RESEARCH AT JRC in support of EU CLIMATE CHANGE policy making

activities and results
from the 6th framework program 2003-2006;
building blocks of
a strategy for concerted action
in the 7th framework program 2007-2013

presented at the first Meeting of the Parties
to the Kyoto Protocol (COP/MOP 1)
28 Nov – 9 Dec, 2005
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RESEARCH AT JRC in support of EU CLIMATE CHANGE policy making

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Climate Change Unit
Institute for Environment and Sustainability
DG JOINT RESEARCH CENTRE

with support and help of
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2005 **EUR 21855 EN**

Introduction

In recent years the Joint Research Centre of the European Commission has focussed its resources to respond to the Scientific and Technical (S/T) challenges arising from the multi-faceted aspects of EU policy. It has done so by organising its activities around the main policy areas and by establishing synergies with other sources of S/T support available in the Member States and by collaborating with EU Agencies and International Organizations.

Implementing and Monitoring the Kyoto Protocol and developing post-2012 climate change policy is definitely an area where an integrated approach to the provision of S/T support is required. There is a clear need to understand interactions between climate change, technological change, competitiveness and different regulatory and policy approaches (e.g. economic instruments and flexible mechanisms). A strong research base must underpin such objectives.

This booklet presents the results of JRC research activities being conducted as part of the 6th Framework Program (2003-2006). Many of these activities are directly supporting the EU policy making process.

During the 7th Framework Program (2007-2013) these and other activities will be coordinated within a coherent framework. This will enhance the effectiveness of the S/T support, in particular to the Directorate-General Environment, which is guiding the EU climate change policy making process.

We consider this work timely and necessary in order to help face the challenge and find an optimal way for "Winning the Battle against Global Climate Change"

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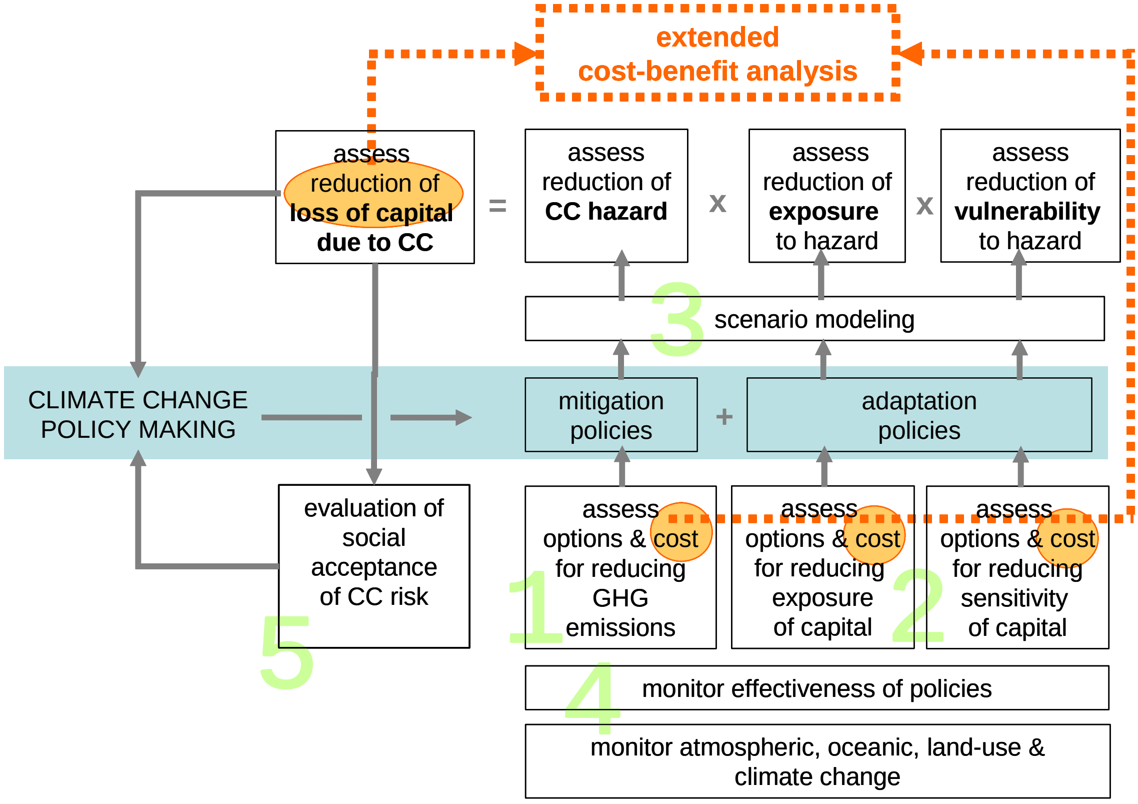


The JRC strategy for combined research activity supports the development of an effective mix of mitigation and adaptation policies (see text)

JRCs Research Strategy

in support of EU climate change policy making

The JRC Climate Change Strategy focuses on the need to develop a complementary mix of mitigation and adaptation polices that reduce the risks of climate change at the least cost.

It therefore proposes studies in the following 5 areas:

1 **Mitigation:** Quantitative assessment of the potential for and cost of various options to reduce climate change hazards by reduction of emissions and enhancement of greenhouse gas sinks.

2 **Adaptation:** Quantitative assessment of the exposure and vulnerability of various forms of “capital” (e.g. infrastructure, human life, …) to climate change hazards, and assessment of the potential and cost of reducing exposure and vulnerability.

3 **Policy Integration and Evaluation:** Integration of mitigation and adaptation strategies in the context of scenario modeling, and assessing policy effectiveness.

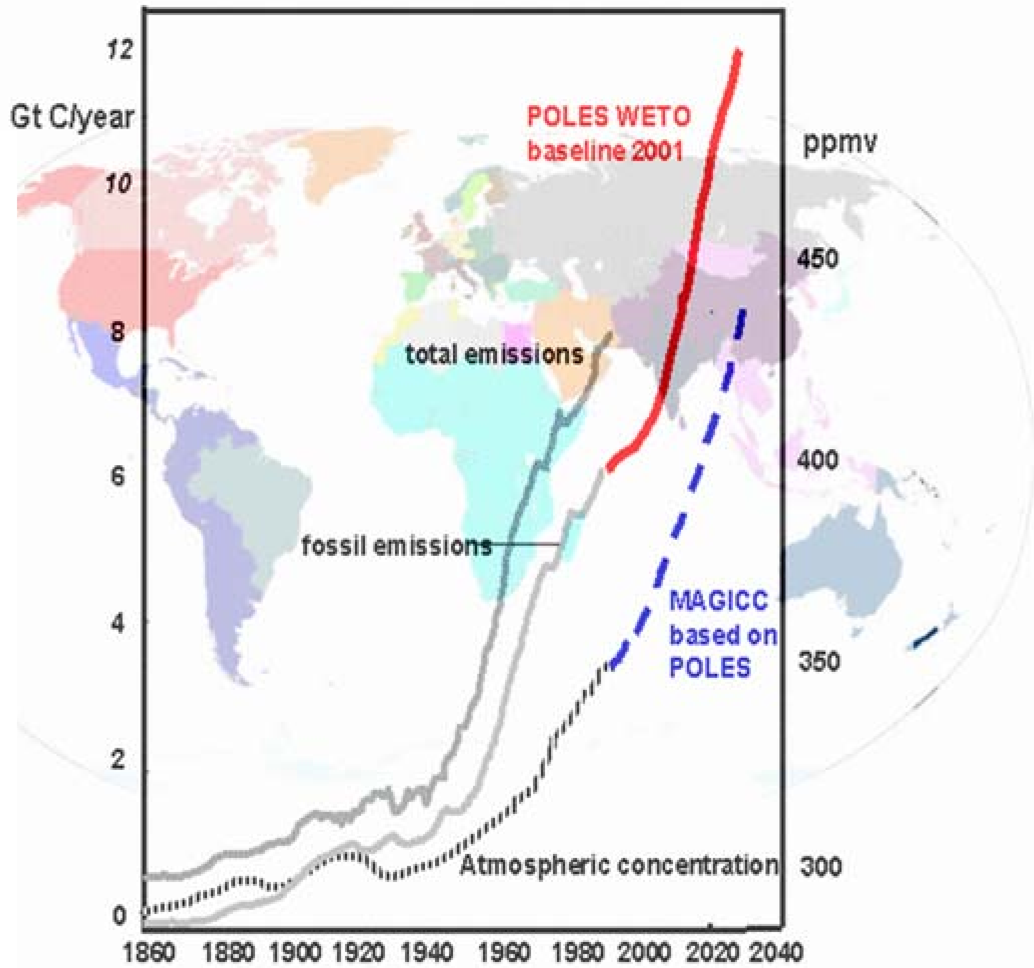
4 **Monitoring and Verification:** Development and promotion of EU- and world-wide methodologies for monitoring climate change, its drivers and its effects, as well as monitoring the effectiveness of policies and verification of reported data and claims.

5 **Stakeholder Perspectives:** Assessment of the social acceptance of climate change risks and climate change policies through stakeholder involvement

Overall, these activities will contribute to an extended cost-benefit analysis of Climate Change policies.

The JRC Climate Change Research Strategy will explore climate change questions from a **European and global perspective**, in support of European Commission services, EU Member States and International Organizations.

STRATEGY



Historic development of carbon emissions and POLES / WETO emission and CO_2 concentration projections till 2030.

Source for historic values: Joos & Samiento (1995)

Energy Use and Transformation

The JRC performs global energy-economy-environment analyses in support of developing EU environment protection policies and energy policies. It does so in full consideration of the Sustainable Development Strategy adopted by the European Council (Gothenburg, 2001)

The JRC played a central role in the European Commissions **World Energy, Technology and Climate Policy Outlook (WETO)** which provides a coherent framework to analyze the energy, technology and environmental trends over the period from now to 2030.

Using **the POLES energy model** and starting from a set of key assumptions on economic activity, population and hydrocarbon resources, WETO describes potential trends in global and European energy systems, taking into account the impacts of climate change policies. The JRC contributed in particular with:

-projections on sectoral energy demand at global level, to the year 2030.

-analysis of resources, reserves, potentials and long-term scarcity signals.

-projections of energy technology mix under alternative policy scenarios.

-assessment of macro-economic multi-sectoral impact of energy policies and/or supply shocks.

