farms depending on their specialisation

-Farming systems currently located in hot and dry areas are expected to be most severely affected by climate change

Evaluation of the CC impacts on Agri sector

- **Evaluation of the agroclimatic conditions**
- -observed warming trend is accelerating through the whole continent
- -precipitation trends are more spatially variable
- -raising extremity, mainly in Central Europe
- Indices based definition of the fundamental agroclimatic conditions that govern the yield potentials

- **Projections for the possible adaptations in the future**
- Weather generator parameters derived from the baseline series /1961-2000/ were perturbed according to the climate change scenarios.
- 86 sites through the environmental zones were evaluated

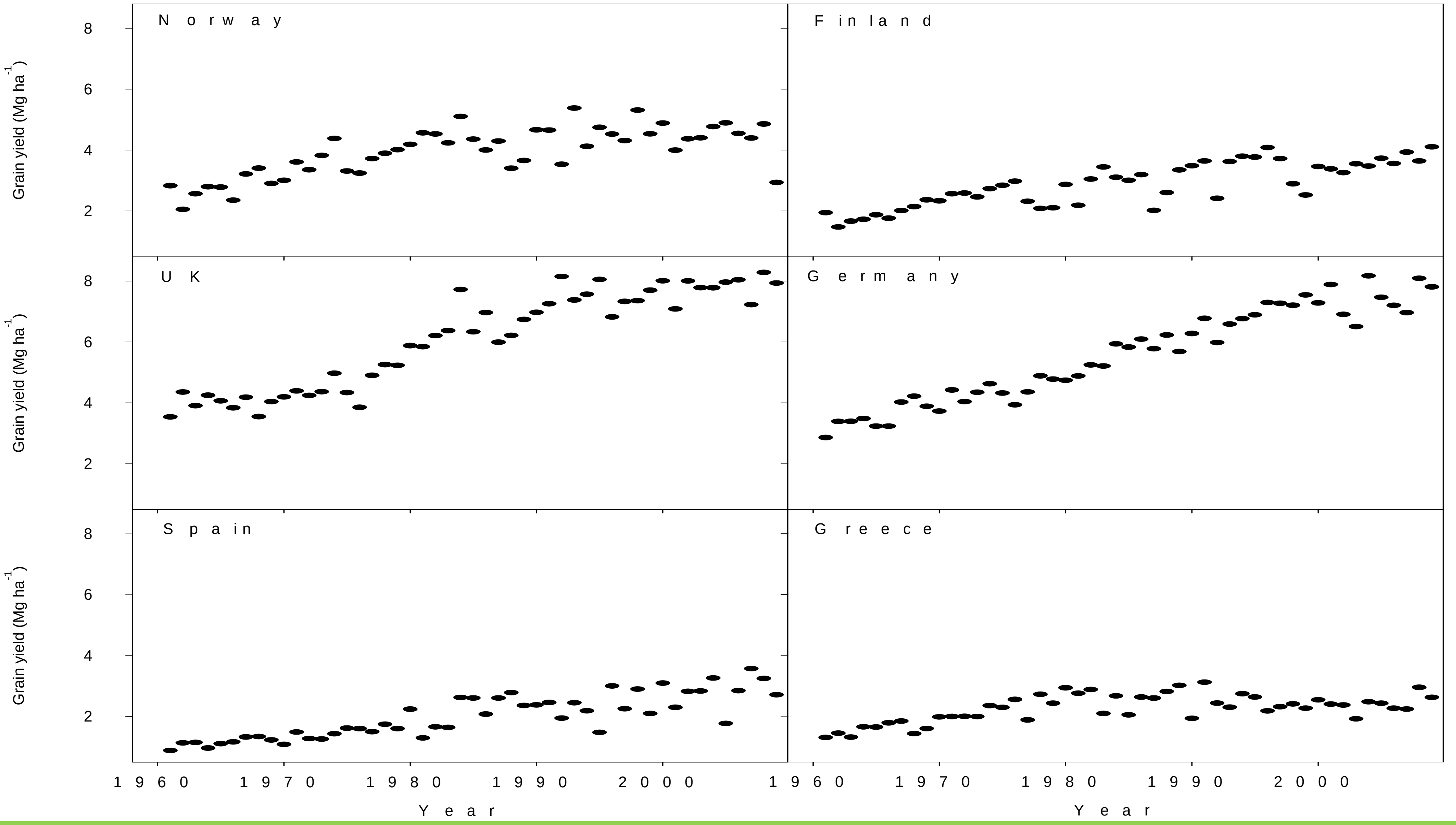
- Impact studies at the regional level

Observed climate changes

- Most of Europe has experienced increases in surface air temperature during 1901 to 2005about 0.9 °C in annual mean over the entire continent
- The recent period shows a trend considerably higher than the mean trend
- For the past 25 years, trends are higher in central and north-eastern Europe, while the temperature trends are lower in the Mediterranean region
- Temperature is increasing more in winter than in summer
- An increase in temperature variability has been observed, primarily due to increase in warm extremes

- An increased occurrence of droughts in large parts of western and eastern Europe, with particularly large increases in the Mediterranean region are observed
- Mean annual precipitation is increasing in most of Atlantic and northern Europe and decreasing along the Mediterranean
- An increase in mean precipitation per wet day has been observed in most parts of the continent, even in areas getting drier

