

INSPIRE: the Infrastructure for Spatial Information in Europe - Research needs and challenges.

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Outline

Introduction to the Joint Research Centre

The case for a spatial data infrastructure in Europe

INSPIRE

Key research challenges

Questions

The Joint Research Centre

Part of the European Commission

Its mission is to provide scientific and technical support for the conception, development, implementation and monitoring of EU policies

Centre of science and technology reference for the EU, independent of special interests, private and national

7 Institutes in 5 Member States \cong 2300 staff \cong 300 M€/y budget + 40 M€ income

1000 partners in networks + 1500 partners in indirect actions



IE - Petten The Netherlands
- *Institute for Energy*



IRMM - Geel Belgium
- *Institute for Reference Materials and Measurements*



ITU - Karlsruhe Germany
- *Institute for Transuranium Elements*



IPSC - IHCP - IES - Ispra Italy
- *Institute for the Protection and Security of the Citizen*
- *Institute for Health and Consumer Protection*
- *Institute for Environment and Sustainability*



IPTS - Seville Spain
- *Institute for Prospective Technological Studies*





3 Institutes, Ispra Site Directorate, 160 ha area,
1.600 JRC staff plus 300 staff from contractors

Institute for Environment and Sustainability

470 staff (250 permanent, 220 visiting scientists and post-docs)

Main fields of activity:

Sustainability of natural resources: water, soils, forest

Sustainable agriculture and rural development

Climate change mitigation

Environmental risks and natural hazards

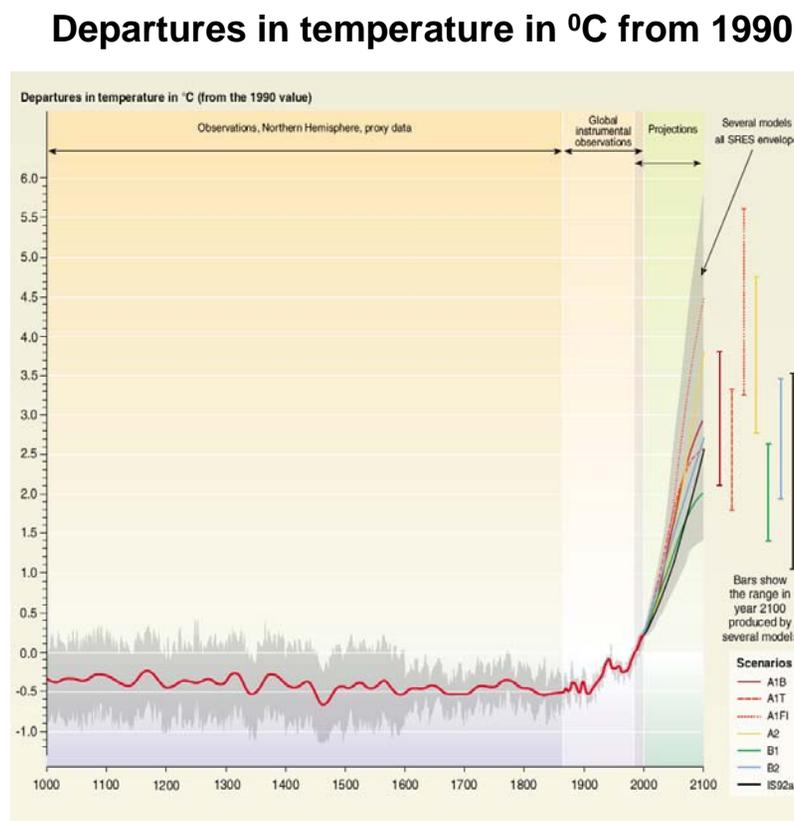
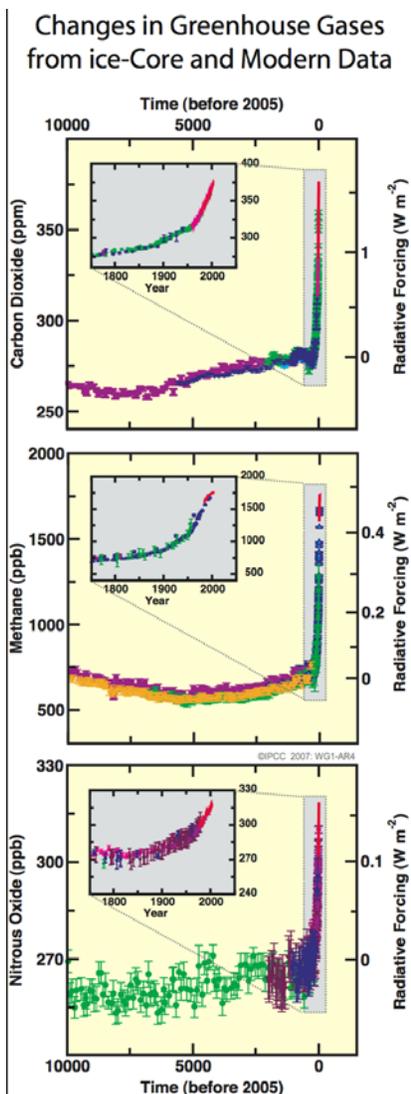
Sustainable transport and air quality

Renewable energies

Environmental dimension of development co-operation

Environmental monitoring and information systems

Why INSPIRE: State of the Environment in Europe



Source: IPCC

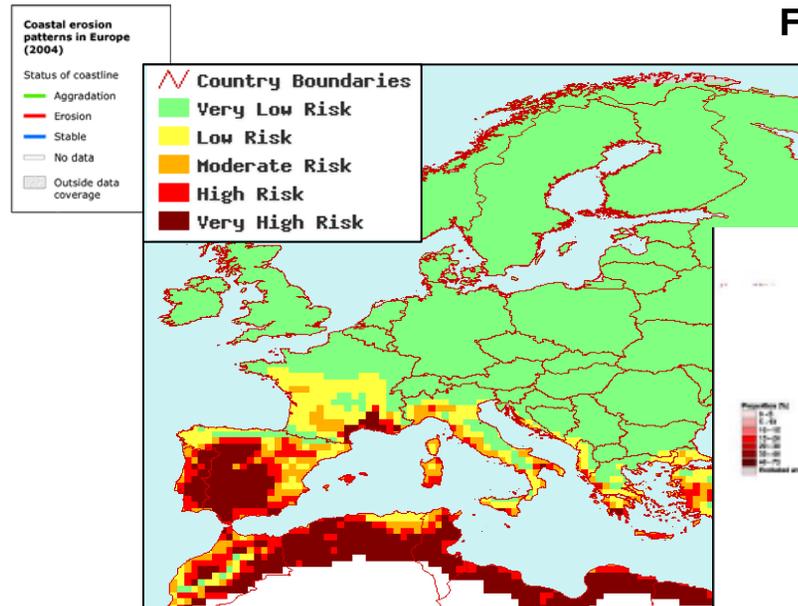
Although Kyoto targets achievable, projections up to 2030 for the EU-15 show a 14% rise of greenhouse gas emissions above 1990 levels

Energy production, and transport are the main contributors to greenhouse gas emission (30% and 20%)

By the end of this century, sea levels could rise by up to 89 centimetres and temperatures could rise by between 1.4 $^{\circ}C$ and 5.8 $^{\circ}C$.

Coastal Erosion

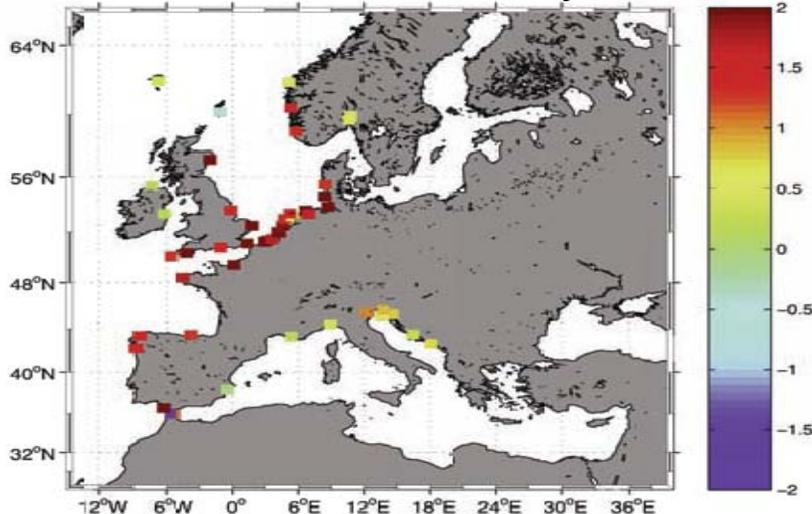
Source: EUROSION Project



Forest Fire Risk

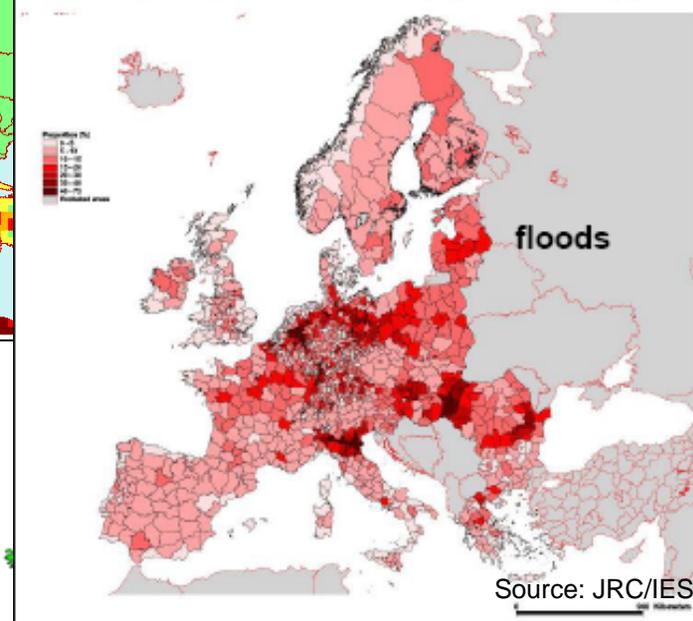
Source: JRC/IES

Sea Level trends in mm/y

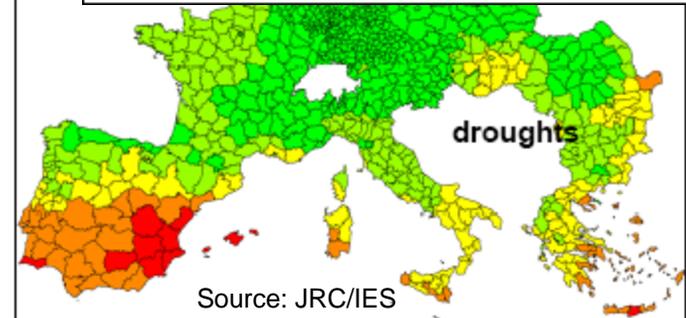


Source: Marcos & Tsimplis, as quoted in JRC/IES

NUTS-3 - Provinces Proportion of province on moderate to very high flood hazard areas (%)



