INSPIRE and Multi-Disciplinary Interoperability

Max Craglia
European Commission
Joint Research Centre

www.jrc.ec.europa.eu

Serving society
Stimulating innovation
Supporting legislation

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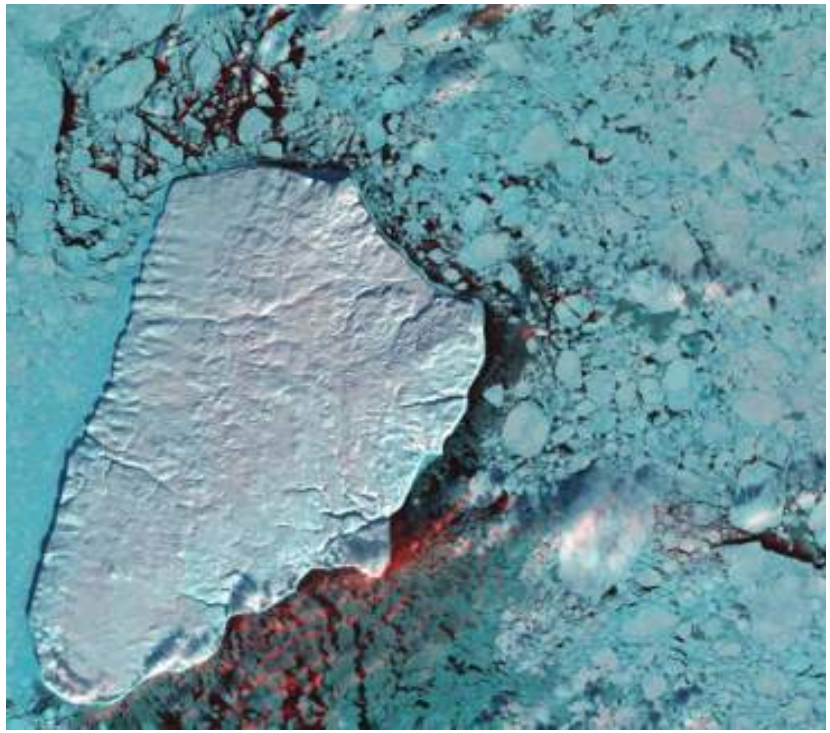
Earth system science needs to model the interactions between nature and society



Nature: Physical equations Describe processes

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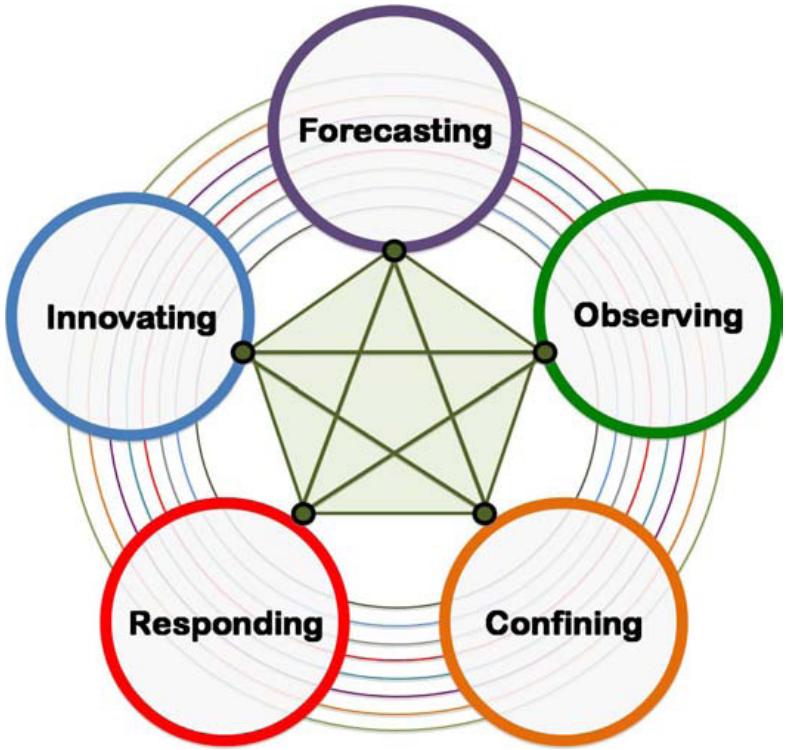
Society: Decisions on how to Use Earth´s resources

Key challenges for sustainability research

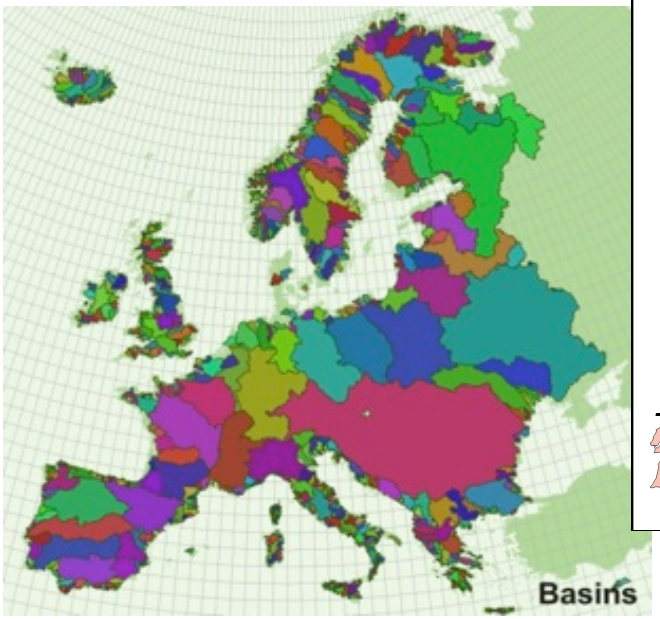
- Develop the information infrastructures necessary for policy based on sound knowledge;
- Foster the multi-disciplinary research necessary to improve our understanding of the relationships environment-society;
- Communicate science more effectively to decision makers and European citizens;
- Engage the public in the scientific process (e.g. help monitor the environment they live in).

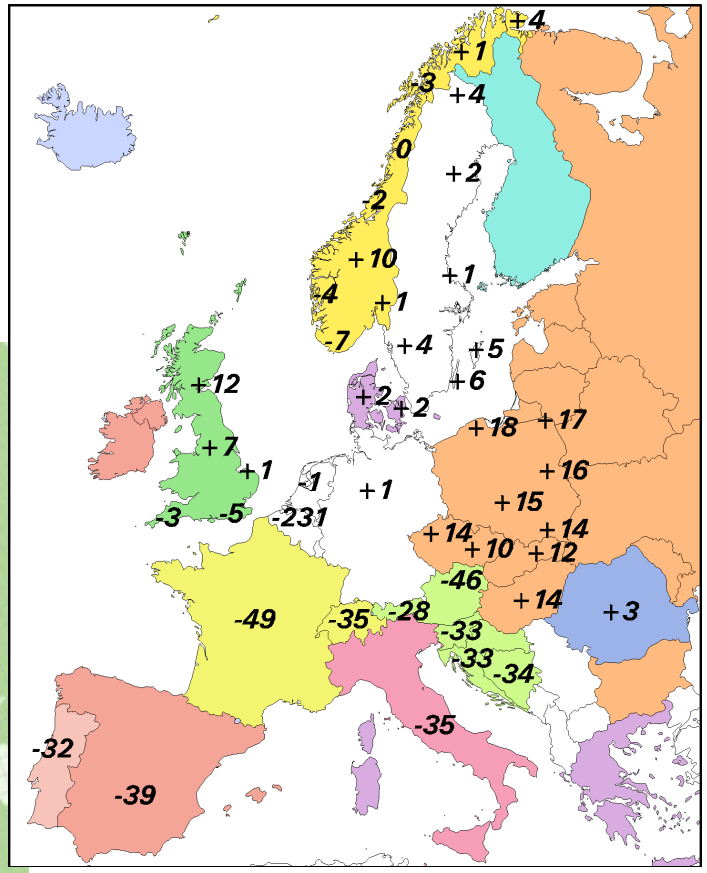


Source: ICSU Global Challenges, 2011

Information Infrastructures: INSPIRE = European SDI

- Needed because natural disasters do not stop at national borders,
- 70% of all fresh water bodies in Europe are part of a trans-boundary river basin
- We could not even agree on how to measure “Height”!



