Digital Earth in Big Data Era

Smart and with People

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1. Origin of Digital Earth and First Definitions

2. Digital Earth SWOT Analysis in EU (JRC Ispra)

3. Digital Earth Vision 2020

4. Big Data Concepts

5. Adaptive Cartography and Context-based Cartography. *Cognitive Style*

6. Neogeography, VGI and Social Media Geographic Information

7. Social Media Geographic Information(SMGI)

1. Origin of "Digital Earth" Concept

Al Gore,
January 31, 1998
Given at the California Science Center, Los Angeles, California

Understanding our planet in the 21st century

A "multiresolution, three-dimensional representation of the planet, into which we can embed vast quantities of geo-referenced data," "navigating through both space and time to view natural, cultural and political information about the planet, virtual reality installations in museums, improved access to public domain data", and "a digital marketplace for companies selling a vast array of commercial imagery and value-added information services.

As a direct result of Al Gore's policy position in 1998, the Digital Earth initiative was established. This was quickly adopted internationally through and an increasing community of international enthusiasts is constructing major components of the Digital Earth vision.

BACKGROUND

a) **A multi-resolution, three-dimensional representation of the planet**

b) **A new framework for integrating a wide variety of geo-referenced data, including natural, cultural and historical components, not limited to 3D space, but also able to deal with time.**

c) Excellent for modelling processes, be it short term hazards, or long term climate change, geological processes, etc.

Prof. Lu Yongxiang, the president of International Society for Digital Earth

described Digital Earth as "a fundamental work of the Earth Sciences. As a common framework for describing Earth's information in the temporal and spatial domains, Digital Earth is at present mainly used for information integration of Earth Observation Systems and provides functions for data's acquisition, storage, transfer, analysis, and processing. Its emphases are on establishing a unified coordinate system and on developing multi-dimensional dynamic virtual display." (1999)

Prof. Xu Guanhua

believed that "Digital Earth is located at the interdisciplinary forefront of earth science, space science and information science and technologies, and it will be a fruit of natural science and social science, and closely associated with human requirements. As a powerful supporting tool, Digital Earth can play a key role in new economic growth and in global sustainable development. It is the inevitable outcome of science, economy, politics, and society and their historical development." (1999)

Prof. Michael Goodchild (2008)

digital Earth includes four aspects: visualisation, ease of use, interoperability and mashups, modelling and simulation

Prof. Chen Shupeng and Prof. van Genderen (2008)

digital earth should have five phases: Data extraction, Information extraction, Knowledge extraction, Modelling, and Decision making

Prof. Li Deren

Key technology of the digital earth consists:

· High Resolution Satellite Image
· Broadband Networks and Data Standards
· Spatial Information Technology and SDI (Spatial Data Infrastructure)
· Science Computation
· Vast Storage and Metadata

Alexander Martynenko, Russia:

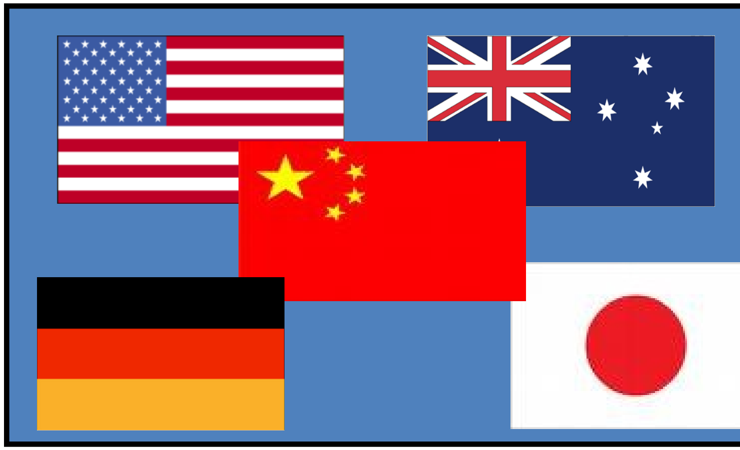
“Today, at the boundary of millennia, the Electronic Earth appears as the prior direction of scientific and technical progress. **Its goal is the cartographic representation of the real world and creation of the global computer model of the Earth,** comprised of millions of space images and electronic maps of various subjects and scales, themes and also reference information.

Martynenko-2

This fundamental problem can be solved by cartographers from different countries, who should meet in the 21 century as partners, possessing **new ideas, courage and intellectual technologies for creating and application of maps.“**

Platforms of Digital Earth

- Scientific Platform (SP)
  - Scientific projects relating to digital earth science and various practices of earth science
- Commercial Platform (CP)
  - Digital earth software developed in commercial corporations



Three points of view:

-international **general, scientific and research discussion** about the role of Digital Earth as an Integrative Concept and **SDIs** as an Engines

-**Big Data – potentials** of Geoinformatics (RS, GIS,VGE,..) in solving of Contemporary Problems

- The challenges for development of data strategies for National (Mapping) Organizations, wide public society and their potential cooperation via **volunteer society efforts** (Volunteer Geographic Information)

Data, Information and Knowledge

Perhaps sometimes in the future
WISDOM

Deliver to People

How?

2. Digital Earth SWOT Analysis in EU (JRC Ispra)

DE Vision – a SWOT analysis - STRENGTHS

- DE is a very useful metaphor
- DE displays some of the characteristics of "magic concepts"
- DE has a global dimension, inclusive of multiple applications and themes
- DE has a strong political backing since the beginning
- DE has a strong technological component
- DE provides a flexible framework to adapt to evolving technologies

Magic Tricycle - Car Design News™ 2008

DE Vision – a SWOT analysis – WEAKNESSES (1/2)

- DE encapsulates many different concepts
- e.g. information system, infrastructure to ***visualise a access geo-information, a virtual model of the Earth*** (or parts of it), an approach to explore the Earth system

- The DE Vision has
  - Ambiguities on its nature: political, vs. academic, vs. a technological initiative
  - Ambiguities on main target audience: policy-makers and planners vs. scientific community or the general public
  - Unclear research focus, which may reduce interest in the scientific community

- DE has uneven visibility in different regions of the world

DE Vision – a SWOT analysis – WEAKNESSES (2/2)

- Unclear relationships and added value of DE in relation to other initiatives such as GEOSS, SDIs, Eye on Earth,..
- Original DE vision does not properly reflect recent changes in society including
  - major role of the private sector (Google, Microsoft), and
  - emergence of social networks (Facebook) at the global level
- Because of the uncertainties above, it is difficul to communicate clearly what DE is, and how it will be put into practice
- This difficulty in communicating the concept makes harder to consolidate links and collaborations with other initiatives and to develop a DE community with active members from different disciplines

DE Vision – a SWOT analysis –OPPORTUNITIES (1/2)

- The increased availability of digital content from public, private sectors and citizens supports the vision of DE
- Developments in technology and policy foster increased data access and sharing
- ISDE with 10 years of history, strong political backing, and the support of the Chinese Academy of Science provide a sustainable platform for achieving the vision
- Increasing profile of DE within the scientific community through symposia and the inclusion of the IJDE in the scientific citation index
- Increasing recognition of the need to build bridges across different related initiatives, as witnessed by the membership of the ISDE in GEO
- Multiple research and government funding opportunities available to develop components and applications of DE

DE Vision – a SWOT analysis –OPPORTUNITIES (2/2)

- Profiling DE as a central vision space where 'Geo-Imagineers' can think out-of-the-box:
  - where they can extend and modify the vision of DE by **incorporating innovative ideas and edge-cutting technologies, combining disciplines, and**
  - ultimately feeding new ideas and requirements into research projects and more practically oriented initiatives

DE Vision – a SWOT analysis - THREATS

- No shared ownership over the vision of DE
- Existing leaderships do not always recognize the importance and power of the DE vision as a mechanism to advance the realisation of DE
- Initiatives are sometimes competing for resources rather than exploiting synergies

- Private sector's own vision and interpretation of DE, and the resources at its disposal, may overshadow and make irrelevant governmental or academic efforts in this area
- Because the success of the private sector's mass market applications, the need for research and development in the area of DE may become less evident to the funders of public sector research programmes