The JRC also provided the energy-economy analyses underlying the European Commissions vision for a post-2012 climate policy,presented in its communication **"Winning the Battle against Climate Change".** Amongst others it analysed three scenarios, based on differing hypotheses of participation and greenhouse gas emission reductions up to 2025. The analyses with the POLES and GEM-E3 models show that the costs of abatement policies, both in marginal terms and total terms, can be significantly reduced if emissions trading and project based mechanisms are used.

***Key Publication**:*
World Energy, Technology and Climate Change Policy Outlook 2030 (WETO). European Commission Community Research, EUR/20366/EN, ISBN 92-894-4186-0, 2003.

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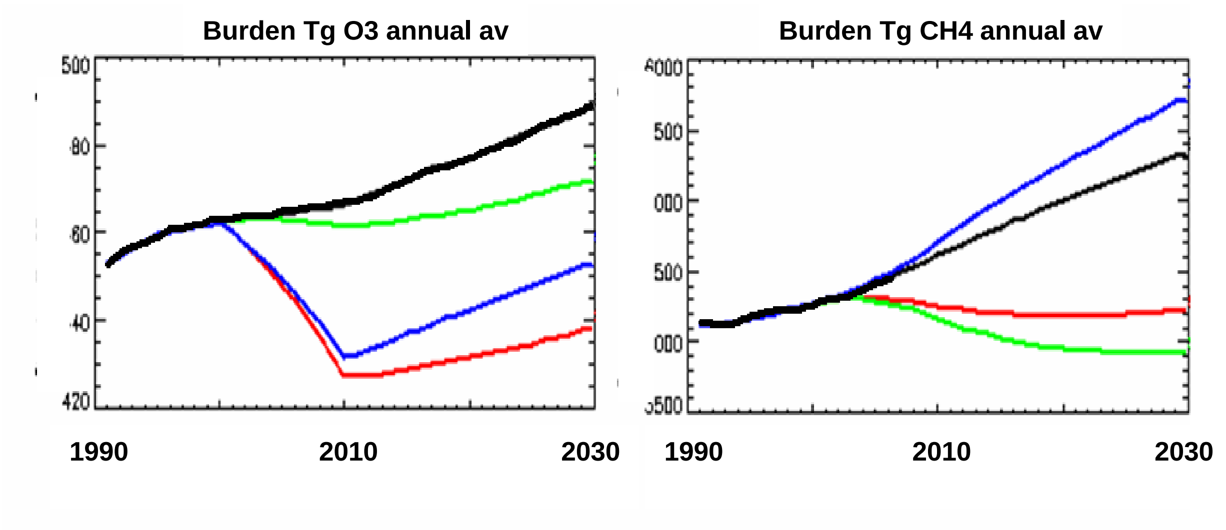
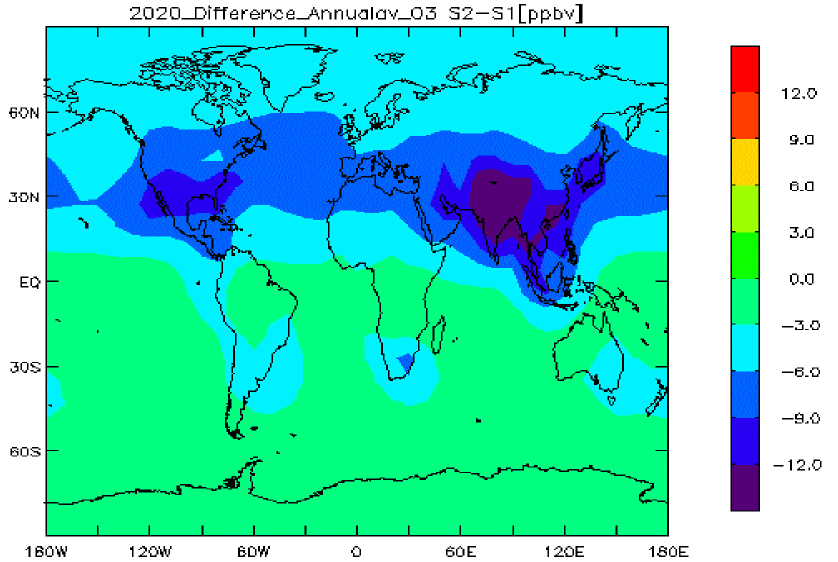


Change in the total burden of ozone and methane in the lower atmosphere, following a number of emission reduction scenarios.

Global emission scenarios:

- ____ *Current Legislation for all gases*
- ____ *Max Feasible NO_x+NMVOC Reduction*
- ____ *Max Feasible CH_4 Reduction*
- ____ *Max Freasible CH_4+NO_x+NMVOC Reduction*



*Reduction in ozone concentration (**in ppbV**) at ground level in the 2020s, when, in addition to the air pollution controls foreseen in present legislation world wide (CLE), additional measures are taken which are considered technically feasible (MFR). One third of the shown reduction results from methane emission controls.*

Linkages with Air Pollution

the triple dividend of reducing methane emissions

Synergies and trade-offs between Climate Change and Air Pollution polices have been identified. They must be studied to assess full cost and benefits and to optimize and integrate these polices.

To explore the relationship between conventional air pollution and climate change, JRC, in collaboration with the International Institute of Applied Systems Analysis (IIASA), compiled two sets of global scenarios for the emissions of methane (CH_4) and other ozone precursors (CO, NMVOC and NO_x) and implemented them in the global **Chemistry Transport Model TM5**. The "Current Legislation" (CLE) scenario considers the anticipated effects of existing emission control legislation. The "Maximum technically Feasible Reduction" (MFR) scenario presumes full implementation of presently available emission control technologies.

With these two scenarios as input the TM5 calculates the global, hemispheric and regional changes in CH_4, *tropospheric* ozone and their climate effect (radiative climate forcing) between 1990 and 2030.

Using the CLE scenario, the model predicts an increase in annual average ozone levels in the Northern Hemisphere by 5 ppbv, and up to 15 ppbv over the Indian sub-continent, between 1990 and 2030. These higher ozone *and* methane concentrations in the atmosphere *increase* radiative forcing by approximately 0.2 Wm^{-2}, hence contribute to global warming.

Maximum feasible reductions of the air pollutants NO_x and NMVOC *alone* (which are pursued by todays air pollution policies) result in lower tropospheric ozone, but at the same time increase the concentration of methane, with an increase in global warming as the overall result. Additional control of methane emissions would have a three-fold benefit: it would further reduce the tropospheric ozone concentration, hence improve air quality and reduce global warming, and it would reduce methane concentrations, hence reduce global warming once more. The sum of the radiative forcings by ozone and methane would be reduced by approximately 0.1 Wm^{-2}. between 1990 and 2030.

Key Publication*:*
Dentener et al., The impact of air pollutant and methane emission controls on tropospheric ozone and radiative forcing: CTM calculations for the period 1990-2030 :Atmos. Chem. & Phys., Vol 5, 1731-1755, 2005

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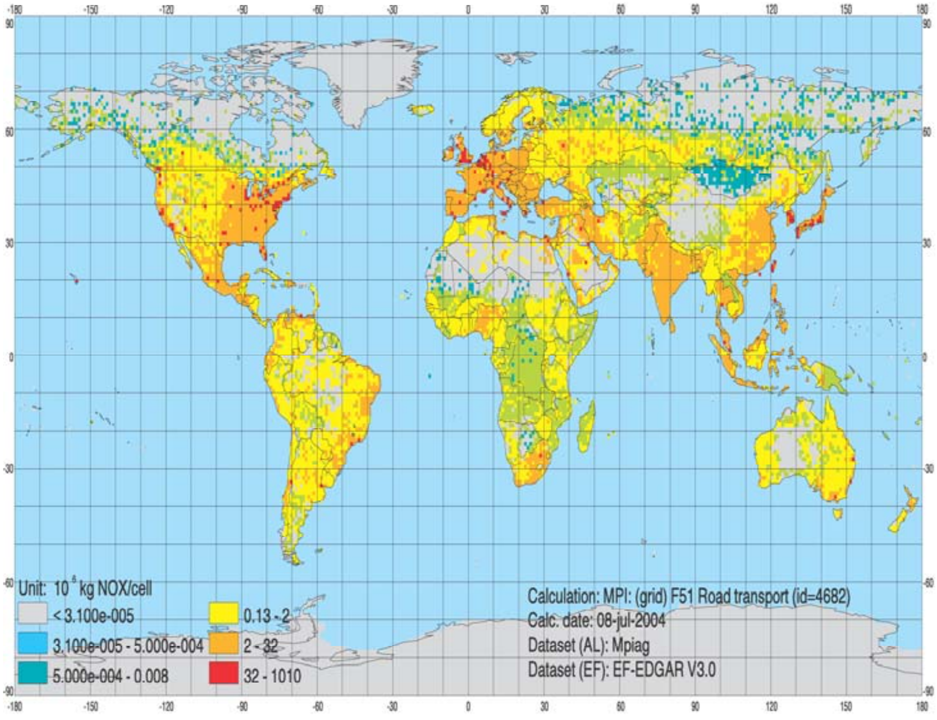
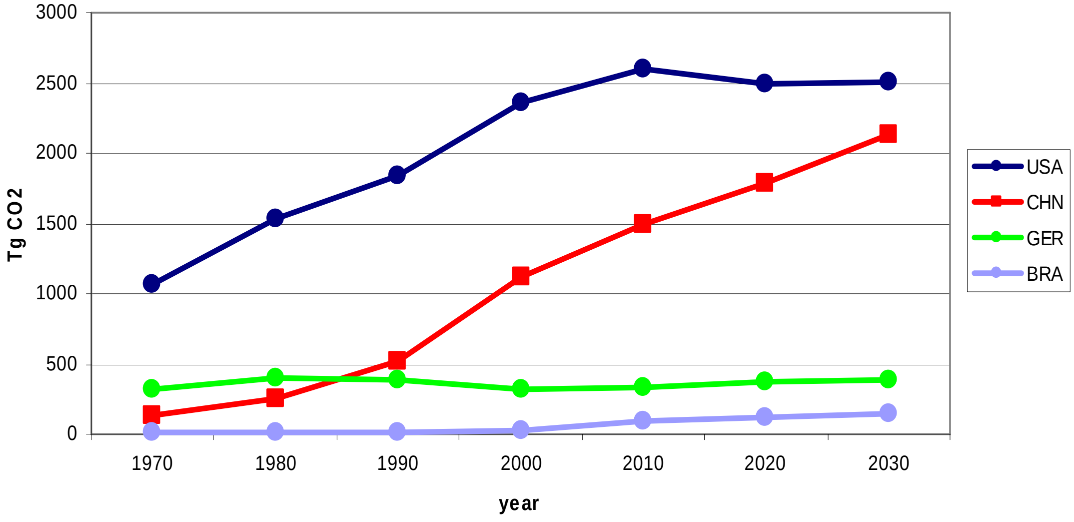
SCENARIOS



Global gridded NO_x emissions from road transport in 2000



Past and projected emissions of CO_2 from fossil and bio fuel combustion, based on resp. EDGAR inventory and POLES model.