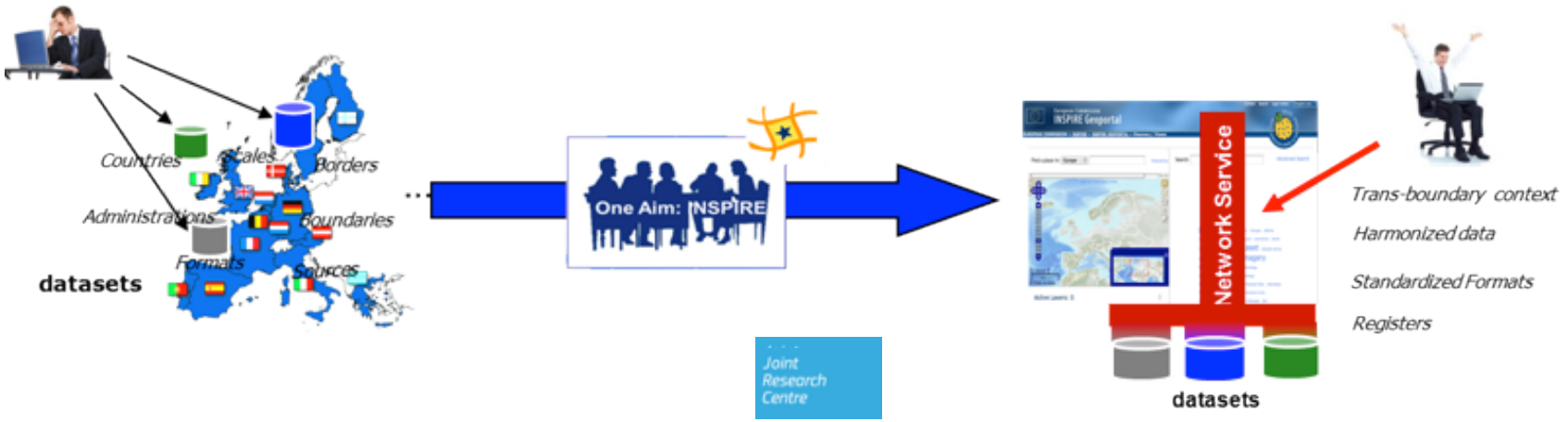


INSPIRE is a legal framework

- The INSPIRE Directive lays down general rules to establish an **Infrastructure for Spatial Information in Europe** for environmental policies and policies which may affect the environment
- INSPIRE is built on the SDIs established and operated by the Member States
- JRC is the technical coordinator
- Implementing Rules (i.e. legislation)
  1. Metadata
  2. Interoperability of spatial data sets and services
  3. Services (discovery, view, download, transform, invoke)
  4. Data and Service sharing (policy)
  5. Monitoring & reporting

INSPIRE in a nutshell

- Comprehensive **data inventory**
- **Facilitate data discovery** through standardised discovery services & metadata
- **Data sharing**
- **Facilitate data access** by allowing view, download and transformation
- **Facilitate data use and interoperability** by adopting common cross-domain models to exchange data



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INSPIRE thematic scope

Annex I

1. Coordinate reference systems
2. Geographical grid systems
3. Geographical names
4. Administrative units
5. Addresses
6. Cadastral parcels
7. Transport networks
8. Hydrography
9. Protected sites

Annex II

1. Elevation
2. Land cover
3. Ortho-imagery
4. Geology

Annex III

1. Statistical units
2. Buildings
3. Soil
4. Land use
5. Human health and safety
6. Utility and governmental services
7. Environmental monitoring facilities
8. Production and industrial facilities
9. Agricultural and aquaculture facilities
10. Population distribution – demography
11. Area management/ restriction/regulation zones & reporting units
12. Natural risk zones
13. Atmospheric conditions
14. Meteorological geographical features
15. Oceanographic geographical features
16. Sea regions
17. Bio-geographical regions
18. Habitats and biotopes
19. Species distribution
20. Energy Resources
21. Mineral resources

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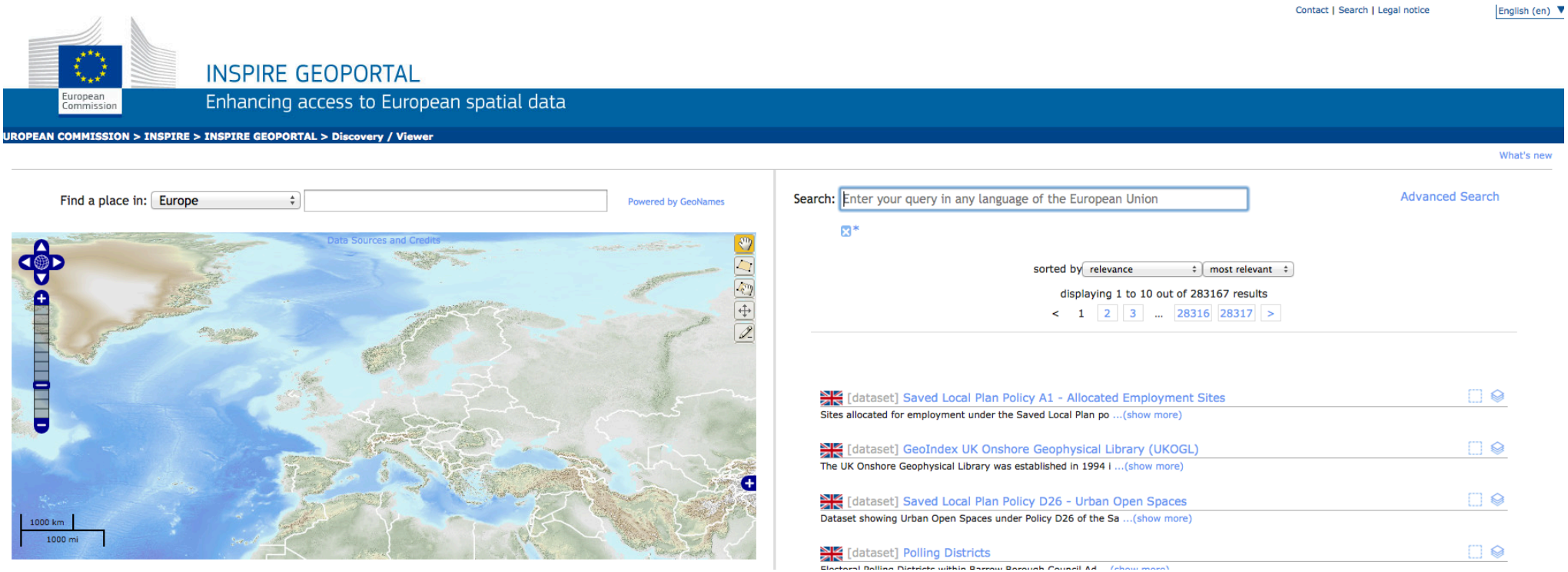
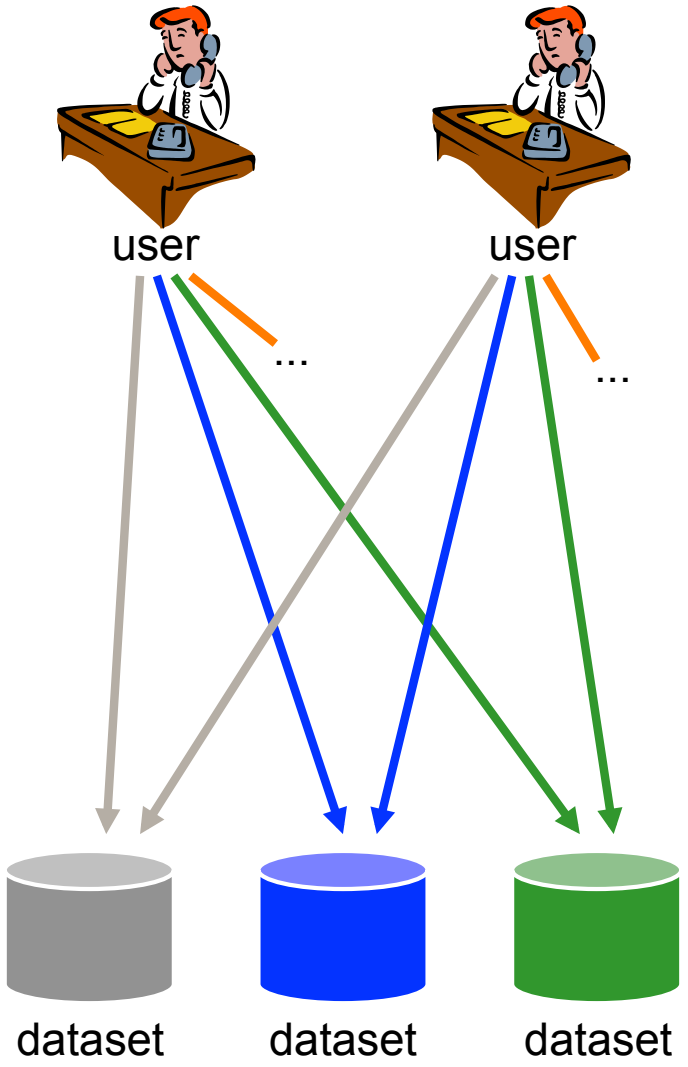
INSPIRE Geoportal

INSPIRE metadata from EU Member States are available online starting from November 2011, and harvested by the INSPIRE Geoportal

Some 250k datasets currently available through the multilingual geoportal developed and managed by the JRC, more to come.