Source: JRC/IES



Source: JRC/IES

Impacts of Flooding

In the period 1998-2002 floods comprised
43% of all disaster events in Europe
100 major floods
700 dead
Half a million displaced people
25 billion Euros uninsured economic
loss

Along the Rhine, 10 m people live in areas
liable to extreme flooding, potential
damage estimated at 165 bn. Euros

101,000 kms of coastline, population doubled
in last 50 years. Assets within 500 mt of
coast = 500-1000 bn euros.



DMI-HIRHAM
A2 scenario
(12km) with 5km
LISFLOOD
model

**Increased
flooding:**

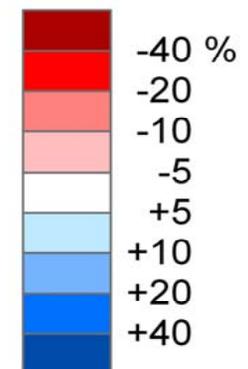
Almost
everywhere

**Decreased
extreme floods:**

Southern
Sweden, Finland,
Russia, Lower
Danube
(decreased
snowmelt?)



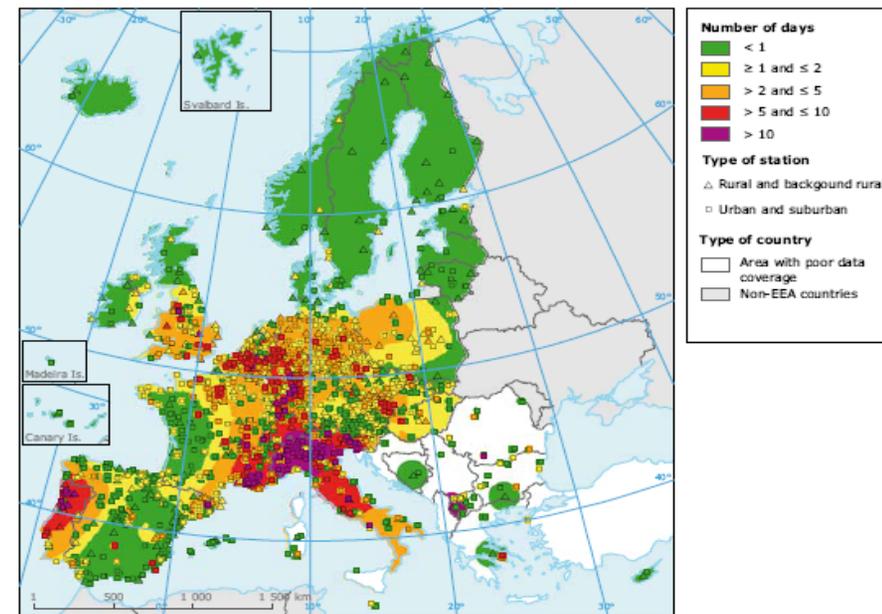
Change in
 HQ_{100} (river
discharge of a
once in 100
years flood)



Less visible but equally important: Environment and Health

- 20 million Europeans suffer respiratory problems every day
 - 10% of European children suffer from asthma
 - In the EU in 2000, about 350,000 were seriously affected due to air pollution caused by fine particulate matter.
-
- Current levels of ground-level ozone cause more than 20,000 premature deaths each year and dangerous levels of 'smog', linked with high summer temperatures and nitrous oxide emissions, are on the rise.

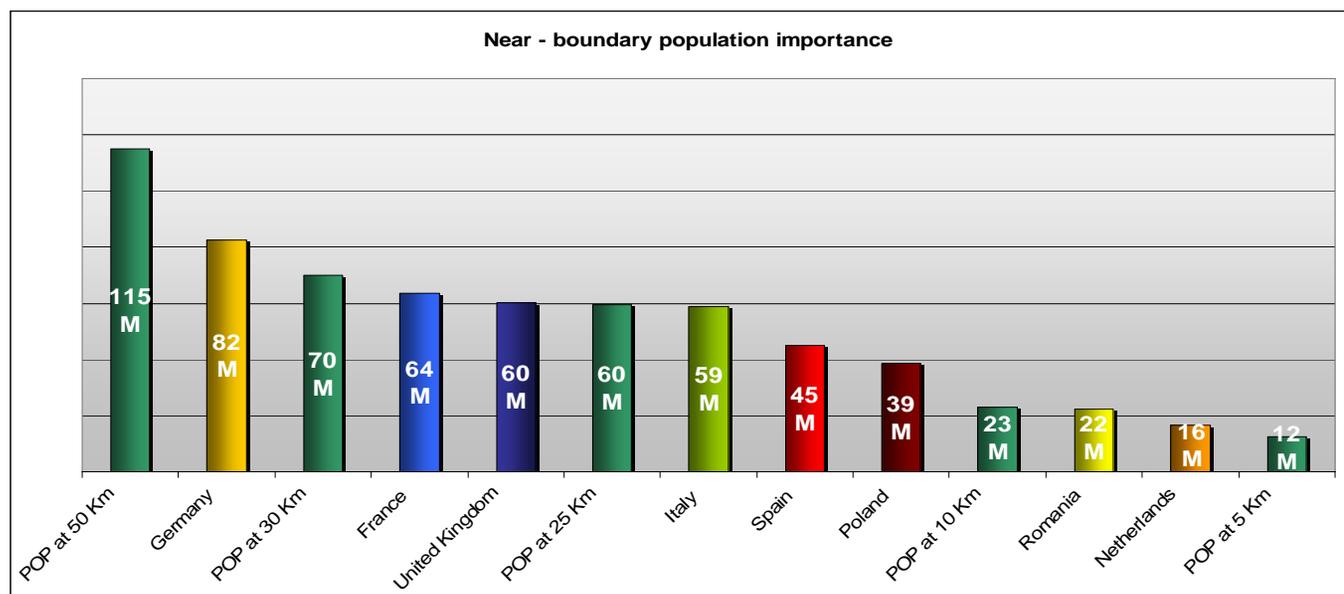
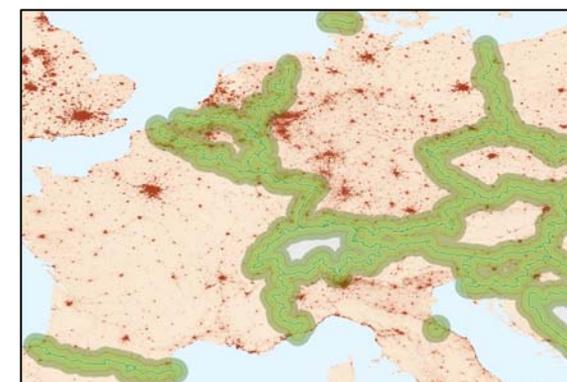
Map 2.1 Number of days with exceedance of the information threshold



Source: eea_technical_report_5_2007.pdf

Environmental phenomena do not stop at national borders!

- 20% of the EU citizens (115 million) live within 50 Kms from a border.
- 60 million EU citizens live less than half an hour (25 kms) from a border