The EDGAR Emission Inventory

consistent emissions of greenhouse and other gases

A consistent emission inventory of greenhouse gases and air pollutants is an important tool to study linkages between Climate Change and Air Pollution and to develop integrated Climate Change and Air Pollution policies.

The JRC, in collaboration with the Dutch Environmental Institute and the German Max Planck Institute for Chemistry, is developing the EDGAR Emission Inventory. It provides global, past, present and future anthropogenic emissions of greenhouse gases and air pollutants (gases and aerosols).

EDGAR is not based on official submissions of data by countries, but rather on knowledge emerging from research projects. As such it may be used to some extent as an independent verification of official inventories.

EDGAR provides emissions by sector and country, for policy related studies, and by sector on a 1 x 1 degree grid, as input to atmospheric chemical transport models.

Currently EDGAR contains **global anthropogenic emissions** of the Kyoto Protocol greenhouse gases CO_2, CH_4, N_2O and F-gases (HFCs, PFCs and SF_6) and of the air pollutants CO, NMVOC, NO_x and SO_2. Emissions of aerosols (Black Carbon and Organic Carbon) and NH_3 will be included in the near future.

Past and present emissions for the period (1890-2000) have been calculated using a so-called emission factor approach; activity data from (inter)national statistical datasets are linked with country specific emission factors in which information on technology and abatement techniques is combined.

Future trends in greenhouse gas and air pollutants emissions due to changes in energy are compiled using energy scenario from the POLES model and using assumptions on development of abatement techniques in the future.

Key Publication:
van Aardenne et al. A 1°×1° resolution data set of historical anthropogenic trace gas emissions for the period 1890–1990, Global Biogeochem. Cycles, 15(4), 909–928, 2001.

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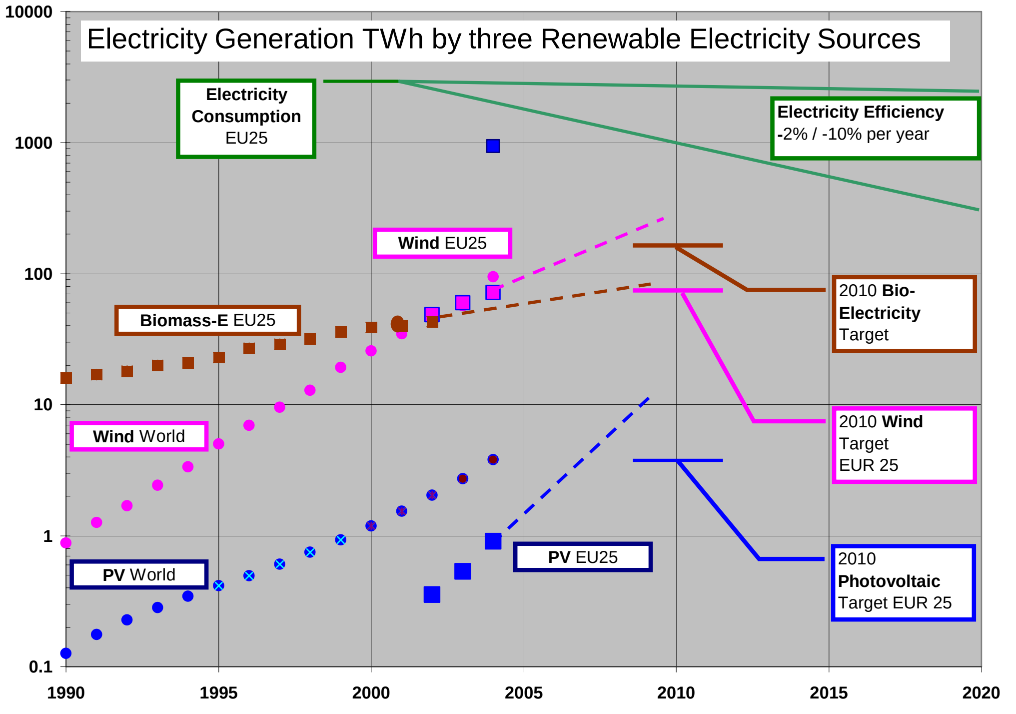
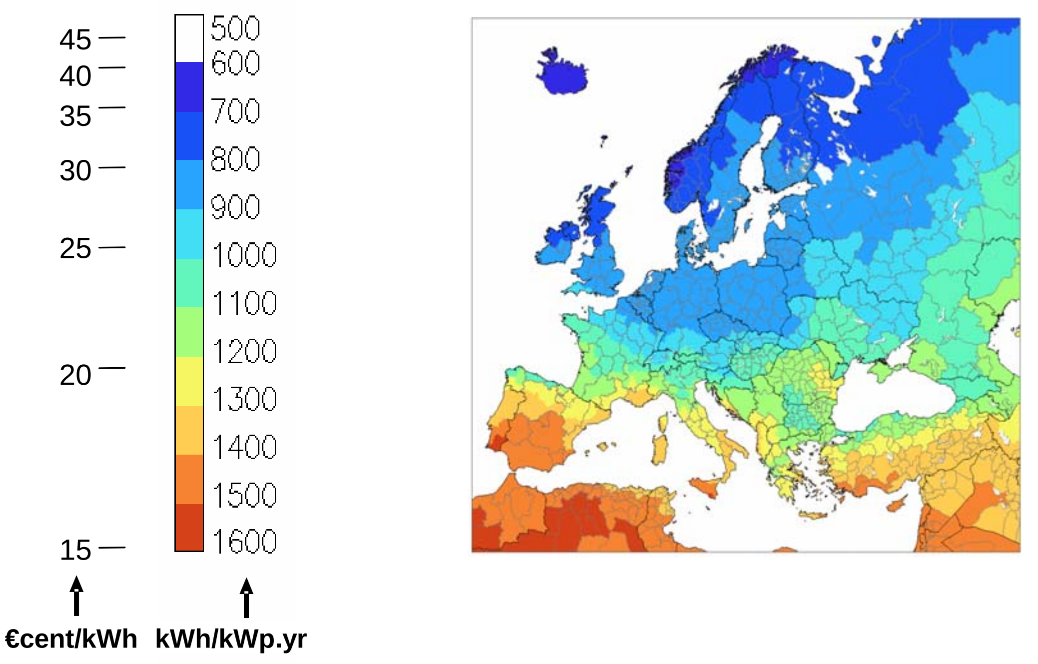


Progress in major renewable electricity technologies, as compared to EU targets for 2010. The graph includes EU electricity demand and effect of end-use efficiency measures. ***(Units: TWh/yr).***



Maps shows i) the energy produced (in kWh/yr) for a photovoltaic solar system with a peak output of 1kW, in various regions of Europe. ii) Cost of PV electricity for a large system (above 5MWp) in Europe, assuming system price of €4000/kWp, payback time of 20 years, interest rate of 3% p.a., inflation rate of 2% and annual maintenance cost of 1% of system cost. In the Mediterranean regions, PV can deliver electricity at prices below 0.20 € per kWh.

Renewable Energies

potential and growth in Europe

European energy strategy and policy is strongly driven by the twin objectives of sustainability and security of energy supply. Implementation of renewable energy (RE) systems and improved electricity end-use efficiency (EEE) are key means of satisfying these objectives.

The JRC established a **Scientific Technical Reference System (STRS)** on Renewable Energy and Energy End-Use Efficiency as a "one-stop shop" for quality-checked, robust and validated data for European Institutions, Member States and stakeholders. It provides feedback on the effectiveness of renewable energy policy measures, particularly with respect to CO_2 emission reductions.

The STRS monitors in particular the progress of the implementation of wind energy, bio-energy and photovoltaics in EU Member States, and compares it with targets set in a range of EU directives. An important part of this activity is dedicated to reaching agreement with industry to reduce electricity demand by accelerating new technologies such as efficient lighting and reduction of stand-by loads.

he JRC also intervenes in specific technological areas where research and harmonization is required such as in the integration of solar photovoltaic (PV) electricity. In a strongly increasing commercial environment, industry relies on JRC's laboratory measurements, to assure fair and transparent markets.

Also, the JRC predicts the electricity generation costs from photovoltaic systems on a regional level (http://re.jrc.cec.eu.int/pvgis/pv/), based on long term historical solar radiation data interpolated to cover every 1x1 km^2 spot in Europe, including topographical shadowing conditions.