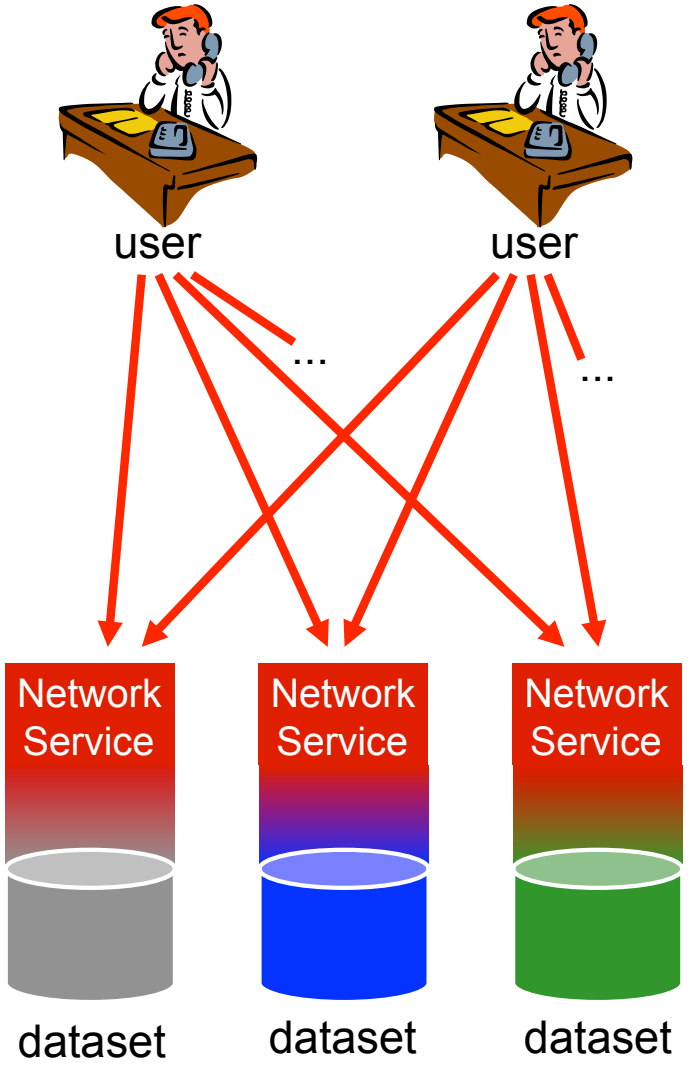
Data interoperability



The starting point …

- Access to spatial data in various ways
- User has to deal with interpreting **heterogeneous data** in different formats, identify, extract and post-process the data he needs
  → **lack of interoperability**

Data interoperability



And what INSPIRE aims at....

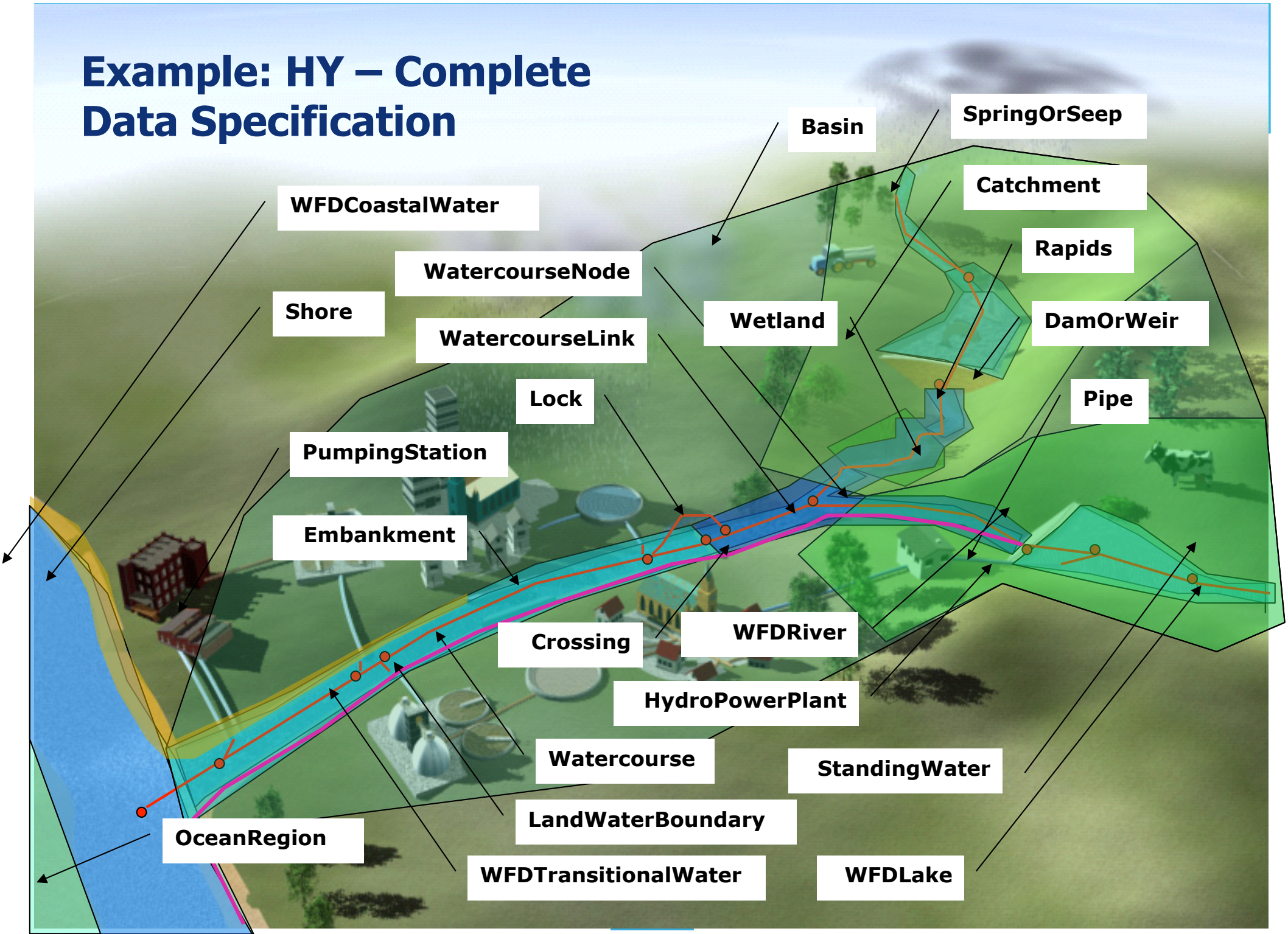
- Provide access to spatial data via **network services** and according to a harmonised data specification to achieve **interoperability of data**

! Datasets used in Member States may stay as they are

! Data or service providers have to provide a transformation between their internal data model and the harmonised data specification

Example: HY – The World

Example: HY – Complete Data Specification



Coordination

- Transparency and inclusiveness
- Stakeholder consultations
- **Support to Member States** on the implementation
- Extend INSPIRE to and ensure consistency of **different policy domains**
- Promote INSPIRE in **international standardisation**

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Key pillars of data interoperability

Conceptual data models

- objects types, properties & relationships
- cross-domain harmonization
- based on a common modelling framework
- managed in a common UML repository

Encoding

- conceptual models independent of concrete encodings
- standard encoding: GML, but also possible to derive other encodings (e.g. based on RDF)

Harmonised vocabularies

- to overcome interoperability issues caused by free-text and/or multi-lingual content
- allow additional terms from local vocabularies

Registers

- provide unique and persistent identifiers for reference to resources
- allow their consistent management and versioning

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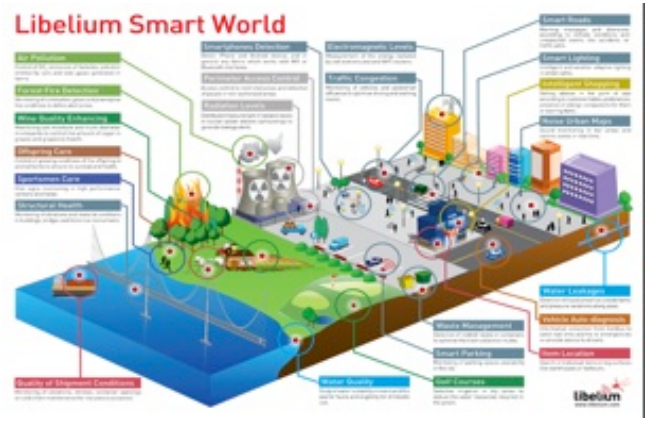
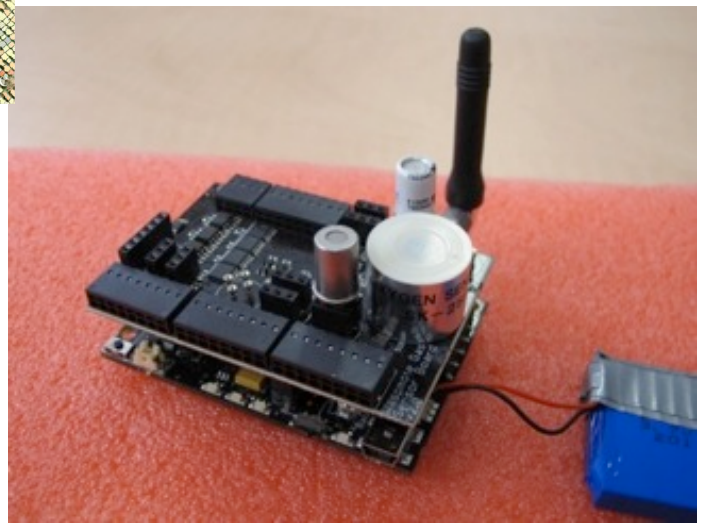
Moving towards Big Data

- 2 Terabytes per day once in operations
- Raises issues of where and how to store the data, how to provide easy and rapid access, how to process and analysis, and maintain over time.
- Australia's DataCube and public research cloud are very interesting models for us.

Massive diffusion of cheap sensors providing new opportunities and challenges





- Mobile phones as increasingly useful sensor platforms
- Drones = highly detailed mapping at low cost
- Waspmotes need programming and issues of calibration and response time but opportunities high..

Sensing society…..