Topics of European Interest

European Propos

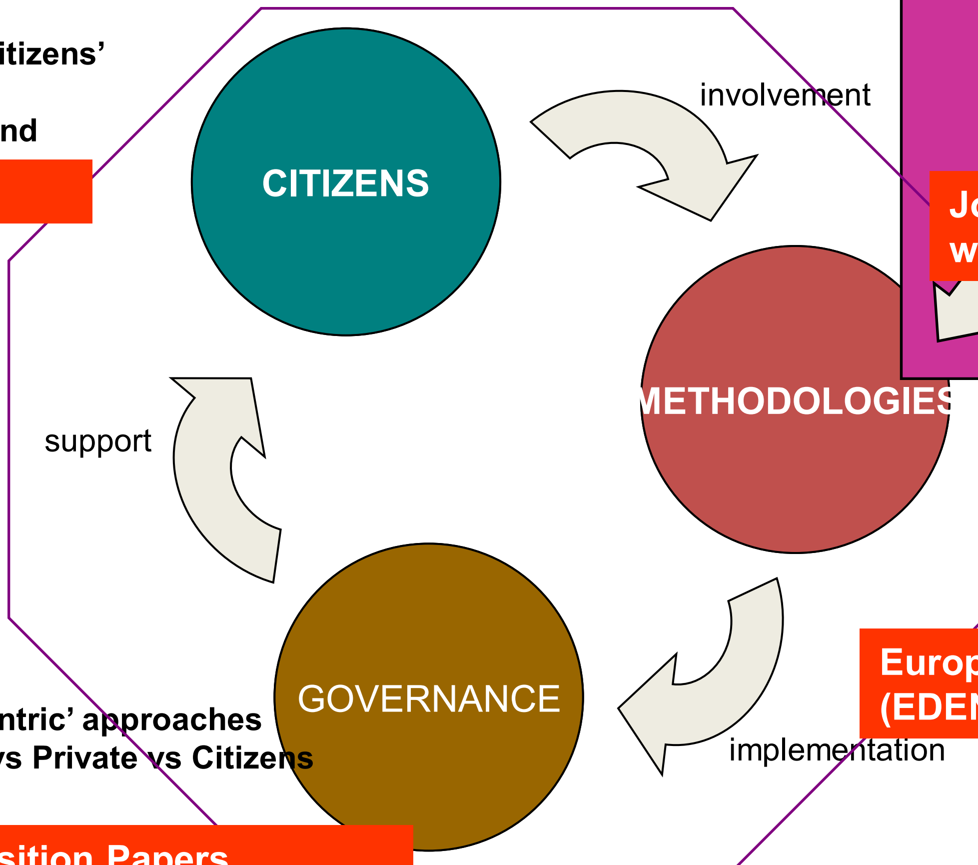
global change and climate change, land-use change, sea level rise, environmental degradation, urban spread, natural resource

impacts on society and economy

Joint conferences and workshops

The role of private citizens' involvement in the development, use, and

Pilots and Events



- Bring together methods and tools
- Integration of scientific research into DE
- Trust & Reliability in

Pilots & Projects

European DE research Network (EDEN)– technological component

- Distributed' vs. 'centric' approaches
- Multifacet: Public vs Private vs Citizens
- Multilevel

•Research & Position Papers
•European Special Interest Group

European DE research Network (EDEN)– socio-economic component

Digital Earth Vision 2020
Digital Earth
What does that mean DE should look like in 5-10 years?

immediate *towards our vision:*

• be immediate, precise and interactive
• offer access to comprehensive 4D information anywhere and anytime,
and be mobile accessible
• be predictive and retrospective, and offer realistic vizualisations with metric integrity of information

- incorporate sound and other qualities, as well as vision
- integrate data from all available sources
- bring together database designers, modellers, simulators, gamers, roboticists and visualisers
- support multidisciplinary research by connecting across data sets
- empower citizens to facilitate, innovate and interact
- blur the boundary of government versus private ownership

4. Big Data Concepts

Big Data: buzz word or reality?

Information superhighway,

SDI´s,

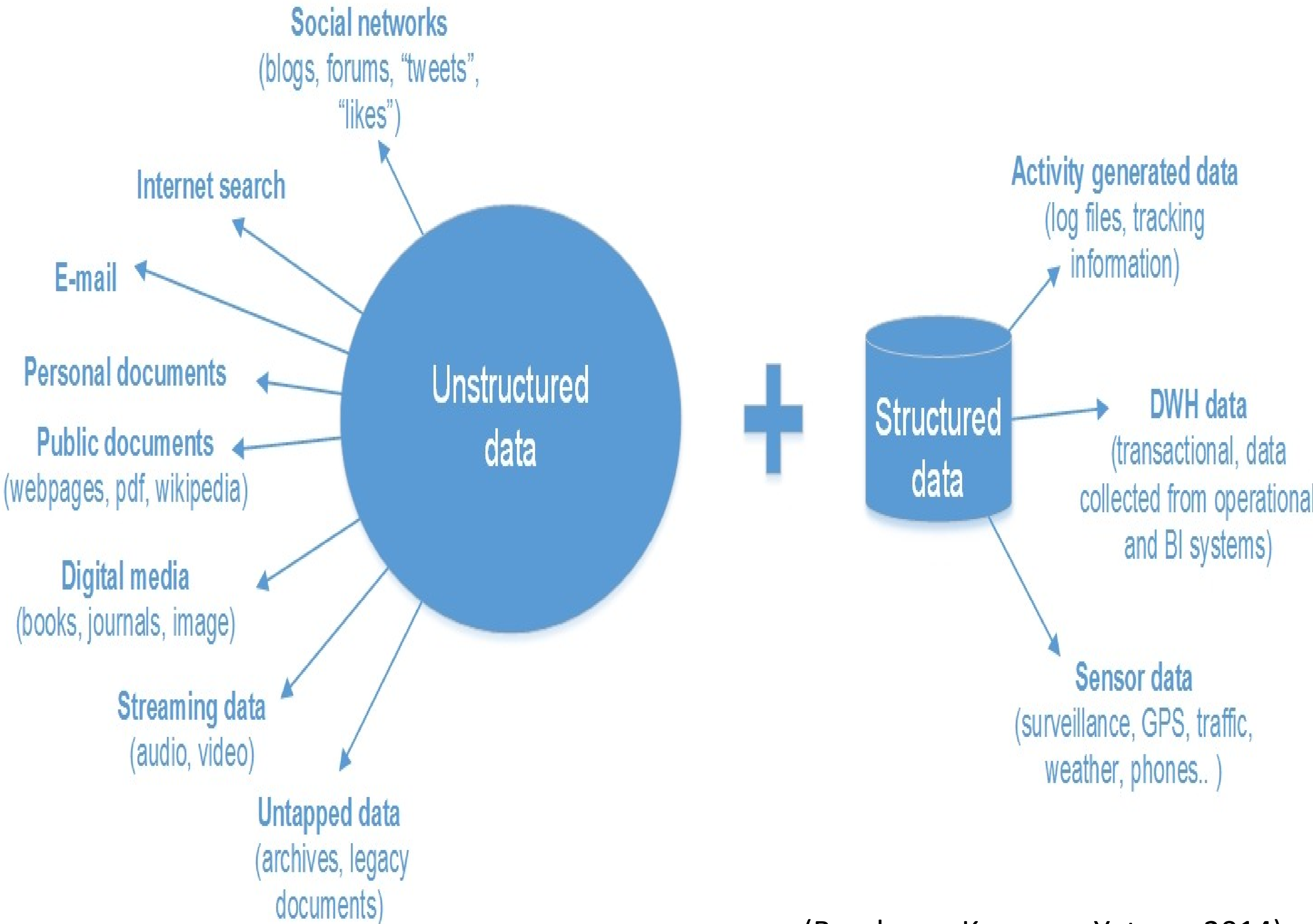
System of Systems concepts (GEO, GEOSS,..)

BIG DATA

A THAT WILL TRANSFORM HOW WE LIVE, WORK, AND THINK

大数据时代

生活、工作与思维的大变革



(Bandrova, Konecny, Yotova, 2014)

BD: Definitions

Zucker, S., (2014) :

“a popular **term** used to describe the exponential growth and availability of data, both structured and unstructured” .

″**There is no rigorous definition of big data**. Initially the idea was that the volume of information had grown so large that the quantity being examined no longer fit into the memory that computers use for processing, so engineers needed to revamp the tools they used for analyzing it all” (Mayer-Schönberger V., Cukier K., 2013).

Today ***era of terabytes or petabytes*** and this trend leads to new challenges in geoinformatics and cartography for gathering, storing, analyzing and visualizing the spatial information and data.

It will not happen first time in the history of cartography that it is one of few ***visualizing disciplines*** to use BD for correct analyzing of huge amount of data and their presentation and visualization on different levels of preciseness according to wishes of ***potential users.***

“Big Data” BD:

It is the **ability of society to harness information in novel ways to produce useful insights or goods** and services of significant value .