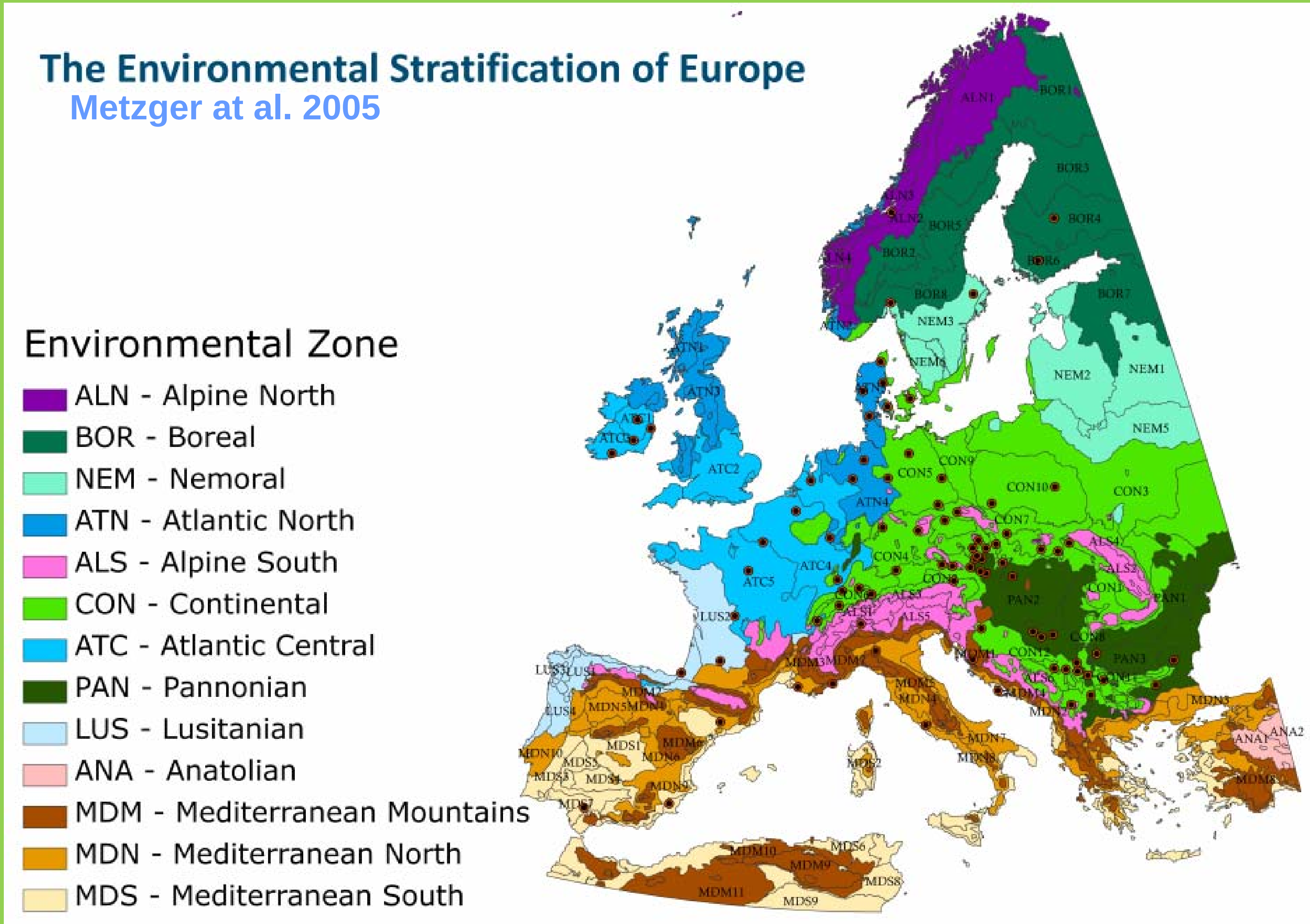
National grain yield of wheat



Basic points of CC impacts evaluation

- The use of scenarios
- Considering natural regions
- Evaluating selected agroclimatic indicators

Taking natural regions



Changes in the median values of selected agroclimatic indicators relative to the 1971-2000

Projection for 2030

SRES A1B, CO_2 458 ppm, Temp. change ~ +2.9

Environmental Zone	Effective global radiation change (%)			Effective growing days change (days)			Huglin index change (%)			Date of the last frost change (days)			Proportion of dry days in AMJ change (%)			Proportion of dry days in JJA change (%)			Proportion of sowing days - early spring change (%)			Proportion of sowing days - fall change (%)		
	E	H	N	E	H	N	E	H	N	E	H	N	E	H	N	E	H	N	E	H	N	E	H	N
ALN	10	9	12	20	16	27	14	19	22	-6	-7	-8	0	0	1	0	0	0	-3	-3	-3	3	5	5
BOR	9	7	8	10	8	10	14	28	17	-4	-8	-4	-3	-1	-3	-3	1	-5	0	2	2	7	8	8
NEM	5	1	8	12	4	16	15	26	15	-5	-6	-5	-1	-1	-1	-1	3	-2	-2	-3	-2	6	7	8