500 million Tweets per day (Aug 2013)

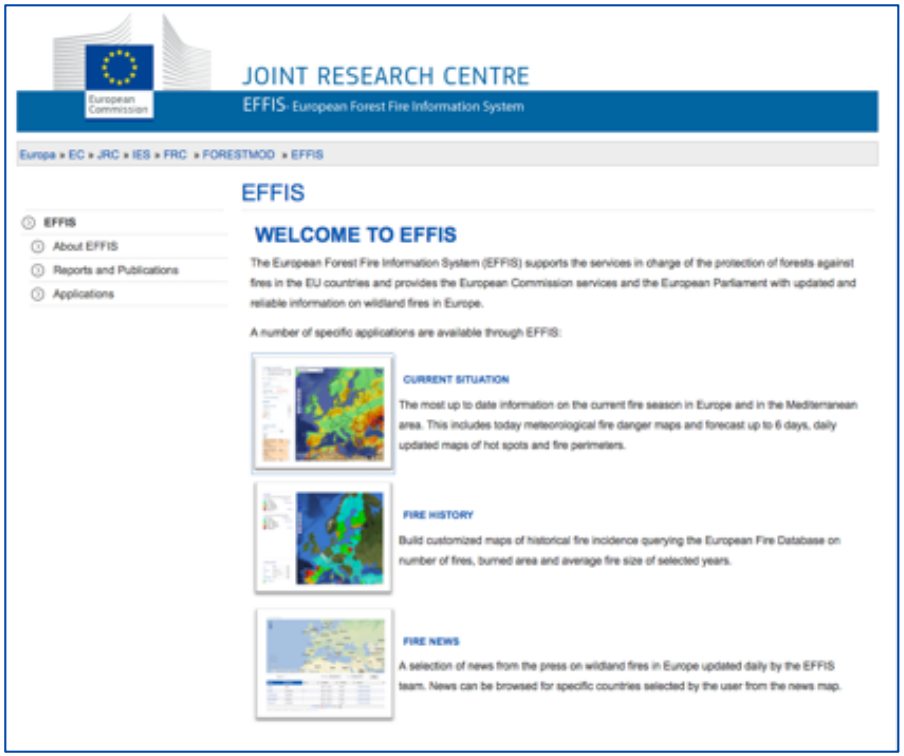
140 characters but complex semantics for data mining
Looking for forest fire in Athens, Greece.

- "New blog posting, Sure-**Fire** Christian drug rehab Health Recovery Services Inc Bassett House, **Athens** (OH)"
- @**Athens**PIO: National Pet **Fire** Safety Day is July 15
- "@Sade_vs_Lex XXX ….. XXXXing by a bon **fire** screamin like he**athens**!"
- Back at hotel in **Athens**. **Fire** skirted village. Little evidence of significant damage. Helicopters still overhead damping scrub. **Beer unaffected.**

- **Is quality a BIG issue?**

Large scale experiment at JRC to assess quality of social network data

- Project at JRC 2010-12 to develop automatic workflow and extract and assess data from Flickr and Twitter related to forest fires and compare to official data from European Forest Fire Information System managed by JRC.



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FOREST FIRE CASE STUDY

RETRIEVAL
Collect the volunteered information from data publicly available on social media platforms as text messages and photo tags.

GEOCODING
Only a fraction of the VGI is explicitly geocoded with coordinates, while the majority is implicitly geocoded with place names.
We extract the place names and their spatial reference and geocode them to make these available for analysis.

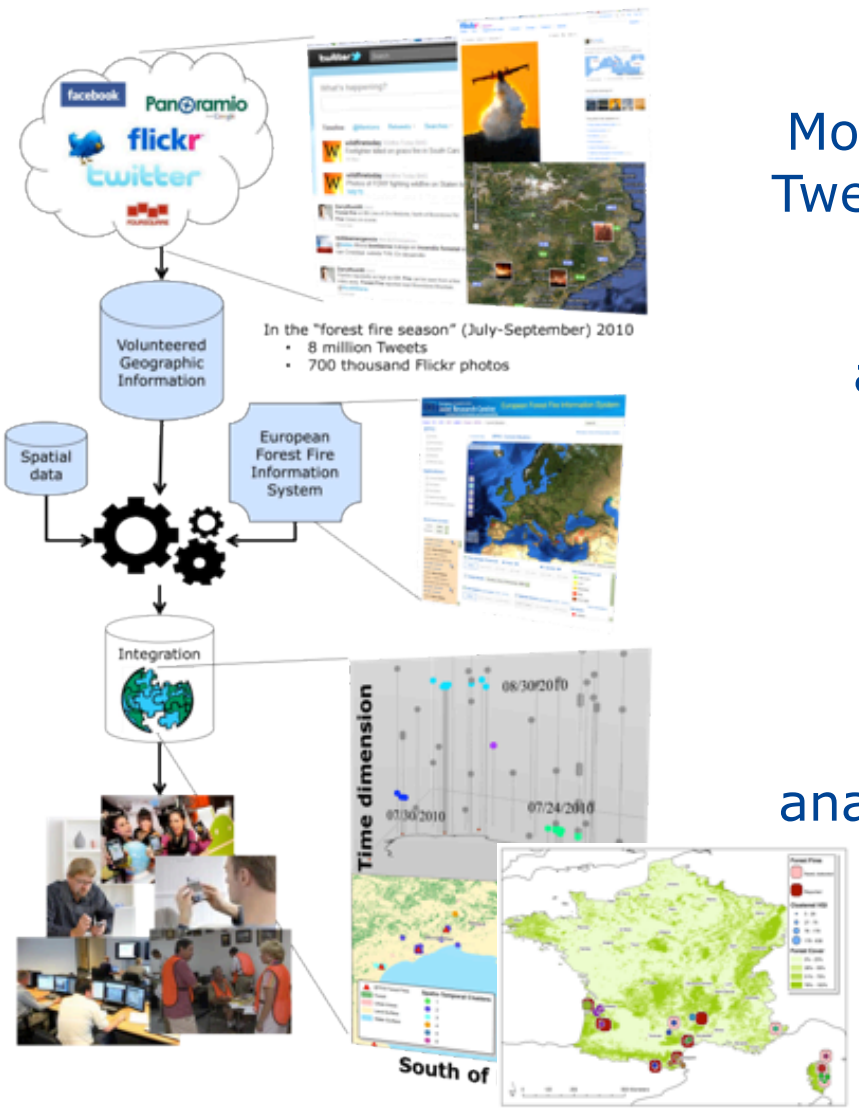
QUALITY ASSESSMENT
The crucial aspect for using volunteered information in the context of crisis management is to assess its quality.
For this task, we explore several methods, including:
- Syntactical validation of the data
- Cross-referencing with other data
- Spatial and temporal clustering

The two main metrics for assessing the quality will be the **credibility** and the **relevance** of data with respect to a specific event.

INTEGRATION
The quality-assessed VGI needs to be integrated within the disaster management process and other official data such as remote sensing images and spatial data infrastructures.

DISSEMINATION & EVALUATION
The two main target audiences for the results are:
1. The general public
2. Decision makers

They have very different needs, that will be addressed in a final step, a task- and user-centered design process.
The added value of the VGI will be rigorously evaluated.



More than 20million Tweets and 1 million Flickr images retrieved and analysed for fires South of France

Spatio-temporal clustering and analysis shows 80% of fires correctly detected

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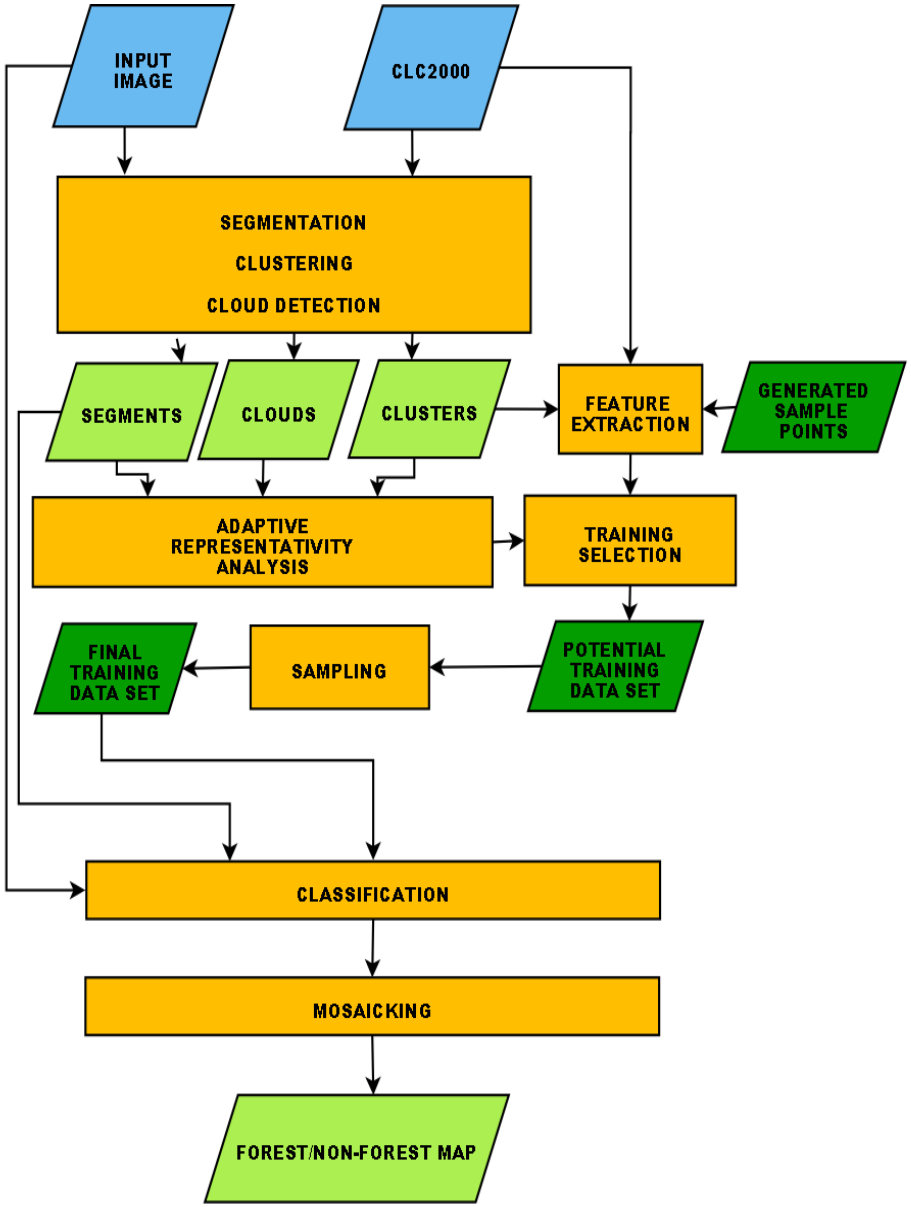
From Data to Processes