Key publications

Jaeger-Waldau et al., Progress of Electricity from Biomass, Wind and Photovoltaics in the European Union. Renewable & Sustainable Energy Reviews, Vol 8, No 2, 157 -182, 2004

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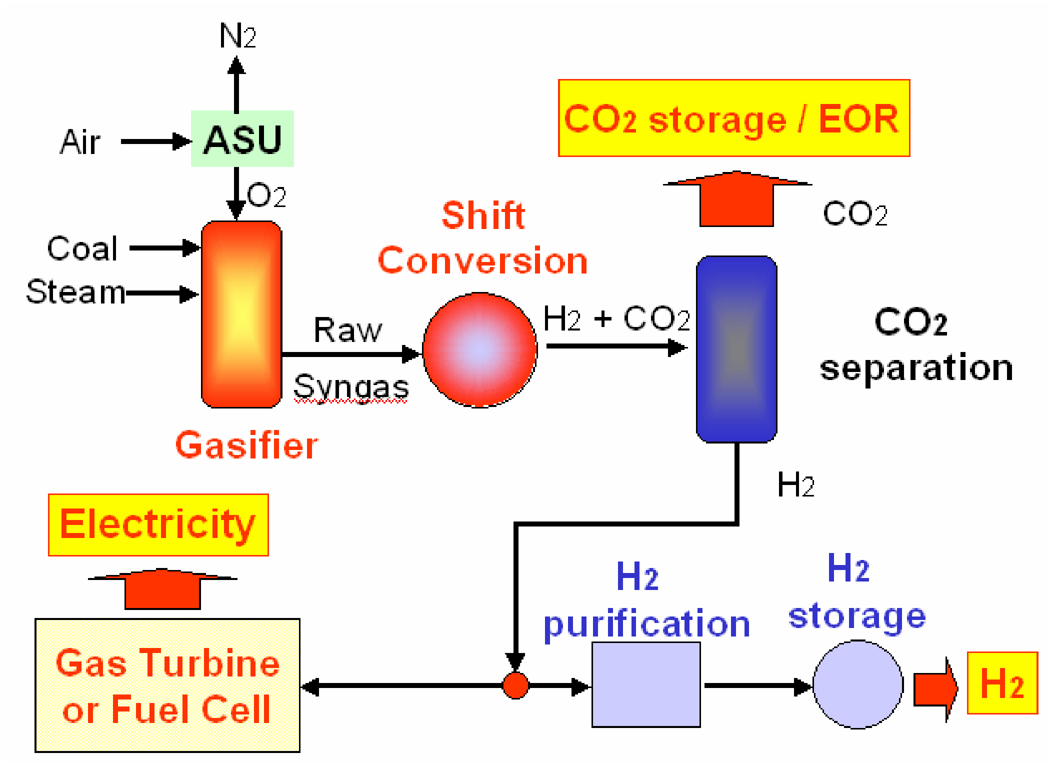

The HYPOGEN concept for the clean generation of hydrogen and electricity from coal. The JRC performs research and development related to all components of the HYPOGEN plant with the exception of the air separation unit (ASU).

Decarbonisation of the Energy Sector

The reduction of greenhouse gas emissions from the power generation sector is one of the most important measures to combat global climate change. The long-term goal is a fully sustainable energy system based on carbon-lean and carbon-free energy sources. Fossil fuels will, however, continue to be the backbone of our energy system in the foreseeable future. This necessitates the development and use of decarbonisation technologies.

The JRC has embarked on a number of research activities to catalyse the development of **a less carbon-intensive energy system**, focusing on harmonising and validating methods for the performance assessment of energy technology chains. These include hydrogen storage, fuel cells and clean up of flue gases. The results obtained from purpose-built novel facilities support innovation via pre-normative research and development work.

Similarly, the JRC aims to identify the potential of a number of CO_2 emission reduction technologies in Europe and has highlighted areas that require further R&D. These technologies include carbon capture and storage, enhanced oil recovery using carbon dioxide, more efficient and less polluting thermal power plants, and the production of fuels and heat from biomass.

Another option is the **HYPOGEN** concept: the co-generation of hydrogen and electricity from fossil fuels with a simultaneous removal of carbon dioxide. The JRC involvement in HYPOGEN is schematically illustrated in the figure.

Key publication:

Tzimas et al., The impact of carbon sequestration on the production cost of electricity and hydrogen from coal and natural-gas technologies in Europe in the medium term, Energy 30 (2005) 2672-2689.

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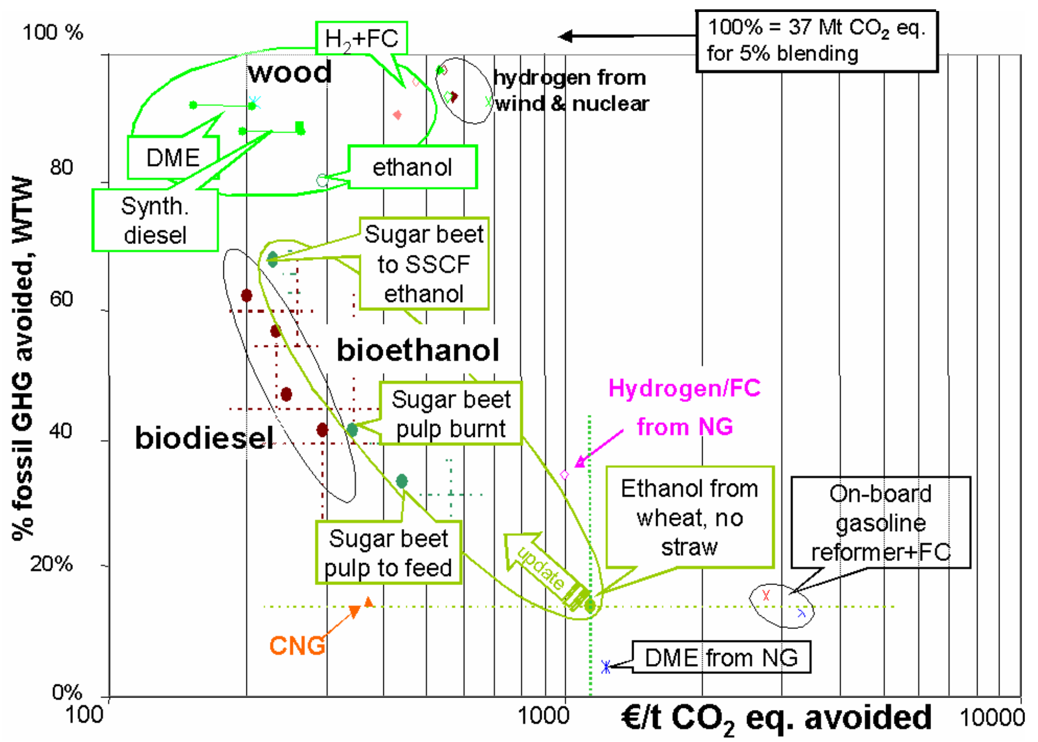

Greenhouse gas (GHG) emissions avoided by various alternative fuel/power-train combinations, when considering all aspects of their production and use (well-to-wheels). The avoided emissions are expressed as % of the GHGs emitted when using conventional diesel and gasoline (2010 technology) and driving the same amount of distance.

Also shown is the specific cost to the EU of the greenhouse gas avoidance for each technology. ***Note that during Sept. 2005 , CO_2 was traded at a price of about 20 € per ton CO_2.***

In conclusion: biofuels, and some other alternative fuels, would save greenhouse gas compared to conventional 2010 fuel technology. Whilst one could argue, that more greenhouse gas could be saved for the same money in other sectors, the bio-fuel development helps other important strategic aspects like the dramatically rising oil-import-dependence in the EU, etc.. The graph shows clearly, which technology sub-fields in bio-fuels promise to be the most “price-worthy” ones.

GHG Emissions from Transport

the JRC-EUCAR-CONCAWE well-to-wheels analysis

The Well-To-Wheels (WTW) analysis, carried out by the JRC together with EUCAR and CONCAWE, estimates greenhouse gas emissions, energy efficiency and industrial costs of all significant automotive fuels and power-trains for the European Union after 2010.

The study specifies all input data and assumptions. This allows stakeholders (e.g. automotive and biofuels industries) to suggest improvements, which are incorporated in periodic updates. It is already being used as a reference by the Directorate-General Transport and Energy of the EC and in tasks of the International Energy Agency.

As an example, the WTW analysis shows that EU production of **biodiesel and bio-ethanol from arable crops** offers well-to-wheels greenhouse gas savings, but at much higher cost (> 100 €/tonne CO_2) than many other forms of greenhouse gas mitigation.

Blending with conventional fuels gives the lowest costs. Making fuels from straw and forest residuals seems more attractive, but the processes are not yet demonstrated. Dimethyl ether should save slightly more greenhouse gas per euro than other wood-derived fuels, such as synthetic diesel/gasoline, methanol, ethanol, or hydrogen, and would be even better in fleet applications, where new distribution infrastructure is less costly.

The study concluded that if the maximum feasible level of bio-resources in the EU was concentrated into making transport fuel, by 2010 one could replace 8 to 12% of EU gasoline and diesel, depending on the mix of fuels chosen. This would reduce greenhouse gas emissions from transport by 5-11%.

***Key Publication**:*
The complete well-to-wheels report can be downloaded from
http://ies.jrc.cec.eu.int/wtw

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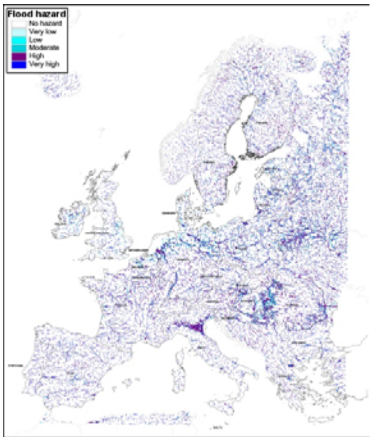
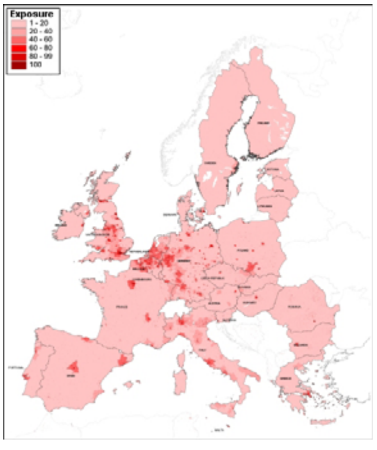
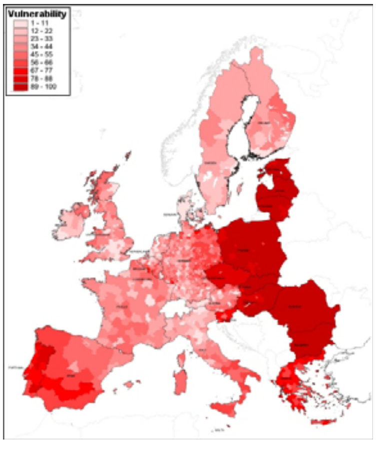


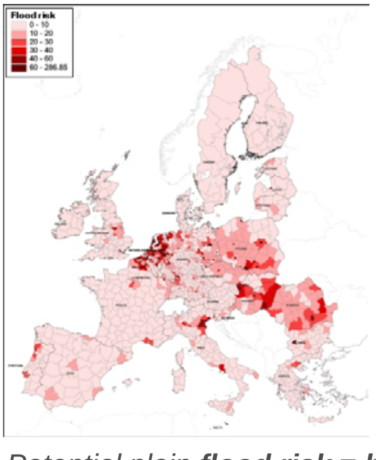
*Flood **hazard** map: based on an algorithm calculating the elevation difference of a location with the nearest river, along the hydrological flow path. Elevation difference and the estimated extreme water level of the river determine the potential flood hazard.*



***Exposure** to floods produced by merging the effect of population density at NUTS-3 level and land-use potential cost of damage due to a flood.*



*Flood **vulnerability**: based GDP per inhabitant. Low GDP per capita results in a high vulnerability*



*Potential plain **flood risk = hazard x exposure x vulnerability** at NUTS-3 level*

Flood Risk in Europe

The JRC has been active for several years in the field of forecasting and prevention of natural hazards such as floods, forest fires and drought.