ATN	3	2	9	8	5	15	13	18	14	-6	-8	-9	-3	-3	-5	5	9	0	7	7	8	4	4	4
ALS	3	5	11	-6	-5	4	14	19	12	-7	-9	-8	-1	-2	-1	2	3	0	4	3	2	3	3	4
CON	-8	-7	0	-4	-5	2	13	19	12	-5	-8	-6	-1	-1	-2	8	9	3	5	5	5	4	4	5
ATC	-4	-6	-1	-2	-4	1	13	18	12	-7	-10	-10	2	2	0	8	14	4	2	2	3	1	1	2
PAN	-24	-15	-10	-12	-5	-6	13	18	12	-6	-8	-5	3	1	-1	18	15	11	4	4	3	0	1	2
LUS	-19	-17	-8	-28	-24	-13	14	19	11	-8	-8	-7	7	8	5	20	21	9	1	1	0	0	0	1
MDM	-15	-10	-3	-14	-9	-1	15	17	12	-3	-4	-3	12	11	8	13	11	3	-2	0	1	1	1	2
MDN	-12	-7	-3	-10	-6	-2	11	14	9	-24	-25	-24	10	8	6	12	8	4	-1	0	-1	-1	0	1
MDS	-19	-18	-6	-9	-9	-3	10	14	9	-11	-12	-12	9	8	4	3	2	1	-8	-9	-7	-7	-3	0

Overview of the methodological approach for using indicators for the evaluation of changes in agroclimatic conditions in Europe under climate change based on the applications in 86 sites. ECHAM (E), HadCM (H) and NCAR (N) (Trnka et al., 2011)

Expected average scores for impacts of climate change on a range crop production limiting factors on some crops