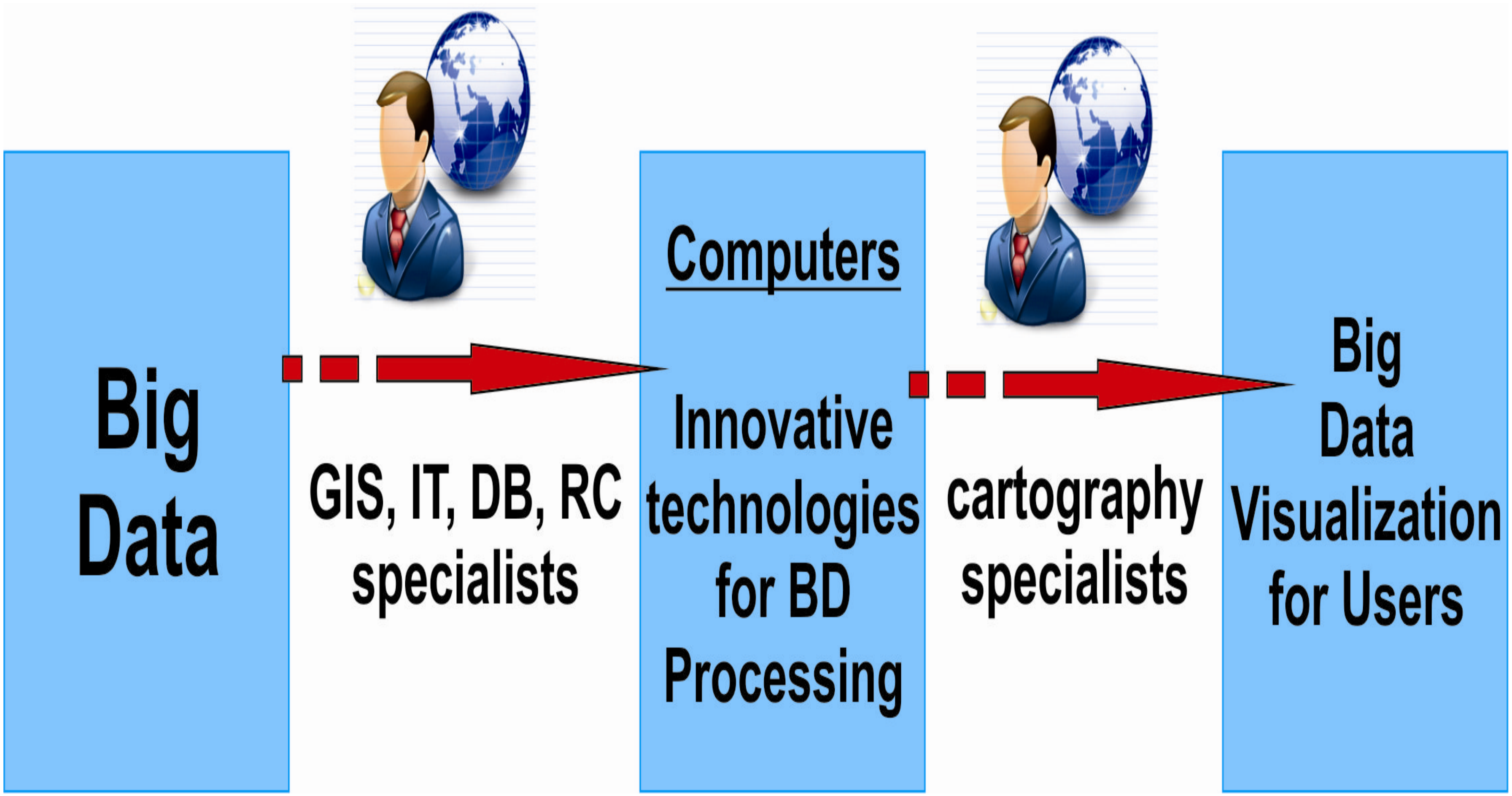
The **bridge between BD and the society cannot be done only by the existing technologies and computers.**

The presence of professionals should be more active in the process of transforming BD in useable variant to users and society.

BD needs to establish teams with people coming from branches which did not work together to now.

Design new complex approaches.

Geographers (physical and human and economical ones), cartographers and geoinformatics + RS want to add their knowledge to enhance such linkages and **develop paradigma for and supportive approaches of higher level usage of BD** in everyday decision making, solving problems and improvement of life of inhabitants.



The Professional Places in BD Era (Bandrova, Konecny, Yotova, 2014)

IGC , August 22 2016, Beijing, P.R. China

From Big to Smart Spatial Big Data with Support of VGEs

Yaochen QIN, Fun QIN, Milan Konecny

Henan University, College of Environment & Planning, Kaifeng, China

Masaryk University, Institute of Geography, Laboratory on Geoinformatics and Cartography, Brno, Czech Republic

2. Many faces of

SMART

Meanings?

Smart versus „Stupid“ or better saying less smart?

Approach in Administration to make documents smart

Business approaches (fast, etc…)

In Geography, Geoinformatics, Remote Sensing: very strong development line of Smart Cities academician Deren Li)

1 Smart city and its application (Deren Li, 2015)

* What is a smart city?

– A smart city is built upon the infrastructure of the digital City. It integrates the real world and the digital world with the internet of things, and perceives the states of everyone and everything in the real world. Then the sensed data is transferred to the cloud computing center for computation and understanding, providing intelligent service for economic development, city management and publics.

– The smart city is a key component of the smart earth

Smart city=digital city+internet of things +cloud computing

Cyber physic space

Do everything on web

Cyber space

See everything on web

The development of the smart city

Informational-ized city → Digital city → Intelligent city

1993

The "information superhighway" starts the information era of the cities

1998

“The build of the digital comfortable community” marks the construction of the digital city and digital earth

2006

The new information technologies such as internet of things and cloud computing integrates the digital city system.

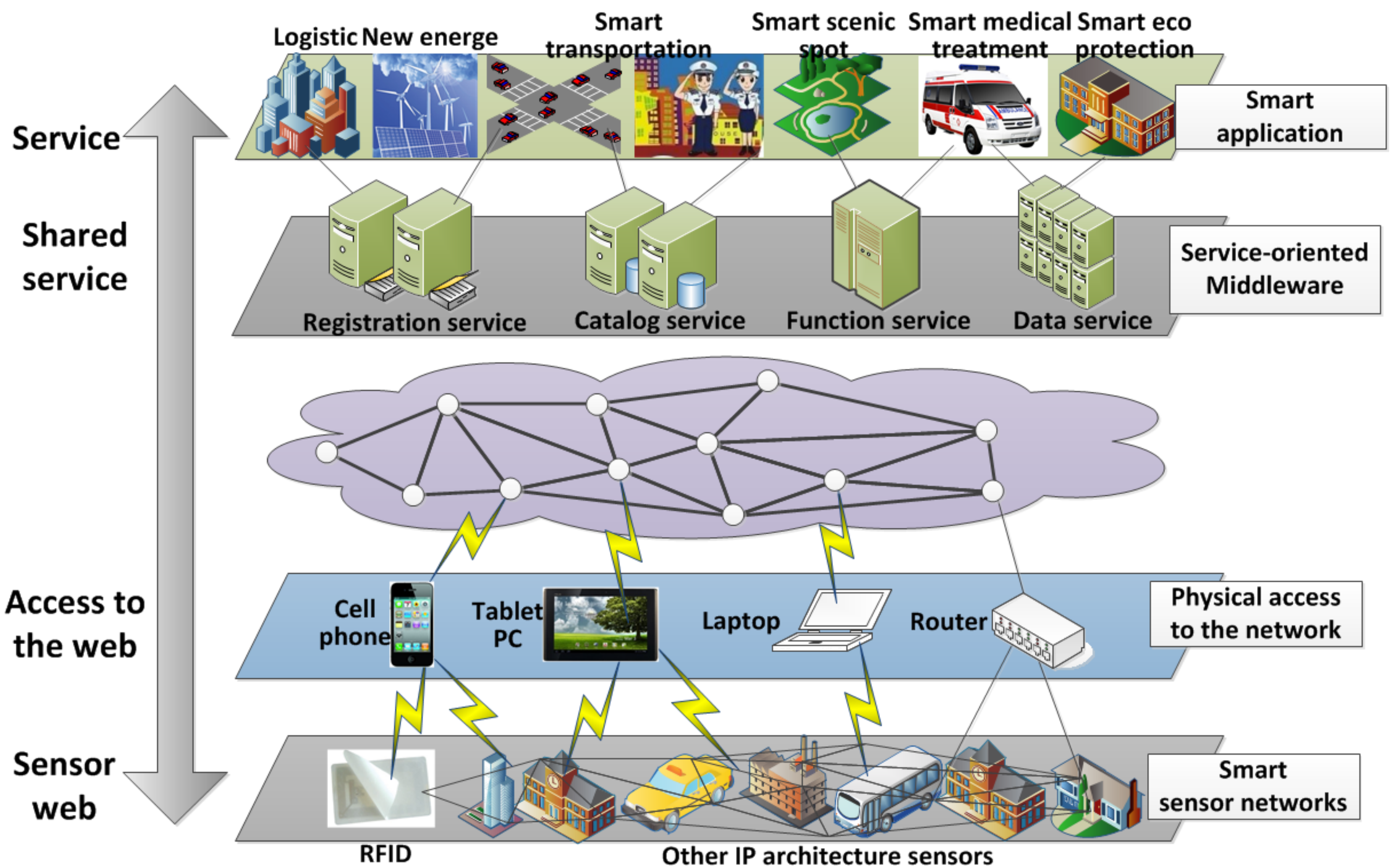
2009

IBM proposed a new concept: “smart city”, marking the digital city into a new stage.