In recent decades we have experienced a significant increase in impacts from such events at both global and European levels. There are several concurrent causes for this trend. On one hand, it is now widely accepted in the scientific community that there is an increased frequency of extreme events due to on-going climate `change. On the other hand, uncontrolled developments are resulting in an increased exposure of assets which in turn results in higher impacts when extreme events occur.

Considering the cohesion of the European Union, it should be noted that natural hazards may create territorial disparities because consequences of extreme events and plans to reduce exposures have an impact on the socio-economic growth of the concerned region.

The aim of research currently undertaken at the JRC is to provide flood risk information at a pan-European scale, using a single, unique and new methodology. The aim is to identify the key areas at risk of potential river flooding.

Flood Risk is composed of three elements:

- **Hazard**: probability and magnitude of occurrence of the event;

- **Exposure**: valued entities that are present at the location involved;

- **Vulnerability**: the lack (or loss) of resistance to damaging / destructive forces.

By following this approach a large GIS database has been designed and developed in order to spatially represent the three components of risk.

Climate change scenarios will be used to predict flood risk in the future.

***Key Publication**:*
Gouweleeuw et al., Flood forecasting using medium-range probabilistic weather prediction. Hydrology and Earth System Sciences 9: 365-380, 2005

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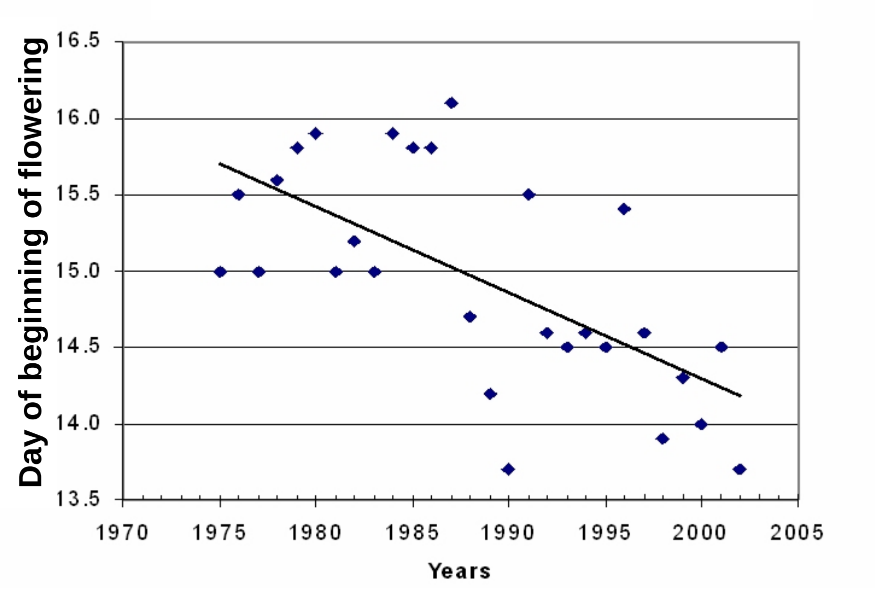
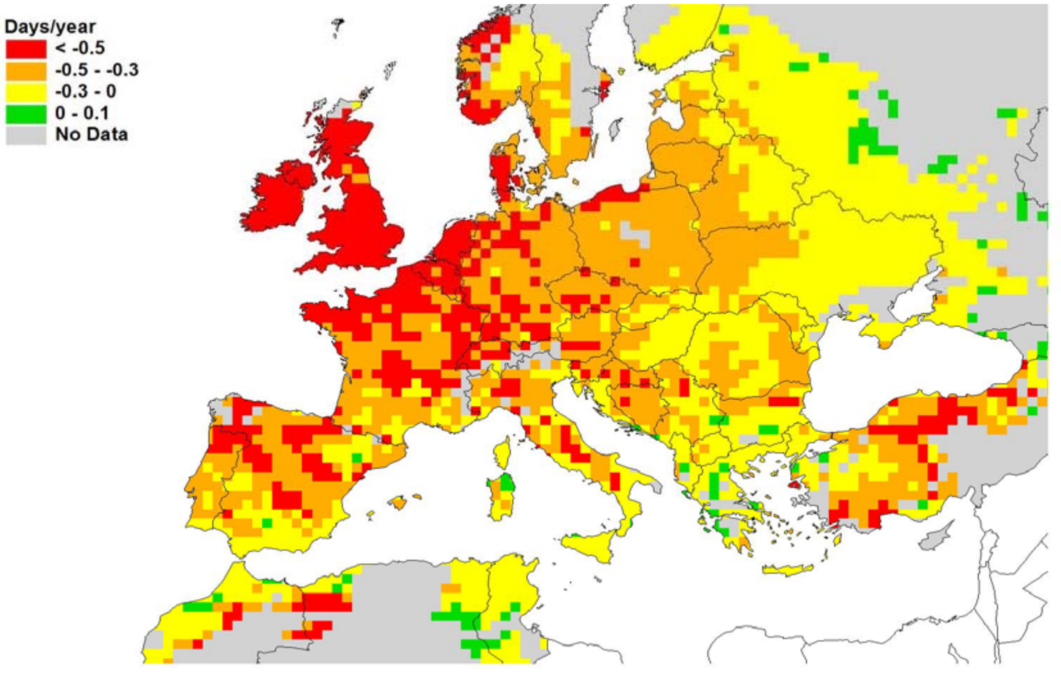


Simulated starting day of flowering (expressed in decades = 10 days). Average of all grid cells with a complete 28 year meteo record



Simulated changes in the occurrence of the beginning of flowering of wheat, between 1975 and 2005 (days/year)

Influence on European Agriculture

Agriculture is one of the production sectors most sensitive to meteorological and climatological conditions. The combined effects of temperature and precipitation change on crop yields are expected to vary by crop, location and magnitude of the change. The JRC focuses on evaluation of the impact of past and future climate changes on European agriculture using a numerical crop model.

Detection of past climate changes

The case-study presented analyzes the occurrence of beginning of flowering of winter wheat as simulated by the crop model. 28 years of weather data (1975-2003) are used as input.

A clear trend towards earlier occurrence of flowering is calculated. According to the model this phenomenon is strictly related to the increase of the mean temperature, inducing a quicker fulfillment of the thermal conditions required for flowering (the anthesis stage).

Advancement of the flowering season by up to 1.4 days/year is seen in many areas of Europe (see red areas on the map). Changes in Central-Eastern Europe were less marked.

Possible future scenarios

Since September 2004 the JRC is, together with other 66 European partners, involved in the DG RTD project ENSEMBLES, which has as its main objective the assessment of possible climate change and its impacts on different production sectors, included agriculture. This will be based on multi-model probabilistic climate forecast.

At the end of the project (foreseen in 2009) a detailed analysis of the possible climate change scenarios up to 2100 and of the necessary agriculture adaptations will be available as support in stakeholder decisions.

***Key Publication**:*

Genovese et al., Climate changes for Europe reflected in the phenology of wheat simulated with the CGMS Model". VIII Congress of European Society for Agronomy, Copenhagen, 11-15 July 2004, pp. 263-264.

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From GLC 2000, the Global Land Cover Map for the year 2000 produced by JRC, in association with UNEP and FAO, on behalf of the Global Land Cover 2000 partnership

Climate Change and Development

Climate Change is also a development problem. Developing countries, having the most vulnerable populations and the least adaptive capacity, are likely to suffer the greatest consequences, despite having so far contributed the least to the problem. Furthermore, within those countries, the poorest members of society often live on the most marginal land and are particularly reliant on natural resources and rain-fed agriculture. They are thus at most risk from flooding and drought.

The role of Earth Observation

Satellite images of the whole of Africa are taken several times a day. Europe has the technical capacity to use these images to monitor land degradation and desertification, forest condition, forest and grassland fires, agricultural production, surface water availability, settlement patterns and urbanization among many other environmental factors. Models developed so far enable the integration of climate change scenarios, Earth observation data, and in-situ measurements for predicting the climatic impact on the poverty level of local populations. This in turn may lead to development projects aiming at the adaptation of local populations to anticipated climatic conditions.

To help provide the information required for sustainable management of natural resources and for effective adaptation to climate change, the JRC proposes the development of an **“Africa Observatory for Sustainable Development”.** The Observatory will provide diagnostics and scenarios in three domains: sustainable management of natural resources; crop production and food security; crisis response and humanitarian aid.

The Observatory will initially focus on the African, Caribbean and Pacific countries, though a global outlook will be maintained for other geographic regions of priority to the European Commission’s Development Aid policy.

Key Publication:

Mayaux et al., A new land-cover map of Africa for the year 2000, Journal of Biogeography, Vol 31, 861-877, 2004.