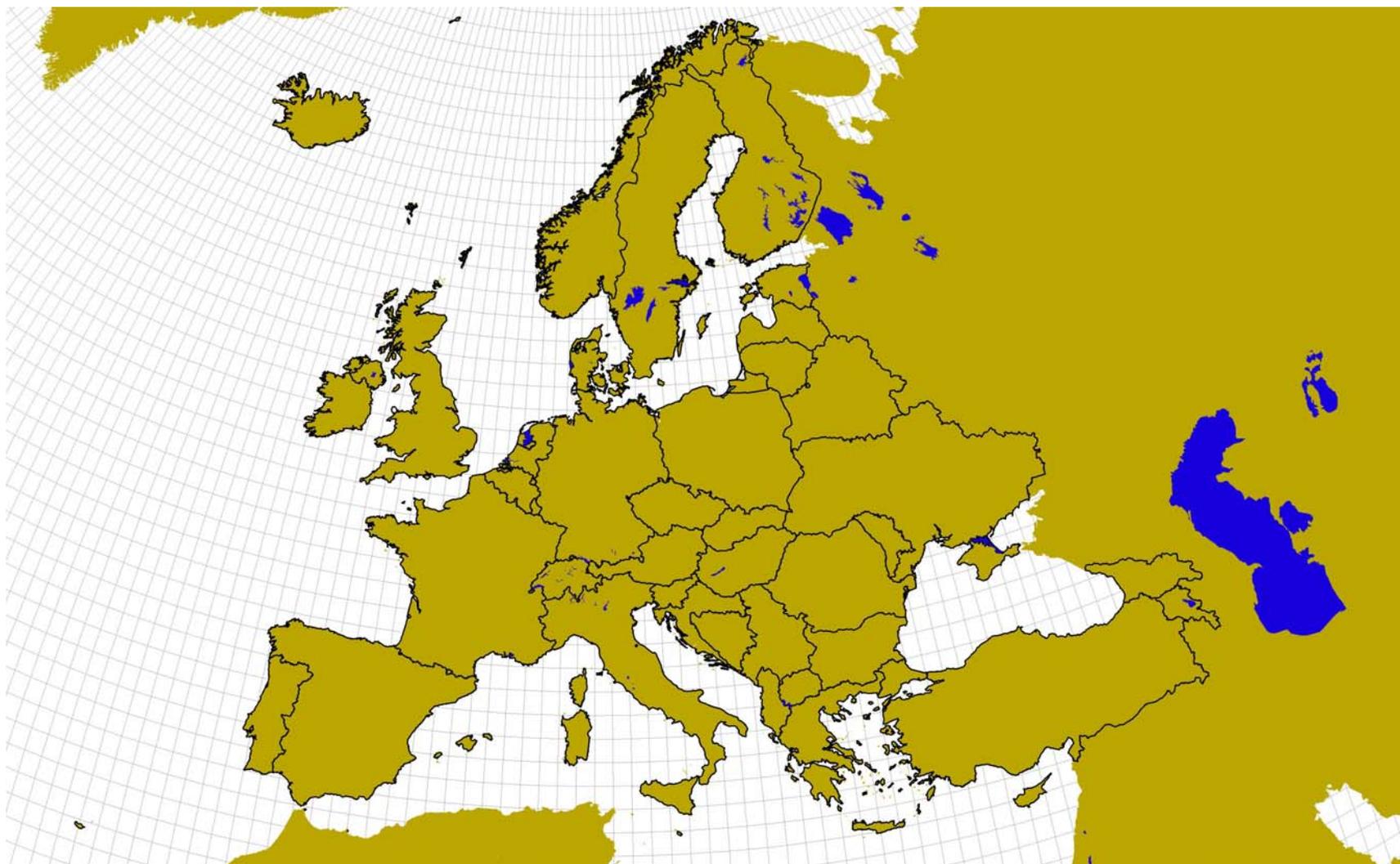


How to address these issues

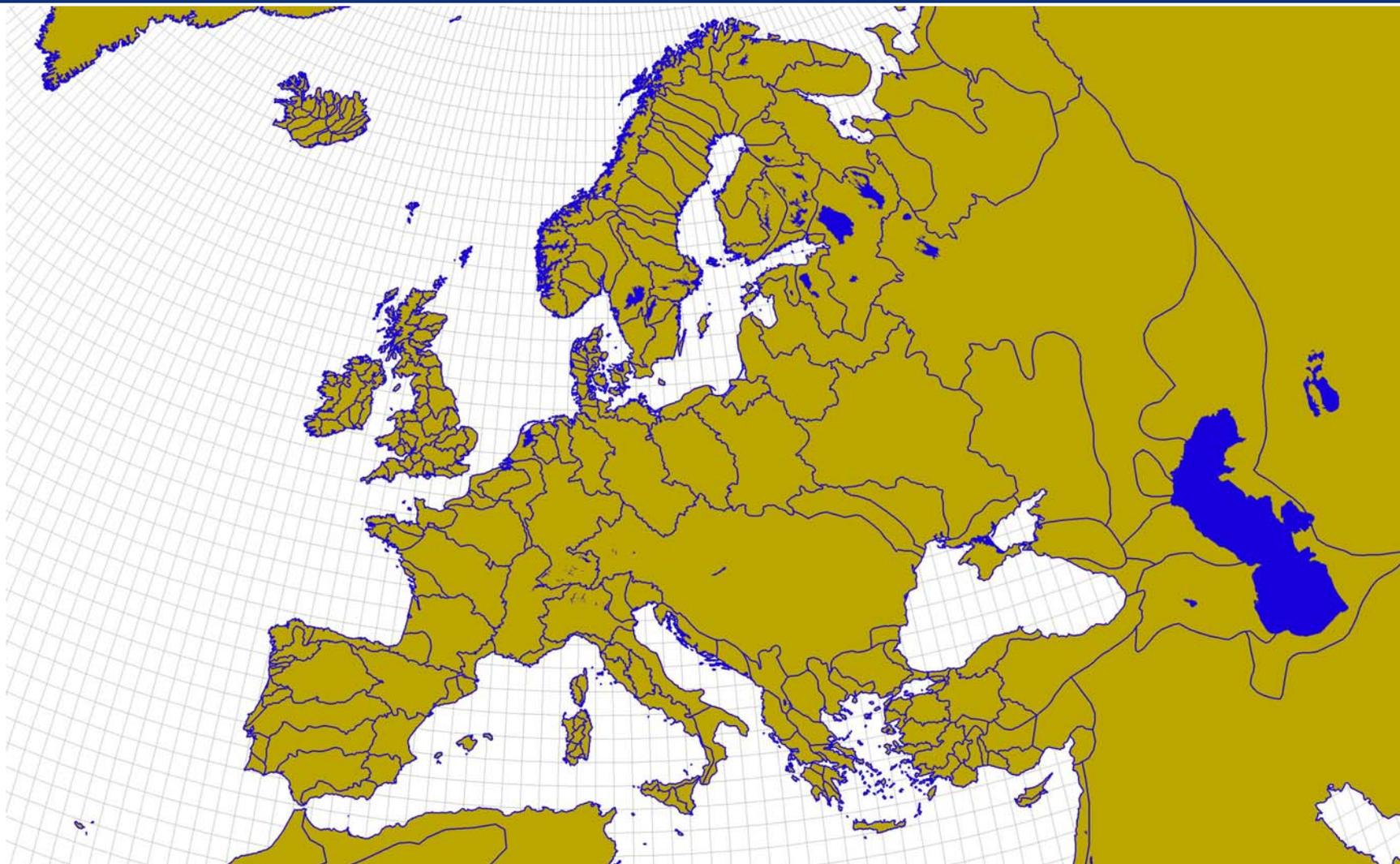
Comprehensive set of policies covering surface and ground water quality, flood assessment, marine and coastal areas, soil, etc.

Right geographical scale i.e. river basin for water quality and floods

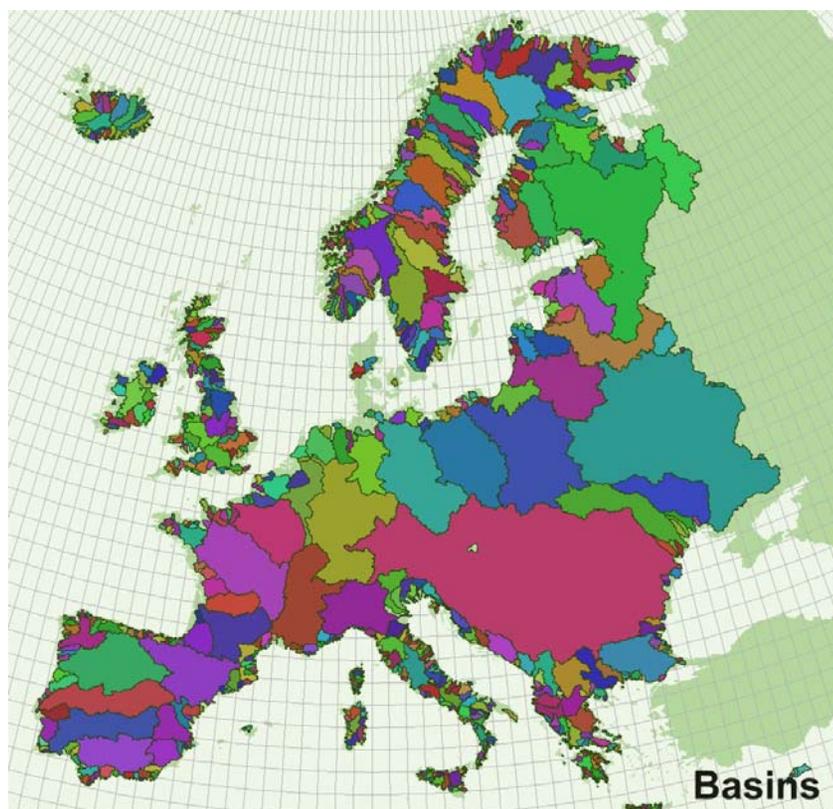
Sound knowledge based on timely, accurate, easily accessed geospatial and environmental information, shared across European, national, and local jurisdictions.