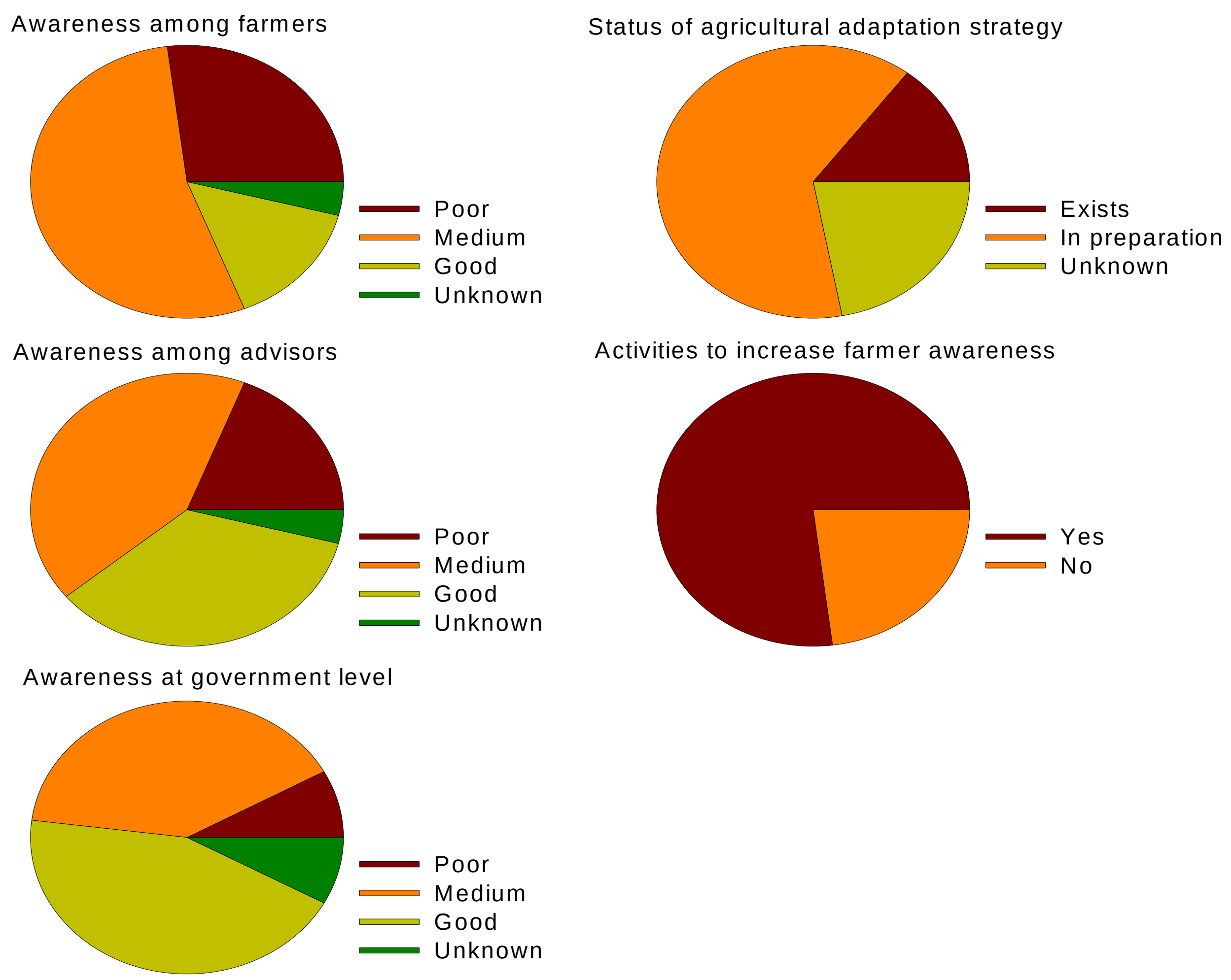
Winter wheat

	Growth Duration	Overwin-tering	Frost	Suitable harv.	Seasonal variability	Drought	Heat stress	Hail	Pest& Diseases	Weeds	Soil erosion	Nitrogen losses
ALN												
BOR	1.5	-1.0	0.0	-0.3	0.0	0.5	0.5	0.0	2.0	1.0	1.0	2.0
NEM	0.3	-0.8	-0.3	1.5	1.3	1.0	1.0	0.5	1.5	0.0	0.3	0.8
ATN	0.2	-0.8	0.0	-0.3	0.3	0.8	1.0	0.5	1.5	1.0	0.8	1.3
ALS	-0.5	1.0	-0.5	1.5	0.0	1.0	1.0	0.0	1.0	0.0	2.0	1.0
CON	-0.2	-0.4	0.0	0.4	0.5	0.4	0.9	0.2	1.4	1.0	0.6	1.3
ATC	-1.0	-0.7	-0.5	-0.3	0.8	0.3	0.3	0.5	0.3	0.5	0.5	0.5
PAN	-0.7	-0.3	0.0	-0.5	1.7	0.7	2.0	1.0	1.3	1.0	0.3	0.8
LUS	-1.0		0.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0
MDM	-1.0	-1.0	0.0	-1.0	0.0	1.0	1.0	1.0	0.0	1.0	0.0	1.0
MDN	-1.3	-0.5	-0.3	-0.5	0.3	0.8	0.5	0.1	0.5	1.0	0.8	0.8
MDS	-0.8	0.0	-0.3	0.3	0.5	0.8	0.8	0.3	0.0	1.0	0.5	0.5