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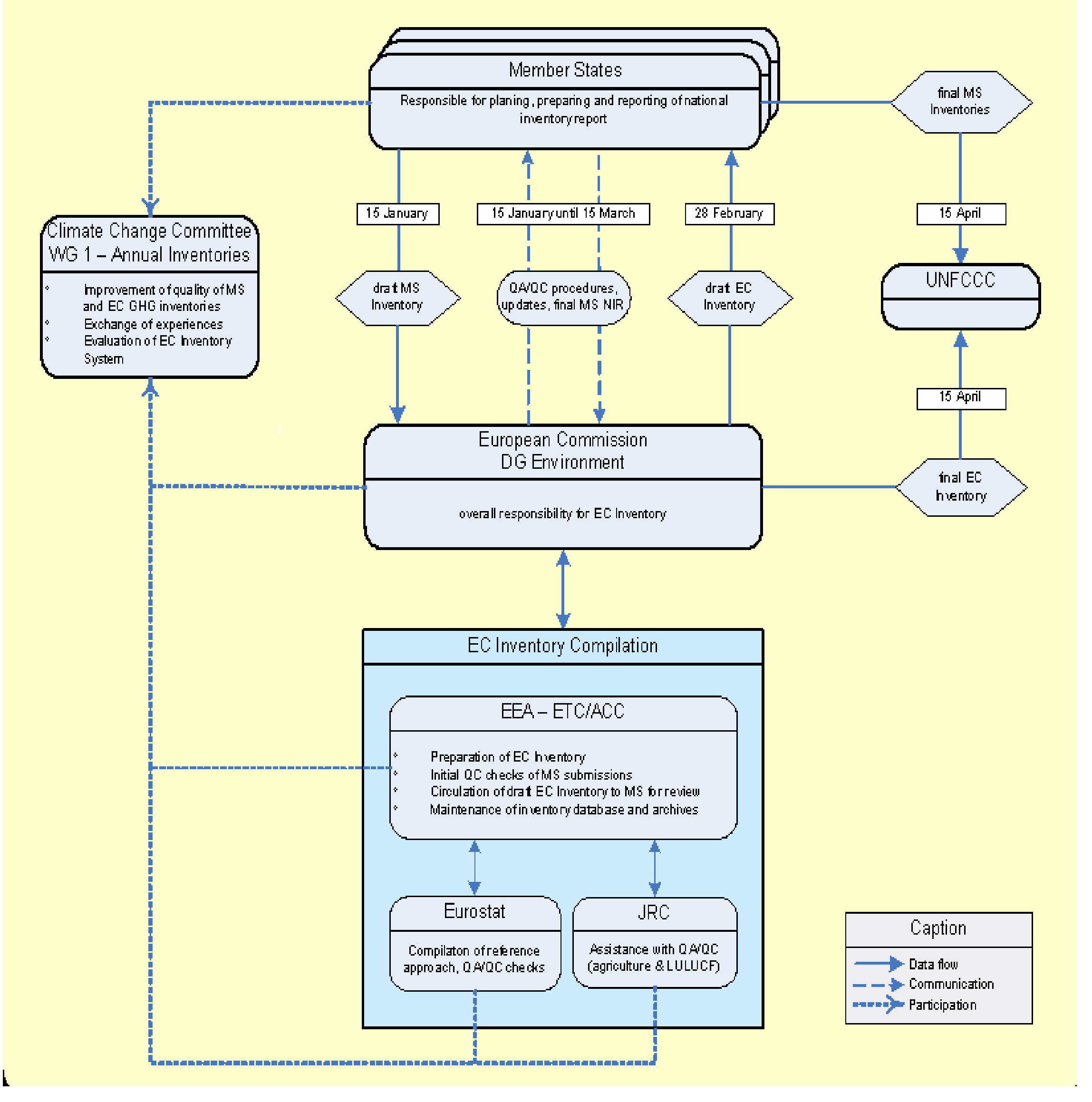
ADAPTATION



The European Community Inventory System

JRCs support for the European Community GHG Inventory System includes participation in DG RTD's CarboEurope project, which aims at quantifying carbon balances in European ecosystems. (picture: measurements of CO2 fluxes in and out of a forest, at JRC's site near Pavia (IT)).

The EC Inventory System

As a Party to the UNFCCC and its Kyoto Protocol, the European Community is obliged to present each year the greenhouse gas emission inventory for the EU15 to the UNFCCC Secretariat

The compilation of this inventory is a joint activity of the Member States and the European Commission (DG Environment), supported by the European Environment Agency, its European Topic Centre on Air and Climate Change, Eurostat, and the JRC.

The JRC provides support for the **Quality Assessment and Quality Control** of reported emissions and sinks of greenhouse gases in the agriculture and forestry sector. It does so because the uncertainty surrounding emissions and sinks of greenhouse gases in these sectors is of particular concern.

The JRC compares and harmonizes methodologies used by the Member States for estimating emissions and sinks. It further develops EU-wide methodologies for such estimates, based on European monitoring networks, remote sensing and modelling.

***Key Publication**:*
Loewe et al., Comparison of metods used withing Member States for estimating CO2 emissions and sinks according to UNFCCC and EU Monitoring Mechanism: forest and other wooded land. Biotechnol. Agron. Soc. Environ. 4, 315-319, 2000

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Climate Change Unit

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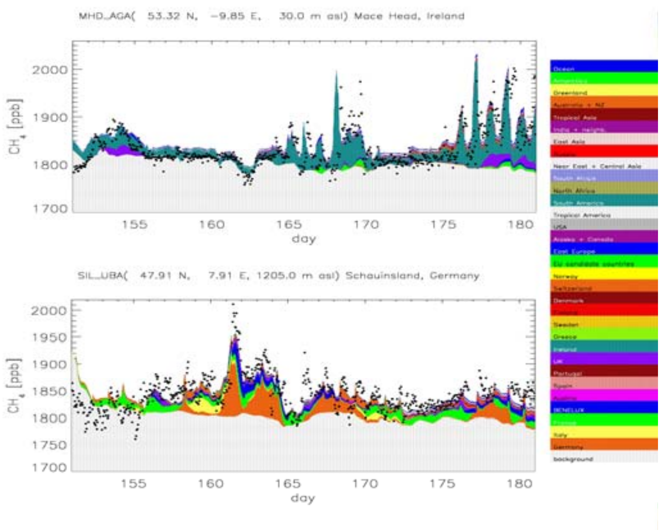
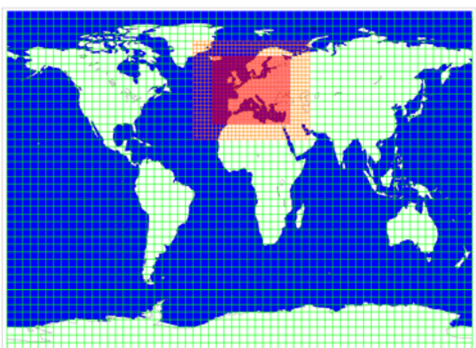
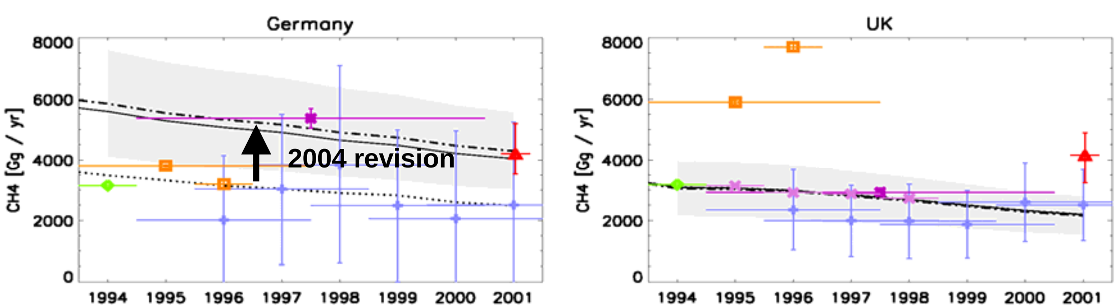


CH4 measurement record at two stations: Mace Head (IRL) and Schauinsland (DE)
Colours show the fraction of the concentration coming from specific countries; grey being the contribution of the global CH4 background



TM5, the chemical trans-port model used to calculate the emissions from the concentrations, is a global model with the possibility to zoom over a particular area.



CH_4 emissions in a few countries according to a range of methodologies. The black lines indicate the official values reported to UNFCCC (2003,2004). The red triangle indicates the JRC result based on inverse modeling. In 2004 Germany revised its official values up by 68.5%

Verification of Methane Emissions

inverse modelling

Methane (CH_4) is one of the greenhouse gases covered by the Kyoto Protocol. It has a broad range of sources in industry and agriculture, which makes it difficult to provide accurate emission inventories using **"bottom-up" IPCC methodology**. In the EU, the uncertainty in the CH_4 emission inventory contributes significantly to the uncertainty in the overall GHG emission inventory.

In order to verify and improve bottom-up inventories JRC has developed a **"top-down" methodology**. It starts from measurements of atmospheric concentrations of CH_4 , uses the atmospheric transport model TM5 in the "inverse" mode, to yield information on the emissions from individual European countries (see Figures)

The accuracy of the CH_4 emissions derived by the top-down methodology depends, amongst others, on the number of stations where CH_4 is measured in the atmosphere. In Europe, this number is not very high, but for several Western European countries the accuracy of the top-down emissions is comparable to the accuracy of the official bottom-up emissions.

The results of JRCs top-down approach suggest up to 50–90% higher anthropogenic CH_4 emissions in 2001 for Germany, France and the UK compared to reported UNFCCC values (EEA, 2003). A recent revision of the German inventory, however, resulted in an increase in reported CH_4 emissions by 68.5% (EEA, 2004), concurrent with the top-down estimate. The top-down estimate for Finland is distinctly smaller than the official values, suggesting much smaller CH_4 emissions from Finnish wetlands than derived from the bottom-up inventory.

The EU-15 totals are relatively close to UNFCCC values (within 4–30%) and appear very robust for different inversion scenarios.

***Key Publication**:*
Bergamaschi et al., Inverse modelling of national European CH4 emissions using the atmospheric zoom model TM5.Atmospheric Chemistry and Physics, 5, 2431-2460, 2005.