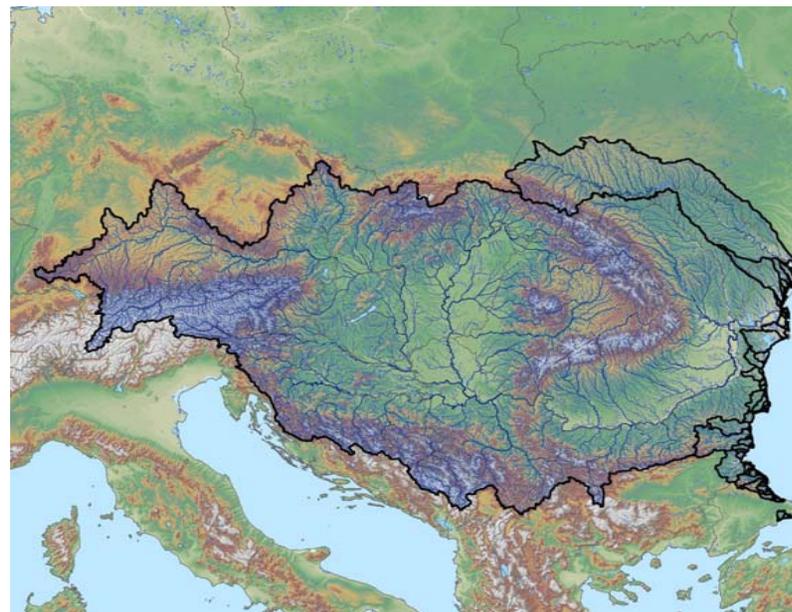
Moving from a national perspective



River Basins

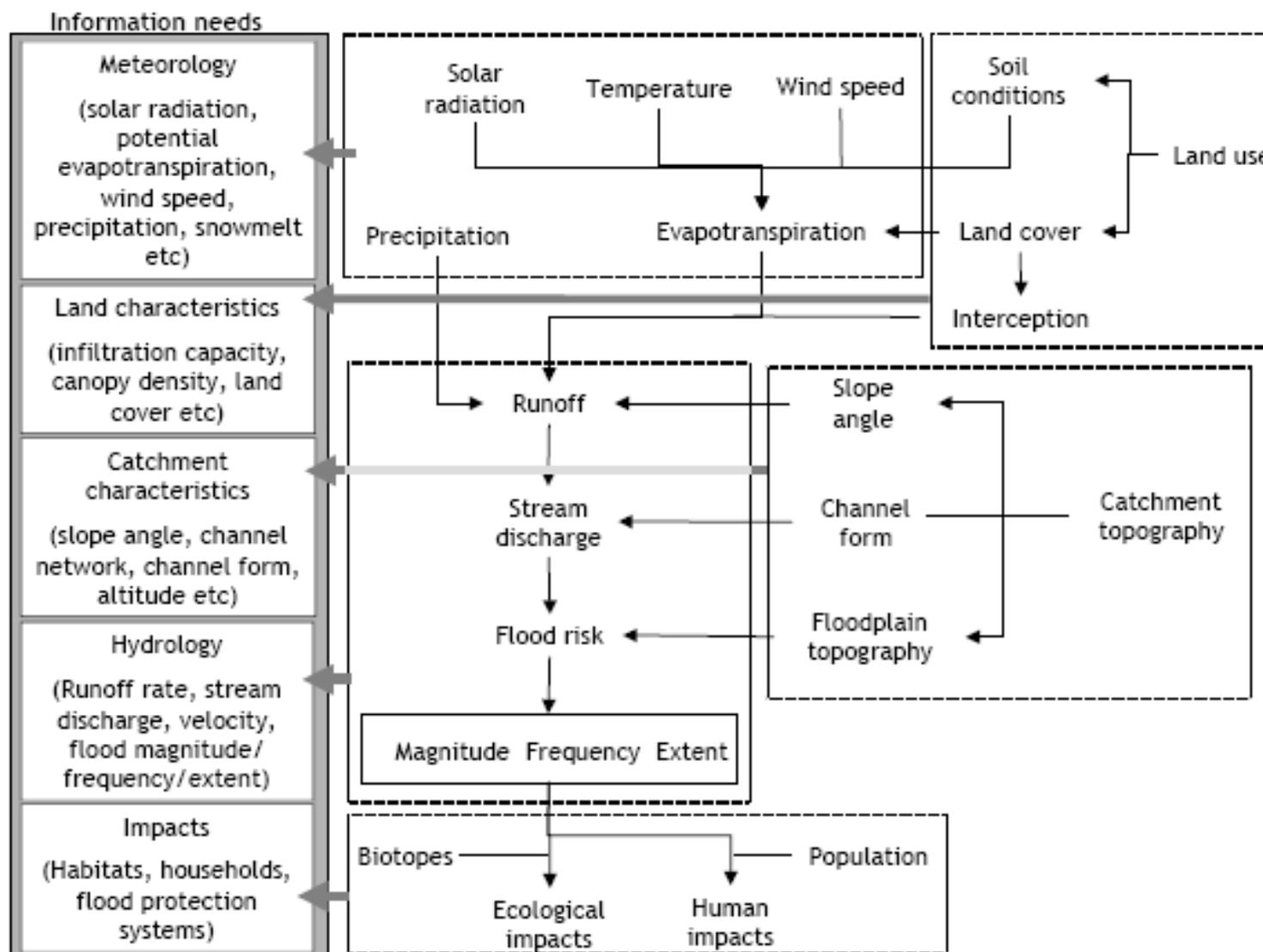


70% of all fresh water bodies
in Europe are part of a trans-
boundary river basin



801.463 km²,
81 million inhabitants, 19
countries

Example of data needs for flood forecasting



Real information problems

Some of these datasets exist either at JRC level or at MS level, but access to latter can be very difficult

For example it took 2.5 years to get 70% of the data for the Danube, but the remaining part is still extremely difficult to get even if one is prepared to pay for it.

The typical kind of problems one finds are:

- trying to find the right contact person is difficult due to frequent staff & political changes;

- technical responsible is not the same as the political responsible, so often we are send from one to the other, because the technician has no mandate to give the data, and the political person does not communicate well to the technical person

- in some cases there is no clear data access and pricing policy which makes negotiations very difficult

- data are not documented anywhere: knowledge is with a limited number of technical persons

If one obtains the data, it is fit for the purpose, but it requires substantial work to convert and re-project

These are typical problems find in many European or trans-border projects.

It is not just a data problem

Increasing shift from sector-based (silos) policy making towards more integrated, cross-sectoral approaches.



- This new approach particularly important for environmental policy
- But very difficult to work across sectors and boundaries

INSPIRE Directive General Provisions

INSPIRE lays down **general rules** to establish an infrastructure for spatial information in Europe for the purposes of Community environmental policies and policies or activities which may have an impact on the environment.

INSPIRE to be based on the infrastructures for spatial information established and operated by the Member States.

INSPIRE does not require collection of new spatial data

INSPIRE does not affect existing Intellectual Property Rights

INSPIRE Principles

Data should be collected once and maintained at the level where this can be done most effectively

Combine seamlessly spatial data from different sources and share it between many users and applications (the concept of interoperability)

Spatial data should be collected at one level of government and shared between all levels

Spatial data needed for good governance should be available on conditions that are not restricting its extensive use

It should be easy to discover which spatial data is available, to evaluate its fitness for purpose and to know which conditions apply for its use

INSPIRE Components

Metadata

Interoperability of spatial data sets and services

Network services (discovery, view, download, transform, invoke)

Data and Service sharing (policy)

Coordination and measures for Monitoring & Reporting

INSPIRE is a Framework Directive

Detailed technical provisions for the issues above will be laid down in Implementing Rules (IR)

JRC is responsible for overall technical coordination of INSPIRE

What Kind of Spatial Data ?

Whose ? - Spatial data held by or on behalf of a public authority operating down to the lowest level of government when laws or regulations require their collection or dissemination

Which data ? - INSPIRE covers 34 Spatial Data Themes laid down in 3 Annexes – (*required to successfully build environmental information systems*)

INSPIRE Scope

Annex I

- Coordinate reference systems
- Geographical grid systems
- Geographical names
- Administrative units
- Addresses
- Cadastral parcels
- Transport networks
- Hydrography
- Protected sites

Annex II

- Elevation
- Land cover
- Ortho-imagery
- Geology

Harmonised spatial data specifications more stringent for Annex I and II than for Annex III

Annex III

Statistical units

Buildings

Soil

Land use

Human health and safety

Utility and governmental services

Environmental monitoring facilities

Production and industrial facilities

Agricultural and aquaculture
facilities

Population distribution –
demography

Area management/restriction
/regulation zones & reporting units

Natural risk zones

Atmospheric conditions

Meteorological geographical features

Oceanographic geographical features

Sea regions

Bio-geographical regions

Habitats and biotopes

Species distribution

Energy Resources

Mineral resources

From Commission proposal to Community Directive implementation

Preparatory phase (2004-2006)

Co-decision procedure

Preparation of Implementing Rules 2005 – 2008 ...

Transposition phase (2007-2008)