The smart city is based on the information infrastructure and the digital city, It pays more attention on the integration of the digital city with the real city through ubiquitous sensor networks, puts more emphasis on the intelligent control and the automatic feedback. It is a more advanced stage of the digital city, and a high-degree integration of the industrialization and information technology.

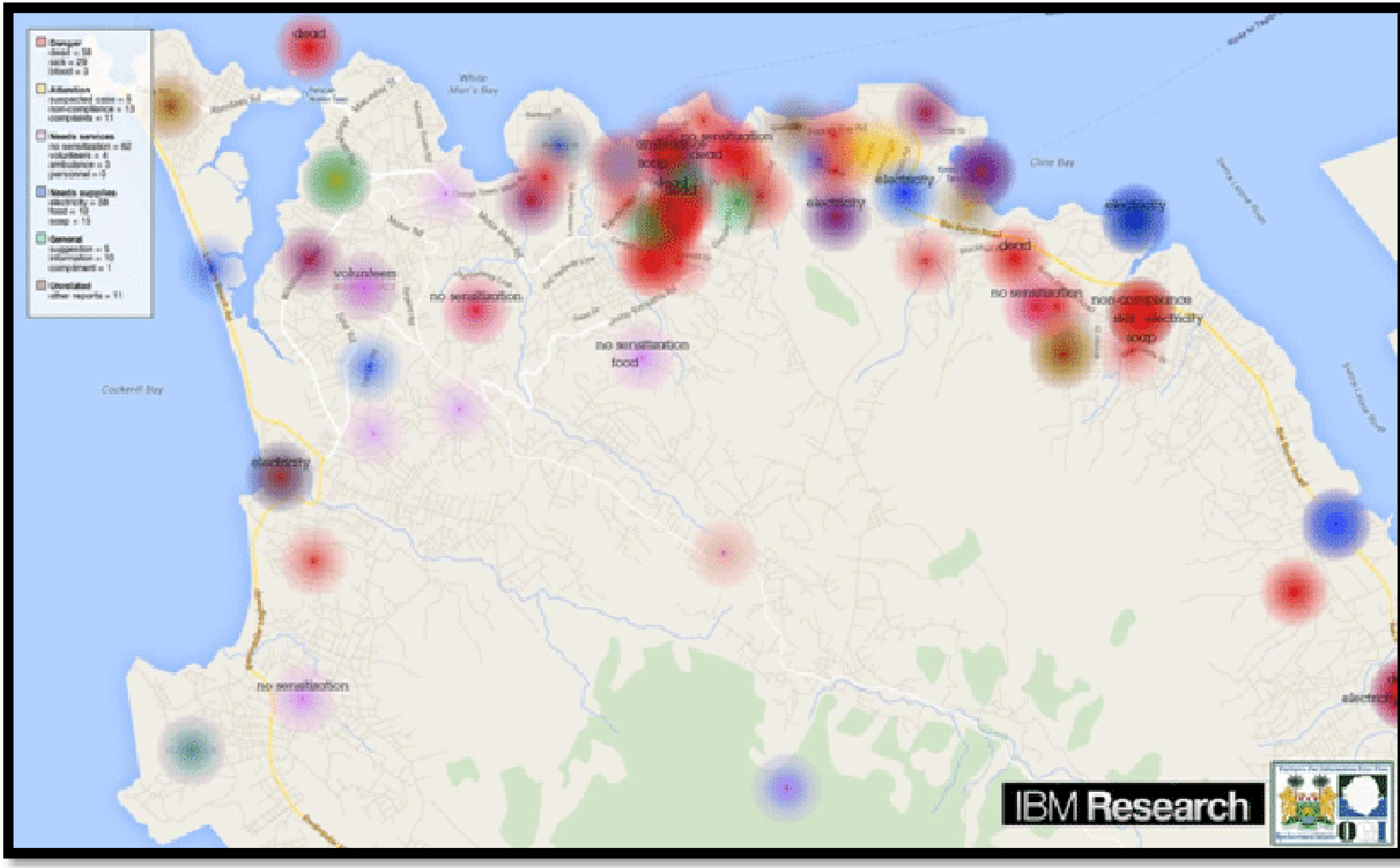
Internet of things

Realize the interoperability between human and human, human and machine, machine and machine.

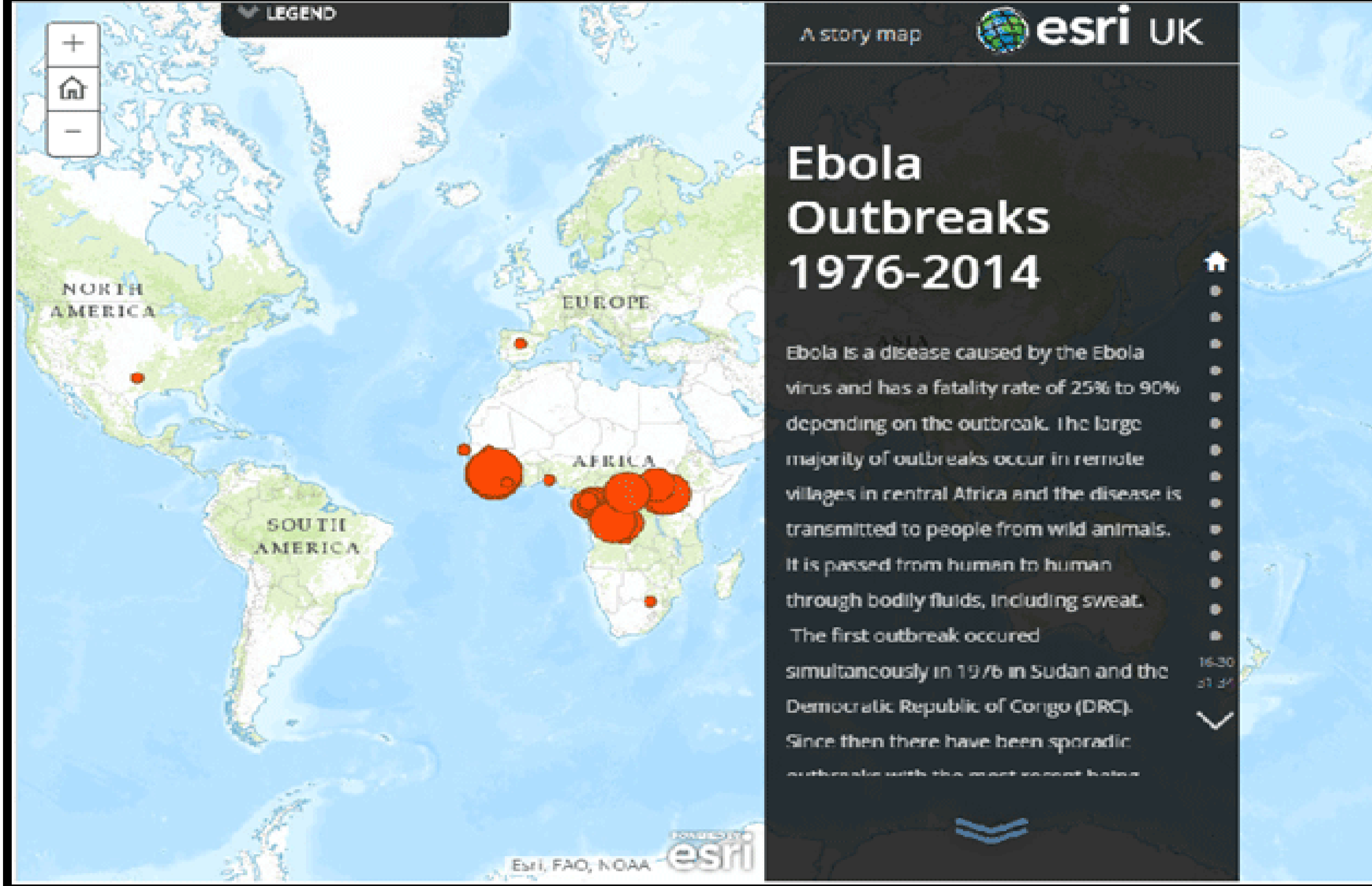


BIG Data and GIS and Maps

Big Data first made mainstream headlines in 2011. When traditional intelligence had failed to trace Osama bin Laden, it was Big Data analysis that pulled disparate spatio-temporal data in real-time to pinpoint his location. This information was used in conjunction with satellite imagery and next generation drone data to support intelligence operations (GIS Lounge).



Kalev Leetaru's Bin Laden mapping – War 2.0



The IBM Ebola tracker. [IBM's Ebola heat map]() uses Big Data technology in combination with a GPS app to track and fight Ebola.

Big Data are increasingly **critical for scientific research and discovery,** presenting particularly significant challenges and notable opportunities for transdisciplinary, international research programmes.