Grape wine

	Growth Duration	Overwin-tering	Frost	Suitable harv.	Seasonal variability	Drought	Heat stress	Hail	Pest& Diseases	Weeds	Soil erosion	Nitrogen losses
ALN												
BOR												
NEM												
ATN	1.5	-1.0	-1.0	1.0	1.0	0.5	0.0	1.0	1.5	0.0	1.0	1.0
ALS	0.0	-0.5	0.0	0.0	1.0	2.0	2.0	1.0	1.5	1.0	0.0	0.0
CON	-0.2	-0.8	-0.3	-0.2	1.3	0.6	0.4	0.5	1.0	0.3	1.2	1.0
ATC	0.3	0.0	-0.3	0.3	1.0	0.7	0.3	1.0	1.0	0.5	1.0	0.5
PAN	0.3	-0.7	0.0	0.4	1.7	0.4	0.5	1.0	0.8	1.0	0.8	0.5
LUS	-1.0		1.0	1.0	1.0	0.0	0.0	1.0	0.0	1.0	1.0	0.0
MDM	-1.0	0.0	0.0	-1.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0
MDN	-1.0	-0.3	0.3	-0.3	0.3	1.0	0.8	0.3	-0.5	0.8	0.8	0.8
MDS	-0.3	0.3	0.8	0.5	0.3	0.6	0.4	0.8	-0.3	-0.1	0.5	0.3

Reported level of climate change awareness among farmers, agriculture advisors and government officials in 26 countries and the status of agriculture adaptation strategy and education programs for farmers (Olesen et al., 2011).



PERSPECTIVES OF EUROPEAN AGRICULTURE UNDER CLIMATE CHANGE

Findings

- The expected impacts (both positive and negative) of climate change in Mediterranean are in several cases smaller than those expected for northern or central Europe
- Probably the bleakest expectations could be found in responses from continental climate of Pannonian environmental zone.
- The differences in climate exposure, sensitivity, and adaptive capacity will differently affect agroecosystems across Europe
- Both short-term adjustments (e.g. changes in crop species, cultivars and sowing dates) and long-term adaptations (e.g. water management, land allocation, farming systems and institutions) are considered as important across most zones.

PERSPECTIVES OF EUROPEAN AGRICULTURE UNDER CLIMATE CHANGE

Recommendations

- Policy will have to support the adaptation of European agriculture to climate change by encouraging resilience of cropping systems
- This includesinvesting in monitoring schemes, early warning systems and crop breeding
- The adaptation to climate change has in particular to be factored in as part of the ongoing technological development in agriculture
- Policy will also need to be concerned with agricultural strategies to mitigate climate change through a reduction in emissions of methane and nitrous oxide
- The policies to support adaptation and mitigation to climate change will need to be linked closely to the development of agri-environmental schemes in the EU Common Agricultural Policy

Recommendations derived from the regional studies

Adapation is necessary and is currently being observed – need to structure such observations

- Impacts are going will mostly occur in France and Eastern Europe – need to confirm these findings
- Uncertainties should be better understood – high uncertainty also leads to generally lower projected yields
- Need to learn from experience on information systems from all European countries

Objectives vs results

- Evaluation of possible impacts from
- change and variability on agriculture and the assessment of critical thresholds for various European areas

- The collection and review of existing agroclimatic indices and simulation models to assess hazard impacts on various European agricultural areas relating hazards to climatic conditions

- Building climate scenarios for the next few decades

- The definition of harmonised criteria to evaluate the impacts of climatic change and variability on agriculture

- Basic evaluation of agroclimatic conditions, local impact studies applied were done