Directive enters into force

Transposition into national legislation

INSPIRE Committee starts its activities

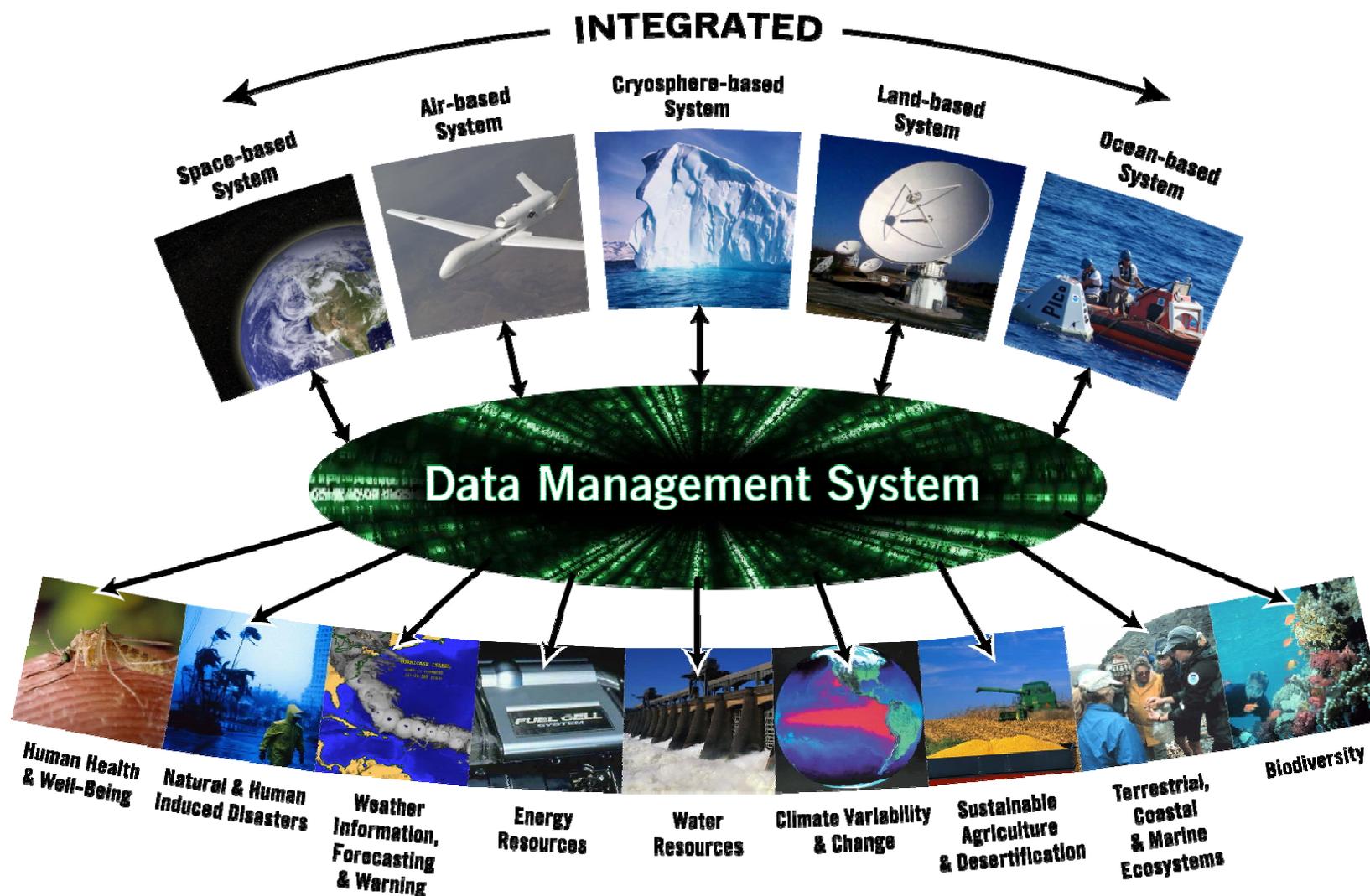
Adoption of Implementation Rules by Comitology

Implementation phase (2009-2013)

implementation and monitoring of measures



INSPIRE and GMES contribute to GEOSS



Metadata

Member States shall create metadata and keep them up to date

Metadata shall include:

- Conformity with IR on interoperability

- Conditions for access and use

- Quality and validity

- The public authorities responsible

- Limitations on public access

Once Implementing Rules adopted:

- Created within 2 years for Annex I, II

- Created within 5 years for Annex III

Interoperability of spatial data sets and services

Implementing Rules shall be adopted for interoperability and where practical for harmonisation of spatial data sets and services

Harmonised data specifications

Annex I, II, III:

- definition and classification of spatial objects
- geo-referencing

Annex I, II:

- common system of unique identifiers for spatial objects;
- relationship between spatial objects;
- key attributes and corresponding multilingual thesauri;
- how to exchange the temporal dimension of the data;
- how to exchange updates of the data.

3rd parties shall have access to these specifications at conditions not restricting their use

Cross-border issues shall be agreed on

Network Services

Member States shall operate a network of the following services available to the public for data sets and services for which metadata has been created:

Discovery services; No charge
View services; No charge (exceptions)

Download services;

Transformation services,

Services allowing spatial data services to be invoked

- *Access to services may be restricted*
- *Services shall be available on request to 3rd parties under conditions*
- *Implementing Rules will be adopted for which cost-benefit considerations are to be taken into account*
- *INSPIRE Geo-portal shall be established – Member States geo-portals*

Implementing INSPIRE: a participatory approach to policy making

Open and transparent approach in:

Formulating the policy (Experts from Member States writing position papers as input)

Assessing likely impact (Expert from MS preparing Extended Impact Assessment, chaired by EA for England and Wales)

Advising on process (INSPIRE Expert Group with representatives MS)

Mobilizing stakeholder through open registration of Spatial Data Interest Communities and Legally Mandated Organisations

Providing input to drafting of Implementing Rules through experts, reference material, and projects

Commenting on Drafts

Example of process for Implementing Rules on Metadata

Call for experts March 2005

Drafting Teams established in October 2005

Draft IR for Metadata published on 2nd Feb. 2007 based on requirement of Directive, review of existing material submitted by SDICS and LMOs, international standards, and drafting team knowledge.

Open for comments by SDICs and LMOs over an 8 week period. 1200 comments received.

Revised Draft to be published in the Summer 2007

Open for public consultation for an 8 week period in October 2007

Comments taken on board and revised proposal

Commission develops its proposal based on all input received and submits to Regulatory Committee TODAY

Committee meets on 14th May to vote

SDI Research Issues and Challenges

Metadata

Interoperability

Service chaining

Policy and impacts

The problem with Metadata

It is difficult to collect and create

- Requires a lot of manual work

- It is even more difficult to maintain

Yet there is a clear need to include more metadata on semantics and context to share understanding of data and appropriate methods

Tensions between “as little as possible” and “as much as necessary”

Tension between Who pays and who benefits

Additional problems when using a legal instrument (binding versus non binding elements)

Flexibility vs. interoperability

Automated Metadata Generation

Possible solutions:

- Closer linkage between data and metadata

 - Models supporting tightly coupled data and metadata

- Modeling of metadata generation rules

- Mining of data semantics

- User tagging and wikipedias

- Move from data producer to user perspective

Interoperability

THE key challenge?

“Where can I cross the Havel?”

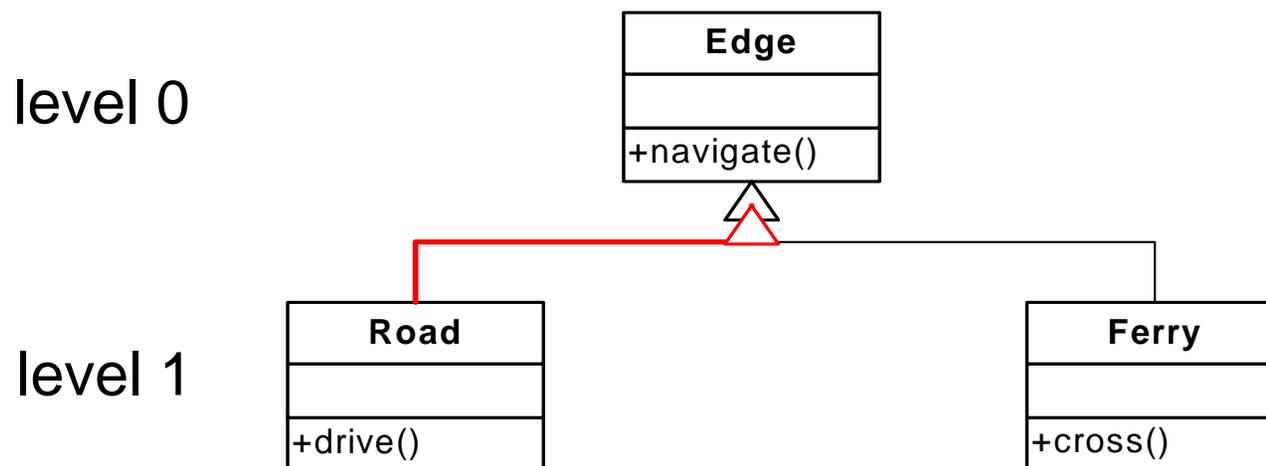
ios
Road data
(e.g., GDF)



Hypothesis

The navigation system used GDF road data

It interpreted **GDF level 0** data (nodes, edges) with **level 1** operations (roads, ferries)



General Problem Statement

BMW accident shows an **ontological problem**

data transfers separate data from operations

activity contexts are lost

target systems misinterpret data in other activities

Activity contexts are essential for the semantics of **geographic information**

Challenge

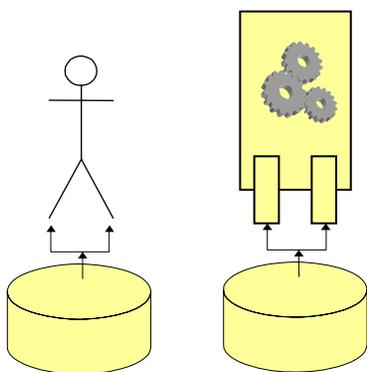
Bring domain communities across multiple themes and fields to make explicit their practices and understanding of both data and processes

Formalise in ontologies, thesauri, and ancillary documentation (towards a semantics reference system)

Encode so that not only humans but machines can also understand

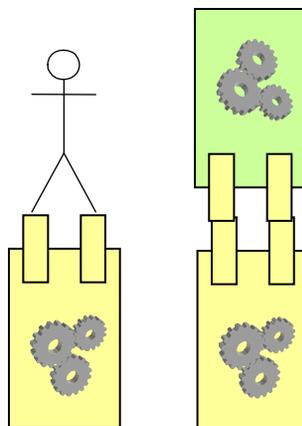
Werner Kuhn's Medium-term research program (3-5 years)

solve 3 semantic interoperability problems:



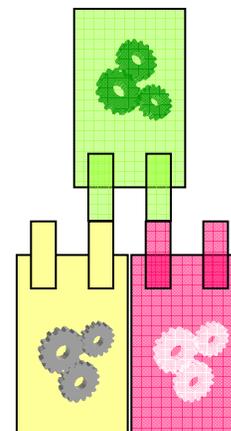
data discovery

e.g., road data for
directions



service discovery

e.g., weather
services



service composition

e.g., wind direction
for gas plume

Technology

publish-find-bind is (understood for) SDI 1.0

...but far from understanding SOA for SDI 2.0

Still with

data-exchange (GML is yet another format)

library-like, hand typed metadata

architectural models from the FTP, CORBA, ...times

But we do not share services & functionalities (delivering *information*)

“web service algebra” (similar to map algebra)

e.g.: $SCS + WPS = WCS$

How to do INSPIRE transformation & invocation services?