Such efforts aim to guide research and produce research results and data **in ways that improve decision-making** on critical issues for humankind and the environment. ,CODATA Workshop, June 9, 2014, Beijing

Recommendations

1. **Respond to the importance of Big Data for international science programmes:**

Scientific Big Data are important for knowledge discovery in advanced sciences: this importance should be recognized and acted upon.

Addressing the combined challenges posed by data volume, complexity and heterogeneity will bring significant benefits to international science programmes and allow them to take advantage of the Big Data age to develop new knowledge, especially on a cross-disciplinary basis.

2. Exploit the benefits of Big Data for society:

Sponsors of international research programmes need to encourage activities that exploit Big Data to promote applied research for the **benefit of society** and to make provision to promote and support such activities.

Research funders, national academies, universities and other research performing institutions should **formulate strategies to exploit Big Data** for knowledge discovery.

3. Improve understanding of Big Data through international collaboration:

Research into the methodologies, theories, technologies and practical applications of Big Data for international science programmes should be strengthened.

This must involve a broad range of experts and research disciplines. Sustained international collaboration will also be essential to achieve this.

4. Promote a universal approach to Big Data:

The knowledge generated by **the exploitation of Big Data in international science programmes stands to benefit all humanity.** This depends, however, on the **widest possible access** to and participation in the creation of that knowledge.

5. Encourage capacity building and skills development:

The **commercial potential of Big Data** and data analytics has been much publicized, as has the pressing need for skills development in data science. This undoubtedly holds true in a research context also. We call on the partners to this initiative to **collaborate with appropriate national and international organizations** to advance an agenda for capacity building and skills development in (Big) Data Science. This involves prioritization of data science in educational regimes and developing the career paths of early career data scientists

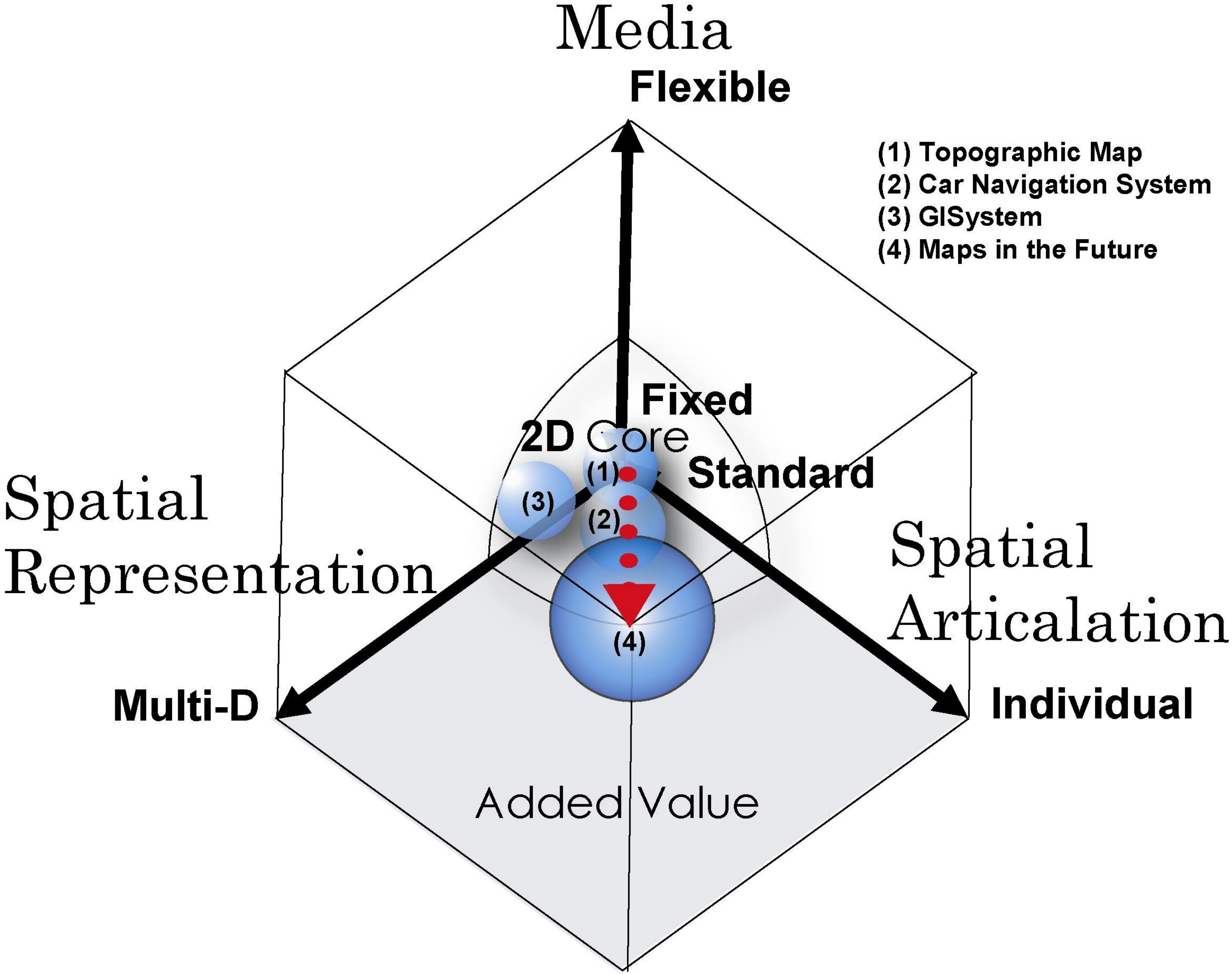
6. Foster development of policies to maximize exploitation of Big Data:
Big Data raise new and more complex access and use problems than previously encountered with scientific data activities.

Policies, guidelines and, where necessary, international agreements should be developed **to maximize the collection, sharing and potential exploitation of Big Data for scientific research.**

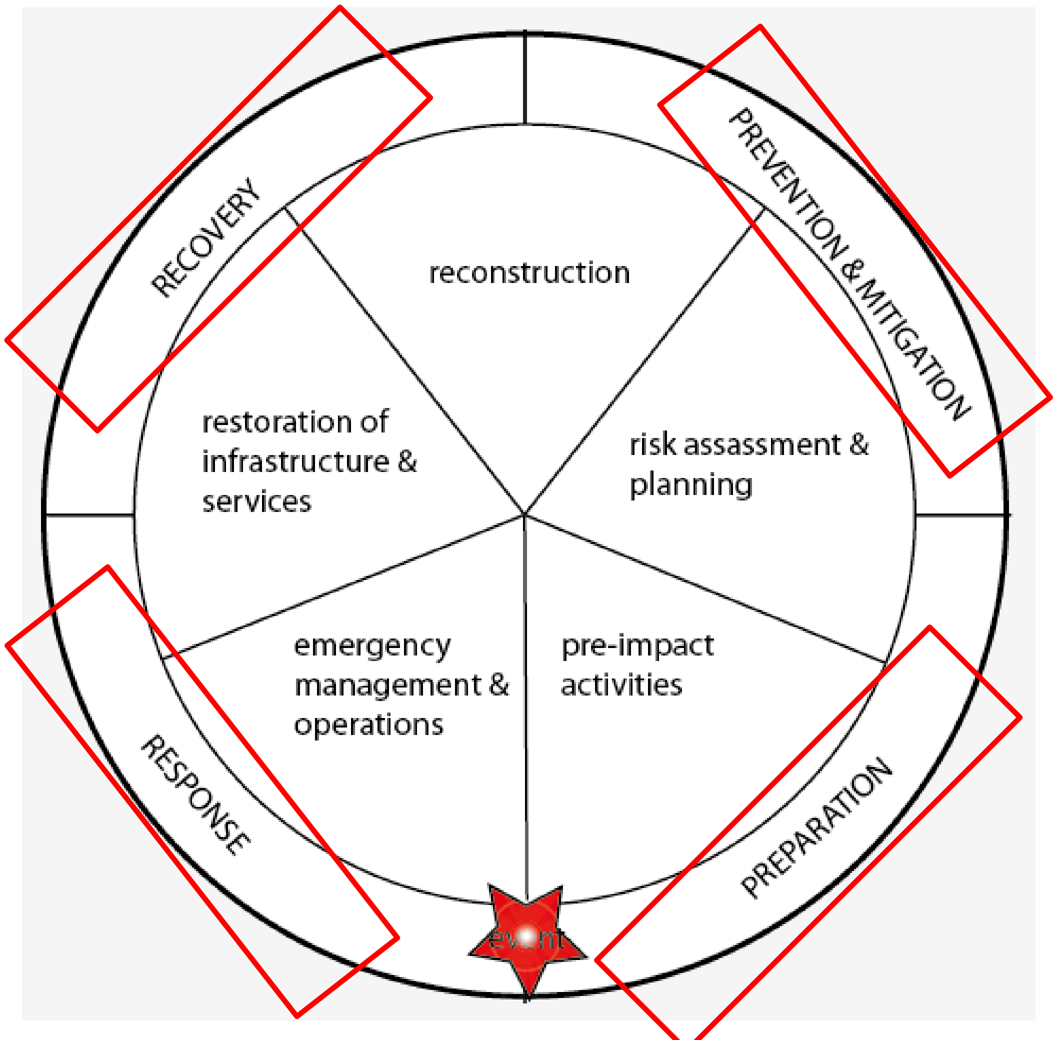
….. on an international and multi-disciplinary basis.