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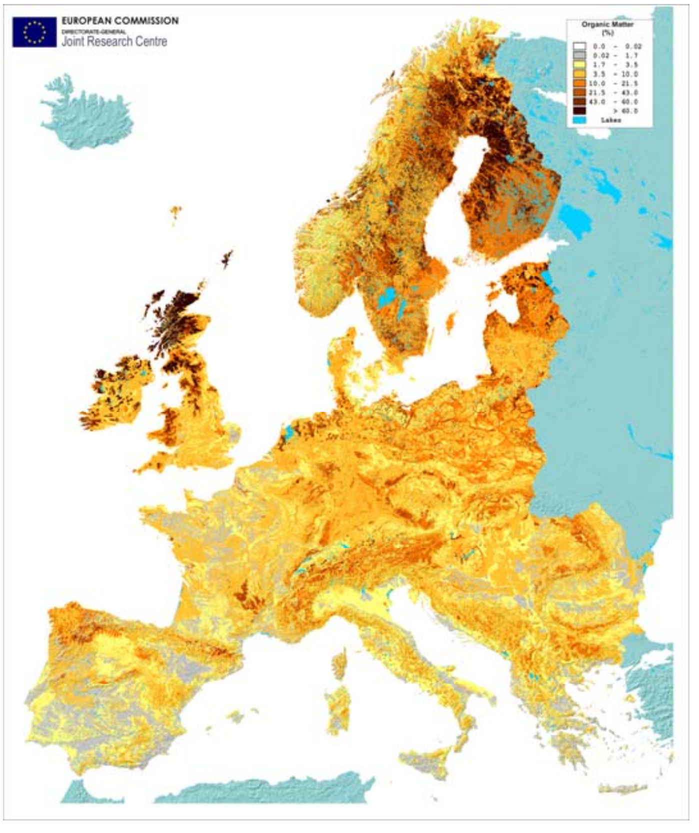
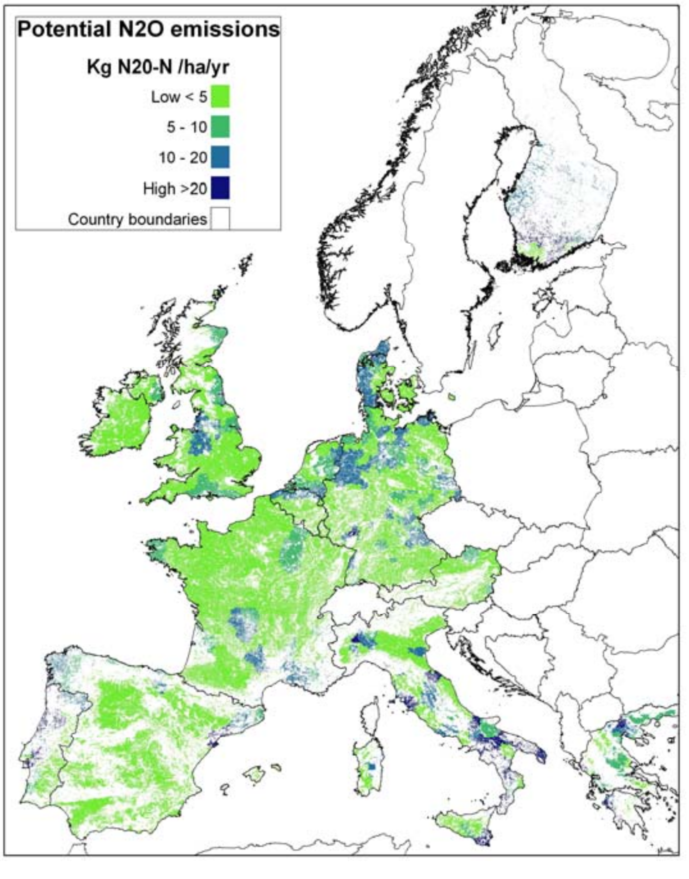


Fraction of organic matter in the topsoil (0-30 cm depth) at a resolution of 1 km based on land cover, temperature and soil data for the 1980s and early 1990s.



Potential direct N_2O emissions as a result of fertilization of agricultural soils

Organic Carbon in European Soil

In Europe, about 70 % of all carbon in the terrestrial biosphere is present in soils. It is important to **maintain this carbon stock** and protect it against inappropriate land use, including some agricultural practices.

Organic material in the soil is essentially derived from residual plant and animal material, broken down by microbes and decomposed under the influence of temperature, moisture and local soil conditions.

Soil which is dark-brown or black in colour usually contains significant amount of organic matter (>15%).

Apart from constituting an important carbon stock, organic matter is also extremely important in all soil processes by acting as a storehouse for nutrients, contributing to soil aeration and ensuring good structure.

On the map shown, the dark brown and blackish tones represent the organic rich Histosols in Scotland, western Ireland and Scandinavia. These areas are in marked contrast to greyish and yellowish areas occupied by Calcisols and Cambisols in southern Europe, where organic matter contents are much lower.

N_2O Emissions from Agricultural Soil

The map is the output of a study estimating direct N_2O emissions from agricultural soil. N_2O has a high global warming potential and due it's long atmospheric lifetime can also affect stratospheric ozone levels.

Regional 'hot-spots' (areas in blue on the map) were identified where agricultural soils with high organic carbon content and moisture content combined with high fertilisation rates produce the potential for high N_2O emissions.

***Key Publication**:*
Jones et al., Topsoil organic carbon in Europe, Proceedings of the 4th European Congress on Regional Geoscientific Cartography and Information Systems, 17-20 June 2003, p.249-251.

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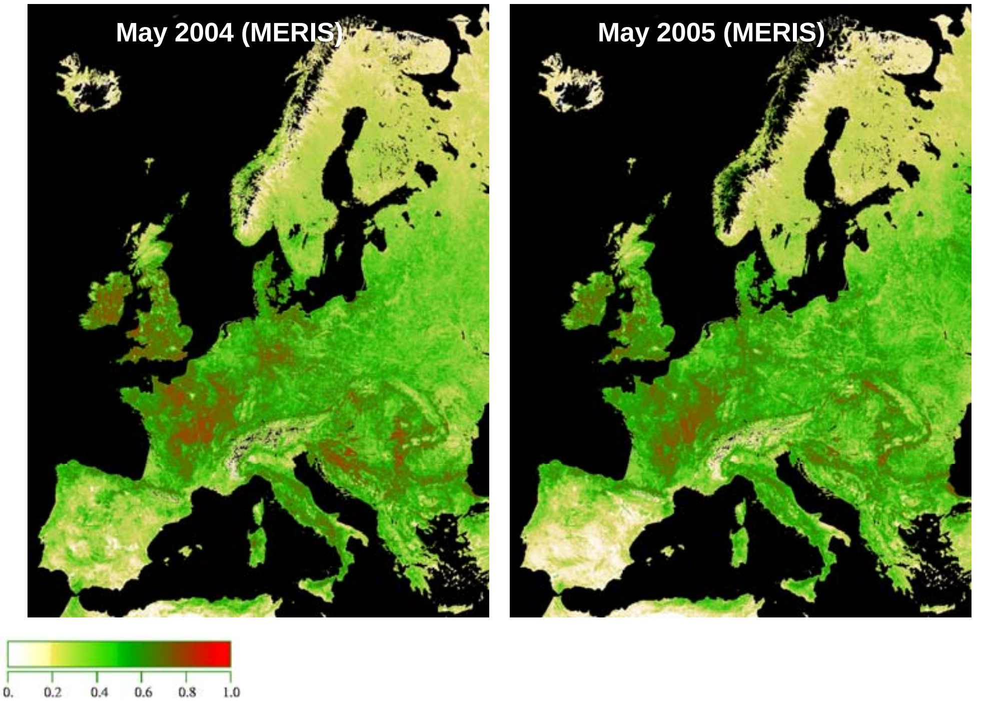
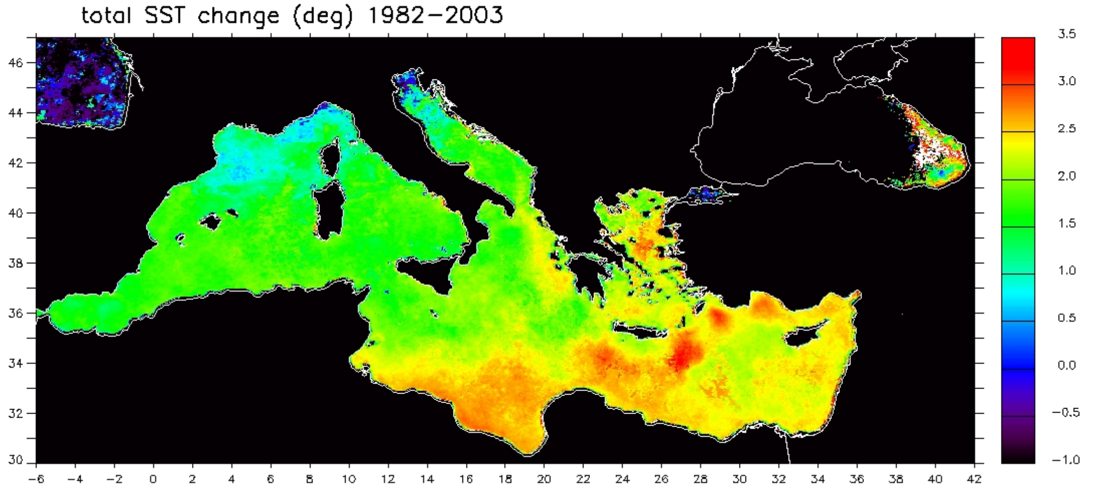


These figures exhibit the inter-annual variation in plant photosynthetic activity over Europe between May 2004 and May 2005. The effect of the 2005 drought in Spain is particularly noticeable. The color scale is selected so that unproductive areas appear in white, while highly productive regions are shown in red and intermediary values appear in shades of green.



The JRC processed 30000 day-time satellite passes from 6 different NOAA AVHRR satellites to obtain sea surface temperature (SST) images covering the Mediterranean Sea for the period January 1982 to December 2003. At meso-scale resolution SST increases may exceed 3-4° in this 22 year period. The observed patterns are likely to be linked to meso-scale circulation and changes in water mass distribution, and have consequences on ecosystem functioning, biodiversity and marine resource distribution.

Remote Sensing and Climate Change

Monitoring the climate is critical to understand what has happened in the past, to predict what is likely occur in the future, and to provide a sound basis for policy decisions and management practices aiming to prevent further changes (mitigation) or to minimize their consequences (adaptation). The atmosphere does not recognize political boundaries, and climatic events are interconnected worldwide. Hence the monitoring itself must be global. Satellite remote sensing offers a unique opportunity to achieve this goal, provided the scientific basis (e.g., models, algorithms, and interpretation tools) and the technical infrastructure (e.g., computers, data bases, and communication networks) are in place. The **Global Climate Observing System (GCOS)** plays a critical role in setting the monitoring standards and requirements to support the UN Framework Convention on Climate Change. In particular, it has identified **Essential Climate Variables (ECVs)** that need to be measured accurately and routinely for long periods of time

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Contribution from the JRC

Through a detailed analysis of space observations, JRC generates and distributes information on some of the GCOS' ECVs such as the plant photosynthetic activity and sea surface temperature (see Figures), as well as environment descriptors such as the brightness of the planet, the productivity of the vegetation, deforestation, changes in land cover, biomass burning, etc.