- If you have BIG Data from multiple sources, you cannot move the data for processing, need to move the analysis and processing to the data.
- Beyond Search and Access, we need also to develop a shared understanding of *what do you do with the data*?
- How do you frame a problem and possible solution according to different disciplinary approaches.
- This quest requires to describe not just the data, but also processes or workflows, leading to new executable web services that are understood across disciplines.

Example: how to make a forest map



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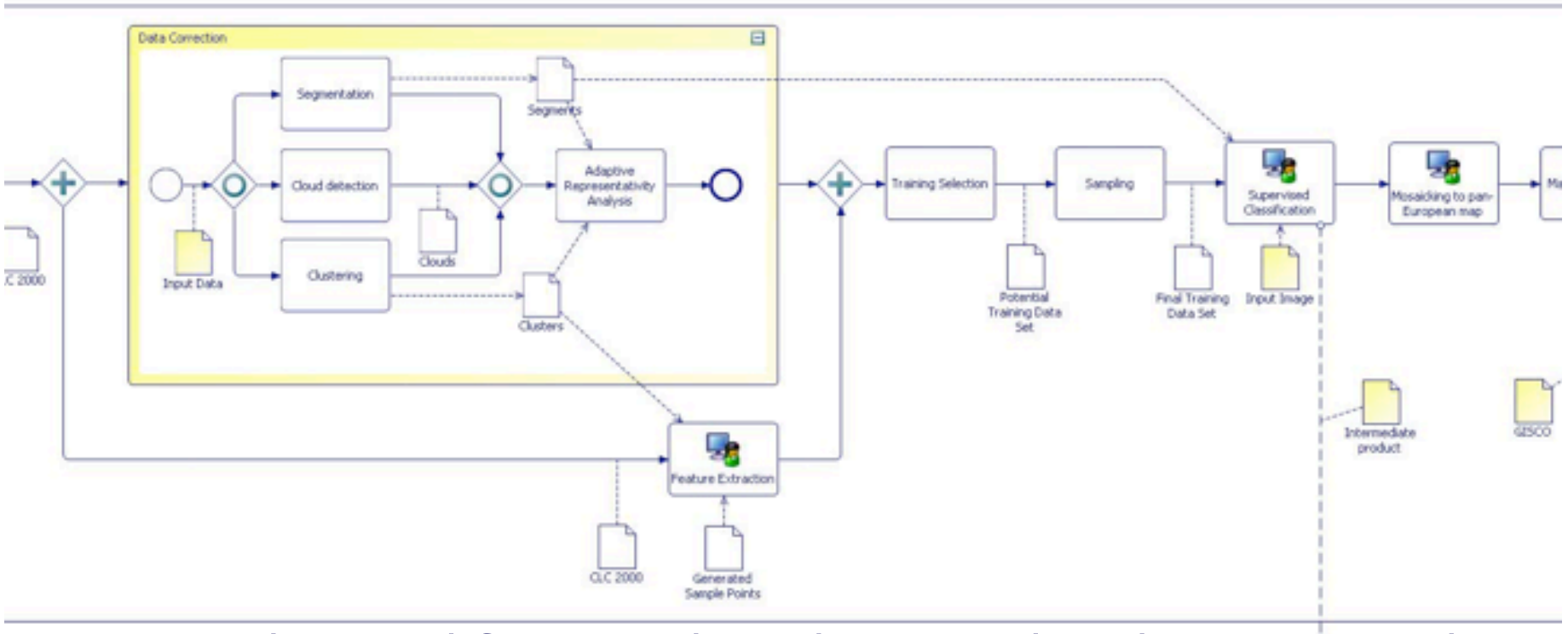
Workflows described in formal modelling language



Executable workflows and models can then be integrated and interfaced with other services to develop chains.

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JRC Model inventory and infrastructure

Inventory of JRC models:

- Point of Contact
- Description of the model
- Policy Area
- Property Rights
- Links to input and output data

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Related Resources (Data)

Input - Natura 2000

vector 100k - end 2009

Input - Corine Land Cover 2006

raster 100m - version 15, Aug. 2011

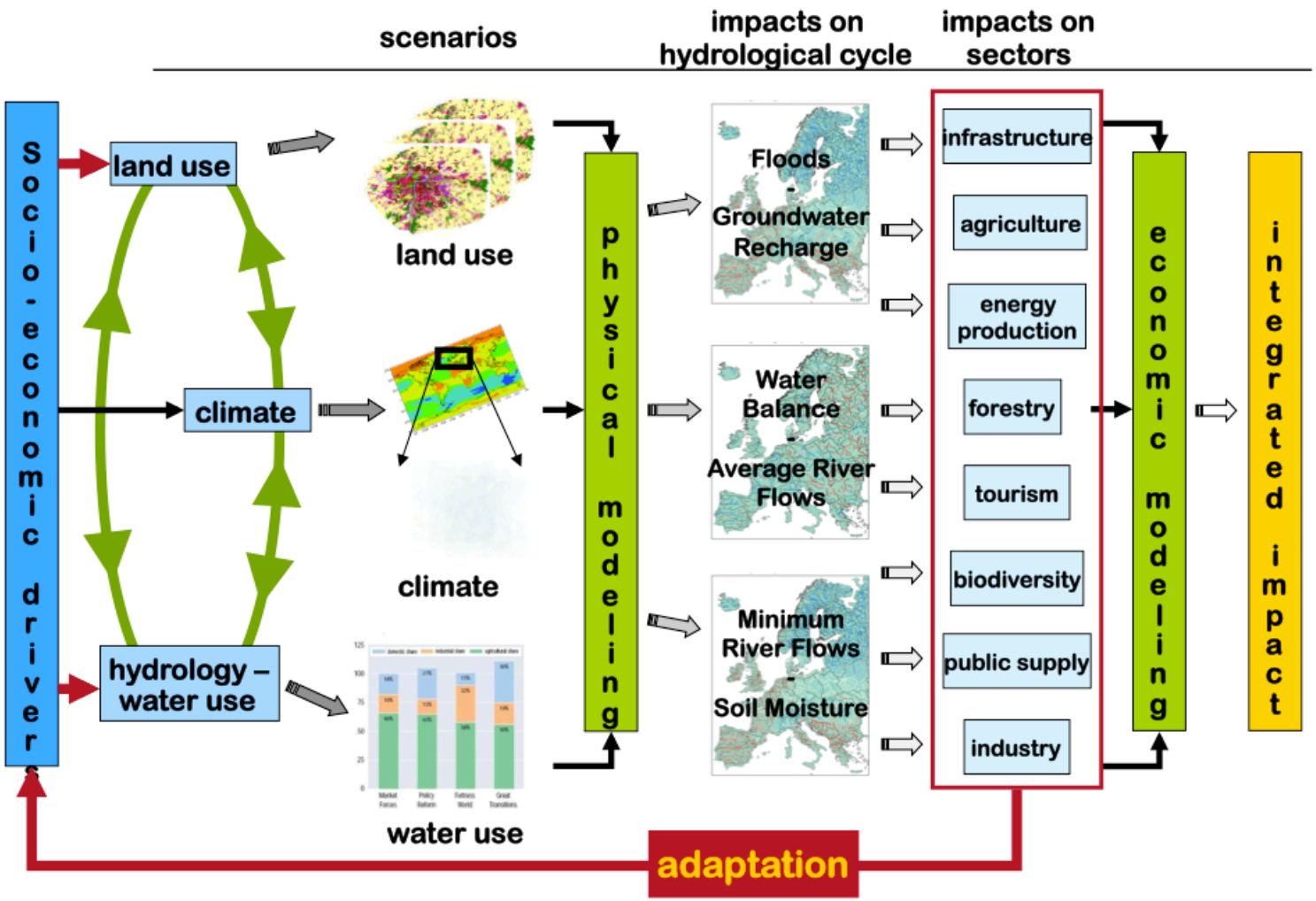
Output - Land Use Map

Simulated map of land use/cover

Ensures:

- Reproducibility
- Transparency

Moving towards integrated modelling



Multidisciplinary Interoperability Challenges

- ✓ Different communities have different theoretical approaches, analytical practices, and multiple layers of knowledge;
- ✓ Different terminologies and ontology, formats and standards;
- ✓ We need have a framework for interoperability that bridges across different disciplines and e-infrastructures

Interoperability Approaches

Federating means connecting systems that agree to a single set of standards
INSPIRE good example backed by law

In a global voluntary framework it is not possible to get agreement on a single set of standards **Brokering** introduces a middle layer of components that build the necessary bridges.