- Completed and published in 2 books

- Method of Weather generator parameters applied

- Indices based evaluation of fundamental agroclimatic conditions through environmental zones in Europe

Use of COST instruments

	YR 1	YR 2	YR 3	YR 4	YR 5
No. of MC / WG meetings	3/7	2/8	2/10	0/5	
No. of STSMs	3	4	11	7	
No. of workshops / conferences	0	2	1	0	1
No. of joint publications	1	1	1	1	
No. of training schools	0	0	1	1	
GASG (activities)	Website	Website/ leaflet	Website/ Poster	Website/ Poster	

Training school (1)

Volos (GR)July 2009, 20 students, 5 days

Climate Change and Variability Impact to Agriculture:

data analysis, indices and models, preliminary evaluation of impacts and adaptations”

Training school (2)

Keszthely (HU), 21 students, 5 days

Climate Change and Variability Impact to Agriculture:

parameterization of agrometeorological models, ground truth experiments and remote sensing application, evaluation of impacts, risk assessment, warning systems, adaptation measures

DISSEMINATION OF RESULTS

Special Issue of the Annals of the New York Academy of Sciences entitled "Trends and Directions in Climate Research“

Impacts of Climate Change and Variability on European Agriculture

Results of Inventory Analysis in COST 734 Countries

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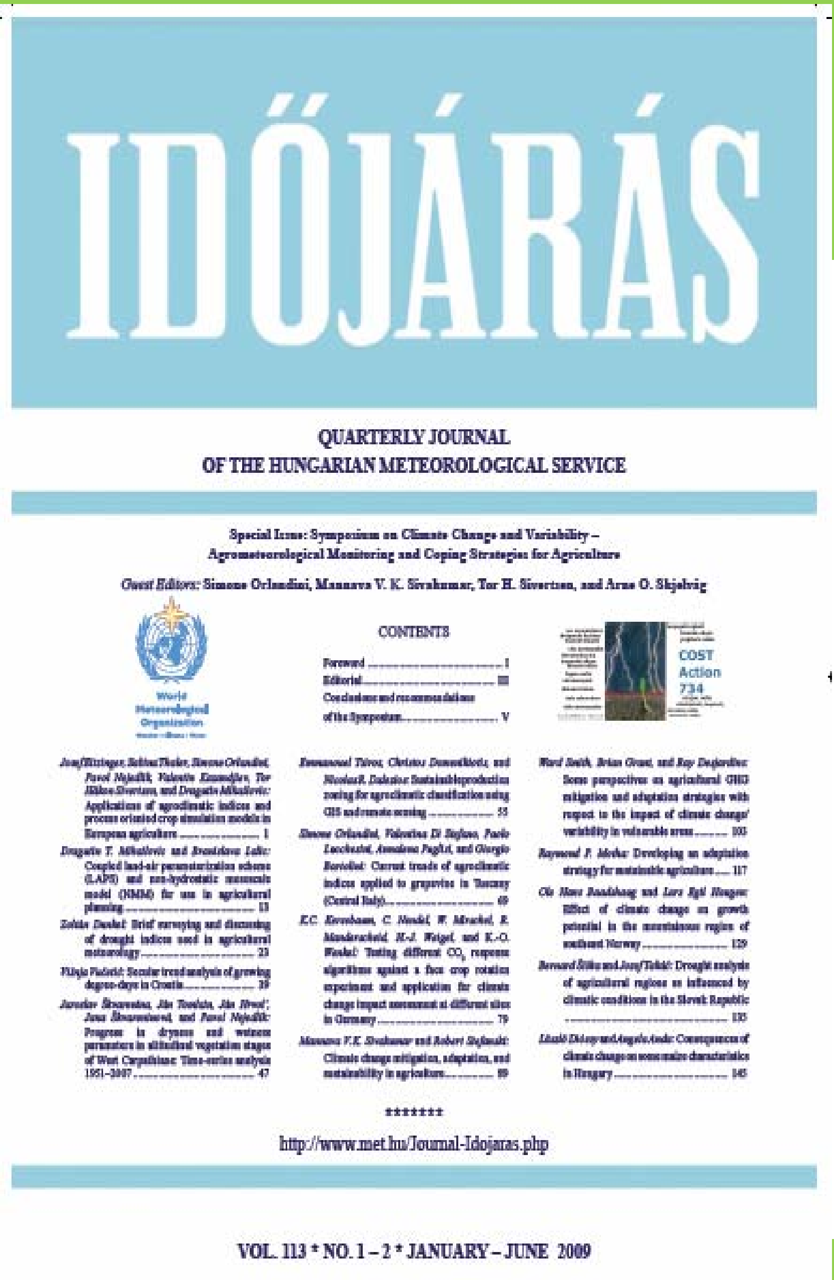
Climate plays a fundamental role in agriculture because of to its influence on production. All processes are regulated by specific climatic requirements. Furthermore, European agriculture, based on highly developed farming techniques, is mainly oriented to high quality food production that is more susceptible to meteorological hazards. These hazards can modify environment–genotype interactions, which can affect the quality of production. The COST 734 Action (Impacts of Climate Change and Variability on European Agriculture), launched in 2006, is composed of 28 signature countries and is funded by the European Commission. The main objective of the Action is the evaluation of possible impacts arising from climate change and variability on agriculture and the assessment of critical thresholds for various European areas. The Action will concentrate on four different tasks: agroclimatic indices and simulation models, including review and assessment of tools used to relate climate and agricultural processes; evalu-