5. ADAPTIVE CARTOGRAPHY and CONTEXT-BASED CARTOGRAPHY

Cognitive Style


Media
Flexible
(1) Topographic Map
(2) Car Navigation System
(3) GISystem
(4) Maps in the Future
Fixed
2D
Core
Standard
(1)
(3)
(2)
(4)
Spatial
Representation
Spatial
Articalation
Multi-D
Individual
Added Value

Disaster management cycle



- User requirements and specifics differ within EM cycle
- Better cartographic support in all stages
- Consequences: minimizing of losses

Fig.1 Very Wide Area of Epicenter

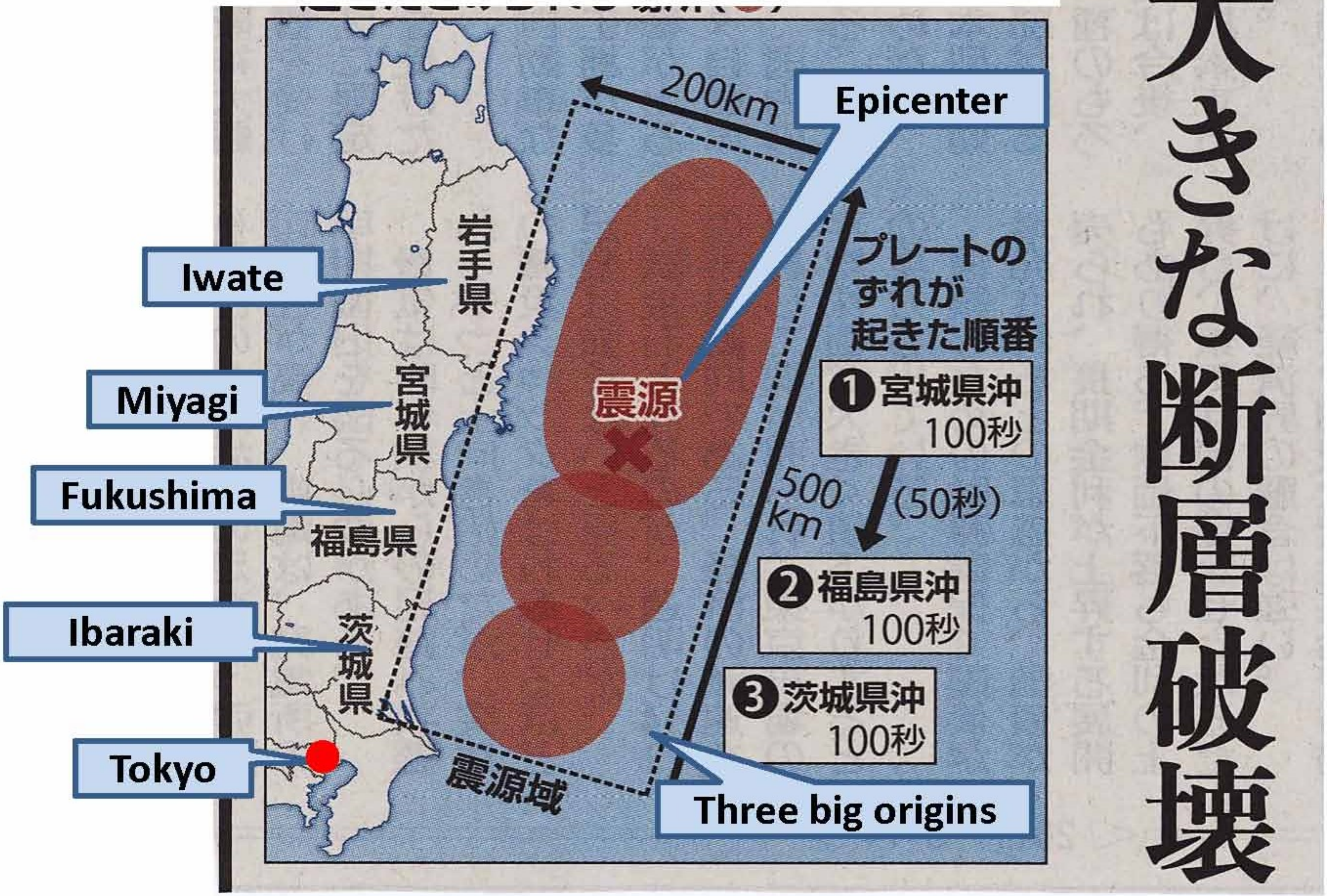


Fig.2b A big boat flown on the roof of a building in Otuchi Town, Iwate Prefecture

Sunji Murai, 2011

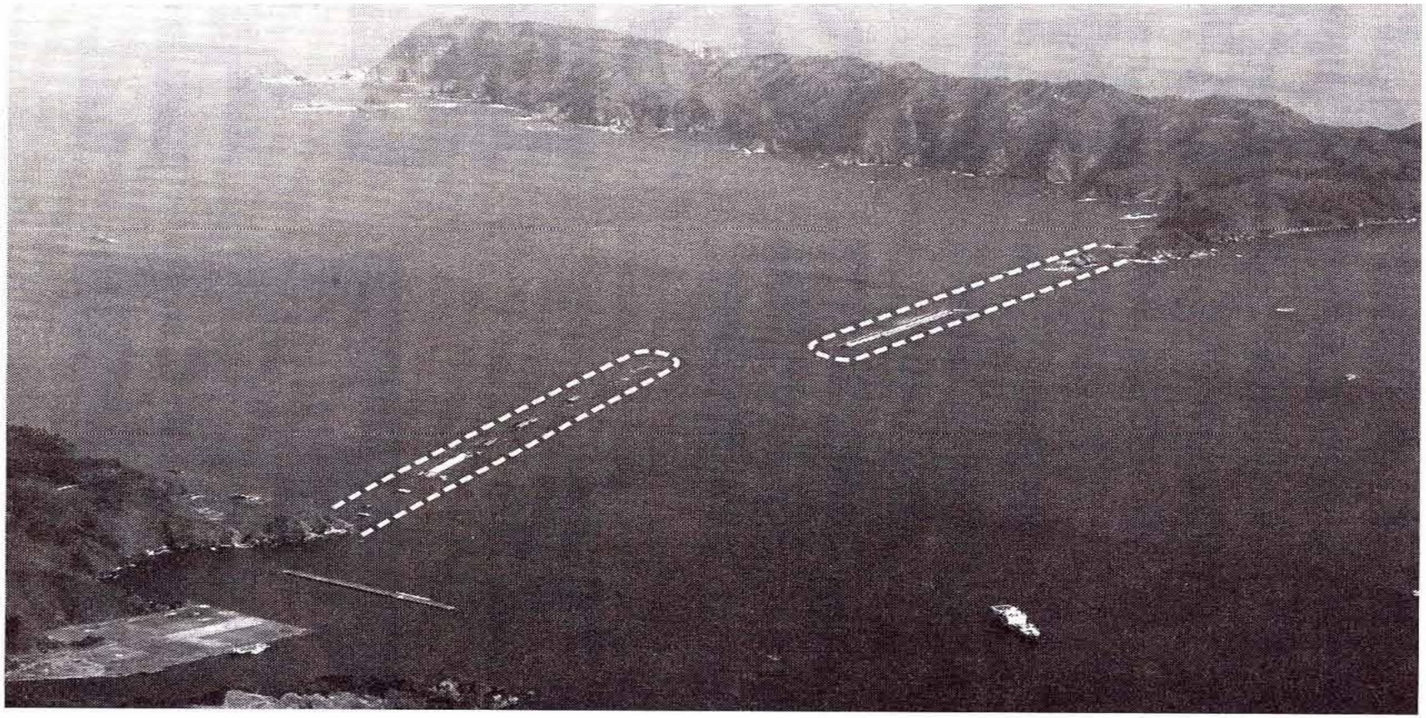
Kamaishi City, Iwate Prefecture constructed huge breakwaters 2km long, 20m thick, 8m above sea level and 65m deep, which have been registered as the deepest breakwaters in the Guinness World Records (see Fig.4a and 4b).