The JRC also hosts **WMO's World Data Centre for Aerosols**, which contains data on global aerosol pollution. Amongst others the Aerosol Optical Depth which is another GCOS Essential Climate Variable.

The JRC thus directly supports international efforts such as the GCOS, the Group on Earth Observations, the Global Earth Observation System of Systems and the Global Monitoring for Environment and Security.

***Key Publication**:*

Knorr et al., 'Global-Scale Drought Caused Atmospheric CO2 Increase', EOS, Transactions of the American Geophysical Union, 86(18):178 and 181, 2005

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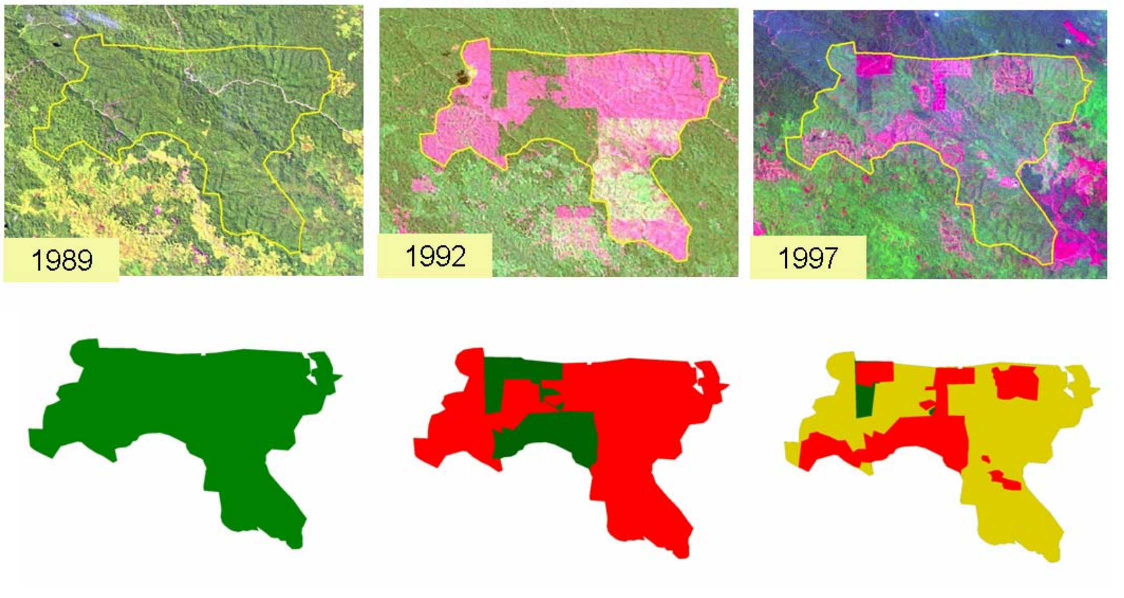
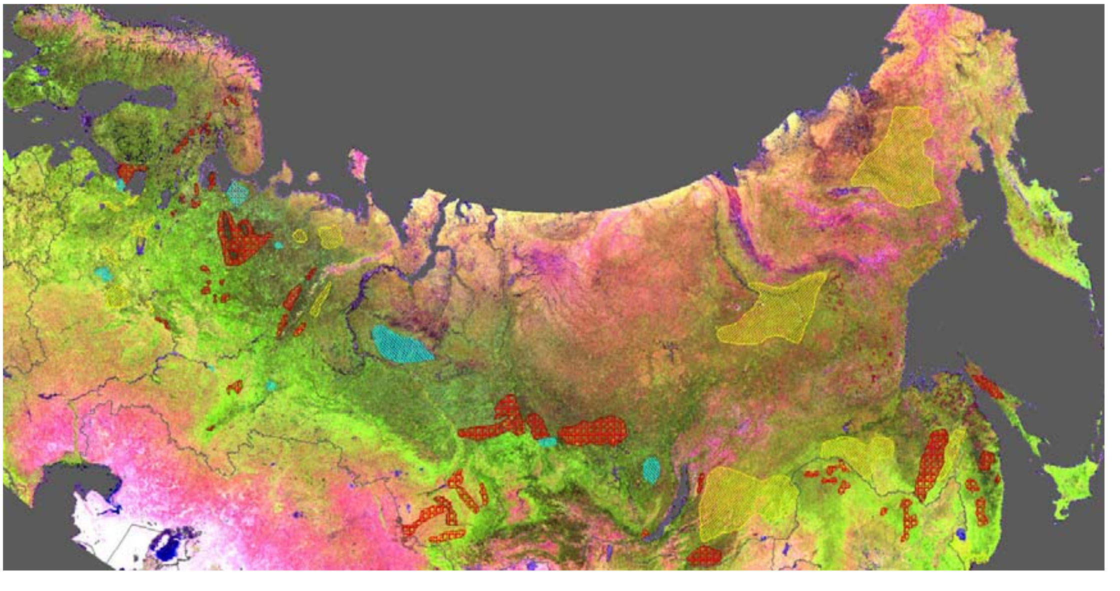


Satellite data can be used to follow the development of a managed forest area (in this case 20 km across) Here we see the outlined region change from natural forest (green) in 1989 to forest and clear cut areas in 1992 (red) to plantations (yellow) in 1997. In the same way that satellites can monitor the development of such an area, they can follow the preservation of protected forests.



Location of hot spot areas of forest cover changes in boreal Eurasia.
The different colours indicate the dominant change processes:
- *red = clear-cut areas or intensive forest management*
- *yellow = increase of fire intensity*
- *blue = other processes*

Monitoring Global Forest Resources

Avoided deforestation provides the potential for reducing future carbon emissions, especially in tropical forests, where both rates of deforestation and of carbon stock changes can be high. If such a scheme is to be considered under a post 2012 system, then adequate mechanisms will be required so as to ensure that any credits allowed for **avoiding deforestation** really do reflect a positive carbon balance over the baseline deforestation scenario. Such mechanisms require methodologies for the measurement of forest conversion, for determining carbon stock values of forests and for designing conversion baselines for carbon crediting.

Expertise of the JRC

Over the last 15 years, the JRC has carried out extensive research into monitoring forest condition and extent and into measuring forest area change from global to local scales using satellite observations.

The JRC has used satellite data to map the extent of forest domains at continental levels, to monitor individual protected areas, to calculate changes in tropical forest areas at global scales and to monitor logging activities. At the same time research is being carried out so as to reduce the uncertainty in forest carbon stocks.

Key Publication:

Achard et al., Determination of deforestation rates of the World's Humid Tropical Forests, Science, Vol 297, 999-1002, 2002.

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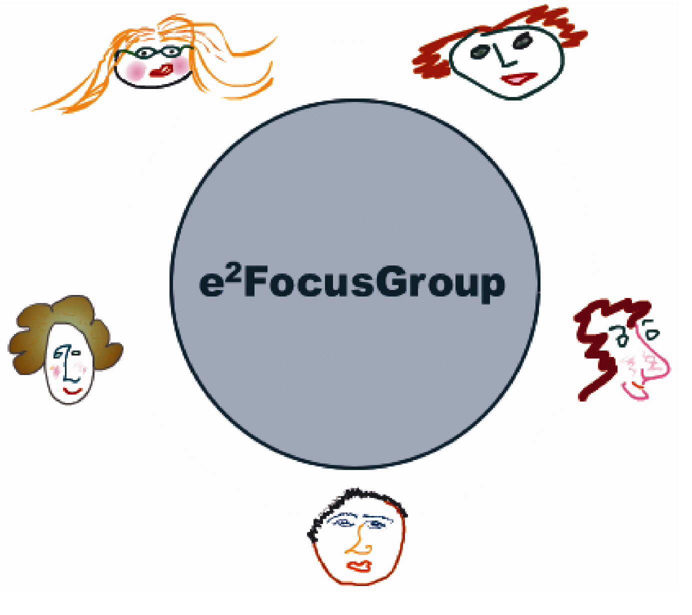
e2FG e-societal engagement



Stakeholder Involvement

It is now widely accepted that informed citizens can engage in high-quality dialogue with the experts to resolve issues in policy areas that are characterised by conflict and uncertainty.

Climate change is a case in point. It is a complex issue requiring the commitment across all spectrums of society, and it is fraught with many uncertainties that cannot be tackled by science alone.

The JRC develops guidelines and tools for Uncertainty Management offering assistance in mapping and communicating uncertainties, involving other spheres of accountability and experience.

This work is strongly supported by state-of-the-art Information and Communication Technologies. Two examples:

V GAS – Climate Change & Lifestyles: not just awareness, also dialogue and engagement… http://alba.jrc.it/vgas/

The V GAS game, developed in 5 languages for 5 EU countries, aims at supporting learning environments and public debate about lifestyles and climate change. A highly interactive and intuitive 3D user interface, allows it to be used by ordinary citizens, NGOs and other stakeholders who wish to investigate their contributions (emissions of 3 greenhouse gases) to a global issue and explore alternative pathways to reduce their burden. VGAS is a new concept for information tools aimed at communicating and mediating the relevant scientific knowledge in processes of social learning and debate.

In its endeavour to communicate science in non-scientific contexts, JRC has an ongoing programme of work on interfaces between climate models and citizens and other stakeholders who engage in the climate change debate. See for instance **http://alba.jrc.it/ulysses**.

The e2Focus Group Platform: e-societal engagement.
http://alba.jrc.it/eFG/

e2FG is an internet platform that enables a small group of people to have a focused discussion about a specific issue; its usage for climate change debate is ideal, not only because it allows virtual meetings with easy accessibility (reducing emissions from travel!) but also because it features functionalities that allow social engagement processes namely the organisation of focus groups or citizen juries.

Key Publication:
Guimarães Pereira, Â. and Pedrosa T., V GAS Energy , lifestyles and climate". European Commission-Joint Research Centre: EUR 21385 EN

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The mission of the JRC is to provide costumer driven scientific and technical support for the conception, development, implementation and monitoring of EU policies. As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of spe-cial interests, whether private or national.

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