IDŐJÁRÁS

QUARTERLY JOURNAL
OF THE HUNGARIAN METEOROLOGICAL SERVICE

Special Issue: Symposium on Climate Change and Variability –
Agrometeorological Monitoring and Coping Strategies for Agriculture

Guest Editors: Simone Orlandini, Mannava V. K. Sivakumar, Tor H. Sivertsen, and Arne O. Skjelvåg

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Joint Symposium with WMO – Agricultural Meteorology Division

ET on impact of climate risks in vulnerable areas: agrometeorological monitoring and coping strategies.

IMPACT: Publication and dissemination

Special Issue of Idojaras disseminated by WMO worldwide (more then 250 copies).

World Climate Conference 3

September Geneva

WCC 3 poster session

COST Action 734

Impacts of Climate change and Variability on European Agriculture

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Within the COST (Cooperation in Science and technology) framework there is a whole European activity regarding the Climate Change and its impact on Agriculture. This Action deals with a multidisciplinary issue being performed in National and Regional Meteorological and Hydrological Services (NMHS), Research Centres and Universities in Europe.
Further to 29 European countries it involves the representatives from the USA, New Zeland and cooperates also with JRC of the EC and WMO.
The main objective of the Action is the evaluation of possible impacts from climate change and variability on agriculture and the assessment of critical thresholds for various European areas.
Main activity of the Action concentrates on four different tasks: agroclimatic indices and simulation models review and assessment of tools used to relate climate and agricultural processes; evaluation of the current trends of agroclimatic indices and simulation model outputs describing agricultural impacts and hazard levels; developing and assessing future regional and local scenarios of agroclimatic conditions; risk assessment and foreseen impacts on agriculture.
The Action has completed the first phase which comprises the survey of the existing methods of the evaluation of agroclimatic conditions used for different purposes. The focus concentrated on the agroclimatic indices and simulation models. Further evaluation includes testing of the indices and models and their use for regional assessment.
Key deliverables of the Action are as follows:
- standardisation and harmonisation of criteria to evaluate the impact of climate change and variability on agricultural activity;
- determination of the current and future impacts on various European agricultural areas;
- determination of critical thresholds;
- formulation of specific recommendations and assessments for policy makers, extension services, farmers and other end-users;
- definition of warning systems

First results show different impacts of climate change on the agricultural production through the regions. The Action entered the second phase of its duration and it will finish in late 2009.

Strengths and weaknesses

Strengths

-multinational global Action

-making the platform which works beyond the COST734 borders regarding data and methods exchange

-bringing a cumulative view overwhelming the fragmented local and national assessment, crop-growth models cross-comparison

-one indices based tool used for overall assessment –Agri-Clim

-generally favorable financial situation

Weaknesses

-scientists are over committed and not everybody was able to contribute in expected way and extent

-weak involvement of WG3 into the projections

-number of individual (country based) attitudes to assess the CC impacts which should lead to NAS.

-variations in the Actions` budget

This presentation was done based on the results of cca 60 scientists who participated to COST 734

thank you for your kind attention