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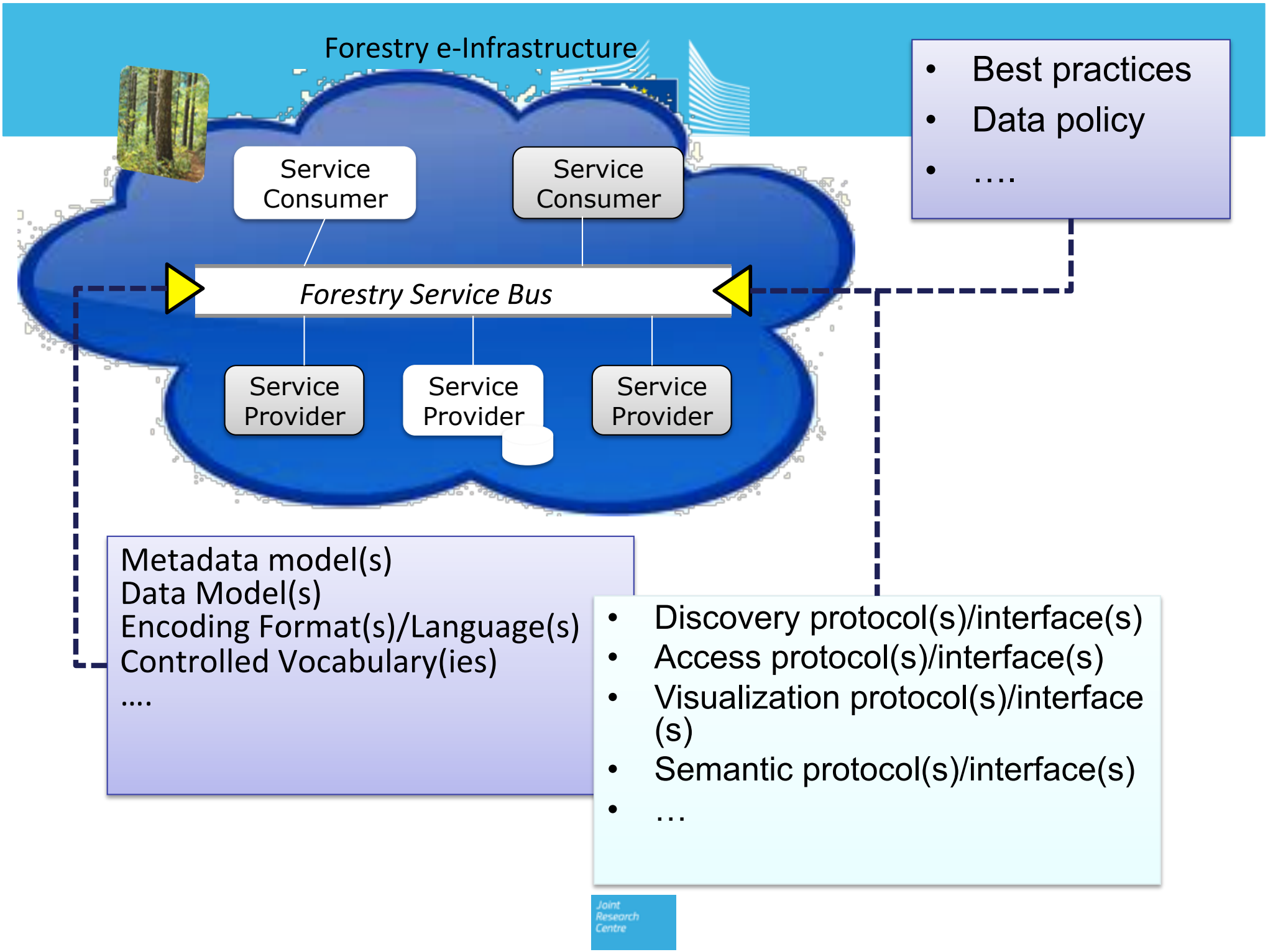
Forestry e-Infrastructure
Service Consumer
Service Consumer
Forestry Service Bus
Service Provider
Service Provider
Service Provider
• Best practices
• Data policy
• ….
Metadata model(s)
Data Model(s)
Encoding Format(s)/Language(s)
Controlled Vocabulary(ies)
….
• Discovery protocol(s)/interface(s)
• Access protocol(s)/interface(s)
• Visualization protocol(s)/interface (s)
• Semantic protocol(s)/interface(s)
• …
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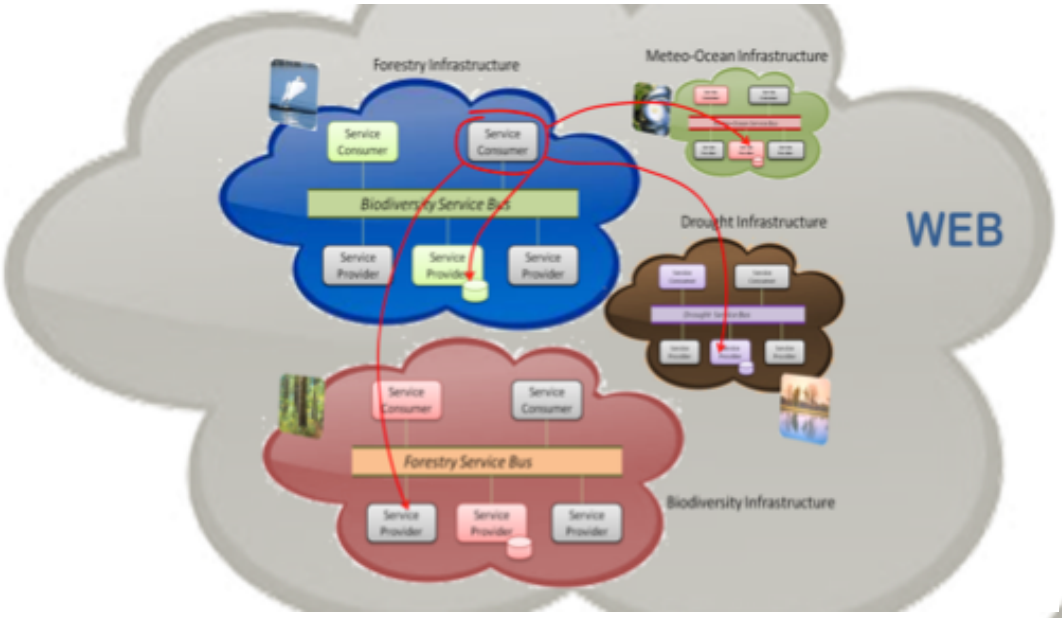
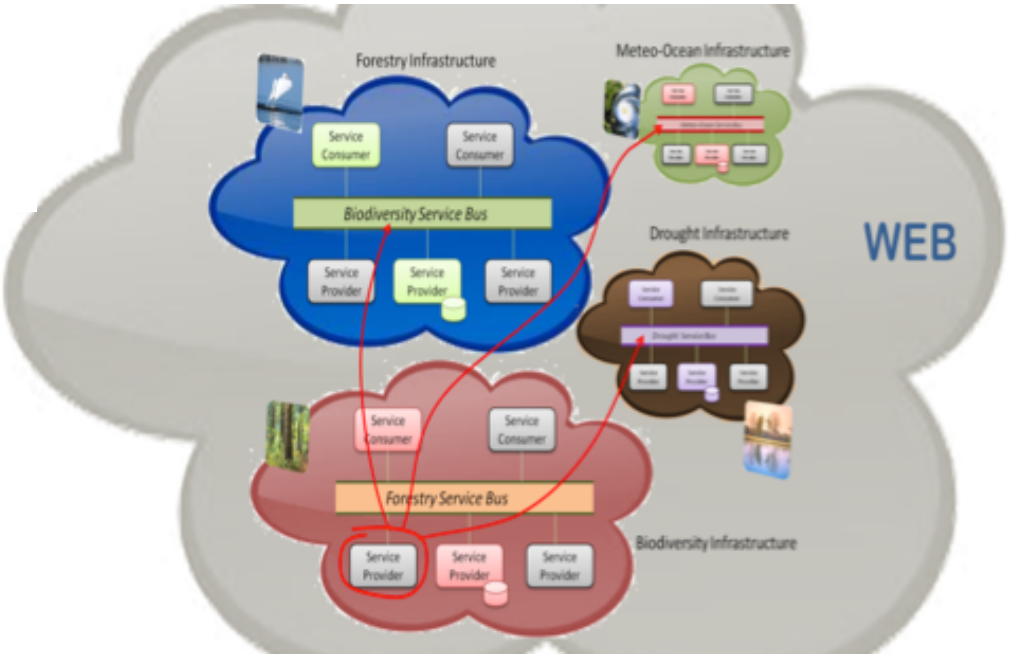
Traditional approaches