Technologies and Services Research

Key Challenge:

Move from infrastructures focussed on access to distributed and heterogeneous **Data** (downloaded and processed by experts) to infrastructures based on services that do the processing and deliver **Information** (and therefore can be used by multiple users, including non-experts, and the public)

ORCHESTRA Project:

Open Architecture and Spatial Data Infrastructure for Risk Management

Goal:

Develop and test interoperable software architecture for risk management applications

Specify interoperable risk management services

Input to standardisation (OGC, ISO, CEN...)

Validate the architecture and services in multi-risk scenarios through pilot applications

Feed into GMES and INSPIRE (implementing rules)

Pilot Application – Thematic Focus

Assessing Pan-European
forest fire risks

Research challenges:
architectural solutions for
schema transformations
and distributed **service**
chaining



Requirement Analysis

End users

Forest fire domain experts conducting policy support towards various EC DGs

Functionalities

Interoperable access to heterogeneous national fire records

Harmonisation of heterogeneous data into a common schema

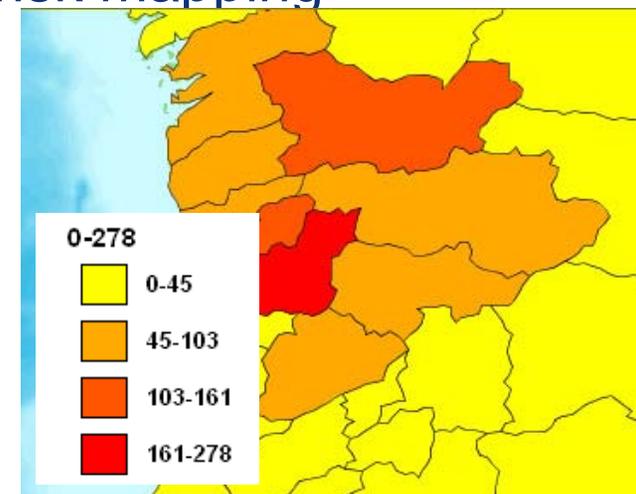
Flexible and distributed forest fire hazard and risk mapping

Measures

Forest fire frequency: number of forest fires aggregated by administrative unit

Forest fire density: forest fire frequency normalised by area

Forest fire risk: forest fire density classified



Pilot Application – Technical Focus

Implement distributed geo-processing for risks analysis
by chaining existing ORCHESTRA (SOAP) services

Feature Access Service (FAS) \cong OGC WFS

Processing Service (PS) \cong OGC WPS

Map Access Service (MAS) \cong OGC WMS

in a new (risk specific) service chain

A Forest Fire Risk Assessment Service

Using

Business Processes Execution Language (BPEL)

Describing the Forest Fire Risk Assessment Service chain

Service Chain Access Service (SCAS)

Deploying executable instance of the Forest Fire Risk Assessment Service

Schema Mapping Service

Harmonizing heterogeneous data from different member states of the
European Union

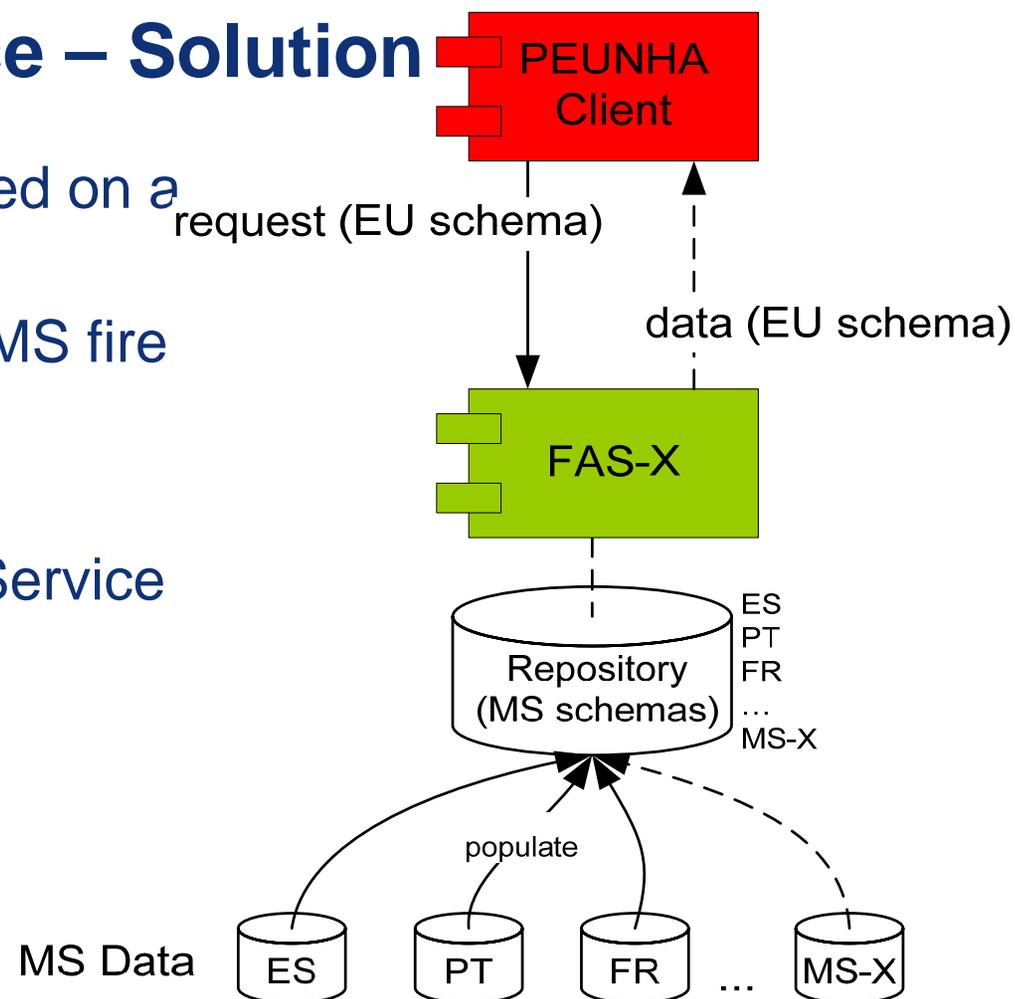
Schema Mapping Service – Solution

Support access to forest fire based on a common European schema

Provide interoperable access to MS fire records

ORCHESTRA Approach:

Translating Feature Access Service (FAS-X)



Analysis

Forest Fire Frequency

Forest Fire Density

Forest Fire Risk

Processing operations

Spatial Join of Forest Fire Points per administrative units

Counting joined points per administrative units

⇒ **Join and Aggregation service**

Normalising Forest Fire Frequency by administrative units

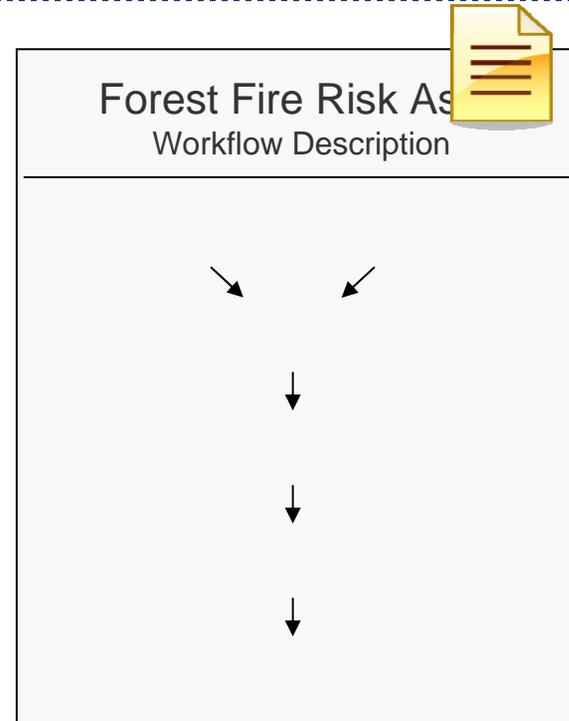
⇒ **Normalisation service**

Classifying risk based on forest fire density per administrative units into risk classes

⇒ **Classification service**



Creation of Forest Fires Risk Assessment Service



Related research activity

Service composition modalities

Control flow

Centralized

Using a central orchestration service coordinating the execution
Orchestration languages: BPEL, XLANG, WSFL, ...

Cascaded

Using service invocation requests (e.g. HTTP GET requests to
WFS, WCS or WPS) as inputs to a WPS operation in form of
Complex Value References

Data flow patterns

Data passed by value

Data passed by reference

INSPIRE related activities : Invoke Spatial Data Services definition

Related research activity

Data harmonization

Architectural solutions

- FAS-X (discussed in the pilot)

- Schema Mapping Service (SMS)

Schema mapping languages

- Model constructs

INSPIRE related activities : Interoperability arrangements (e.g. transformation services, data transformations)

Challenge

No standard service chain interface

High flexibility, but complicates
clients development

service chain re-usability (and discovery)

Service chains conformance

getCapabilities: is it mandatory?