Fig.4a The Deepest Water Break against Tsunami in Kamaishi Bay. Iwate Prefecture

©Google

Sunji Murai, 2011

Fig.4b Destructed Water Break in Kamaishi Bay By Tsunami



世界最深の防波堤 無残

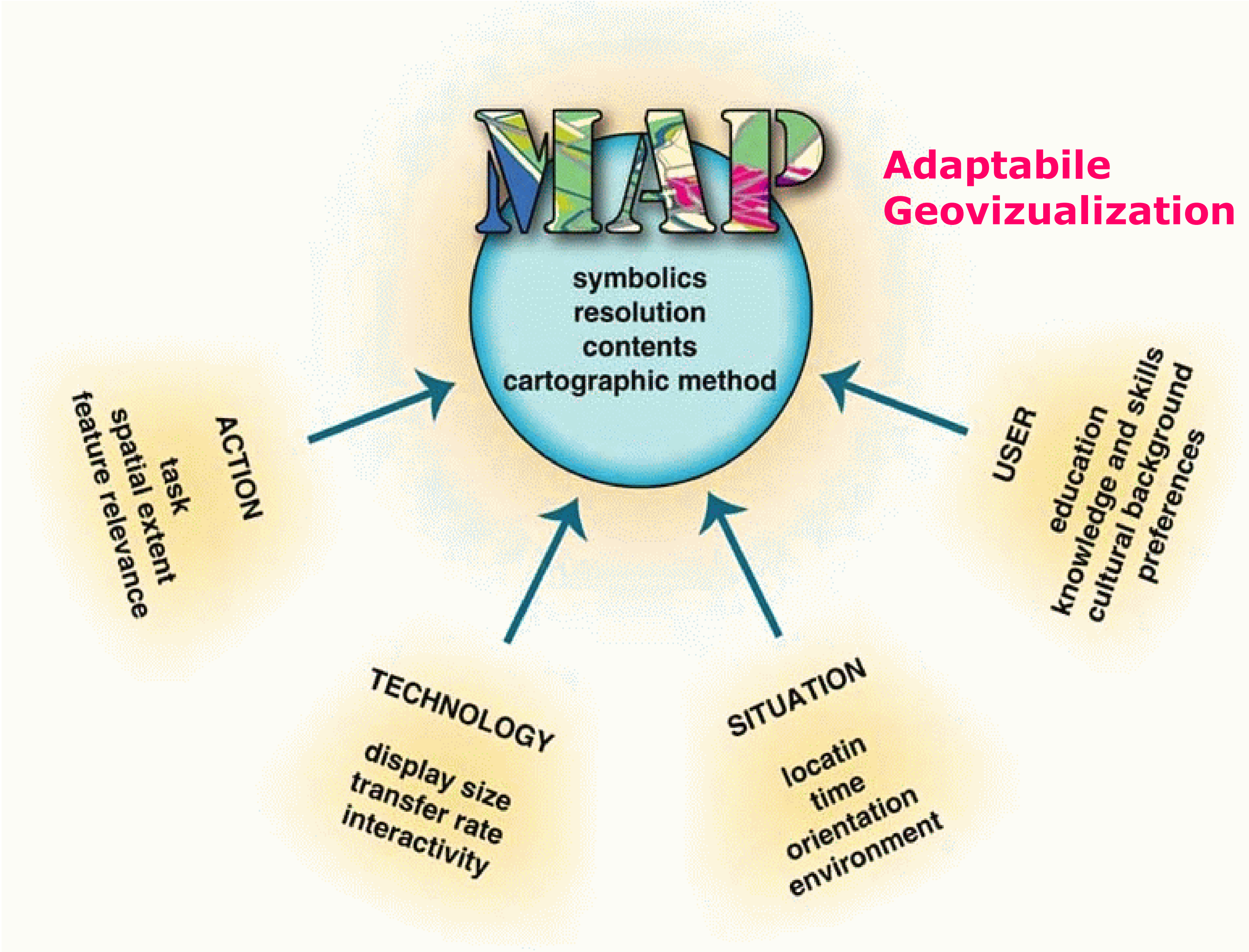
Sunji Murai, 2011

ADAPTIVE CARTOGRAPHY
Adaptability of Cartographic Representation

Context-Based Cartography

The subject-matter of adaptive cartography is **automatic creation of correct geodata visualization with regard to situation, purpose and the user.**

Adaptive maps are still maps in the conventional sense – they are correct and well-readable medium for transfer of spatial information. The user controls map modifications ***indirectly via modification of context***.



Adaptabile Geovizualization

Figure: Examples of changes in visualization according to change of context (Friedmanová, Konečný and Staněk 2006)

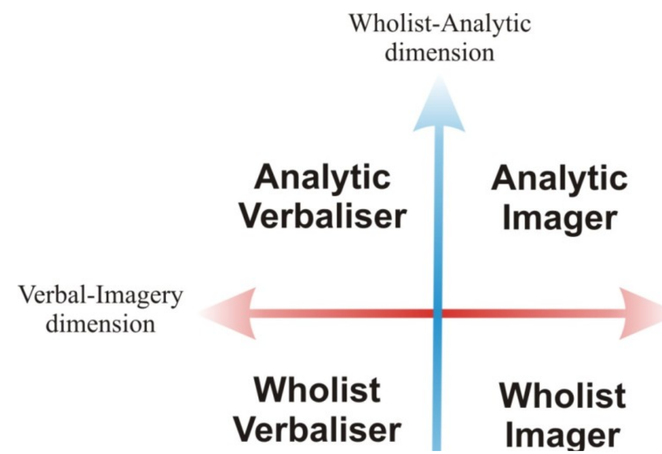
Personality of map users

Cognitive style

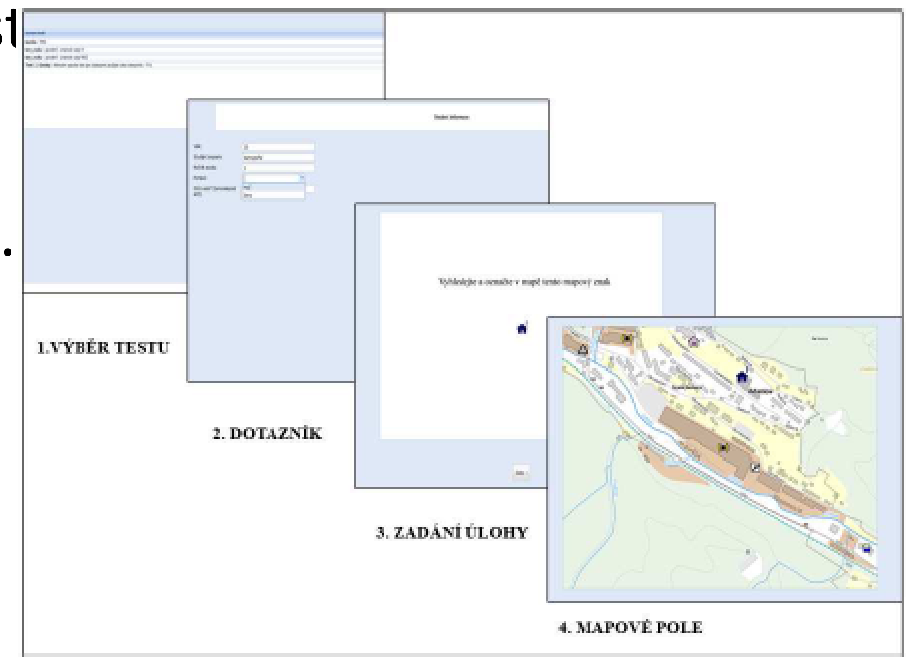
Cognitive style or "thinking style" is a term used in cognitive psychology to describe the way individuals think, perceive and remember information, or their preferred approach to using such information to solve problems. Cognitive style differs from cognitive ability....

(Konecny et al., 2011 Usability of selected base maps for crises management – users perspectives. Applied Geomatics, DOI 10.1007/s12518-011-0053-1. Springer JW. 2011, pp. 1-10. ISSN 1866-9298.)

Cognitive Aspects of Geovisualization



- Interdisciplinary research.
- Theory of cognitive styles.
- Concept and design of test environment (MuTeP).
- International cooperation.



Obr. 11.7: Posloupnost jednotlivých snímků testu v programu MUTEP – výbě testu, dotazník, zadání, úkol (upraveno podle ŠTĚRBA et al., 2011)

6. Neogeography, VGI and Social Media Geographic Information

VGI Volunteer Geographic Information

How to manage volunteer geographic information?
Chaos or help?

Volunteer geographic information **VGI**:

“The terms, *“crowdsourcing” and “collective intelligence”* draw attention to the notion that the collective contribution of a number of individuals may be more reliable than those of any one individual.

The term VGI refers specifically to geographic information and to the contrast between the actions of amateurs and those of authoritative agencies.” Goodchild (2009, p. 18)

7. Social Media Geographic Information (SMGI)

Michele Campagna, Cagliari, Italy:

Social Media Geographic Information (SMGI)

the opportunities offered by the ***analysis of social media data*** for ***knowledge building and decision-making*** support in Geodesign.