The providers publish in the multiple standards of the users = Heavy on providers

The consumers deal with the great variety of standards in each discipline = Heavy on users




Forestry e-Infrastructure
Service Consumer
Service Consumer
Forestry Service Bus
Service Provider
Service Provider
Best practices
Data policy
Semantic Web
Google
netCDF
RDF
HMA
ISO
International Organization for Standardization
OOI
OCEAN OBSERVATORIES INITIATIVE
WIKI
mpg123
JPEG 2000
OASIS
esri
Geographic Information
GEOSS
OPEN ARCHIVES
Click here to visit the CDI Database
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IEEE
W3C
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OGC
GML
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OPeNDAP
GeoNetwork
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mantic protocol(s)/inter

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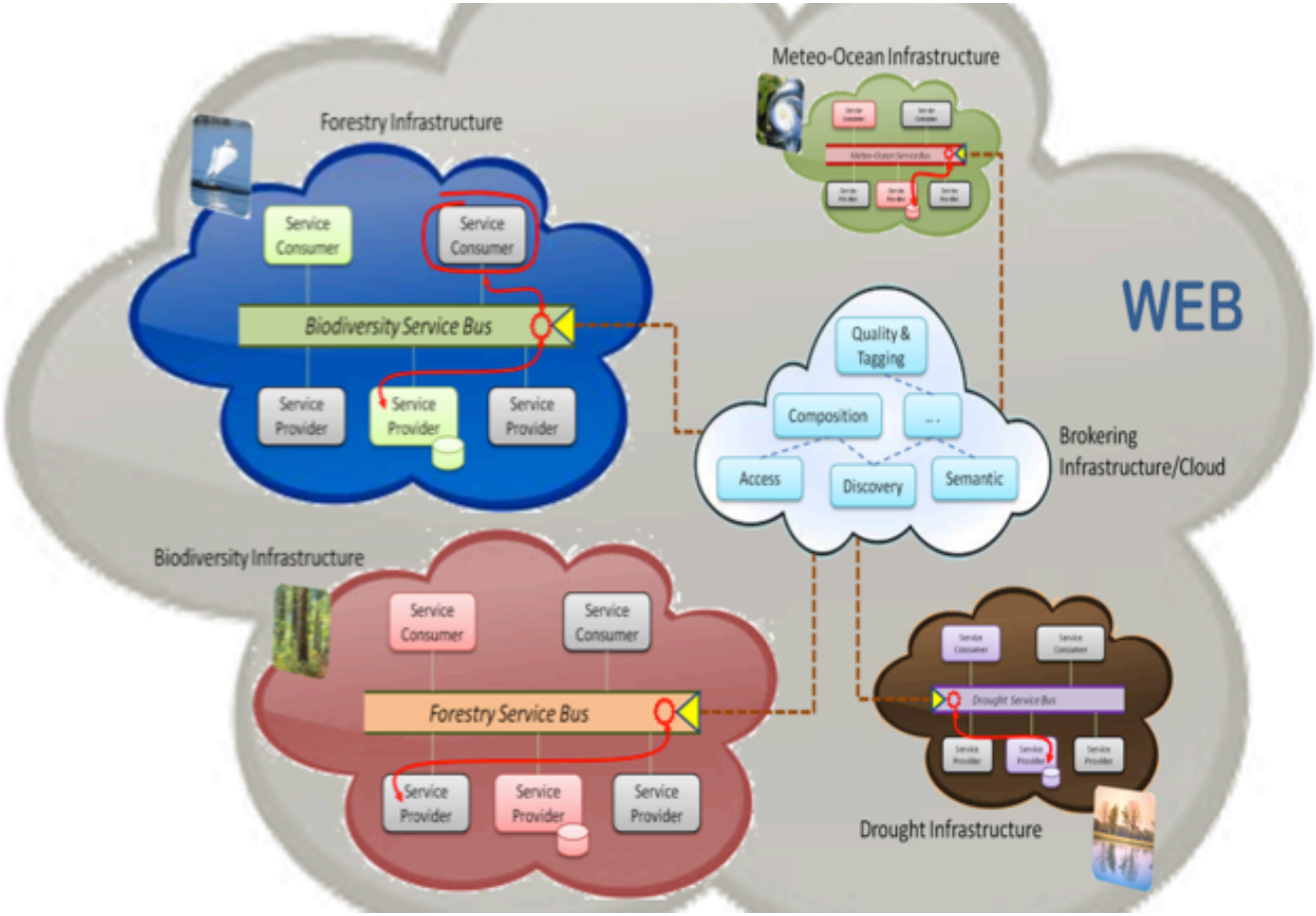
New approach: Brokering = middleware building the bridges across communities