Alternative interaction modalities

Asynchronous invocation of service chains

From chaining by hand (artisan's approach) to at least semi-automatic chaining

i.e. ability of services to find other services, identify their properties, assess
appropriateness to task and data available, choose between competing
solutions

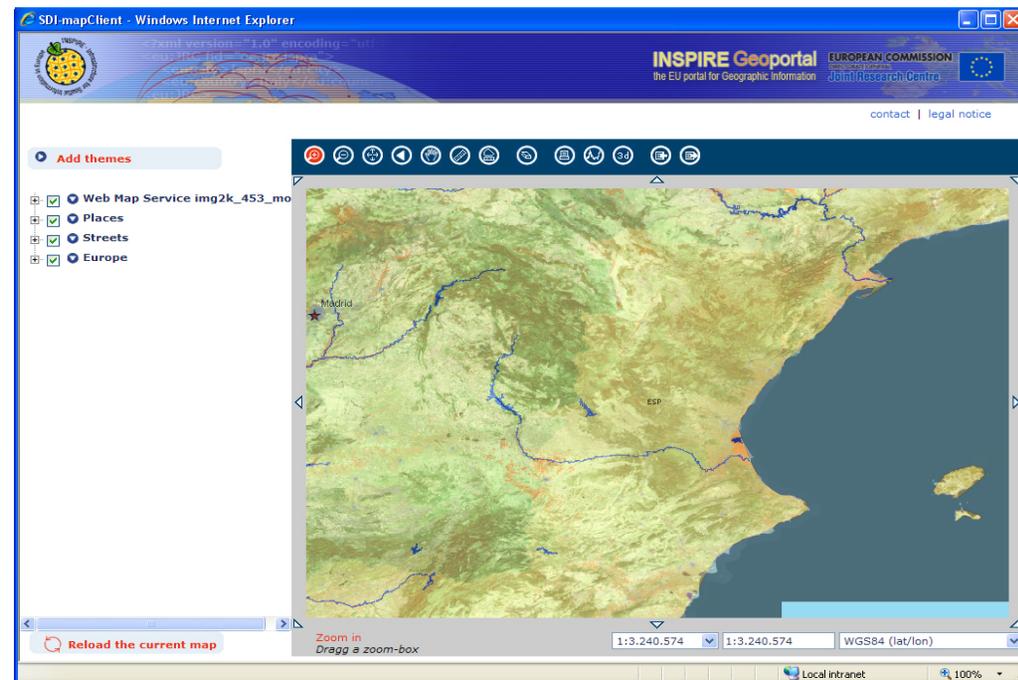
Back to interoperability but also need to encode trustworthiness ?

How would chaining with different DRM for both data and services work out?

The INSPIRE Geoportal

Requirements (1)

- Required by the INSPIRE Directive
 - Provide access to the Member States INSPIRE services
- Aim to provide an operational platform to satisfy the requirements of the directive and IR
- Development and operation under EC responsibility
- INSPIRE geoportal dependent on the IR development

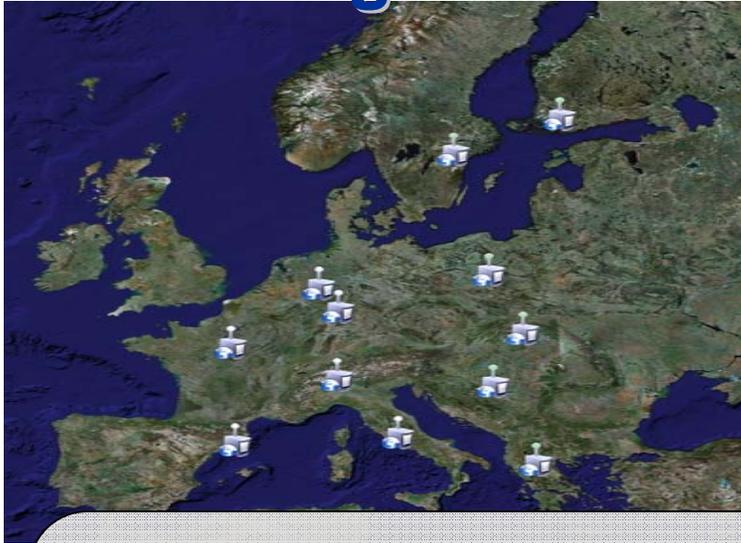


The INSPIRE Geoportal

Requirements (2)

- **discovery services** - search for spatial data sets and spatial data services on the basis of the content of corresponding metadata, display the metadata content;
- **view services** - as a minimum, display, navigate, zoom in/out, pan, or overlay spatial data sets and display legend information and any relevant content of metadata;
- **download services**, enabling copies of complete spatial data sets, or of parts of such sets, to be downloaded;
- **transformation services**, enabling spatial data sets to be transformed;
- “**invoke spatial data services**”, enabling data services to be invoked.

Challenges of the INSPIRE Geoportal

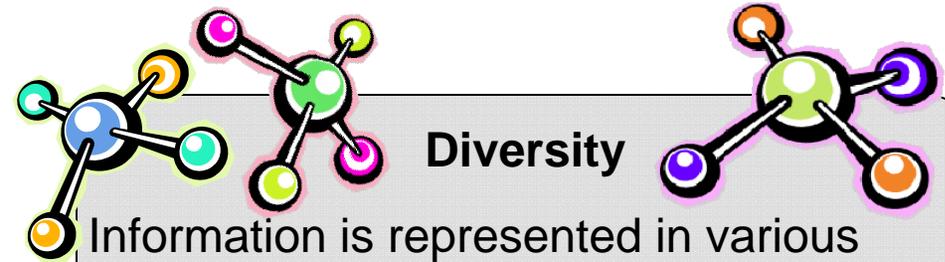


Distribution

A European SDI is formed by regional and local SDIs that have their own Metadata models, Catalogues, etc.

Multilinguality

The European Union comprises 23 official languages. This has significant impact on how discovery of data and services is performed.



Diversity

Information is represented in various data models and coordinate reference systems.

Current Status

Prototype Development

- Under the responsibility of EC JRC
- Open to joint developments with MS
- Test drive International standards and specifications
- Valuable resource of experiences
- Support INSPIRE DTs
 - provides a test platform for the development of the INSPIRE IRs

Current Priorities

- Metadata
- Discovery services (catalogue interoperability)
- View services

Access Distributed Catalogues

EC JRC Distributed Catalogues study (2006)

http://inspire.jrc.it/reports/DistributedCatalogueServices_Report.pdf

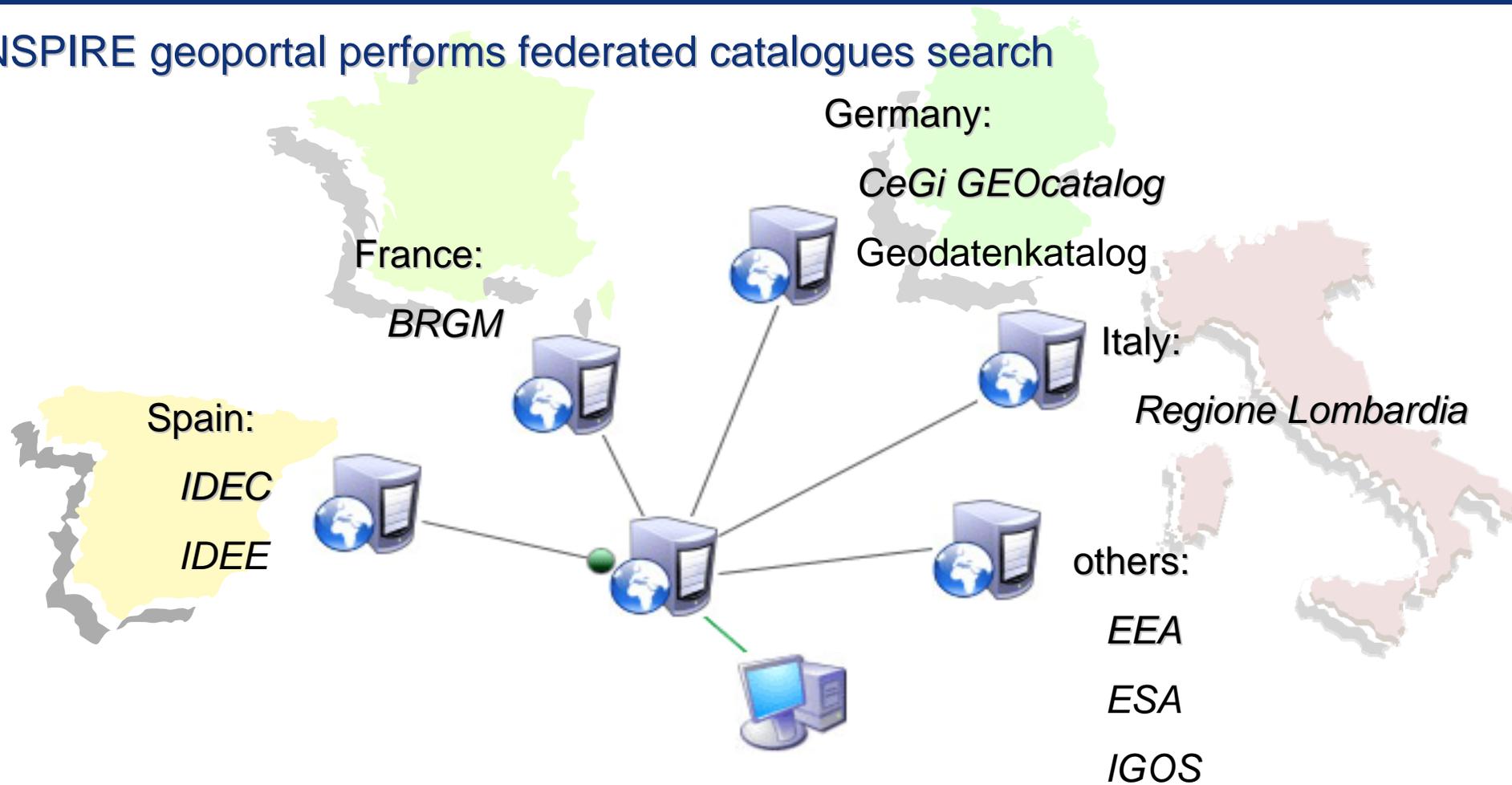
- Assess state of the art in metadata catalogue technologies and “test drive” use of standards
- Specific adapters need to be implemented on a case by case basis
- Shortcomings in OGC specification result in too many degrees of freedom in implementations

Impact

- OGC updated specification 2.0.2
- ISO TC211 ad hoc group established



The INSPIRE geoportal performs federated catalogues search



Moving target

We are struggling with an SDI v 1.0 while we see emerging:

Geobrowsers, Geotagging, Mash ups, GeoCommons and crowdsourcing,
Social networks and Geo-Gaming (Second Life, MySpace, etc.)