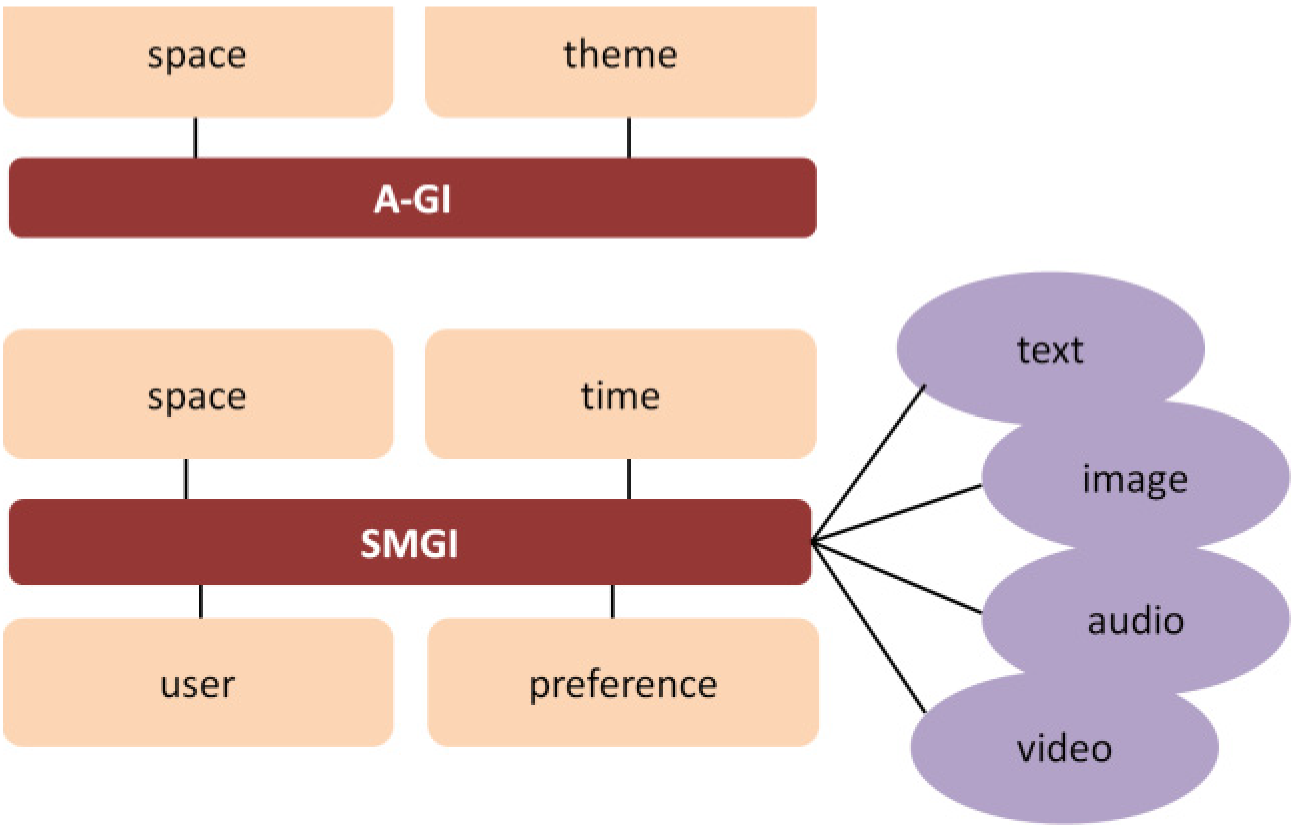
Geodesign: term identifying an approach to planning and design deeply rooted in geographic analysis and able to inform collaborative decision-making.

Currently, two major categories of spatial data resources may be considered suitable for Geodesign approaches, namely

Authoritative Geographic Information (A-GI) from Spatial Data Infrastructures (NEBERT 2004) and

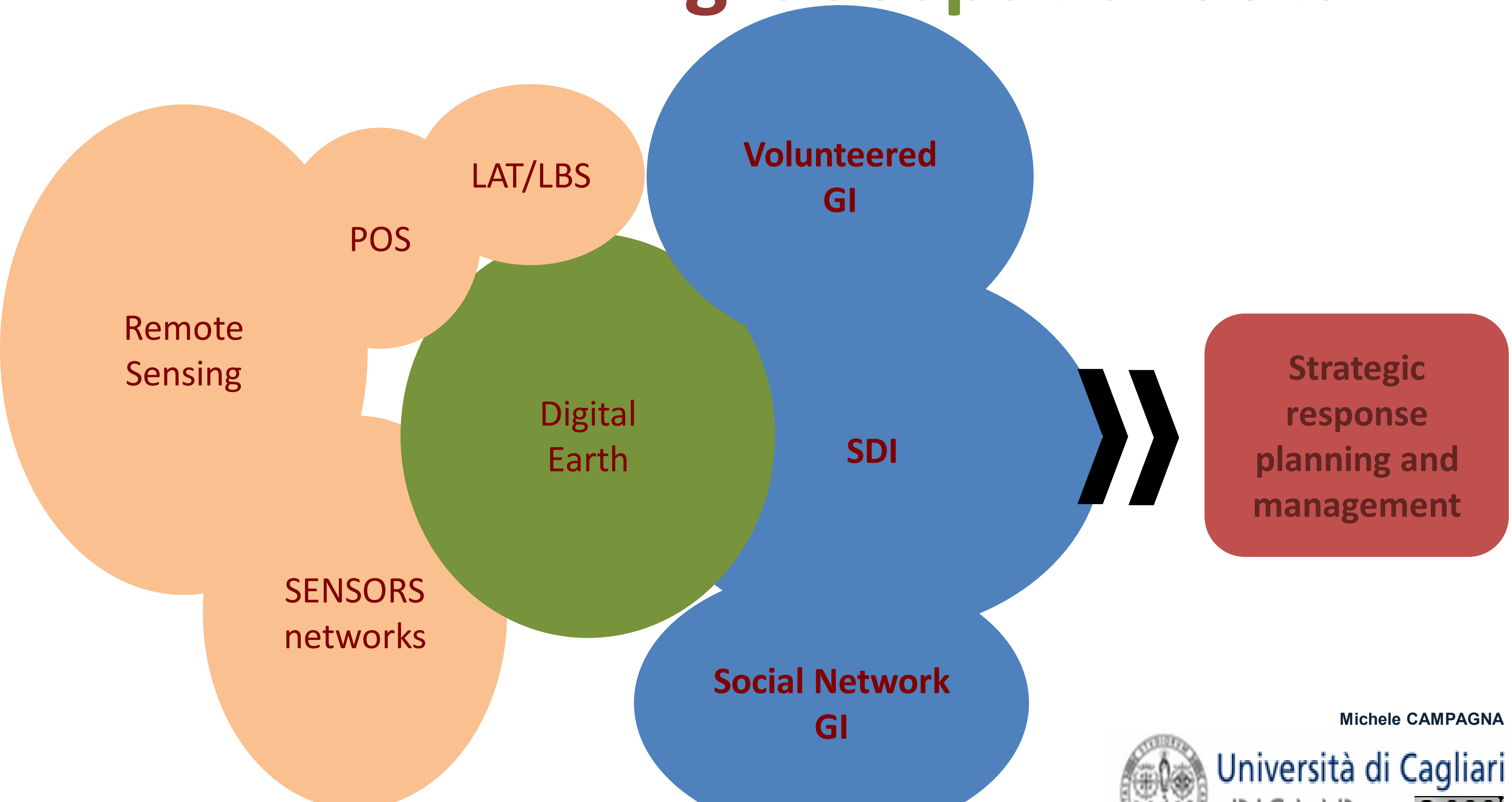
spatial **User Generated Contents (UGC),** commonly referred
to **as Volunteered Geographic Information (VGI)** (GOODCHILD 2007).

Fig. 1: Differences between A-GI (up) and SMGI (down) data models



Michele Campagna, Pierangelo Massa, Roberta Floris, The Role of Social Media Geographic Information (SMGI) in Geodesign.
p. 164, 2016

New info sources: Big Geospatial data



Michele CAMPAGNA
Università di Cagliari
DICAAR

Czech example of VGI

National volunteer activity

ZMAPUJ TO,

i.e.

Put it on the map

http://www.zmapujto.cz/

We have to clean it up

Hui Lin, Brno, 2011:

What are we looking for?

- **Feeling it in person**
- **Knowing it beyond reality**

A new framework for the communication of geographic Information and knowledge.

Hui Lin:

As the geographic language

Maps provides geographic environmental information with its graphic symbols. It is also the base for the development of GIS. Currently it is still with us everywhere with the digital networks.

GIS has led the development of geographic environmental analysis with its geo-database for over 40 years and it currently shows the bottleneck of geographic modeling.

VGE studies show a new platform for geographic knowledge sharing, with the integration of map symbols and image in its database and the model management as the “double core” system.

Let’ s go to cooperate

Milan Konecny

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BOLSHOJE SPASIBO !!!!!

O Brigado

Bardzo Dziekuje

Chvala

THANK YOU

Muchas Gracias

Terima KasimO Brigada

Kammsa Hamida

Aligator

SHUKRAN

BLAGODARJA

DĚKUJI (in Czech)

PRAGUE

BRNO