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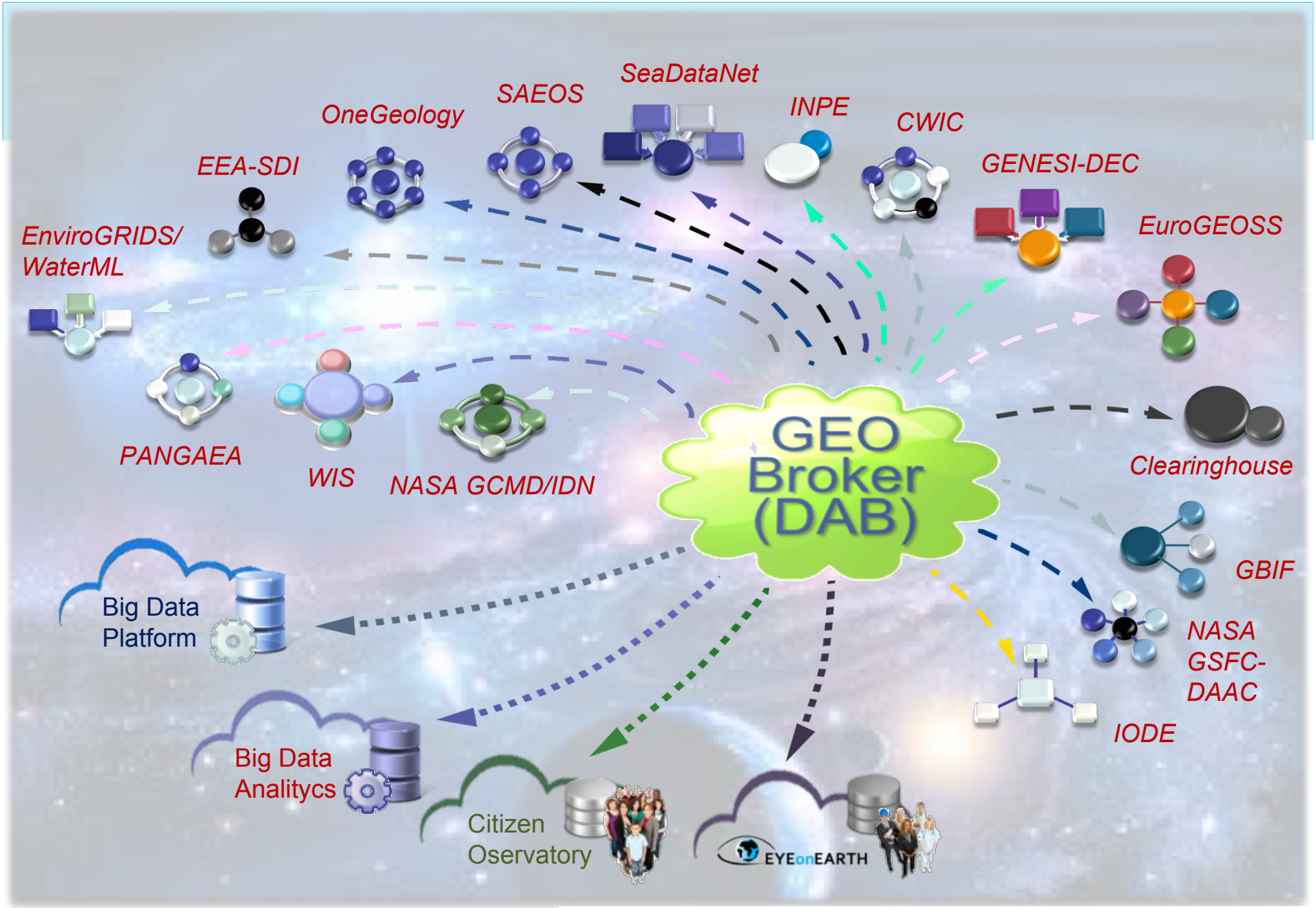
SeaDataNet
SAEOS
OneGeology
INPE
CWIC
EEA-SDI
GENESI-DEC
EnviroGRIDS/
WaterML
EuroGEOSS
PANGAEA
WIS
NASA GCMD/IDN
GEO
Broker
(DAB)
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DAAC
IODE
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Citizen
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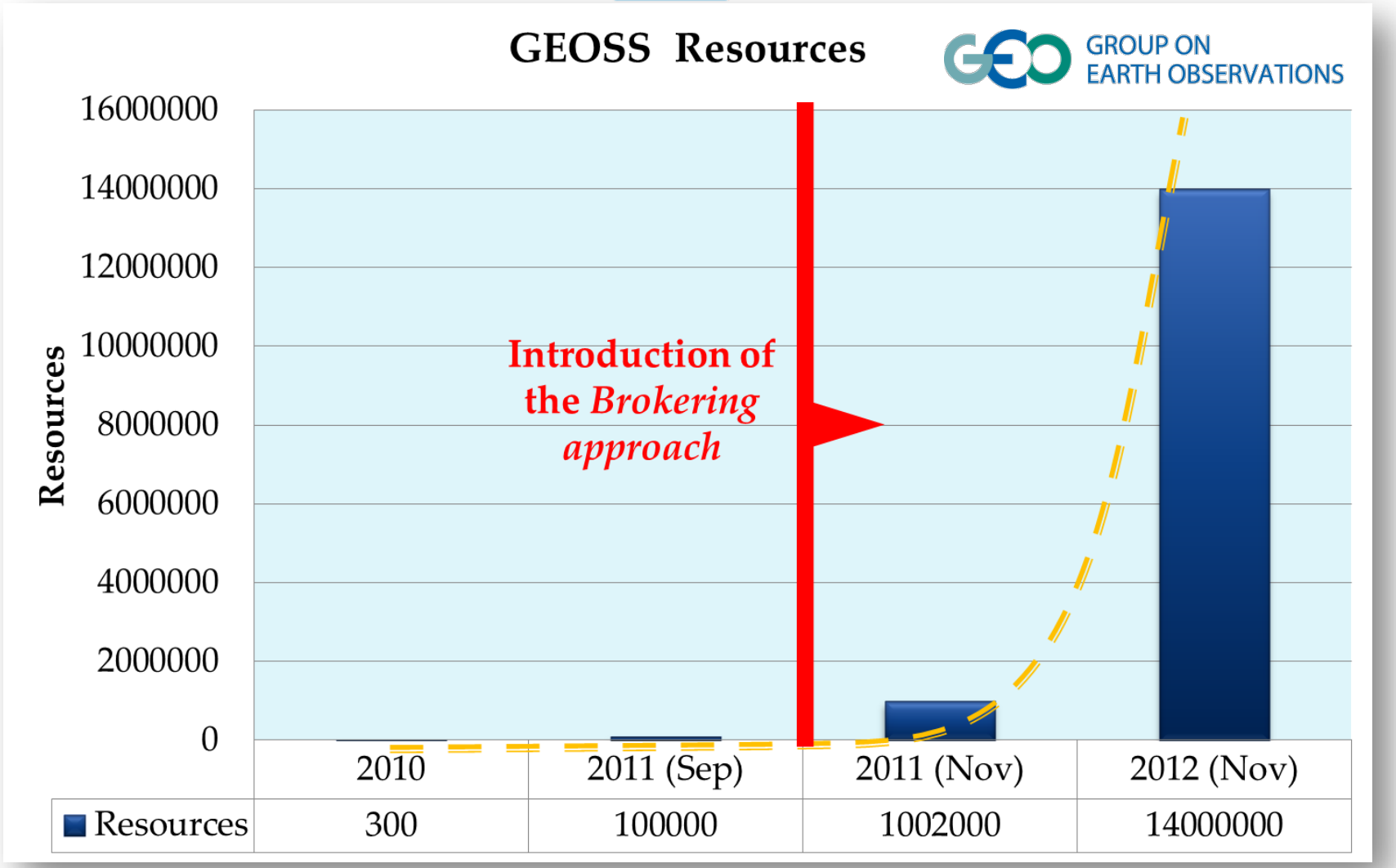
GEOSS Resources
GROUP ON EARTH OBSERVATIONS
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Resources
Introduction of the Brokering approach
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2011 (Sep)
2011 (Nov)
2012 (Nov)
Resources
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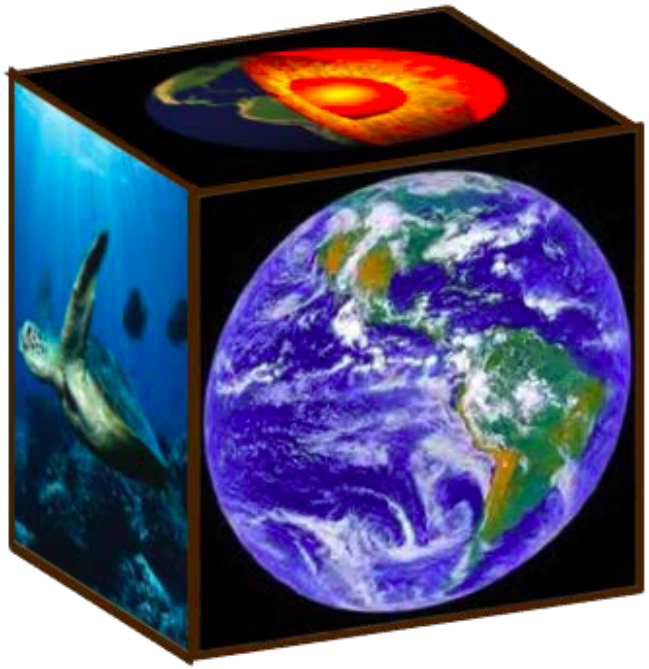
NSF EarthCube

- To transform the conduct of research in geosciences by supporting the development of community-guided cyberinfrastructure to integrate data and information for knowledge management across the Geosciences
- JRC participating with Italian National Research Council to EarthCube pilots
- Brokering adopted as a principle given the range of existing data centres and large capacities



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Digital Earth is the frame for our activities

- 3, 4, n-D: from the **global to local** (inside buildings, and under ground and under water) and everywhere on Earth.
- Visualize change through historical data and **integrated models.**
- Contribute to a **multi-disciplinary** shared understanding of how the Earth system works and impact of human activity.
- **Dynamic, interactive, participative**: synthesis of heterogeneous data from people, sensors, statistics, models. **Ubiquitous**, open and accessible for people and things on line at all times.
- Easy to use and **open.**

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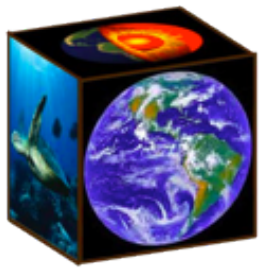
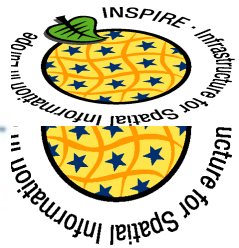
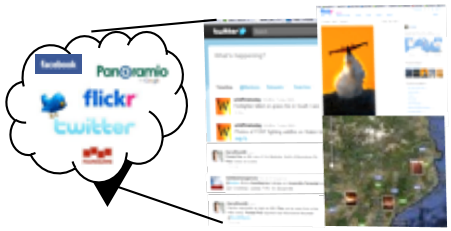
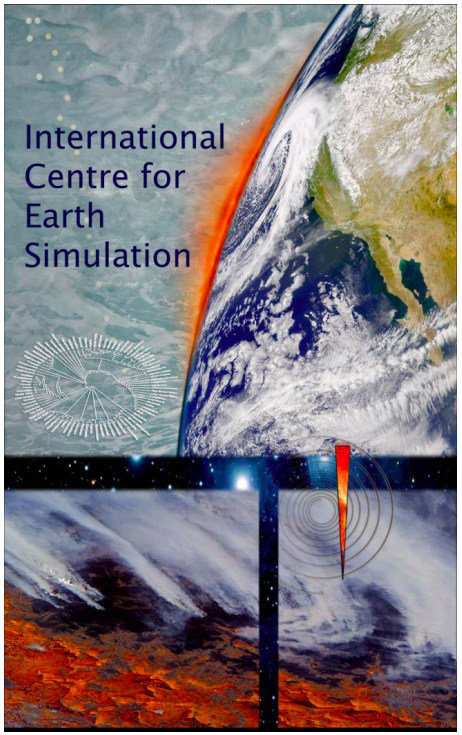
From Vision to Implementation

- Deepening and extending INSPIRE
- Researching the Observation Web = new data sources from citizens and sensors
- Researching multi-disciplinary interoperability linking data, models, outcomes
- Global collaborations (GEOSS, NSF EarthCube, ICES, …….)









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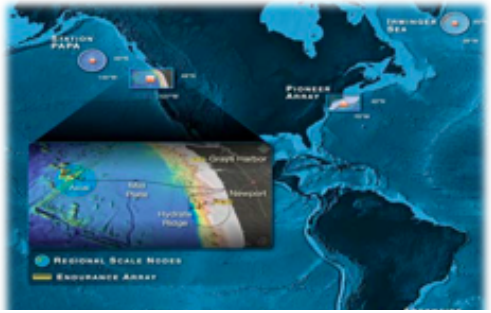
Digital Earth, a laboratory for Digital Science

- Develop in Horizon 2020 a prototype Digital Earth to test and show feasibility of DE vision
- Two new projects (2014-16) at JRC on Urban Quality of Life and Digital Earth Platform
- Connect the many pieces at our disposal data, models, scenarios, networks, citizen-generated content
- Contribute to turning the ICES vision into reality.



Right: Screenshot from *Spacefighter: The Evolutionary City (Game)*, a prototype video game system for interpreting global urban development behaviours, developed during two studios of postgraduate students from the Berlage Academy and MIT, led by Winy Maas and Arie Graafland. (MVRDV/DSD)

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Thank you for your kind attention

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