How to exploit opportunities (stability vs. innovation)



Technology
PUBLISHED BY MIT
Review

July/August 2007

Second Earth

The World Wide Web will soon be absorbed into the World Wide Sim: an environment combining elements of Second Life and Google Earth.

By Wade Roush

Policies

SDIs assume sharing is good for you!

Data Sharing culture?

- Horizontal working vs. vertical

- Sharing against performance audits and target monitoring? (getting worse rather than better?)

Who wants to be “coordinated”?

Data Access

- Religious debates “ free data” vs. cost recovery

Immaturity of the market, fear of the unknown.

Impacts

Unknown! (so how can we tell if we are “successful”?)

In increasing competition between public agencies, who wants to have “leaps of faith”, and/or potentially benefit others whilst bearing the costs?

Still about data access not about information delivery

Key Findings of international review

Costs **relatively** easier to measure than benefits

Benefits:

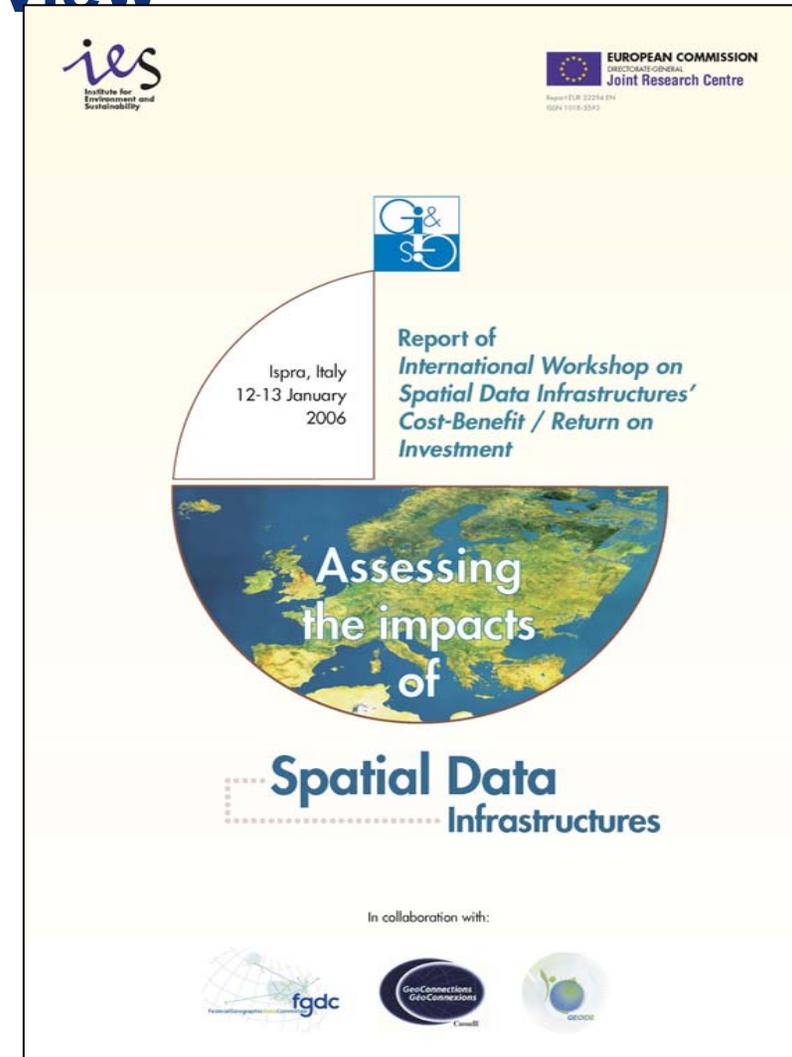
- Efficiency benefits

- Effectiveness benefits

- Wider socio-economic benefits (e.g. better governance, greater accountability, reduced risks, increased innovation and new business opportunities)

CBA does not replace policy-making:

Most studies reviewed have positive benefits/cost ratios but all have front loaded investments which maybe politically unpalatable compared to education, health, law and order.



Catalunya Study: Key findings

Costs: €1.5 million over 4 years (2002-06)

- Human resources account for 76% of total cost during launch period (2002-03) and 91% during operational period (2004-05)

Benefits: assessed for 2006 with a focus on local government level

- Efficiency savings account for 500 hours per month = €2.6 m
- Effectiveness savings account for another 480 hours per month
- Wider social benefits are not quantifiable but clear narrowing of digital divide between small local authorities and larger ones
- Benefits to private sector visible but not outstanding yet

Four years of investment recovered in 6 months

Full report published on www.ec-gis.org/inspire.

Lessons learned

- Possible to measure impacts, with outcomes validated by user groups
- Methodology appropriate for spatial data infrastructures or e-gov initiatives once operational
- Other methodologies (e.g. MCA) better to evaluate ex-ante alternative strategies or investments from multiple stakeholders
- Indicators useful BUT much preliminary work AND in depth interviewing necessary to gather quality information
- Planning to repeat across multiple regions in comparative study
- More research on alternative approaches needed (e.g. measuring value added) and published!



JRC IJSDIR

International Journal of Spatial Data Infrastructures Research

Call for Papers

<http://ijsdir.jrc.it>

To sum up

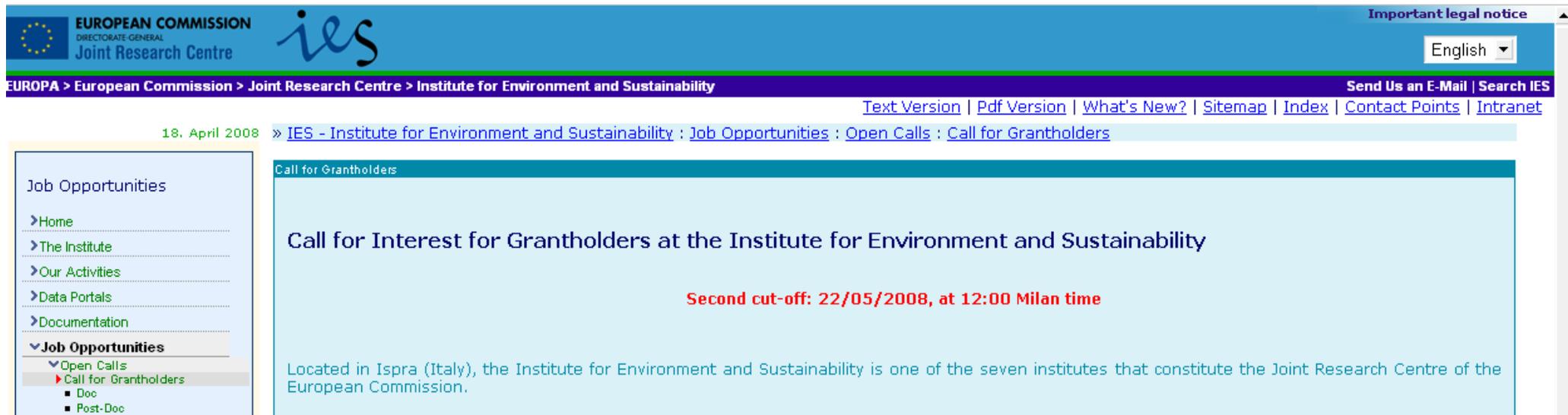
Need to develop spatial data infrastructure that build on the existing technologies, standards and practices but do not freeze future development

Need to move from data to information and services

Incorporate social network and new means of GI production and consumption (Web 2.0)

Research in interoperability, service chaining, impacts desperately needed

Want to join us? <http://ies.jrc.ec.europa.eu/callgrant.html>



The screenshot shows the website header with the European Commission and IES logos. A navigation menu includes links for Home, The Institute, Our Activities, Data Portals, Documentation, and Job Opportunities. The Job Opportunities section is expanded to show Open Calls, Call for Grantholders, Doc, and Post-Doc. The main content area features a 'Call for Interest for Grantholders at the Institute for Environment and Sustainability' with a red 'Second cut-off: 22/05/2008, at 12:00 Milan time' notice. A sidebar on the left lists navigation options, and a top navigation bar includes links for Text Version, Pdf Version, What's New?, Sitemap, Index, Contact Points, and Intranet.

Register in EPSO <http://europa.eu/epso/>



The banner features the Europa logo and the text 'European Personnel Selection Office'. It includes a navigation bar with links for Legal notice, Site map, FAQ, Webmaster, Index, Search on EUROPA, and Contact. The bottom left corner displays 'EUROPA > EPSO'.

Thank you for your attention

More information on INSPIRE: www.ec-gis.org/inspire

More info on ORCHESTRA: www.eu-ORCHESTRA.org

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A particular thanks to: Anders Friis, Ioannis Kanellopoulos Roberto Lucchi, Michael Lutz, Nicole Ostlaender, for their contributions to the slides.

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